

Mighty Mini

Positive Displacement Metering & Dispensing Pump



Operator's Manual

90-2591 Rev E



Scientific Systems, Inc.

349 N Science Park Rd., State College PA 16803

Phone: 800-441-4752 / 814-234-7317 Fax: 814-238-7532

www.laballiance.com

Table of Contents

1. INTRODUCTION	1-1
1.1 Description of the MightyMini Pump	1-1
1.1.1 Pump Features	1-1
1.1.2 Wetted Materials	1-2
1.2 Specifications for the MightyMini Pump	1-2

2. INSTALLATION	2-1
2.1 Unpacking and Inspection.....	2-1
2.2 Location/Environment.....	2-1
2.3 Electrical Connections.....	2-1
2.4 Solvent Preparation.....	2-1
2.4.1 Solvent Out-gassing and Sparging	2-1
2.4.2 Cavitation	2-2
2.4.3 Filtration	2-2
2.4.4 Solvents With Harmful Effects	2-2
2.5 Instrument Installation	2-3
2.5.1 Mobile Phase Reservoirs	2-3
2.5.2 Inlet Tubing and Filters	2-3
2.5.3 Outlet Tubing	2-3
2.5.4 Priming the Pump and the Flushing Lines	2-3
2.6 Preparation for Storage or Shipping.....	2-4
2.6.1 Isopropanol or methanol Flush	2-4
2.6.2 Packaging for Shipping.....	2-4

3. OPERATION	3-1
3.1 Front Panel.....	3-1
3.1.1. Digital Display Pump Keypad.....	3-1
3.1.2. Status L.E.D.....	3-2
3.1.3. Power-up Configuration.....	3-2
3.1.4. Power-up Flow Rate Calibration.....	3-2
3.1.5. Power-up Tests.....	3-2
3.2 Rear Panel Remote Inputs	3-4
3.2.1 Hardware Implementation.....	3-4
3.2.2 Hand-Shaking	3-5
3.2.3 Command Interpreter.....	3-5
3.3 MightyMini Control Options.....	3-7

4. THEORY OF OPERATION.....	4-1
4.1 Mechanical Operation	4-1

4.1.1 Liquid System Flow Path	4-1
4.1.2 Pump Cycle	4-1
4.2 Electronic Control	4-1
4.2.1 Microprocessor Control.....	4-1
4.2.2 Power Supply.....	4-2
4.2.3 Remote Interfacing	4-2
4.2.4 Motor Stall Detector.....	4-2
<hr/>	
5. MAINTENANCE	5-1
5.1 Filter Replacement	5-1
5.1.1 Inlet Filters	5-1
5.2 Changing Pump Heads	5-1
5.2.1 Removing a Pump Head.....	5-1
5.2.2 Cleaning the Pump Head Assembly.....	5-3
5.2.3 Replacing Piston Seals.....	5-3
5.2.3.1 Removing the Seals.....	5-4
5.2.3.2 Cleaning the piston.....	5-4
5.2.3.3 Replacing the Seals.....	5-5
5.2.4 Changing the Piston	5-5
5.2.5 Replacing the Pump Head.....	5-5
5.3 Conditioning New Seals	5-6
5.4 Check Valve Cleaning and Replacement	5-6
5.5 Cleaning the Pump.....	5-7
5.6 Lubrication.....	5-8
5.7 Fuse Replacement.....	5-8
5.8 Quick Guide to problem Solving.....	5-9
<hr/>	
6. LIST OF REPLACEMENT PARTS	6-1
Warranty Statement	6-2

1. INTRODUCTION

This operator's manual contains information needed to install, operate, and maintain the Mighty Mini Positive Displacement Metering and Dispensing Pump.

1.1 Description of the Mighty Mini Pump

The Mighty Mini Metering and Dispensing pump is designed to provide accurate metering for demanding applications. The flow rate on a Mighty Mini pump fitted with 5 mL pump heads can be set in 0.001 mL increments from 0.001 to 5.000 mL/min. Pump heads are constructed of biocompatible (metal-free) PEEK™ material.

The low pulsation flow rates produced by the reciprocating, single-piston pumps are achieved by using a programmed stepper motor to accelerate the refill cycle.

