USERS GUIDE

MODEL 500G GRADIENT
HPLC SYSTEM

Analytical Scientific Instruments

TABLE OF CONTENTS

Analytical Scientific Instruments, Inc.
1-800-344-4340

Model 500G Gradient HPLC System

Description and Specifications

The Model 500G Gradient HPLC System consists of two dual piston reciprocating pumps with high pressure mixing. The pumps come configured with one of four pump heads: Micro, Analytical, Semi-prep, or Prep. In each case the pumps feature a self-priming pump head, a patented "floating pump seal" design for extended seal wear, and an integral prime/purge assembly for changing solvent quickly. The user interface includes intuitive software control and programmable solvent compressibility compensation.

Model 500G Specifications: Micro Pump Head

Flow Rate:	Programmable from 0.5 µL/Minute to 4 mL/Minute
Maximum Pressure Setting:	6,000 psi (Default = 5,400 psi)
Maximum Pressure Cap.:	6,000 psi at 4 mL/minute as indicated on the pump display panel.
Accuracy:	+/- 1% or +/- 2 microliter/min., whichever is greater
Precision:	.25% from 0.1 mL/min. to 10 mL/min. at 20 degrees C

Model 500G Specifications: Analytical Pump Head

Flow Rate:	Programmable from .001 mL/Minute to 10 mL/Minute
Maximum Pressure Setting:	6,000 psi (Default = 5,400 psi)
Maximum Pressure Cap.:	6,000 psi at 10 mL/minute as indicated on the pump display panel.
Accuracy:	+/- 1% or +/- 2 microliter/min., whichever is greater
Precision:	.25% from 0.1 mL/min. to 10 mL/min. at 20 degrees C

Model 500G Specifications: Semi-Prep Pump Head

Flow Rate:	Programmble to .010 mL/Minute to 20 mL/Minute
Maximum Pressure Setting:	3,000 psi (Default = 2,500 psi)
Maximum Pressure Cap.:	3,000 psi at 20 mL/minute as indicated on the pump display panel.
Accuracy:	+/- 1% or +/- 4 microliter/min., whichever is greater
Precision:	.25% from 1.0 mL/min. to 20 mL/min. at 20 degrees C

Model 500G Specifications: Prep Pump Head

Flow Rate:	Programmble to .100 mL/Minute to 80 mL/Minute
Maximum Pressure Setting:	1,440 psi (Default = 1,200 psi)
Maximum Pressure:	1,000 psi at 80 mL/minute as indicated on the pump display panel.
Accuracy:	+/- 2% or +/- 20 microliter/min., whichever is greater
Precision:	.5% from 10.0 mL/min. to 80 mL/min. at 20 degrees C

General Specifications Applied to all Pump Head

Operating Temperature:	0C to 40C, Non-Condensing Ambient
Operating Altitude:	2000M MAX
CAT II :	Device
Dimensions:	10 ¼" wide x 6-1/2" high x 14" deep
Weight:	32 Pounds
Power Input:	AC 100-240V 50/60Hz, 100VA
Fuse:	T1.6A, 250V

Note: Accuracy and precision specifications require de-gassed solvents and *ASI* parts and accessories.

Model 500G Gradient HPLC System

Description and Specifications (Continued)

Model 500G Gradient Specifications: All Pump Heads

Programming Control:	Alphanumeric keypad
Gradient Profile:	Step and linear profiles at multiple levels
Number of Programmable Files:	20 files with the ability to link programs
Maximum Program Steps:	20
Maximum Time per Step:	650 minutes in 0.1 steps
Remote Control:	Contact closure and RS232
Concentration Range Setting:	0-100% in 1.0% steps
Flow Rate Accuracy:	See pump specifications previous page

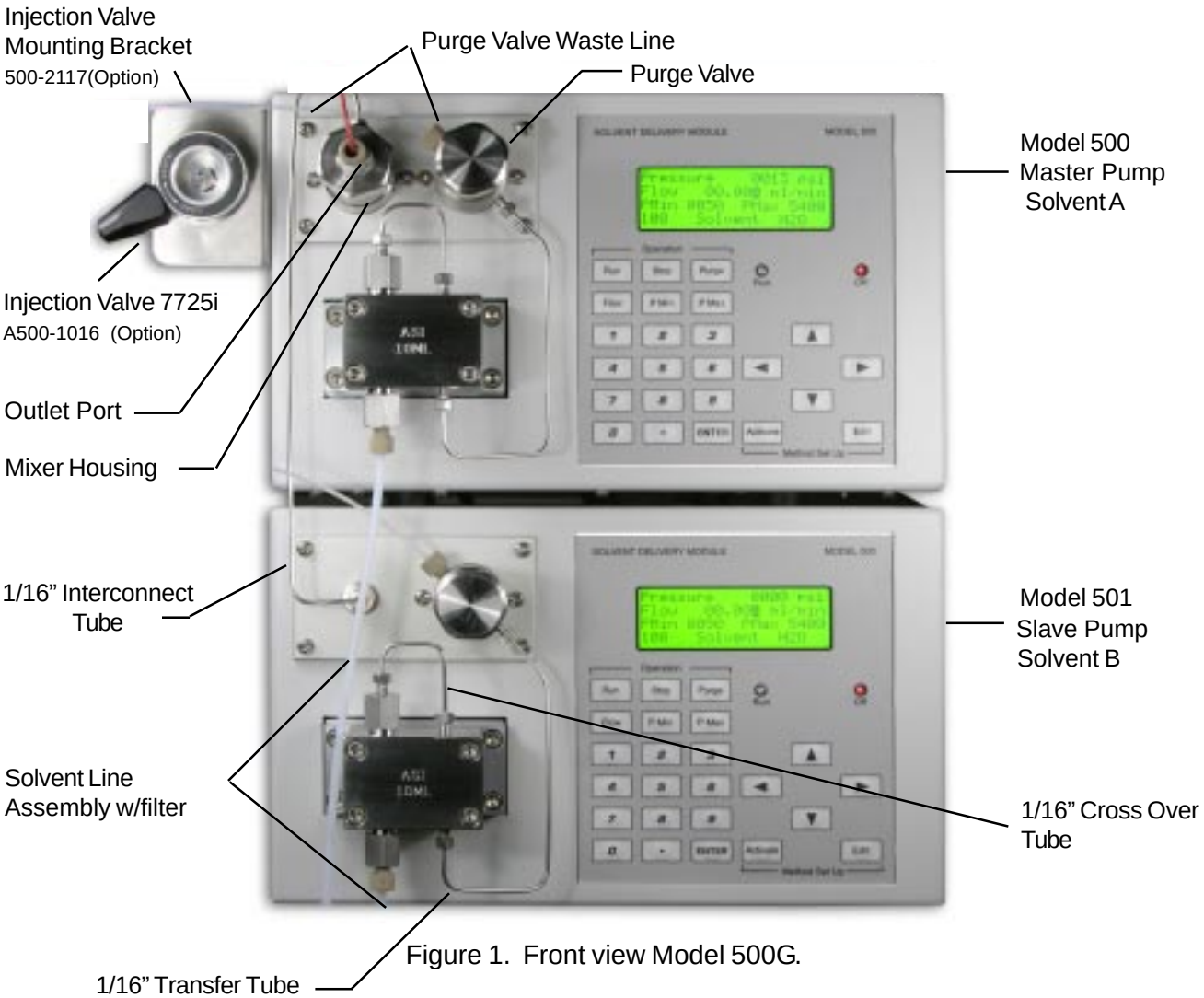


Figure 1. Front view Model 500G.

