M1-Class Pump

Economical Piston Pump for HPLC and High Performance Metering

Operator Manual

903030Rx REV I

TELEDYNE ISCO
Everywhereyoulook™

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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 M1-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. Teledyne ISCO assumes no liability for the misuse of the information described in this manual in regards to installation, repair, or operation of the M1-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 M1-Class Pump.

Description of the M1-Class Pump

The M1-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 M1-Class Pump includes:

- Single-head design with digital stepper motor drive and electronic fast refill
- Stainless Steel or PEEK fluid path
- 4-digit LED top panel user keypad
- Back panel Micro USB and RS-232 serial communication ports for complete control and status
- Self-flushing pump head
- A diaphragm-type pulse damper, which reduces pulsation in the system by as much as 90%
- Outlet Filter

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).

Self-Flushing Pump Head

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

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.

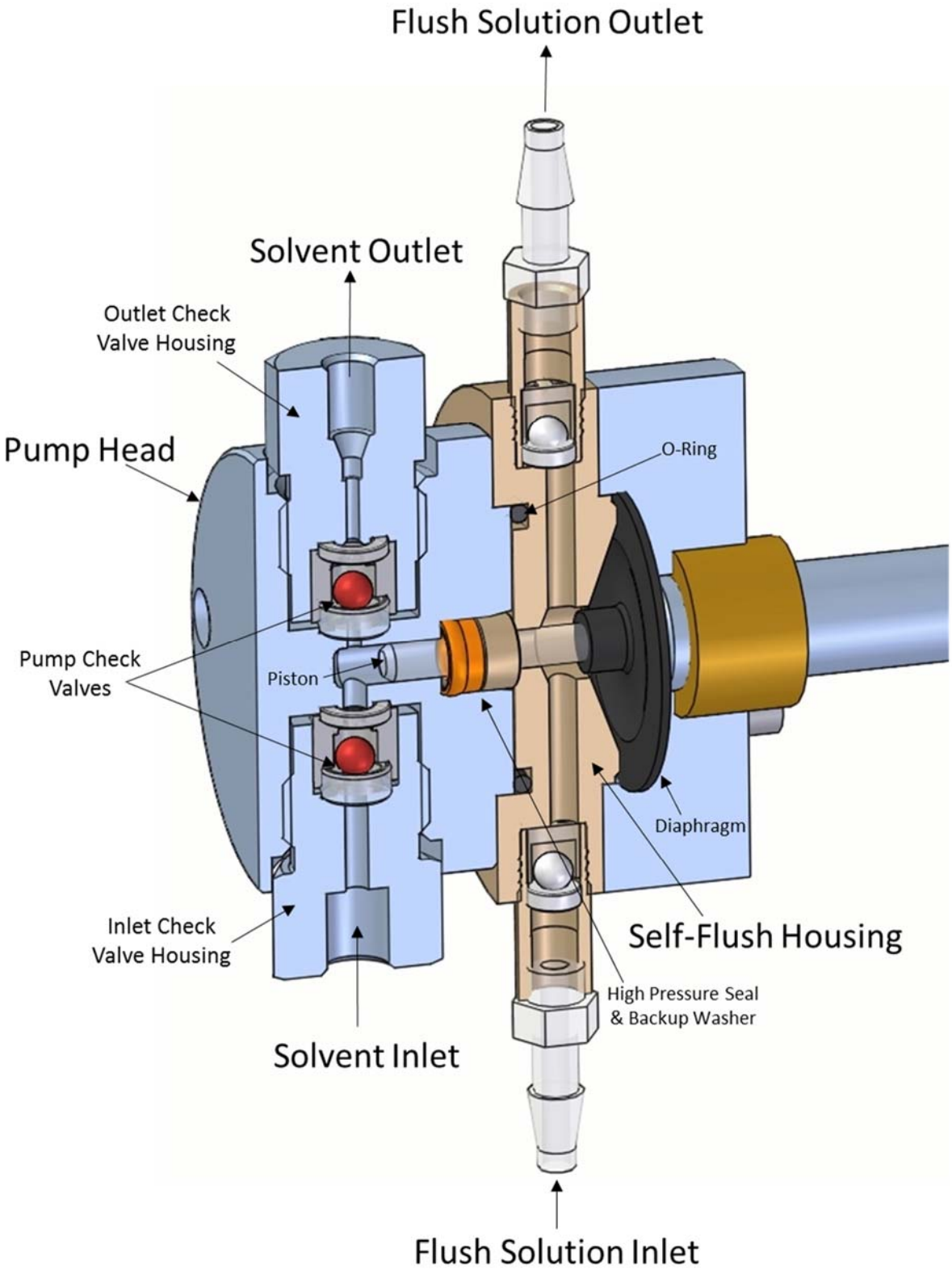
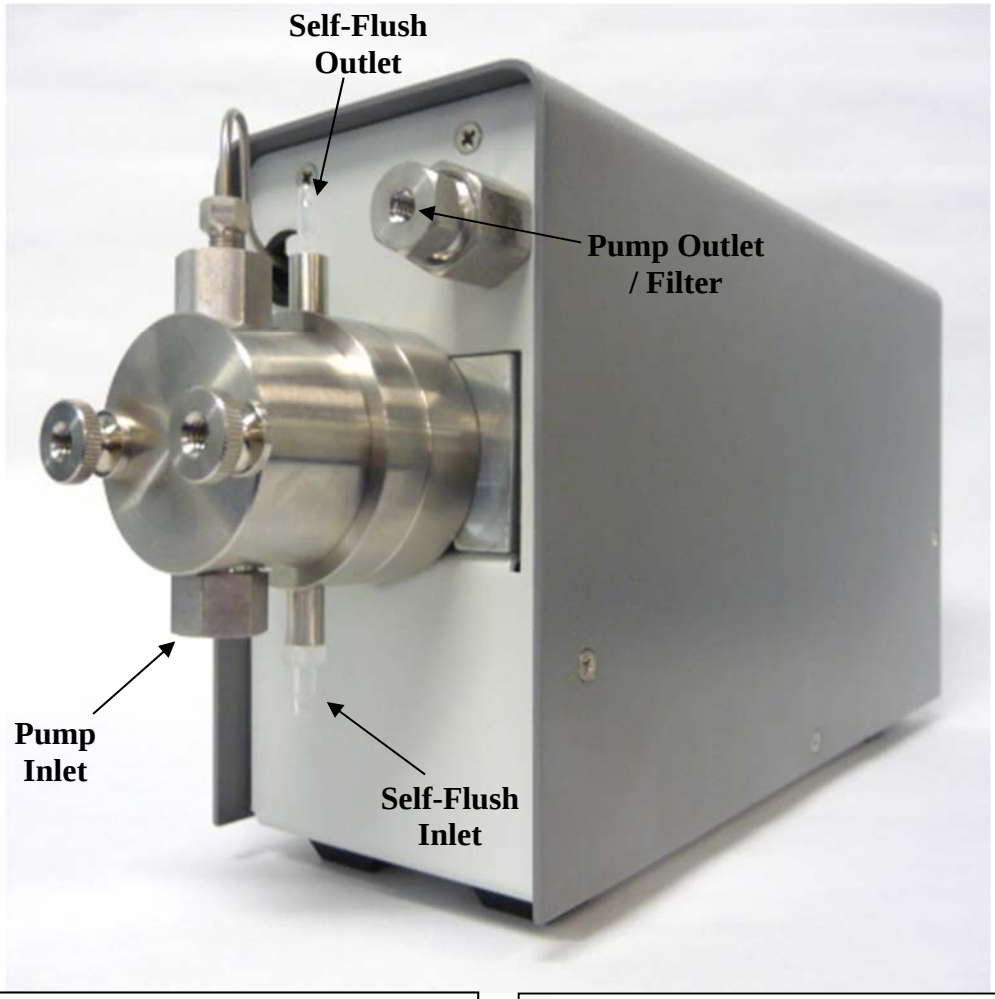