1.1.1 Pump Features

- Single-Head Design with Stepper Motor Drive and Electronic Fast Refill
- Sapphire Piston and High Performance UHMW, HPLC-grade Seal
- Ruby Ball / Sapphire Seat Check Valves
- External 24-Volt Power Supply - Universal Input:
90 – 260 VAC / 50 – 60 Hz
- Positive Displacement Provides Consistent Flow Rates with Varying Back Pressure
- All PEEK (Plastic) Fluid Path (except where indicated)
- Isolation Cavity behind Pump Head with Vent/Weep Holes; can be configured for Automatic Piston Wash – consult factory
- Available in Kit-Form for OEM Applications
- Interactive Digital Keypad, RS-232 PC Control & Monitoring, Remote Run/Stop
- Fluid Path Isolated from Electrical Components
- EZChrom and other PC drivers available; Multiple Unit Control (up to 4 Mighty-Mini pumps) with SCU Handheld Controller – see SCU data sheet
- Digital stepper motor design prevents flow rate drift over time and temperature variations

1.1.2 *Wetted Materials*

Pump heads, check valve bodies, and tubing are made out of PEEK™. Other materials common to the pump are synthetic ruby and sapphire (check valve internals and piston), stainless steel (piston ferrule), and fluorocarbons (seals)

1.2 **Specifications for the Mighty Mini Pump**

Flow Rate Range 0.001 to 5.000 mL/min

Pressure Capability 500 p.s.i. across entire flow range

Flow Accuracy..... $\pm 5\%$ for a flow rate of 0.20 mL/min and above, with 80:20 Water/IPA @ 500psi*

Note: Flow accuracy may degrade if back pressure drops below 100 psi

Flow Repeatability..... 0.2% RSD

Pulsation $\pm 10\%$ @ 2.5 ml/min and 500 p.s.i.

Dimensions 5" H x 3" W x 10.5" D

Weight 3.0 lbs

Power External Power Supply

To Supply: 90-260Vac, 50-60 Hz, 30W

From Supply to Pump 24VDC, center positive, 2.1mm post, 2 AMP

Remote Inputs.....RS-232

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

2. INSTALLATION

2.1 Unpacking and Inspection

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

2.2 Location/Environment

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

2.3 Electrical Connections

Unpack the Mighty Mini 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.

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

2.4 Solvent Preparation

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

2.4.1 Solvent Out-gassing and Sparging

Solvent out-gassing occurs because the mobile phase contains dissolved atmospheric gases, primarily N₂ and O₂. These dissolved gases may lead to bubble formation and should be removed by degassing the reagents 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 solvents, so other gases dissolved in the solvent diffuse into the

helium bubbles and are swept from the system. Solvent filtration is not an effective alternative to helium degassing.

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

Solvent mixtures using water and organic solvents (like methanol 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.

2.4.2 Cavitation

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

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

2.4.3 Filtration

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

2.4.4 Solvents With Harmful Effects

The use of THF, Methylene Chloride, and/or Concentrated Sulfuric Acid is to be avoided with the PEEK™ pumps.

2.5 Instrument Installation

2.5.1 Mobile Phase Reservoirs

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

2.5.2 Inlet Tubing and Filters

The inlet tubing used in the Mighty Mini pumps (all head types) is 0.085" ID x 1/8" OD. All inlet lines are supplied in a 36" (91 cm) length, and are made of a Teflon-based material. Use a 0.5 micron slip-on inlet filter.

2.5.3 Outlet Tubing

Outlet tubing (not supplied with the pump) should have a 1/16" outer diameter. PEEK™ tubing with a 0.020" inner diameter is normally used. The tubing must be cut squarely with no burrs. The tube itself should not be crimped and the center hole must be open. PEEK™ tubing may be cut with a plastic tubing cutter or razor knife.

2.5.4 Priming the Pump and the Flushing Lines

Connect a syringe to a pump head. Run each pump head at a flow rate of 3 to 5 mL/min. Prime the pump head by pulling mobile phase and any air bubbles through the pump head and into the syringe (a minimum of 10 mL). Connect the outlet tubing back to the pump head.

2.6 Preparation for Storage or Shipping

2.6.1 *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.

2.6.2 *Packaging for Shipping*

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

3. OPERATION

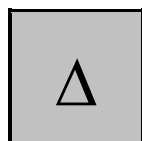
3.1 Front Panel



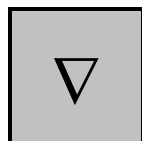
Mighty Mini Pump Front Panel

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

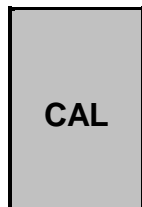
3.1.1. Digital Display Pump Keypad



When pressed, this button increases the flow rate set point.



When pressed, this button decreases the flow rate set point.



This button is used to adjust flow calibration (as required). Calibration is a power-up function (see below).

This button is also used to cycle between **Prime** and **Normal** mode. In **Prime** mode, pump flow rate ramps up to maximum (5 ml/min) and holds there until CAL button is pressed again.