Model 500G Gradient HPLC System

Unpacking and Installation

The Model 500G Gradient HPLC system consists of two high pressure HPLC pumps. The Model 500 serves as the master control pump and will also be referred to as the pump which delivers solvent A. In addition to control, the Model 500 also incorporates the gradient mixer and external contacts for remote control operation. The Model 501 serves as a slave pump and will also be referred to as the pump which delivers solvent B. Unless it is specifically noted in the user guide text one can assume the same general installation, repair, and trouble shooting procedures apply equally to both pumps.

Important: Cut and remove the two large tie-wraps from the under side of each pump chassis before running the pump. Cut the tie wraps and pull them out of the chassis vents and discard.

1. After unpacking the instrument, check the contents with the packing slip to verify that the shipment is complete. Inspect all items and report any damage immediately to the shipping carrier, your local distributor or *ASI*. If any items are damaged, save the shipping container which may be required for claims purposes.
2. Place pumps on a level bench top with sufficient space for detectors and other ancillary equipment. In a gradient system the pumps are stacked on top of each other with the Model 500 on top. The pumps should be located away from direct sunlight and from areas subject to wide temperature fluctuations such as air vents.
3. Install the solvent inlet line assembly and solvent filter to the pump inlet check valve (**figure 1**). Always use a solvent filter to protect the check valves and system hydraulics from contaminants. Solvent bottles should be placed at approximately the same level as the pump or higher. In special circumstances the solvent reservoir can be located below the pump inlet (maximum 36") without a loss of pump performance.
4. Install optional injection valve mounting bracket with screws provided **(figure 1)**.
5. Install the waste line in the purge valve body (1/4 – 28 finger tight fitting), with the outlet placed in a suitable solvent waste container (**figure 1**).
6. Install the interconnect tube between pumps A and B with the open end wrench provided in the accessory kit. Install an outlet tube (not provided) to the outlet port to connect the Model 500 pump to the rest of the chromatographic system. The outlet port will have a black plug in it for shipping and is located directly to the left of the purge valve (**figure 1**).

Note 1: In order to maintain flow accuracy, it is essential to degas the solvent. The most efficient method of degassing is the use of an inline degasser. Alternatively, solvents can be sonicated under vacuum for approximately 15 minutes or continuously sparged with helium.

***Note 2*:** The pump is shipped with 2-propanol in the pump head. Make sure the new solvent is miscible with 2- propanol or flush with an intermediate solvent to insure solvent compatibility.

Unpackaging and Installation (continued)

7. Plug in the power cord. The power input module is a universal type, which functions at all voltage between 100 and 250V. The fuse valve is 1.6A, and should be a high break time lag or a slow blow.
8. Remote Start, Stop and Analog pressure output funtions are available on the rear panel. Connect pinouts to appropriate external devices. See page 15 for remote control operation.
9. Connect Pump A to Pump B using the RS 232 cable provided in the accessory kit. The RS 232 cable connects to the RS 232 output on Pump A and the RS 232 input on Pump B (**figure 2**).
10. Turn the power on (both pumps) with the main switch at the rear left side of chassis. The red LED lamp located on the right side of the key pad should come on, indicating that the pump is now ready for operation.

Nominal Voltage	**Fuse (Amp)**
100-250V	T 1.6A

Figure 2. Back View Model 500G.

Unpackaging and Installation (continued)

11. At start-up the pump will automatically detect and briefly display the pump head type and software revision. There are four pump head options; Micro, Analytical, Semi-Prep, and Prep.

WARNING!
SHOCK HAZARD

If this system is used in a manner not specified by the manufactuerer, the protection provided by the system may be impaired.

Installing the Wash Seal Option*

The piston wash seal option consists of two sections of 1/16" OD tubing with 1/4 - 28 fittings on one end. The fittings connect to ports on the left (inlet) and bottom (outlet) of the pump manifold (**figure 3)**. The inlet reservoir should be placed next to the pump and the outlet reservoir located on the floor. A wash solution containing 5% isopropol alcohol or methanol is recommended. There will be no damage to the wash seals if the pump is run without a wash solution. To start the flow of wash solution apply vacuum to the outlet tube. The wash solution will flow by gravity as long as the inlet reservoir is higher than the outlet reservoir. The flow of the wash solution is controlled by the relative internal diameters of the inlet (0.020") and outlet (0.020") tubing.

***Note 1:** Applies to pumps ordered with a wash seal option P/N A500-1005K. If a wash seal option is ordered separately, see wash seal installation pg 19.

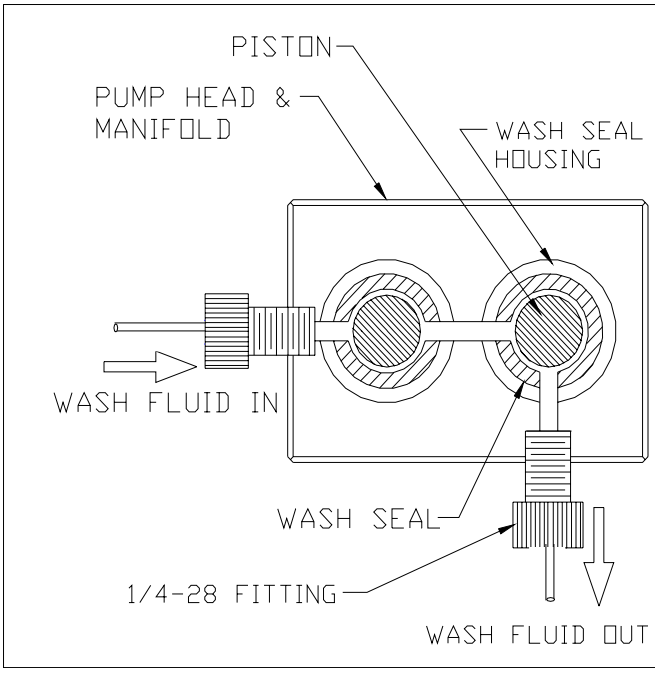


Figure 3. Diagram of Wash Seal Option Connections.

Running the Model 500G Gradient HPLC System

Routine Operation

Priming the Pump

Refer to the keypad layout in figure 4 for key orientation and definition.
1. Open purge valve 1 turn. The pump will self prime at any flow rate. Use of the ***Purge*** function only speeds the process.
2. Press ***Purge*** . The pump will automatically begin to purge at a flow rate of 10mL/min. During this process the pump will draw solvent through the inlet line displacing air until all the air has been purged from the system and flow is evident from the purge valve outlet waste line. The pump is considered primed when no more air is present in the solvent stream coming out of the purge valve waste line. This process usually takes about 2-3 minutes and consumes 20-30mL of solvent. After the purge process is complete, press ***Stop*** **.**
3. Close the purge valve

Note 1: Make sure when you are changing solvents the new and old solvent systems are compatible. If there is a problem with solubility you may have to purge the pump with a solvent of intermediate polarity.

Setting Flow Rate

Refer to the flow screen layout in figure 5 for field orientation.
1. Press ***Flow*** and enter the numerical value for flow rate in mL/min. including a decimal for fractional values.
2. Press ***ENTER*** and ***Run*** or go to another setting . Subsequent changes in flow rate require only entering the numerical value and pressing ***ENTER*** . Changes in flow may also be made by using the ▲ ▼ keys. The pump can be stopped at any time by pressing the ***Stop*** key.

