SP8800/8810 LC Pump
Operators Manual

Spectra-Physics

Part Number
A0099-235 9/88 D

SP8800/8810 HPLC Pump Consumables and Spare Parts

RECOMMENDED SPARE PARTS

	Part Number
Maintenance Kit	A3197-010
(Contains all the items that may be necessary to maintain the pump in normal usage for one year.) Includes:	
Chrome Pistons (2)	A2964-010
Piston Seals (6)	A2962-010
Inlet Check Valve	A1595-020S
Outlet Check Valve	A1590-020S
Crossover Tube Assembly	A2945-010S
Transducer Tube Assembly	A3118-010S
Kel-F Seals (6)	A2973-010
Inlet Filters (3)	A0574-010
Piston Seals (pack of 10)	A3070-010
Helium Sparger	A0369-010
Pump Spring	A2993-010

OPTIONS

Inlet Liquid End	A2981-010S
Outlet Liquid End	A2982-010S
Sapphire Piston Kit	
Includes 2 Sapphire Pistons, plus:	
Piston Seals (2)	A2962-010
Backup Seals (2)	A2963-010
Solvent Tray	A3190-010
Semi Prep Kit	A3091-010
(above includes Inlet and Outlet Liquid Ends and Check Valves)	
Column Bypass Valve with Bracket	A3112-010
RS-232-C Module	A3115-010
System Organizer	A3180-010
Accessory Kit to Organizer	A3189-010
SP8800 or SP8810 Inert Titanium Pump	

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Section 1
Installation

INTRODUCTION

The SP8800 Series Pumps have been designed for ease of use and unsurpassed performance. They can be used as standalone pumps or as modules in a totally automated LC system. The SP8800 offers low pressure ternary mixing that provides accurate proportioning of binary or ternary mobile phase compositions in either the gradient or isocratic mode. The Isocratic SP8810 Pump offers all of the features and performance of the SP8800, except that the ternary proportioning valve, associated electronic circuitry and software are not included.

These pumps permit as many as 40 lines of programming in each of 10 method files, which are sufficient for even the most complex of gradient profiles.

The built-in Startup File can be used to transform the pumps into true turn-key systems. The Startup File remains resident in the unit even with the power switched off, and is automatically reloaded whenever the power switch is turned on. Simply turn the pump power switch on and press [INITIALIZE] and [ENTER] for chromatography to begin. Information on "Proper Use of the Startup File" is presented in Section 3 for the SP8810 and Section 4 for the SP8800).

The pumps are engineered for reliability and ease of maintenance. These pumps are designed to make proper maintenance of the pump easier than ever to ensure that your chromatography results are accurate and remain accurate. A built-in Maintenance Log (refer to Section 6) allows you to follow the lifespan and wear of specific parts (seals, pistons, and check valves) and alerts you whenever routine maintenance is scheduled.

Another standard feature is the ability to automatically initiate a Cleanup File (refer to Section 3 for the SP8810 and Section 4 for the SP8800) at the end of the run to flush out the system and clean the column. Should service ever be required, the resident

diagnostics and modular design of these pumps will reduce down-time to the absolute minimum. The simplicity and durability of the pumps translate into fewer service calls and a minimum of spare parts that need to be kept on hand.

The Flow Stability Test, described under "Monitoring the Pump Performance in Section 3 (for the SP8810) and Section 4 (for the SP8800), greatly enhances your ability to track the pump performance. The test can be run either continuously or automatically prior to each injection with the results documented on every integrator report.

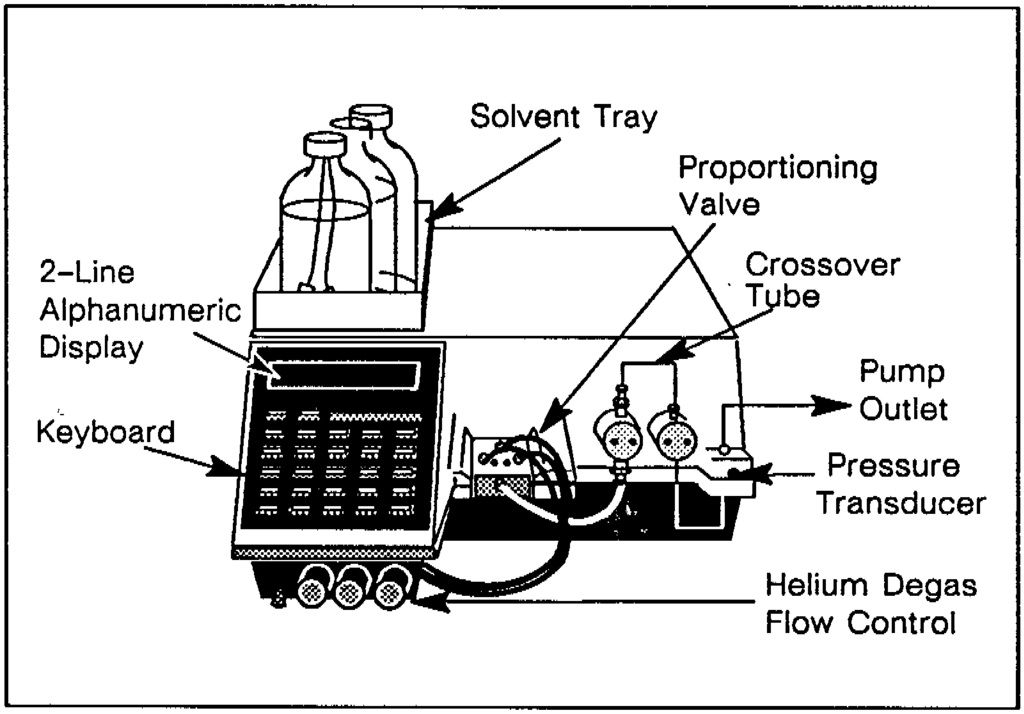


Fig. 1.1 The SP8800
Ternary LC Solvent Delivery System

INSPECT YOUR INSTRUMENT

When you receive your pump, inspect the package for evidence of damage. If any is found, have the carrier note this condition on both the delivery receipt and the freight bill. The carrier is responsible for damage incurred during shipment.

After unpacking, inspect your pump and its accessories for parts shortages and/or physical damage. If damage is found, notify both the carrier and your Spectra-Physics representative. Please DO NOT return any goods without prior authorization (either a Re-

turned Goods Authorization or Returned Materials Authorization number) from a Spectra-Physics representative.

Accessory Kit

An accessory kit is supplied with each pump and includes the following tools and parts.

Parts included in Both SP8800 and SP8810 Kits

Quantity	Description
1	SP8800/8810 Operators Manual
1	External Function Plug
1	20 mL Priming Syringe
1	Luer-Lock Syringe Adapter
1	Hex/Ball Wrench
1	Stainless Steel Nut and Ferrule
1	Power Cord
1	Fuse
	(The power cord and fuse are specific for regional power requirements.)

Additional Parts in SP8800 Kit

3	1-liter Solvent Bottles
3	Solvent Bottle Cap and Tubing Assemblies
1	Plastic Spiral Wrapping for Solvent Tubes
1	Solvent Bottle Tray
1	Column Bypass Valve (center port)
1	Filter/Mixer
1	Bypass/Filter Mounting Bracket
2	6 1/2 inch Stainless Steel 1/16-inch OD (.02-inch ID) LC Tubing
1	10 1/2 inch Stainless Steel 1/16-inch OD (.02-inch ID) LC Tubing
2	Cap Screws
2	Phillips Head Screws, 3/8 inch
2	Split Lock Washers
2	Piston Seals
2	Kel-F Seals
1	10-feet, 1/16-inch Teflon Tubing

Additional Parts in SP8810 Kit

1	Solvent Tube and Inlet Filter

Options Available

The chrome-plated stainless steel pistons shipped standard in SP8800 Series Pumps have been exhaustively tested and found to perform better than sapphire pistons for most LC applications. However, the optional Sapphire Pistons Kit provides alternative pistons for specialized applications. The kit should be used if you are experiencing short seal or piston life due to highly buffered or low pH mobile phases.

The backup seal included in the Sapphire Pistons Kit need only be used when buffered solvents are in use. This seal provides a means of keeping the low pressure side of the piston seal wet. This prevents buffer salts from crystallizing on the piston surface and forming a ridge, which can cause piston seal failure within a short period of time.

NOTE: Backup seals are not available for the chrome-plated stainless steel pistons. The chrome-plated pistons cannot be backflushed.

The sparge tubing, provided as a standard item for the gradient pump, is available as a degasing option for the isocratic pump.

Spectra-Physics supplies a variety of options for your SP8800 Series LC Pump and accessories for all your LC needs. For a partial listing of available options for your pump, please refer to Appendix B or contact your Spectra-Physics representative.

VERIFY VOLTAGE SETTING

The pumps are configured from the factory for either 115 or 230 VAC operation depending upon the country of destination. Check the label on the rear of the instrument to ensure the proper voltage setting for your area (Fig. 1.2). If the indicated voltage setting on the rear label is not consistent with your area, DO NOT CONNECT THE POWER CABLE! Contact your Spectra-Physics representative.

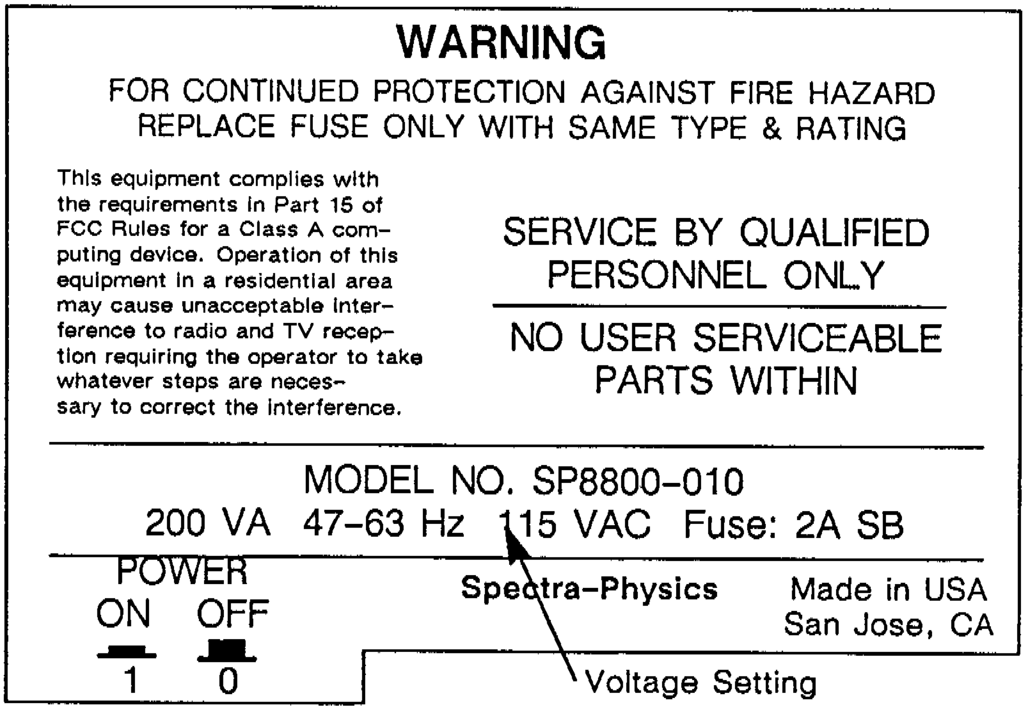


Fig. 1.2 Label Indicating Voltage Setting

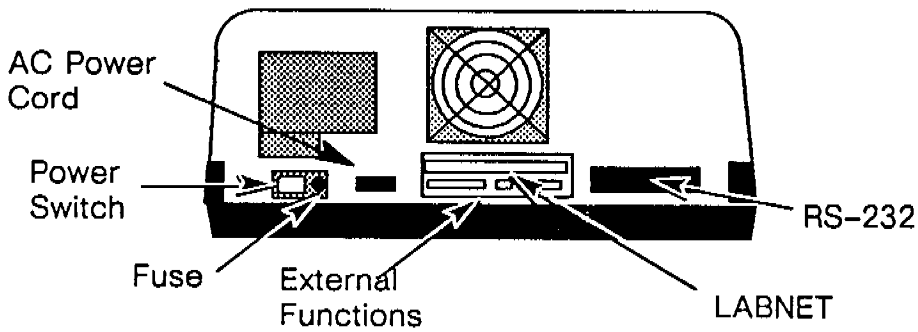


Fig. 1.3 Rear Panel of SP8800/8810

CHECK INITIAL RESPONSE TO POWER ON

Place the pump on a level surface leaving enough room behind the instrument for good air flow and access to electrical connections. Locate the AC power cord and attach it to the AC power connector on the rear of the instrument (Fig. 1.3). Plug the power connector into an appropriately grounded power outlet.

WARNING: For safe operation and optimum performance, the pump must be connected to a properly grounded power receptacle.

"Turn the power on by pressing the Power Switch (refer to Fig. 1.3). The fan starts and the display on the keyboard show:

SP8800	FILE 1 LOADED
UNIT 1	

or for the Isocratic version:

SP8810	FILE 1 LOADED
UNIT 1	

In some versions the UNIT 1 designation may be omitted.

This screen indicates that the Startup File was activated when the unit power was turned on and then loaded into File 1. Subsequent Startup Files are loaded into the files from which they were saved (see Section 3 for "PROPER USE OF THE STARTUP FILE"). Pressing any of the function keys clears this message.

If these messages do not appear as written, contact your Spectra-Physics representative.

NOTE: If the pump has been turned off for an extended period of time, the fluorescent display may require 2 hours warmup to regain full brightness, which is typical for fluorescent displays.

CONNECTION AND PREPARATION OF SOLVENTS

General

The pump is shipped with methanol in the pump heads and connecting tubings. Your desired solvent *must* be miscible with methanol or the pump *must* first be flushed with an intermediary solvent (refer to the table on solvent miscibility in Section 6).

SP8810 Isocratic Pump

NOTE: The following two steps apply only to the isocratic pump:

1) **Connect the Solvent Bottle**

Find a safe, convenient place to set the solvent bottle. The top of the pump may be used, since it is constructed of materials which are highly resistant to solvent attack. However, to protect against spillage or bottle breakage, the solvent bottle should be placed in an appropriate secondary container and properly secured. Insert the solvent tube and inlet filter into your solvent bottle.

2) **Degas the Solvent**

All solvents used in high performance liquid chromatography should be filtered through a 2-micron (or less) fluorocarbon filter and degassed before use to prevent dissolved gases from coming out of solution and disturbing the chromatographic performance.

Fill the solvent bottle with the desired solvent. The initial degas of the solvent can be done in any of three ways.

- Air can be removed by sparging the solvent with helium (which is an inert gas) – refer to "Helium Sparging" later in this section.
- The solvent bottle filled with solvent can be placed in an ultra–sonic bath while pulling a slight vacuum from a water faucet aspirator for approximately 5 minutes.
- A 0.5–micron sintered glass vacuum filter can be used. This technique ensures that the solvent is properly filtered as well as degassed.

To continue installation of the isocratic pump, please refer to "PRIME THE PUMP" further in this section.

SP8800 Ternary Pump

NOTE: The three steps below apply only to the gradient pump unless the Degassing option is purchased for installation on the isocratic pump. In this case, the first two steps also apply to isocratic pump installation.

1) **Connect the Helium Sparging Tubing**

The sparge tubing (Fig. 1.4) attaches to the quick-connect fittings on the gas manifold on the underside of the front of the pump (Fig. 1.5). Remove the solvent bottles and solvent tubing assemblies from the Accessory Kit and position the pump and solvent bottles in their desired locations. Fasten the helium sparge line from each solvent bottle to the corresponding helium manifold extender tube. Tighten end coupling firmly by hand. DO NOT use a wrench on this type of fitting. The extender couplers are marked for ease of identification. Attach the helium supply line and its extension in the same manner.

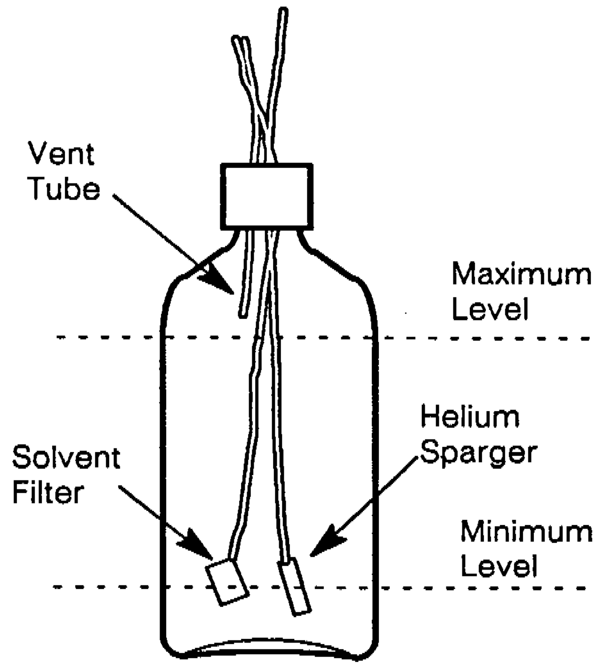


Fig. 1.4 Solvent Bottle and Cap Assembly

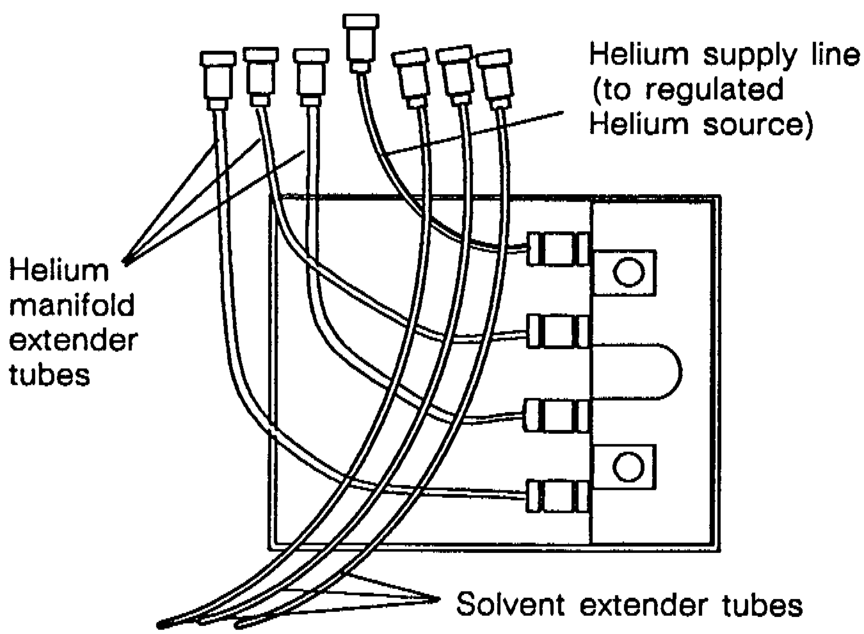


Fig. 1.5 Helium Connections to the Gas Manifold (on underside of pump)

Attach the other end of the helium supply line to a helium source regulated at about 10 psi and turn on the gas supply. The helium

supply to each bottle can now be controlled from the front of the pump as shown in Fig. 1.6.

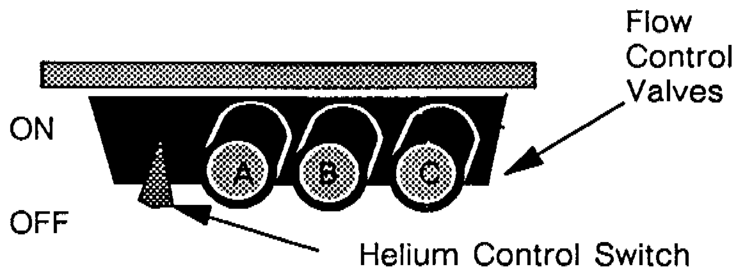


Fig. 1.6 Gas Manifold Valve Controls

WARNING: DO NOT USE THE HELIUM CONTROL VALVES to turn off the helium sparging. Use the helium control switch. The switch automatically vents the helium sparge lines and thereby prevents solvent from diffusing into the helium sparging tubing.

Place the three solvent bottles in a safe, convenient location at or above the elevation of the pump. The top of the pump may be used since it is constructed of materials that are highly resistant to solvent attack. However, to protect against spillage or bottle breakage, the solvent bottle should be placed in an appropriate secondary container and properly secured. The use of the solvent tray shown in Fig. 1.1 is recommended, since it prevents the bottles from accidentally tipping over and retains the spillage if a bottle is broken.

Fill each bottle with the desired solvent and secure the bottle cap. Attach the A, B, or C label to each solvent bottle cap to identify it. Each solvent line must be attached to its corresponding extender tube, which is connected to the appropriate ternary mixing valve port: A, B, or C. Pass the extender tubes through the slot underneath the keyboard alongside of the helium sparging tubing.

2) **Start Helium Sparging**

With solvent in the bottles and the sparge tubing connected, turn on the helium supply and set the tank pressure regulator to 10 psi. Push up the helium control switch (refer to Fig. 1.6) on the front of the gas manifold. To start helium flowing, turn the appropriate

knobs (A, B, or C) counter-clockwise until the solvent is bubbling vigorously (approximately 20 - 30 mL/min). Sparge at this high helium rate for about 10 minutes to purge all the air form the bottles, then reduce the flow to a trickle (approximately 5 mL/min).

NOTE: The solvent bottle caps should be checked periodically to ensure that a tight fit is maintained. To prevent air from diffusing back into the bottles, use a small, positive helium flow and make sure that all vent lines are in place. (Preferably, the end of the vent lines should be lower than the bottle.) Placing the vent line ends in a small amount of liquid allows easy verification of positive helium flow.

3) Install Filter/Mixer, Bracket, and Column Bypass Valve

Included with your gradient pump is an in-line filter/mixer and column bypass valve. They are conveniently mounted using the bracket provided. The bracket mounts easily and allows unrestricted access to pump heads and fluid connections. Pump maintenance is not hampered in any way. Use of the bypass valve allows you to easily prime and purge the pump at a high rate without putting your column at risk. Solvent reservoir changes can be made quickly and easily.

The in-line filter/mixer provides downstream protection of injectors and columns while further increasing the pump's mixing capabilities. The 2-micron filter element is easily replaced when needed.

Installation

a. Install the column clip onto the bracket using the 1/2-inch screws supplied. Press the filter/mixer into position on the column clip (Fig. 1.7). Note that the larger end (inlet) faces toward the right rear of the pump when installed.

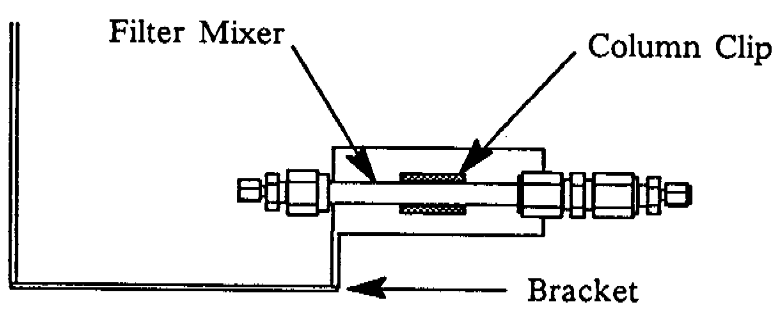


Fig. 1.7 Filter/Mixer Clip with Filter/Mixer Installed

b.. Attach the bracket to the front bezel of your pump using the supplied phillips-head screws and split-lock washers (Fig. 1.8).

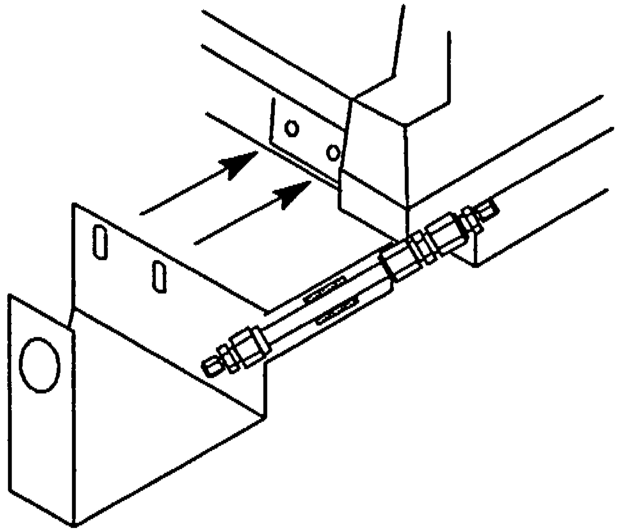


Fig. 1.8 Attaching Bracket

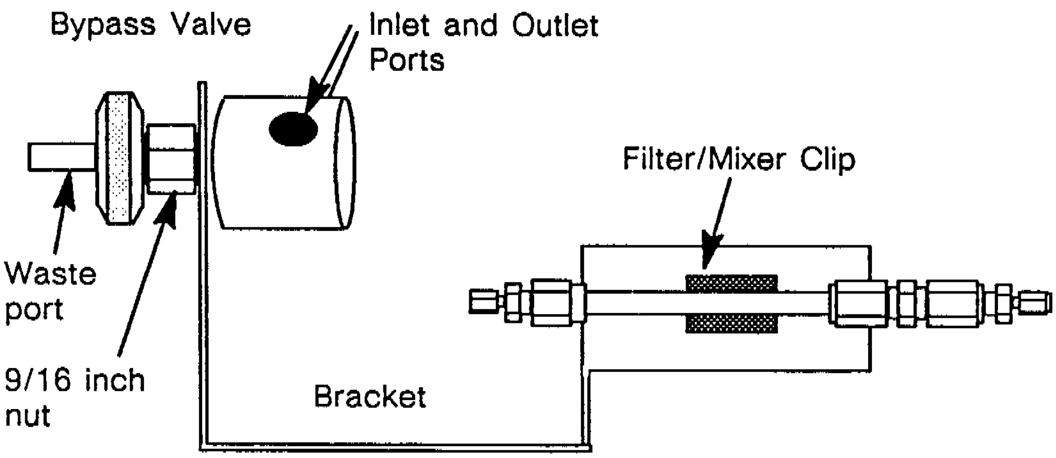


Fig. 1.9 Components Mounted on the Bypass Valve Bracket

c. Loosen the 9/16-inch valve nut.

d. Place the bypass valve into the bracket with the inlet and outlet ports facing up (Fig. 1.9) and attach it securely by tightening the 9/16-inch nut.

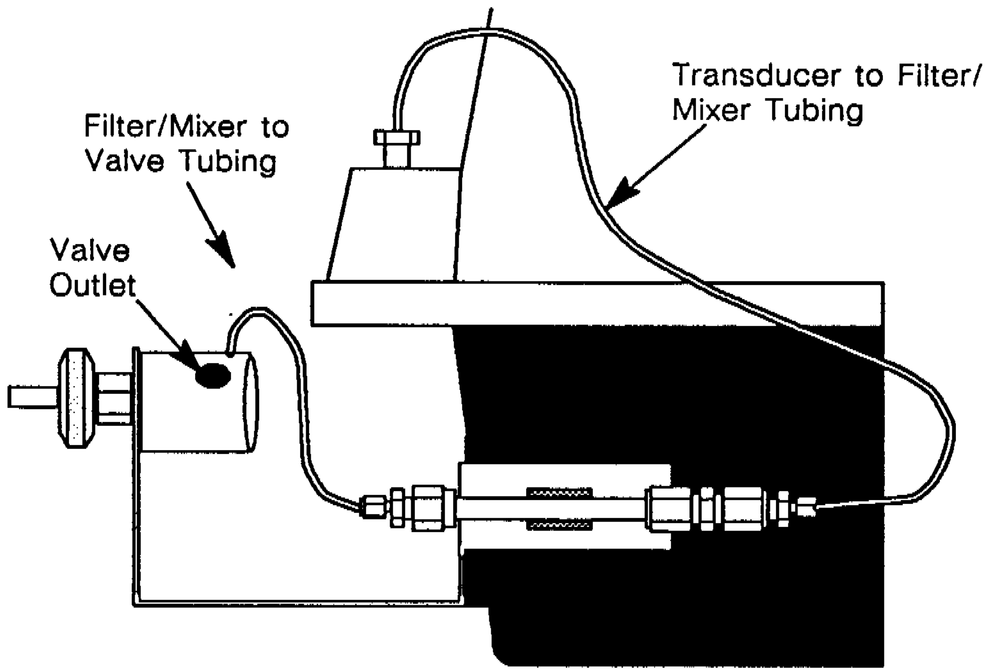


Fig. 1.10 Routing of the Tubing

Make Tubing Connections

e. Place the 1/16-inch male compression fitting with ferrule onto the piece of 10 1/2-inch stainless steel tubing supplied (1/16-inch OD). Insert them into the outlet of the pressure transducer. Tighten the compression fitting initially 3/4 turn after fingertight to make a leakfree connection.

f. Connect the other end of the tubing from the pressure transducer to the inlet of the filter mixer (the end furthest from the front of the pump), making the connection as described in step e. above.

g. Use one piece of the 6 1/2-inch tubing to connect the outlet of the filter mixer (the end closest to the Bypass valve) to the inlet of Bypass valve (upper left opening).

h. Use the second piece of 6 1/2-inch tubing to connect from the outlet of the bypass valve to the next device in your LC system.

Use of the Bypass Valve

a. To bypass solvent flow from your column or to prime the pump, open the valve one turn counter clockwise.

