BLS-Class Pump

Binary High Pressure Piston Pump for HPLC and High Performance Metering

Operator Manual

903108 REV I

CHROM TECH®

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Warning Symbols and Task Specific Hazard Warnings:

The following warning symbols are present to alert you to risks that can arise when you install, operate or maintain the BLS-Class pump. Such risks include chemical exposure, electric shocks, and others.

When the following symbols appear in the manual, as well as words such as "**CAUTION, NOTE,** or **WARNING**," their accompanying text identifies the specific risks and explains how to avoid them. SSI assumes no liability for the misuse of the information described in this manual in regards to installation, repair, or operation of the BLS-Class pump and its components.

SAFETY SYMBOLS


CAUTION – HIGH VOLTAGE


CAUTION – REFER TO MANUAL


EARTH GROUND

SYMBOLES DE SÉCURITÉ


ATTENTION – HAUTE TENSION


ATTENTION – SE REPORTER AU MANUEL


TERRE

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1. INTRODUCTION

This operator's manual contains information needed to install, operate, and perform minor maintenance on the BLS-Class Pump.

Description of the BLS-Class Pump

The BLS-Class pump is designed to be a reliable component within basic analytical or sophisticated research instruments, in routine HPLC analyses or as a dependable metering pump for general laboratory or industrial use.

For pump specific information and specifications, please refer to Appendix B.

Pump Features

The BLS-Class Pump includes:

- Rapid refill mechanism to reduce pulsation
- Automatic pump shut-off if the pressure exceeds the maximum pressure limit
- User settable upper and lower pressure limits
- Integrated prime/purge valves
- 5-digit LED front panel user keypads
- PRIME mode to flush out entrapped air bubbles upon start-up
- Back panel USB, micro-USB, and RS-232 serial communication ports for complete control and status
- Remote digital inputs for gradient control
- Digital stepper motor design that prevents flow rate drift over time and temperature, which is a common problem found in analog design
- Drip tray with optional leak sensor
- Optional pressure monitoring with transducer
- Self-flushing pump head
- A diaphragm-type pulse damper, which reduces pulsation in the system by as much as 90% and may include an isolated pressure transducer (i.e., the transducer adds no dead volume).
- Outlet Filters
- External static mixer with 60 µL mixing volume
- Optional integrated two-channel vacuum degassing system

Wetted Materials

Pump heads, check valve bodies, and tubing are made out of type 316 stainless steel or PEEK, depending on version ordered. Other common materials are synthetic ruby and sapphire (check valve internals and piston), UHMWPE (seals), PTFE (check valves).

Long Term Pressure Calibration Accuracy

This note applies if the 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.

If pressure calibration and/or drift is a concern, consult the factory.

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 self-flush seal 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.

Recommended Use of Self-Flush Feature

It is **strongly** 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 must 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 during 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.

Solutions of either 100% IPA, 100% Methanol, 20% IPA/water mix, or 20% Methanol/water mix are the required choices for the flush solution. Do not use only water for the self-flush solution (e.g. DI water, tap water, filtered water), as water alone can cause abrasion of the high-pressure piston seal, as well as the self-flush seal. If there is any doubt about which self-flush solution to use, please consult the factory.

Refer to Figure 1, on the next page, for detailed drawing of a self-flushing pump head.

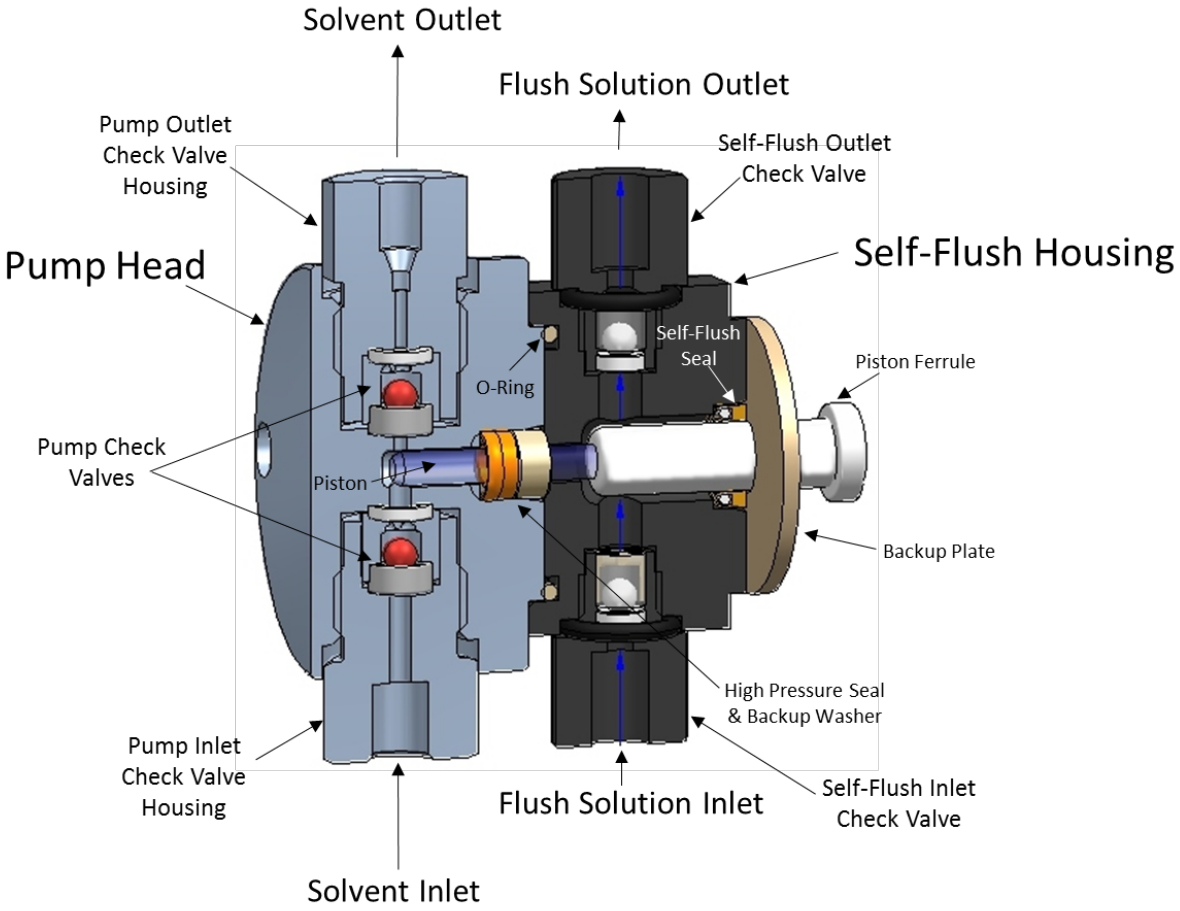


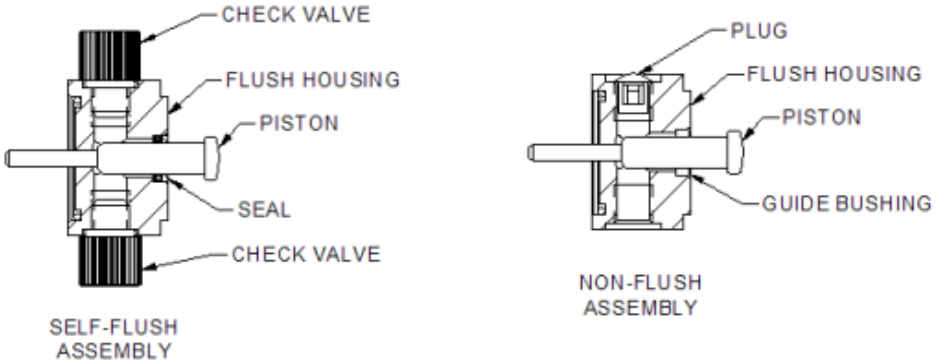
Figure 1, BLS-Class Self-Flushing Pump Head

(May not represent exactly what is installed in the purchased pump.)

PUMP MODIFICATION WHEN SELF-FLUSH IS NOT USED

If the self-flush feature is not used, it is strongly recommended to carefully remove the self-flush seal with the seal tool provided, and replace with the provided guide bushing *(see illustration below).* If this is not done; low flow rates, excessive noise and shortened pump life will result.

