

Octave™ 100 Pump



User Manual

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Symbol	Description
	Caution, Risk of Danger
	Caution, Risk of Electric Shock
	Protective Conductor Terminal (Ground/Earth)

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1. INTRODUCTION

This operator's manual contains information needed to install, operate, perform user maintenance, and service the Octave 100 Pump.

1.1. Description

The Octave™ 100 Pump is a dual-piston high performance pump ideal for use with the Octave 100 Chromatography System. The pump has non-metallic PEEK heads and built-in pressure transducer. Flow rate can be set in 0.1-ml increments from 0.0 to 100.0 ml/min. The Octave 100 Pump is also useful as a metering pump for general laboratory or industrial use.

1.1.1 Pump Features

- Integrated prime/purge valve
- Dual inlet and outlet check valves assure reliability
- Self-flushing pump heads
- Front panel flow adjustment in 0.1 ml/min increments
- User-settable upper and lower pressure limits. The pump is automatically stopped if the pressure drops below the preset lower pressure limit (the lower pressure limit is enabled after 50 pump strokes) or if the pressure exceeds the upper pressure limit
- Microprocessor advanced control
- Tactile response, chemically resistant front panel keypad
- Chemically-resistant LED digital display
- Digital stepper motor design prevents flow rate drift over time and temperature
- Back panel RS232 serial communications port for complete control and status monitoring

1.1.2 Wetted Materials

PEEK™ (heads, tubing, check valves); synthetic ruby and sapphire (piston and check valves); stainless steel (high-pressure seal, pressure transducer); Ti-Nitride (self-flush ferrule); PTFE, ETFE, Kalrez®, and UHMWPE (o-rings and seals), Tygon® (flush tubing).

1.1.3 Self-flushing Pump Heads

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 secondary seal and 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.

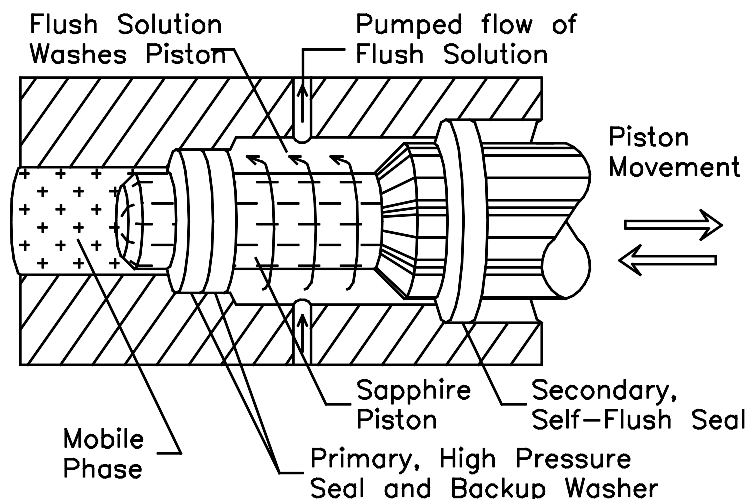


Figure 1-1. Self-flushing Pump Head

1.1.4 Self-flush and Seal Life

It is recommended that the Self-flush feature be used at all times to improve seal life. With every piston stroke, an extremely thin film of solvent 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. Volatile solvents will dry rapidly behind the seal (without the use of Self-flush), which will dry and degrade the seal.

Isopropanol, methanol, 20% isopropanol/water or 20% methanol/water mix are good choices for the flush solution.

1.2. Specifications

Flow Rates	0.0 to 100.0 ml/min
Pressure	0 to 1000 psi
Pressure Accuracy	± 1% of full-scale pressure
Pressure Zero Offset.....	-0, +2 psi
Pulsation.....	± 4.0% @ 50 ml/min and 250 psi
Flow Accuracy	± 2% for a flow rate of 0.20 ml/min and above, with 80:20 Water/IPA @ 500 psi*
Flow Precision	0.2% RSD
Dimensions	5.5" high x 10.375" wide x 17.5" deep
Weight	30 lb
Power	100-240 Vac, 50-60 Hz, 45W (The main voltage supply shall not exceed ±10%)
Environmental	Indoor use only
Altitude	2000 M
Temperature.....	10 to 30°C
Humidity	20 to 90% Relative humidity
Remote Inputs.....	RS-232

*Flow rate is dependent on solvent selection and operating pressure. See Section 3 to adjust flow rate for solvent and pressure.

2. INSTALLATION

2.1. Unpacking and Inspection

Prior to opening, inspect shipping container 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 Octave 100 Pump is normal laboratory conditions. The area should be clean and have a stable temperature and humidity. The instrument should be located on a stable flat surface with space for ventilation and the necessary electrical and fluid connections. (Reference IEC 1010 installation category II, and Pollution degree 2 environment).