   NOTE: Unless you are using a syringe to prime your pump (see Fig. 1.11), you will need to connect a waste line to the

waste port as described under *Purging the Pump (with Column Bypass Valve Installed).*

b. To allow solvent to flow through the column, close the valve by turning clockwise until the valve stem seats. Do not overtighten the valve. A light touch is all that is necessary.

PRIMING AND PURGING PUMPS

Priming the Pump (with Column Bypass Valve Installed)

NOTE: This procedure applies only to pumps which have a column bypass valve installed.

Connect the 20 cc luer tip priming syringe to the waste/prime port of the column bypass valve (Fig. 1.11). Position a beaker nearby to collect the syringe discharge, since two or three syringe volumes may be needed to fully prime the pump. Create a pump Edit File that contains equal proportions of all solvent lines connected (A, B, and/or C); refer to the "Brief Instructions on Creating a Run File" in Section 4 (SP8800) for more detailed instructions. Make sure that the syringe is fully depressed and that the connections are air tight.

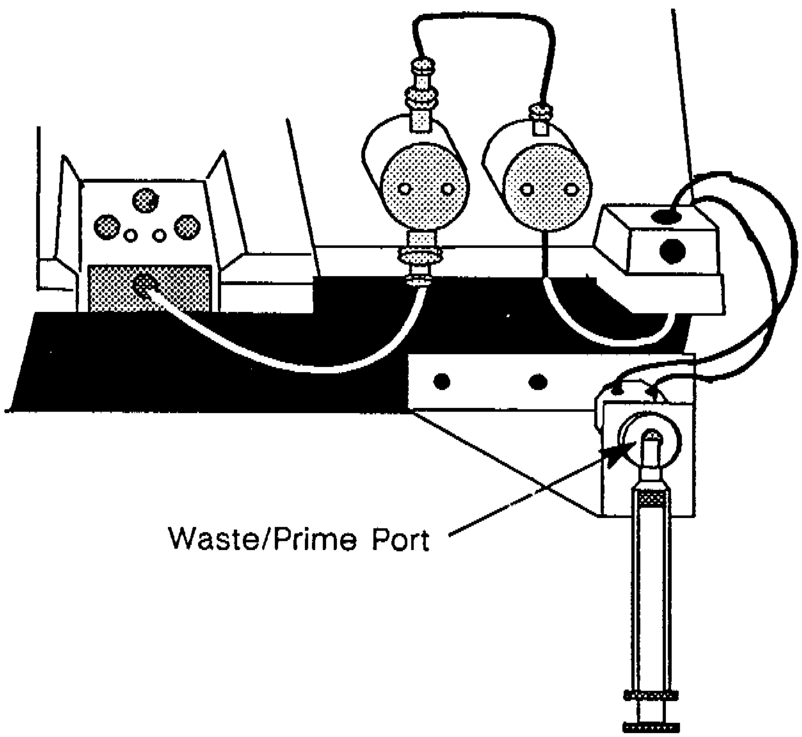


Fig. 1.11 Priming the Pump

Open the bypass valve by turning the knob one turn counterclockwise. Press PURGE, enter the created file number, then press ENTER to initiate a purge cycle on the pump for the desired file.

CAUTION: The pump's proportioning valve will not allow solvents to flow when the pump is stopped. Initialize or purge a file to allow solvent flow.

Slowly draw back on the syringe to create a small vacuum on the solvent lines to draw the solvent from the solvent bottles into the pump heads. If the syringe fills with air prior to the solvents reaching the pump head, then the syringe must be temporarily disconnected at the luer-lock fitting, emptied into the nearby beaker, and reconnected to finish drawing the solvents into the pump head.

Purging The Pump (with Column Bypass Valve Installed)

Once the pump has been primed, close the column bypass valve gently and disconnect the syringe. Install the waste tubing using the luer–lock adapter and 1/16–inch Teflon tubing. Route the tubing to an appropriate waste container. Open the bypass valve 1 turn and allow the pump to purge until all air has been removed from the solvent lines leading into the ternary valve (if gradient) and the pump heads. Typically about 10 mL or about 1 minute is enough. The solvent inlet filters inside each solvent bottle should be in a vertical position to ensure that air within the filter will not be trapped. Stop the pump and continue with the installation procedure.

Priming the Pump (without the Column Bypass Valve)

Remove the crossover tube from both liquid ends (Fig. 1.12). Connect the 20 cc priming syringe fitted with the luer-lock adapter (provided in the Accessory Kit) to the outlet from the LC pump outlet check valve (see Fig. 1.12). Position a beaker nearby to collect the syringe discharge, since two or three syringe volumes may be needed to fully prime the pump. Create a pump Edit File that contains equal proportions of all solvent lines connected (A, B, and/or C); refer to the "Brief Instructions on Creating a Run File" in Section 3 for more detailed instructions. Make sure that the syringe is fully depressed and that the connections are air tight.

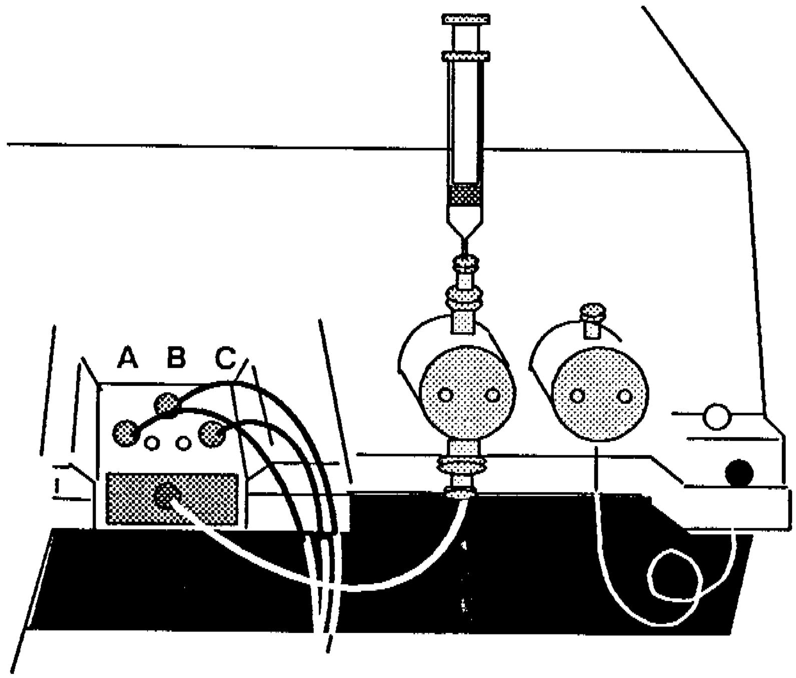


Fig. 1.12 Priming the Pump (without Bypass Valve)

Press PURGE, enter the created file number,then press ENTER to initiate a purge cycle on the pump for the desired file. Slowly draw back on the syringe to create a small vacuum on the solvent lines to draw the solvent from the solvent bottles into the pump heads. After one of the solvent lines has circulated through the pump head, the pump should be able to finish priming the remaining lines by itself. If the syringe fills with air prior to the solvents reaching the pump head, then the syringe must be temporarily disconnected at the luer-lock fitting, emptied into the nearby beaker, and reconnected to finish drawing the solvents into the pump head.

Purging the Pump (without the Column Bypass Valve)

Once the pump has been primed, disconnect the syringe from the outlet check valve and reconnect the crossover tube. Tighten the fitting finger-tight, the 1/4 turn pat finger-tight using a 1/4-inch open-end wrench. Allow the pump to purge into a beaker until all air has been removed from the solvent line leading into the pump heads. Typically about 10 mL or about 1 minute is enough. The solvent inlet filters inside each solvent bottle should be in a vertical

position to ensure that the trapped air within the filter is removed. Stop the pump and continue with the installation procedure.

SYSTEM INSTALLATION KIT

A System Installation kit is available that provides all the necessary tubings and fittings for the proper connection of the various components in your HPLC system. An *LC Systems Manual* is included with the kit which shows recommended system configurations.

NOTE: Overtightening an LC fitting will deform the fitting and cause a leak. A standard LC fitting, consisting of a nut and ferrule, should be tightened finger-tight, then tightened an additional 1/4 turn using an appropriately sized wrench.

Installation of a Dynamic Mixer (Gradient Pump Only)

For the majority of applications, a dynamic mixer is NOT needed. The pump stroke on the SP8800 is only 60 microliters and is designed to provide efficient mixing for the microliter volumes proportioned with its ternary proportioning system. However, for some applications, a dynamic mixer may be required. Connection to your system should be in accordance with the assembly instructions included with the mixer, or refer to Appendix B.

Installation of the Injection Valve

Using the precut tubing provided in the accessory kit, follow the manufacturer's instructions for the proper connection of the LC pump to your manual injection valve or to your autosampler. If the tube length provided is too short, any LC tubing with an internal diameter of .020 inches or less could be substituted. However, care must be taken to ensure that the tubing ends are properly cut and polished. For small-bore or short-column applications, we recommend purchasing precut lengths of LC tubing. Contact your local Spectra-Physics representative for information on the variety of precut lengths and internal diameters available.

Connecting the Column

The trend toward shorter columns with smaller packing diameters places very stringent requirements upon the types of fittings and tubings used. Special care should be taken to ensure that all fittings and tubing have very low dead volume to prevent peak broadening

as the sample enters or leaves the column. and that the tubing is properly cut and fitted into the connectors. Always connect the column with the eluant flow in the direction indicated on the column label; not all columns are reversible. Spectra-Physics has a variety of columns available with different packings, internal diameters and lengths. (Contact your local Spectra-Physics representative.)

SYSTEM CONFIGURATION

The pumps have external function controls, RS-232-C and LAB-NET (Spectra-Physics local area network) communications capabilities to enable the inclusion of the pump into a Spectra-Physics Modular LC System or any system of your choice. For more details, please refer to Section 8.

Spectra-Physics' Universal System Organizer (part number A3180-010) can be used to generate many custom system layouts of your choice. The Organizer adjusts in height, has an optional sliding bracket capable of mounting all popular manual injector or bypass valves, and can be stacked. The system shown in Fig. 1.13 contains an SP8800 Ternary Proportioning Pump, SP8780 Autosampler, SP4270 or SP4290 Computing Integrator, SP8450 Variable Wavelength UV-Vis Detector, and SP8790 Column Oven Controller, all in 44 inches of linear bench space.

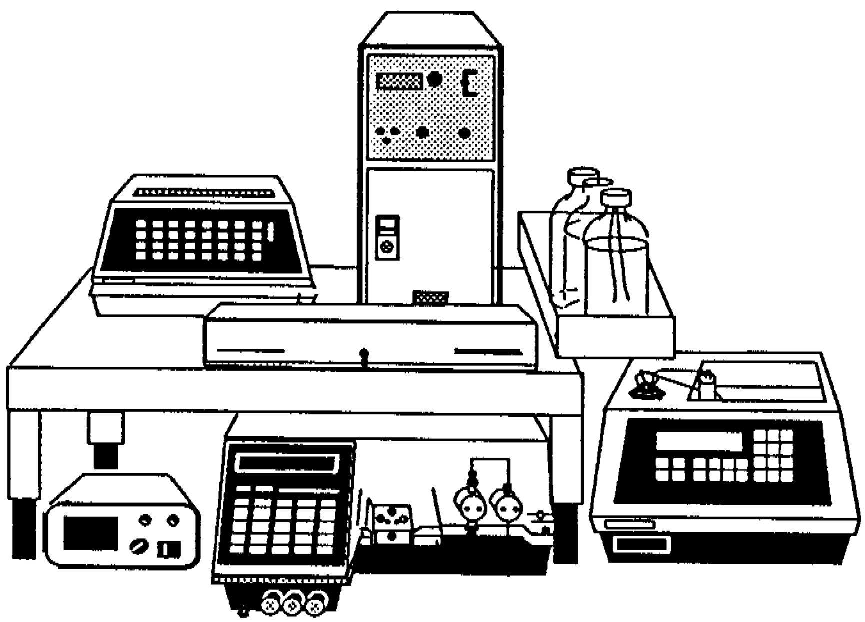


Fig. 1.13 A Spectra-Physics Modular LC System

Section 2
Keyboard Overview

Section 2
Keyboard Overview

INTRODUCTION

The SP8800/8810 keyboard (Fig. 2.1) contains 13 function keys, 3 cursor keys, 10 numeric keys, a decimal point, and 2 indicator lights. Data entry and system status are displayed on the 2-line display. Through this window, you can create and edit Run Files and monitor the real-time status of the pump's operation.

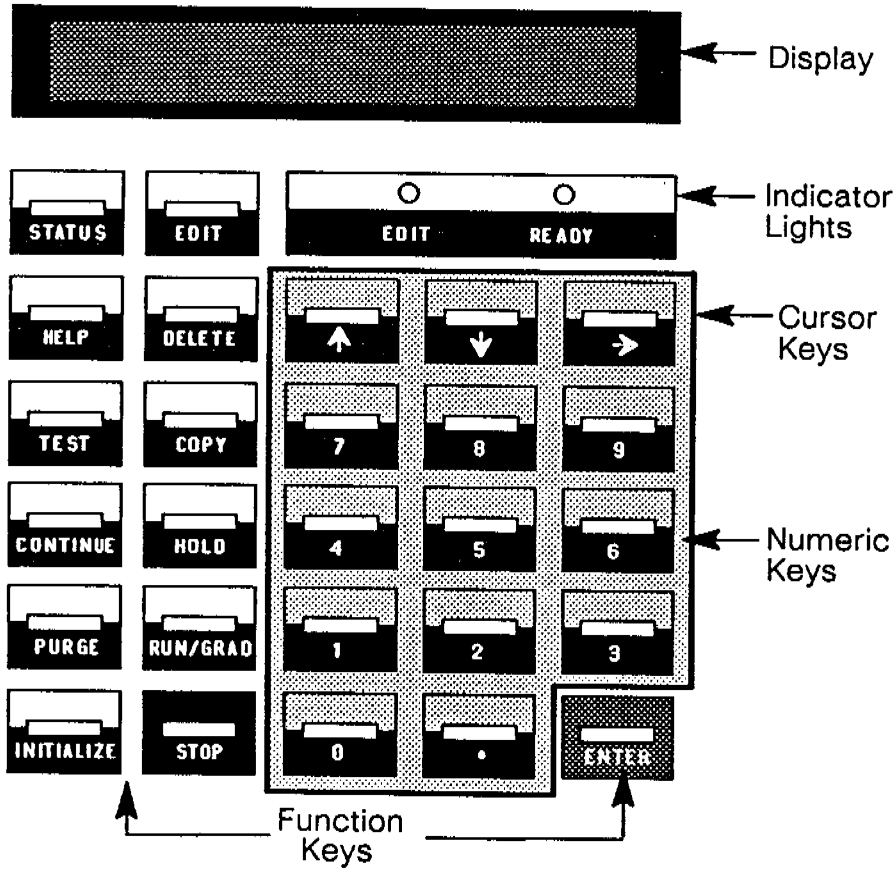


Fig. 2.1 SP8800 Pump Keyboard

NOTE: The SP8810 keyboard is identical to the SP8800, except a key labeled [RUN] is substituted for [RUN/GRAD].

The [HELP] key provides all the information necessary to perform routine chromatography immediately at your fingertips. Only when

very detailed information is required will you need to consult the manual. However, since the Operators Manual provides additional useful information, it is advisable that you familiarize yourself with its contents.

The following keys are grouped according to function.

The STATUS, HELP, and TEST keys provide information about the pump's current conditions.

gives the current run conditions.

defines the last key or function used.

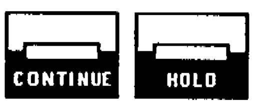
provides access to a series of options and diagnostics.

The EDIT, DELETE, and COPY keys enable files to be edited, modified, deleted, or copied.

files 0–9.

file, line, or last entry.

one file to another.



HOLD pauses, and CONTINUE restarts the pump run time clock and gradient composition.

PURGE runs the pump at maximum pressure or flow, whichever is reached first.

[RUN/GRAD] starts the run time clock in the Active (Run) File program.

NOTE: The SP8810 has a key labeled [RUN] substituted for [RUN/GRAD].

[INITIALIZE] loads and starts a file program at initial conditions with the clock stopped at time 0.

[STOP] immediately halts the pump.

The file keys are in the top half and the run control keys are in the bottom half of the keyboard.

DESCRIPTION OF KEY FUNCTIONS

When pressed, the first STATUS screen is displayed.

Time	%A	%B	%C	PSI
0.0	100	0.0	0.	0

NOTE: Solvent compositions are not displayed in the SP8810.

Pressing the key again brings up the second screen:

File	Stat	Flow	MaxP	PSI
1	STOP	1.00	2000	0

The values for Flow and MaxP can be changed at any time by using the cursor ([→]) key to select the function you wish to change. Enter the new value and then press [ENTER]. The pump immediately executes the changes and places an asterisk (*) next to the file number to signify a modified Run File. Changes made in the status ONLY ALTER the Run File, and are LOST when the Edit File is re-initialized.

When the $\boxed{\text{STATUS}}$ key is first pressed, the current Run File is displayed starting with a real-time display for time, percentage of solvents and pressure.

Time	Current run time. Shows 0.0 on initialization of the file and remains so until the $\boxed{\text{RUN/GRAD}}$ key is pressed or an INJECT command is received. The time during a run is updated every 0.1 min. Allowed values are 0 to 650 minutes in 0.1-minute increments.
%A,B,C	(Not present in the SP8810.) Current percentages of the individual solvents. Indicates changes during a gradient run. The percentages are updated every 0.1 min. Allowed values are 0 to 100% in 0.1% increments. The sum must equal 100%.
PSI	Current control pressure. The units can be changed to BARS or MPa. The pressure is updated every 0.5 sec.
File	Current or last initialized pump file number. A value of "n* " indicates that either the flow or maximum pressure has been changed through the STATUS screen (n = file number).
Flow	Current set flow or the flow of the 0.0 Time Line of the last initialized file. Allowed values are 0 to 10 mL/min (30 mL/min for prep heads) in 0.01 mL/min increments.
MaxP	The user-selectable maximum pressure limit. If exceeded, the pump stops.
Stat	The current stat(e) of the pump; i.e. HOLD, RUN, INIT, RDY, NRDY, PURG, STOP, etc.
HOLD	Pump is still running but held at chosen time and solvent percentages.

RUN — [RUN/GRAD] key has been pressed to start isocratic or gradient program.

INIT — A file has been initialized, but the pump has not yet fully referenced at the new flow conditions.

RDY — READY display indicator. The pump is running and is referenced at the initial conditions.

NRDY — NOT READY display. The pump is running but for some reason has lost its flow reference point. The pump automatically re-references and returns to the RDY state.

PURG — PURGE. The pump ramps to the maximum flow or pressure limit.

STOP — Pump has been stopped.

EDIT

When pressed, the last file edited is displayed

File	Max PSI	Min PSI
#1	6000	0

with the cursor under the file number. A new file number (0–9) can be selected, in which case, on pressing [ENTER] the cursor moves over under the Max PSI number. If a new file is not selected, on pressing [ENTER], the "zero" Time Line of the No. 2 EDIT screen is accessed with the cursor under the %A number.

Time	%A	%B	%C	Flow
0.0	100	0.0	0.0	0.00

NOTE: Solvent compositions are not displayed in the SP8810.

From here, the file can be edited (see Section 4, "File Editing").

HELP

When pressed, this key provides a help screen(s) for the function of the last command key that was pressed (STATUS, EDIT, TEST, etc). If the cursor is on a value other than the first value of a screen, pressing HELP provides information about that variable. Pressing HELP HELP brings up the help screen that gives you directions in using the HELP key. Use the cursor key (↓) to view additional text. HELP can also be used when FAULT messages occur.

DELETE

Pressing this key once deletes the prior entry. If you are in EDIT mode, press once to delete the entry at the cursor, or press a second time to delete the whole line. If the cursor is under column "File," in the No. 1 screen, pressing DELETE produces:

```
Delete File (n) _
```

```
(n = file to delete)
```

Pressing ENTER deletes the entire current file. Pressing a number, then ENTER deletes the designated file. Regardless, the next screen displayed will be the No. 1 screen of the deleted file with the cursor under the file number. To abort the Delete File function, simply press the STATUS key.

TEST

This key provides access to non-routine functions and pump diagnostics. Select the desired function with the cursor key (→) and then press ENTER:

```
DIAGNOSTICS     LOG     RS232
CLEANUP   OPTIONS   UNIT#
```

DIAGNOSTICS	Diagnostics (see Section 6, "Troubleshooting").
LOG	Maintenance Log that enables the pump to inform you when routine maintenance is recommended (see Section 5, "PROPER MAINTENANCE LOG USAGE").
RS-232	RS-232 communication parameters (see Section 7, "RS-232-C COMMUNICATIONS").
CLEANUP	Parameters for setting a timed-delay flush file and shutdown routine (see Section 3, "PROPER USE OF THE CLEANUP FILE").
OPTIONS	Non-routine pump parameters: normal or prep operation, pressure units for display, unstable flow shutdown, etc. (see "Additional Features" in Section 3).
UNIT#	LABNET unit number (1-31). Not present in some versions.

COPY

This key functions only in the EDIT mode. When pressed produces:

```
Copy File n To File _
```

(n = current file being edited)

Entering a number (0-9, 11) and then pressing ENTER copies the file currently being edited into the designated file. The screen displayed next is the designated file. If you do not enter a number and just press ENTER you are returned to the display of the current file with no action being taken. To create a new Startup File for initial power-on, simply COPY the desired file into File 11. File 11 is the Startup File and is stored in nonvolatile memory. (See "Proper Use of the Startup File" in Section 3.)

CONTINUE

Pressing this key produces:

```
Continue File (n) _
```

(n = current file being run)

If a file number is entered, the running file continues at an identical time in the file designated. If just ENTER is pressed (no number), the run continues in the same file (see section on "HOLD") from the time where it was put on HOLD. If the value within the parentheses is n*, then the Run File has been altered from that stored in memory (i.e. the flow or maximum pressure has been changed through the STATUS screen).

HOLD

When pressed produces:

```
Hold At Time (n.n) _
```

(n.n = current real time)

Pressing just ENTER holds the run at the current time and current gradient composition. Entering a time value moves the gradient to that time, solvent percentage and flow conditions, then holds the program there (the pump continues to run). The display shows the No. 1 STATUS screen with a hold message replacing the Time heading:

HOLD	%A	%B	%C	PSI
3.5	46.6	53.4	0.0	1675

NOTE: Solvent compositions are not displayed in the SP8810.

The program continues when CONTINUE and ENTER are pressed (RUN/GRAD also releases a HOLD).

PURGE

Pressing this key produces:

```
Purge File (n) _
```

(n = last initialized file)

Entering a file number (0–9) causes the pump to either ramp up to its maximum flow or the the user–set upper pressure limit (Max PSI) of the designated file at the solvent percentages of the "zero" Time Line of that file. Pressing just ENTER (no number) does this for the last initialized file. If the value within the parentheses is n*, then the current Run File is altered from that stored in memory (i.e. the flow or maximum pressure have been changed outside of EDIT).

RUN/GRAD (SP8800 only)

RUN (SP8810 only)

This key is an immediate command; ENTER is not required. When pressed, the time (gradient) clock starts for the last initialized file. The display moves to the No. 1 STATUS screen regardless of where it was when RUN/GRAD was pressed. At 0.0 time, the right–hand 0 flashes until 0.1 min is reached to indicate the pump clock has started.

INITIALIZE

When pressed it produces:

```
Initialize File (n) _
```

(n = last file initialized)

When a file number (0–9) is entered, it starts the pump at the flow and solvent percentages of the zero time line of the file designated.

Pressing just ENTER (no number), starts the pump at the last initialized file. If the value within the parentheses is n*, then the the Run File is different from that in memory (i.e. either the flow or maximum pressure has been altered outside of EDIT).

As with RUN/GRAD (or RUN), this is also an immediate command not requiring ENTER to activate. This stops the pump. The display then goes to the No. 1 STATUS screen. The time indicated is the actual time at which the pump was stopped. To reset the time back to zero, the file must be re-initialized. Pressing the CONTINUE or RUN/GRAD will re-start the pump and time clock.

Cursor Keys

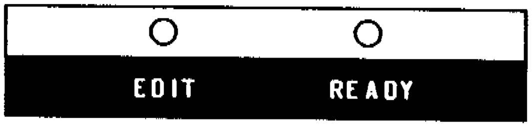
The arrow keys are used to scroll the display up and down, or move the cursor to the right on the display. The right cursor "wraps around" when it reaches the last item on the screen. The up and down keys may also "wrap around" when the display reaches the first or last line of a display.

–


Numeric Keys

These are the numeric keys numbered 0–9 and the decimal point.

This key is used for entering data. When pressed it causes the file to accept the value at the cursor and move to the next value on the line. If the cursor is on the last value of a line, the ENTER key causes the whole line to be accepted.



Indicator Lights

The EDIT light is lit whenever the pump is in the Edit mode. The READY light comes on when the pump has achieved stable operating conditions (referenced) after a file has been initialized.

Section 3
SP8810 Operation and File Editing

Section 3
SP8810 Operation and File Editing

CONTENTS OF THIS SECTION

This section provides the information listed below:

- Use of good operating practices
- A brief operation procedure
- Brief instructions on how to create a run file
- Additional useful pump features
- Features accessed from the Options menu
- Detailed file editing information

FOLLOW GOOD OPERATING PRACTICES

As is discussed below, we recommend that you always follow good operating practices.

Keep Good Records

To assist in the process of identifying and isolating any future problems you might experience with either your equipment or your chromatography, we strongly recommend that good records be kept of all system conditions (i.e. %RSDs on retention times and peak areas, peak shape and resolution, column pressure, and detector sensitivity, etc.). At a minimum, a chromatogram of a typical sample and standard mixture, well documented with system conditions, should be saved for future reference. Careful comparison of retention times, peak shapes, column pressure, peak sensitivity and baseline noise can provide valuable clues to identifying and SOLVING future problems.

Make Safety A Habit

Good laboratory practices should be kept in mind at all times while operating any high performance liquid chromatograph. The greatest danger is probably associated with the large volume of toxic and/or flammable solvents used and stored in the laboratory. Special care needs to be taken to ensure proper ventilation, storage, handling, and disposal of all solvents and samples, You should become familiar with toxicity data and special dangers associated with all chemicals used in the laboratory, and exercise extreme care when

handling noxious samples or solvents. Especially, observe the precautionary measures displayed on solvent containers which explain the user's responsibility regarding environmental protection regulations.

While HPLC system operate at high pressures, liquids are not highly compressible, and therefore, do not store much energy. For this reason, little immediate danger arises from the high pressure in HPLC. If a leak occurs it should be corrected as soon as possible, particularly if flammable solvents are used. Whenever you are working on an HPLC system, WEAR EYE AND SKIN PROTECTION. And last, always shut down the HPLC system and return it to atmospheric pressure before attempting any maintenance.

Always Filter HPLC Solvents

Most chemical manufacturers provide a line of high purity or spectro-quality reagents that are free of chemical impurities. Routine filtration of all solvents or eluents through a 2-micron (or less) fluorocarbon filter before placing them in the solvent reservoir will significantly prolong the life and effectiveness of the inlet filters, pump check valves and seals, injector, and column.

CAUTION: Never use hydrochloric acid solutions. In general, any halide tends to corrode unpassivated stainless steel at any concentration. In mixing chemicals or buffer solutions, take care to avoid high concentrations of organic acids and salts. Also, aqueous solutions containing metal ions found in stainless steel can produce electro-chemical reactions that facilitate corrosion. Therefore, salt solutions of the following metals should be avoided: manganese, chromium, nickel, copper, iron, and molybdenum. A method for passivation of stainless steel components can be found in Section 5.

Spectra-Physics offers a completely inert titanium version of both pumps, gradient and isocratic. For more information, contact your local Spectra-Physics representative.

Follow Good Sample Preparation Procedures

The chromatographer should always study the solubility of the sample in the mobile phase. Precipitation of the sample can plug the system by obstructing the flow through the injector and/or the column. This obstruction may result in irreparable damage to parts of the system. Particulate matter may be avoided by filtering the samples through 2-micron (or less) filters before introduction into the chromatograph.

Degas The Eluents For Isocratic Operation

Degassing of the eluants for the isocratic pump may be accomplished simply by pulling a vacuum on the solvent bottles. For more information, refer to "Degas the Solvent" in Section 1.

BRIEF SP8810 OPERATING INSTRUCTIONS

Purge All Solvent Lines

If none of the solvent lines has solvent in it, refer to "Priming the Isocratic Pump," in Section 1.

Air will slowly diffuse through thin-wall teflon tubing. If the pump flow has been turned off, the solvent line must be purged with degassed solvent before use.

1) Select or create a pump file (see "BRIEF INSTRUCTIONS ON CREATING A RUN FILE" or "Creating A File" further on in this section,).
2) Disconnect the pump outlet from the LC column and direct the open end into a waste container (alternatively, open the bypass valve if this option is installed).
3) Press [PURGE], enter a file number, and then press [ENTER]. The pump will ramp up to its maximum flow without exceeding the maximum pressure (MaxP) setting. Allow the pump to purge for about 4–5 mL or about 1 to 2 minutes maximum.
4) Stop the pump and reconnect the pump to the column or injector (alternatively, close the bypass valve).