Figure 1, M1-Class Self-Flushing Pump Head

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

2. QUICK STARTUP GUIDE

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



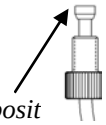
Self-Flush

- Connect the self-flush inlet tubing to the self-flush inlet line.
- Attach the small piece of supplied tubing to the self-flush outlet connection.
- Attach the syringe to the small piece of outlet tubing.
- Draw the syringe back to prime.
  Draw approximately 20 mL of fluid.
- Remove the syringe and replace the small piece of tubing with the self-flush outlet tubing.
- Place the self-flush outlet tubing in the self-flush solution.

**Replace self-flush solution weekly.*

Pump

- Connect the pump inlet tubing to the pump inlet.
  Make sure ferrule is in the correct posit



- Attach the syringe to the outlet filter.
- Draw syringe back to prime.
  Draw approximately 20 mL of fluid.
- Press the RUN/STOP button and continue to draw on syringe until no bubbles are seen.
- Remove the syringe.
- Connect outlet tubing.
- The pump is ready for operation.

**Replace solvent weekly.*

3. INSTALLATION

Unpacking and Inspection

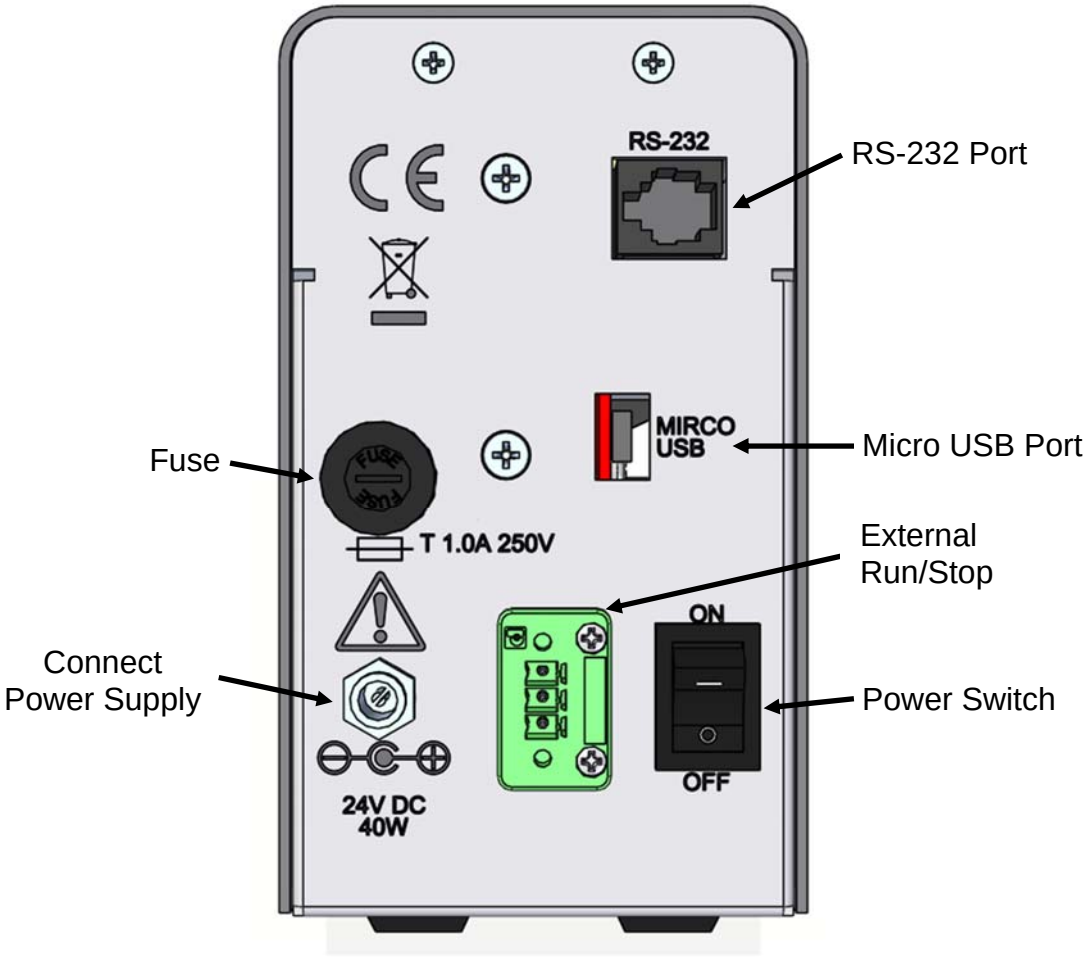
Prior to opening the shipping container, inspect it for damage or evidence of mishandling. If it has been damaged or mishandled, notify the carrier before opening the container. Once the container is opened, inspect the contents for damage. Any damage should be reported to the carrier immediately. Save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