2.3. Electrical Connections

Position the pump there so that is at least a four inch clearance on all sides to permit proper ventilation. Plug the the power cord supplied with the pump into a properly grounded electrical outlet.

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

2.4. 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 solvents is also required.

2.4.1 Solvent Out-gassing and Sparging

Solvent out-gassing occurs because the mobile phase contains dissolved atmospheric gases, primarily N₂ and O₂. 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 have atmospheric gases dissolved back into the mobile phase within four hours.

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

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

2.4.2 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.

2.4.3 Filtration

Solvent filtration is good practice for the reliability of the Octave 100 Pump and other components. Solvents should always be filtered with a 0.45-micron filter prior to use. This ensures that no particles will interfere with the operation of the piston seals and check valves. Solvents in which buffers or other salts readily precipitate will need to be filtered more often. After filtration, the solvents should be stored in a closed, particulate-free bottle.

2.4.4 Solvents with Harmful Effects

Materials in the Octave 100 Pump that contact mobile phase include: PEEK (heads, tubing, check valves); synthetic ruby and sapphire (piston and check valves); stainless steel (high-pressure seal, pressure transducer); Ti-Nitride (self-flush ferrule); PTFE, ETFE, Kalrez[®], and UHMWPE (o-rings and seals).

Some solvents to specifically avoid using with the pump are:

Aqua Regia	Hydrobromic Acid
Bromine	Hydrofluoric Acid
Chlorine Anhydrous	Hydrofluorsilicic Acid
Copper Chloride	Hydrogen Peroxide
Ferric Chloride	Iodine
Ferrous Chloride	Mercuric Chloride
Freon 12 (wet)	Tetrahydrofuran (THF)
Guanidine	

Also, do not leave strong acids such as concentrated hydrochloric, sulfuric or nitric acids in the pump for a prolonged period, as these can attack PEEK and other system components.

When used in conjunction with the Octave Chromatography Module, also do not use the following solvents:

Acetonitrile*
Aromatic hydrocarbons (> 2 h exposure; toluene, benzene, xylene)
Partially halogenated hydrocarbons (chloroform, methylene chloride, ethylene chloride, trichloroethane)
Strong bases (30% sodium hydroxide @ 90°C, 10% ammonium hydroxide @ 100-day exposure)
Ketones and aldehydes (methyl ethyl ketone, acetone*, acetaldehyde, formaldehyde)
* Up to 10% acetone or acetonitrile may be used with the system but should not be used in any storage solutions

2.5. Instrument Installation

2.5.1 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 (e.g. hexane). Mobile phases should be degassed, filtered and covered. (See Section 2.4.)

2.5.2 Self-flush Solution

Self-flush heads require 250-500 ml 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.

2.5.3 Self-flush System Set-up

1. Connect one length of 1/8" OD tubing to the bottom (inlet) self-flush port on the left pump head (see Figure 2-1 left panel). The fitting for the connection is a 1/4-28 nut and ferrule. Make sure the fitting is finger-tight so the connection does not leak.

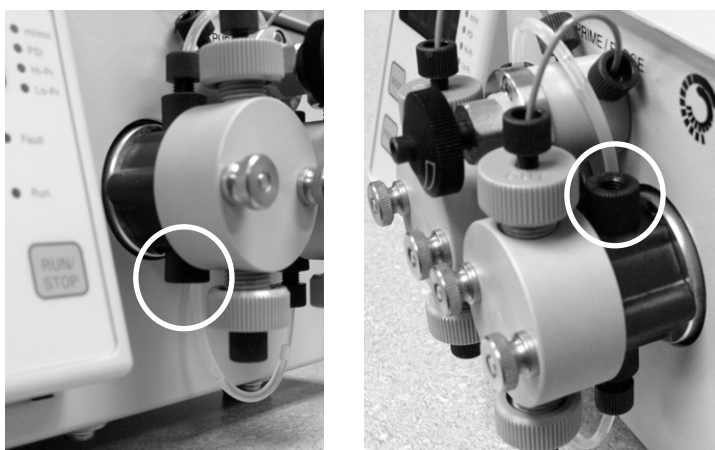


Figure 2-1. Self-flush inlet (left) and outlet (right) connections (circled)

2. In similar fashion, connect another length of 1/8" OD tubing to the top (outlet) self-flush port on the right pump head (see Figure 2.1 right panel). Note that the two pump heads are "daisy-chained" together with a pre-installed length of tubing that connects the top outlet flush port on the left head to the bottom inlet flush port on the right head.
3. Immerse the end of the tubing connected to the bottom flush port inlet on the left pump head in a reservoir containing 250 ml 20% methanol. Connect the end of the tubing connected to the top flush port outlet on the right pump head to a syringe and pull 10-20 ml of flush solution through the outlet line. Place the outlet line in the flush solution. Secure both lines in the flush solution so they remain immersed during pump operation.
4. Take care not to kink or overly stress the flush tubing. Check for leaks when the pump is in operation. The flush solution should flow smoothly.