Initialize the Desired File and Inject Your Sample

1) Press [INITIALIZE], enter a file number, and press [ENTER] to load the desired Pump File as the Run File. Wait for the pump ready light and for the column to equilibrate before making an injection. In general, it is good practice to allow the column to equilibrate for 10 to 20 column volumes.
2) Inject the sample, then press [RUN].
3) If you are making a manual injection, fill the injection loop, inject the sample, and press [RUN] in succession. If an autosampler is used, simply initiate the autosampler run sequence.

BRIEF INSTRUCTION FOR CREATING A RUN FILE

For more detailed instructions, refer to "FILE EDITING" further on in this section.

Select a File to Edit

Press the [EDIT] key, enter the desired file number, and then press [ENTER]. Enter the desired values for the maximum and minimum allowed pump pressures.

FILE	Max PSI	Min PSI
1	6000	100

Enter the Initial Pump Conditions

Press the [↓] key to enter the desired initial flow rate. Be sure to use the [ENTER] key to "accept" the new values.

Time	Flow
0.0	1.5

Enter the End-of-Run Conditions

Upon completion of the initial flow rate, either a blank time line will appear (if using a new file) or a second time line (if editing an old file). Enter the time and flow rate for the end-of-run or for the completion of the first segment.

0.0	1.5
1.0	1.5

If additional segments are needed, advance to the next time line.

NOTE: Flow rate changes are step changes.

When finished, exit the edit function by pressing [STATUS] or any other function key.

Initialize the New File

To use the newly created file, press [INITIALIZE], enter the new file number, and press [ENTER].

ADDITIONAL USEFUL FEATURES

Quick Edits Using the [STATUS] Key

The pump flow rate and MaxP setting can be changed in the current Run File directly from [STATUS]. Changes are activated immediately, but are lost when the Pump File is re-initialized. Permanent changes must be made in the EDIT mode. An altered file is indicated by an asterisk (*) next to the file number.

Use of the [HOLD] and [CONTINUE] Keys

The [HOLD] key enables you to specify the time value in the current Run File which the pump will use for the flow rate setting. The [HOLD] key is particularly useful for "jumping" to and "holding" at the end–of–run flow rate, for column cleaning or to more rapidly recover from a faulty injection.

Pressing [CONTINUE] and [ENTER] restarts the pump time clock beginning at the currently set Hold time (does not start clock held at zero time). Re-initializing the file brings the clock back to initial conditions.

[CONTINUE] releases the pump from an imposed Hold condition and allows you to jump to another file, starting at the current program time specified in the Hold command.

Proper Use of the Startup File

The Startup File (any file copied to File 11) can be used to save a file in non-volatile memory. This memory is not lost when the power switch is turned off. The Startup File is automatically loaded into the Run File when power is switched on. To change the Startup File, use the [COPY] key to copy the current Edit File to file 11.

When the pump is switched on, a message appears in the display:

```
SP8810          FILE 1 LOADED
UNIT 11
```

The FILE 1 LOADED message means that a Startup File has been loaded from the pump's non-volatile memory into the active Edit and Run Files. The Startup File remains in memory even if the power is turned off. This feature allows the pump to be used in a turn-key mode. The Startup File automatically loads back into the file number from which it was stored. To use the file, simply turn the power on, press [INITIALIZE] and [ENTER] and the unit

begins pumping the chosen solvent mixture (at the zero time composition).

To create the Startup File, create the desired isocratic or gradient file in any of the 10 pump files (0–9). While still in the EDIT mode, press the [COPY] key:

Copy File (n) to File _

Enter the value **11** for the desired file number. The Startup File stores an exact copy of the chosen file when you press [ENTER].

There is a perceptible time lag before the screen returns to the EDIT screen. This is because all the lines are copied even if they are blank.

Battery Backup

The battery backup protects the RAM and all of the pump files against loss during power failures up to 100 hours, NOT against the intentional or unintentional switching off of the pump's AC power switch. The Startup File will not be lost, but automatically reloads as the Run File when the pump is switched on.

To temporarily save all of the pump files from erasure during transport of the pump to a new location, simply pull the plug from the AC power outlet; DO NOT turn the power switch off. The battery backup protects the volatile RAM from erasure.

Proper Use of the Cleanup File

NOTE: Recommended routine maintenance is discussed in detail in Section 5.

The Cleanup File feature, as well as the Maintenance Log, is designed to encourage and simplify proper maintenance of the pump. Good chromatography practice dictates that the pump and column should never be allowed to sit idle with salts or corrosives in them. At the completion of a series of samples, flush the pump, all the tubings, and the column of all salts and corrosive solvents.

The Cleanup File feature allows you to specify a file number to initiate and run at a much lower flow rate when a series of samples is completed. Press [TEST], cursor to the Cleanup menu, then press [ENTER]. The following screen appears:

Cleanup Values	
Time :	File :

This feature works in the following manner: A timer starts at the end-of-run and resets whenever:

- o a pump program is started, meaning the RUN/GRAD key is pressed, pin 7 on the external functions connector is pulled to ground, or
- o a file is initialized, meaning the INITIALIZE and ENTER keys are pressed.

You specify the time interval to be longer than the recycle time on the autosampler. If manual injections are used, the time interval should be the maximum time likely between injections. The pump operates in the normal fashion. If, however, the timer ever exceeds the specified time interval, the pump initiates and runs the designated Cleanup File. For example, in the following Pump File, the pump automatically resets to the Time 0.0 conditions upon reaching the last time line (10.0 min in the following example).

```
Time  Flow
0.0   1.5
10.0  1.5
```

However, at Time 10.0 in the above example, the pump also starts a special "Cleanup " timer. If the timer reaches the time set in the Cleanup menu before the next injection (indicating pump inactivity), the pump initializes and runs the file specified in the Cleanup menu.

The Cleanup File operates slightly different than any other file in the pump. The pump automatically "HOLDS" at .01 minutes prior to the last program line (instead of resetting back to the initial conditions at Time 0.0). IN THIS FILE ONLY, the pump never reaches the last line of the file. Since flow rate changes are step changes (refer to "FILE EDITING" further on in this section), the desired final flow condition must be set in the NEXT TO LAST TIME LINE.

NOTE: To ensure the best performance from the pump, the minimum flow rate should be set such that the column pressure is greater than 100 psi.

In the following Pump File, if the file is executed as the Cleanup File,

```
Time  Flow
0.0   1.5
5.1   0.2
5.2   .2
```

the pump HOLDS at the 5.2-minute Time Line, but never actually executes the final line. Therefore, the final flow conditions are determined by the NEXT TO LAST TIME LINE in any file run as the Cleanup File. To avoid mistakes, simply duplicate the desired final conditions, i.e. offset in time by 0.1 minute (as shown in the prior example).

CAUTION: Any time the pump will be operated unattended for an extended period of time, check the solvent reservoir and waste containers to ensure that sufficient capacity remains.

A zero (0) entered as the Time in the Cleanup Values Menu inactivates the feature.

Proper Use of the Maintenance Log

NOTE: Recommended routine maintenance is discussed in detail in Section 5.

Then Maintenance Log is designed to allow you to record when maintenance was last performed on the pump and to set intervals for future maintenance or operational checks. The Maintenance Log enables you to plan a schedule of routine maintenance that helps safeguard against unexpected failures or poor chromatographic performance.

You can enter the date of last replacement or repair of a check valve, piston, or piston seal and the desired interval in liters of solvent pumped before a message reminds you that attention is required. The expected intervals will vary depending on your operating conditions and maintenance habits. For more information, refer to Section 5.

Monitoring the Pump Performance

The Pump has the capability to automatically monitor its own performance and warn you if a flow problem exists. The Flow Stability Tests can be implemented in three different ways.

Certain flow conditions are monitored all of the time. If unstable flow conditions exist, for instance, i.e. the pump runs out of solvent or the seal suddenly fails or the check valve traps an air bubble, the pump responds with the appropriate message:

```
OUT OF SOLVENT
or
UNSTABLE FLOW
```

The OUT OF SOLVENT condition causes the pump to shut off immediately. However, you can determine the pump response to UNSTABLE FLOW. The pump always reports the error, but whether or not the pump shuts down upon detection of UNSTABLE FLOW can be selected in the OPTIONS menu under the [TEST] function key (refer to "OPTIONS MENU" below).

The pump can also initiate a Flow Stability Test on a continuous basis. The test can be initiated from DIAGNOSTIC 203 in the DIAGNOSTICS menu under the function key. The results are continuously displayed until another key is pressed. The results consist of 2 parts. The first is a summary of the performance evaluation (STABLE, ACCEPTABLE, or UNSTABLE) and the second is a number that measures the difference between the expected target pressure and the actual target pressure. Further explanation of this number can be found in Section 6.

OPTIONS MENU

Refer to Sections 5 and 6 for information on diagnostics for performance monitor8ing and hardware troubleshooting. Section 7 contains information on External Functions and RS–232. The remainder of this section will focus on the pump features accessed from the OPTIONS menu under the [TEST] key. All selections are retained in non–volatile memory.

Pressure Units for Display

The Isos Pump has selectable pressure units for display. You can select between PSI, BARS, or MPa. Press the [TEST] function key and move the cursor to the OPTIONS menu. Press [ENTER]. Use the [↓] key to cursor to select the Pressure Units option. Press [ENTER] again. Use the cursor keys ([↓] or [↑]) to select the desired units for display. The factory-set unit is PSI.

```
Select Pressure Units
for Display  ↑↓    PSI
                   BAR
                   MPA
```

Flow Range

The pump has the optional capability of substituting Semi-Preparative Pump Liquid Ends to increase the flow rate range. The pump cannot sense which liquid ends are in place, so you MUST select either Prep or Normal in the Flow Range menu to enable the pump

to use the proper flow constants in its software. The allowed flow ranges are 10 uL/min to 10 mL/min for the Normal Head and 30 uL/min to 30 mL/min for the Prep Head/

Press the [TEST] function key and move the cursor to the OPTIONS menu. Press [ENTER] . Use the [↓] key to locate the Pump Flow Range option. Press [ENTER] again. Use the cursor keys ([↓] or [↑]) to select either Prep or Normal flow ranges. The factory-set response is Normal.

```
Select Flow Range for
Pump Operation  ↑↓  NORMAL
                    PREP
```

Unstable Flow Shutdown

The pump constantly monitors itself for flow stability. The pump evaluates its flow stability over approximately 10 cam cycles, depending on the flow rate, and issues a "performance rating."

For more information on the Flow Stable, Flow Acceptable, and Flow Unstable performance ratings, refer to Section 6. If the pump fails its evaluation. (Flow Unstable rating) on 10 consecutive evaluation periods, the fault message "UNSTABLE FLOW" is displayed. You can select the pump response to the unusable flow condition to be either to: (a) report the error and continue, or (b) report the error and stop.

Press the [TEST] function key and move the cursor to the OPTIONS menu. Press [ENTER]. Use the [↓] key to find the Unstable Flow Response option. Press [ENTER]. Use the cursor keys ([↓] or [↑]) to select the desired response, STOP or CONTINUE. The factory-set response is CONTINUE.

```
Select Pump Response to
UNSTABLE FLOW  ↑↓  Continue
                   Stop
```

AC Power Failure Recovery

The pump can recover from an AC power line failure in one of two ways. The first option is to reload the active Run File and effectively execute a CONTINUE to allow the pump to resume exactly where it was before the power failure. The file which was running completes and the pump responds as if no failure had happened (except an error message is issued). Data from the current sample analysis may be corrupted, but subsequent runs should run

normally. The second option enables the pump to recover with its memory intact, but remains Stopped until the file is re-initialized or $\boxed{\text{RUN}}$ is pressed.

Press the $\boxed{\text{TEST}}$ function key and move the cursor to the OPTIONS menu. Press $\boxed{\text{ENTER}}$. Use the $\boxed{\downarrow}$ key to find the Power Failure Recovery option. Press $\boxed{\text{ENTER}}$ again. Use the cursor keys ($\boxed{\downarrow}$ or $\boxed{\uparrow}$) to select the desired response. The factory-set response is for the pump to remain Stopped.

```
Select Response to Power
Recovery      ↑↓    Continue
                     Stop
```

FILE EDITING

Introduction

The pump has 10 program files available (numbered 0–9), which contain up to 40 Time Lines each. This is enough to handle even the most complex flow program.

Allowed Values

Flow Range— The SP8810 pump accepts any value from 10 uL/min to 30 uL/min as valid entries. However, once the file is initialized, only 10 uL/min to 10 mL/min, or 30 uL/min to 30 mL/min will be allowed for the Normal or Prep Head, respectively.

Time- Allowed values are 0 to 650 minutes in 0.1-minute increments. Extending files increases the number of allowed Time Lines, but not the allowed total time of 650 minutes.

File Types

The pump has 5 different types of files:

- o Edit Files
- o Run or Active File
- o Modified Run or Active File
- o Startup File
- o Cleanup File

Edit Files— are files numbered from 0 to 9 and can only be addressed in the Edit mode. All changes are retained until they are re-edited in the Edit mode.

Run or Active File— is the last initialized file and the currently "running" or "activated."

Modified Run or Active File— was changed (modified) out of Edit mode, either from the STATUS function or remotely. An asterisk (*) is displayed next to the file number to indicate that the file was modified out of Edit mode. Changes are lost when the Edit File is re-initialized.

Startup File— is any Edit File that has been copied into file 11. File 11 is stored in non-volatile memory and is automatically activated whenever the pump power switch is switched back on.

Cleanup File— is any Edit file whose file number has been entered into the Cleanup menu under the [TEST] function key.

Time Lines

A Time Line defines the flow for a specific point in time. For example:

Time	Flow
0.0	1.50
20.0	2.00
. . . .	

The last Time Line entered is automatically the end of run (except when used as the Cleanup File), and unless a HOLD or EXTEND to a new file is entered, the pump recycles back to the initial conditions.

CREATING OR EDITING A FILE

To create or EDIT a new file, press the [EDIT] key. The first EDIT screen appears on the display:

File	Max PSI	Min PSI
1	6000	0

The cursor is under the File value. To edit File 1, simply press [ENTER]. To edit another file (0 to 9), press the desired number (e.g., **2**), then press [ENTER]. The number appears under the word "File," and the cursor then moves over to the maximum pressure (Max PSI) value:

File	Max PSI	Min PSI
2	6000	0

Use the numeric keys to choose the desired maximum pressure, then press [ENTER]. This is the pressure above which the pump will STOP. The value entered should be in the correct pressure units (PSI, BARS or MPa), selected under OPTIONS with the [TEST] function key, then repeated with the minimum pressure (Min PSI). The minimum pressure is the value below which the pump will STOP.

NOTE: New values are not accepted until [ENTER] is pressed somewhere on the line. If the screen is scrolled or exited for any reason prior to pressing [ENTER], the new values are lost and the original values retained.

Entering Isocratic Flow Values

When the Min PSI value is entered, the display moves to the first or "zero" Time Line of the EDIT screen.

```
Time     Flow
 0.0     0.00
```

Choose a value for the Flow and press [ENTER]. The display scrolls sown (the column headings will disappear) and the cursor then moves to the Time value on the "blank" Time Line:

```
0.0      36.0     0.0     64.0      1.25
_
```

The file is ready for a new Time Line. Simply choose a desired "end of run" time and press the [ENTER] key twice:

```
 0.0        1.25
10.0        1.25
```

When [ENTER] is pressed a third time, the display again scrolls down as it did before and displays the cursor on the blank line:

```
 0.0        1.25
 _
```

The file now contains the parameters needed for an isocratic run.

Editing An Existing File

To edit an existing file, press [EDIT]:

File	Max PSI	Min PSI
1	3000	200

The last file that was edited appears on the EDIT screen with the cursor under the file value. Press the desired file number if different from the one visible (do not press [ENTER] yet). If a different file is chosen, that file number appears and the cursor remains under the word "File":

File	Max PSI	Min PSI
2	3000	200

If a different file is chosen, pressing [ENTER] loads the new file and moves the cursor to the Max PSI on that screen.

File	Max PSI	Min PSI
2	4000	300

NOTE: If a different file is chosen, do not use the [↓] key (down arrow) to exit this screen. The [ENTER] key must be pressed to accept the new file.

If the existing file is desired, pressing [ENTER] accepts the screen and moves the cursor to the "zero" Time Line of the EDIT screen. To change any of the pressure limit values of the existing file, use the [→] key to move to Max PSI:

File	Max PSI	Min PSI
1	3000	200

At this point, change the Max PSI value, or by using either the (right arrow key) or [ENTER] key, move and change the Min PSI value. After the Min PSI value is changed or accepted, pressing [ENTER] accepts the new values and moves the cursor to the %A value of the "zero" Time Line.

Time	Flow
0.0	1.25

At this point, either change the Flow value and press [ENTER], or just press [↓] to move to the next line. Pressing [ENTER] scrolls down to the "blank" Time Line.

Changing The Time Value

The value under the Time column can be changed in all but the zero Time Line. To do this, use [↓] to move to the desired Time Line:

0.0	1.00
10.0	$\underline{1}$.50

Then use [⇥] to move back around to the Time value:

0.0	1.00
$\underline{1}$0.0	1.50

The Time value can be changed at this time by choosing the desired value and pressing [ENTER].

When multiple Time Lines exist, there is one restriction on changing the Time value. The value chosen must be a time between the two adjacent Time Lines. For example:

5.0	1.00
$\underline{1}$0.0	1.00
20.0	1.00
.	
.	

The time of 10.0 minutes can only be changed in the range of 5.1 to 19.9 minutes. Otherwise, an error message appears on the screen:

ILLEGAL GRADIENT TIME

A new Time Line may be inserted by scrolling to the blank line, entering the desired values, then pressing [ENTER]. Regardless of the Time value, the new line is inserted into the file in the proper sequence.

Section 4
SP8800 Operation and File Editing

Section 4

SP8800 Operation and File Editing

CONTENTS OF THIS SECTION

This section provides the information listed below:

- Use of good operating practices
- A brief operation procedure
- Brief instructions on how to create a run file
- Additional useful pump features
- Features accessed from the Options menu
- Detailed file editing information

FOLLOW GOOD OPERATING PRACTICES

As is discussed below, we recommend that you always follow good operating practices.

Keep Good Records

To assist in the process of identifying and isolating any future problems you might experience with either your equipment or your chromatography, we strongly recommend that good records be kept of all system conditions (i.e. %RSDs on retention times and peak areas, peak shape and resolution, column pressure, and detector sensitivity, etc.). At a minimum, a chromatogram of a typical sample and standard mixture, well documented with system conditions, should be saved for future reference. Careful comparison of retention times, peak shapes, column pressure, peak sensitivity and baseline noise can provide valuable clues to identifying and SOLVING future problems.

Make Safety A Habit

Good laboratory practices should be kept in mind at all times while operating any high performance liquid chromatograph. The greatest danger is probably associated with the large volume of toxic and/or flammable solvents used and stored in the laboratory. Special care needs to be taken to ensure proper ventilation, storage, handling, and disposal of all solvents and samples, You should become familiar with toxicity data and special dangers associated with all

chemicals used in the laboratory, and exercise extreme care when handling noxious samples or solvents. Especially, observe the precautionary measures displayed on solvent containers which explain the user's responsibility regarding environmental protection regulations.

While HPLC system operate at high pressures, liquids are not highly compressible, and therefore, do not store much energy. For this reason, little immediate danger arises from the high pressure in HPLC. If a leak occurs it should be corrected as soon as possible, particularly if flammable solvents are used. Whenever you are working on an HPLC system, WEAR EYE AND SKIN PROTECTION. And last, always shut down the HPLC system and return it to atmospheric pressure before attempting any maintenance.

Always Filter HPLC Solvents

Most chemical manufacturers provide a line of high purity or spectro-quality reagents that are free of chemical impurities. Routine filtration of all solvents or eluents through a 2-micron (or less) fluorocarbon filter before placing them in the solvent reservoir will significantly prolong the life and effectiveness of the inlet filters, pump check valves and seals, injector, and column.

CAUTION: Never use hydrochloric acid solutions. In general, any halide tends to corrode unpassivated stainless steel at any concentration. In mixing chemicals or buffer solutions, take care to avoid high concentrations of organic acids and salts. Also, aqueous solutions containing metal ions found in stainless steel can produce electro-chemical reactions that facilitate corrosion. Therefore, salt solutions of the following metals should be avoided: manganese, chromium, nickel, copper, iron, and molybdenum. A method for passivation of stainless steel components can be found in Section 5.

Spectra-Physics offers a completely inert titanium version of the pump. For more information, contact your local Spectra-Physics representative.

Follow Good Sample Preparation Procedures

The chromatographer should always study the solubility of the sample in the mobile phase. Precipitation of the sample can plug the system by obstructing the flow through the injector and/or the column. This obstruction may result in irreparable damage to parts of the system. Particulate matter may be avoided by filtering the samples through 2-micron (or less) filters before introduction into the chromatograph.

Degas The Eluents For Ternary Operation

Helium degassing of solvents is essential to ensure that bubbles do not form on the low pressure side of the pump (such as in the ternary proportioning valve), and thereby reduce the performance of the pump and the LC system. The pump comes equipped with a helium degassing manifold located under the keyboard on the left side of the pump.

Inspect each solvent reservoir cap to ensure that each is in good condition and fits snugly with all tubing lines in place. Verify that the helium flow into each bottle is adequate to maintain degas (about 5 mL per minute) and that the vent tubes are in place. If the helium degas to the eluant reservoirs has been turned off, the residual air in the bottles must be purged out by increasing the helium flow to the bottles to a rapid flow for 10 minutes, then reducing the flow back to a slow trickle of about 5 mL per minute.

BRIEF OPERATING INSTRUCTIONS

Purge All Solvent Lines

If none of the solvent lines has solvent in it, refer to "Priming the Gradient Pump", in Section 1.

Air will slowly diffuse through thin-wall teflon tubing. If the pump flow has been turned off or if any of the solvent lines from the solvent reservoirs to the ternary proportioning valve have not been used in the past several hours, those lines must be purged with degassed solvent before use.

1) Select or create a pump file (see "BRIEF INSTRUCTIONS ON CREATING A RUN FILE" or "Creating A File" further on in this section) that has nearly equal compositions of all solvent lines in use. We recommend that a standard file be designated as the Purge File.

2) Open the bypass valve or disconnect the pump outlet from the LC column and direct the open end into a waste container.

3) Press $\boxed{\text{PURGE}}$, enter a file number, and then press $\boxed{\text{ENTER}}$. The pump will ramp up to its maximum flow without exceeding the maximum pressure (MaxP) setting. Allow the pump to purge for about 4–5 mL or about 1 to 2 minutes maximum.

4) Stop the pump and reconnect the pump to the column or injector (alternatively, close the bypass valve if this option is installed).

Initialize the Desired File and Inject Your Sample

1) Press [INITIALIZE], enter a file number, and press [ENTER] to load the desired Pump File as the Run File. Wait for the pump ready light and for the column to equilibrate before making an injection. In general, it is good practice to allow the column to equilibrate for 10 to 20 column volumes.
2) Inject the sample, then press [RUN] on the pump.
3) If you are making a manual injection, fill the injection loop, inject the sample, and press [RUN] in succession. If an autosampler is used, simply initiate the autosampler run sequence.

BRIEF INSTRUCTION FOR CREATING A RUN FILE

For more detailed instructions, refer to "FILE EDITING" further on in this section.

Select a File to Edit

Press the [EDIT] key, enter the desired file number, and then press [ENTER]. Enter the desired values for the maximum and minimum allowed pump pressures.

FILE	Max PSI	Min PSI
1	6000	100

Enter the Initial Pump Conditions

Press the [↓] key to enter the desired initial solvent compositions and flow rate. Be sure to use the [ENTER] key to "accept" the new values.

Time	%A	%B	%C	Flow
0.0	60	30	10	1.5

Enter the End-of-Run Conditions

Upon completion of the initial conditions, either a blank time line will appear (if using a new file) or a second time line (if editing an

old file). Enter the time, solvent compositions, and flow rate for the end-of-run, or for the completion of the first segment.

0.0	60	30	10	1.5
1.0	20	70	10	1.5

If additional segments are needed, advance to the next time line.

NOTE: The solvent compositions are linear interpolatons between time lines, while flow rate changes are step changes.

When finished, exit the edit function by pressing [STATUS] or any other function key.

Initialize the New File

To use the newly created file, press [INITIALIZE], enter the new file number, and press [ENTER].

ADDITIONAL USEFUL FEATURES

Quick Edits Using the [STATUS] Key

The pump flow rate and MaxP setting can be changed in the current Run File directly from [STATUS]. Changes are activated immediately, but are lost when the Pump File is re-initialized. Permanent changes must be made in the EDIT mode. An altered file is indicated by an asterisk (*) next to the file number.

Use of the [HOLD] and [CONTINUE] Keys

The [HOLD] key enables you to specify the Time value in the current Run File program which the pump will use for the solvent compositions and flow rate settings. The [HOLD] key is particularly useful for "jumping" to and "holding" at the end-of-run solvent conditions and flow rate, for column cleaning or to more rapidly recover from a faulty injection.

Pressing [CONTINUE] and [ENTER] restarts the pump time clock beginning at the currently set Hold time (does not start clock held at zero time). Re-initializing the file brings the clock back to initial conditions.

[CONTINUE] releases the pump from an imposed Hold condition and allows you to jump to another file, starting at the current program time specified in the Hold command.

Proper Use of the Startup File

The Startup File (any file copied to File 11) can be used to save a file in non-volatile memory. This memory is not lost when the power switch is turned off. The Startup File is automatically loaded into the Run File when power is switched on. To change the Startup File, use the $\boxed{\text{COPY}}$ key to copy the current Edit File to file 11.

When the pump is switched on, a message appears in the display:

```
SP8800          FILE 1 LOADED
UNIT 11
```

The FILE 1 LOADED message means that a Startup File has been loaded from the pump's non-volatile memory into the active Edit and Run Files. The Startup File remains in memory even if the power is turned off. This feature allows the pump to be used in a turn-key mode. The Startup File automatically loads back into the file number from which it was stored. To use the file, simply turn the power on, press $\boxed{\text{INITIALIZE}}$ and $\boxed{\text{ENTER}}$ and the unit begins pumping the chosen solvent mixture (at the zero time composition).

To create the Startup File, create the desired isocratic or gradient file in any of the 10 pump files (0–9). While still in the EDIT mode, press the $\boxed{\text{COPY}}$ key:

```
Copy File (n) to File _
```

Enter the value **11** for the desired file number. The Startup File stores an exact copy of the chosen file when you press $\boxed{\text{ENTER}}$.

There is a perceptible time lag before the screen returns to the EDIT screen. This is because all the lines are copied even if they are blank.

Battery Backup

The battery backup protects the RAM and all of the pump files against loss during power failures up to 100 hours, NOT against the intentional or unintentional switching off of the pump's AC power switch. The Startup File will not be lost, but automatically reloads as the Run File when the pump is switched on.

To temporarily save all of the pump files from erasure during transport of the pump to a new location, simply pull the plug from the

AC power outlet; DO NOT turn the power switch off. The battery backup protects the volatile RAM from erasure.

Proper Use of the Cleanup File

NOTE: Recommended routine maintenance is discussed in detail in Section 5.

The Cleanup File feature, as well as the Maintenance Log, is designed to encourage and simplify proper maintenance of the pump. Good chromatography practice dictates that the pump and column should never be allowed to sit idle with salts or corrosives in them. At the completion of a series of samples, flush the pump, all the tubings, and the column of all salts and corrosive solvents.

The Cleanup File feature allows you to specify a file number to initiate and run when a series of samples are completed. Press [TEST], cursor to the Cleanup menu, then press [ENTER]. The following screen appears:

```
Cleanup Values
Time  :              File  :
```

This feature works in the following manner: A timer starts at the end-of-run and resets whenever:

- o a pump program is started, meaning the [RUN/GRAD] key is pressed, pin 7 on the external functions connector is pulled to ground, or
- o a file is initialized, meaning the [INITIALIZE] and [ENTER] keys are pressed.

You specify the time interval to be longer than the recycle time on the autosampler. If manual injections are used, the time interval should be the maximum time likely between injections. The pump operates in the normal fashion. If, however, the timer ever exceeds the specified time interval, the pump initiates and runs the designated Cleanup File. For example, in the following Pump File, the pump automatically resets to the Time 0.0 conditions upon reaching the last time line (10.0 min in the following example).

Time	%A	%B	%C	Flow
0.0	100	0	0	1.5
2.0	80	20	0	1.5
4.0	60	20	20	1.5
10.0	60	20	20	1.5

However, at Time 10.0 in the above example, the pump also starts a special "Cleanup " timer. If the timer reaches the time set in the Cleanup menu before the next injection (indicating pump inactivity), the pump initializes and runs the file specified in the Cleanup menu.

The Cleanup File operates slightly different than any other file in the pump. The pump automatically "HOLDS" at .01 minutes prior to the last program line (instead of resetting back to the initial conditions at Time 0.0). IN THIS FILE ONLY, the pump never reaches the last line of the file. Since flow rate changes are step changes (refer to Section 4), the desired final flow condition must be set in the NEXT TO LAST TIME LINE.

NOTE: To ensure the best performance from the pump, the minimum flow rate should be set such that the column pressure is greater than 100 psi.

In the following Pump File, if the file is executed as the Cleanup File,

Time	%A	%B	%C	Flow
0.0	50	50	0	1.5
5.0	0	100	0	1.5
5.1	0	100	0	.2
5.2	0	100	0	.2

the pump HOLDS at the 5.2-minute Time Line, but never actually executes the final line. Therefore, the final flow conditions are determined by the NEXT TO LAST TIME LINE in any file run as the Cleanup File. To avoid mistakes, simply duplicate the desired final conditions, i.e. offset in time by 0.1 minute (as shown in the prior example).