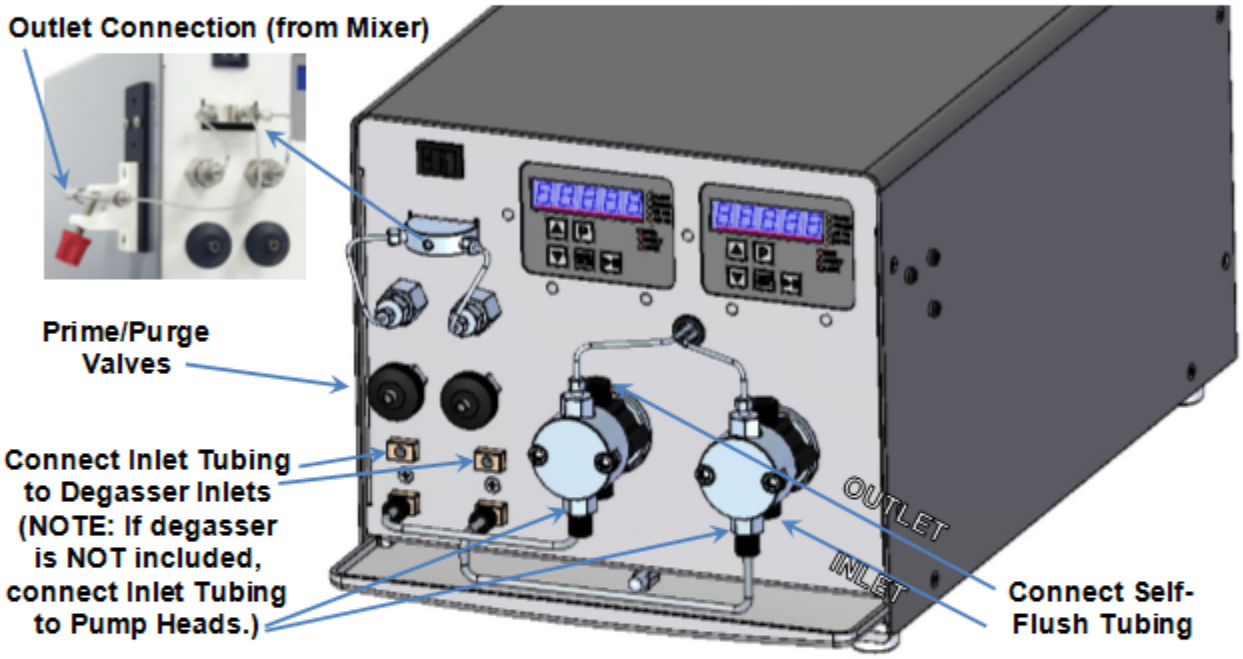
Also, it is good practice to remove the inlet and outlet self-flush check valves and install a plug at the top of the self-flush housing, leaving the bottom of the self-flush housing open. Doing this allows for easy visual notification if there is a leak in the high pressure pump seal.



2. QUICK STARTUP GUIDE

CAUTION: Always release pressure from the pump slowly. A rapid pressure release could cause the pulse dampener diaphragm to rupture, if present. Please refer to "Priming the Pump and Flush Line" in the manual for more information.

Prepare a self-flush solution of 250-500mL of either 100% IPA, 100% Methanol, 20% IPA/water mix, or 20% Methanol/water mix; these are the required choices for the flush solution. Do not use only water for the self-flush solution (e.g. DI water, tap water, filtered water), as water alone can cause abrasion of the high-pressure piston seal, as well as the self-flush seal. If there is any doubt about which self-flush solution to use, please consult the factory.



Self-Flush

- Connect self-flush solution **inlet** tubing to the **bottom-right** self-flush check valve, and the **outlet** tubing to the **top-left** self-flush check valve as shown.

Note: The self-flush housings are interconnected at the factory for flow-through with a single inlet/outlet.

- Attach syringe to **outlet** self-flush tubing using the supplied piece of short tubing.
- Draw syringe back to prime.
- After liquid has been pulled through the tubing into the syringe, remove syringe and place tubing in self-flush solution.

**Replace self-flush solution weekly.*

Pump

- Connect pump inlet tubing as shown. *Make sure ferrule is in the correct position.*
- Attach syringe to Prime/Purge valve.
- Open Prime/Purge valve by turning knob counterclockwise one to two turns.
- Draw syringe back to prime. *Draw approximately 20 mL of fluid.*
- Press PRIME button (P), continue to draw on syringe until no bubbles are seen.
- Close Prime / Purge valve.
- Press PRIME button (P).
- Remove syringe. **Repeat procedure for second pump.**

**Replace solvent weekly.*

3. INSTALLATION

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.

Location/Environment

The instrument must be located on a stable flat surface with at least a four inch clearance on all sides for proper ventilation and the necessary electrical and fluid connections. The acceptable environment for the BLS-Class pump is normal indoor laboratory conditions and must adhere to pollution degree 2. The installation altitude shall not exceed 2,000 meters. The area must 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.

Electrical Connections

Using the power cord supplied with the pump, or equivalent, plug the pump into a properly grounded electrical outlet. Acceptable input power is 100 – 240 VAC, 50/60 Hz. Voltage fluctuations must not exceed ±10% of the nominal supply voltage.

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

Drip Tray

The drip tray is included in the box, shipped loose. Slide it into its slot towards the bottom of the pump until it is fully installed. If the pump is supplied with a leak sensor, install this into the slot provided. Please note that the leak sensor is connected to the control board within the pump, so do not attempt to completely remove this from the pump unless it is first disconnected from the board.

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.

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 to 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.

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.

Filtration

Solvent filtration is good practice for the reliability of the BLS-Class pump and other components in the 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.

Solvents with Harmful Effects

Except for PEEK pump heads, all portions of the BLS-Class pump that contact mobile phase are manufactured of type 316 stainless steel, ceramic, sapphire, ruby, or fluoropolymers. Some of these materials are extremely sensitive to acids (including some Lewis acids) and acid halides. Avoid using solvents that contain any amount of hydrochloric acid.

Some solvents to specifically avoid are:

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

In addition, some users of HPLC systems have observed that chloroform and carbon tetrachloride slowly decompose to liberate hydrochloric acid, which, as noted above, attacks stainless steel. Do not leave these solvents in the systems for a prolonged period.

It is also recommended to avoid ammonium hydroxide. Although ammonium hydroxide will not harm the pump itself, it is likely to damage the stator and rotor in injection valves.

Instrument Installation

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.

Self-Flush Solution

If the Self-Flush feature is being used, prepare a 250-500 mL self-flush solution of either 100% IPA, 100% Methanol, 20% IPA/water mix, or 20% Methanol/water mix. This solution should be replaced with a fresh solution weekly to avoid frequent pump maintenance. If there is any doubt about which self-flush solution to use, please consult the factory.

Inlet Tubing and Filters

Inlet tubing is supplied with the pump startup kit, has a 0.085” ID, a 1/8” OD, and is made of a Teflon-based material. Use a 20 micron slip-on inlet filter.

Outlet Tubing

Outlet tubing (not supplied with the pump) should be compatible with the supplied outlet fittings. The tubing must be cut squarely and with no burrs. The tube itself should not be crimped and the center hole must be open. A tubing cutter is recommended for cutting stainless steel tubing. PEEK tubing may be cut with a plastic tubing cutter or razor knife.

Priming the Pump and the Flushing Lines

Be sure all of the connections downstream of the prime/purge valve are closed. Connect a syringe to the priming valve. Open the prime/purge valve 1 to 2 turns (counter-clockwise). Prime the pump by pulling mobile phase and any air bubbles through the system and into the syringe (a minimum of 20 mL). Press the Prime button and continue to draw on the syringe until no bubbles are seen. Close the prime/purge valve. Press the Prime button and remove the syringe. Be sure to replace solvent weekly.

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

The pulse damper diaphragm can be damaged by over-pressurization (above 6,000 psi), or due to rapid decompression of the damper from high pressure to

atmospheric pressure. The system pressure must be allowed to bleed down slowly to <500 psi before opening the fluid path to atmosphere. Typical bleed down parameters are ~3 seconds from 6,000 psi, or ~2 seconds from 4,000 psi.

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. Be sure to replace the self-flush solution weekly.

Please refer to the Quick Startup Guide (section 2) for more information.

Preparation for Storage or Shipping

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.

Packaging for Shipping

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.

CAUTION: Although heavy, this pump is a delicate instrument and must be carefully packaged to withstand the shocks and vibration of shipment.