2.5.4 Inlet Tubing and Filters

All inlet lines are supplied with a 1/8" OD and are made of a Teflon-based material. An inlet tee is provided, and provides a means of installing one inlet line to feed both pump heads. Connect the two ends of the tee to the bottom inlet ports on each pump head, and the inlet line to the central connection on the tee.

2.5.5 Outlet Tubing

Outlet tubing (not supplied with the pump) should have a 1/16" or 1/8" outer diameter. Tubing with a minimum 0.030" inner diameter is recommended to avoid contribution to back-pressure at high flow rates. The tubing must be cut squarely with no burrs. The tube itself should not be crimped and the center hole must be open. PEEK tubing may be cut with a plastic tubing cutter or razor knife.

2.5.6 Priming the Pump

(Also see Section 3.1.1). Be sure all of the connections downstream of the prime/purge valve are closed. Connect a syringe to the prime/purge valve. Open the prime/purge valve 1 to 2 turns (counter-clockwise). Run the pump at a flow rate 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). Close the prime/purge valve and stop the pump.

2.5.7 Long Term Pressure Calibration Accuracy

The pressure 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 psi. after about 1 year of operation (i.e., with no back pressure on the pump a reading of 1-9 psi. may be displayed).

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

2.6. Preparation for Storage or Shipping

After rinsing the pumps with deionized water, disconnect the outlet tubing from the pump heads. Insert the inlet tubing in 100% isopropanol. For each pump head open the prime/purge valve and use a syringe to draw a minimum of 50 ml. Close the prime/purge valve and pump a minimum of 5 ml of isopropanol to exit. Leave the inlet tubing connected to the pump. Place the inlet tubing in a small plastic bag and attach it to the tubing with a rubber band. Plug the outlet port with the shipping plug.

Rinse the self-flush system by inserting the inlet tubing connected to the flush housing in fresh 100% isopropanol. Connect a 30-ml syringe to the Luer fitting on the outlet tubing connected to the flush housing. Draw at least 50 ml isopropanol through the system with the syringe. Disconnect the inlet tubing, draw excess liquid through the system with the syringe, and then disconnect the outlet tubing.

CAUTION: If packaging the pump for shipping, re-package 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, the pump is a delicate instrument and must be carefully packaged to withstand the shocks and vibration of shipment.