CAUTION: Any time the pump will be operated unattended for an extended period of time, check the solvent reservoirs and waste containers to ensure that sufficient capacity remains.

A zero (0) entered as the Time in the Cleanup Values Menu inactivates the feature.

Proper Use of the Maintenance Log

NOTE: Recommended routine maintenance is discussed in detail in Section 5.

Then Maintenance Log is designed to allow you to record when maintenance was last performed on the pump and to set intervals for future maintenance or operational checks. The Maintenance

Log enables you to plan a schedule of routine maintenance that helps safeguard against unexpected failures or poor chromatographic performance.

You can enter the date of last replacement or repair of a check valve, piston, or piston seal and the desired interval in liters of solvent pumped before a message reminds you that attention is required. The expected intervals will vary depending on your operating conditions and maintenance habits. For more information, refer to Section 5.

Monitoring the Pump Performance

The pumps have the capability to automatically monitor their own performance and warn you if a flow problem exists. The Flow Stability Tests can be implemented in three different ways.

Certain flow conditions are monitored all of the time. If unstable flow conditions exist, for instance, i.e. the pump runs out of solvent or the seal suddenly fails or the check valve traps an air bubble, the pump responds with the appropriate message:

```
OUT OF SOLVENT
or
UNSTABLE FLOW
```

The OUT OF SOLVENT condition causes the pump to shut off immediately. However, you can determine the pump response to UNSTABLE FLOW. The pump always reports the error, but whether or not the pump shuts down upon detection of UNSTABLE FLOW can be selected in the OPTIONS menu under the $\boxed{\text{TEST}}$ function key (refer to "OPTIONS MENU" below).

The pump can also initiate a Flow Stability Test on a continuous basis. The test can be initiated from DIAGNOSTIC 203 in the DIAGNOSTICS menu under the function key. The results are continuously displayed until another key is pressed. The results consist of 2 parts. The first is a summary of the performance evaluation (STABLE, ACCEPTABLE, or UNSTABLE) and the second is a number that measures the difference between the expected target pressure and the actual target pressure. Further explanation of this number can be found in Section 6.

OPTIONS MENU

Refer to Sections 5 and 6 for information on diagnostics for performance monitoring and hardware troubleshooting. Section 7

contains information on External Functions and RS–232. The remainder of this section will focus on the pump features accessed from the OPTIONS menu under the [TEST] key. All selections are retained in non–volatile memory.

Pressure Units for Display

The pump has selectable pressure units for display. You can select between PSI, BARS, or MPa. Press the [TEST] function key and move the cursor to the OPTIONS menu. Press [ENTER]. Use the [↓] key to cursor to select the Pressure Units option. Press [ENTER] again. Use the cursor keys ([↓] or [↑]) to select the desired units for display. The factory-set unit is PSI.

```
Select Pressure Units
for Display  ↑↓     PSI
                    BAR
                    MPA
```

Flow Range

The pump has the optional capability of substituting Semi-Preparative Pump Liquid Ends to increase the flow rate range. The pump cannot sense which liquid ends are in place, so you MUST select either Prep or Normal in the Flow Range menu to enable the pump to use the proper flow constants in its software. The allowed flow ranges are 10 uL/min to 10 mL/min for the Normal Head and 30 uL/min to 30 mL/min for the Prep Head/

Press the [TEST] function key and move the cursor to the OPTIONS menu. Press [ENTER] . Use the [↓] key to locate the Pump Flow Range option. Press [ENTER] again. Use the cursor keys ([↓] or [↑]) to select either Prep or Normal flow ranges. The factory-set response is Normal.

```
Select Flow Range for
Pump Operation  ↑↓    NORMAL
                      PREP
```

Unstable Flow Shutdown

The pump constantly monitors itself for flow stability. The pump evaluates its flow stability over approximately 10 cam cycles, depending on the flow rate, and issues a "performance rating."

For more information on the Flow Stable, Flow Acceptable, and Flow Unstable performance ratings, refer to Section 6. If the

pump fails its evaluation (Flow Unstable rating) on 10 consecutive evaluation periods, the fault message "UNSTABLE FLOW" is displayed. You can select the pump response to the unusable flow condition to be either to: (a) continue, or (b) report the error and stop.

Press the [TEST] function key and move the cursor to the OPTIONS menu. Press [ENTER]. Use the [↓] key to find the Unstable Flow Response option. Press [ENTER]. Use the cursor keys ([↓] or [↑]) to select the desired response, STOP or CONTINUE. The factory-set response is CONTINUE.

```
Select Pump Response to
UNSTABLE FLOW ↑↓  Continue
                   Stop
```

AC Power Failure Recovery

The pump can recover from an AC power line failure in one of two ways. The first option is to reload the active Run File and effectively execute a CONTINUE to allow the pump to resume exactly where it was before the power failure. The file which was running completes and the pump responds as if no failure had happened (except an error message is issued). Data from the current sample analysis may be corrupted, but subsequent runs should run normally. The second option enables the pump to recover with its memory intact, but remains Stopped until the file is re-initialized or [RUN/GRAD] is pressed.

Press the [TEST] function key and move the cursor to the OPTIONS menu. Press [ENTER]. Use the [↓] key to find the Power Failure Recovery option. Press [ENTER] again. Use the cursor keys ([↓] or [↑]) to select the desired response. The factory-set response is for the pump to remain Stopped.

```
Select Response to Power
Recovery      ↑↓   Continue
                   Stop
```

FILE EDITING

Introduction

The pump has 10 program files available (numbered 0–9), which contain up to 40 Time Lines each. This is enough to handle even the most complex gradient.

Allowed Values

Flow Range— The pump accepts any value from 10 uL/min to 30 uL/min as valid entries. However, once the file is initialized, only 10 uL/min to 10 mL/min, or 30 uL/min to 30 mL/min will be allowed for the Normal or Prep Head, respectively.

Solvent %— Allowed values are 0% to 100% in 0.1%-increments. The sum of %A, %B, and %C must equal 100%.

Time- Allowed values are 0 to 650 minutes in 0.1-minute increments.

File Types

The pump has 5 different types of files:

o Edit Files
o Run or Active File
o Modified Run or Active File
o Startup File
o Cleanup File

Edit Files— are files numbered from 0 to 9 and can only be addressed in the Edit mode. All changes are retained until they are re-edited in the Edit mode.

Run or Active File— is the last initialized file and the currently "running" or "activated."

Modified Run or Active File— was changed (modified) out of Edit mode, either from the STATUS function or remotely. An asterisk (*) is displayed next to the file number to indicate that the file was modified out of Edit mode. Changes are lost when the Edit File is re-initialized.

Startup File— is any Edit File that has been copied into file 11. File 11 is stored in non-volatile memory and is automatically activated whenever the pump power switch is switched back on.

Cleanup File— is any Edit file whose file number has been entered into the Cleanup menu under the $\boxed{\text{TEST}}$ function key.

Time Lines

A Time Line defines the solvent composition and flow for a specific point in time. For example:

Time	%A	%B	%C	Flow
0.0	50.0	50.0	0.0	1.50
10.0	50.0	50.0	0.0	1.50
15.0	40.0	60.0	0.0	1.50
20.0	20.0	80.0	0.0	2.00
22.0	20.0	80.0	0.0	2.00

. . . .

During a gradient run, two Time Lines define a linear change in composition. In the example above, %A remains isocratic between 0 and 10 minutes; – changes at the rate of 2%/min (gradient) between 10 and 15 minutes; then – 4%/min (gradient between 15 and 20 minutes (see Fig. 4.1). Changes in the flow, however, are step changes. In the same example, the flow remains at 1.50 mL/min until 20.0 minutes and then makes a step change to 2.00 mL/min.

The last Time Line entered is automatically the end of run (except when used as the Cleanup File), and unless a HOLD is entered, the pump recycles back to the initial conditions. In the previous example, a flow of 2.00 mL/min with a solvent composition of 20% A, 80% B, and 0% C is maintained from 20 to 22 minutes. At 22 minutes, the flow and solvent compositions immediately return to those specified at time 0.0 and remain there until you press [RUN/GRAD] to start the program again.

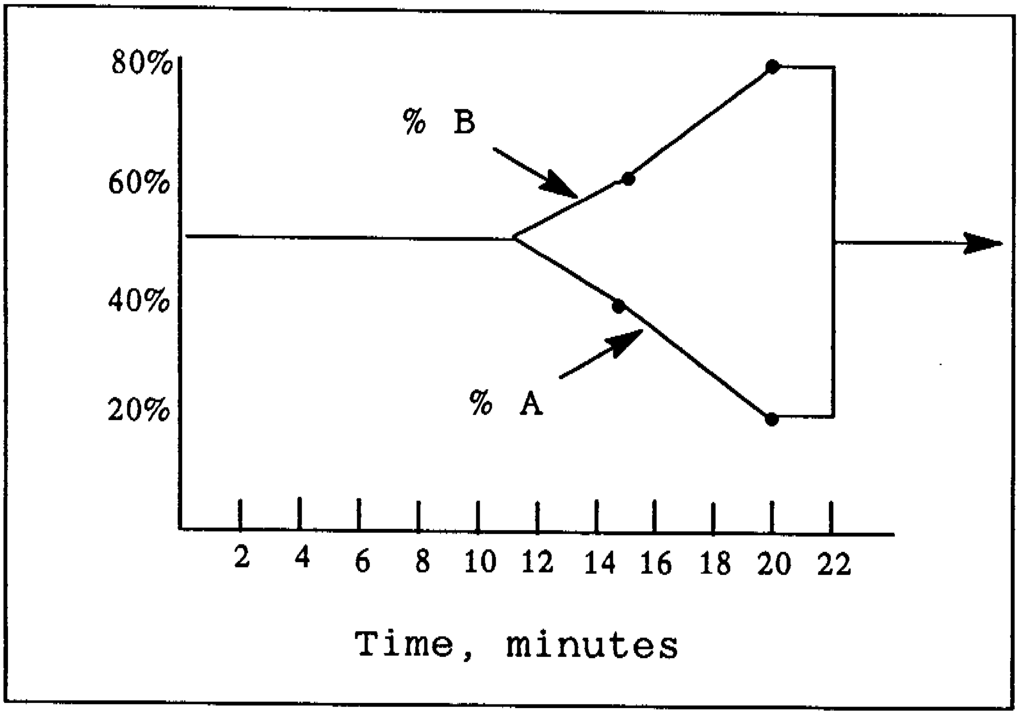


Fig. 4.1 Example of a Gradient Run Using the SP8800

Creating A File

To create or EDIT a new file, press the [EDIT] key. The first EDIT screen appears on the display:

File	Max PSI	Min PSI
1	6000	0

The cursor is under the File value. To edit File 1, simply press [ENTER]. To edit another file (0 to 9), press the desired number (e.g., **2**), then press [ENTER]. The number appears under the word "File," and the cursor then moves over to the maximum pressure (Max PSI) value:

File	Max PSI	Min PSI
2	6000	0

Use the numeric keys to choose the desired maximum pressure, then press [ENTER]. This is the pressure above which the pump will STOP. The value entered should be in the correct pressure units (PSI, BARS or MPa), selected under OPTIONS with the [TEST] function key, then repeated with the minimum pressure

(Min PSI). The minimum pressure is the value below which the pump will STOP.

NOTE: New values are not accepted until [ENTER] is pressed somewhere on the line. If the screen is scrolled or exited for any reason prior to pressing [ENTER], the new values are lost and the original values retained.

Isocratic Run

When the Min PSI value is entered, the display moves to the first or "zero" Time Line of the EDIT screen.

Time	%A	%B	%C	Flow
0.0	100	0.0	0.0	0.00

The cursor is under the %A value. If the [ENTER] key is pressed at this point, the percentage value is accepted "as is" and the cursor moves to Flow (the percentages must add up to 100%). However, to create a binary or ternary mix, select the desired %A (36 in the following example) and press [ENTER]. The cursor then moves to the %B.

Time	%A	%B	%C	Flow
0.0	36.0	0.0	0.0	0.00

At this point, if the [ENTER] key is pressed without choosing a value for %B, the 0.0 remains (or is accepted); a value equal to 100% minus %A appears under the %C, and the cursor moves to Flow:

Time	%A	%B	%C	Flow
0.0	36.0	0.0	64.0	0.00

If a value is entered for %B, then a value for %C is automatically entered so that the total of %A plus %B plus %C is 100% and the cursor moves to Flow:

Time	%A	%B	%C	Flow
0.0	36.0	0.0	64.0	0.00

Choose a value for the Flow and press [ENTER]. The display scrolls sown (the column headings will disappear) and the cursor then moves to the Time value on the "blank" Time Line:

0.0	36.0	0.0	64.0	1.25
_				

The file is ready for a new Time Line. For an isocratic run, simply choose a desired "end of run" time and press the ENTER key three times:

0.0	36.0	0.0	64.0	1.25
10.0	36.0	0.0	64.0	1.25

At this point, all the percentages have been accepted and the flow value is carried down from the previous line. It can be changed at this point if desired. When ENTER is pressed a fourth time, the display again scrolls down as it did before and displays the cursor on the blank line:

0.0	36.0	0.0	64.0	1.25
_				

The file now contains the parameters needed for an isocratic run.

Gradient Run

A gradient is created by entering different percentage values for %A, %B, and %C after a Time value is chosen. A multi-step gradient requires creating new Time Lines with differing solvent percentages:

Time	%A	%B	%C	Flow
0.0	36.0	42.0	22.0	1.25
10.0	40.0	38.0	22.0	1.25
15.0	44.0	34.0	22.0	1.25
....				

The pump performs a straight-line or linear percentage change between any two lines. Again, upon executing the last Time Line of a file, the pump automatically resets to the original conditions set at Time 0.0 and remains there until you press RUN/GRAD to restart the program.

Editing An Existing File

To edit an existing file, press [EDIT] :

File	Max PSI	Min PSI
1	3000	200

The last file that was edited appears on the EDIT screen with the cursor under the file value. Press the desired file number if different from the one visible (do not press [ENTER] yet). If a different file is chosen, that file number appears and the cursor remains under the word "File":

File	Max PSI	Min PSI
2	3000	200

If a different file is chosen, pressing [ENTER] loads the new file and moves the cursor to the Max PSI on that screen.

File	Max PSI	Min PSI
2	4000	300

NOTE: If a different file is chosen, do not use the [↓] key (down arrow) to exit this screen. The [ENTER] key must be pressed to accept the new file.

If the existing file is desired, pressing [ENTER] accepts the screen and moves the cursor to the "zero" Time Line of the EDIT screen. To change any of the pressure limit values of the existing file, use the [→] key to move to Max PSI:

File	Max PSI	Min PSI
1	3000	200

At this point, change the Max PSI value; or by using either the (right arrow key) or [ENTER] key, move and change the Min PSI value. After the Min PSI value is changed or accepted, pressing [ENTER] accepts the new values and moves the cursor to the %A value of the "zero" Time Line.

Time	%A	%B	%C	Flow
0.0	36.0	42.0	22.0	1.25

Choose the new value for %A on the numeric pad, but do not press [ENTER] at this time (see "Advanced Editing Techniques"):

Time	%A	%B	%C	Flow
0.0	40_	42.0	22.0	1.25

To change the other percentage values, use the ⇥ key to move to the next value.

Time	%A	%B	%C	Flow
0.0	40	42.0	22.0	1.25

If %B value does not need to be changed, simply press [ENTER]. The %C value is adjusted accordingly and the cursor moves to Flow:

Time	%A	%B	%C	Flow
0.0	40.0	42.0	22.0	1.25

At this point, either change the Flow value and press [ENTER], or just press [↓] to move to the next line. Pressing [ENTER] scrolls down to the "blank" Time Line.

Changing The Time Value

The value under the Time column can be changed in all but the zero Time Line. To do this, use [↓] to move to the desired Time Line:

0.0	50.0	30.0	20.0	1.00
10.0	80.0	12.0	8.0	1.00

Then use ⇥ to move back around to the Time value:

0.0	50.0	30.0	20.0	1.00
10.0	80.0	12.0	8.0	1.00

The Time value can be changed at this time by choosing the desired value and pressing [ENTER].

When multiple Time Lines exist, there is one restriction on changing the Time value. The value chosen must be a time between the two adjacent Time Lines. For example:

5.0	50.0	30.0	20.0	1.00
10.0	80.0	12.0	8.0	1.00
20.0	100	0.0	0.0	1.00

.

.

The time of 10.0 minutes can only be changed in the range of 5.1 to 19.9 minutes. Otherwise, an error message appears on the screen:

ILLEGAL GRADIENT TIME

A new Time Line may be inserted by scrolling to the blank line, entering the desired values, then pressing [ENTER]. Regardless of the Time value, the new line is inserted into the file in the proper sequence.

Advanced Editing Techniques

Ratioing Percentages

When editing an existing file containing either a single- or multiple-step gradient, the [ENTER] key can be used after changing one of the values to automatically update the other two without changing their relative ratio to each other. This feature is particularly useful when trying to maintain constant solvent selectivity (% organic modifiers), while still varying the solvent strength (% water).

NOTE: To avoid this feature, simply use ⇥ (instead of the [ENTER] key) after the first % value change; then use the [ENTER] key to bring down the % that remains constant. The pump automatically updates the third solvent to total 100%.

Access the "zero" Time Line of the No. 2 EDIT screen on an existing file:

Time	%A	%B	%C	Flow
0.0	50.0	25.0	25.0	1.00

Enter the value 40 and press [ENTER] [ENTER].

Time	%A	%B	%C	Flow
0.0	40.0	30.0	30.0	1.00

The values of %B and %C are adjusted automatically to total 100%... and more importantly, their *ratio* to each other has remained constant.

To change %B:

Time	%A	%B	%C	Flow
0.0	50.0	25.0	25.0	1.00

Press [→] and type **40**, then press [ENTER] [ENTER].

Time	%A	%B	%C	Flow
0.0	40.0	40.0	20.0	1.00

This feature is useful for maintaining a constant organic-to-organic solvent ratio (mobile phase selectivity) while changing the aqueous solvent (solvent strength) during a gradient run. To create a ternary, linear gradient, first create a "zero" Time Line:

Time	%A	%B	%C	Flow
0.0	80.0	12.0	8.0	1.00

Press [ENTER]:

0.0	80.0	12.0	8.0	1.00
_				

Type **10** and press [ENTER] [ENTER] [ENTER].

0.0	80.0	12.0	8.0	1.00
10.0	80.0	12.0	8.0	1.00

Press the [ENTER] key again to access the "blank" line, then use the [↑] (up arrow) to return to the previous Time Line:

0.0	80.0	12.0	8.0	1.00
10.0	80.0	12.0	8.0	1.00

Press the [ENTER] key or [→] to move to the %A value.

0.0	80.0	12.0	8.0	1.00
10.0	80.0	12.0	8.0	1.00

Type **50** and press [ENTER] [ENTER]:

0.0	80.0	12.0	8.0	1.00
10.0	50.0	30.0	20.0	1.00

A linear, ternary gradient has been created as shown in Fig. 4.2.

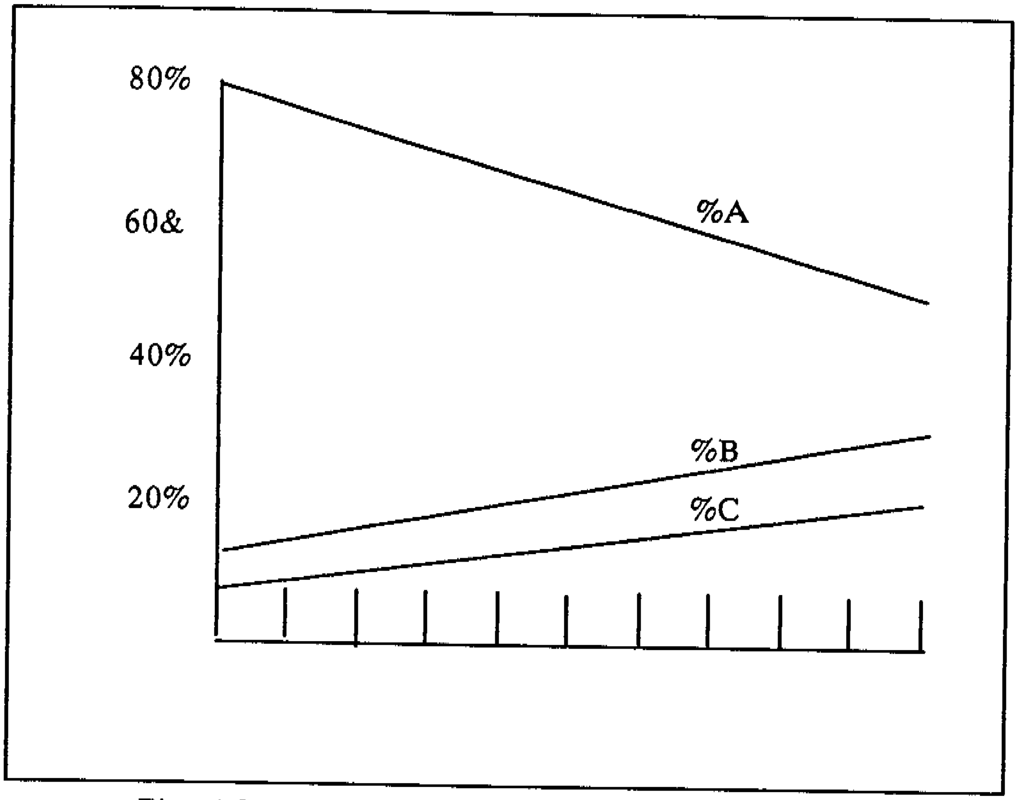


Fig. 4.2 Ternary Gradient Using Solvent Ratioing

Section 5
Routine Maintenance

Section 5

Routine Maintenance

When properly maintained your SP8800 or SP8810 Pump will provide years of trouble-free operation. To keep your pump operating at its best performance and reliability and maintain the warranty status, it is very important that it receives routine preventive maintenance. Accordingly, your pump is designed for ease of maintenance.

NOTE: Maintenance of the pump is the responsibility of the user. Spectra-Physics does not provide routine maintenance under warranty. However, routine maintenance contracts are available from Spectra-Physics. Please contact your local representative if you are interested is purchasing a maintenance contract.

This section contains easy-to-follow, step-by-step procedures needed to maintain your SP8800/8810 Pump properly.

PROPER MAINTENANCE LOG USAGE

The Maintenance Log provides a convenient way for you to keep track of pump maintenance. Whenever a set maintenance interval has been exceeded, the Log "reminds" you of this via either the pump's display or the integrator's report (SP4270, SP4290, or SP4200). It keeps separate "liters pumped" counters, called "VOL" for each major maintenance item (the pump seals, pistons, and check valves). You may set a "Scheduled Maintenance Due" (SMD) interval for each item starting from the date of the last maintenance. When SMD is exceeded by VOL, the reminder "MAINTENANCE DUE - SEE PUMP LOG" is displayed on the pump or integrator. You may choose to use this feature to set regular intervals for maintenance, such as seal changes, pump/column cleaning, or simply to serve as a reminder to verify that the system is operating properly.

If the SP8800/8810 is connected as part of a Spectra-Physics LC System consisting of an SP8780 Autosampler and Integrator (SP4290, SP4270, or SP4200), the scheduled "MAINTENANCE DUE - SEE PUMP LOG" message can be documented automaticaly as part of the pump header in the integrator report. To activate this feature, you must select the Local/Remote reporting option at the end of the Maintenance Log Table.

The Maintenance Log is constructed in the form of a table (see Table 5.1). Enter the *date* in six digits (e.g, 05/04/87) for the last time maintenance was performed on each item. The entry of a new date causes the VOL (volume) counter for that item to reset to zero. All six digits in the date must be entered for it to be accepted. A separate VOL counter is kept for each item and incremented by 1 for every liter pumped. Whenever a VOL counter exceeds the amount you've set in SMD, the maintenance prompt appears on the display or on the integrator's report (Local/Remote option).

Table 5.1 Maintenance Log Structure

ITEM	DATE	SMD	VOL
Seal1	9/ 4/86	200	*201
Seal2	9/ 4/86	200	*201
Piston1	10/ 9/85	600	400
Piston2	10/ 9/85	600	400
Inlet	9/ 4/86	600	201
Outlet	9/ 4/86	600	201
Report	Local/Remote		

In the example given in Table 3.1, a fairly complete maintenance was done on 9/ 4/86, when both seals and check valves were replaced. The asterisk (*) in the table indicates that the volume pumped (VOL) has exceeded the set interval of 200 liters (SMD) for maintenance or re-evaluation of the pump performance. The message "MAINTENANCE DUE-SEE PUMP LOG" appears on the display at each file initialization (INIT) and on every integrator report (remote reporting optional). The * interval remains set until either the date has been updated or the SMD value has been increased.

The volumes of mobile phase that you can expect to use are very dependent upon the eluant being pumped and your chromatographic practices. To obtain the maximum lifetime and best performance from your pump, please read the following information on "EXTENDING THE MAINTENANCE PERIOD."

The actual maintenance intervals will be specific to your application and to your adherence to good or poor chromatographic practices. Pump pistons and check valves have been known to last for years. Even the seals themselves can last more than a year for some applications. The following instructions are an initial guideline to help you set up your Maintenance Log for the first time, and from there determine your specific maintenance interval.

Set both seal SMD counters to 200 liters, and the check valve and piston SMD counters to 600 liters. Then whenever the interval has been exceeded, the message "MAINTENANCE DUE - SEE PUMP LOG" is displayed. This message occurs every time a file is initialized or on every integrator report until the interval is reset or increased. You should then either verify that the pump needs maintenance or that the pump is operating properly. Diagnostics 203 (flow stability) and 204 (check valve integrity) will assist you. If a maintenance interval is exceeded and the pump does not require maintenance, increase the SMD interval by another 50 liters from the previous setting. Once you have established an expected interval for your system, use that interval for routine preventive care.

Setting a value of zero (0) for any SMD interval inactivates the Maintenance Log for that specific item. To inactivate the entire Log, a zero (0) must be entered for all SMD intervals.

If you find that the interval before component failure is either unacceptable or variable, then the source of the problem must be identified. Start by very carefully reading this section and Section 6 of this manual. Poor chromatographic practices are by far the most common source of problems - IT REALLY DOES SAVE TIME TO DO IT RIGHT THE FIRST TIME. For example, an unusually fast seal failure may indicate either incorrect installation or a scratched piston. A scratched piston may be caused by improper installation of the seal or piston, by allowing the pump to sit idle with a buffered eluant in it, or by failing to filter your eluants. Follow the recommendations of this manual carefully, for they are based on many years of experience.

On some occasions a particular application, such as one using a high buffer concentration with low aqueous content, may get better performance from our optional Sapphire Piston, than with our standard stainless steel piston. The Sapphire Piston has a backup seal combination that includes back flush capability. For more information, contact your local Spectra-Physics representative.

EXTENDING MAINTENANCE PERIOD

As mentioned earlier, the volume of mobile phase you can expect to pump before maintenance is due is very much dependent on the way that the pump is being used. Following these guidelines helps you extend the life and improve the performance of your pump.

- Use only high quality, spectrograde or HPLC grade solvents.