4. OPERATION

Front Panel Controls and Indicators

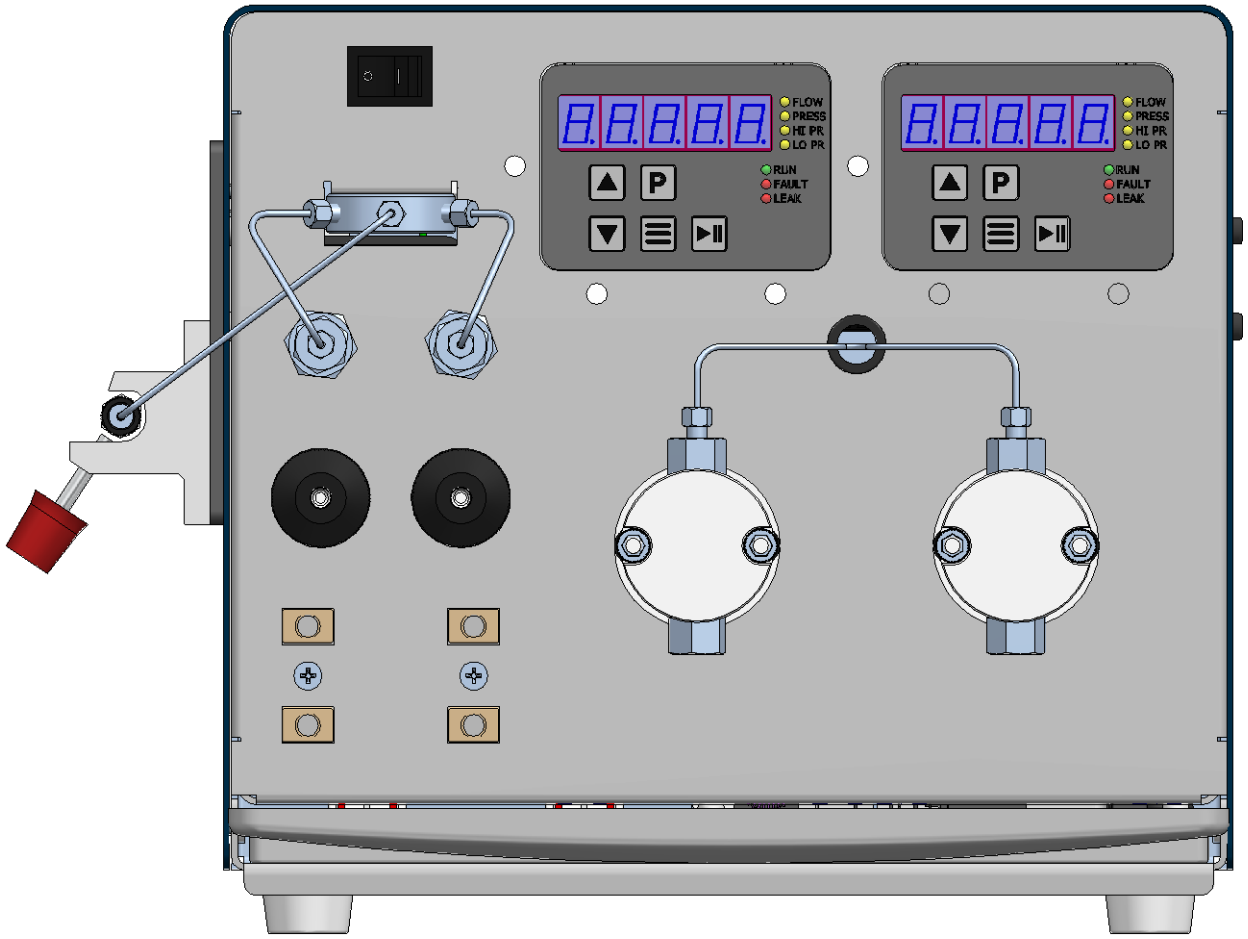


Figure 2, BLS-Class Pump Front Panel Components

Prime/Purge Valve

CAUTION: When the PRIME button (P) is pressed, the pump will run at the maximum flow rate. Be sure the prime/purge valve is open.

The prime/purge valve vents the flow to atmosphere and permits efficient priming of the BLS-Class pump. When the valve is closed (fully clock-wise), high-pressure flow is directed to the Filter/Outlet port. When the valve is opened (counter clock-wise), 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 down-stream at the injector/column interface). To prime the pump, draw about 20 to 30 mL of mobile phase.

Filter/Outlet

A high-pressure in-line filter (0.5 micron rating) is included at the output of each pump channel. The Filter's outlet port is the high pressure filter closure and is designed for a 1/16" OD tubing connection.

Digital Display

The 5-digit display shows the pump flow rate (mL/min), system pressure (psi, bar, or MPa), or the set upper or lower pressure limit (psi, bar, or MPa) when operating. Choice of display is selected with the MODE key.

Keypad

RUN/STOP button - alternately starts and stops the pump.

UP-ARROW button - increases the displayed parameter.

DOWN-ARROW button - decreases the displayed parameter.

PRIME button – the pump will run at its maximum flow rate. To exit prime mode, either press the PRIME button again, or press the RUN/STOP button.

MODE button - cycles 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. NOTE: If the pump does not have pressure monitoring, this button will be disabled.

Fast and Slow Button Repeat:
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. Once slow button repeat has begun, fast button repeat can be initiated by using a second finger to press down the second arrow button. 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.

Status LEDs

FLOW.....When lit, the display shows flow rate in mL/min.

PRESS.....When lit, the display shows system pressure in psi, bar, or MPa.

HI PR .....When lit, the display shows the user-set upper pressure limit in psi, bar, or MPa.

LO PR .....When lit, the display shows the user-set lower pressure limit in psi, bar, or MPa.

RUN .....When lit, this indicates that the pump is running.

FAULT.....When lit, a pressure or leak fault has occurred.

LEAK.....When lit, a leak has been detected.

Menu Screens

Pressure Readout:
Displays the current system pressure in psi, as read by a pressure sensor within the pump cabinet.

Upper Pressure Limit:
Displays the upper pressure limit for the pump. This value may be adjusted by using the up and down arrow keys, or the appropriate serial commands. When the system pressure exceeds the upper pressure limit, an upper pressure fault will be triggered, and the pump will stop. In some cases, there may be a small amount of headroom between the upper pressure limit and the system pressure which actually triggers the fault, which may cause the fault to appear to be delayed. In these cases, it may be advantageous to set the limit to a slightly lower value.

Lower Pressure Limit:
Displays the lower pressure limit for the pump. This value may be adjusted by using the up and down arrow keys, or the appropriate serial commands. When the system pressure is below the lower pressure limit, a lower pressure fault will be triggered, and the pump will stop. There is a delay between the start of the pump and the monitoring of the pressure for the low pressure fault. This delay is typically 20 pump strokes.

Leak Sensor

If present, the leak sensor will monitor the drip tray for the presence of leaking solvent. If a leak is detected, the **LEAK** LED will illuminate. As default mode, the presence of a leak will not trigger a pump fault or cause the pump to stop.

The Leak Mode can be altered with the **LMx** serial command (Appendix A) so that the presence of a leak will trigger a pump fault and cause the pump to stop and display "**driP**." This condition will persist until the drip tray is free of solvent and the leak sensor has been dried. Once cleaned, pressing the **RUN/STOP** button or issuing the appropriate serial command will restore normal pump operation.

NOTE: The leak sensor technology is temperature dependent and may cease to function properly outside normal operating temperatures. With each power-up of the pump, the leak sensor is inactive for a period of 5 minutes to allow for circuit equilibration. Normal operation will begin following equilibration.

Power-Up Configuration

Flow Compensation:
On power-up, press and hold the PRIME button on the front panel while pressing the Power On switch under the front display panel. Release the PRIME button when the pump displays "CAL". The pump will then display a number between 85.0 and 115.0. This value represents the amount of compensation affecting the running speed of the pump, in percentage. The nominal value is 100.0, and indicates that the pump is running at 100.0% of the intended speed, meaning there is no secondary adjustment. A value of 98.7 means the pump is running 1.3% slower than nominal; a value of 106.4 means the pumps is running 6.4% faster than nominal. To change the flow compensation number use the up arrow

and down arrow buttons. When the correct value has been selected, press the RUN button to store the value and 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 "rESEt". The parameters stored in non-volatile memory, i.e., the flowrate, the flow compensation, the lower pressure limit, the upper pressure limit, and the selected solvent will be reset to the factory default values. If the firmware is upgraded to a newer version, a non-volatile memory reset will automatically occur.

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

Rear Panel Remote Input

A female USB-A2.0, female USB Micro-B, and a male DE9 RS-232C port are provided on the back panel (Figure 3). A computer with appropriate software can be used to control the pump operation remotely via these connections.

See Appendix A for details on connection and operation.

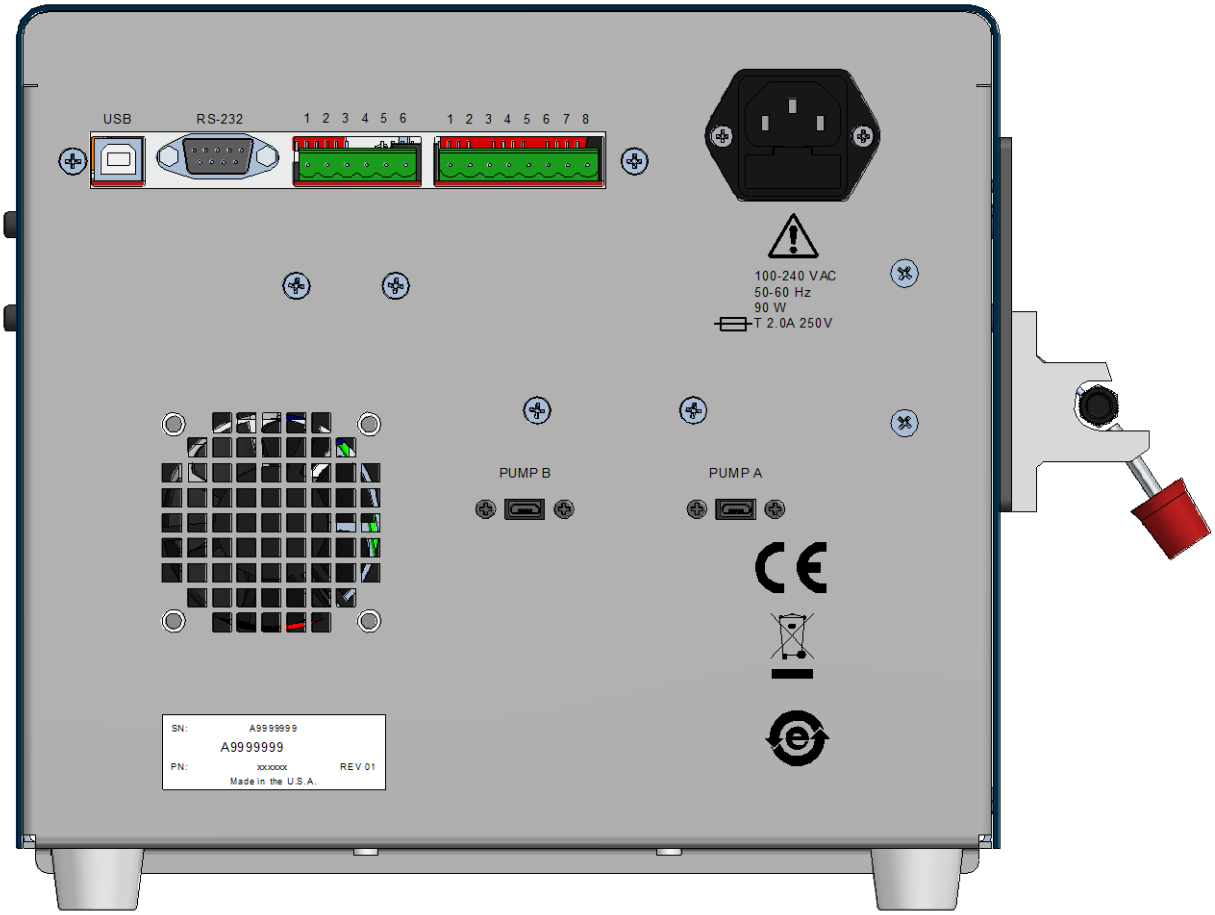


Figure 3. BLS-Class Pump Rear Panel

WARNING: To avoid electric shock, do not remove the pump's protective cover. To avoid nonlethal electric shock when the pump is in operation, avoid touching the areas marked with the high voltage warning symbol. Remove the power cord and turn the pump off before touching these areas.