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

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

3.1.2. Status LEDs

- RUN Lights to indicate that the pump is running.
- FAULT Lights when a fault occurs and stops the pump.

3.1.3. Power-up Configuration

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

3.1.4. Power-up Flow Rate Calibration

The Mighty Mini includes a calibration feature to improve flow rate accuracy for the wide variety of solvents that may be used with the pump.

The factory flow calibration is based on 80/20 v/v Water/IPA with 500 p.s.i. back pressure.

Flow calibration can be adjusted to incorporate flow characteristics of various solvents, by using a compensation number that is built into the pumps programming. NOTE:

- The function is available at power up for the pump.
- While turning on the power depress the CAL key.
- Factory default is "100". And Resetting the pump will reset the variable to "100".
- Increase or decrease this by using the UP or DOWN arrow keys.
- Each step will change the flow rate by 1%. Flow Rate can be adjusted between 95% and 105% of the factory setting.

3.1.5. Power-Up Tests

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

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

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

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

3.2 Rear Panel Remote Inputs

One RS-232C modular jack is provided on the back panel. A computer with appropriate software or the keypad control module is used as a remote control device for pump operation via this connection.

3.2.1 Hardware Implementation

Each REMOTE INPUT serial communications port is configured for 9600 baud, 8 data bits, 1 stop bit, and no parity. The connector is a standard RJ-11 modular telephone type jack. The pin-out is:

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

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

<u>Pump (RJ11)</u>	<u>Signal</u>	<u>IBM (DB25)^a</u>	<u>IBM (DB9)^b</u>
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 DB9.

3.2.2 Hand-Shaking

The Mighty Mini pump uses hardware handshaking. Each pump monitors the DSR input and disables the DTR output when the pumps are in refill. In addition, the pump will not transmit if the DSR input becomes active.

3.2.3 Command Interpreter

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

Each command is characterized by a unique two-letter command code, and only one command can be issued per line. Case is not important; that is, the command codes "RU" "Ru" "rU" and "ru" are all equivalent. Response strings sent by the pump are terminated by the "/" character. The command packets are listed in Table 3-1.

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

Table 3-1. Mighty Mini Pump Commands

Command	Response	Comments
RU	OK/	Sets the pump to the RUN state.
ST	OK/	Sets the pump to the STOP state.
FLxxx	OK/	Sets the flowrate to x.xx mL/min where the range is fixed for the pump head size, i.e., for 0.01 to 5.00 mL/min xxx = 001 to 500.
FMxxxx	OK/	Sets the flowrate to x.xxx mL/min, i.e. for 0.001 to 9.999mL/min xxxx = 0001 to 9999. for 10.00 to 12.00mL/min xxxx = 1000 to 1200
FOxxxx	OK/	Sets the flowrate to xx.xx mL/min where the range is fixed for the pump head size, i.e., for 0.01 to 5.00 mL/min xxxx = 0001 to 0500.
CC	OK,0,y.yy/ (y.yy or yy.yy)	Reads the pump's current flowrate, where: y.yy or yy.yy = Flowrate in mL/min
CS	OK,x.xxx,0,0,PSI,w,v,1/ (x.xxx or xx.xx)	Reads the current pump setup, where: x.xxx or xx.xx = Flowrate in mL/min PSI = Units (PSI, ATM, MPA, BAR, or KGC) w = Pump head size (0 = standard) v = Run status (0 = stopped, 1 = running)
ID	OK,vx.xx 161m511 firmware/	Identifies the pump type and EPROM revision x.xx
RF	OK,x,y,z	Reads the fault status, where: x = Motor stall fault (0 = no, 1 = yes) y = Upper pressure limit fault (0 = no, 1 = yes) z = Lower pressure limit fault (0 = no, 1 = yes)
HTx	OK/	Sets the pump head type, where: x = 1 for a stainless steel 10 mL/min pump head x = 2 for a plastic 10 mL/min pump head The pump is stopped; and, the pressure compensation and pressure limits are initialized, when the head type is changed.
KD	OK/	Disables the keypad. (Default status at power-up is enabled.)
KE	OK/	Enables the keypad.
RH	OK,x/	Reads the pump head type, where: x = 1 for a stainless steel 10 mL/min pump head x = 2 for a plastic 10 mL/min pump head
SF	OK/	Puts the pump in fault mode. Turns on the FAULT LED and stops the pump immediately.
RE	OK/	Resets the pump configuration to its default power-up state.
#	(no response)	Clears all characters from the command buffer.