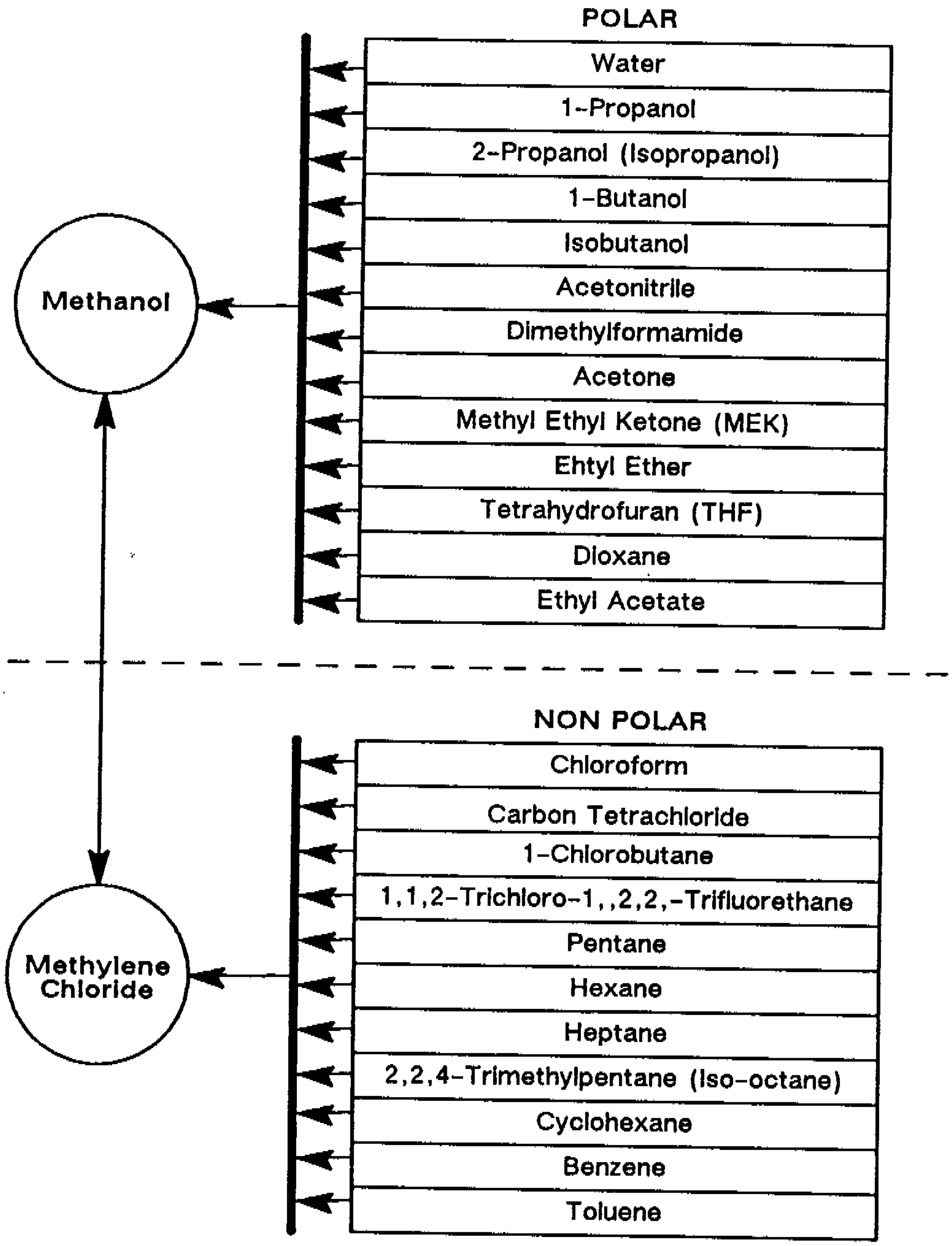
- o Filter solvents (through at least a 2–micron filter) before placing them in the solvent reservoirs.
- o Pre–filter the water through at least a 2–micron filter to remove particulate matter and organic contamination.
- o Avoid pH extremes. Spectra–Physics offers a chemically inert Titanium Pump if a mobile phase must be used that is outside the pH range of 2.2 to 8.
- o Verify that the solvents used are miscible in all proportions. This is very important for a buffered mobile phase. Precipitation of salts quickly damages maintenance parts.
- o Never leave the pump filled with buffered solvent when not pumping. Either lower the flow to 0.1 mL/min. or thoroughly flush the pump. Flush with at least 25 mL of pure filtered water.
- o The pump should be filled with methanol if it is to be left idle for more than two days. This avoids the possible growth of organisms in aqueous solvent systems.
- o Never use hydrochloric acids solutions. In general, any halide tends to corrode unpassivated stainless steel at any concentration.
- o Avoid metal ions that can cause corrosion due to electrochemical processes. Typical metal ions to avoid: manganese, chromium, nickel, copper, iron, molybdenum.

  NOTE: The inert, titanium version SP8800 and SP8810 Pumps are capable of pumping metal ions and other corrosive solvent systems. Contact your local Spectra–Physics representative for more information on these pumps.

PUMP PREPARATION FOR MAINTENANCE

To prepare the pump for maintenance, flush the pump with 25 mL of methanol. If an incompatible solvent is resident in the pump, flush with appropriate solvents before flushing with methanol. Table 5.2 lists various normal and reverse phase solvents and compatible intermediary solvents for flushing. For example, if chloroform is being used as the mobile phase solvent, an intermediate flush of 25 mL methylene chloride would be appropriate before flushing with methanol.

Table 5.2 Miscibility of Most Common HPLC Solvents



QUICK PISTON SEAL MAINTENANCE

The pump piston seals can be replaced quickly without removing the complete liquid end assemblies. The following procedure will save you time if only the piston seals need to be replaced.

1. After flushing the pump with methanol as described earlier in "PUMP PREPARATION FOR MAINTENANCE," stop the pump flow.

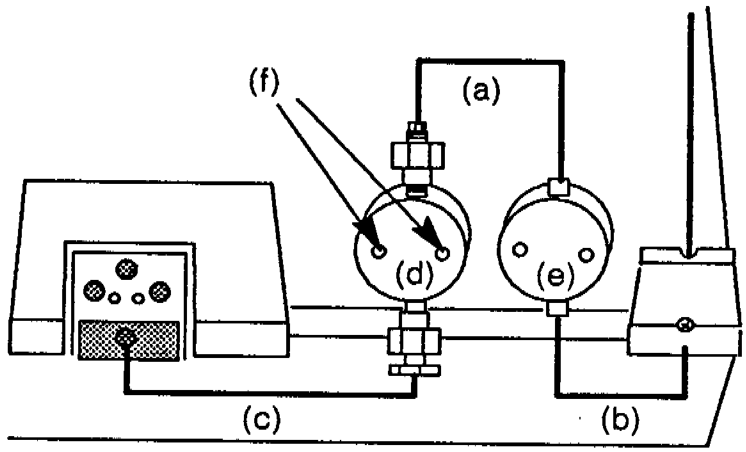


Fig. 5.1 Front of Pump Showing Liquid Ends

2. Refer to Fig. 1. Remove the top crossover tube (a) and the transducer crossover tube (b). At this point, only the low pressure solvent inlet tube (c) should be connected to the left (inlet) pump head (d) and no tubes connecting the right (outlet) pump head (e).
3. Using the supplied 9/64–inch allen hex wrench, remove (turn counter–clockwise) the two cap screws (f) from each liquid end pump head. Remove the two pump heads and lay them on the bench in front of the pump. Carefully examine the seal holder and the inside surfaces of the piston holder housing. If they show evidence of contamination, proceed to "Liquid End Maintenance" for thorough cleaning.

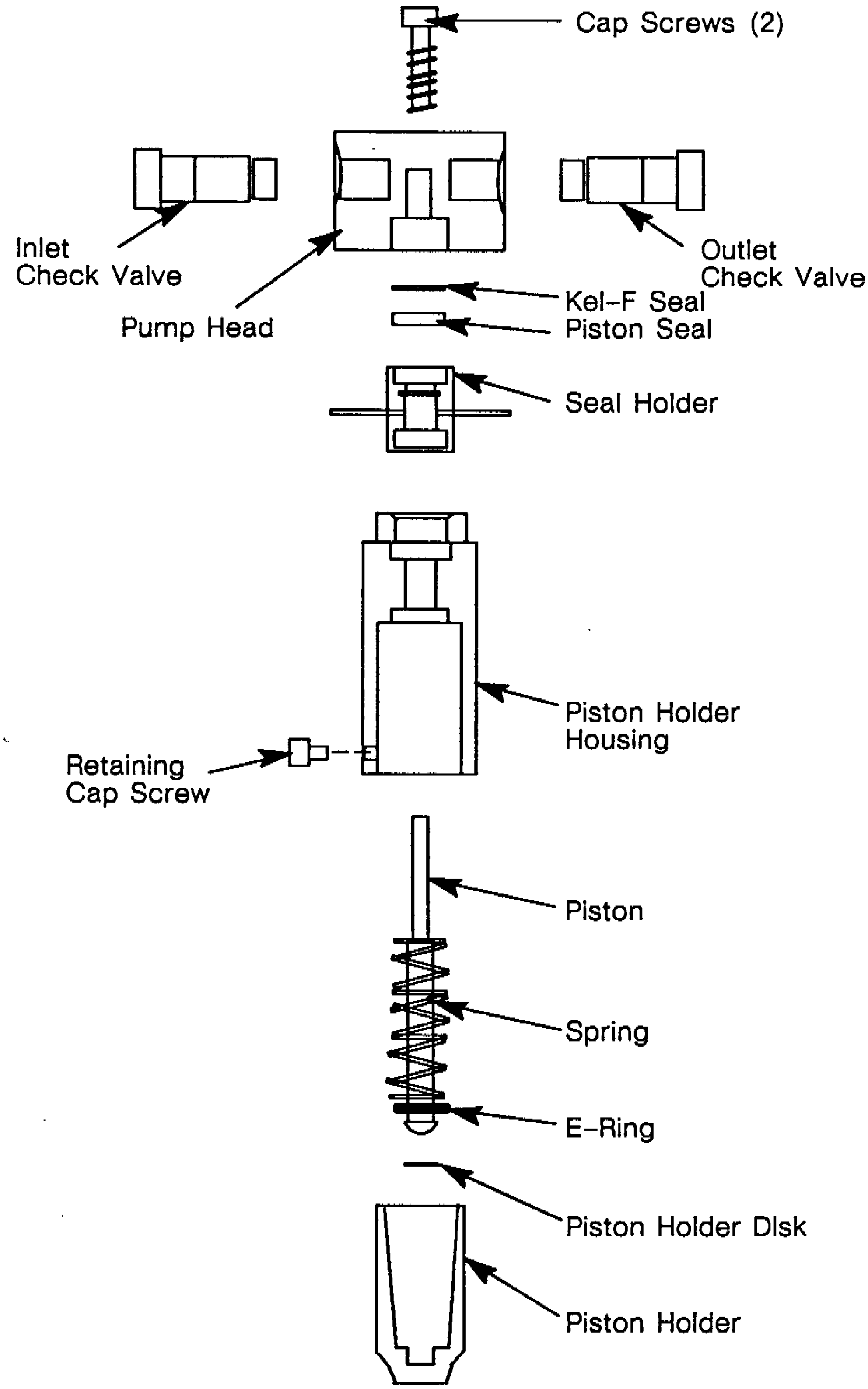


Fig. 5.2 Liquid End Components

4. Remove the seal holder on each pump head by grasping its exposed tube's top and bottom and pulling gently (Fig. 5.2).

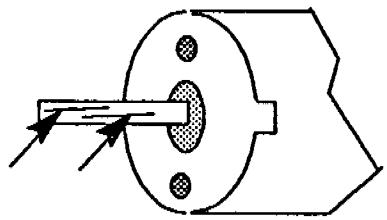


Fig. 5.3 Piston Scratches

5. Examine the two pistons for contamination and scratches (Fig. 5.3). Proceed to "Liquid End Maintenance" if damaged.
6. Carefully pry the piston seals from the seal holders using the plastic dowel supplied in the accessory kit (Fig. 5.4). Flush the holders if contamination is present.

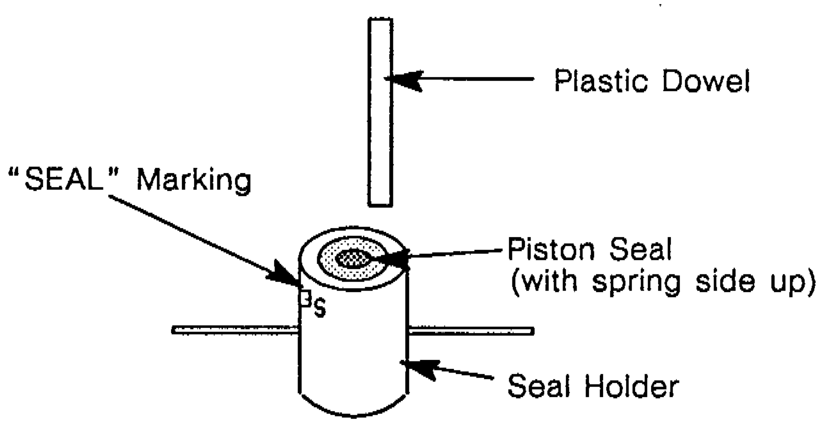


Fig. 5.4 Removing Seals From Holders

7. Place the seal holders near the cylinders with the end up marked "SEAL".

   NOTE: It is possible to install the seal in the wrong end of the seal holder. Install the piston seal only in the end marked "SEAL".
8. The Kel-F seal (refer to Fig. 5.2) should remain firmly implanted inside the pump head. If it has been dislodged, a new seal must be installed. Replace the pump seal (step 9), then place the Kel-F seal over the seal holder and continue to step 10.

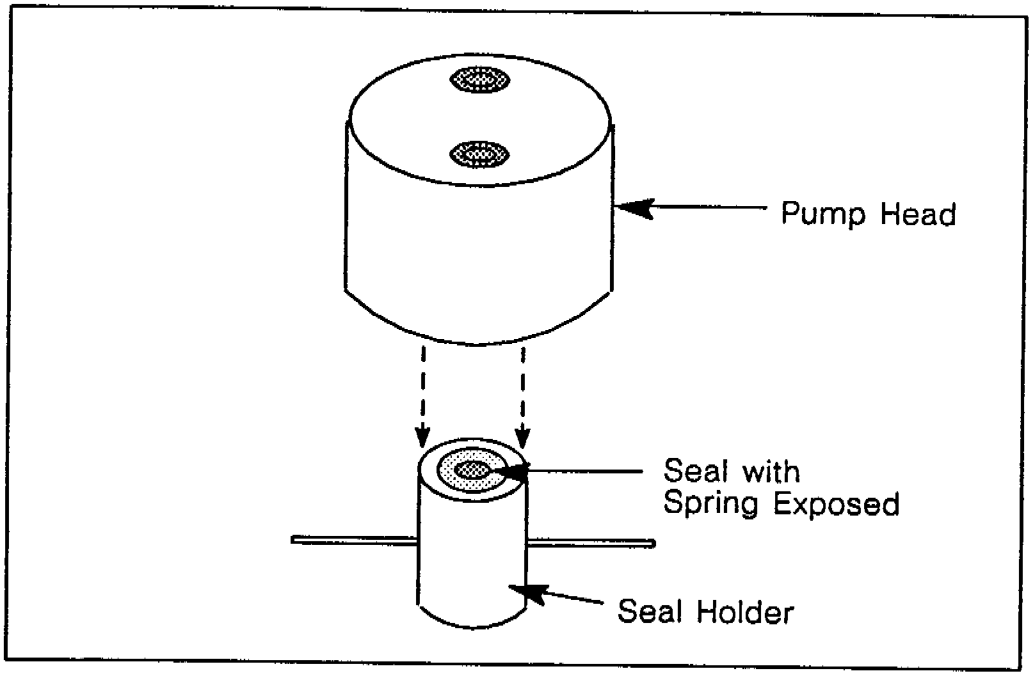


Fig. 5.5 Installing Seals in Holders

9. Install new piston seals by setting them in position (spring side up) on the seal holder and gently pressing them into place with the pump head.
10. Place the holder/pump head combination carefully onto the piston and into position. The inlet check valve is oriented in a down position.
11. Install the 9/64-inch cap screws and tighten firmly (40 inch/pounds is recommended).
12. Purge the pump at 3000 - 4000 psi with methanol for five minutes to condition the seals and cleanse the pump.

NOTE: We suggest you use an old column or flow restrictor for seal conditioning to avoid damage to your analytical columns.

COMPLETE LIQUID END MAINTENANCE

For thorough cleaning, piston replacement or total liquid end reconditioning, the liquid ends must be removed.

Having a second set of reconditioned liquid ends on hand for quick replacement, will additionally save time and allow maintenance to be performed at your convenience. Contact your local Spectra–Physics representative if you are interested in obtaining spare components (part numbers are listed in Appendix B).

CAUTION: Keep the liquid end components as clean as possible. Contamination decreases seal life significantly.

Liquid End Removal

1. Remove all tubing attached to the pump heads. Be careful not to lose the inlet check valve ferrule seat. It will probably fall from the inlet check valve (Figs. 5.6) when the inlet tubing is removed.
2. It is necessary to position the pump cam to enable the liquid ends to be removed. Press [TEST] then [ENTER]. Either move the cursor ([↑] or [↓]) to `Maintenance Position` or type 207 and press [ENTER]. The pump motor rotates for a few seconds and then is electrically locked into position. The pump is now in its maintenance position. It will hold this position (if power is maintained) until either a file is initialized or purged or if you press [ENTER].

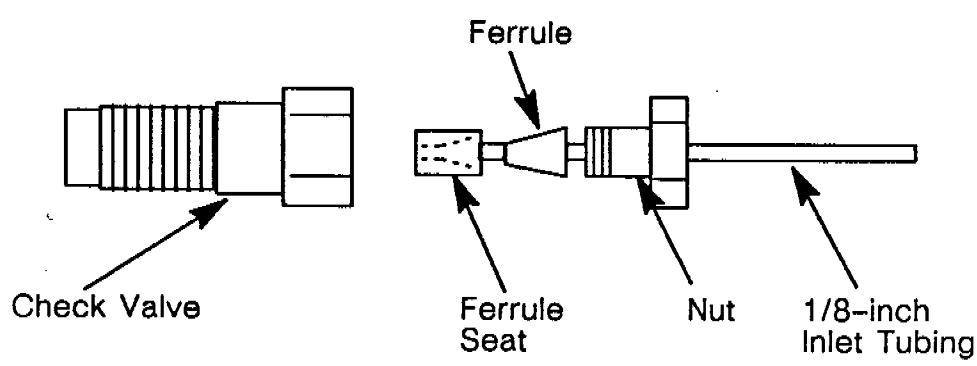


Fig. 5.6 Check Valve and Ferrule Seat

3. Remove the inlet (lower) and outlet (upper) check valves from the left (inlet) pump head.

   NOTE: It is not necessary to remove the check valves to replace a piston, however, they are easier to remove at this time if total liquid end reconditioning is to be done.

4. Push in the right (outlet) liquid end and rotate it clockwise (90 degrees) until it releases from the pump module. Remove the liquid end and set it aside.
5. Push in the left (inlet) liquid end and rotate it counter clockwise (90 degrees) until it releases from the pump module. Remove it and set it aside.

Liquid End Disassembly

1. Separate the pump head from the piston holder housing (refer to Fig. 5.7) by removing the two 9/64-inch hex cap screws.
2. The Kel-F seal in the cylinder bore must be removed only if damaged (scratched, warped or torn). To remove, using tweezers, pull gently on the seal's inner circumference. (Be careful not to scratch the cylinder surface!)
3. Examine the pump head for contamination. Flush the pump head or place it into an ultrasonic bath.
4. While retaining the piston holder (**the components are spring loaded and may shoot out!**; see Fig. 5.7), remove the 9/64-inch retaining cap screw. This allows the piston holder to be removed from the piston holder housing. Separate the holder, piston, spring and housing.

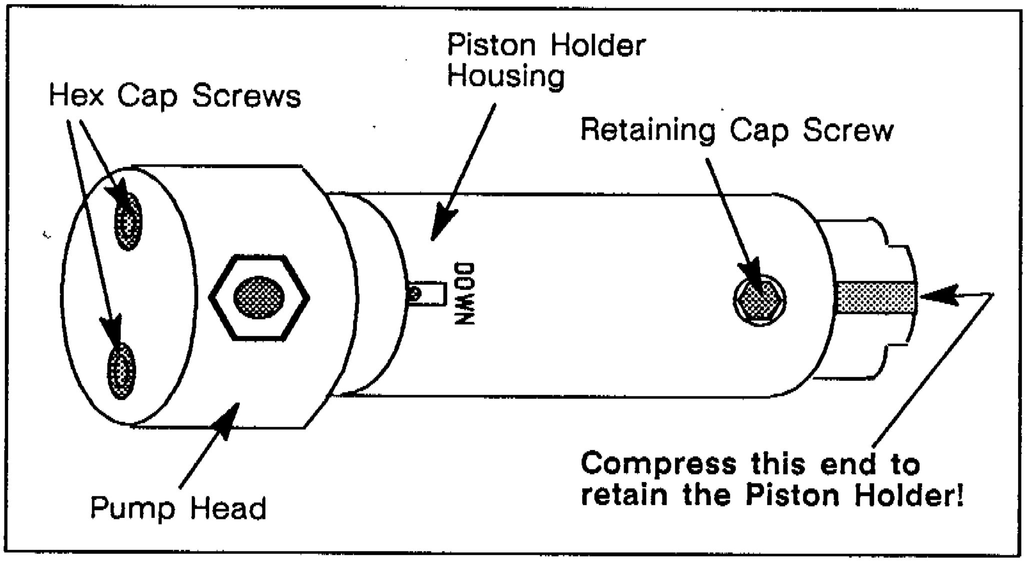


Fig. 5.7 Retaining the Piston Holder

5. Examine all parts for wear, corrosion or contamination. Clean or replace as necessary.
6. Examine the piston carefully for fine scratches or scoring (see Fig. 5.3) which can reduce seal life. Replace the piston if scratched.
7. Thoroughly flush all components.

Liquid End Assembly

1. Place the seal holder on end on a clean, flat surface with the "SEAL" marking up. Install the piston seal (spring side up) into the seal holder (Fig. 5.8). Use the pump head to press the seal into the seal holder.

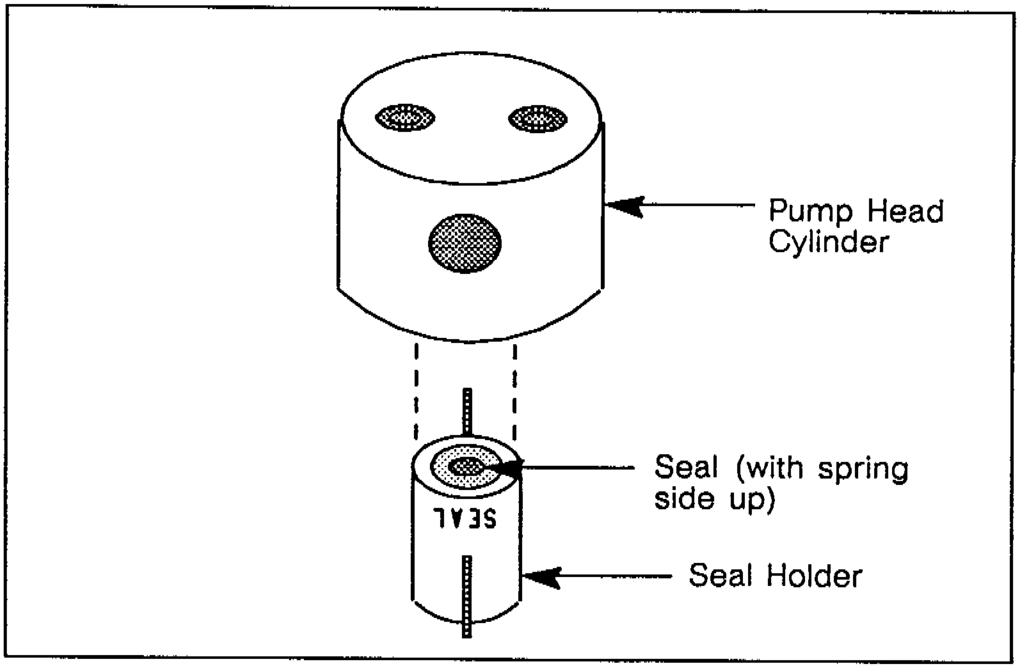


Fig. 5.8 Seal Installation

2. Place the seal holder into the piston holder housing so that the seal marking is visible and on the opposite side of the housing from the "DOWN" marking on the retainer housing (Fig. 5.9).

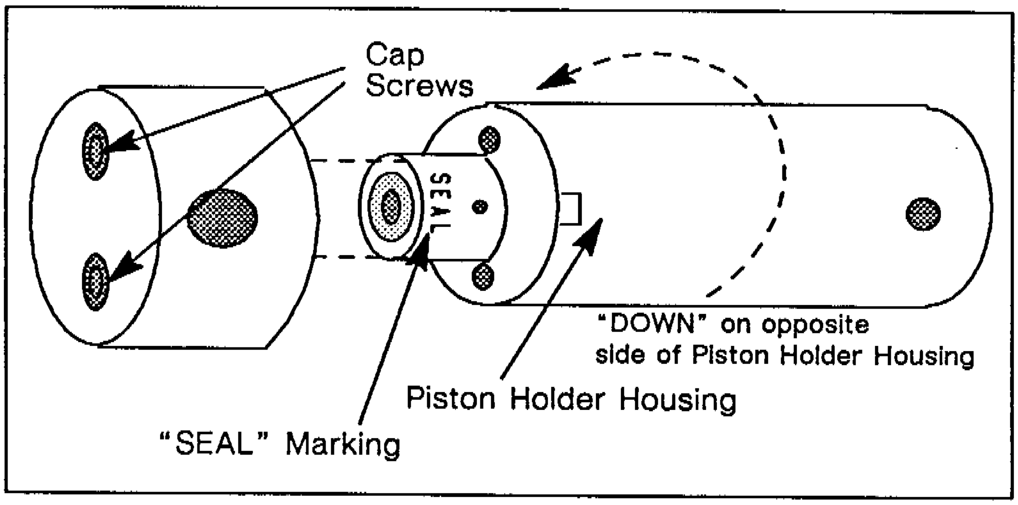


Fig. 5.9 Alignment of Seal Holder

3. Install the pump head onto the housing using the two 9/64–inch allen cap screws. For the inlet liquid end, the inlet check valve must align with the "DOWN" marking on the housing (Fig. 5.10). Tighten the screws to 40 inch/pounds (tight).

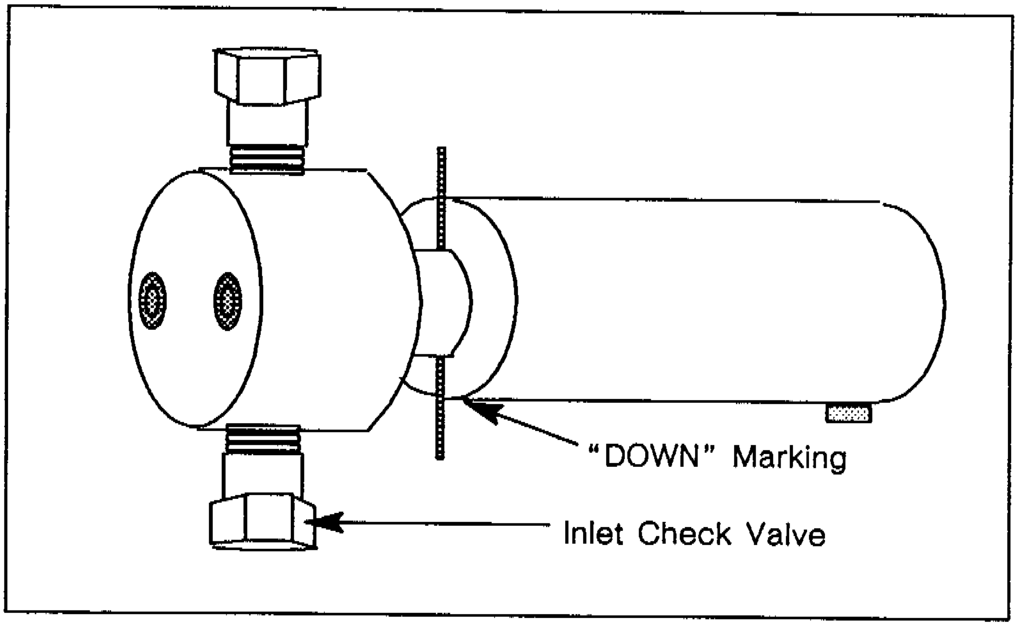


Fig. 5.10 Alignment of Check Valve

4. Install the piston into the piston spring and then into the piston holder housing.

   NOTE: Install E–rings (supplied in accessory kit) if new pistons are being used. Install these in the position shown in Fig. 5.11.

   Place the piston holder over the piston and into the holder housing.

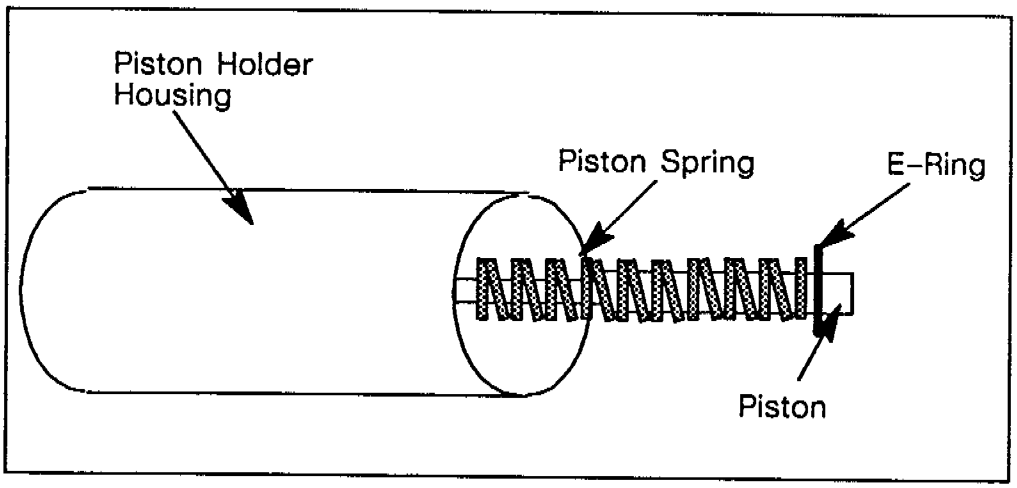


Fig. 5.11 Piston Installation

5. Compress the piston holder into the holder housing and install the retainer screw as shown, so that the screw enters the slot in the piston holder. Tighten the screw snugly.