5. MAINTENANCE

Cleaning and minor repairs of the BLS-Class Pump can be performed as outlined below.

Recommended Spare Parts Lists

Pump specific Recommended Spare Parts Lists are included with this pump in the box. The spare parts list can also be accessed through our website, by entering the pump's serial number at the following address:

http://www.ssihplc.info:8081/spareparts/

The pump serial number is included on the front cover of the manual, and on the back of the pump.

Filter Replacement

Inlet Filters

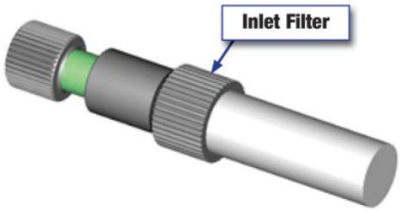


Figure 4, Inlet Filter

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 100% water or an aqueous solution is pumped without any inhibitors, microbes will grow in the inlet filter over time, even if fresh solution is made every day. Always use well filtered, HPLC grade solvents for the mobile phase.

Outlet Filter

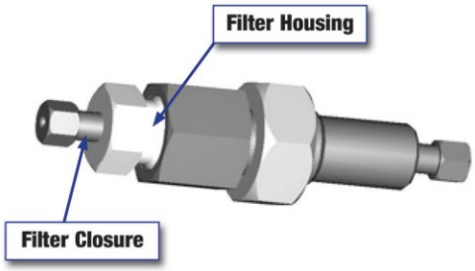


Figure 5, Outlet Filter

To service the outlet filter on stainless steel pumps:

1. Unscrew the filter enclosure from the filter housing.
2. Use a seal insertion/removal tool or a non-metallic object (such as a wooden toothpick) to remove the large seal that remains in the housing.

CAUTION: Do not use a metal object such as a screwdriver or paperclip to remove the seal. Doing so can scratch the precision surface of the seat and may cause the filter to leak.

3. Unscrew the old filter and remove the small seal from the filter closure.
4. Place one of the small seals included in the replacement element kit over one of the new filters from the kit. Screw the new filter into the filter closure (finger tight).
5. Place one of the large seals from the replacement kit on the filter closure. Insert the filter closure into the housing and tighten ¼ turn after seating.

To service a **PEEK** outlet filter, simply open the filter housing and clean or replace the filter element inside.

Pump Head Assemblies

CAUTION: When working with aggressive or toxic solvents, residual amounts of these chemicals could be present in the system.

Removing the Pump Head Assembly

The standard Stainless Steel and PEEK pump head assemblies are shown below in *Figures 6, 7, 8, and 9.* Notice that there is a guide bushing used in the place of the self-flush seal when the self-flush is not being used.

To remove the pump head:

1. Turn OFF the pump power.
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 PTFE tubing.
4. Remove the inlet line from the inlet check valve.
5. Remove the outlet line from the outlet check valve.
6. Remove the inlet and outlet self-flush lines.
7. Carefully remove the two Allen nuts at the front of the pump head with a 3/16 Allen wrench.

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.
   a. Move the pump head straight out from the pump and remove it from the piston. **Be careful not to break or damage the piston.**
   b. Remove the seal and seal backup washer from the piston if they did not stay in the pump head.
   c. Remove the O-ring.

9. Carefully separate the self-flush housing from the pump. Move the flush housing straight out from the pump and remove it from the piston. Also remove the self-flush seal or guide bushing from the piston if it did not stay in the flush housing.