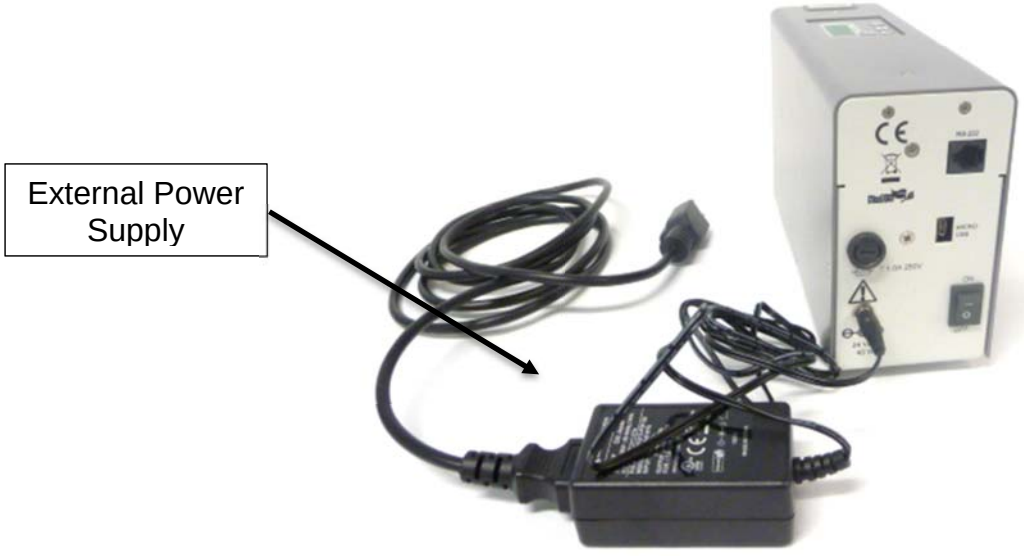
Refer to the figures on the following page. Unpack the M1-Class pump and connect the power supply to the back of the pump. Position the pump so that there is at least a four-inch clearance on all sides to permit proper ventilation. Then plug the pump into a properly grounded 100-240V electrical outlet.

Location/Environment

The instrument must be located on a stable flat surface with surrounding space for ventilation and the necessary electrical and fluid connections. The acceptable environment for the M1-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





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

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 M1-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 M1-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.

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 the 20 micron inlet filter supplied with the pump.

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

Connect a syringe to the pump outlet. Pull a minimum of 20 mL into the syringe. Press the Run/Stop button and continue to pull mobile phase and any air bubbles in the system into the syringe. Stop the pump. Remove the syringe and reconnect the pump outlet tubing.

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, etc.

To prime the self-flush lines, simply place the inlet line in the flush solution and connect a syringe to the outlet line. Pull on the syringe until the inlet line is filled with flush solution and there is liquid in the syringe. 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.

Preparation for Storage or Shipping

Isopropanol (or methanol) Flush

Disconnect the outlet tubing from the pumps. Insert the inlet filter in isopropanol (or methanol). Use a syringe to draw a minimum of 20 mL through the head. Seal the inlet and outlet ports with the shipping plugs.

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

Top Panel Controls and Indicators

Figure 2, M1-Class Pump Keypad Control Panel

Digital Display Pump Keypad

The 4-digit display shows the pump flow rate (mL/min). The Green RUN LED is lit when the pump is running, and the Red FAULT LED is lit when a malfunction is detected (pump automatically stops).

▲	UP-ARROW button - increases the flow rate set point.
▼	DOWN-ARROW button - decreases the flow rate set point.
CAL	This button is used to adjust flow calibration (see below).
RUN / STOP	When pressed, this button alternately starts and stops the pump.

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.

Power-Up Configuration

On power-up, press and hold the CAL button to access the PUMP SETUP MENU. The LED display will briefly show “SETT”, and then enter the pump setup menu. Each setup parameter includes a TITLE screen followed by a VALUE screen. Within the pump setup menu, use the CAL button to cycle forward through the menu screens.

While a changeable value is displayed, use the UP and DOWN ARROW buttons to modify the value. Depending on the pump model, certain values may not be changeable.

To exit the pump setup menu and save all changes, press the RUN/STOP button. Note that changes will NOT be saved until the RUN/STOP button is pressed; exiting the pump setup menu by turning the instrument power off will discard all changes.

Firmware Identification:

The first setup parameter displayed is the instrument firmware identification, denoted by the title screen “F-Id”. Press the CAL button to advance the menu screen to display the firmware part number.

Firmware Version:

The next setup parameter displayed is the instrument firmware version, denoted by the title screen “Ver”. Press the CAL button to advance the menu screen to display the firmware version.

Flow Compensation:

The next setup parameter displayed is the flow rate compensation, denoted by the title screen “Cal”. Press the CAL button to advance the menu screen to display the flow rate compensation value, a number between 85.0 and 115.0 which 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.

Motor Stall Detector:

The next setup parameter displayed is the motor stall detector, denoted by the title screen “Stal”. Press the CAL button to advance the menu screen to display the motor stall detector state, either on (enabled) or off (disabled). While enabled, the motor stall detector creates a motor stall fault when the motor rotation is not properly detected.

Solvent Select:

The next setup parameter displayed is the Solvent Select feature, denoted by the title screen “SSel”. Press the CAL button to advance the menu screen to display the currently selected solvent, or OFF if this feature is disabled. Solvent Select allows the pump to produce accurate flow rates for various solvents, as shown in the table below.

PUMPED LIQUID	DISPLAY 2 ACRONYM	COMPRESSIBILITY (10^{-6} per bar)
Acetonitrile	ACn	46
Hexane	C6H14	167
Isopropanol	IPA	84
Methanol	CH3OH	121
Tetrahydrofuran (THF)	C4H8O	54
Water	H2O	46

Leak Detector:

The next setup parameter displayed is the leak detector, denoted by the title screen “Drip”. Press the CAL button to advance the menu screen to display the leak detector state, either on (enabled) or off (disabled). While enabled, the leak detector creates a leak warning (default) or leak fault (configurable with LM2 command) when a leak is detected.

Analog Input Mode:

The next setup parameter displayed is the analog input mode, denoted by the title screen “Inpu”. Press the CAL button to advance the menu screen to display the currently selected analog input mode, either voltage (0-10Vdc) or current (4-20mA). Refer to Appendix A for additional details.

Analog Input Enable/Override:

The next setup parameter displayed is the analog input enable/override, denoted by the title screen “AnEn”. Press the CAL button to advance the menu screen to display the analog input enable/override state, either on (enabled) or off (disabled). While enabled, the analog input enable/override allows the analog input to be used without the need to wire the enable line on the external control connector. Refer to Appendix A for additional details.

Constant Pressure PID Setup:

The next 3 setup parameters displayed are the PID parameters used by Constant Pressure pumps, denoted by the title screens “PID-P”, “PID-I”, and “PID-D”. For Constant Flow pumps, the value screens will display off.

Serial Baud Rate:

The next setup parameter displayed is the serial baud rate, denoted by the title screen “Baud”. Press the CAL button to advance the menu screen to display the current baud rate, either 9600 or 192 (19200). Note that the

RUN/STOP button must be used to exit the pump setup menu and save all changes; changes made to the baud rate will then become effective on the next power cycle.