3. OPERATION

3.1. Front Panel Controls and Indicators

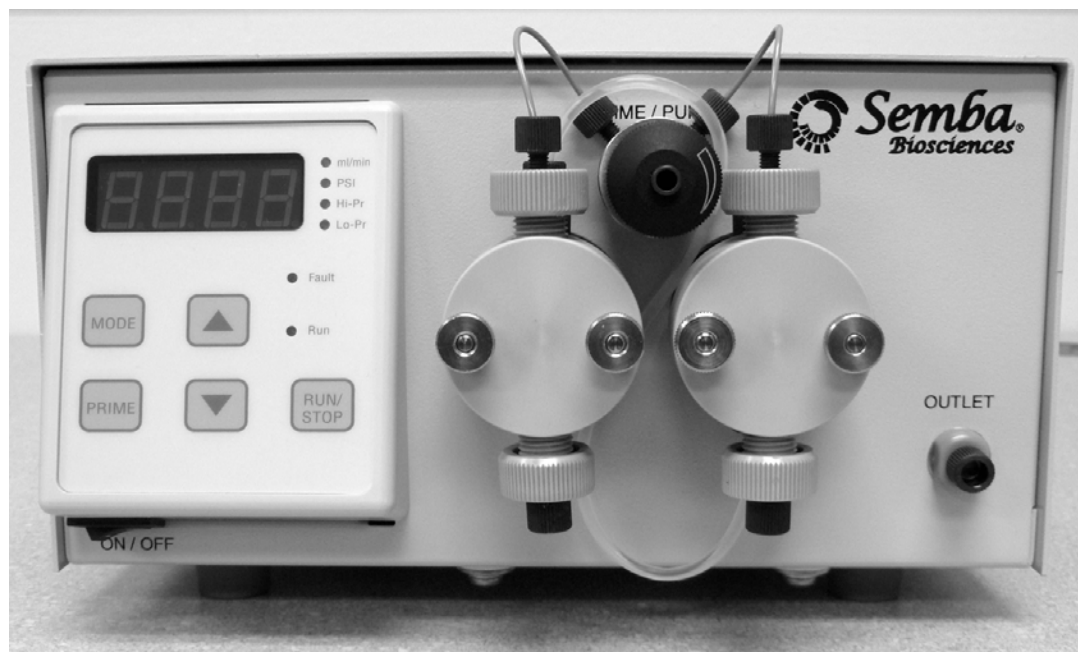


Figure 3-1. Octave 100 Pump Front Panel

3.1.1 Prime/Purge Valve

The prime/purge valve (seen as the round black knob between the pump heads in Fig 3-1) vents the flow to atmosphere and permits efficient priming of the Octave 100 pump. When the valve is closed (fully clockwise) firmly, high-pressure flow is directed to the outlet port. When the valve is opened (counter clock-wise) one-half to one full turn, pressure is vented and flow exits through the drain port in the prime/purge valve stem assembly. Suction with a Luer tip syringe at the drain port will purge air bubbles from the pump and reservoir lines (provided there are no open valves to lines downstream at the injector/column interface). To prime the pump, draw about 20 to 30 ml of mobile phase.

The pump may also be primed by pressing the PRIME key on the front panel. If this is done there is no need to use a syringe to draw solvent through the pump.



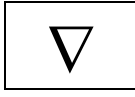

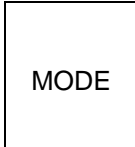
CAUTION: When you press the PRIME key, the pump will run at the maximum flow rate. Be sure the prime/purge valve is open!

3.1.2 Control Panel

3.1.2.1 Digital Display

The 4-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.

3.1.2.2 Keypad

	When pressed, this button alternately starts and stops the pump.
	When pressed, this button increases the flow rate.
	When pressed, this button decreases the flow rate.
	When the PRIME button is pressed, the pump runs at the maximum flow rate for the pump head. It will stop when any button is pressed.
	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.

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.

3.1.2.3 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 PRESS	When lit, the display shows the user-set upper pressure limit in psi.
LO PRESS	When lit, the display shows the user-set lower pressure limit in psi.
PUMP RUN	Lights to indicate that the pump is running.
FAULT	Lights when a fault occurs and stops the pump.

3.1.2.4 Power-up Configuration

Pressure Compensation: On power-up, press the PRIME button on the front panel while pressing the Power On switch on the rear of the pump. The pump will display a number from 0 to 5, this represents the running pressure of the pump from 0 psi to 500 psi. Each digit represents 100 psi. To change the pressure compensation number use the up arrow and down arrow buttons. When you have selected the correct pressure compensation press the RUN button to return to normal operation of the pump.

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 flow rate, 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.

3.1.2.5 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.

Display Software Checksum Mode: If the pump is operating erratically, there is the possibility that the firmware stored in the program memory integrated circuit (EPROM) has been corrupted. Each version of firmware has a checksum which is printed on the EPROM's label. The pump's cover must be removed to gain access to the EPROM which is located on the Pump Control Board; therefore, this should be only done by a qualified technician. To verify that the firmware has not been corrupted, do the following: The software checksum can be displayed during power-up by pressing and holding the RUN/STOP and the DOWN-ARROW buttons when the power is switched on. Release the buttons when the display reads "CHE". After approximately 25 seconds, the 4-digit hexadecimal checksum will be displayed. To exit this mode, press the RUN/STOP button. If the checksum displayed does not match the checksum printed on the EPROM's label, the EPROM must be replaced. Note: If the pump is operating correctly, the firmware version and checksum can be displayed then written in the manual for future comparison. This will save time during future troubleshooting since the pump's cover will not have to be removed to read the EPROM's label.

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 Loop back Test Mode: If an external device will not communicate to the pump via the serial port, the serial port loop back 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.