Setting Under-pressure Limit (P Min)

Refer to the keypad layout in figure 4 for key orientation and definition.
1. The default setting for ***P Min*** is 0 psi. Once ***P Min*** is set, this setting becomes the default value. If ***P Min*** has a positive value and the pump is started the prompt "Reset MIN Value ? Yes". will appear requesting ***P Min*** to be reset. The pump will not start if ***P Min*** has a positive value and must be running and under pressure to set ***P Min***.
2. Press ***P Min*** and enter numerical value for ***P Min***, then press ***ENTER*** . The pump will shut off when the pressure drops below this value and prompt "Reset MIN Value ? Yes".
3. Press ***ENTER*** to reset the numerical value for ***P Min*** as required then press ***ENTER*** and ***Run*** .

Note: This is an important feature which will turn the pump off when the solvent bottle is empty. Running a pump for prolonged periods of time without any solvent may damage the piston rods and/or seals.

Routine Operation (Continued)

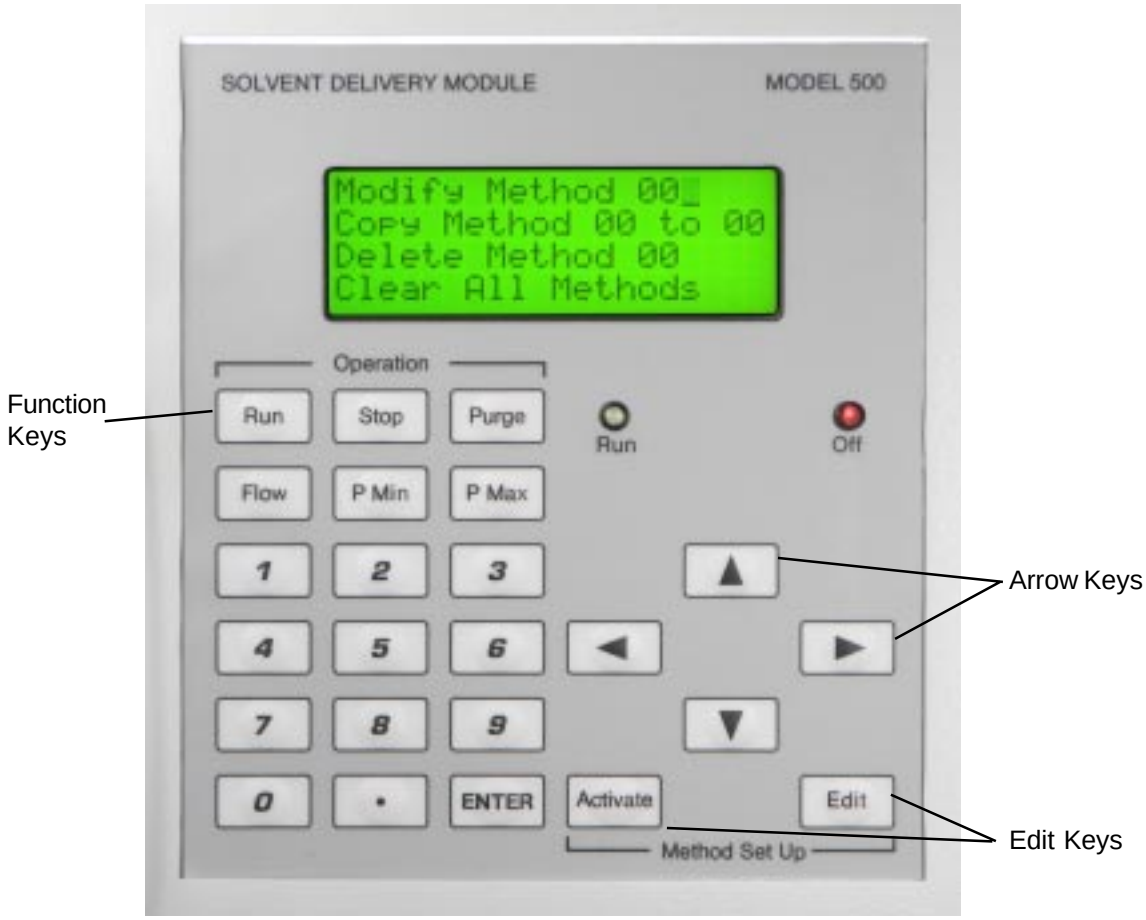


Figure 4. Keypad Layout.

Figure 5. Flow Screen.

Running the Model 500G Gradient HPLC System

Routine Operation (Continued)

Setting Over-pressure Limit (P Max)

1. Press ***P Max*** and enter numerical value for maximum desired over-pressure limit.
2. Press ***ENTER*** then ***Run***. If this ***P Max*** is exceeded, the pump will automatically shut down and prompt "Reset MAX Value ? Yes", then press ***ENTER*** and reset a new ***P Max*** value and press ***ENTER***. In order to resume operation without changing ***P Max*** value press ***ENTER*** and ***Run*** **.** If the pump continues to reach ***P Max*** and shut down, the cause needs to be identified and corrected.

Note: At start-up, the pump automatically detects the head type and sets the maximum pressure to a default value which is 90% of the maximum specified upper pressure limit for the pump head type.

Head Type	Default Limit	Maximum Limit
Analytical head	5,400 psi	6,000 psi
Semi Prep head	2,500 psi	3,000 psi
Prep head	1,200 psi	1,440 psi

Solvent Compressibility Compensation

The Model 501/500 contains a library of solvents and their solvent compressibility factors you can select to automatically compensate for changes in solvent compressibility. The solvents appear on the screen in their abbreviated names as shown in the table on page 11. Relying on the factory default value for solvent compressibility will result in +/- 2.5% accuracy for most solvents and pressures. Selecting the specific solvent being run will result in a +/- 1% accuracy or better for all pressures and for all HPLC solvents.

Note: It is essential to degas the mobile phase to achieve maximum accuracy and minimum pressure pulsations. If air is present in the pump head, pulsation will occur. It may be necessary to run the pump for 10 to 30 minutes to remove residual air in the pump head.

To Select a Solvent:

1. Press ***Flow*** to edit the pump flow screen. A solvent library is listed on page 11. Solvents are displayed in their abbreviated name with a numerical compressibility factor. Use the ▶ key to get to the numerical value and the ▲ ▼ keys to display a solvent to be selected. Press ***ENTER*****,** the pump will now automatically compensate for the compressibility of the selected solvent. For solvents not listed in the library, additional compressibility values can be assigned to any of the labels designated S16 to S29.
2. Use labels S16 to S 29 for solvents whose compressibility values are not in the pump library. Instructions on how to determine compressibility factors (CF) for solvents other than those listed can be found on page 11.

Remote Control:

The Model 500G System can be controlled remotely in one of two ways. External contact closures enables the system to be controlled by most HPLC autosamplers, for instructions see page 15. The 500G system can also be controlled from a remote computer via the RS 232 interface. Software for RS 232 cotrol can be delveloped by the user or provided by third party software control packages like LabView. Please contact *ASI* for a list of RS 232 commands, connections protocols and third party software suppliers and consultants.

Running the Model 500G Gradient HPLC System

Routine Operation (Continued)

Solvent Library

Abbreviation	Solvent Name	Compressibility Factor (CF)
H2O	Water	100
IPA	Isopropal Alcohol	167
Aceto	Acetone	195
MeOH	Methonol	185
THF	Tetrahydrofuran	160
STD	Factory default	125
PPNL2	2 – Propanol	167
AGN	(not assigned)	138
NHPTN	Heptane	200
BTNL2	Butanol - 2	180
ISBTL	Isobutyl Alcohol	190
BTNL1	Butanol – 1	190
BTLAC	n – Butyl Acetate	170
DMTNS	Dimethyl Sulfoxide	167
ACN	Acetonitrile	180
S16 – S29	User selectable	

Determining Compressibility Factors

Use the following procedure to calculate compressibility factor for solvents not listed in the solvent library. In general, the more compressible the solvent, the higher the compressibility factor needs to be. water is 100, hexane is 200.