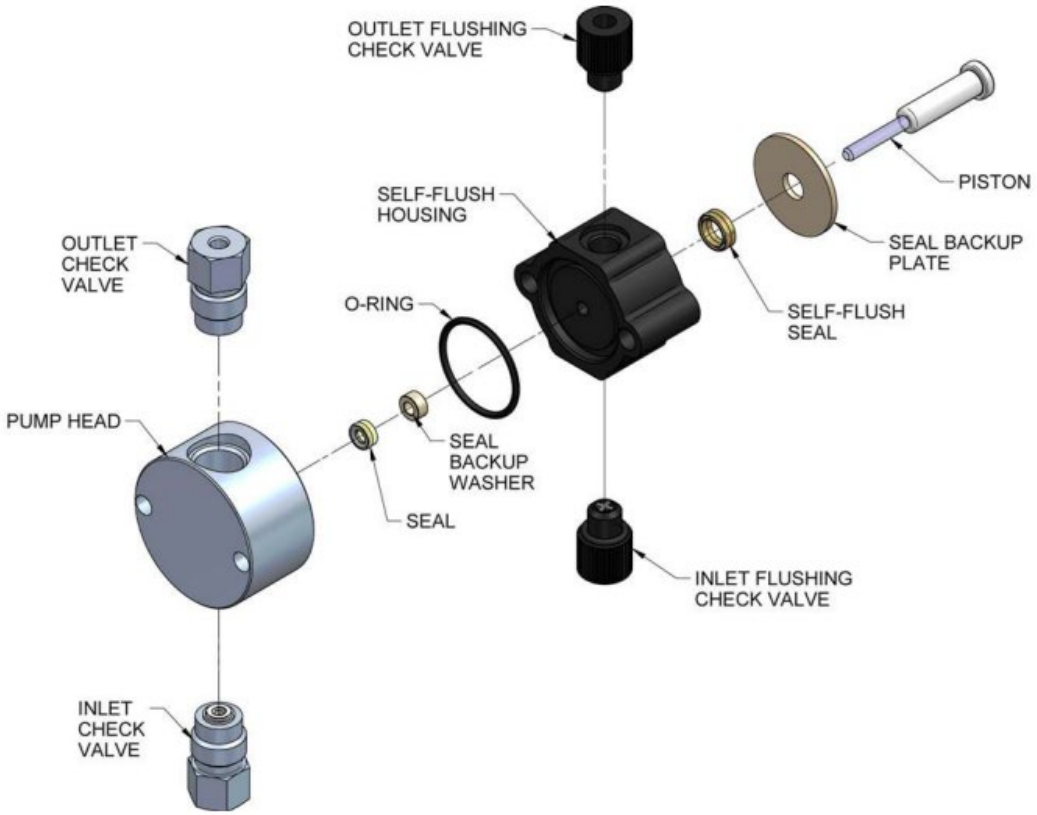


Figure 6, Stainless Steel Self-Flushing Pump Head Assembly

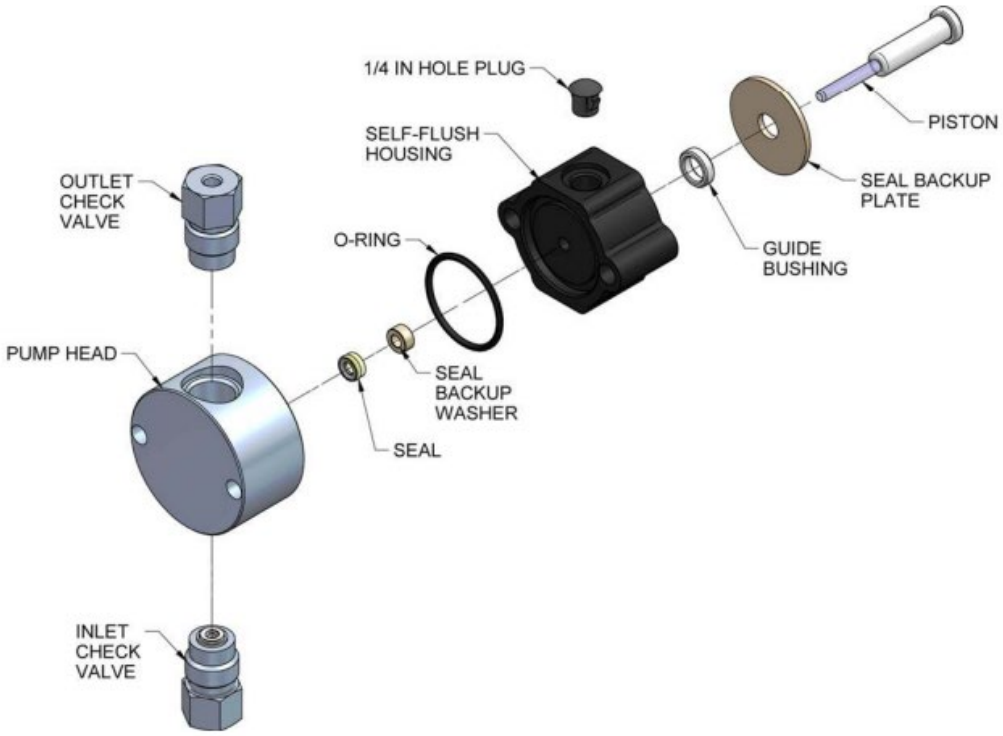


Figure 7, Stainless Steel Non-Self-Flushing Pump Head Assembly

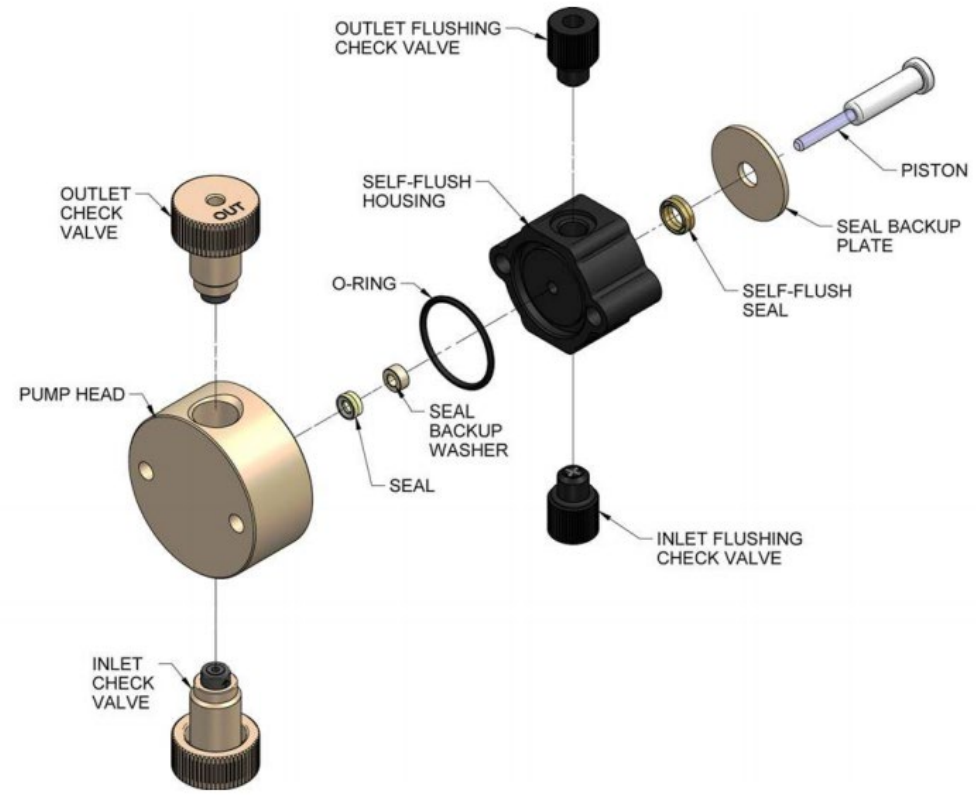


Figure 8, PEEK Self-Flushing Pump Head Assembly

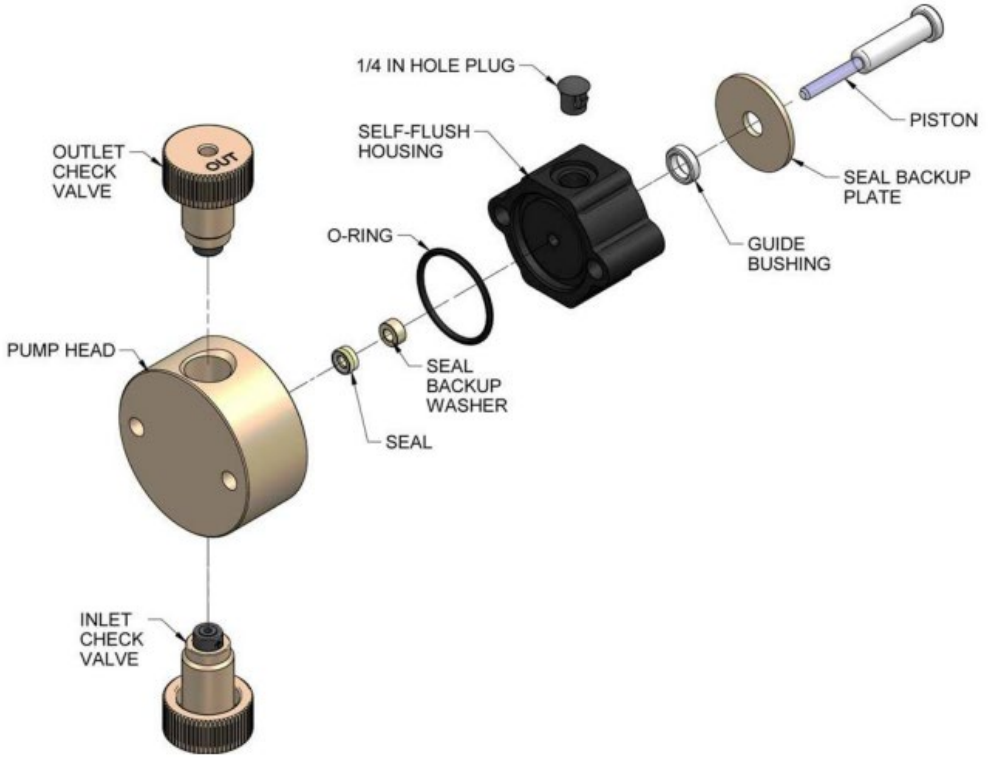


Figure 9, PEEK Non-Self-Flushing Pump Head Assembly

Cleaning the Pump Head Assembly

Note: If the piston seal or self-flush seal are going to be removed, it is recommended to have a new set on hand to install after cleaning. It is not recommended to reinstall the used piston seal or self-flush seal since they are likely to be scratched and damaged during removal and would not provide a reliable seal if reused. If the seal is removed, use only the flanged end of the plastic seal removal tool supplied with the seal replacement kit. Avoid scratching the sealing surface in the pump head.

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. Be sure no fibers from the cleaning swab remain in the components.

The pump head, check valves, and flushing 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 reassembly.

Replacing the Pump Head

1. Carefully align the flush housing and gently slide it into place on the pump. Make sure that the Inlet self-flush check valve is on the bottom and the Outlet self-flush check valve is on the top. If misalignment with the piston occurs, gently realign the piston holder.
2. Install the O-ring in its grove.
3. 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.
4. Finger tighten the Allen nuts into place. To tighten firmly, alternately turn nuts 1/4 turn with a suitable tool (alternating side-to-side) while gently rotating the pump head to center it.
5. Torque the Allen nuts to 30 in-lbs using a suitable torque wrench and 3/16 Allen wrench adaptor.
6. Reattach the inlet and outlet lines. Reattach the self-flush lines. Change the flushing solution.

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.

Removing the Seals

1. Remove the pump head and self-flush assemblies as described above.
2. Remove the backup washer if it is present in the pump head.
3. 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 of the sealing surface and create a leak.

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

Replacing the Seals

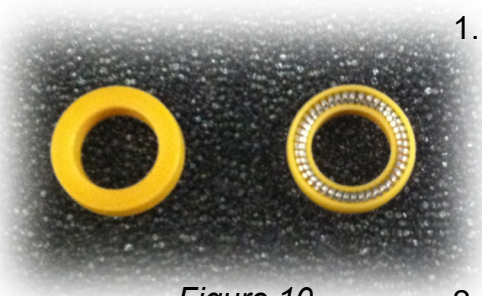


Figure 10, Example of polymer side vs. energizer side of seal. Note: stainless steel energizer shown. Seal could have fluoropolymer O-ring energizer instead (black O-ring).

1. Place a **high pressure replacement seal** (*Figure 10*.) on the rod-shaped end of the seal insertion/removal tool so that the energizer is visible when the seal is fully seated on the tool. Insert the seal into 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 looking into the pump head cavity, only the polymer side of the seal should be visible.
2. Place a **self-flush replacement seal** on the seal insertion/removal tool so that the energizer 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 side of the seal will be visible in the seal cavity.

   NOTE: If the self-flush feature is not being used, install the provided guide bushing in the place of the self-flush seal.
3. Place the seal back-up washer over the high-pressure seal in the pump head.
4. Replace the self-flush and pump head assemblies.
5. Condition the new seals as described below.

Conditioning New Seals

New seals should be conditioned prior to use. Conditioning is the process of running the seals wet under controlled conditions to allow surfaces to seat and to prepare the seal for operation.

Note: Use only organic solvents to condition new seals. Buffer solutions and salt solutions should never be used to condition new seals. Recommended solvents are HPLC-grade methanol and isopropanol, and water mixtures of either.

Suggested Conditioning Parameters: 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 in the following chart and according to the pump head type. Then run the pump for another 15 minutes under conditions for PHASE 2 in the following chart, according to pump flow and pressure capabilities.

Seal Conditioning Parameters		
Flow Rate Setting	Pressure (psi) Phase 1	Pressure (psi) Phase 2
20-30% of Maximum Pump Flow	*1,000	*1,500
* - or 95% of Maximum pump capability		

Pistons

Cleaning the Piston

1. After the pump head and self-flush housing are removed, gently remove the backup seal plate from the pump housing, using either a small screwdriver or toothpick in the slot on top of the pump housing.
2. Grasp the metal base of the piston assembly to 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 pad 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. To reinstall the piston, grasp the metal base of the piston assembly and insert it into the slot in the piston carrier until it bottoms in the slot.

Replacing the Piston

Remove the pump head and self-flush assemblies.

1. Grasp the metal base of the piston assembly to avoid exerting any side load on the sapphire rod, and remove the piston from the slot in the carrier by sliding it up.
2. 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.
3. Replace the pump head as described below.

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, simply cleaning the pump head with the appropriate laboratory apparatus may resolve any issues.

Check Valve Cleaning

1. To clean pump check valves, remove the pump head and immerse the entire head into a laboratory ultrasonic cleaner.
2. Sonicate for about 30 minutes using a standard cleaning solution. Rinse the pump head thoroughly with distilled water.
3. Replace the pump head assembly.
4. Run the pump at 1 mL/min (3 mL/min for a 40 mL pump head) with distilled water for fifteen minutes. Always direct the output directly to a waste beaker during cleaning (do not recycle).