PI	OK,a.aaa,b,c,d,1,0,g,0,0,0 ,k,l,m,n,0,0,q/ (a.aaa or aa.aa) (c or cc)	Reads the current pump setup, where: a.aaa or aa.aa = Flowrate in mL/min b = Run status (0 = stopped, 1 = running) c or cc = Flow Calibration d = Pump head type (see RH command) g = 1 if pump started and frequency controlled, else 0 k = Priming (0 = no, 1 = yes) l = Keypad lockout (0 = no, 1 = yes) m = PUMP-RUN input (0 = inactive, 1 = active) n = PUMP-STOP input (0 = inactive, 1 = active) o = ENABLE IN input(0 = inactive, 1 =active) q = Motor stall fault (0 = no, 1 = yes)
----	--	---

3.3 Mighty Mini Control Options

Control of the Mighty Mini pump is achieved using the RS-232 port on the rear panel. Various user-selectable pump control options are available, ranging from a compact keypad controller to a high-end software package for an entire system. A summary of the main features of each control option is presented below with a brief installation procedure. Refer to the appropriate manual for details.

4. THEORY OF OPERATION

4.1 Mechanical Operation

4.1.1 Liquid System Flow Path

The flow path of the Mighty Mini pump starts at the inlet of each pump head, pumps through the pump heads, and out the outlet of the pump head.

4.1.2 Pump Cycle

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

During the pumping phase, the pump piston moves forward driven by an eccentric cam connected directly to a motor.

At the end of the pumping phase, the pump enters the refill phase. The motor speed is adjusted by the microprocessor, so that the piston quickly retracts, refilling the pump head with solvent. The piston then moves forward again as the pumping phase begins.

4.2 Electronic Control

4.2.1 Microprocessor Control

The pump is controlled by hybrid microprocessor circuitry, which (1) provides control signals to the motor power board, (2) provides external input/output and remote control interfacing. Firmware programming is stored in an EPROM.

The motor power board contains programmed logic components which (1) provide suitable motor micro-stepping modes, (2) allow appropriate motor power adjustment, (3) maximize motor power output, (4) reduce motor resonance effects, and (5) customize motor stepping uniformity.

The microprocessor optimizes the refill speed for the set flow rate. As a result, at 1 mL/min flow the refill rate is more than five times faster than if the motor operated at constant speed. The optimum refill minimizes the resulting pulsation while avoiding cavitation effects in the solvent entering the pump head.

The flow rate of any high-pressure pump can vary depending on the operating pressure and the compressibility of the fluid being pumped. The pump is calibrated at 500 psi using an 80:20 mixture of water and isopropanol.

4.2.2 Power Supply

Using the supply provided with the pump, inputs from 100-240 VAC, 50-60 Hz are acceptable. Using a power supply not provided by SSI, or an inappropriate power cord may result in undesirable operating conditions.

4.2.3 Remote Interfacing

One RS-232C modular jack is provided on the back panel. See Section 3.2 for information on pump operation via this connection.

4.2.4 Motor Stall Detector

The motor can stall and create a loud buzzing sound if the flow path connected to the pump's outlet becomes plugged, if the pressure exceeds the maximum pressure rating of the pump, or if the mechanism jams. In the event a motor stall occurs, the electrical current being supplied to the motor is turned off and the fault status can be determined through the RS232 "PI" or "RF" commands. See Section 3.2.3.

The fault is canceled by sending a stop ("ST") command via the serial communications port on the back panel.

5. MAINTENANCE

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

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

5.1 Filter Replacement

5.1.1 Inlet Filters

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

5.2 Changing Pump Heads

5.2.1 Removing a Pump Head

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

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

CAUTION: Check that the cap screws at the front of the pump head are secure before removing any tubing from the pump head.

3. Remove the inlet line from the inlet check valve holder.
4. Remove the outlet line from the outlet check valve holder.
5. Remove inlet and outlet flush tubing.