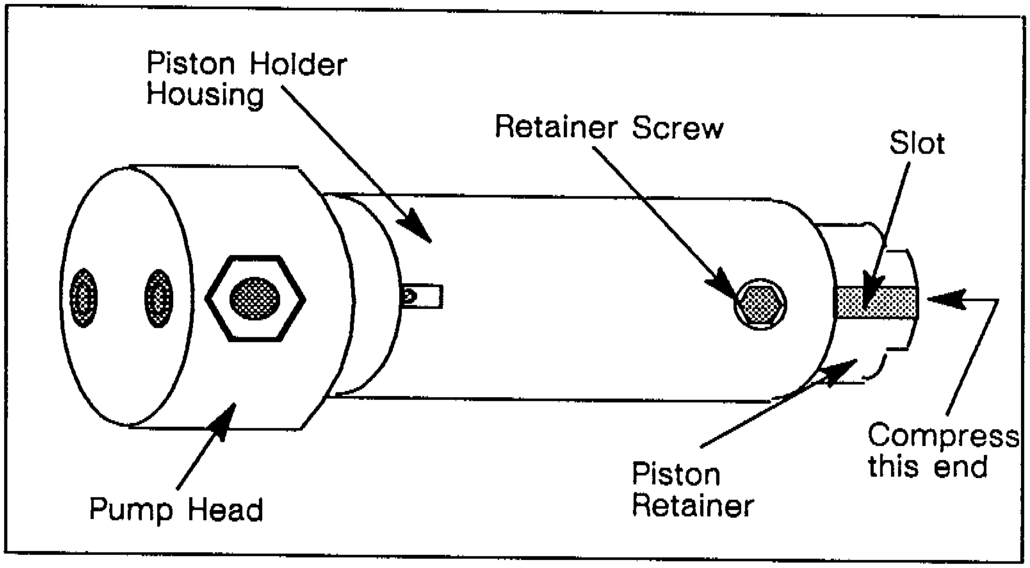


Fig. 5.12 Installing the Retainer Screw

Liquid End Installation

To install the liquid end assemblies into the pump, a special maintenance diagnostic test routine is used. If the pump has not been switched off since the liquid ends were removed, the pump motor should still be in its maintenance position. If not, press [TEST] and [ENTER]. Type **207** and press [ENTER]. Wait for a few seconds until the pump motor has stopped. The pump is now in its maintenance position. The liquid ends can now be installed.

1. Replace the left (inlet) liquid end first. This liquid end contains the tapped holes for the check valves.

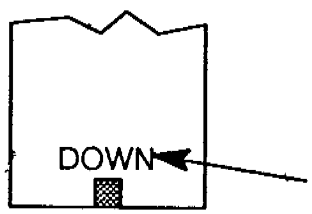


Fig. 5.13 "DOWN" Etched On Piston Holder Housing

NOTE: The lower side of the piston holder housing is etched with "DOWN". Refer to Fig. 5.13.

Position the liquid end with "DOWN" at the 3 o'clock position and then press and rotate clockwise (90 degrees) until it locks into position.

2. Replace the right liquid end.

Position the liquid end with "DOWN" at the 9 o'clock position and then press and rotate it counterclockwise (90 degrees) until it locks into position.

3. Replace the check valves and tubing. (Do not overtighten fittings.) Generally, a 1/4-turn beyond fingertight is sufficient to make a leak-free connection. Be sure that the ferrule seat is in place.

NOTE: The inlet check valve has a wider fitting opening than the outlet check valve and contains a non-captive ferrule seat. This check valve is positioned on the lower side of the left (inlet) liquid end (see Fig. 5.14).

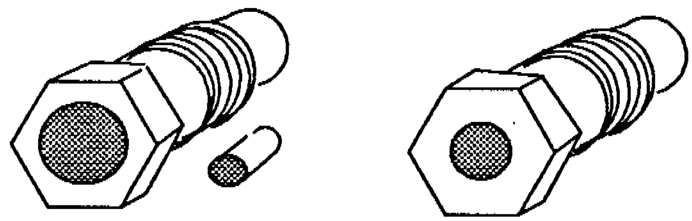


Fig. 5.14 Check Valves

CHECK VALVE MAINTENANCE

If the Maintenance Log feature of your SP8800/8810 Pump has notified you that it is time to replace check valves or if check valve replacement was recommended in Section 6, "TROUBLESHOOTING," then follow these steps.

CAUTION: The replacement check valves produced by Spectra-Physics are manufactured in a clean-room environment and capped to protect them from contamination. It is very important to maintain a clean environment when installing them.

Inlet Check Valve (bottom position)

1. Remove the inlet tubing (Fig. 5.15) from the check valve. Be careful not to lose the ferrule seat which falls from the check valve.

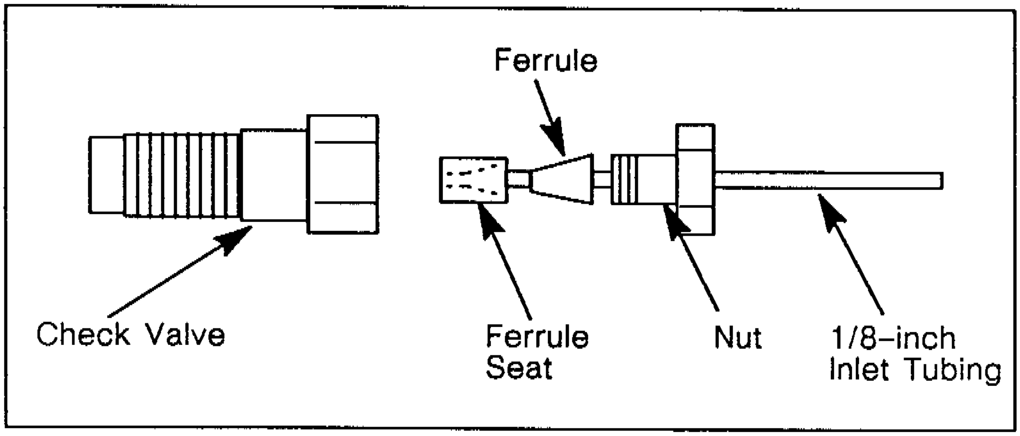


Fig. 5.15 Ferrule Seat and Inlet Check Valve

2. Remove the defective check valve by rotating the valve counter clockwise with a 1/2-inch open-end wrench.
3. Install the new check valve by rotating clockwise until the valve is snug against the liquid end cylinder. Reconnect the inlet tubing, remembering to install the new ferrule seat. (DO NOT OVERTIGHTEN!)

Outlet Check Valve

1. Remove the crossover tubing from the outlet check valve and the top of the right (outlet) pump head.
2. Remove the defective check valve by rotating it counter clockwise with a 1/2-inch open-end wrench.
3. Install the new check valve by rotating it clockwise until snug and tighten with a 1/2-inch open-end wrench. Replace the connecting tubing. Tighten fittings only enough to stop leaks. Generally, this is 1/4-turn beyond fingertight.

FAN FILTER

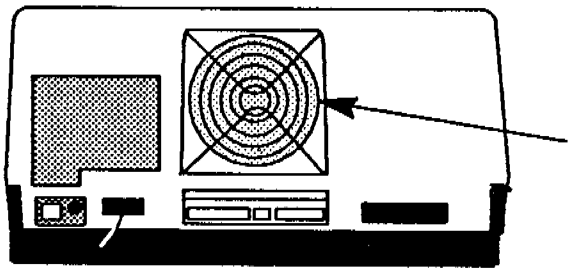


Fig. 5.16 Filter Location

Your pump uses an electric fan to remove the heat generated by the electronic circuitry and pump motor from the instrument housing. A foam filter removes airborne contaminants from the cooling

air. With time (depending on the environment), the filter will become clogged, restricting the flow of air. If allowed to continue, the flow of air is eventually cut off which may cause the instrument to overheat. The pump stops pumping automatically if overheating occurs and displays a warning message. To avoid this condition, the filter should be cleaned every six months (more often in dirty environments).

1. Gently pull on the filter to remove it from the back of the instrument.
2. Wash the filter in warm soapy water. Rinse and allow the filter to dry.
3. Replace the filter by gently pushing it back into position.

BATTERY

A 9-volt transistor battery provides the power to maintain pump files should the power line voltage fail. A fully charged alkaline battery maintains files for at least 100 hours. The pump displays a low battery warning message automatically every 10 hours if the battery is failing. This indicates that it must be replaced. Remove the battery from the rear of the pump (Fig. 5.17) and replace it with a fresh alkaline 9-volt battery.

NOTE: The power switch must be left on while changing the battery in order to maintain pump files.

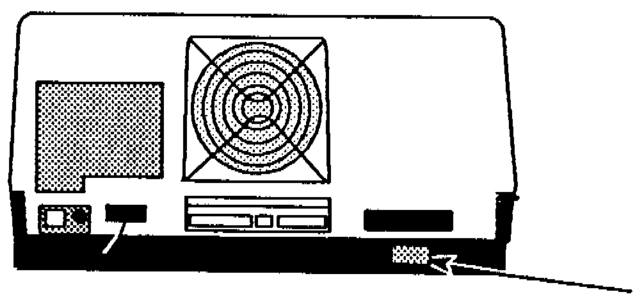


Fig. 5.17 Battery Location

PASSIVATION OF PUMP

All the major type 316 stainless steel components used in the SP8800/8810 Pump are passivated prior to assembly to ensure the removal of porous particles from the surface and to coat the surface with a layer of chromium oxide, which is highly resistant to corrosion.

However, stainless steel components are subject to corrosion from strong acid solutions (in particular, materials containing halides)

organic acids, and sometimes even water (the inlet filter is particularly susceptible due to its large surface area). Resistance to corrosion of the stainless steel components can be enhanced by using the following procedures.

NOTE: Before installing any new parts **not** supplied by Spectra-Physics such as stainless steel tubing, the parts should first be passivated using the following methods:

1. Parts to be passivated must first be cleaned and degreased using a degreasing solvent by completely immersing the part and drawing the solvent through the tubing.
2. The cleaning solvent must then be removed again by washing the part first with methanol, and then with successive washes of deionized water until the surface area to be passivated is thoroughly clean.
3. When the surface area to be passivated is thoroughly clean, it is passivated by wetting the surface with a 20% nitric acid solution in deionized water for about 10 minutes at room temperature.
4. After passivation, the parts must again be thoroughly cleaned to remove any residual nitric acid. Wash with deionized water until the system is neutral to pH paper. Follow up with another wash using 50–50 water/methanol followed by methanol. When thoroughly clean, blow dry using nitrogen. (Do not use the laboratory air system or air from a compressor that may contain an oily residue.)

CAUTION: DO NOT expose a column to the passivation mixture. Remove the column before pumping if it is necessary to pump passivation solvents through the pump. It is preferable, however, to remove the components from the pump and then passivate them apart from the system.

NOTE: If frequent passivation is required to protect your pump from aggressive solvent systems, you may wish to consider using the inert titanium version SP8800/SP8810. The inert pumps do not require passivation.

Section 6
Troubleshooting

Section 6

Troubleshooting

INTRODUCTION

Your SP8800/8810 Pump is designed to operate trouble-free for many years when properly maintained. However, in the event of mechanical or electrical failure, the problem can be easily diagnosed. Because your pump is composed of discrete internal modules, any of these can be quickly replaced to help keep downtime to a minimum.

This section helps you determine if your pump is operating correctly and can assist you in identifying a malfunctioning module if trouble occurs.

The first portion of this section refers to two very important diagnostic test routines, FLOW STABILITY and HARDWARE SERIES. They verify flow stability and electrical/mechanical operation. The use of these two tests is recommended to assure the best performance possible from your pump.

The second portion of this section deals with general LC system troubleshooting techniques. It provides information to help you locate a problem instrument or component in your chromatography system. If you are not sure which component of your chromatography system is responsible for poor system performance, you will likely find these suggestions helpful.

Next, are instructions on troubleshooting your pump. Featured here are detailed descriptions of the built-in hardware and electronics diagnostics available.

The last portion of this section provides a quick reference troubleshooting guides that can save you time in diagnosing problems when the symptoms are known.

FLOW STABILITY AND HARDWARE SERIES TEST ROUTINES

Under most circumstances the FLOW STABILITY and HARDWARE SERIES diagnostics tests will provide a thorough evaluation of the condition of your pump. It is recommended that these two tests be used first if the performance of the pump is in question.

Flow Stability Test

Your microprocessor–controlled pump is constantly monitoring its flow stability while pumping. A proprietary internal software program allows the pump to determine when flow stability has been adversely affected by leaking check valves, out–gassing solvents or other hardware failures.

The test is operational whenever the READY light is on. It is recommended that you review flow stablility prior to the start of analysis each day. To see the status of the flow stability test, first press $\boxed{\text{TEST}}$ then press $\boxed{\text{ENTER}}$ twice. The test requires that 10 pump cycles occur before any results can be calculated and displayed. This is necessary to insure accurate results. If the pump READY light has been on for more than 10 pump cycles the status display is immediate. The messages displayed are either:

```
FLOW STABLE  XX
STABLE RANGE (0-25)
```

(where XX is a number between 0 and 25)

which means that the flow is currently stable, therefore, analysis can begin. Or—

```
FLOW ACCEPTABLE XX
ACCEPTABLE RANGE (26-90)
```

(where XX is a number between 26 and 90)

which means that the flow stability was found to be within acceptable limits. Reproducible chromatography can be expected within this range.

The value displayed in the FLOW STABILITY test is affected by the compressibility of the solvent being pumped and the compliancy of the hardware (tubings, column, etc.). Therefore, the results are reported in two ways: a) an overall judgement of the pump performance— STABLE, ACCEPTABLE or UNSTABLE; b) a number indicating where within the range the result lies. Unless a very volatile or compressible solvent is being pumped, for example hexane, a number near the higher end of the range (60–90) probably indicates that the system is not ideal, and further troubleshooting might improve the flow stability.

The message—

```
FLOW UNSTABLE XX
UNSTABLE RANGE > 90
```
(where XX is a number above 90)

means that the pump is not maintaining a stable flow. The results of chromatography may be nonreproducible.

NOTE: Mobile phase composition changes will likely cause the results of the test to show unstable flow until column equilibration.

If the results of the flow stability test are abnormal for your LC application, follow these steps to locate the problem:

1. Test the integrity of the inlet and outlet check valves by activating Test 204. Refer to "DIAGNOSTICS TESTS" further in this section for information on using this test.
2. Verify that the mobile phase solvents are adequately degassed.
3. Refer to the recommendations of "GENERAL LIQUID CHROMATOGRAPHY SYSTEM TROUBLESHOOTING TECHNIQUES."

The flow stability test may be activated from a remote terminal via LABNET or RS-232-C. Enter Test 203.

Hardware Series Test

This test evaluates the condition of the ternary proportioning valve, pump motor, pressure transducer and most of the electronic circuitry in your SP8800/8810 Pump. The pump must be idle (not pumping) before activating this test. The test will not affect pump files.

To initialize the test, press [TEST] then [ENTER]. To select the Hardware Series you may either use the [↑] arrow key to scroll up once, then press [ENTER], or type **220** and press [ENTER].

The display prompts you to "`release system pressure`" either through the column bypass valve or by another means. This is important, since the pump will operate during the test and an excessively high column pressure may be generated if not bypassed.

After pressing [ENTER], the test is started. The pump components are tested in the following order.

1) Pressure transducer and circuitry

2) Input/output ports
3) Ternary proportioning valve and circuitry (SP8800 only)
4) Motor drive circuitry
5) Cam Marker and circuitry
6) Motor revolution and sine/cosine circuitry

As each portion of the test is completed a message is displayed. If all components and circuitry are within specifications, the message

```
Hardware series tests
completed - PASSED
```

is displayed at the end of the test.

If a fault is found during the test, you'll see a message describing the problem. Refer to the "DIAGNOSTIC TESTS" for Test 220 later in this section for more information on test messages.

GENERAL LIQUID CHROMATOGRAPHY SYSTEM TROUBLESHOOTING TECHNIQUES

The following is a helpful guide when troubleshooting a liquid chromatographic system:

- Study the effects of changing flow rate or solvent composition on the chromatogram and then change only one variable at a time while observing the result.
- Define not only the symptoms, but provide quantitative information of their magnitude. Record all parameter settings.
- Make sure that the problem can be repeated. If the problem is of a random nature, note not only the time and date of each occurrence, but the sequence of events prior to the occurrence of the problem.
- Eliminate chemical and operating contributing factors. Check and/or replace the column. Clean the column, dilute the sample, and check the mobile phase for purity. Run solvents on a scanning UV spectrometer over a range of $\pm$ 50 nm of working wavelength.
- Check the pump for flow rate accuracy.
- Beware of changes made to the chromatographic system (e.g., new solvents, columns, or samples). If a problem develops after a change has been made, revert to the conditions existing before the problem appeared.
- Check the date when the last periodic maintenance procedures were performed on the system and when the pump seals and filters were replaced.

- o Make sure that the solvents are degassed and that air is excluded from all fluid lines. If bubbles are still present, check the condition of the inlet filters and adjust the seal of the fittings without overtightening them. Check for leaks on all fluid lines.
- o Run a test sample. Most column manufacturers provide a sample, a chromatogram, and a set of conditions that you can use. Compare the new chromatogram with the one supplied by the manufacturer and with your own chromatograms obtained prior to the problem.
- o Replace the column with a flow restrictor (a column filled with glass beads) that provides a minimum of 1000 psi (69 bars) pressure drop at normal analytical flow rates. Note the pressure drop and compare with the values obtained earlier. Observe how consistent the pressure is under isocratic conditions.

The following information lists the most common chromatography system problems that may occur. An explanation of possible remedies is provided along with each symptom.

Drifting, Noisy or Unusual Baseline

As a first step, stop the pump flow and monitor the detector baseline. If the noise and drift are still present after 10 minutes, the fault is likely to be in the detector. Refer to your detector operators manual for further information on diagnosing detector problems.

Equilibration – Allow adequate time for the total system to fully equilibrate. The system must be at temperature and mobile phase composition equilibrium to avoid baseline drift.

Solvent UV Cutoff – A detector wavelength too close to the mobile phase UV cutoff causes excessive flow–related noise on the baseline and a baseline shift. As an example, the UV cutoff of LC grade methanol is 205 nm. This is the point of 1.0 absorbance unit. However, even at 220 nm, methanol absorbs more than 0.2 absorbance unit. To reduce this sensitivity of the detector to the mobile phase, either raise the detector wavelength or change to a solvent with a lower UV cutoff. In this case, UV–grade acetonitrile (cutoff 190 nm) may be a better solvent to use.

Mobile Phase Degassing – Use thoroughly degassed solvents to avoid noise and spikes attributed to dissolved gases in the mobile

phase. Your SP8800 pump provides for continuous helium degas of solvents. Maintain sufficient helium flow to insure positive flow from the vent line. Caps must seal tightly and vent lines must be in place.

Mobile Phase Composition – (SP8800 only.) Verify that the pump or pumps are properly proportioning the solvents. Using a solvent that is spiked with a UV–absorbing material (i.e., toluene, anisole, etc.) and a gradient program can help isolate composition inconsistencies.

Column – Replace or condition the column to avoid drift due to column aging or degradation.

Solvent Contamination – Change the solvents used for the mobile phase. "Ghost" peaks are often related to impurities in the mobile phase solvents. Run a blank analysis to spot solvent impurities.

Retention Time Reproducibility

Composition – Inconsistent composition proportioning (SP8800 only) is likely if the peak retention times are variable, yet the unretained peak is consistent in retention time from run to run. Use a spiked (UV–absorbing) solvent and run a gradient program to help diagnose proportioning problems.

Flow Rate – Pump–flow induced retention time inconsistencies will also affect the unretained peak. Measure the pump flow with the column in the system to detect flow irregularities due to column obstructions.

Column – As the column ages or starts to degrade, long term (day–to–day) retention time variances are more likely than short term (run–to–run).

Equilibration – Allow the system to fully equilibrate before starting analysis. If using a gradient profile (SP8800 only) for your analysis, the pump file can be programmed to return to initial conditions prior to the end of the run to help speed equilibration after analysis.

Changes in Detector Sensitivity

Manually inject a standard sample and compare the results to sample results previously achieved to help determine if the detector has lost sensitivity or if the chromatography system is at fault. If the detector is suspected, refer to your detector's operators manual.

Column – Verify that the column has not degraded and is the proper column for the analysis. Replace the column with a new one.

Injections – If using an autosampler, verify the volume of sample injected by manually reproducing the injections. If manually injecting, verify the sample loop and the condition of the sample valve.

Sample – Is the sample analysis well known? If not, use a known test sample to verify detector response. The sample may not be stable in its present environment. Verify the sample concentration.

Baseline Spikes

Stop pump flow to determine if baseline spikes are due to electrical disturbances or from bubbles in the mobile phase passing through the detector flow cell. If the spikes do not stop when the pump flow is stopped, the problem is likely electronic in nature. Refer to your detector's operators manual.

Bubbles – Thoroughly degas mobile phase solvents. Check all fittings for tightness. Clean or replace plugged solvent inlet filters which may cause pump piston cavitation. Attach a coil of small bore tubing to the sample exit line of the detector to provide a slight back pressure on the flow cell. **CAUTION:** Do not exceed the pressure rating of the flow cell.

DIAGNOSTIC AIDS

This portion of the troubleshooting section assumes that the source of the problem is known to be the SP8800/8810 Pump. If not, refer to the earlier portion of this section on "General LC System Troubleshooting."

Your SP8800/8810 Pump contains advanced built–in flow, hardware and electronics diagnostic aids to notify you of performance problems and to help you quickly identify a failed component. The diagnostics are divided into Messages and Diagnostic Tests.

Messages – When certain real time performance faults are encountered, your pump displays a message informing you of the problem. Refer to the following list of messages if more explanation is needed.

Diagnostic tests – The Diagnostic tests are internal computer programs that exercise the pump's hardware and circuitry and verify

operation. If any abnormal behavior is found it is reported as a message or a electronics circuit board failure code.

Messages

The following messages may occur while operating your SP8800/8810 Pump.

ZERO FLOW RATE – A pump file was initialized which contains a flow rate of zero as initial conditions. To remedy, enter a valid flow rate in the first line of the pump file. Rates between .01 and 10 mL/min are valid for the standard SP8800/8810 Pumps. The optional preparative liquid ends extend the maximum flow rate to 30 mL/min.

EXCEEDS FLOW RANGE – A flow rate was entered in the pump file which exceeded the flow rate capabilities of the pump. The maximum flow rate for the standard SP8800/8810 Pumps is 10mL/min. If higher flow rates are needed, the preparative option can be added to extend flow rates to 30 mL/min. Contact your local Spectra–Physics representative for information.

ILLEGAL SOLVENT %S – (SP8800 only.) A composition entry for a solvent in a pump file caused the total composition to exceed 100%. The sum of all three solvent percentages will always equal 100%.

OVER GRADIENT TIME LIMIT – The last time line entry in a pump file exceeded the maximum run time limit. The maximum gradient time allowable is 650 minutes (>10 hours).

FILE FULL – The maximum number of time lines in any pump file is 40. If more lines are needed to form a complex gradient or flow rate program refer to Section 4 on "Linking Files."

MAX PRESSURE EXCEEDED – The column pressure of the system has exceeded the MaxP (maximum pressure) value entered into the pump file. The value entered may need to be increased. Default for the variable is 6000 PSI. If your working column pressure is increasing, check for column plugging.

OUT OF SOLVENT – The pump has detected that no solvent is available. Check reservoir levels and prime pump.

ILLEGAL GRADIENT TIME – A new time value was entered that was out of sequence with the preceding and following values.

UNSTABLE FLOW – The internal diagnostic programs have determined that the pump flow is not stable. Depending on the state of

the Unstable Flow Shutdown Option the pump either stops or continues when unstable flow is detected. See Section 3 for more information on the Unstable Flow Shutdown option.

UNABLE TO ZERO – The circuitry associated with the pressure transducer auto zero is unable to offset the current transducer reading. Make sure that the column pressure is released before initiating Auto Zero Test 210.

FULL SCALE OUT OF RANGE – The number entered during test 209, Transducer Range, is not within the acceptable range. Re-enter the value printed on the transducer cable Refer to "System PCB Replacement" in Appendix D for more information about transducer range adjustment.

BELOW MIN PRESSURE – The column pressure has fallen below the set Min PSI (minimum pressure) while the pump is referenced (READY light on). Check for mobile phase leaks.

POWER FAILURE RECOVERY – The main power to your pump has returned. Files have been retained. Check source of line voltage power interruption.

MAINTENANCE DUE–SEE LOG – A volume milestone has been reached. Consult the Maintenance Log for component identification by pressing the [TEST] key, moving the cursor to **LOG** and pressing [ENTER]. For more information, refer to "Proper Maintenance Log Use" in Section 5.

LOW BATTERY – The 9–volt dc battery used for pump file retention during a power outage does not contain sufficient charge. Replace the battery following the instructions in Section 5, "Routine Maintenance." The battery must be replaced while the power switch is on to maintain pump files.

OVER TEMPERATURE SHUTDOWN – The internal temperature of the pump cabinet has exceeded component safety limits. The pump will not operate until the temperature is lowered. The fan filter is most likely plugged. Clean the filter as described in Section 5, "Routine Maintenance." If the message appears after filter maintenance, contact your local Spectra–Physics representative.

Diagnostic Tests

Your SP8800/8810 Pump has extensive built–in diagnostics that evaluate the present condition of your pump. These tests help you to locate problems quickly. In most cases the tests isolate the prob-

lem to the failed module or component. There are active and passive tests. Passive tests can be used any time and do not affect either file memory or pump performance. Active tests should not be activated while the pump is flowing, as they will affect pump performance.

Initializing Tests

To initialize a diagnostic test, press the [TEST] key on the keyboard. A menu is displayed. Press [ENTER] to access the diagnostic tests menu. Either move the cursor ([↑] or [↓]) to the appropriate test or enter the number of the test you wish to activate.

Test Results

After each test is run a message appears advising you of the results of the test. In most cases if trouble was found the message indicates the failure or failed component.

```
Diagnostic Tests Menu

To run Flow Stability
test press ENTER
ROM test                200
RAM test                201
Program version no.     202
Flow stability test     203
Check valve test        204
Pump cycle step count   205
External inputs test    206
Maintenance position    207
Display test            208
Transducer range        209
Transducer auto zero    210
Motor step/valve test   211
RS-232 test             212
Hardware series test    220
```

ROM – TEST 200 (Passive)

This test verifies the integrity of the ROM (Read Only Memory) in your pump. The ROM is where all of the built-in programs for the pump operation are stored. If faults are found in any part of ROM the following message is displayed:

```
ROM TEST failed, U3 or
ROM TEST failed, U4
```

U3 and U4 refer to the integrated circuit location of the ROM chip on the System PCB. Contact your local Spectra-Physics representative for information on replacement ROM chips.

RAM – Test 201 (Active)

CAUTION: The RAM test erases pump files (except the Startup File) when activated. Once activated the test runs to completion (about 1 hour) unless the power switch is turned off.

This test verifies the integrity of the RAM (Random Access Memory) in your pump. The RAM is where your pump files are stored and where temporary calculations are performed. If any faults are found with RAM the following message is displayed:

```
RAM TEST failed
```

NOTE: This test cannot be initiated from a remote device via LABNET or RS-232.

Program Version – Test 202 (Passive)

This test displays the software version that is installed in your pump. Spectra-Physics may make changes to the pump software at some future time. This test allows easy identification of the software version currently installed.

Flow Stability – Test 203 (Passive)

Refer to the description of "Flow Stability Test" at the beginning of this section.

Check Valve – Test 204 (Active)

This test is a secondary test to the flow stability test (Test 203). It will help you to further diagnose the source of flow stability problems. If the results indicate a "defective" check valve, the test should be repeated to ensure the results were not due to an isolated transient condition (such as a single air bubble).

NOTE: Test 204 affects flow accuracy while the test is running. Do not activate the test during an analysis. The test operates at flow rates of 2.5 mL/min and below. The READY light does not have to be on for the test to operate.

When activated, Test 204 causes the pump to maintain a constant column pressure for a period of between 8 and 10 pump cycles. During this time the test is monitoring the condition of the inlet and outlet check valves of the pump. When the monitoring period

is complete, the pumping is returned to normal constant flow control and a message is displayed showing the results. If a check valve is defective it should be replaced following the instructions in Section 5, "Routine Maintenance" for check valve replacement.

To activate the test, press [ENTER]. If the current flow rate is greater than 2.5ml/min a message will be displayed prompting you to reset the flow rate to less than 2.5ml/min. Press [ENTER] to run test. A message is displayed informing you of the 8 - 10 pump cycle delay before test completion. Pressing [ENTER] after the results are displayed will rerun the test .

Test 204 can be activated from a remote LABNET or RS-232-C terminal by sending Test 204 to the pump.

NOTE: Changing mobile phase concentration may cause the test to report a good check valve as defective. Stabilize composition before running test.

NOTE: Defective check valves tend to perform better at higher column pressures. Lowering the column pressure (decrease flow rate) increases the tests sensitivity to marginal check valves.

Test 204 Result Messages

The following messages may be displayed as the result at the termination of Test 204.

```
Both check valves good
```

Both the inlet and outlet check valves are performing well.

```
Inlet valve good
Outlet valve acceptable
```

The inlet check valve is performing well. The outlet check valve is performing adequately. While still usable, the outlet check valve may need replacement in the near future.

```
Inlet valve acceptable
Outlet valve good
```

The outlet check valve is performing well. The inlet check valve is performing adequately. While still usable the inlet check valve may need replacement in the near future.

```
Both valves acceptable
```

Both the inlet and outlet check valves are performing adequately. While still usable they may need replacement in the near future. Highly compressible solvents may cause good check valves to report as acceptable.

```
Outlet check valve is
defective. Press HELP
```

The outlet check valve is defective and should be replaced. Follow the instructions in Section 5 "Routine Maintenance".

```
Inlet check valve may be
defective. Press HELP
```

The inlet check valve may be defective. An air bubble lodged in the check valve or piston seal or a slight leak at an inlet fitting may cause this message to be displayed. Verify that solvents are adequately degassed and that fittings are tight. Purge the pump and rerun Test 204 to verify the message. If this same message results replace the inlet check valve by following the instructions in section 5 "Routine Maintenance".

```
Bubbles or leaks likely
Check degas. Press HELP
```

The test has determined that the check valves are not the cause of the flow problems. Verify that solvents are adequately degassed and that fittings are tight. Observe the inlet tubing while purging the

pump. If air bubbles are seen increase the helium degas rate (SP8800 only) or tighten the leaking fitting. The low pressure proportioning used by SP8800 requires well degassed solvents. Bottle caps must seal tightly and vent lines must be used to prevent air from entering the solvent reservoirs. The vent lines can be placed in liquid so that the positive flow of helium from the lines can be observed.