1. Select H2O as solvent (compressibility factor set to 100)
2. Run the pump at the expected flow rate (setpoint flow rate) and back pressure with the solvent (or solvent mixture). The back pressure should be within +/- 50% of the pressure the pump will normally operate at.
3. Measure the flow rate using a stop watch and volumetric flask or pipette. Measurement time should be more than 90 seconds to insure accuracy.

Calculate solvent compressibility; C, using:

$$C = ((\text{Set point flow rate})/(\text{Measured flow rate}))(A/(B+P))$$

A = .137 B = 43,450 P = operating pressure in psi

Calculate the compressibility factor; CF, using :

$$CF = 100 + (C-.00000301)/.0000000596$$

Running the Model 500G Gradient HPLC System

Routine Operation (Continued)

Editing a Method (**figure 6**)

Using the ***Edit*** key on the lower right corner of the key pad will access the edit screen. Four options will be displayed which can be selected by using the ◄ ► keys.

Edit Screen

Modify Method 00
Copy Method 00 to 00
Delete Method 00
Clear All Methods

To Modify or Build a New Method:

1. Press ***Edit***.
2. Enter the number of the method to be edited, press ***ENTER***. Alternatively, the ▲ ▼ keys can also used to input the numer.
3. Press the ◄ ► key to the parameter that needs to be edited.
4. Enter a new value, press ***ENTER***.

To Copy a Method:

1. Press ***Edit***.
2. Press the ► key once to get to the ***Copy Method*** field.
3. Enter the number of the method to be copied, press ***ENTER***. Use the ▲ ▼ keys to input the number of the method that is to be copied. (Do not press ***ENTER*** yet.)
4. Press the ► key once.
5. Enter the number of the method that will be written over and press ***ENTER***. Alternatively, the ▲ ▼ keys can also used to input the numer.
6. The display will ask you to confirm by pressing ***ENTER*** again. Once the copy is completed, the display will return to the ***Main Operating Menu***.

To Delete a Method:

1. Press ***Edit***.
2. Press the ► key three times to get to the ***Delete Method*** field.
3. Enter the number of the method to be deleted and press ***ENTER***. Alernately, the ▲ ▼ keys can also be used to input the number.
4. The display will ask you to confirm by pressing ***ENTER*** again. Once the method is deleted, the display will return to the ***Edit*** screen.

To Delete all Methods:

1. Press ***Edit***.
2. Use the ► key to get to the ***Clear All Methods*** field press ***ENTER***.
3. The display will ask you to confirm by pressing ***ENTER*** again. Once the methods are deleted, the display will return to the ***Edit*** screen.

Routine Operation (Continued)

Method File and Edit Screens

Figure 6. Edit Screen.

Figure 7. Method File Screen.

Routine Operation (Continued)

Editing a Method File (**figure 7**)
Gradient programming is achieved by editing a gradient method in the Model 500 which is used to control the Model 501. Refer to the edit method and edit program screens in **figures 6 and 7** for field orientation and layout.

Select Method File:
Press ***Edit*** on the Model 500 and with the cursor on *Modify Method* select a program to edit by entering 00 to 25 then press ***ENTER***. The method number can also be input by using the ▲ ▼ keys to increment or decrement. In addition to selecting a program, pressing ***Edit*** also allows you to copy, delete, or clear all programs.

Edit Step Function:
The second field on the method screen is *Step00*. Enter the step size or use the ▲ ▼ keys to change the step size and press ***ENTER***. Enter 0 if you do not want a step gradient. The step size you enter will determine the percentage change in solvent *B* and the gradient time will determine when each step will occur. The number of steps is determined by dividing the change in %B by the step size. The step time is determined by dividing the gradient time by the number of steps. For example, if the step size is 10 and the method gradient is from 0 to 100% B in 30 minutes the number of steps will be 10 (100/10) and the the step time will be 3 (30/10). In other words the B composition will increase 10% every 3 minutes. A programmed isocratic hold is required to hold the composition at 100% B.

Edit Link Function:
The step field is followed by the *Link00* field. The link functions allows you to link the current method being edited to another method file. Enter the desired link file number or use the ▲ ▼ keys to change the link value and press ***ENTER***. When the pump has finished executing the last line of the current method, the pump will begin to execute the first line of the method file number that was entered into the link field.

Edit Flow Rate:
The flow rate is entered in the *Flow* field. Enter the desired flow rate and press ***ENTER***. This flow rate is equal to the combined flow of both pumps, and will remain constant throughout a method run. Pump B will display the flow rate for solvent *B* during the method run.

Edit Method File:
The actual method file is a series of steps (T00 - T19) which include a time (max 650.0 min. per step) and a percent composition (1 - 100) for solvents *A* and *B*. When entering time, decimal points are not required. For example, if you wish to set a time of 10 mintues enter 100. Once the percent composition for solvent A has been entered the solvent *B* percent is entered automatically. Each numerical entry must be followed by pressing the ***ENTER*** key for that entry to be incorporated into the program. With the cursor on a step (T00 - T19) the ▲ ▼ keys can be used to scroll between steps. The keys can be used to scroll between the step time, solvent composition, and steps.

Select Solvents:
See pages 11 for a complete explanation of solvent selection and compressibility. Use the ◀ ▶ keys to place the cursor at the *Slvnt A* field and use the ▲ ▼ keys to select solvent. Follow the same procedure for *for the Slvnt B* field.

Running the Model 500G Gradient HPLC System

Routine Operation (Continued)

Running and Stopping a Method

Press ***Activate***. Enter the number of the method file you wish to run (00 – 25), press ***ENTER*** and ***Run***. This process will start the method file at T0 conditions (times out after 60 minutes) until the ***Run*** key is pressed again or the "Start"/"Common" pins on the back panel are shorted (by remote contact closure **figure 2**). Both of these commands will initiate the method run starting at T0. Pressing ***Stop*** or shorting the "Stop" Common" pins at any time will terminate the method run. If the slave pump is not connected via the RS 232 cable when the ***Run*** key is pressed, a warning will be displayed that says:

********Warning********
Slave not connected
Hit enter to confirm

Make sure the RS232 cable is installed properly between the master and slave pumps. You can override this warning by pressing ***ENTER***. In this condition the master pump will operate by itself with a flow profile that matches the solvent gradient profile for the pump A.

Remote Control by External Contact Closure and Autosampler Control

The *ASI* model 500 gradient system can be controlled from an autosampler or an injector valve, or any external device that will provide a brief contact closure to a terminal on the rear panel of the model 500 pump. The six pin connector terminal includes 3 pins labeled "START", "STOP", and "COMMON" (**figure 2**). **When the 500G system is under autosampler control all timing and injection functions are controlled by the autosampler. If the autosampler requires two common outputs from the Model 500G to activate Start/Stop switch closures use a "jumper" (short piece of wire) to connect the common terminals at the autosampler. Start/Stop functions require a momentary pulse and should normally be left open.**

After a method file has been created, it is run as outlined above by pressing the ***Activate*** , ***ENTER*** and ***Run*** keys. The selected method file will begin at step T0 conditions and maintain these conditions for 60 minutes before "timing out" and automatically stoping the pump. This same "time out" feature is active between multiple method runs, so the user must start the original method within 60 minutes or the pump will stop. During this time the timer (T0) will display the time in 0.10 minute increments. The 500G system is now in the "Idle" condition and is ready to run the method file. The pump return to "Idle" after running each method file.