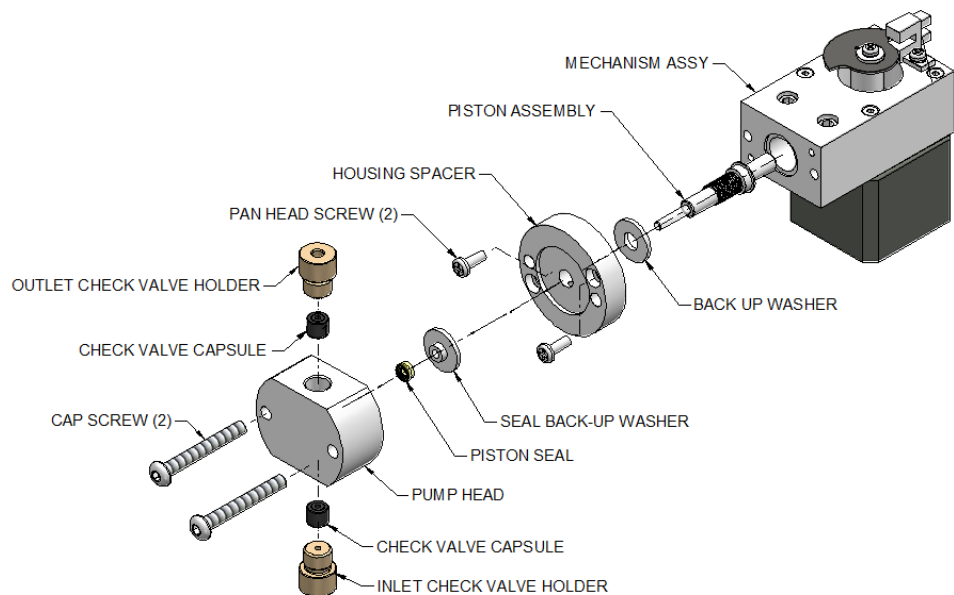
6. Momentarily turn ON the Mighty Mini pump and quickly turn OFF the power upon hearing the refill stroke. This reduces the extension of the piston and decreases the possibility of piston breakage.
7. Unplug the power cord.
8. Carefully remove the two cap screws at the front of the pump head using a 1/8" Allen Wrench.

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

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

CAUTION: Use care when removing the flush housing. Housing retains compression spring. Hold housing tightly while removing pan head screws.

10. Carefully remove the two pan head screws holding the flush housing on the pump using a Phillips screwdriver. Separate the self-flush housing from the pump. Move the self-flush housing straight out from the pump and remove it from the piston. Be careful not to break or damage the piston. Also remove the backup washer and piston assembly from the pump.



Mighty Mini Pump Head and Mechanism Assembly

5.2.2 *Cleaning the Pump Head Assembly*

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

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

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

3. If the check valves have been removed, tighten the check valves on Bioclean (PEEK™) pumps firmly by hand. Do not go $\frac{1}{4}$ turn past finger tight.

If the piston seal has been removed, insert a new seal as described in Section 5.2.3, then continue with Section 5.2.5 to replace the pump head.

5.2.3 *Replacing Piston Seals*

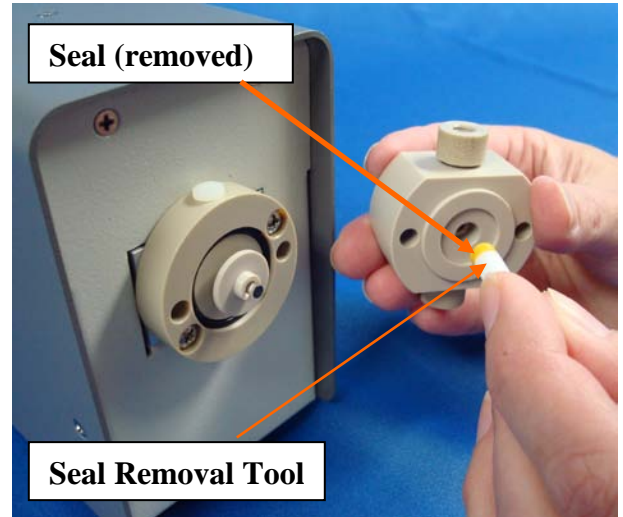
Lower than normal pressure, pressure variations, and leaks in the pumping system can all indicate possible problems with the piston seal. Depending on the fluid or mobile phase used, piston seal replacement is often necessary after 1000 hours of running time.

Each replacement seal kit contains one seal, one backup washer, one seal insertion/removal tools, and a pad to clean the piston when changing the seal.

5.2.3.1 Removing the Seals

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

CAUTION: Using any other "tool" will scratch the finish.



5.2.3.2 Cleaning the Piston

1. Once the pump head is removed, gently remove the flush housing by removing the two screws holding it to the housing.
2. Grasp the metal base of the piston assembly so that you avoid exerting any side load on the sapphire rod, and remove the piston from the housing.
3. Use the scouring pad included in the seal replacement kit to clean the piston. Gently squeeze the piston within a folded section of the pad and rub the pad along the length of the piston. Rotate the piston frequently to assure the entire surface is scrubbed. Do not exert pressure perpendicular to the length of the piston, as this may cause the piston to break. After scouring, use a lint-free cloth, dampened with alcohol, to wipe the piston clean.
4. Grasp the metal base of the piston assembly, and insert it into the bushing in the housing. Do not remove the grease that may be on the metal end of the piston.