3.2. Rear Panel Remote Input

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

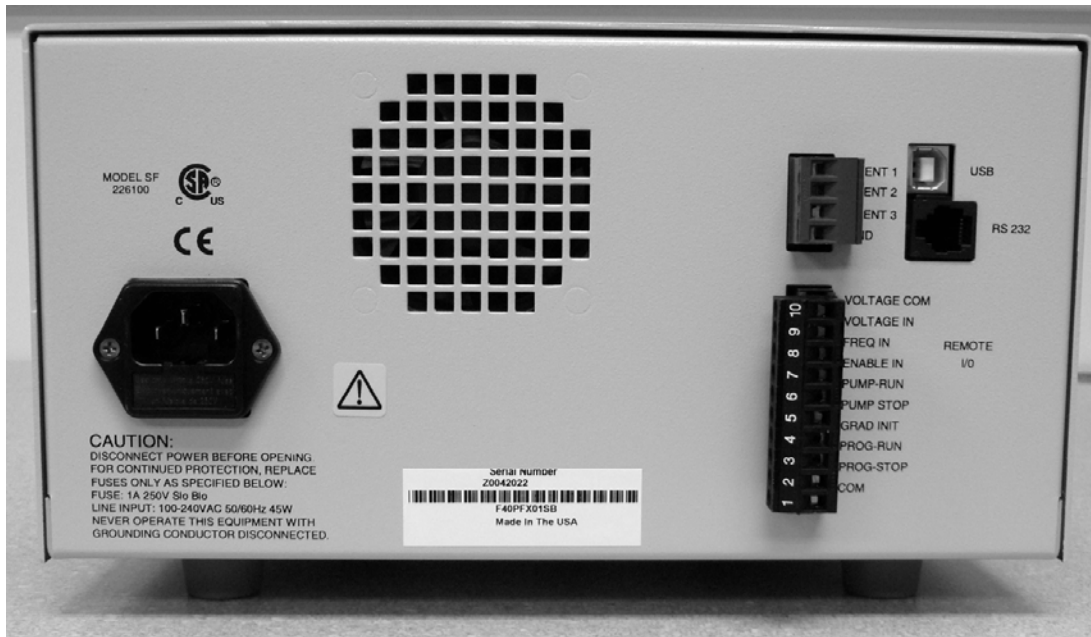


Figure 3-2. Octave 100 Pump Rear Panel

4. THEORY OF OPERATION

4.1. Mechanical Operation

4.1.1 Liquid System Flow Path

The flow path of the Octave 100 pump starts at the inlet of the pump head, passes through the pump head and through the prime/purge valve, into the transducer/tee then finally through the bulkhead coupling and out the front panel of the pump.

4.1.2 Pump Cycle

The pump cycle consists of two phases, the pumping phase and the refill phase.

During the operation of the pump, one pump piston displaces fluid at a constant rate from one head, while the other piston is refilling the other pump head with fluid. When that piston is finished displacing fluid, the other piston immediately starts. This results in a constant, stable flow from the pump at high pressure.

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 power board, (2) interfaces with the keyboard/display, (3) receives signals from the pressure transducer and refill flag, and (4) provides external input/output and remote control interfacing. Firmware programming is stored in an EPROM.

The motor power board contains programmed logic components which (1) provide suitable motor micro-stepping modes, (2) allow appropriate motor power adjustment, (3) maximize motor power output, (4) reduce motor resonance effects, and (5) customize motor stepping uniformity. MOSFET power transistors efficiently control the motor power provided by a 36 Vdc linear power supply. This board also provides the 12 VDC (linear power supply) and the 5 VDC (switching power supply) used by the pump circuits.

A specially shaped cam provides refill in a fraction of the full cam revolution. The remaining revolution of the cam provides a linear piston displacement for constant flow of the mobile phase. In addition to the rapid refill characteristics of the cam, 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. As a result, at 1 ml/min flow the refill rate is more than five times faster than if the motor operated at constant speed. The optimum refill minimizes the resulting pulsation while avoiding cavitation effects in the solvent entering 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 pump is calibrated at 1,000 psi using an 80:20 mixture of water and isopropanol.

The Octave 100 Pump is equipped with a built-in pressure transducer, which senses fluid pressure. The output is sent to the microprocessor circuit, which provides the information presented on the digital display. This pressure information is compared with the user-set upper and lower pressure limits to control pump shut-off if the limits are exceeded.

4.2.2 DC Power Supply

A switching regulator provides the DC voltage necessary to run the motor and electronics. AC input power for the pump must be between 85 and 265 VAC, and 47 to 63

Hz. The AC line is filtered and fused by the power entry module. Internally a fuse located on the Motor Drive PCB protects the motor supply voltage, and the low voltage conversions have thermal and short-circuit protection.

4.2.3 Remote Interfacing

An RS-232C modular jack is provided on the back panel. See Section 3.2 for information on pump 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 when 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 cam shaft 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. A pump cycle is defined as the time it takes for the camshaft to complete one complete revolution. One revolution of the camshaft produces a delivery phase and a refill phase. Each specific flow rate has a corresponding cycle time. For the Octave 100 Pump, the cycle time is approximately: 30 seconds at 0.4 ml/min, 3 seconds at 4.00 ml/min, and 0.3 seconds at 40.00 ml/min.

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.

5. MAINTENANCE

Each Octave 100 Pump is supplied ready for use with the Octave 100 Chromatography System. As with any precision pump, optimal performance requires the use of properly filtered solutions and solvents, thorough rinsing and proper storage after use, and replacement of the flush solution at regular intervals. Low flow rates, lower than normal pressure, or leaks in the pumping system can all indicate possible problems with the piston seal, piston, or check valves. Cleaning and replacement of these parts can be performed by the user as outlined below. Piston seal replacement could be necessary after 1,000 hours of running time (see Section 5.3.3). Please call Semba Biosciences for assistance on repairs or ordering information on parts.

5.1. Check Valve Cleaning

A common cause of pumping problems is stuck or fouled check valves. Many check valve problems are the result of small particles or sample/solvent residue interfering with their operation. To clean check valves without disassembly, pump a strong solution of liquid, laboratory grade detergent (e.g. Alconox) through the check valves at a rate of 3 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.