Pressure Smoothing Filter:

The next setup parameter displayed is the pressure smoothing filter, denoted by the title screen “PAvg”. Press the CAL button to advance the menu screen to display the pressure smoothing filter value, a number between 0 and 16 which represents how much smoothing is applied to the pressure signal. Higher values denote increased smoothing.

Non-volatile Memory Reset

On power-up, press and hold the UP ARROW button perform an instrument reset. The LED display will briefly show “reset”, and then enter the normal pump operating menu. A reset restores the instrument to its original factory settings. A reset automatically occurs when the firmware is updated.

Rear Panel Inputs

Micro USB and RS-232C ports 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 more details on connection and operation.

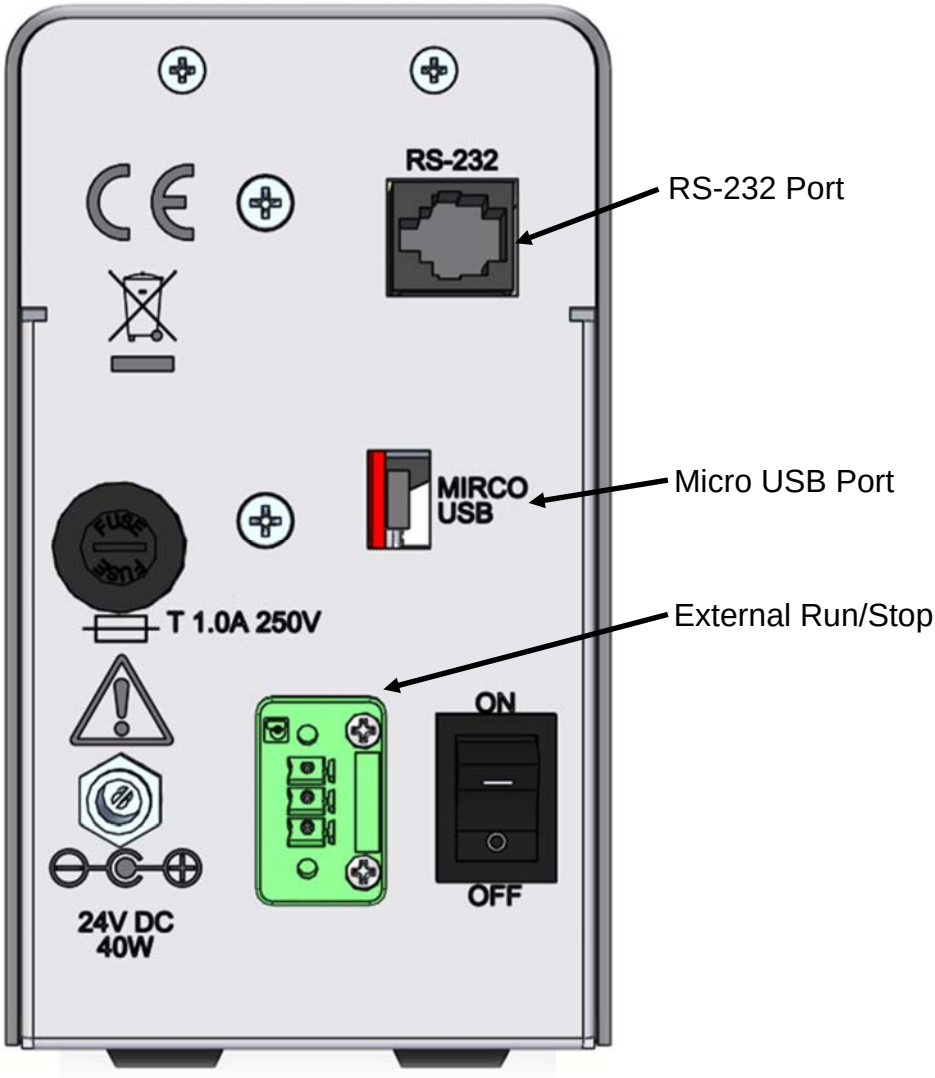


Figure 3, M1-Class Pump Rear Panel

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.

Run / Stop Connector

An external RUN / STOP connector is located on the back. This connection can be used to remotely start and/or stop the pump. To command the pump to run, connect RUN INPUT (pin 1) GROUND (pin 2). To command the pump to stop, connect STOP INPUT (pin 3) to GROUND (pin 2). The inputs are active low and latched on the falling edge, thus they may be triggered either by a pulse or by a latched connection.

Connect bare wire ends from the Fraction Collector to the mating connector according to the instructions above. Refer to your Fraction Collector manual or contact the manufacturer directly with any questions on connecting the cable.

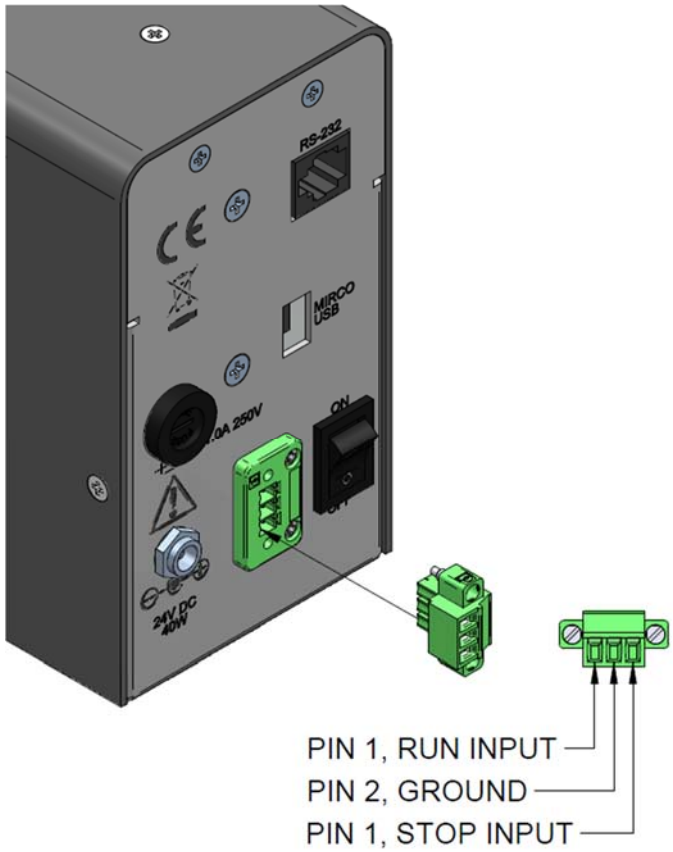


Figure 4, Run/Stop Connector

5. MAINTENANCE

Cleaning and minor repairs of the M1-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 bottom of the pump.