5.2.3.3 Replacing the Seals

1. Place a high-pressure replacement seal on the rod-shaped end of the seal insertion/removal tool so that the spring is visible when the seal is fully seated on the tool. Insert the tool into the pump head so that the open side of the seal enters first, facing the high-pressure cavity of the pump head. Be careful to line up the seal with the cavity while inserting. Then withdraw the tool, leaving the seal in the pump head. When you look into the pump head cavity, only the polymer portion of the seal should be visible.
2. Place seal back-up washer over the high-pressure seal. Place seal back-up washer over the counter-bore of the flush housing. Orientation is not important in these cases.
3. Attach the pump head as described in Section 5.2.5. Use caution so as not to damage the sapphire piston.
4. Condition the new seal as described in Section 5.3.

5.2.4 Changing the Piston

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

5.2.5 Replacing the Pump Head

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

1. Make sure that the inlet valve is on the bottom and the outlet valve is on the top. Carefully align the flush housing and gently slide it into place on the pump. If misalignment with the piston occurs, gently push up on the piston housing. Tighten the two screws that hold the flush housing onto the mechanism housing.

2. Line up the pump head and carefully slide it into place. Be sure that the inlet valve is on the bottom and the outlet valve is on the top. Do not force the pump head into place.
3. Tighten the button head screws that hold the head into place. To tighten firmly, alternately turn screws 1/4 turn while gently wiggling the pump head to center it.

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

4. Re-attach the inlet and outlet lines.

5.3 Conditioning New Seals

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

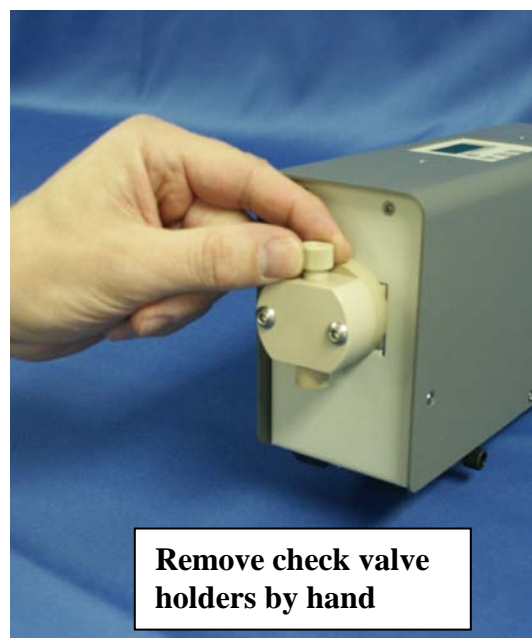
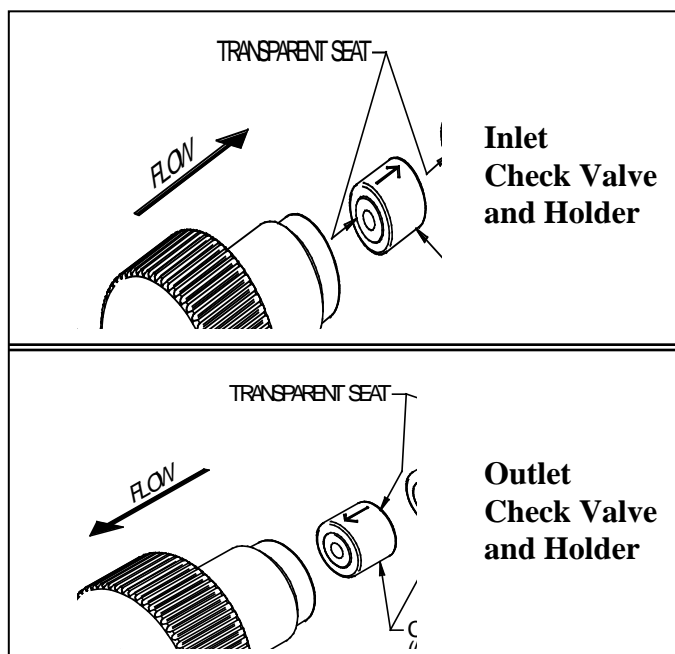
Using a restrictor coil or a suitable column, run the pump with a 50:50 solution of isopropanol (or methanol) and water for 30 minutes at the back pressure and flow rate listed under PHASE 1 below.

Pump Head Type	PHASE 1 (30 min.)	
	Pressure	Flow Rate
(PEEK)	250 psi	< 2.5 mL/min.