If this procedure does not return the pump to proper performance, the check valves should be replaced. An example of new check valves from their package can be seen in *Figure 11* below.

Check Valve Replacement

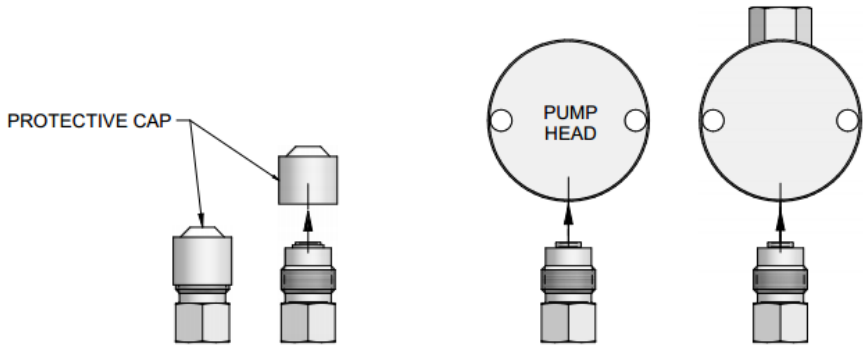


Figure 11, New Check Valves from package and proper orientation.

1. Remove the pump head assembly.
2. Remove the check valve housings, capsules and seals (Stainless Steel only) from the pump head, being careful not to scratch the sealing surfaces in the pump head. If necessary, use a seal removal tool to remove the capsules and/or capsule seals from 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.

CAUTION: Make sure check valve is kept in the above position to avoid losing parts

Note: The size of the through-holes in the pump head. If one is larger, then this side attaches to the Inlet check valve assembly. If the through-holes are the same size, then the orientation does not matter.

3. Hold one new check valve assembly as shown in *Figure 11* and unscrew the protective cap. With the check valve assembly maintained in the above position, thread it into the proper pump head port until it is snug Install the other check valve assembly similarly.

NOTE: It may be easier to install the Outlet check valve first (if the hole sizes are different), from below; then turn the pump head upside down and install the Inlet check valve.

4. Reinstall the pump head assembly
5. Tighten the check valve housings on Stainless Steel pumps to 75 inch-lbs, or enough to seal at maximum pressure. For PEEK pumps, tighten each check valve housing firmly by hand. PEEK Housings can be tightened to proper torque settings using SSI special tool P/N 06-1123T1 (consult factory or distributor). With this tool, torque PEEK housings to 12-15 inch-lbs.
6. Reattach the solvent inlet and outlet lines.
7. Reconnect the self-flush lines to the self-flush check valves.

Self-Flush Check Valves

Self-flush check valves can be replaced without removing the pump head of self-flush assembly, and do not require any tools. When installing new check valves, notice the outlet has a transparent washer, and the Inlet has a cross ball retainer. Also, the words INLET and OUTLET should be visible on the top of the self-flush check valves.

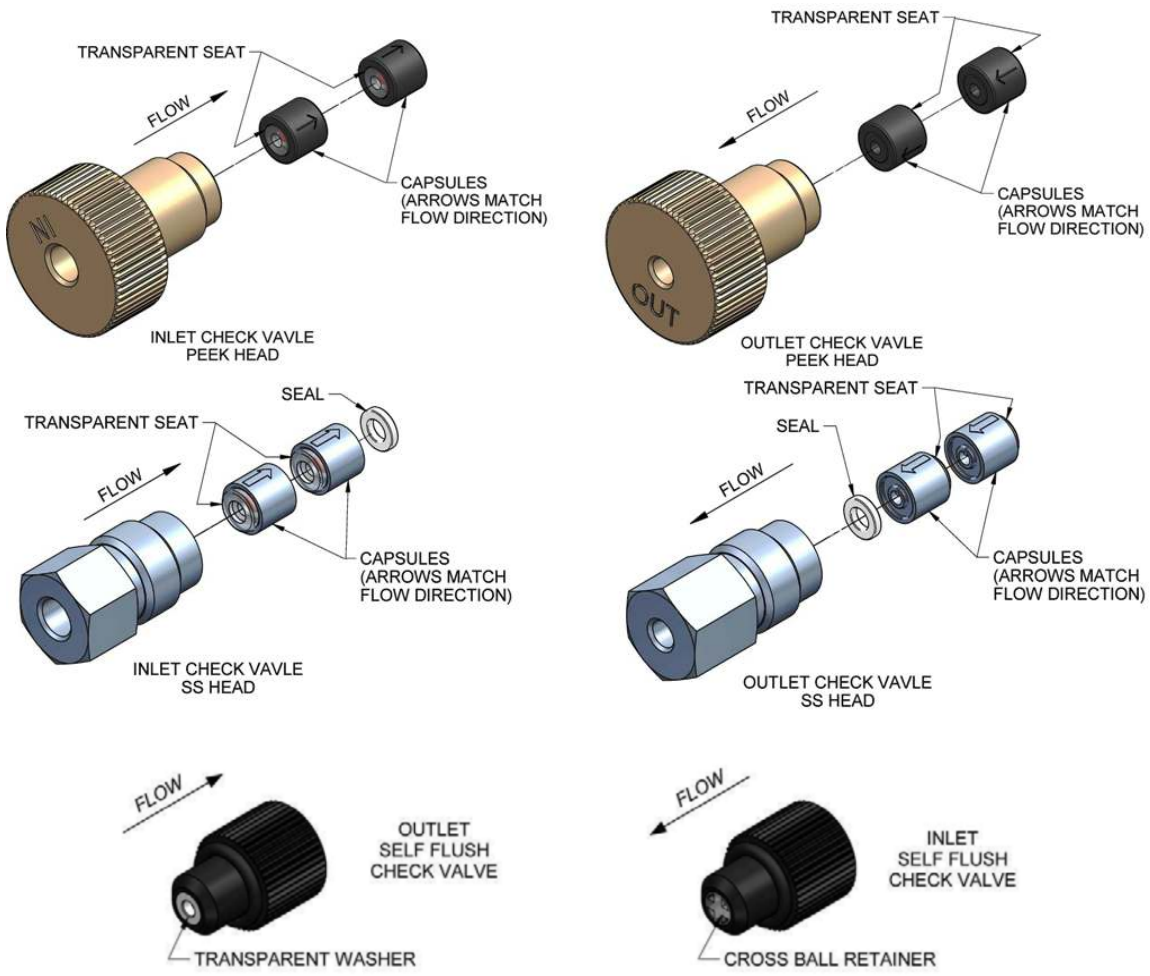


Figure 12, Check Valve Assemblies for Stainless Steel, PEEK Pumps, Self-Flush Housing

Note: The Sapphire Seat is an opaque white ring. The red ruby ball can be seen through the ring. Flow is always away from the sapphire seat, as shown by the directional arrows etched on the capsules.

The Stainless Steel capsules also include one removable PTFE seal (as shown in *Figure 12* above). There is no PTFE seal between capsules on dual check valve PEEK heads. The seal may stick inside housing or pump head.

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.

Pulse Damper Replacement

Removing the Pulse Damper

CAUTION: Always release pressure from the pump slowly. A rapid pressure release could case the pulse damper diaphragm to rupture

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 screws that secure the pulse damper from the underside of the pump.
5. Remove the pulse damper.

Pulse Damper Refurbishing

Refurbishing the pulse damper is a time-consuming procedure. It is recommended to return the pulse damper to have it rebuilt. Do not attempt to refill or refurbish the pulse damper without a refurbishing kit. Instructions are furnished with the kit.

Pulse Damper Installation

1. Position the pulse damper, aligning it with the 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 screws to hold the pulse damper in place.
3. Connect the pump outlet tubing to the port at the rear of the pulse damper (i.e., toward the rear of the cabinet). With the remaining pulse damper port towards the front of the cabinet, connect the line from the pulse damper to the bulkhead outlet filter.
4. Connect the transducer's wire harness connector to pressure board connector P1.
5. Replace the pump cover.

Cleaning the Pump

1. Prepare the following solvents, utilizing the solvent preparation methods detailed in the above section:
   a. 100% isopropanol
   b. 100% filtered, distilled water
   c. 20% nitric acid/water solution (only prepare if the flow path is stainless steel)
2. Direct the pump outlet line to a waste beaker.
3. Press the PRIME (P) button to set the pump flow rate to maximum.
4. Pump 100% isopropanol through the pump for 3 minutes.
5. Pump 100% filtered, distilled water through the pump for 3 minutes.

For stainless steel flow paths, proceed to Step 6; For PEEK flow paths, the cleaning procedure is completed.

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

6. Pump a 20% nitric acid/water solution through the pump for 3 minutes.
7. Flush the pump with 100% filtered, distilled water for at least 3 minutes.
8. Pump 100% isopropanol through the pump for 3 minutes.

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

Lubrication

The BLS-Class 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. Keeping the interior of the pump free of dirt and dust will extend the pump's useful life.

Fuse Replacement

Two fuses are located in the power entry module at the rear of the cabinet.

Troubleshooting the fuses is straightforward. If the power cord is plugged in and the on/off power 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 *(Figure 13)*.