Alternatively, check valves can be removed and cleaned in a sonic bath or by using a wash bottle and directing a stream of water, isopropanol, or other solvent through the valve. Use caution with this method to avoid exposure of the solvent to skin – wear gloves and protective goggles. To remove the check valves, unscrew the top and bottom outlet and inlet check valve assemblies, respectively, from the pump head. Each of the assemblies contains two black PEEK check valves (see Figs. 5-1 and 5-2). Handle the check valves carefully to avoid scratches. Inside each check valve is a synthetic ruby ball, which should move freely. Flow through the check valve is directional, as indicated by the small arrow embossed in the housing.

After cleaning (i.e. washing until the ruby ball moves freely), reassemble the check valves inside the inlet and outlet housings, paying careful attention to the orientation of the check valves – for the inlet (bottom) housing the arrows on the housings should face away from the knurled end and toward the pump head, and for the outlet (top) housing the arrows should face toward the knurled end and away from the pump head.

Carefully tighten the check valve assemblies to the pump head and check for leaks.

If the check valves are not able to be cleaned, replace them with new parts.

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 self-flush housing also contains check valves that can be removed for cleaning as described above. See Fig. 5-2 for location.

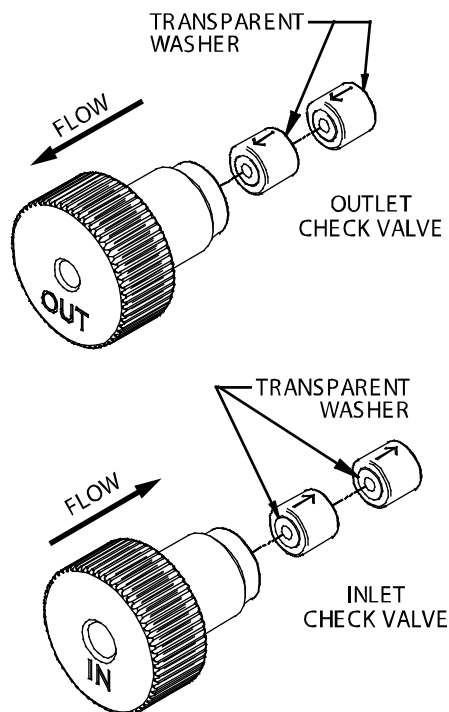


Figure 5-1. Pump Head Check Valves

5.2. Inlet Filter Replacement

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.

5.3. Changing Pump Heads

5.3.1 Removing the Pump Head

1. Turn OFF the power to the Octave 100 Pump.
2. Unplug the power cord.
3. Remove the inlet line and filter from the mobile phase reservoir. Be careful not to damage the inlet filter or crimp the Teflon tubing.
4. Remove the inlet line from the inlet check valve.
5. Remove the outlet line from the outlet check valve.
6. Remove inlet and outlet self-flush lines.
7. Carefully remove the two knurled nuts at the front of the pump head.

CAUTION: Be careful not to break the piston when removing the pump head. Twisting the pump head can cause the piston to break.

8. 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.
9. 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.