Filter Replacement

Inlet Filters

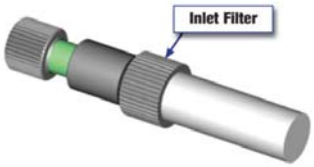


Figure 4, Inlet Filter

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

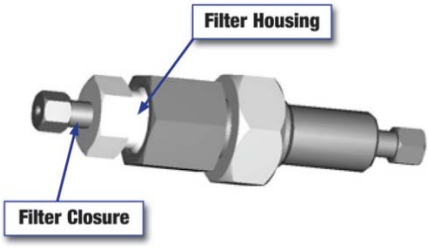


Figure 5, Outlet Filter

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 pump head assemblies are shown in Figures 6. and 7.

NOTE: Before removing the pump head assembly, momentarily turn ON the pump and quickly turn OFF the power upon hearing the refill stroke. This reduces the extension of the piston and decreases the possibility of piston breakage.

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 flushing check valves.
7. Carefully remove the two knurled thumb screws or Allen nuts at the front of the pump head using a suitable tool.

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. Be careful not to break or damage the piston.

10. Remove the self-flush diaphragm from the piston by carefully grasping the sealing flange on two sides and sliding it straight out on the piston being careful not to exert side pressure that may break the piston.

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 seals are removed: 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.

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. Gently place the diaphragm onto the piston with center hub protruding away from the pump. Push diaphragm all the way back into recess and against metal base of piston. Do not exert pressure perpendicular to the length of the piston, as this may cause the piston to break.

2. Carefully align the flush housing and gently slide it into place on the pump. Make sure that the Inlet valve is on the bottom and the Outlet valve is on the top. If misalignment with the piston occurs, gently push up on the piston holder.

3. Install the O-ring in its grove.

4. 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.

5. Tighten the thumb nuts that hold the pump head in 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.

6. Torque the thumb nuts to 30 in-lbs using a suitable torque wrench and 5/32” hex adaptor.

   Reattach the inlet and outlet lines. Reattach the self-flush lines. Change the flushing solution.