The "Idle" condition allows the user to equilibrate the chromatography system and the autosampler time to carry out control functions. From the "Idle" condition the method file can be run by pressing ***Run*** on the keypad a second time, or by using an external device (autosampler) to provide a contact closure (short "Start"/"Common") as described above. Once the method run has been initiated the method will start at T0. If an autosampler is being used to run a method multiple times a single contact closure when the 500G system is in the "Idle" condition will start the method again. If the method Link function has been used the system will not go into the "Idle" condition until the Link function has been carried out.

It is generally accepted as good chromatography practice to edit the method file so the starting and ending conditions are the same. Otherwise the method will automatically switch to the T0 conditions at the end of the method file.

Maintenance and Repair

General Maintenance Information

This section covers the replacement and installation of routine replacement parts which can be performed by the user. These repairs are typical of many pumps used in Liquid Chromatography and are described in detail in this section. Other repairs may need to be performed by the factory and can be arranged through your local distributor or routed directly to *ASI*. To maintain your pump in top working condition *ASI* recommends a preventative maintenance schedule which includes replacing both check valve cartridges and pump seals every 6 months. A complete list of user serviceable spare parts required for these operations is located in this manual.

Cleaning Instructions

Before shutting the system down for even brief periods of time flushing and cleaning is recommend. This is especially true if buffer solutions have been used. This procedure will vary depending on the solvent(s) which have been used, and requires flushing the system with appropriate solvents that are ultimately miscible with water. A final flush solution of 50/50 water/alcohol is recommended for both intermediate and long term storage. If a wash option has been installed, purge the wash cavity with compressed air prior to long term storage.

No user serviceable parts under cover. Contact your authorized service engineer for repair.

WARNING: SHOCK HAZARD

Maintenance and Repair

General Maintenance Information (Continued)

Replacing the Check Valve Cartridges (recommended every 6 months)

The pump inlet and outlet check valve cartridges are contained in hex nut housings located on the top (outlet) and bottom (inlet) of the pump head assembly (**figure 8**).

Outlet Check Valve Cartridge: Using the 1/4" open end wrench (provided) loosen the 1/16" cross over tube nuts and remove the 1/16" cross over tube. Remove the outlet housing with a 1/2" open end wrench (not provided) and replace the outlet cartridge making sure the *ASI* arrow on the cartridge is aligned with the flow direction. Replace the housing and cross over tube and tighten all fittings until they are leak free.

Inlet Check Valve Cartridge: Remove the fingertight fitting on the inlet line and follow the same general directions for replacing the outlet cartridge. Be sure the *ASI* arrow on the cartridge is aligned with the flow direction .

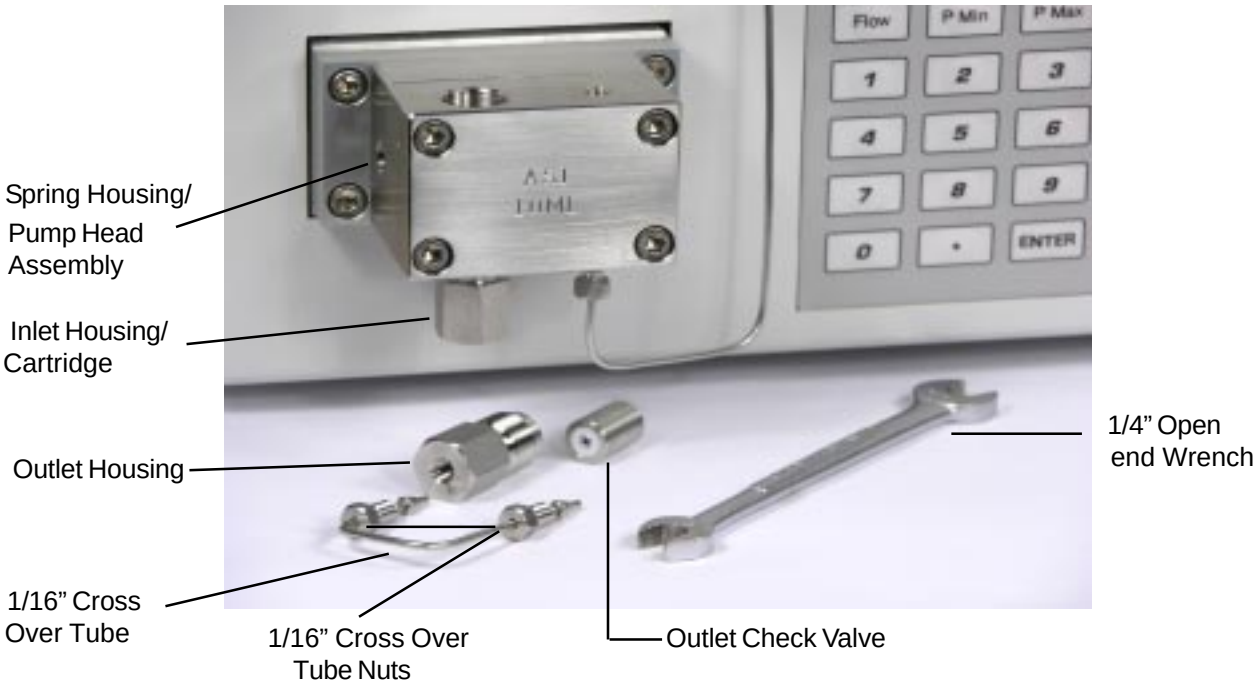


Figure 8. Check Valve Replacement

General Maintenance Information (continued)

Replacing the Piston Seal Assembly (recommended every 6 months)

Using the open end wrench (provided) remove the 1/16" interconnect tube which connects the output of the pump head to the purge valve body (**figure 1**).

Using the 9/64" allen wrench with a T bar handle (provided) loosen and remove the (4) socket head cap screws which connect the pump head to the manifold and spring housing. Loosen these screws evenly. Remove and pull the pump head away from the pump, alignment pins, and manifold. This step will expose the two piston seal assemblies **(figure 9**). The seals may be grasped with the finger tips and gently pulled forward and free of the sapphire piston. Use care when pulling these seals off to avoid scratching of the sapphire piston.

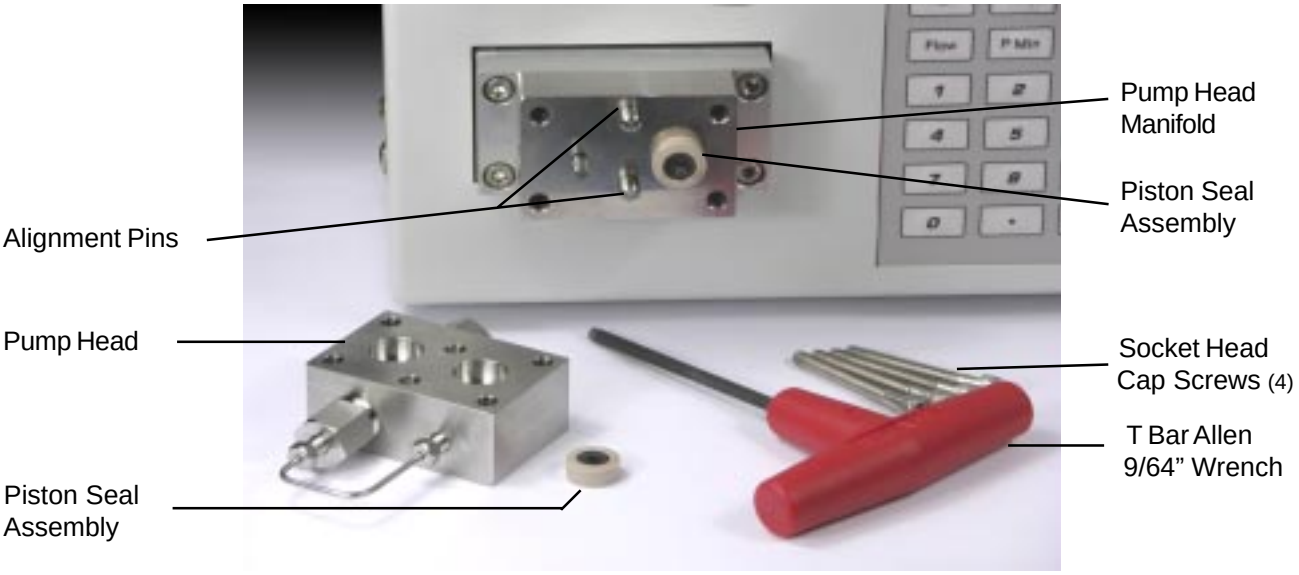


Figure 9. Piston Seal Assembly Replacement.