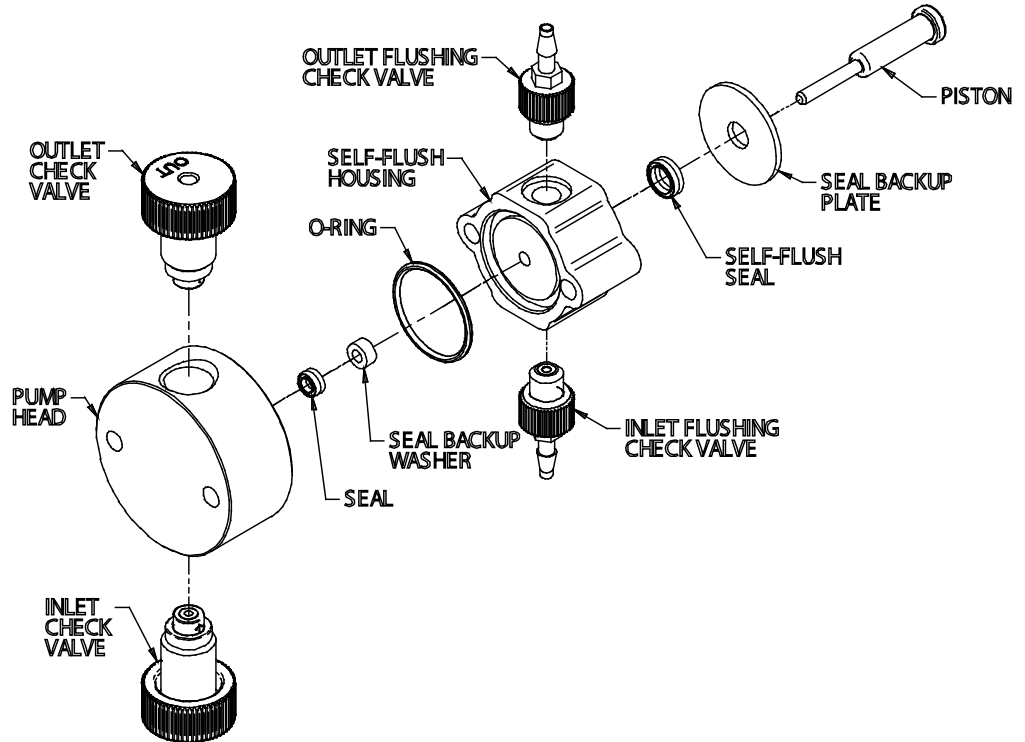


Figure 5-2. Pump Head Assembly

5.3.2 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.
3. If the check valves have been removed, tighten the check valves to 10-15 inch-pounds or enough to seal at maximum pressure.

If the piston and flushing seals have been removed, insert new seals as described in Section 5.3.3, then continue with Section 5.3.5 to replace the pump head.

5.3.3 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.

5.3.3.1 Removing the Seals

1. Remove the pump head as described in Section 5.3.1.
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 5.3.2.

5.3.3.2 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.

5.3.3.3 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 5.3.5.
5. Condition the new seal as described in Section 5.4.

5.3.4 Changing the Piston

1. Remove the pump head as described in Section 5.3.1.
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 5.3.5.

5.3.5 Replacing the Pump Head

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.
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.

5.4. 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. There is no need to condition the seals on new pumps (they are conditioned at the factory).

Using a backpressure regulator or a suitable column, run the pump with a 50:50 solution of isopropanol (or methanol) and water for 60 minutes at 2 ml/min with 500 psi backpressure.

5.5. Cleaning the Pump

1. Disconnect the components attached to the pump outlet.
2. Direct the pump outlet tubing to a waste beaker.
3. Set the flow rate to 10 ml/min.
4. Pump 100% isopropanol through the pump for 3 minutes.
5. Pump 100% filtered, distilled water through the pump for 3 minutes.

The pump is now prepared for any mobile phase or short- or long-term shutdown.

5.6. Cleaning the cabinet

Cabinet may be cleaned with tap water or mild soap solution.

5.7. Lubrication

The Octave 100 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 a 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. Fuse Replacement

Three fuses protect the Octave 100 Pump. 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 motor power circuit board and is in series with the 48 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 fan does not run, 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: 1 A slow-blo 250 VAC.

If the front panel appears to function normally but the pump motor does not run, check the fuse located on the motor power circuit board. Replace it with a 5 A slow-blo fuse.