NOTE: Pulse dampeners must not be used with Spectra-Physics pumps. The flow is dynamically controlled and will be adversely affected by compliant loads.

```
Test aborted
```

The pump is unable to establish a reference column pressure within 10 pump cycles. The test is aborted. The pump has serious flow problems. Verify that the solvents used are miscible in all concentrations encountered. Increase the column pressure by raising the flow rate. The check valves require more than 100 psi column pressure to operate properly. Defective check valves will usually operate well enough at higher pressures to allow the test to run.

Pump Cycle Step Count Test 205 (Passive)

Normally 12,800 motor drive pulses are required for one revolution of the pump motor, as detected by the cam sensor. Test 205 displays a count of the number of pulses required for the last complete motor revolution and a message indicating if the count is acceptable (passed) or not (failed). If the number is greater than 13,184, either the motor to the cam coupler is slipping or the cam sensor is faulty. Numbers less than 12,416 indicate a faulty cam sensor or failed System PCB. Use Test 220, Hardware Series test to confirm the integrity of the cam sensor and System PCB.

NOTE: Test 205 requires that a file has been previously initialized and a full cam revolution has occurred. Otherwise, both a low number and a test failure is reported. If a failure is reported, initialize a file, ensure at least one cam revolution has occurred, and then repeat the test.

External Inputs – Test 206 (Passive)

Test 206 allows you a convenient way to monitor the status of two of the external input lines, *pump stop* and *run/grad*. The pump

stop line causes the pump to stop pumping when momentarily grounded. A momentary ground at the run/grad input line causes the run time clock to begin which activates the gradient program (SP8800 only). Use this test if you are having difficulty interfacing your pump to a controlling device.

When initialized by pressing $\boxed{\text{ENTER}}$, the display continuously shows (updates every 0.1 second) the current state of the pump stop and run/grad inputs. A zero (0) means the input is grounded (active) and a one (1) means the input is "high" (inactive).

Maintenance Position – Test 207 (Active)

This test is used during pump liquid end maintenance. The pump motor is rotated to a special position and held in place. In this position the liquid end assemblies can be easily removed and replaced. The motor holds its position as long as the unit power remains on or until either a pump file is initialized or purged, or you press $\boxed{\text{ENTER}}$. See Section 5 for liquid end maintenance instructions.

NOTE: This test cannot be initiated from a remote device via LABNET or RS-232.

Display – Test 208 (Passive)

Test 208 exercises the SP8800/8810 pump display. When initiated, the display alternates between 4 displays:

- o All dots on
- o All dots off
- o Alphanumeric character set
- o Symbol pattern

This test is useful for detecting a faulty display or drive circuitry. Contact your Spectra-Physics representative if the displays appear unusual.

NOTE: This test cannot be initiated from a remote device via LABNET or RS-232.

Transducer Range – Test 209 (Active)

Your SP8800/8810 Pump features advanced circuit designs which allow the pressure transducer range adjustment to be set by entering a value from the keyboard. No adjustment of potentiometers is necessary. Your pump comes from the factory preset to the proper range. The value is stored in a special non-volatile RAM location,

and must only be reset if the pressure transducer or System Circuit board are replaced. If this occurs the range number must be re-entered. The calibration number is recorded on a tag attached to the transducer cable. The pump's top cover must be removed to gain access to the tag. To enter the number, press [ENTER] and the display will show—

ENTER FULL SCALE OUTPUT
(X.XXX MV/V):

(where X.XXX is the current value stored)

At the cursor, type the 4-digit number. For example, **3.456** and press [ENTER].

NOTE: This test cannot be initiated from a remote device via LABNET or RS-232.

Set Autozero – Test 210 (Active)

Your pump features advanced circuit designs that allow the pressure transducer's output to be zeroed automatically without the need for adjustment of potentiometers. A simple press of a key sets the transducer zero adjustment. When activated, the test will prompt:

```
Release system pressure.
Then press the ENTER key.
```

"Release system pressure" means to open a column bypass valve or remove the column from the system. This ensures that the transducer is actually sensing zero system pressure while the transducer zero offset is being set.

NOTE: This test cannot be initiated from a remote device via LABNET or RS-232.

Motor Step/Valve Exercise – Test 211 (Active)

The motor step/valve test exercises the pump motor and the TPV (ternary proportioning valve on the SP8800). When activated, the pump motor is continuously stepped and the TPV sequentially opens and closes each of its valves at a rate of 1 valve per 0.5 seconds. This test is useful for detecting an intermittently failing TPV or pump motor. The EDIT and READY light blink in binary fashion to indicate which valve is currently open.

Valve	EDIT	READY
A	off	on
B	on	off
C	on	on

To access this test, press [ENTER]. The test continues until either the [STOP] key is pressed or a pump file is initialized. If the pump power is switched off while the test is running, subsequently, when the power is switched back on the test is automatically started.

NOTE: This test cannot be initiated from a remote device via LABNET or RS-232.

Hardware Series – Test 220 (Active)

NOTE: The external events connector (if present) must be removed from the rear of the pump before initiating Test 220. Otherwise, "Board Failure: Code 8" may occur.

The Hardware Series test is an extensive evaluation of the system PCB (Printed Circuit Board). The system PCB contains all of the circuitry for the operation of the pump, except for the display functions. Once activated the test exercises and diagnoses the condition of various circuits. The pump must be idle (not pumping) before activating the test.

To activate the test, press [TEST] and press [ENTER]. Either cursor up once and press [ENTER] or type **220** and press [ENTER].

The display shows—

```
Release system pressure.
Then press ENTER.
```

Open the column bypass valve or otherwise remove column pressure from the transducer. Press [ENTER] to continue the test.

The display shows—

```
"Test in Progress"
```

If no problems are found, the following messages appear as each portion of the test is completed:

```
TRANSDUCER TEST PASSED
PORT TEST PASSED
VALVE TEST PASSED (SP8800 only)
```

```
MOTOR DRIVE TEST PASSED
CAM MARKER TEST PASSED
REVOLUTION TEST PASSED
HARDWARE SERIES TESTS COMPLETED - PASSED
```

If problems are found during the test, a message suggesting the most likely failure is displayed, although in some cases other failures are possible. The following system PCB failure messages may be encountered.

BOARD FAILURE: CODE XXX – If the failure is identified as a component on the system printed circuit board or if the test cannot determine the failed component, a message is reported where XXX is a 1–, 2– or 3– digit number.

8

Remove the external events connector from the rear of the pump. This test exercises the input lines and may be affected by attached cabling.

1–100

Pertains to failures of the system printed circuit board. Contact your local Spectra–Physics representative for information about obtaining a replacement. Appendix D describes how to remove and replace the system PCB.

101, 102, 103

Indicates the ternary proportioning valve's electrical system (SP8800 only) has failed. Refer to Appendix D for "Ternary Proportioning Valve Replacement."

104, 105

Possible broken or loose pump motor cable wire. Refer to Appendix D for instructions on removing the top cover and for pump motor cable location. Examine the pump cable for broken or loose wires. If the cable is not defective, replace the System PCB. Contact your local Spectra–Physics representative about obtaining a replacement.

124

Too many motor steps were needed to complete a cam revolution. You may have a loose motor coupler or faulty system PCB. Contact your local Spectra–Physics representative for service information.

125

Too few motor steps were needed to complete a cam revolution. You may have a faulty cam sensor or System PCB. Con-

tact your local Spectra-Physics representative for service information.

TRANSDUCER UNPLUGGED - The pressure transducer was not detected. Check the connection of the transducer cable to the system PCB at J200. Refer to Appendix D for "TOP COVER REMOVAL " and to Fig. D.3 for J200 location.

CANNOT ZERO TRANSDUCER - The transducer circuitry is not able to compensate for the zero offset of the transducer. Make sure that the system is at zero column pressure (column bypassed) before starting the test. If so, replace transducer. Contact your local Spectra-Physics representative, or refer to Appendix D for "Pressure Transducer."

CHECK FUSE F2 - (SP8800 only.) Fuse F2 is used to protect the valve drive circuitry from excess current. Follow the instructions in Appendix D for "SYSTEM PCB REPLACEMENT" to remove the system PCB. Check for integrity of fuse F2 on the PCB. If the fuse is not defective, replace the PCB.

CHECK FUSES F3 AND F7 - These fuses are used to protect the motor drive circuitry. Follow the instructions in Appendix D, "TOP COVER REMOVAL" to access fuse locations. Fuses F3 and F7 are located near the rear of the unit.

CAM MARKER NOT FOUND - This message indicates that the sensor that detects pump cam revolutions is not operational. Either the motor coupling is loose or the cam sensor is defective. Remove the top cover following the instructions in Appendix D, "TOP COVER REMOVAL." Tighten the motor-to-cam coupler if loose, or replace cam sensor (part number A2992-010). Refer to Fig. H.6 for parts locations or contact your local Spectra-Physics representative.

VALVE CABLE UNPLUGGED - (SP8800 only.) The test has detected that the ternary proportioning valve cable is disconnected from the system PCB at J8. Follow the instructions in Appendix D, "TOP COVER REMOVAL." Locate J8 by referring to Fig. D.3.

CAM SENSOR FAILURE - The cam sensor cable (part number A2992-010) is defective and needs to be replaced. Contact your local Spectra-Physics representative for service information.

NO CURRENT TO MOTOR - The test has detected no current flow through the pump motor. Either the motor cable is unplugged at J6 on the system PCB or the entire drive circuitry is defective. Follow the instructions in Appendix D, "TOP COVER RE-

MOVAL." Locate the motor cable connection J6 by referring to Fig. H.6 If the motor is connected, replace the system PCB. Contact your local Spectra–Physics representative for information on obtaining a replacement. Refer to Appendix D for instructions on "SYSTEM PCB REPLACEMENT."

QUICK REFERENCE TROUBLESHOOTING GUIDE

Overpressure	Drifting Baseline	Noisy Baseline	RT* Reproducibility	Ghost Peaks	No Peaks	Distorted Peaks	Sensitivity Changes	Cycling Baseline	Spikes	AREA OF PROBLEM	ACTION
●	●									Plugged guard column or static mixer filter.	Replace guard column or mixer filter.
	●			●						Composition change during run.	If possible, use two solvents with closer response properties.
	●	●								Leak in detector cell.	Replace detector cell.
	●		●	●						Column aging.	If new column, condition overnight.
●	●	●	●	●		●				Column deteriorating.	Replace column.
	●		●							System not at equilibrium.	Enter a longer equilibrium time.
●	●	●						●		Immiscible solvents.	Use different solvents, use dynamic mixer.
	●						●			Gases re-dissolving in mobile phase.	Use helium degassing; increase helium flow.
	●	●			●					Faulty recorder.	Shunt recorder input to verify problem.
	●		●					●		Temperature changes.	Use temperature control.
	●	●	●		●					Flow unstable.	Adjust flow.
●	●	●		●						Contamination of mobile phase/injector.	Change solvents, clean system.
	●	●			●		●	●	●	Detector malfunction (electronics).	Refer to detector manual.
		●			●	●				Detector malfunction (optics).	Refer to detector manual.

* RETENTION TIME

Overpressure	Drifting Baseline	Noisy Baseline	RT* Reproducibility	Ghost Peaks	No Peaks	Distorted Peaks	Sensitivity Changes	Cycling Baseline	Spikes	AREA OF PROBLEM	ACTION
		●							●	Power line fluctuations.	Use regulating line transformer.
			●			●	●			Column overload; wrong column.	Dilute sample; use correct column.
						●	●			Overloaded column.	Dilute sample.
				●		●	●			Sample decomposition.	Stabilize sample.
									●	Bubbles.	Degas solvents; replace inlet filters.
				●	●					Mobile phase (weak/strong).	Adjust mobile phase strength.
			●	●	●		●			Sample (dilute/strong).	Adjust sample concentration.
					●					Bypass valve open, leaking; detector on shunt.	Correct.
								●		Incomplete mixing of solvents.	Check dynamic mixer operation.
			●							Unstable composition.	Use pre-mixed solvent to verify problem.
			●						●	Leaking fittings.	Tighten or replace fittings.
						●				Void in column or fitting connection.	Re-do connections with proper fitting or replace column.
●					●					Injector travel improperly adjusted or plugged.	Adjust injector.
		●			●					Shielded cables not grounded.	Ground cables.

* RETENTION TIME

HARDWARE TROUBLESHOOTING GUIDE

Symptom	Possible Cause	Diagnostic	Remedy
No response when power is switched on.	Power cord defective.	none	Replace cord.
	Fuse F1 blown.	none	Refer to Appendix D for fuse replacement.
Only fan runs with power on.	Fuse F4 or F5 and F6 blown.	none	Refer to Appendix D for fuse replacement.
No display.	System PCB defective.	none	Replace System PCB. See Appendix D
No display. Fan and pump run OK.	Fuse F5 blown.	Test 220 (terminal)	Refer to Appendix D for fuse replacement.
No response to keyboard entry. Display OK.	Keyboard defective.	Test 220 (terminal)	Contact local SP rep.
	System PCB defective.	Test 220 (terminal)	Replace System PCB. See Appendix D
Random display.	Display defective.	Test 208	Contact local SP rep.
Display test runs automatically when power is switched on.	System PCB defective.	none	Replace System PCB.

Symptom	Possible Cause	Diagnostic	Remedy
Pump motor will not run.	Max pressure set to zero.	STATUS key	Set Max pressure to a value > 100 psi.
	Motor defective.	Test 220	Replace motor.
	Motor cable unplugged.	Test 220	Connect cable.
	Drive circuit failure.	Test 220	Replace System PCB. See Appendix D
	Fuses F3 and F7 blown.	Test 220	Replace fuses. See Appendix D
	Target pressure low.	none	Press purge and then reinitialize file.
Improper composition.	TPV defective.	Test 220	Replace TPV. See Appendix D
	TPV drive defective.	Test 220	Replace System PCB. See Appendix D
	Cam marker failure.	Test 220	Replace Cam marker.
TPV does not click open.	Fuse F2 defective.	Test 220	Replace fuse. See Appendix D
	TPV drive failure.	Test 220	Replace System PCB. See Appendix D

Symptom	Possible Cause	Diagnostic	Remedy
Flow unstable. (No READY light)	Check valve failure.	Test 203 and 204	Replace check valve.
		Test 204	See Section 5.
	Immiscible solvents.	Test 203 and 204	Change solvent system.
	Unstable load (column).	Test 203 and 204	Pump must see stable, non-compressible load.
	Insufficient degas.	Test 203 and 204	Increase helium rate. Use vent line and good bottle to cap seal.
	Circuitry failure.	Test 220	Contact local Spectra-Physics representative.
	Partially clogged frit or filter on high pressure side of pump.	Test 203	Replace filter or frit.
Sudden shift in PSI display with no flow.	Transducer failure.	none	Replace transducer. Contact local SP rep.
	Circuitry failure.	Test 220	Replace System PCB. See Appendix D
Pump will not remotely stop or start (external inputs).	Incorrect wiring.	Test 206	Correct wiring.
No RS-232-C communication.	Defective module.	Test 212	Replace module. Contact local SP rep.
	Improper switch settings or file.	none	Refer to manual for proper RS-232-C interface parameters.

Symptom	Possible Cause	Diagnostic	Remedy
No LABNET communications	Incorrect unit number.	File parameter.	Change unit number setting. Do not use zero.
	Defective LABNET supply or cables.	none	Replace LABNET supply or cables.
	Defective circuitry.	Test 220	Replace System PCB. See Appendix D.

Section 7
Communications

EXTERNAL FUNCTIONS CONTROL

The SP8800/8810 pump has an 8-pin connector that plugs in at the rear of the pump (refer to Fig. 7.1). Several external functions allow for hardware communications between the pump and other devices:

- Pump Ready Output
- Pump Stop Input
- Run Gradient Input

In addition, there are three other connections:

- a ground line,
- a +5 volt DC source
- a pressure analog output

Noting the pin numbers labeled on the rear of the instrument and the pin assignments in the Table 7.1, push wire into appropriate hole of connector and tighten the corresponding fastening screw.

Press the edge connector onto the External Controls Port on the rear of the pump (refer to Fig. 7.1).

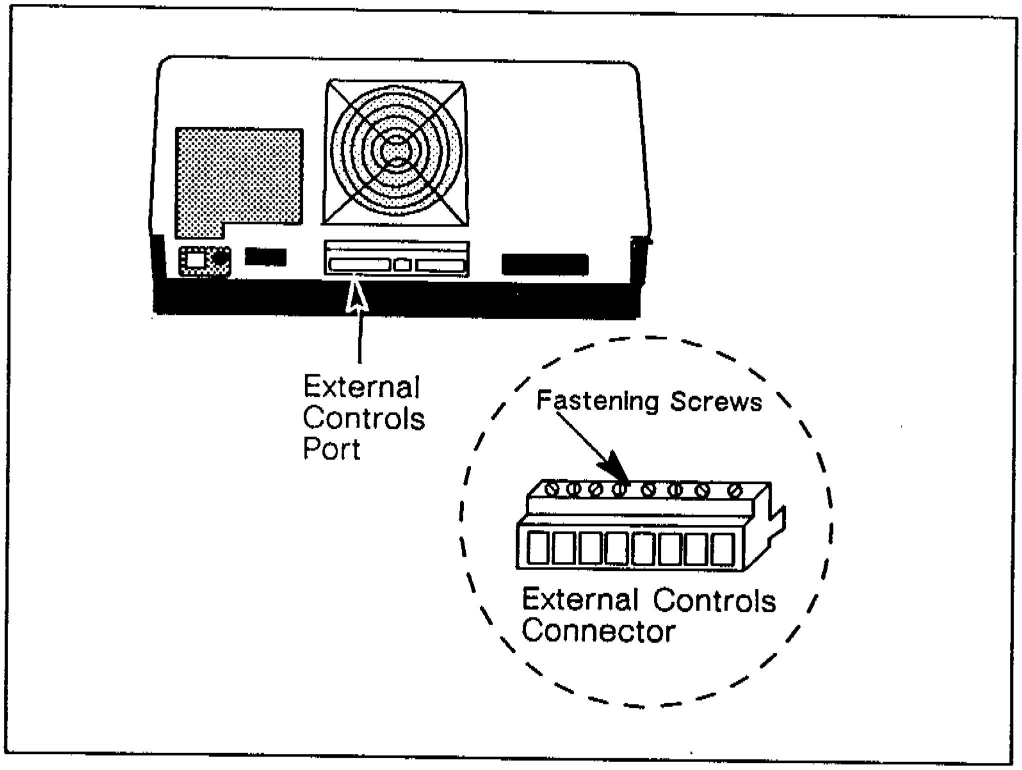


Fig. 7.1 Connecting the External Controls Connector

The pin assignments are as follows:

Pin 1. PUMP READY (Output)
This output remains normally low (zero) whenever the pump READY light on the front panel is on. It signifies that the pump is at a constant flow rate and that the pump is ready for analysis. This output operates as a transistor open collector capable of sinking up to 30 mA to ground and withstanding a maximum of +30 vdc.

Pin 2. +5 vdc
This regulated +5 vdc supply can be for pullup resistors or for powering relays. The current is limited to 150 mA to protect itself against external shorts.

Pin 3. Ground (Reference)
This is the ground reference which should be used for all inputs or outputs.

Pin 4. Analog Pressure (Output)
This is the analog output signal from the pressure transducer. It is calibrated for 100 mv per 1000 psi. The

output is offset by approximately 0.05 volts, but may vary between transducers within the range of 0 to 0.2 volts.

Pin 5. PUMP STOP (Input)
A low level causes the pump to STOP, equivalent to pressing the [STOP] key. The pump does not restart until this line goes high and the pump is then reinitialized.

Pin 6. Not used.

Pin 7. RUN/GRAD or RUN (Input)
A falling edge (1 to 0 transition) starts the Run Clock on the last Initialized File or, if no file is initialized, runs the Startup File (equivalent to pressing the [RUN/GRAD] or [RUN] keys for the SP8800 and SP8810, respectively).

Pin 8. Not used.

All inputs are tied to +5 vdc through "pullup" resistors.

Table 7.1. Pin Assignments for External Controls Port

Pin Number	**Function**	**Active State**
1 (Output)	Signal Pump READY State	low
2	+5 vdc, 150 mA maximum	
3	Ground	
4 (Output)	Analog output from pressure transducer (0.1 v/1000 psi)	
5 (Input)	Pump STOP command	low
6 Not Used		
7 (Input)	Pump RUN/GRAD command	low
8 Not Used		

RS-232-C COMMUNICATIONS OPTION

There are two types of RS-232 devices: Data Terminal Equipment (DTE), such as terminals, and Data Communications Equipment (DCE), such as modems and "smart" devices. Usually a DTE device is interfaced to a DCE device. If two similar devices are interfaced, a non-standard cable is necessary to switch pin connections. Nonstandard "custom" interfaces are beyond the scope of this manual.

RS-232 Module Installation

CAUTION: Make sure that the SP8800/8810 Pump's power switch on the rear of the unit is in the OFF (out) position.

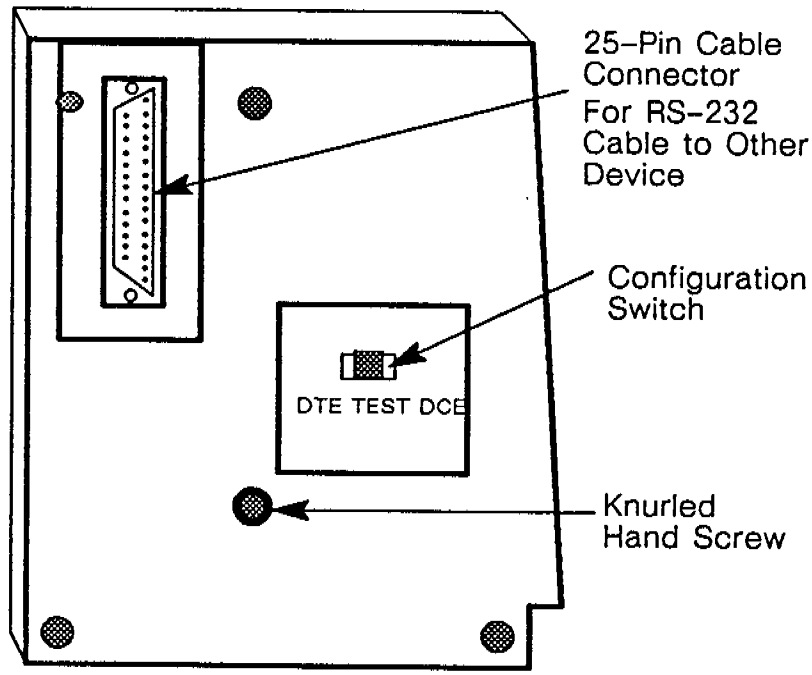


Fig. 7.2 RS-232 Module

The RS-232 Module connects to the RS-232 port (see Fig. 7.3) on the lower right side of the pump's rear panel. Align the printed circuit board to the RS-232-C port and push on the module to connect the module to the printed circuit board. Use the knurled hand screw (Fig. 7.2) on the RS-232 Module to finish tightening and to anchor the module firmly to the rear of the pump.

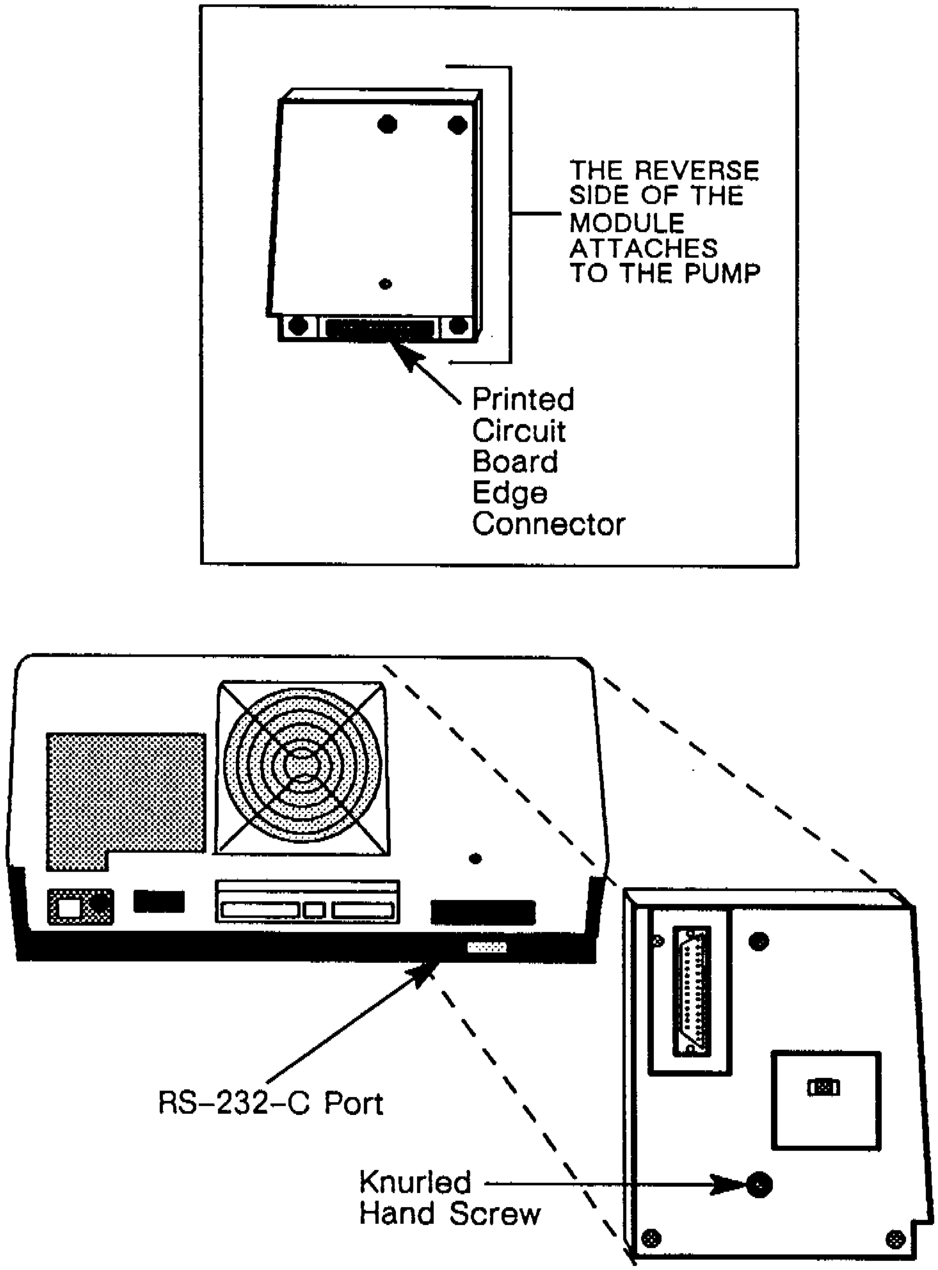


Fig. 7.3 Attaching the RS-232 Module to the Pump

Set the RS-232-C Configuration Switch (Fig. 7.2) to the desired mode. Normally for communications to take place, the unit with the *greatest control over transmission* assumes the role of DCE (Data Communications Equipment), with the other unit assuming the role of DTE (Data Terminal Equipment).

In most cases, when interfaced to CRT terminals, the pump assumes the DCE role (RS-232 Module switch set to DCE). The

same is true when the pump interfaces to computers, since most computers are configured to assume the DTE role in a computer modem arrangement.

For the majority of cases described, a straight-through cable, with proper end connector termination is sufficient to provide communication with full RS-232 "handshaking." There are, however exceptions to the standard. In these cases refer to the manual supplied with the device to which you are interfacing.

Connecting RS-232

1. Attach the RS-232-C cable to the RS-232-C female end connector on the module and attach the other end of the cable to the RS-232-C connector on the peripheral.
2. Configure the peripheral to:
   - o RS-232
   - o 1200 baud
   - o 1 stop bit
   - o Character length -- 8 bits (8 data bits, 1 start bit)
   - o Parity OFF (or none)
   - o Full Duplex

To change the baud rate, parity, or duplex response of the SP8800/8810, press the [TEST] key, select the RS-232 menu, and make the desired selections from the menu. The options available are listed in Table 7.2.

Table 7.2 SP8800/8810 Communications Parameters

PARAMETER	DEFAULT	RANGE
DTE/DCE		Selected with Switch.
Baud Rate	1200	110, 150, 300, 600, 1200 2400, and 4800.
Data Bits		Set by Parity selection.
Parity	None	Odd, Even None.
Stop Bits		Set by baud rate: 110 Baud=2 All others=1
Echo	Off	On, Off
Xon/Xoff	Off	On, Off

DTE/DCE	The two main classes of RS-232 devices.
Baud Rate	Translates closely to the number of bits per second. A baud setting of 1200 results in ASCII characters being transmitted at about 120 per second.
Data Bits	8 bits with Parity OFF or 7 bits plus Parity.
Parity	Selects proper parity for transmissions. The pump does not check parity on communications received.
Stop Bits	The number of data bits that determine the end of a character ; prepares the unit to look for the start bit of the next character, usually 1 (2 at 110 baud).
Echo	Transmits back data received so it can be displayed. Normally used only in connections to terminals.
Xon/Xoff	Xon enables the pump to remporarily halt incoming transmissions when its buffer is full. Used primarily in modem applications.