Push the new piston seal assembly over the end of the exposed sapphire piston with a finger tip or thumb, but do not allow your finger nails to contact the seal as damage may occur. This procedure aligns the piston seal assembly on the sapphire piston. It is normal for the seal not to push completely over the end of the sapphire piston. If the seal is pushed out of the housing during this operation place the piston seal assembly, seal down, on a clean surface and press down to pop the seal back into the housing. Press the seal assemblies partially on the ends of the sapphire piston rods as far as possible without popping the seals out of the housings. Carefully install the pump head on the manifold using the two alignment pins for guidance. When the pump head is pressed firmly against the manifold, the seals will be pressed over the sapphire pistons. To avoid scratching the sapphire piston do not allow the pump head to contact the sapphire piston. Replace the pump head with the socket head cap screws and use the T bar allen wrench to tighten the screws. The screws should be tightened evenly to avoid excess loads. Tighten the upper left screw followed by the lower right screw until a metal to metal seal is achieved. This procedure will compress the PEEK seal housing slightly. Use of the T bar will provide the necessary torque to insure the screws are fully tightened. Re-connect the 1/16" inter-connect tube.

Maintenance and Repair

General Maintenance Information (Continued)

Replacing the Wash Seal Assembly (inspect every 6 months)

If the pump has a wash seal option installed, it may be necessary to inspect and/or replace these seals periodically. Each wash seal assembly (wash seal and PEEK housing) is installed over the metal piston shaft and contained by a recess on the rear side of the manifold similar to the piston seal assembly.

The wash seal assemblies can be inspected, changed, or installed by removing the pump head and the piston seal assemblies described in the previous section. After the piston seal assemblies are removed, remove the 1/4 28 fingertight fittings from the manifold and pull the manifold away from the spring housing and alignment pins until it is free (**figure 3 and 10**). At this stage, the sapphire piston, piston shaft and the face of the spring housing are exposed. Normally the wash seal assemblies will be retained on the stainless steel piston shaft. Remove the wash seal assembly from the piston shaft and clean the piston shaft if necessary. Depending on the condition of the wash seal assemblies they can either be cleaned by sonication or replaced.

Replace the wash seal assembly by pushing the wash seal assembly over the end of the sapphire piston (use care to avoid contact with the sapphire piston) and onto the piston shaft and against the face of the spring housing. Replace the manifold by correctly orienting it with the alignment pins (the pins are asymmetrical) on the spring housing. When pushed forward toward the spring housing, the manifold will contact the face of the spring housing and the wash seal assemblies will be seated properly. Install the piston seal assemblies and pump head following the instructions in the previous section.

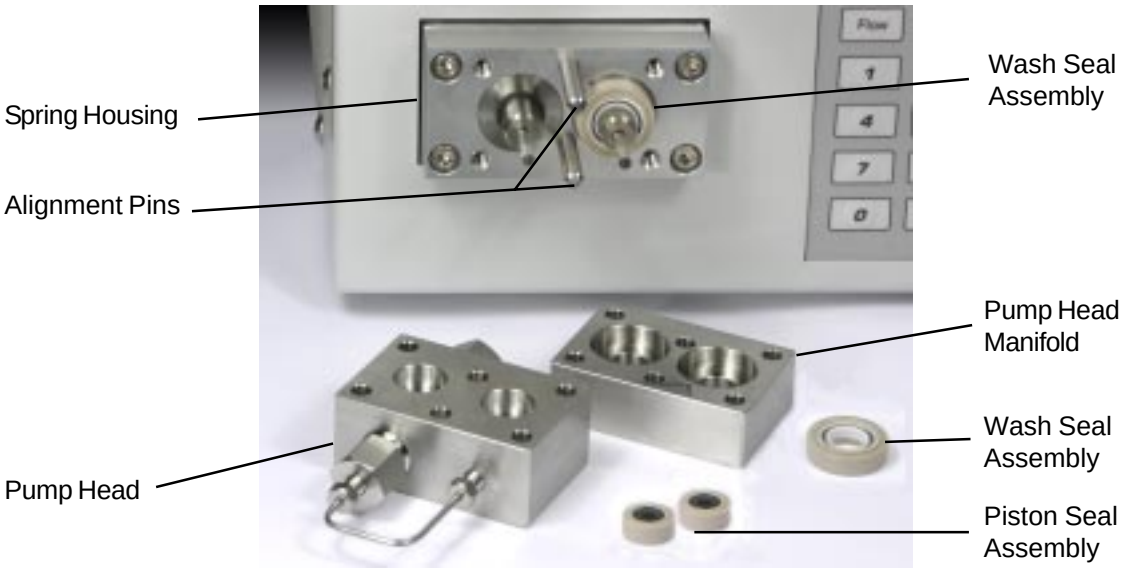


Figure 10. Wash Seal Assembly Replacement

General Service Information (Continued)

Replacing the Sapphire Pistons (inspect every 6 months)

The complete spring housing/pump head assembly (pump head & manifold) must be removed from the pump when the sapphire pistons are being inspected and/or replaced.

Remove the interconnect tube that connects the pump head to the purge valve body. Using the 9/64" T Bar allen wrench, remove the pump head, piston seal assemblies, manifold, and wash seal assemblies, if installed, as described in the previous two sections. Using the same tool, remove the four stainless steel socket head cap screws which attach the spring housing to the frame drive casting (**figure 11**). The spring housing is spring loaded and these springs are compressed when installed. It is necessary to back these four screws out slowly, first loosening the two screws on one side about a turn, and then loosening the two screws on the other side about the same amount, until the assembly if free of the frame drive. Failure to follow this process may cause damage to the screw threads in the frame drive casting. Pull the spring housing free from the pump. The piston shafts are now visibly protruding from the rear of the assembly. **The sapphire piston can fall out of the assembly at this point if the assembly is not kept level.** Gently remove the sapphire pistons from the spring housing assembly. Clean the sapphire piston by sonicating in soapy water and inspect of the sapphire surface under magnification for scratches. Any scratch or defect in the sapphire surface can contribute to leaks.

To re-install sapphire pistons, push the sapphire pistons back into the spring housing through the rear bushings using care to avoid scratching the sapphire surface. Tighten the spring housing to the frame drive casting and install the wash seal assemblies, manifold, piston seal assemblies, and pump head following the procedures described in the previous two sections.