5.4 Check Valve Cleaning and Replacement

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

To replace the check valves, first turn OFF the power to the pump. Remove the inlet line and filter from the mobile phase reservoir. Be careful not to damage the inlet filter or crimp the Teflon tubing. Remove the outlet line from the outlet check valve and the inlet line from the inlet check valve. Loosen each check valve holder, preferably by hand, or using a suitable tool if required. Completely remove the holder and locate the black check valve capsule inside. Remove the capsule, noting the proper orientation as shown below. The capsule and holder are both discarded.



The check valve kit includes a new capsule and check valve holder, both inlet and outlet. The inlet check valve holder has a larger opening (1/4"-28, flat-bottom seat) for the 1/8" inlet tubing; the outlet check valve has a smaller opening (#10-32, cone seat) for the 1/16" outlet tubing. The capsules are the same (interchangeable), but oriented differently when installed.

The inlet check valve holder must be connected at the bottom opening in the pump head, and the outlet at the top. Install the new capsule into the head with the proper orientation as shown above. Then thread the new holder into the proper pump head port until snug. Tighten firmly by hand, no more than one quarter turn past snug. **DO NOT OVER TIGHTEN.**

Note that the black check valve capsules have a directional arrow etched into the body as shown above to ensure proper orientation.

Note that with the Mighty Mini pump, check valves can be replaced without removing the pump head.

5.5 Cleaning the Pump

1. Disconnect the outlet tube.
2. Insert a waste line in the pump outlet.
3. Set the flow rate to maximum.
3. Pump 100% methanol or isopropanol through the pump and injector for 3 minutes.
5. Pump 100% filtered, distilled water through the pump and injector for 3 minutes.

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

6. 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.

5.6 Lubrication

The Mighty Mini pump has no lubrication requirements. The bearings in the pump housing and piston carrier are permanently lubricated and require no maintenance.

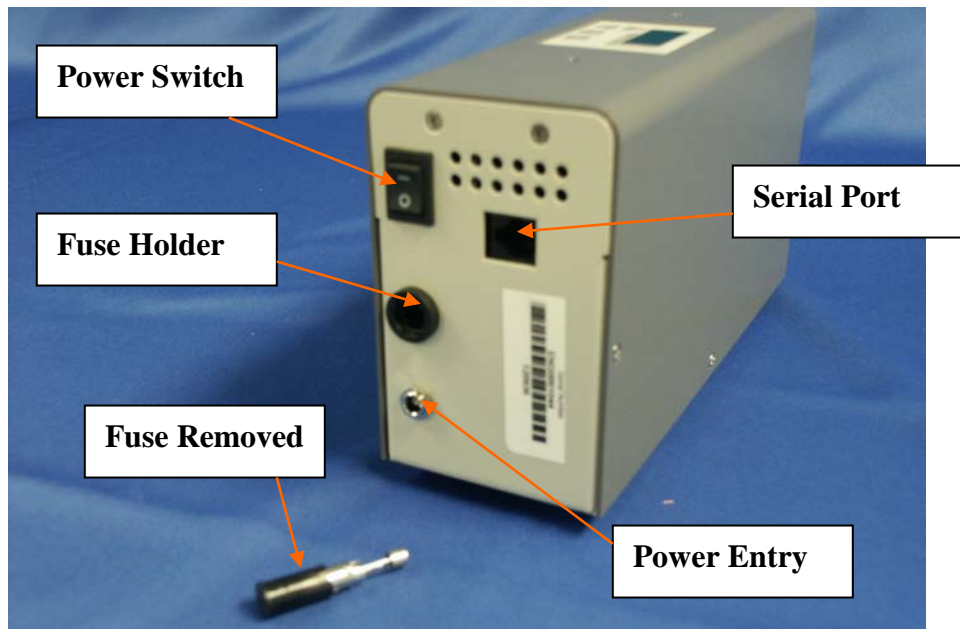
5.7 Fuse Replacement

Two fuses protect the Mighty Mini pump. One fuse is located at the rear of the cabinet. Access it by pressing in on the fuse holder and turning ¼-turn counterclockwise.

The other fuse is located on the motor power circuit board.

NOTE: Disconnect power before checking any fuse.

Troubleshooting the fuses is straightforward. If the power cord is plugged in and the ON/OFF power switch is ON and none of the displays light, check the 0.5A Slo-Blo fuse at the rear of the cabinet. If a particular pump does not run, check the 5A Slo-Blo fuse on the drive circuit board located inside the cabinet.