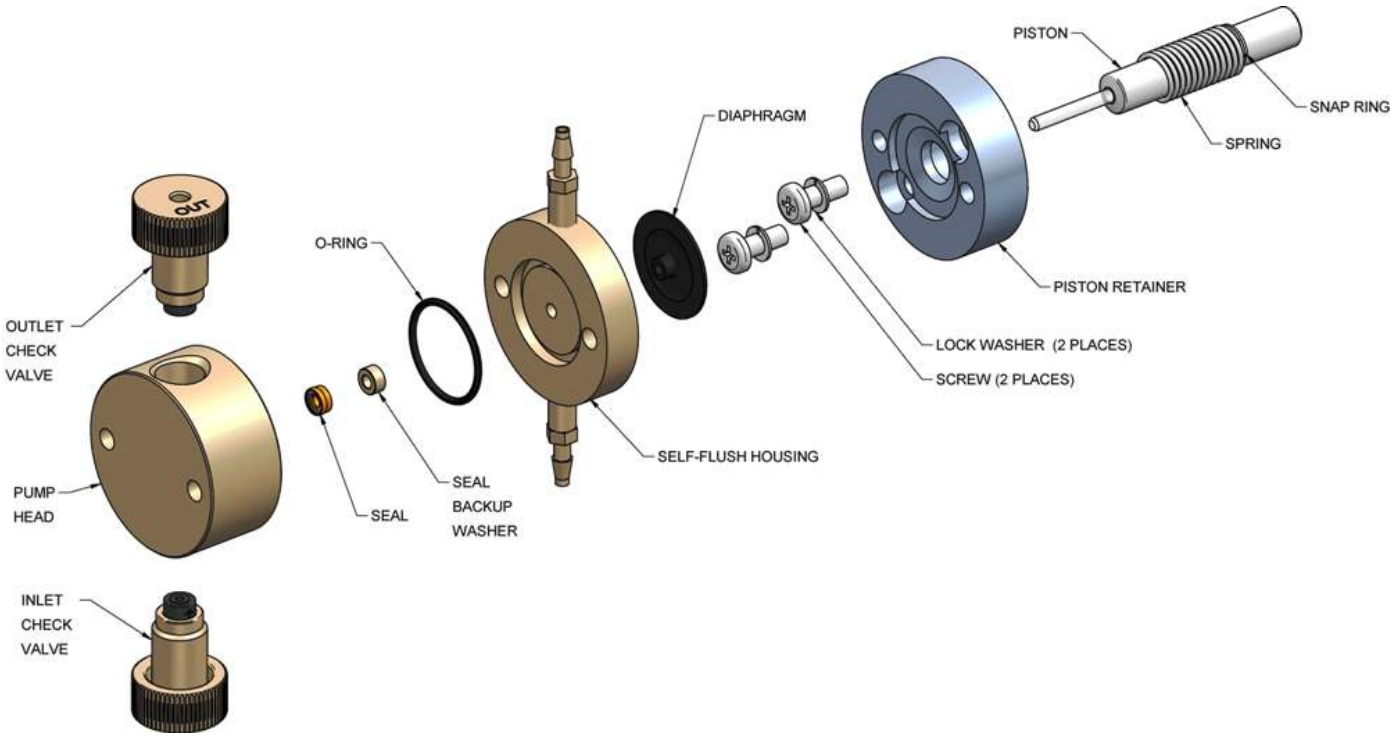


Figure 6, PEEK Self-Flushing Pump Head Assembly

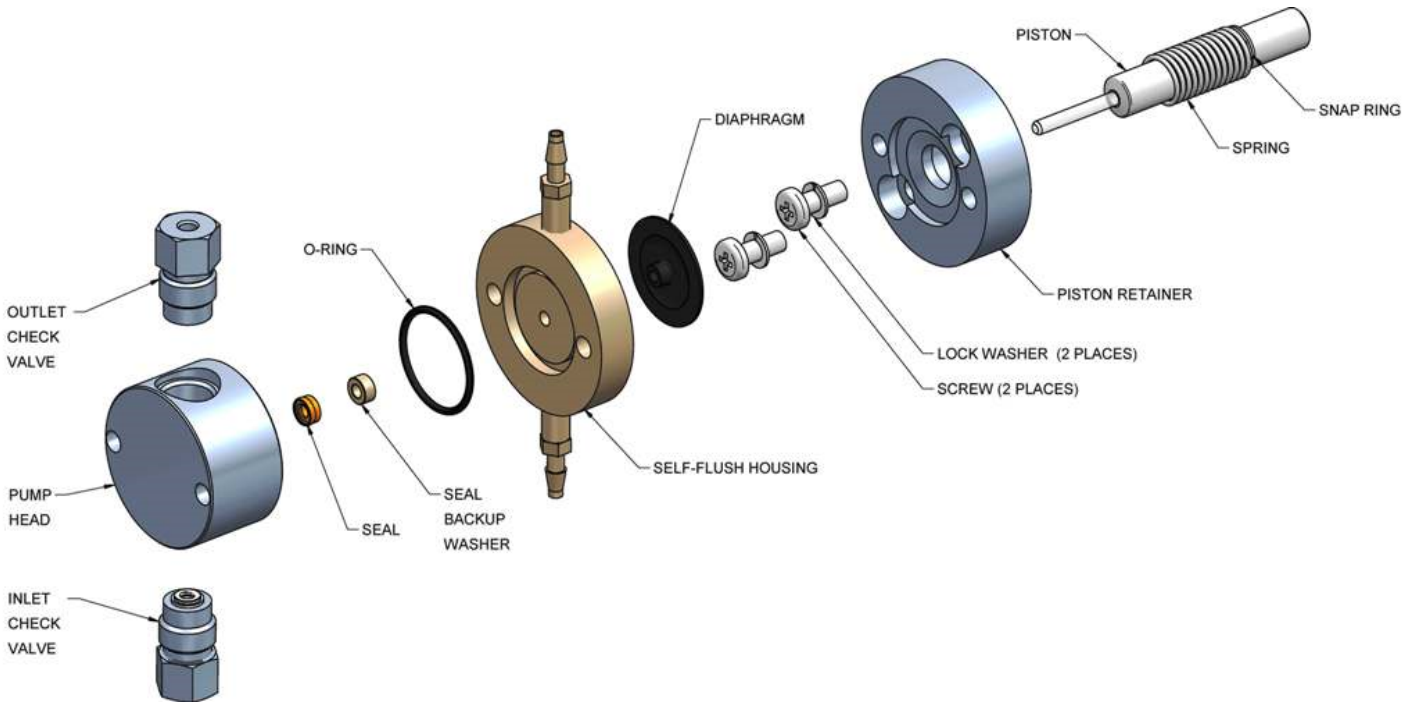


Figure 7, Stainless Steel Self-Flushing Pump Head Assembly

Piston Seals

Replacing Piston Seal

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.

The spare parts list details the pump head types and appropriate seal kit choices. Each replacement seal kit contains one seal, one backup washer, a seal insertion/removal tool, a diaphragm, and a pad to clean the piston when changing the seal.

Removing the Seal

1. Remove the pump head 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. Inspect, and if necessary, clean the pump head as described above.

Replacing the Seal

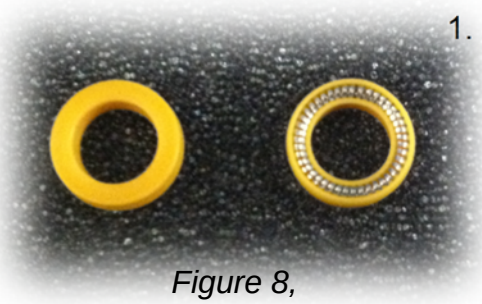


Figure 8, Example of polymer side vs. energizer side of seal. Note: stainless steel energizer shown. Seal could have fluoropolymer o-ring energizer instead (black o-ring).

1. Place a high pressure replacement seal (Figure 8) on the rod-shaped end of the seal insertion/removal tool so that the energizer side is visible when the seal is fully seated on the tool. Insert the seal into the pump head so that the energizer 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 looking into the pump head cavity, only the polymer side of the seal should be visible.
2. Install the seal backup washer in the pump head.

TIP: In some cases it may be easier to slide the backup washer onto the piston prior to replacing the pump head with the seal already installed.

3. Replace the pump head as described below.
4. Condition the new seal 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 below and according to the pump head type.

Pump Type	Pressure	Flow Rate
M1-Class, 5 mL/min pump	1,000 psi	3 mL/min
M1-Class, 10 mL/min pump	1,000 psi	6 mL/min
M1-Class, 40/100 mL/min pump	250 psi	30 mL/min

Pistons

Cleaning the Piston

NOTE: It is an optional step to remove the piston in order to clean it, but not necessary. Move to step 5. if not removing piston to clean.

1. Remove the pump head and self-flush housing, as described above.
2. Press the piston retainer against the pump housing, remove the two Philips head screws from the retainer. Do not allow the spring pressure to force the retainer away from the housing as the screws are loosened.
3. After both screws have been removed, slowly allow the spring pressure to push the retainer out of the housing. Gently pull the retainer straight out and carefully remove it from the piston and threaded rods. Also, gently pull the spring straight out of the housing and remove.
4. Grasp the metal base of the piston assembly to avoid exerting any pressure perpendicular to the length of the piston, and gently pull it from the pump housing.
5. 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.

Replacing the Piston

1. Remove the pump head and self-flush housing, as described above.
2. Press the piston retainer against the pump housing, remove the two Philips head screws from the retainer. Do not allow the spring pressure to force the retainer away from the housing as the screws are loosened.
3. After both screws have been removed, slowly allow the spring pressure to push the retainer out of the housing. Gently pull the retainer straight out and carefully remove it from the piston and threaded rods. Also, gently pull the spring straight out of the housing and remove.
4. Grasp the metal base of the piston assembly to avoid exerting any pressure perpendicular to the length of the piston, and gently pull it from the pump housing.
5. Remove the snap ring from the groove on the old piston and place it into the groove on the new piston.

6. Place a small amount of high quality grease on the back end of the metal base of the piston assembly. Grasp the metal base of the piston assembly near the front to avoid exerting any pressure perpendicular to the length of the piston, and gently slide it into the pump housing.
7. Gently slide the spring over the piston assembly and back into the pump housing. Carefully align the retainer and gently push it straight in against the spring force until the retainer is against the housing. If misalignment with the piston occurs, wiggle while pushing the retainer to align the piston & retainer.
8. Hold the retainer flush against the housing. Insert and tighten the Philips head screws. Do not allow the spring pressure to force the retainer away from the housing. Insure that there are no gaps between the retainer and the housing.
9. Replace the pump head assembly.

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/100 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 9* below.