Replace with 2 amp fuses, 5x20mm, Slo-Blo (time-lag), 250V

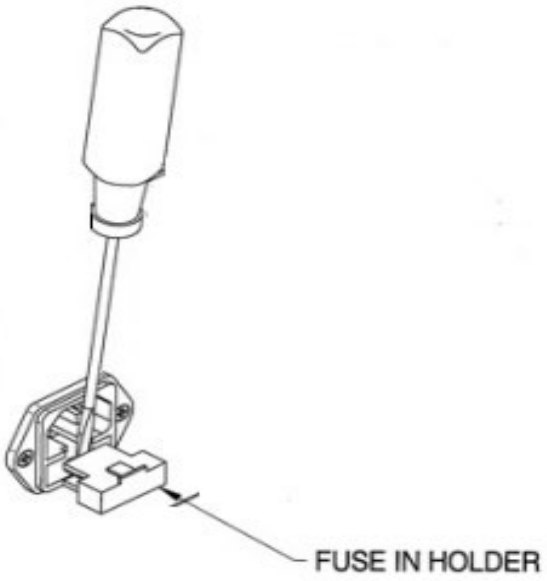


Figure 13, Fuse replacement

6. QUICK GUIDE TO PROBLEM SOLVING

Noticed Issue	This May Mean	Possible Cause	Possible Solution
1. Uneven pressure trace. 2. Pressure drops. 3. No flow out the outlet check valve.	1. Bubble in check valve. 2. Leaks in system. 3. Dirty check valve. 4. Bad check valve.	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.	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. 5. Clean or replace inlet filter.
1. Uneven pressure trace. 2. Pressure drops. 3. Fluid between the pump head and the retainer.	1. Leaks in system. 2. The piston seal or self-flush seal is worn.	1. Fittings not tight. 2. Long usage time since last piston seal / self-flush seal change. 3. Salt deposits on seal or self-flush seal (especially if buffered aqueous mobile phases are used).	1. Check all connections for leaks. 2. Replace piston seal & self-flush seal. 3. Check the piston for salt deposits. Clean as necessary.
Pump makes a loud clanging or slapping noise (intermittent contact with cam).	Piston carrier is catching in piston guide.	1. Cap nut screws on the pump head are loose. 2. Seal(s) are worn. 3. Piston guide is worn	1. Check cap nut screws on pump head. Tighten if necessary. 2. Replace seals. 3. Replace piston guide and seals.
No power when pump turned ON.	Blown fuses in the power entry module.	1. Power surge. 2. Internal short.	1. Replace only with the appropriate fuses. 2. Contact service technician if problem persists.
Colored dye in mobile phase.	Pulse damper diaphragm has burst.	Sudden pressure drop when purging system.	Replace pulse damper.
Pump runs for 50 pump strokes, then shuts down.	Lower pressure limit is activating.	1. Mobile phase is not properly filtered. 2. Particles from worn seal trapped in the system (e.g., tubing, filters, injection valve, or column inlet).	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.
1. Pump shuts down after run is called even with no column connected. 2. Pump runs to maximum pressure and shuts down.	Clog in fluid system.	1. Particulate matter clogging inlet system or head of column. 2. Plugged detector line. 3. Injection valve improperly positioned. 4. Column inlet clogged with dirt accumulation.	1. Filter mobile phase and sample. 2. Check syringe for a barb(s) breaking septa pieces off into the system. 3. Turn pump off immediately and carefully clean lines and cell. 4. Check injection valve for proper rotation. 5. Clean inlet and/or replace column.
No power when pump turned ON. Fan does not run.	Blown fuses in the power entry module.	1. Power surge. 2. Internal short.	1. Replace only with the appropriate fuses. 2. Contact service technician if problem persists.
PEEK fittings or components leak.	PEEK parts with interference have been forced to seal with brute force tightening.	1. Film of fluid between surfaces. 2. Salt crystals between surfaces. 3. Scratches in mating surfaces.	1. Clean and dry mating surfaces. 2. If scratched, replace defective part.

7. APPENDIX A

Rear Panel Serial Communications Port

A female USB-A 2.0, female USB Micro-B, and a male DE9 RS-232C port are provided on the back panel for the binary control. A computer with appropriate software can be used to control the pump operation remotely via these connections. Additional drivers may be required for utilization of the USB ports. The proper driver may be downloaded from the SSI website at the following address:

www.ssihplc.com — from the home page, under the Support section, select the Downloads tab.

Hardware Implementation

The RS-232 REMOTE INPUT serial communications port is configured for 9600 baud, 8 data bits, 1 stop bit, and no parity. The connector is a standard male DE9 D-subminiature type jack.

Command Interpreter

The cabinet contains a gradient board that stores a gradient method, and communicates between the controlling application and the two pump control boards. Once the method is downloaded, the gradient board can run the method on its own. The gradient board's high-level command interpreter receives and responds to command packets. The gradient board 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 single-letter command code. Commands are case sensitive; that is, the command codes "s" and "S" are different.

A linefeed must be used to indicate the end of a transmitted string. A received linefeed will cause the pump to start to process the received command.

Response strings sent by the pump are terminated by the "/" character.

Gradient Protocol List

The command packets for the gradient control board:

METHOD COMMANDS			
Command	**Format**	**Description**	**Response**
T	T,aa.aaa,bbb,cccc,g<LF>	**Set Method Step** aa.aaa: total flow in mL/min, decimal value, 0.00 to 655.35 bbb: A%, integer value, 0 to 100 ccccc: step time duration in 100th of minutes, integer value, 0 to 65535 g: gradient type, 0=step, 1=linear	OK/: accepted ER/: rejected
c	c<LF>	**Set Method Complete** This command must follow the T to complete the method download procedure	OK/: accepted ER/: rejected
s	s<LF>	**Start Pump Equilibration** Starts the pumps in equilibration step (step 1)	OK/: accepted ER/: rejected

m	m<LF>	**Run Method** Starts the gradient (step 2)	OK/: accepted ER/: rejected
S	S<LF>	**Stop Pumps** Stops both pumps. Method can only be restarted at equilibration step	OK/: accepted ER/: rejected
h	h<LF>	**Hold Method** Hold the method, stop the pumps and the gradient timer	OK/: accepted ER/: rejected
J	J<LF>	**Resume Method** Resume the method, restart the pumps and continue the gradient timer	OK/: accepted ER/: rejected
R	R<LF>	**Stop Method but Keep Pumps Running** Stops the current method run, but still keep both pumps running	OK/: accepted ER/: rejected
r	r<LF>	**Read Method** Returns the current method stored in MGB	Return method EPROM value by byte **1-2**: total flow in µL **3**: %A **4-5**: total time in minutes **6**: gradient type, 0=step, 1=linear
P	P,P_min,P_max<LF>	**Set pump pressure limit** Set the lower and upper pressure limit P_min: lower pressure limit P_max: upper pressure limit	OK/: accepted ER/: rejected
p	p<LF>	**Read stop pump option** Reads the "stop pump at end of method" option	**OK,0/**: keep pump running at the equilibration flow rate when the method is completed **OK,1/**: stop pump at the end of method; **OK,2/**: keep pump running at the last step flow rate when the method is completed
o	o<LF>	**Set pump option: Stop at the end of method** Sets the pump option so the pump will stop at end of method	OK/: accepted ER/: rejected
q	q<LF>	**Pump option: Go to equilibration step** Set the option so the pump will go to equilibration step when the method is completed	OK/: accepted ER/: rejected
Q	Q<LF>	**Pump option: Stay at the last step** Set the option so the pump will keep running at the last step flow when the method is completed	OK/: accepted ER/: rejected
other			ER/: command rejected

Status Commands

The status command set may be used at any time to identify and record general system and pump parameters.

All commands are case sensitive.

STATUS COMMANDS			
Command	**Format**	**Description**	**Response**
i	i<LF>	**Read pump flow resolution**	Ok,xxxx/ ,where xxxx is 10, 100, 1000 or 10000, 10 representing 0.1 resolution, 100 representing 0.01 resolution, ect.
g	g<LF>	**Get Status**	OK,a,b.bb,c.cc,d.d,e.e,f.f,g/ a: pump status code: 0=shutdown, 1=start, 2=step0, 3=ready, 4-23= step1-20, 60=pump a below low pressure, 61=pump b below low pressure 62=pump a above max pressure; 63=pump b above max pressure 64=pump a motor stall fault; 65=pump b motor stall fault b.bb: equil/gradient time in minute; c.cc: step time in minute; d.d: total flow in ml/min; e.e: % of solvent A; f.f: % of solvent B; g: current pump pressure in PSI.
z	z<LF>	**Get firmware version**	SSI Binary Gradient Board + Firmware PN + version/: E.g.: SSI Binary Gradient Board 181030 v1.00./

Direct Pump Control

The MGB can be used to relay commands directly to and from each pump independently and without interpretation. The 'O' command will send a command string to either pump 1 or pump 2 (selectable) and return that pump's response to the command string.

The 'O' command should only be used during pump set-up for functions such as establishing pressure limits, solvent selections, etc.

The 'O' command should never be used while a method is running. Unexpected responses may occur. During a pump method, the Pump Status commands are fully functional.