Quick Guide to Problem Solving

<u>You Notice</u>	<u>This May Mean</u>	<u>Possible Cause</u>	<u>You Should</u>
<ol style="list-style-type: none"> 1. Uneven pressure trace. 2. Pressure drops. 3. Pump shuts OFF. 4. No flow out the outlet check valve. 	<ol style="list-style-type: none"> 1. Bubble in check valve. 2. Leaks in system. 3. Dirty check valve. 4. Bad check valve. 	<ol style="list-style-type: none"> 1. Solvent not properly degassed. 2. Fittings are not tight. 3. Mobile phase not properly filtered. 4. Particles from worn piston seal caught in check valve. 5. Plugged inlet filter. 	<ol style="list-style-type: none"> 1. Check to be certain that mobile phase is properly degassed. 2. Check connections for leaks by tightening fittings. 3. Prime the system directly from the outlet check valve. 4. Clean or replace the check valves. See Section 5.4. 5. Clean or replace inlet filter. See Section 5.1.1.
<ol style="list-style-type: none"> 1. Uneven pressure trace. 2. Pressure drops. 3. Fluid between the pump head and the chassis. 	<ol style="list-style-type: none"> 1. Leaks in system. 2. The piston seal(s) are worn. 	<ol style="list-style-type: none"> 1. Fittings not tight. 2. Long usage time since last seal change. 3. Salt deposits on seal (especially if buffered aqueous mobile phases are used without the flush head.) 	<ol style="list-style-type: none"> 1. Check all connections for leaks. 2. Replace piston seal. See Sections 5.2 and 5.3. 3. Check the piston for salt deposits. Clean as necessary. See Section 5.2.4.
<p>Pump makes a loud clanging or slapping noise (intermittent contact with cam).</p>	<p>Piston carrier is catching in piston guide.</p>	<ol style="list-style-type: none"> 1. Cap nut screws on the pump head are loose. 2. Seal(s) are worn. 3. Piston guide is worn 4. Salt build-up on piston carrier from use of buffers. 5. Excess lubricant on piston carrier. 	<ol style="list-style-type: none"> 1. Check cap nut screws on pump head. Tighten if necessary. 2. Replace seals. 3. Replace piston guide and seals. See Sections 5.2 and 5.3. 4. Consider changing to a flushing pump head if using buffers. 5. Clean excess lubricant and dirt off piston carrier. See Section 5.7.
<ol style="list-style-type: none"> 1. Pump shuts down after run is called even with no column connected. 	<p>Clog in fluid system.</p>		<ol style="list-style-type: none"> 1. Remove and clean both the inlet and bulkhead filters. See Section 5.2. 2. If the problem persists, remove tubing from system one piece at a time until you find the clogged piece. Most clogs occur outside the pump itself.
<p>No power when pump turned ON.</p>	<p>Blown fuses in the power entry module.</p>	<ol style="list-style-type: none"> 1. Power surge. 2. Internal short. 	<ol style="list-style-type: none"> 1. Replace only with the appropriate fuses (1A for 100-120 Vac or 1/2A for 220-240 Vac). 2. Contact service technician if problem persists.
<p>PEEK fittings or components leak.</p>	<p>You cannot force PEEK parts with interference to seal by brute force tightening.</p>	<ol style="list-style-type: none"> 1. Film of fluid between surfaces. 2. Salt crystals between surfaces. 3. Scratches in mating surfaces. 	<ol style="list-style-type: none"> 1. Clean and dry mating surfaces. 2. If scratched, replace defective part.
<p>Flush heads leak flush solution.</p>	<p>Flush area not sealed.</p>	<ol style="list-style-type: none"> 1. Large (Size 016) O-ring is flattened and no longer seals. 2. Head not sufficiently tightened. 3. Scratches in mating surfaces. 4. Leaky flush seal. 	<ol style="list-style-type: none"> 1. Replace O-ring. 2. Tighten head. 3. Replace leaky parts.

6. LIST OF REPLACEMENT PARTS

Bioclean (PEEK™)

<u>Part No.</u>	<u>Description</u>
880454	Mighty Mini check valve replacement kit
880195	Mighty Mini seal kit, includes seal and tool
880350	Mighty Mini piston assembly (1 ea)
880140	Mighty Mini PCB with program (1ea)
880971	Mighty Mini front PCB board
880341	Mighty Mini Head Kit

Scientific Systems, Inc.

Warranty Statement

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

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

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

The warranty shall not apply to wear items, specifically:

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

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

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

Limitations of Warranty. THE FOREGOING WARRANTIES AND LIMITATIONS ARE CUSTOMER'S EXCLUSIVE REMEDIES AND ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.