Check Valve Replacement

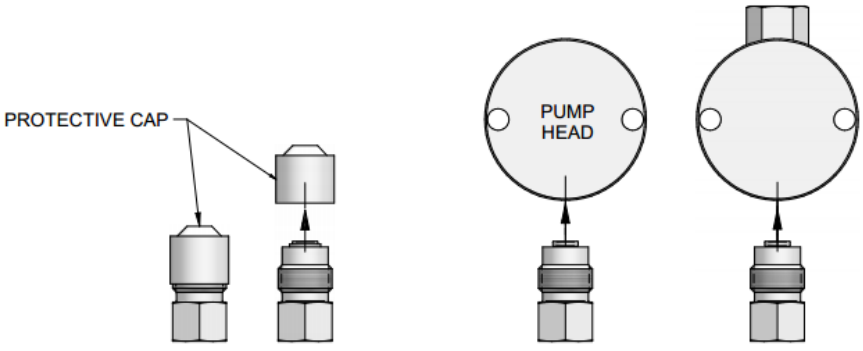


Figure 9, New Check Valves from package and proper orientation.

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 9,* 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.

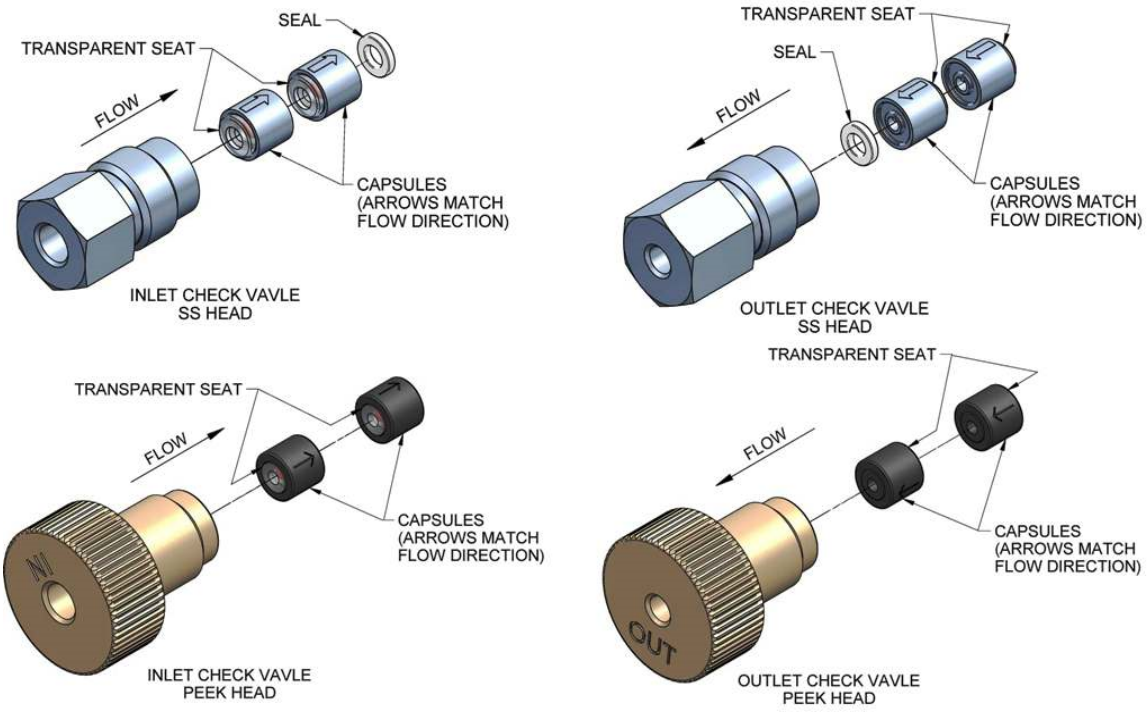


Figure 10, Stainless Steel (SS) and PEEK Check Valves.

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 TEFZEL seal (as shown in *Figure 10* above). There is no TEFZEL 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. Pump, check valves can be replaced without removing the pump head.

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. Remove the four screws that secure the pulse damper from the underside of the pump.
4. 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 four mounting holes in the bottom of the cabinet. the pressure transducer should be pointed toward the rear of the cabinet.
2. From the underside of the pump cabinet, tighten the four screws to hold the pulse damper in place.
3. Connect the tubing from the pump head to one port of the pulse damper. Connect the line from the prime/purge valve to the other port.
4. 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.

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

Lubrication

The M1-Class pump has no lubrication requirements. The bearings in the pump housing and piston carrier are permanently lubricated and require no maintenance. Keeping the interior of the pump free of dirt and dust will extend the pump's useful life.

Fuse Replacement

One fuse protects the M1-Class Pump, and is located at the rear of the cabinet (Figure 11). Access it by pressing in on the fuse housing with a flathead screwdriver and turning ¼ turn counterclockwise.

NOTE: Disconnect power before checking any fuse.

Troubleshooting the fuse is straightforward. If the power cord is plugged in and the on/off power switch is on and the display does not light, check the fuse in the rear of the cabinet.

Fuse requirements are 1A, 250V time lag for the M1-Class. The fuse is 5x20mm in size. One fuse is required per pump.

Figure 11, 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 diaphragm is worn.	1. Fittings not tight. 2. Long usage time since last seal / diaphragm change. 3. Salt deposits on seal or diaphragm (especially if buffered aqueous mobile phases are used).	1. Check all connections for leaks. 2. Replace piston seal & diaphragm. 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, 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 - POWER-UP FUCTIONS & RS-232 INTERFACE

Rear Panel Serial Communications Port

A USB 2.0 Micro-B and an RJ12 6P6C RS-232C port are provided on the back panel. 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 port. 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 by default for 9600 baud, 8 data bits, 1 stop bit, and no parity. The connector is a standard RJ12 modular telephone type jack. When looking at the connector on the rear panel of the pump, pin 1 is at the top and pin 6 is at the bottom. The pin-out is:

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

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

Pump (RJ12)	Signal	IBM (DB25)[a]	IBM (DE9)[b]
1, 6	Ground	7	5
2	DSR	20	4
3	RXD	2	3
4	TXD	3	2
5	DTR	6	6

a Jumper pins 4, 5, and 8 on DB25.
b Jumper pins 1, 7, and 8 on DE9.

Command Interpreter

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

Each command is characterized by a unique two-letter command code. Commands are not case sensitive; that is, the command codes "ST" "St" "sT" and "st" are all equivalent. Response strings sent by the pump are terminated by the "/" character.

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

Optionally, a carriage return may be used to indicate the end of a transmitted string. A received carriage return will cause the pump to immediately respond to the received command, and may help speed communications.

Pump Command List

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.
MF	OK,MF:<max_flow>/	Maximum Flow Rate: returns the maximum allowable flow rate for the pump, in ml/min.