O	O,x,yyyyy<LF>	**Direct Pump Command** Sends the contained command string directly to selected pump x: pump address, 1= pump 1, 2 = pump 2 yyyy: command string sent to pump. Consult pump manual for associated commands	OK,xxxx/ accepted xxxx = response from pump ER/ rejected

Pump Protocol List

The command packets for individual pump channels via the gradient board's 'O' pass through command, or via the micro USB cables:

Command	Response	Comments
CC	OK,<pressure>,<flow>/	Current Conditions: returns the following values: <pressure>: current operating pressure <flow>: current flow rate in ml/min
CF	OK/	Clear Faults: clears any active faults.
CS	OK,<flow>,<UPL>,<LPL>, <units>,0,<R/S>,0/	Current Status: returns the following values: <flow>: current flow rate in ml/min <UPL>: Upper Pressure Limit <LPL>: Lower Pressure Limit <units>: pressure units <R/S>: Run/Stop state, where 0 = stop, 1 = run
FIxxxxx	OK/	Flow Input: sets the flow rate using 5 digits. Intended for all pumps. If the entered value exceeds the maximum allowable flow rate of the pump, the flow rate will be automatically set to the maximum allowable flow rate. input range: 0 to 99999
GS	OK,GS:<seal>/	Get Seal: returns value of seal stroke counter.
ID	OK, <ID> Version <version>/	ID (Legacy): returns firmware version and part number where <ID>: firmware part number <version>: firmware revision
KD	OK/	Keypad Disable: disables front panel buttons.
KE	OK/	Keypad Enable: enables front panel buttons.
LMx	OK,LM:<mode>/	Leak Mode: sets leak sensor mode, where 0 = detected leak does not cause fault 1 = detected leak does cause fault
LP	OK,LP:<LPL>/	Lower Pressure Limit: returns value of lower pressure limit.
LPxxxxx	OK/	Low Pressure Limit: stores value for low pressure limit. input range: 0 to 99999 (an input value greater than the maximum allowable limit stores the maximum allowable limit, cannot exceed upper pressure limit) If pressure units are set to psi, input value must be of the format x psi e.g., LP200 = 200 psi If pressure units are set to bar, input value must be of the format x.x bar e.g., LP200 = 20.0 bar If pressure units are set to MPa, input value must be of the format x.xx MPa e.g., LP200 = 2.00 MPa
LS	OK,LS:0/ or OK,LS:1/	Leak Status: returns leak sensor status, where 0 = no leak detected 1 = leak detected
MF	OK,MF:<max_flow>/	Maximum Flow Rate: returns the maximum allowable flow rate for the pump, in ml/min.
MP	OK,MP:<max_pressure>/	Maximum Pressure: returns the maximum allowable pressure for the pump.

PI	OK,<flow>,<R/S>,<p_comp>, <head>,<0>,<1>,<0>,<0>, <UPF>,<LPF>,<prime>, <keypad>,<0>,<0>,<0>, <0>,<fault>/	Pump Information: returns the current pump information, where: <flow>: current flow rate in ml/min <R/S>: Run/Stop state, where 0 = stop, 1 = run <p_comp>: manual pressure compensation value <head>: head identification <UPF>: Upper Pressure Fault status <LPF>: Lower Pressure Fault status <prime>: prime state, where 0 = not in prime, 1 = in prime <keypad>: keypad state, where 0 = buttons enabled, 1 = buttons disabled <fault>: fault status, where 0 = no faults, 1 = pump faulted
PR	OK,<pressure>/	Pressure: returns current operating pressure.
PU	OK,psi/ or OK,bar/ or OK,MPa/	Pressure Units: returns active pressure units.
RE	OK/	Reset: reset all user adjustable values to factory defaults. This includes the current flow rate, upper pressure limit, lower pressure limit, solvent, and user flow rate compensation.
RF	OK,<stall>,<high_p>,<low_p>/	Read Faults: returns status of all fault indicators, where 0 = no fault, 1 = fault. <stall>: motor stall fault <high_p>: high pressure fault <low_p>: low pressure fault
RU	OK/	Run: run pump.
ST	OK/	Stop: stop pump.
UC	OK,UC:<user>/	User Compensation: returns user flow rate compensation where xxx.x = xxx.x % e.g. UC102.5/ = 102.5% compensation, or +2.5%
UCxxxx	OK,UC:<user>/	User Compensation: stores user flow rate compensation where xxx.x = xxx.x % e.g. UC102.5/ = 102.5% compensation, or +2.5% input range: 0850 to 1150
UP	OK,UP:<UPL>/	Upper Pressure Limit: returns value of upper pressure limit.
UPxxxxx	OK/	Upper Pressure Limit: stores value for upper pressure limit. input range: 0 to 99999 (an input value greater than the maximum allowable limit stores the maximum allowable limit) If pressure units are set to psi, input value must be of the format x psi e.g., LP200 = 200 psi If pressure units are set to bar, input value must be of the format x.x bar e.g., LP200 = 20.0 bar If pressure units are set to MPa, input value must be of the format x.xx MPa e.g., LP200 = 2.00 MPa
ZS	OK/	Zero Seal Counter: reset seal life stroke counter to zero.
#	(no response)	Clears all characters from the command buffer.

Rear Panel 6-Pin Terminal Board Connector

A 6-pin terminal board connector is provided on the back panel. Any device capable of providing contact closure (minimum duration 100 ms) may be used as a remote controlling device. For ease of wiring, the terminal board connector may be removed by pulling firmly rearward. Care should be taken to reinsert the connector firmly and in the proper orientation; misalignment is possible.

After a method has been downloaded to the instrument, the method may be controlled via contact closure. The first step of the method is equilibration; connect pins 3 and 4 to initiate equilibration. After the specified equilibration time period has elapsed, the instrument will remain in equilibration until the gradient trigger is received on pins 3 and 4 again. At any time during the gradient, connect pins 3 and 4 to terminate the method and stop the pumps.

8. APPENDIX B

Specifications for the BLS-Class Pump, 5 mL/min

Flow Rate* .....0.001 to 5.000 mL/min, per channel

Pressure ..... 0 to 6,000 psi for Stainless Steel heads

..... 0 to 5,000 psi for PEEK heads

Pressure Accuracy..... ±1% of full-scale pressure

Pressure Zero Offset.... ±2 PSI

Flow Accuracy..... ±2% of set point between 5-95% of flow range with 80:20 Water/IPA @ 1000 psi, per channel

Flow Precision..... 0.2% RSD, per channel

Dimensions .....9" high, 10" wide, 17" deep

Weight.....30 lb

Power.....100-240 VAC (±10%), 50-60 Hz, 90 W

Fuse Ratings..... 2A, 250V time lag, 5x20mm size, two required per pump

Remote Inputs.....RS-232, USB Micro B, USB 2.0 A, Digital I/O

Environmental ..... Indoor Use Only

Altitude ..... 2000 M

Ambient Temperature ..10º to 30º C

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

Specifications for the BLS-Class Pump, 10 mL/min

Flow Rate* .....0.01 to 10.00 mL/min, per channel

Pressure ..... 0 to 6,000 psi for Stainless Steel heads

..... 0 to 5,000 psi for PEEK heads

Pressure Accuracy..... ±1% of full-scale pressure

Pressure Zero Offset.... ±2 PSI

Flow Accuracy..... ±2% of set point between 5-95% of flow range with 80:20 Water/IPA @ 1000 psi, per channel

Flow Precision..... 0.2% RSD, per channel

Dimensions .....9" high, 10" wide, 17" deep

Weight.....30 lb

Power.....100-240 VAC (±10%), 50-60 Hz, 90 W

Fuse Ratings..... 2A, 250V time lag, 5x20mm size, two required per pump

Remote Inputs.....RS-232, USB Micro B, USB 2.0 A, Digital I/O

Environmental ..... Indoor Use Only

Altitude ..... 2000 M

Ambient Temperature .. 10º to 30º C

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

Specifications for the BLS-Class Pump, 40 mL/min

Flow Rate* ..... 0.1 to 40.0 mL/min, per channel

Pressure ..... 0 to 1,600 psi for Stainless Steel or PEEK heads

Pressure Accuracy..... ±1% of full-scale pressure

Pressure Zero Offset.... ±2 PSI

Flow Accuracy..... ±2% of set point between 5-95% of flow range with 80:20 Water/IPA @ 1000psi, per channel

Flow Precision..... 0.2% RSD, per channel

Dimensions .....9" high, 10" wide, 17" deep

Weight.....30 lb

Power..... 100-240 VAC (±10%), 50-60 Hz, 90 W

Fuse Ratings..... 2A, 250V time lag, 5x20mm size, two required per pump

Remote Inputs.....RS-232, USB Micro B, USB 2.0 A, Digital I/O

Environmental ..... Indoor Use Only

Altitude ..... 2000 M

Ambient Temperature .. 10º to 30º C

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

*Flow rate is dependent on solvent selection and operating pressure.

9. WARRANTY STATEMENT

Scientific Systems, Inc. (SSI) warrants that instruments or equipment manufactured by the company for a period thirty-six (36) months from date of shipment to the original purchaser (or to the drop ship location as indicated on the Purchase Order from the original purchaser), against defects in materials and workmanship under normal installation, use and maintenance. Products sold by SSI but not manufactured by SSI carry the Original Manufacturer's Warranty, beginning as of the date of shipment to SSI's original purchaser. 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 twelve (12) months from date of shipment to the original purchaser against defects in materials and workmanship under normal installation, use and maintenance. Defective Product will be accepted for return to SSI only if the request for return is made within thirty (30) days from the time of discovery of the alleged defect, and prior to return, the original purchaser obtains a Return Goods Authorization (RGA) number from SSI, and provides SSI with the serial number of each instrument to be returned.

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	Pistons	Piston and Wash Seals
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. Freight costs for the return of reported defective Product from the original purchaser to SSI is the responsibility of the original purchaser. Freight costs for the return of reported defective spare parts is the responsibility of SSI. SSI shall specify the freight carrier for returns. SSI shall bear the expense of return shipment to original purchaser (or to the drop ship location as indicated on the Purchase Order from the original purchaser).

If it appears to SSI that any Product has been subjected to misuse, negligence, accident or excessive wear, or is beyond the warranty period, the original purchaser and/or customer shall be notified promptly. SSI shall communicate 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 the original purchaser and/or 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.