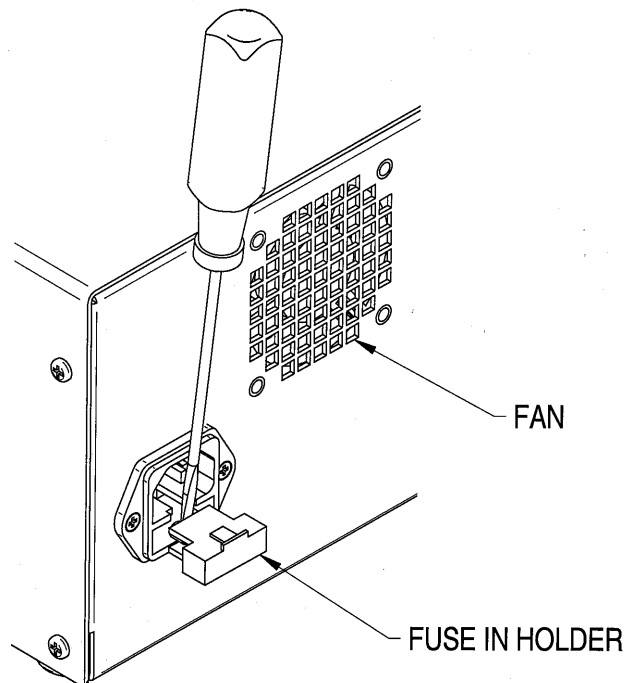


Figure 5-3. Main Fuse

6. QUICK GUIDE TO PROBLEM SOLVING

You Notice	This May Mean	Possible Cause	You Should
<ol style="list-style-type: none"> 1. Uneven pressure trace. 2. Pressure drops. 3. Pump shuts OFF. 4. No flow out the outlet check valve. 	<ol style="list-style-type: none"> 1. Bubble in check valve. 2. Leaks in system. 3. Dirty check valve. 4. Bad check valve. 	<ol style="list-style-type: none"> 1. Solvent not properly degassed. 2. Fittings are not tight. 3. Mobile phase not properly filtered. 4. Particles from worn piston seal caught in check valve. 5. Plugged inlet filter. 	<ol style="list-style-type: none"> 1. Check to be certain that mobile phase is properly degassed. 2. Check connections for leaks by tightening fittings. 3. Prime the system directly from the outlet check valve. 4. Clean or replace the check valves. See Section 5.1. 5. Replace inlet filter. See Section 5.2.
<ol style="list-style-type: none"> 1. Uneven pressure trace. 2. Pressure drops. 3. Fluid between the pump head and the chassis. 	<ol style="list-style-type: none"> 1. Leaks in system. 2. The piston seal(s) are worn. 	<ol style="list-style-type: none"> 1. Fittings not tight. 2. Long usage time since last seal change. 3. Salt deposits on seal (especially if buffered aqueous mobile phases are used without the self-flush head.) 	<ol style="list-style-type: none"> 1. Check all connections for leaks. 2. Replace piston seal. See Sections 5.3.3 and 5.4. 3. Check the piston for salt deposits. Clean as necessary. See Section 5.3.3.2
<p>Pump makes a loud clanging or slapping noise (intermittent contact with cam).</p>	<p>Piston carrier is catching in piston guide.</p>	<ol style="list-style-type: none"> 1. Cap nut screws on the pump head are loose. 2. Seal(s) are worn. 3. Piston guide is worn 4. Salt build-up on piston carrier from use of buffers. 5. Excess lubricant on piston carrier. 	<ol style="list-style-type: none"> 1. Check cap nut screws on pump head. Tighten if necessary. 2. Replace seals. 3. Replace seal backup washer and seal. See Sections 5.3 and 5.4. 4. Consider changing to a self-flushing pump head if using buffers. 5. Clean excess lubricant and dirt off piston carrier. See Section 5.3.
<p>Pump runs for 50 pump strokes, and then shuts down.</p>	<p>Lower pressure limit is activating.</p>	<ol style="list-style-type: none"> 1. Mobile phase is not properly filtered. 2. Particles from worn seal trapped in the system (e.g., tubing, filters, injection valve, column inlet). 	<ol style="list-style-type: none"> 1. Check to be certain the low-pressure limit is set to 0 psi. 2. Only increase the low-pressure limit after the pump attains operating pressure. 3. Contact service technician.
<ol style="list-style-type: none"> 1. Pump shuts down after run is called even with no column connected. 2. Pump runs to maximum pressure and shuts down. 	<p>Clog in fluid system.</p>		<ol style="list-style-type: none"> 1. Remove and clean or replace the inlet filter. See Sections 5.2. 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.
<p>No power when pump turned ON. Fan does not run.</p>	<p>Blown fuses in the power entry module.</p>	<ol style="list-style-type: none"> 1. Power surge. 2. Internal short. 	<ol style="list-style-type: none"> 1. Replace only with the appropriate fuses 1A 250 VAC. 2. Contact service technician if problem persists.
<p>Front panel appears OK but pump motor does not run.</p>	<p>Blown fuse on the motor power circuit board.</p>	<ol style="list-style-type: none"> 1. Power surge. 2. Internal short. 	<ol style="list-style-type: none"> 1. Replace only with the appropriate fuse. 2. Contact service technician if problem persists.
<p>PEEK fittings or components leak.</p>	<p>You cannot force PEEK parts with interference to seal by brute force tightening.</p>	<ol style="list-style-type: none"> 1. Film of fluid between surfaces. 2. Salt crystals between surfaces. 3. Scratches in mating surfaces. 	<ol style="list-style-type: none"> 1. Clean and dry mating surfaces. 2. If scratched, replace defective part.
<p>Self-flush heads leak flush solution.</p>	<p>Flush area not sealed.</p>	<ol style="list-style-type: none"> 1. Large (Size 016) O-ring is flattened and no longer seals. 2. Head not sufficiently tightened. 3. Scratches in mating surfaces. 4. Leaky self-flush seal. 	<ol style="list-style-type: none"> 1. Replace O-ring. 2. Tighten head. 3. Replace leaky parts.

7. WARRANTY STATEMENT

Semba Biosciences, Inc. (SEMBA) warrants instruments or equipment manufactured by it for a period twelve (12) months from date of shipment to customer against defects in materials and workmanship under normal conditions of 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 SEMBA's option, parts determined by SEMBA 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 SEMBA 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 SEMBA, and provides SEMBA with the serial number of each instrument to be returned. Freight costs for the return of defective Product is the responsibility of SEMBA. SEMBA shall specify the freight carrier for returns.

The warranty shall not apply to any Product that has been repaired or altered except by SEMBA or those specifically authorized by SEMBA, 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	Filter Elements
Inlet Lines	

The following is the exclusive procedure by which to make claims under this warranty. Customer shall obtain SEMBA'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 SEMBA. 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 SEMBA at customer's expense. SEMBA shall bear the expense of return shipment.

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