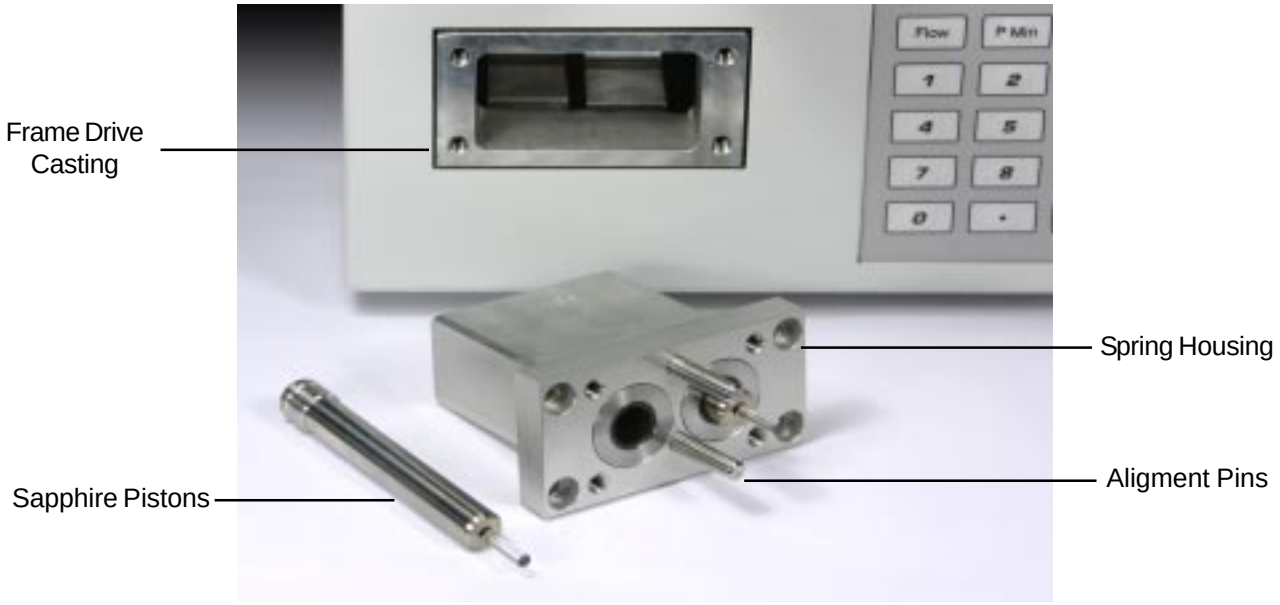


Figure 11. Spring Housing Replacement.

Trouble Shooting Guide

The following trouble shooting guide has been prepared for the novice as well as experienced service technician. Often it is more expedient to simply replace old parts with new ones and get back to work, but for the chromatographer who doesn't have the budget for that, or who is down on a weekend with no spare parts, we hope these tips get your HPLC pump up and running, and keep it running.

Problem	Cause	Remedy
Erratic Pressure	Dirty inlet valve	Remove inlet valve and flush with 50mL of clean HPLC grade solvent.
	Dirty outlet valve	Replace with new valve. *ASI* uses the same check valve cartridge for both inlet and outlet.
	Clogged solvent filter	Replace with new filter.
	Leak at solvent inlet line [1]	Tighten fitting or replace.
	Worn pump seal or piston	Replace seal. Inspect piston and replace if worn.
	Air in pump head [2]	Purge pump for 30 seconds, then operate at 1,000 PSI or higher. The air will dissolve in the solvent and be expelled within about 30 minutes.
	Not using degassed Solvents	Degas, preferably using vacuum and sonication.
	Bubbles in inlet line	Degas solvent. Replace solvent inlet filter. Make sure solvent bottle still has solvent!

[1] ***Note:*** *This problem may not be easy to detect! On the intake side of the pump there is a slight vacuum, so air will leak into the pump rather than solvent leaking out. There will be no visible sign of a leak. To detect this problem, make sure that there is no air in the intake lines, then open the outlet fitting and watch for air bubbles coming out (place a drop of solvent at the outlet fitting to observe air bubbles). If you continue to observe air bubbles after 60 seconds, then air is probably entering the head from the inlet fitting, a leaky pump seal, or an insufficiently tightened inlet housing.*

[2] ***Note****: This symptom is normal after replacing a pump seal or piston. Wet the seal and inside of the pump head with IPA to reduce the amount of time it takes to eliminate air from the head.*

Trouble Shooting Guide Continued

Problem	Cause	Remedy
Operating pressure is lower than normal	Worn seal or piston	Replace seal. Inspect piston and replace if worn.
	Air in pump head or intake line	Purge pump for 30 seconds, then operate at 1,000 PSI or higher. The air will dissolve in the solvent and be expelled within about 30 minutes.
	Clogged solvent inlet filter	Clean or replace with new filter
	Dirty inlet valve / outlet valve	Remove valve and flush with 50 mL of clean HPLC grade solvent. Replace with new check valve.
	Leaky fitting [1]	Tighten or replace fitting
Seal Life unusually Short	Worn or scratched piston [2]	Replace with new piston.
	Build-up of salts on piston	Always run DI water through the pump before shutting down for the day when running buffers.
	Mobile phase incompatible with seal material	Use a Teflon seal.

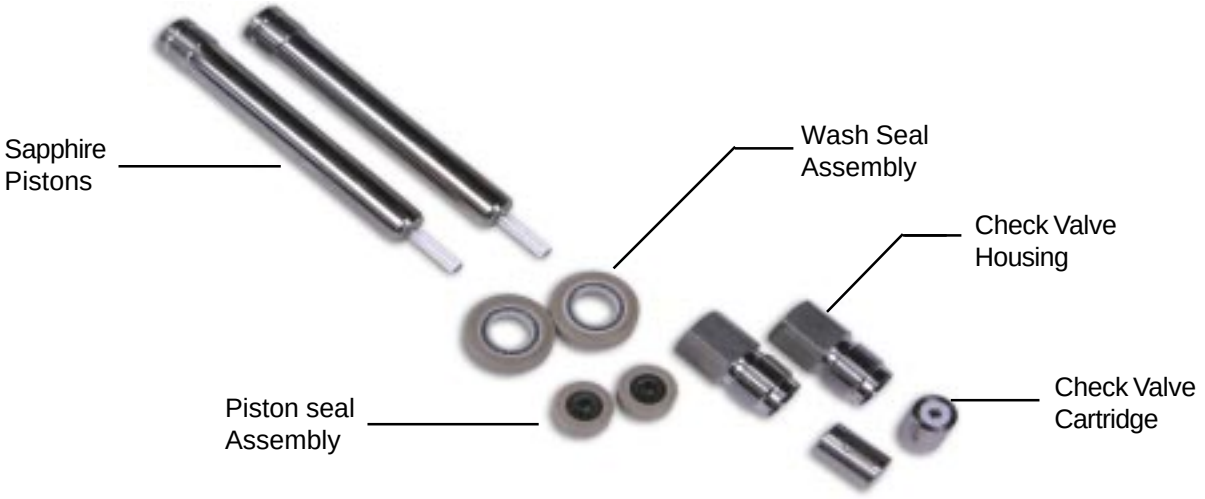
[1] ***Note:*** *If a slight amount of additional tightening does not slow stop the leak, replace the fitting. Over-tightening the fitting can damage the seat, strip the threads, or worse, cause the nut to shear off. Never exceed 15 in-lbs of torque.*

[2] ***Note:*** *It is not always obvious by visual inspection if a piston is worn or scratched. Use a magnifying glass to look for a glazed appearance, or axial grooves and scratches. The piston is worn if any of these conditions are visible.*

Trouble Shooting Guide Continued

Problem	Cause	Remedy
Frequent Check Valve Failure	Contaminated solvent	Use clean HPLC grade solvent.
	No solvent filter	Always use 10 micron or finer solvent filter.
	Worn pump seal of Piston [1]	Replace seal. Inspect piston and replace if worn.
	Service life of check valves has been exceeded	Install new valves.
Failure to Prime	Excess back pressure in the pump head	Open purge valve, or open pump head fittings at outlet check valve.
	Check Valve installed upside down	Verify that arrow on check valve body is aligned with the flow for both inlet and outlet check valves.
	Clogged solvent inlet filter	Clean or replace with new filter

[1] ***Note:*** *If the seal is badly worn, then the pump head will be contaminated with seal wear material. Remove the check valves from pump head and sonicate the head in a light soap solution for 30 minutes. Rinse thoroughly, then sonicate for 10 minutes in deionized water. Wet seal and pump head with IPA prior to reassembly. The inlet valve should be flushed with 50 mL of HPLC grade IPA or Water, and inspected.*



ASI Replacement Parts.