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
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. FC102.5/ = 102.5% compensation, or +2.5%
UCxxxx	OK,UC:<user>/	User Compensation: stores user flow rate compensation where xxx.x = xxx.x % e.g. FC102.5/ = 102.5% compensation, or +2.5% input range: 0850 to 1150
ZS	OK/	Zero Seal Counter: reset seal life stroke counter to zero.
#	(no response)	Clears all characters from the command buffer.

8. APPENDIX B

Specifications for the M1-Class Pump, 5 mL/min

Flow Rate*	0.01 to 5.00 mL/min
Pressure	0 to 2,000 psi for Stainless Steel or PEEK head
Flow Accuracy	Within 2% of set flow rate, 0.20 mL/min and above; 80:20 Water/IPA @ 1000 psi
Flow Precision	0.5% RSD
Dimensions	5.5" H x 3" W x 10.5" D
Weight	3.5 lbs
Power	External Power Supply; To Supply: 100-240 VAC, 50-60 Hz, 40 W From Supply to Pump: 24VDC, center positive, 2.1mm post, 1.7 AMP

From Supply to Pump: 24VDC, center positive, 2.1mm post, 1.7 AMP

Features	Autoflush™ piston wash
Remote Inputs	RS-232, USB 2.0 Micro-B
Fuse Ratings	1A, 250V time lag, 5x20mm size, one required per pump

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

Specifications for the M1-Class Pump, 10 mL/min

Flow Rate*	0.01 to 10.00 mL/min
Pressure	0 to 2,000 psi for Stainless Steel or PEEK head
Flow Accuracy	Within 2% of set flow rate, 0.20 mL/min and above; 80:20 Water/IPA @ 1000 psi
Flow Precision	0.5% RSD
Dimensions	5.5" H x 3" W x 10.5" D
Weight	3.5 lbs
Power	External Power Supply; To Supply: 100-240 VAC, 50-60 Hz, 40 W From Supply to Pump: 24VDC, center positive, 2.1mm post, 1.7 AMP

From Supply to Pump: 24VDC, center positive, 2.1mm post, 1.7 AMP

Features	Autoflush™ piston wash
Remote Inputs	RS-232, USB 2.0 Micro-B

Fuse Ratings ..... 1A, 250V time lag, 5x20mm size, one required per pump

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

Specifications for the M1-Class Pump, 40 mL/min

Flow Rate* ..... 0.1 to 40.0 mL/min

Pressure ..... 0 to 500 psi for Stainless Steel or PEEK head

Flow Accuracy ..... Within 5% of set flow rate, 0.8 mL/min and above;
80:20 Water/IPA @ 100 psi

Flow Precision ..... 1.0% RSD

Dimensions ..... 5.5" H x 3" W x 10.5" D

Weight ..... 3.5 lbs

Power ..... External Power Supply;
To Supply: 100-240 VAC, 50-60 Hz, 40 W
From Supply to Pump: 24VDC, center positive,
2.1mm post, 1.7 AMP

Features ..... Autoflush™ piston wash

Remote Inputs ..... RS-232, USB 2.0 Micro-B

Fuse Ratings ..... 1A, 250V time lag, 5x20mm size, one required per pump

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

Specifications for the M1-Class Pump, 100 mL/min

Flow Rate* ..... 0.1 to 100.0 mL/min

Pressure ..... 0 to 250 psi for Stainless Steel or PEEK head

Flow Accuracy ..... Within 5% of set flow rate, 2 mL/min and above;
80:20 Water/IPA @ 100 psi

Flow Precision ..... 1.0% RSD

Dimensions ..... 5.5" H x 3" W x 10.5" D

Weight ..... 3.5 lbs

Power ..... External Power Supply;
To Supply: 100-240 VAC, 50-60 Hz, 40 W
From Supply to Pump: 24VDC, center positive,
2.1mm post, 1.7 AMP

Features ..... Autoflush™ piston wash

Remote Inputs ..... RS-232, USB 2.0 Micro-B

Fuse Ratings ..... 1A, 250V time lag, 5x20mm size, one required per pump

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

9. WARRANTY STATEMENT

Teledyne ISCO Three Year Limited Warranty

The Limited Warranty is exclusive to Teledyne ISCO ("Teledyne") trademarked Good(s) providing a three-year limited warranty against defects in material or workmanship for each Good(s) containing a serial number. The limited warranty shall, unless otherwise agreed, commence at the time of original shipment from Teledyne. Good(s) found to be defective during the warranty period will be repaired or replaced by the factory designated service center at no charge to the customer. The determination to repair or replace defective Good(s) shall reside solely with Teledyne. Teledyne's sole liability is exclusively limited to the repair or replacement of the defective Good(s).

No item may be returned for service without a Return Material Authorization (RMA) number issued by Teledyne.

Teledyne is not liable for consequential, administrative, or punitive damages including loss of use.

Teledyne will pay surface transportation charges to and from the service center within the 48 contiguous United States of America for the repair or replacement of Good(s) proved to be defective within the first 30 days of original shipment.

During the remainder of the warranty period, the customer will pay to return the defective Good(s) to Teledyne. Teledyne will not pay airfreight or customer's packing and crating charges.

The Limited Warranty does not cover loss or damage resulting from transportation between the customer's facility and the service center.

The limited warranty excludes damage caused by normal wear and tear, expendable/consumable items, including but not limited to, desiccant, pH sensors, charts, ribbon, lamps, tubing, and glassware; fittings and wetted parts including valves; check valves, pistons, piston seals, wash seals, cylinders, pulse damper, diaphragms, inlet lines and filter elements, and damage due to corrosion, misuse, accident, improper installation, or failure to properly maintain as specified in the Installation and Operation Manual applicable to the Good(s). This warranty does not cover products sold under any other trademark, or for which any other warranty is specifically stated.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES AND OBLIGATIONS AND TELEDYNE ISCO SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

****This warranty is only applicable within the United States of America and countries where Teledyne does not have an authorized representative.****

Issues may often be resolved without returning the instrument to the service center. Please call the applicable Repair Services number below prior to requesting an RMA

Additional warranty terms available at www.teledyneisco.com/en-us/terms-and-conditions/customer-terms-and-conditions

Shipping Address: Teledyne ISCO – Attention: Repair Services
4700 Superior Street
Lincoln, NE 68504 USA

Mailing Address: Teledyne ISCO
PO Box 82531
Lincoln, NE 68501 USA

Phone:
Repair Services: (800) 775-2965 (Scientific Instruments)
(866) 298-6174 (Water & WasteWater)
Customer Service: (800) 228-4373 (USA & Canada)
Fax: (402) 465-3001
Email: iscoservice@teledyne.com

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