Replacement Parts

Micro HPLC Pumps

Description	Part Number
Model 501	501-0002
Model 500	500-0002
Model 500G Gradient System,	500G-0002
Model 501 High Pressure	501-0002HP
Model 500G High Pressure Gradient System	500G0002HP
Spring Housing/Pump Head Assembly	A500-1000
Hydraulic Module with Damper, Purge Valve&Outlet Manifold	A500-3054
Wash Seal Kit, Isocratic	A500-1023K
Wash Seal Kit, Gradient	A500-1033K
Wash Seal Assembly, 2/Pack	A500-1023-02
Wash Seal Assembly, 10/Pack	A500-1023-10
Solvent Inlet Line Assembly	500-2135-01
Transfer Tube	500-1280-01
Interconnect Tube	500-1285-01
Cross Over Tube	500-3112-01
Static Mixer 150µL	412-0150
Static Mixer Cartridge 250µL	410-0250
Injection Valve Mounting Bracket	500-2117
Injection Valve WX -1000-01 with 20uL loop	A500-1017
Pressure Tansducer	A500-4012
Stainless Steel Nuts 10/32, 10/Pack	900-0622
Stainless Steel Ferrules 10/Pack	910-0622
Fingertight Fittings 10/32, 10/Pack	800-0631
Piston Seal Assembly, UHMW, 2/Pack	A500-1009-U-2
Piston Seal Assembly, UHMW, 10/Pack	A500-1009-U-10
Ceramic Piston	A500-1117
Inlet Housing	500-1131
Outlet Housing	500-1132
Inlet/Outlet Cartridge	A500-1133
Inlet Check Valve Filter	A500-1180
Solvent Filters, 10um, each	850-0620
Solvent Filters, 10um, 5/Pack	850-0621

Replacement Parts

Analytical HPLC Pumps

Description	Part Number
Model 501	501-0000
Model 500	500-0000
Model 500G Gradient System	500G-0000
Spring Housing/Pump Head Assembly	A500-1001
Wash Seal Kit, Isocratic	A500-1005K
Wash Seal Kit, Gradient	A500-1015K
Wash Seal Assembly, 2/Pack	A500-1005-02
Wash Seal Assembly, 10/Pack	A500-1005-10
Solvent Inlet Line Assembly	500-2135-01
Transfer Tube	500-1280-01
Interconnect Tube	500-1285-01
Cross Over Tube	500-3112-01
Static Mixer 500µL	420-0500
Static Mixer 350µL (standard)	420-0350
Mixer Adapter	500-3111
Injection Valve Mounting Bracket	500-2117
Injection Valve WX-1000	A500-1017
Pressure Tansducer	A500-4012
Stainless Steel Nuts 10/32, 10/Pack	900-0622
Stainless Steel Ferrules 10/Pack	910-0622
Fingertight Fittings 10/32, 10/Pack	800-0631
Piston Seal Assembly, Teflon, 2/Pack	A500-1006-T-2
Piston Seal Assembly, UHMW, 2/Pack	A500-1006-U-2
Piston Seal Assembly, Teflon, 10/Pack	A500-1006-T-10
Piston Seal Assembly, UHMW, 10/Pack	A500-1006-U-10
Sapphire Piston Assembly	A500-1116
Inlet Housing	500-1167
Outlet Housing	500-1196
Inlet/Outlet Cartridge	A500-1050
Inlet Check Valve Filter	A500-1182
Solvent Felters, 10um, each	850-0620
Solvent Filters, 10um, 5/Pack	850-0621

Replacement Parts

Semi-Prep HPLC Pumps

Description	Part Number
Model 501	501-0020
Model 500	500-0020
Model 500G Gradient System	500G-0020
Spring Housing/Pump Head Assembly	A500-1002
Wash Seal Kit, Isocratic	A500-1045K
Wash Seal Kit, Gradient	A500-1055K
Wash Seal Assembly, 2/Pack	A500-1045-02
Wash Seal Assembly, 10/Pack	A500-1045-10
Solvent Inlet Line Assembly	500-2135-02
Transfer Tube	500-1280-02
Interconnect Tube	500-1285-02
Cross Over Tube	500-3112-02
Static Mixer 500µL	420-0500
Injection Valve Mounting Bracket	500-2117
Pressure Tansducer	A500-4012
Stainless Steel Nuts 10/32, 10/Pack	900-0622
Stainless Steel Ferrules, 10/Pack	910-0622
Fingertight Fittings 10/32, 10/Pack	800-0631
Piston Seal Assembly, UHMW, 2/Pack	A500-1026-U-2
Piston Seal Assembly, UHMW, 10/Pack	A500-1026-U-10
Sapphire Piston	A500-1024
Inlet Housing	500-1910
Outlet Housing	500-1196
Inlet Cartridge	A500-1060
Outlet Cartridge	A500-1050
Solvent Filters, 20micron for 1/8' ID, each	850-1246
Solvent Filters, 20um for 1/8" ID, 5/Pack	850-1247

Replacement Parts

Prep HPLC Pumps

Description	Part Number
Model 501	501-0040
Model 500	500-0040
Model 500G Gradient System	500G-0040
Spring Housing/Pump Head Assembly	A500-1003
Wash Seal Kit, Isocratic	A500-1048K
Wash Seal Kit, Gradient	A500-1058K
Wash Seal Assembly, 2/Pack	A500-1048-02
Wash Seal Assembly, 10/Pack	A500-1048-10
Solvent Inlet Line Assembly	500-2135-03
Transfer Tube	500-1280-02
Interconnect Tube	500-1285-02
Cross Over Tube	500-3112-02
Static Mixer 500µL	420-0500
Injection Valve Mounting Bracket	500-2117
Pressure Tansducer	A500-4012
Stainless Steel Nuts 10/32, 10/Pack	900-0622
Stainless Steel Ferrules 10/Pack	910-0622
Fingertight Fittings 10/32, 10/Pack	800-0631
Piston Seal Assembly, Teflon, 2/Pack	A500-1046-T-2
Piston Seal Assembly, Teflon, 10/Pack	A500-1046-T-10
Piston Wiper Seal 80mL, 2/Pack	500-1127-80
Ceramic Piston	A500-1044
Inlet Housing	500-1911
Outlet Housing	500-1196
Inlet Cartridge	A500-1060
Outlet Cartridge	A500-1050
Solvent Filters, 20um for 1/4" ID, each	850-1246
Solvent Filters, 20um for 1/4" ID, 5/Pack	850-1247

Warranty

The warranty on *ASI* pumps is one year parts and labor. The warranty does not include routine consumable parts including but not limited to check valves, piston seals, and pistons. Defective routine consumable parts will be replaced free of charge for a period of 30 days from the ship date. Please contact customer service to get a Return Authorization Number (RA#).

Please note: Any unsatisfactory product purchased through your local distributor should be returned to them according to their specific return policies.