The RS-232-C cable must have the pin assignments as specified in the following table.

Table 7.3 RS-232 Module
RS-232-C Interface Pin Assignment
(RS-232-C lines are always described from the DTE perspective)

PIN	FUNCTION
1	Protective Ground
2	Transmit Data
3	Receive Data
4	Request to Send
5	Clear to Send
6	Data Set Ready
7	Signal Ground
8	Receive Line Signal Detect
20	Data Terminal Ready

Table 7.3 lists the pin connections and their functions for a typical RS-232 interface on the DB-25 connector. Tables 7.4 and 7.5 list the pin connections for the IBM PC XT and AT RS-232 interfaces, respectively.

Table 7.4 IBM PC XT RS-232 Pin Connections

PIN NO.	NAME	MEANING
2	TD	Transmit Data
3	RD	Receive Data
4	RTS	Request to Send
5	CTS	Clear to Send
6	DSR	Data Set Ready
7	SG	Signal Ground
8	DCD	Data Carrier Detect
20	DTR	Data Terminal Ready

Table 7.5 IBM PC AT RS-232 Pin Connections

STANDARD RS-232 PIN NO.	NAME	IBM PC AT PIN NO.	MEANING
8	DCD	1	Carrier Detect
3	RD	2	Receive Data
2	TD	3	Transmit Data
20	DTR	4	Data Terminal Ready
7	SG	5	Signal Ground
6	DSR	6	Data Set Ready
4	RTS	7	Request to Send
5	CTS	8	Clear to Send
22	RI	9	Ring Indicator

Using the RS-232-C Interface

RS-232-C is the current version of the Electronics Industry Association (EIA) standard for serial data communications. The standard defines hardware and software parameters including voltage levels, loading characteristics and the type of connector. The DB-25S (female) and the DB-25P (male) connectors (Fig. 7.4) are mandatory. Although 25 pins are available, some pin connections are rarely used.

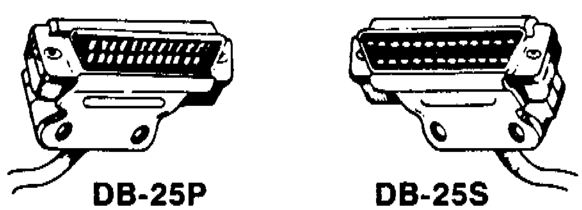


Fig. 7.4 Male and Female Connectors

The RS-232 signal is encoded typically into voltages of +5 to +15 (logic 0) and −15 to −5 (logic 1) volts DC. RS-232 was originally intended for fairly short distances of 50 feet or less, but it is being used for distances well over 500 feet. Line amplifiers can increase the RS-232 signal for even longer distances.

Interfacing to the IBM PC XT or AT

Equipment needed:

- o IBM Personal Computer XT or AT
- o Asynchronous serial card that is optional in the IBM PC XT and included in the AT (set for RS-232 and COM1)
- o SP8800/8810 equipped with RS-232 Module (DCE switch position)
- o Communications program for the computer.

An asynchronous serial RS-232 interface card that comes standard with the IBM-XT/AT can be connected to the pump. The connectors are shown in Figs. 7.5 and 7.6. The IBM PC AT comes with a 9-pin connector; an adapter cable (IBM #1502067) to convert to a 25-pin connector must be obtained. Jumpers on the RS-232 interface must be examined and placed in the proper positions to provide protocols matching those in Table 7.5 for the SP8800/8810.

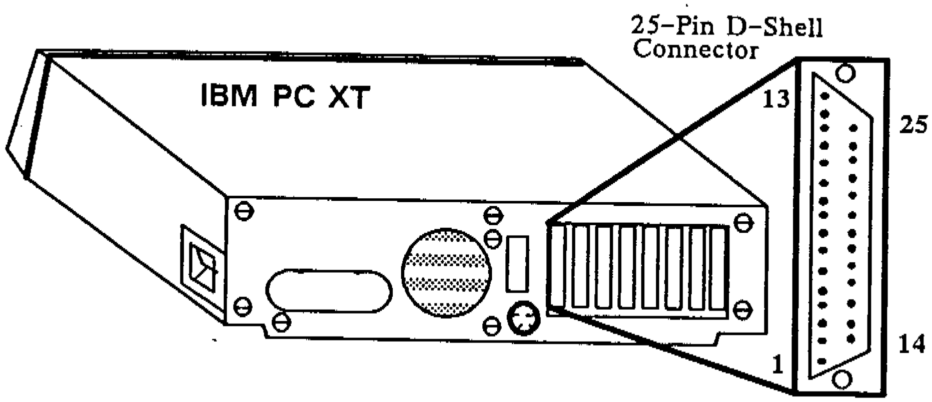


Fig. 7.5 Position of Asynchronous Communications Adapter and Back of IBM PC XT

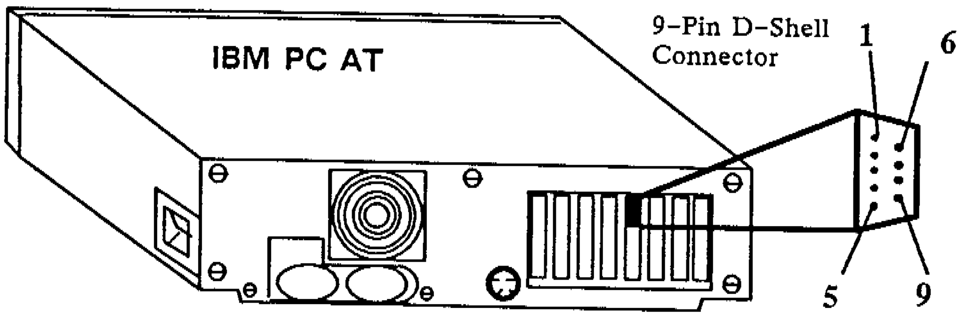


Fig. 7.6 Position of Asynchronous Serial/Parallel Adapter and Back of IBM PC AT

LABNET COMMANDS

LABNET is a low-cost, easy to use interactive communications network designed specifically for automating chromatography in the laboratory. With LABNET, the SP8800/8810 can be linked together with other compatible devices.

This link is a simple three wire cable and power supply. Instruments can be added or removed without the need for programming or software changes.

When linked through LABNET, most of the SP8800/8810 functions can be accessed by any compatible terminal or Spectra-Physics integrator. File editing, status, and run control can be handled through these external devices, either at the same location or remotely.

Hardware Required

Connecting the SP8800/8810 into LABNET is a simple matter. Only three items are needed in addition to the pump and the other compatible devices (integrator, autosampler, etc.).

- LABNET power supply -- A2363-010 (115V) or A2363-020 (220V) One required per network.
- Y-connector Kit -- A2364-010 (one for each instrument).
- Network Cables -- 1-meter, A2365-020 or 10-meter, A2365-010 (as many as required).

Connecting the SP8800/8810 to LABNET

The following is the recommended technique for initial installation of instruments in a LABNET network:

1. Turn power to all instruments to **OFF**, except the pump.
2. Set the LABNET unit numbers on each instrument to the desired values. Instruments intended to act as a single system should all be set to the same number. Values of 1 to 31 are valid. To set the unit number on the SP8800:
   a. Press the [TEST] key.
   b. Using the [→] key, select **UNIT #** and press [ENTER].
   c. Enter in the desired unit number. This number remains in effect until changed, even if the power is turned off.
   d. Turn the pump power **OFF**.
3. Attach a Y-connector to LABNET connector on each instrument (refer to each instrument's Operator's Manual for con-

nector location). The location of the SP8800/8810 LABNET connector is shown in Fig. 7.7.

4. Plug the LABNET power supply into a conveniently located AC power outlet. Then attach the power supply connector to the Y-connector of one of the instruments (usually at one end of the network). Only one power supply is necessary for each network.
5. Interconnect the remaining instruments with 1-meter or 10-meter network cables.
6. Restore power to all instruments. If an autosampler is in the system, turn its power on last. It runs its own rollcall of the instruments in its system.

To disconnect an instrument from the network, simply remove the LABNET connector from the back of the instrument.

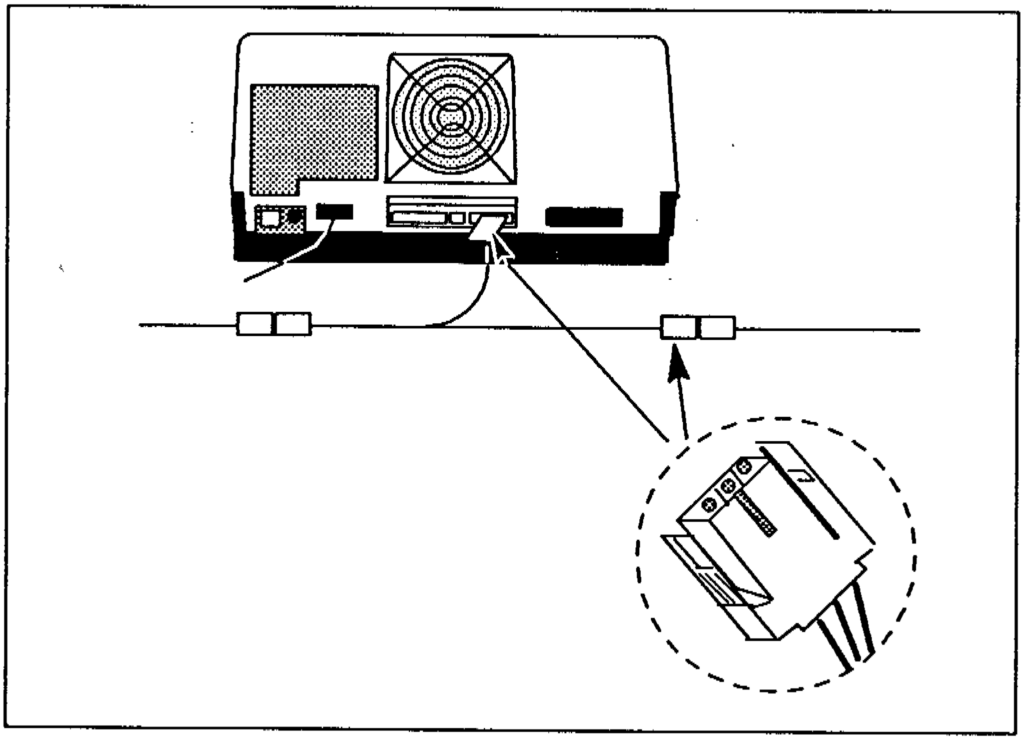


Fig. 7.7 SP8800 LABNET Connector

Instrument Communication

LABNET provides local and remote communication and control of the SP8800/8810 via direct commands and/or BASIC programs entered from a terminal, Spectra-Physics integrator, or ChromStation computer. The message can consist of a command to perform a physical task such as starting the pump, changing an operating parameter such as the flow rate, or asking for information.

Through LABNET, most editing and monitoring tasks are available to the local or remote terminal. A BASIC program can take complete control of practically all of the control functions.

The general format for a direct command to the SP8800/8810 looks like this:

/n.P/command [ENTER]

where–
n = unit number of the pump
.P = device code of the pump
command = the task to be performed (i.e., STATUS, DIALOG, etc.)

Unless information is directed to other than the local terminal, LABNET assumes that the sending device will receive all returning messages. Refer to the *LABNET Operators Manual* (part number A0099–083) for details on LABNET commands and structure.

Direct Commands

With a few modifications, most of the run control functions available on the keypad are accessible through LABNET. The file editing functions are expanded for easier reading. A full listing of the pump control and editing commands are in Table 7.6, and a listing of pump File variables accessible through LABNET is in Table 7.7.

Editing a File

Use the DIALOG command to create or edit individual files. As an example, to set up a gradient run (SP8800) in File 3 of unit 1:

/1.P/DIALOG 3 [ENTER]

The pump dialog will begin:

```
SOLVENT FILE 3
ERASE FILE?Y *

   TIME     %A       %B      %C      FLOW
   0.0      100.0    0.0     0.0     0.00
   0.0      60*      0.0*    40.0    1*

MAX. PRESS. LIMIT ( 6000 PSI) = 2500*
MIN. PRESS. LIMIT (    0 PSI) = 200*
VOLUME DELAY (     0 ML) = *
END OF SOLVENT FILE DIALOG
```

(* denotes pressing [ENTER] key)

The DIALOG command must be followed by a number designating the file to edit. If the command is used without a number the following error message appears:

```
FAULT   10:   SYNTAX ERROR
```

To change any of the values within a file, or add a new line, start the DIALOG as before. To change a value:

```
/1.P/DIALOG 3*
SOLVENT FILE 3
ERASE FILE?N*

   TIME      %A       %B       %C       FLOW
   6* 6.0    60.0     0.0      40.0     1.00
    * 6.0    50*      *        50.0*    1.00*
MAX. PRESS. LIMIT ( 2500 PSI) = *
MIN. PRESS. LIMIT (  200 PSI) = *
VOLUME DELAY (      0 ML) = *

END OF SOLVENT FILE DIALOG
```

(* denotes pressing [ENTER] key)

The existing values for MAX PRESS., MIN. PRESS. and VOLUME DELAY are within the parentheses. These values can be changed by entering the desired value.

To add a new line:

```
/1.P/DIALOG 3*

SOLVENT FILE 3
ERASE FILE?N *

   TIME      %A       %B       %C       FLOW
   10*       60*      *        40.0*    1.00
```

(* denotes pressing [ENTER] key)

Listing a File

There three ways to obtain a file listing through LABNET:

```
PRFILE (n), PRMETHOD (n), or FILE (n)
```

PRFILE is used to obtain a listing of the EDIT file. As an example, to request a file listing from pump unit number 12 to be printed at the local terminal (integrator, computer, etc), the direct command would be:

```
/12.P/PRFILE 3        [ENTER]
```

The file listing would then be printed at the requesting terminal:

```
LC CONDITIONS
UNIT  12     FILE  3

    TIME     %A      %B      %C      FLOW
    0.0      60.0    0.0     40.0    1.50
    6.0      60.0    0.0     40.0    1.50

MAX. PRESS. LIMIT =  3000 PSI
MIN. PRESS. LIMIT =   200 PSI
```

PRMETHOD is used primarily to print the existing RUN file (the last file that was initialized). When a file number is specified (PRMETHOD n), it performs the same function as PRFILE n. If the RUN file has been changed, either through direct command or using the STATUS screens on the keypad, PRMETHOD will issue an ALTERED RUN FILE message.

```
LC CONDITIONS
UNIT  12     ALTERED RUN FILE  3

    TIME     %A      %B      %C     FLOW . .
```

FILE (n) is used to provide a file listing in the form of variable statements. This command is primarily used when saving the pump file in some external storage device.

```
/12.P/FILE 1                [ENTER]
```

The pump will return:

```
TI= 0.0:FL= 1.00:PA=  60.0:PB= 0.0:PC= 40.0:PU=
1000:PL= 0:FI= 1
TI= 5.0:FL= 1.00:PA=  60.0:PB= 0.0:PC= 40.0:PU=
1000:PL= 0:FI= 1
```

Status

By using the STATUS command, a "snapshot" of the real time running conditions can be obtained.

```
/12.P/STATUS                    [ENTER]

LC STATUS
UNIT  12    RUN FILE  1

   TIME      %A      %B      %C      FLOW
   12.4      60.0    0.0     40.0    1.50

CURRENT  PRESSURE =  1478 PSI
MAX. PRESS. LIMIT =  3000 PSI
MIN. PRESS. LIMIT =   200 PSI
```

Again, if the flow or pressure limit has been changed outside of DIALOG, an ALTERED RUN FILE message will appear.

Similar to the FILE (n) command, STATLET allows the listing of the "snap shot" STATUS as its variables:

```
/12.P/STATLET                    [ENTER]

TI= 5.3:FL= 1.00:PA=  60.0:PB= 0.0:PC= 40.0:PU=
1000:PL= 0: PR= 1256: FI= 1
```

Sending to Another Remote Device

To have information or responses sent to other than the local data system:

```
CMD!"/2.P,4.PP/ PRINT PR"
```

In this example, the command PRINT statement (CMD!) was issued to pump 2 (/2.P) to send to the printer/plotter 4 (,4.PP/) the pressure reading (PRINT PR).

The RS-232 port on the pump can be addressed from other devices on LABNET by addressing the pump's unit number (x) using the suffix X.PT.

BASIC Programming of the SP8800/8810

Any Spectra-Physics LABNET integrator with BASIC programming capability can control the SP8800/8810. All of the LABNET commands listed in Table 7.6 and all of the variables in Table 7.7 can be embedded within a BASIC program (refer to the integrator's Operators Manual for specifics in Autolab BASIC programming).

Editing Using BASIC

As an example, to change the flow rate of pump 12 at some specific point during a run:

```
10 CMD!"/12.P/ SETFL=2"
```

The flow rate will be changed to 2 ml/min "on-the-fly".

To change the flow value in the EDIT file:

```
10 CMD!"/2.P/"
20 !"EDIT 2"          (editing file 2)
30 !"TI=6.0"          (editing 6.0 min time line)
40 !"FL=2"            (change flow to 2 ml/min)
```

In this manner, a complete file can be set up through a BASIC program instead of going through LABNET dialog or using the EDIT key on the keypad. To do this, requires knowing how the edit file accepts data. Refer to the FILE command shown previously. This provides a listing of each time line as BASIC statements (see the list of variables in Table 7.7). To construct a time line requires defining the time (TI) and two of the three solvent percentages (PA, PB or PC). The file (FI), the flow (FL) and the pressure limits (PU and PL) can be defined once for the entire file. Setting up a simple isocratic file would look something like this:

```
10 CMD!"/1.P/"
20 !"EDIT 4"
30 !"TI=0"
```

When the EDIT command is used, the time line designated (TI) is automatically set to 0.0, but you can specify any time line.

```
40 !"FL=1.5" : !"PU=3000" : !"PL=200"
50 !"PA=60" : !"PB=20"
```

The third solvent (PC) is automatically calculated so the total adds up to 100 %. To set up the second time line of the isocratic system requires just the time:

```
60 !"TI=6.0"
```

As in any other form of editing, the values from one line will be carried down to the next if they are not changed. List the file with the PRFILE command and see the results.

In the same manner, variables calculated or stored in the data system can be used to set up the pump parameters. Using the above example:

```
10 CMD!"/";$2Un;".P/"
20 !"EDIT";Ed
30 !"TI=";$5.2Ti(1)
40 !"FL=";$4.2Fl : !"PU";$4Pu : !"PL=";$4Pl
50 !"PA=";$5.2Pa : !"PB=";$5.2Pb
60 !"TI=";$5.2Ti(2)
```

Where ED, TI, FL, PU, PL, PA, and PB are all variables stored within the data system and sent to the pump. UN (unit number) is not sent to the pump.

Echoing

When a value is changed or a command is given to the pump over LABNET, the pump will echo back the time line with the change:

```
10 CMD!"/2.P/EDIT 1"
TI= 0.0:FL= 1.00:PA=  60.0:PB= 0.0:PC= 40.0:PU=
1000:PL= 0:FI= 1
```

To avoid this echoing, use the NOTEXT command:

```
10 CMD!"/2.P,NOTEXT/"
```

This command only needs to be used once, generally at the beginning of the program, if no other text directing commands are given.

Saving Pump Data

To save a pump value (flow, pressure, etc) at the local data system for later use requires an INPUT statement. As an example, to save the pressure value from pump 3:

```
10 CMD!"/3.P/"
20 INPUT"PRINT PR";Pr
```

To input more than one value at a time requires a PROMPT command. This command forces the pump to wait for the INPUT command before sending out the data. This eliminates the possibility of the pump sending data faster than the data system can handle it. An example of this would be collecting data in a FOR..TO..NEXT loop:

```
10 CMD!"/12.P/"
20 !"EDIT5"
25 FOR I=1 TO 50
30 CMDPROMPT "/12.P/PRINT PA"
40 INPUT PA(I)
50 !"LINE"              (moves down one time line)
60 NEXT
```

For additional information about LABNET commands and BASIC programming refer to the *LABNET Operators Manual* (A0099-083).

Table 7.6
LABNET Control Commands

Command	Function
ABTEST	Abort diagnostics test.
Carriage Return	No operation.
CHANGE TI= n	Change the time value of the current edit line to n.
CONTINUE or CONTINUE n	Continue running the gradient clock using the current run file, or a new run file specified by n.
DELETE	Delete the current line pointed to, or abort a potential line insert. The zero time line cannot be deleted.
DIALOG n	Initiate EDIT file dialog. A file number n must be used.
EDIT or EDIT n	Access the last edited file or open File n for editing. EDIT n will start at the zero time line. EDIT will start at the last line accessed. Either will lock the specified file from editing by another user until it is closed.
ERASE	Restore the current file being edited to the non-default power up status.
Escape (ESC)	Stops a diagnostic test, dialog or report that is being sent.
FILE or FILE n	Returns to the sending device a listing of the current EDIT file, or File n, as a series of BASIC statements.
HOLD or HOLD n.nn	Hold the run time clock at the current time or at a specified time n.nn. The pump will continue running.

SEARCH XX= value	Finds the line at which the designated variable, e.g. TI, has the desired value.
SET	Used before the run variables FL, PU, or PL to reset them on-the-fly.
STATLET	Sends a "snapshot" status of all the current operating conditions in a variable format.
START	Starts the gradient time clock at the next cam marker.
STATUS	Sends a "snapshot" status of all the current operating conditions in a readable format.
STOP	Stops the pump and holds the gradient time clock.
TEST n	Executes the diagnostic test n.

Table 7.7
LABNET Variables for the SP8800

NAME	FUNCTION
FI	The file currently being edited or the run file, depending on the status report.
FL	Flow rate (mL/min).
PA	Percent A solvent.
PB	Percent B solvent (SP8800 only).
PC	Percent C solvent (SP8800 only).
PU	Maximum pressure limit.
PL	Lower pressure limit.
PR	Current operating pressure.
PV	Gradient delay volume.
TI	Time (min.)of gradient or of the time line currently being edited.
CF	File specified as Cleanup File.
CT	Delay time specified for Cleanup File.

Appendix A
Specifications

FEATURE	SPECIFICATION
Pump Design	Dual piston, pulseless design with 12,800 control steps per cam revolution.
Floating Piston Design	Long seal life.
Bright Fluorescent Display	2 lines, 48 characters.
"Bayonet-Mounted" Liquid Ends	Easy maintenance and parts replacement.
Flow Range	0.01 to 10 mL/min standard. Up to 30 mL/min using prep option. Settable in 0.01 mL/min increments.
Flow Precision	0.2 % RSD[a]
Maximum Pressue	6000 psi for standard head; 2500 psi for prep option.
Compressibility Compensation	Automatic
Method Files	Ten method files of 40 steps each.
Startup File	User defined file that is stored in non-volatile memory.
Cleanup File	User programmed file initiated automatically at end of sample run to clean out pump and column.
Flow Stability Test	Pump flow diagnostic to verify proper pump performance.
Diagnostics	Diagnostic tests to verify proper electrical and mechanical operation.

Help Screens	Over 430 line of Help text provides specific information for all pump operations.
Communications	Contact closures and LABNET standard. RS-232-C optional.
Battery Backup	100-hr backup of RAM memory.
Battery Backup	Height- 7 1/4 inches Width- 15 3/4 inches Depth- 20 inches
Weight	33 pounds
Power Consumption	200 VA

SP8800 Only:

Pump Design	Micro-stepped pump with low pres sure ternary mixing capability. A helium degas manifold is standard.
Internal Volume	800 microliters.
Composition Range	0 to 100 % in 0.1 % increments.
Composition Repeatability	0.2 % RSD[b]
Composition Repeatability	0.2 %RSD
Gradient Linearity	0.5 % maximum dviation from linearity.[c]
Gradient Delay	Dead volume compensation settable in 0.01 mL increments.
Minimum Flow for Gradient	0.05 mL/min.
High Internal Mixing	No mixer required.

[a] Typical RSD obtained on chromatographix retention times.

[b] Typical RSD obtained on chromatographic retention times using solvent proportioning.

[c] Typical deviation from the best fit linear line from 15% to 85% gradient composition without a mixer.

FUSE LOCATIONS

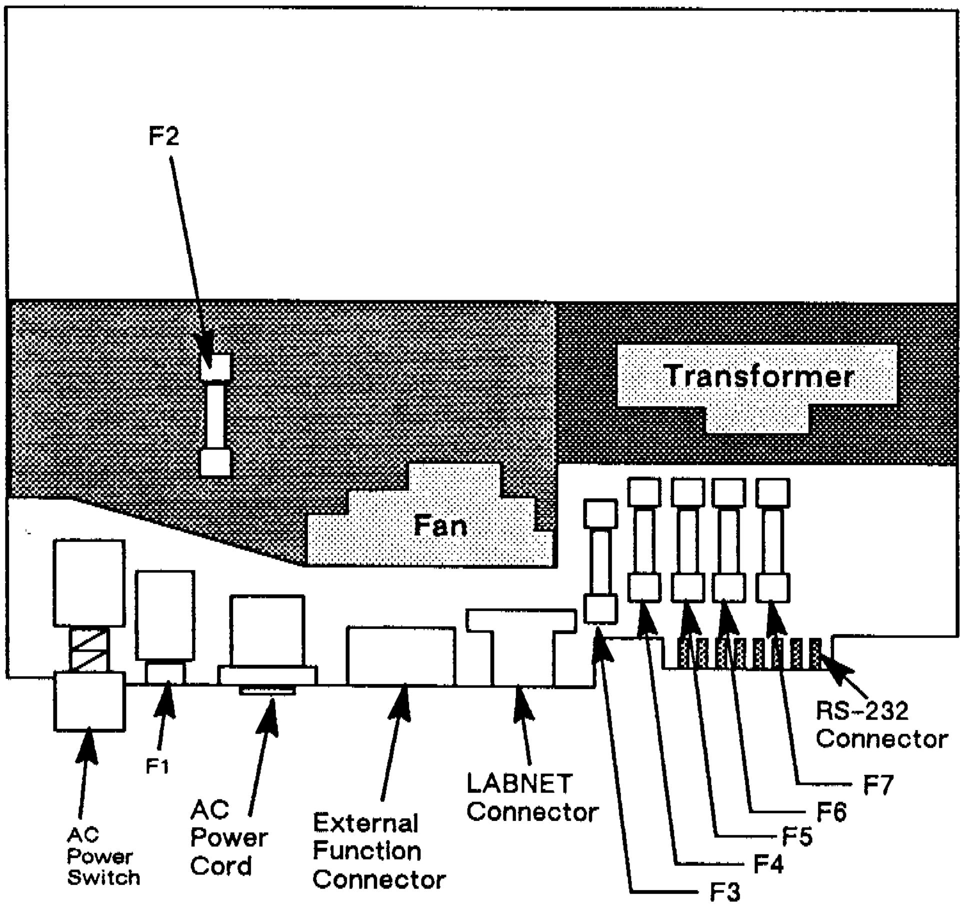


Fig. C.1 Top View With Cover Off

Fuse	Ratings	Description
F1	220 V Versions 1.0A 110 V Versions 2.0A	Main power fuse
F2	0.2A SLO BLO	TPV Fuse
F3	3.2A SLO BLO	± 32 volt dc pump motor
F4	2A SLO BLO	+ 5 volt dc supply
F5	0.75 SLO BLO	± 15 volt dc supplies
F6	0.75 SLO BLO	± 15 volt dc supplies
F7	3.2A	± 32 volt dc pump motor

REPAIR

These instructions are provided as a guide for repairing your SP8800/8810 Pump. The following procedures should only be attempted if you are proficient with electrical/mechanical devices.

WARNING!!!

Switch power off and remove the power cord from the rear of the pump before starting any of the following procedures!

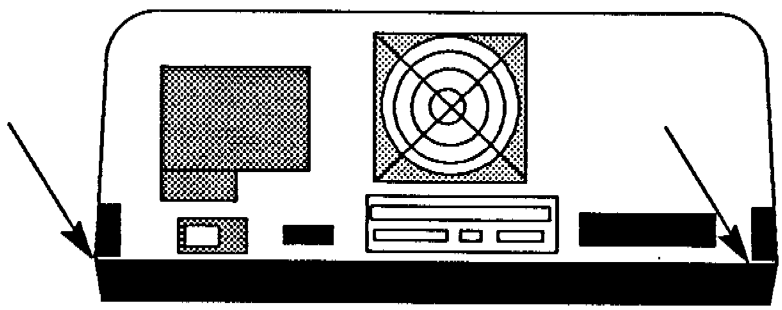


Fig. C.2 Cover Screws

TOP COVER REMOVAL AND REPLACEMENT

1. Switch power off and remove the power cord from the rear of the pump.
2. Remove the two Phillips-head screws.

SYSTEM PCB REPLACEMENT

If the system PCB is diagnosed to be defective during troubleshooting, it can be easily removed and repaired by Spectra-Physics. In most locations, reconditioned system PCBs are available for exchange. Contact your local Spectra-Physics representative.

Removal

1. Remove the RS-232-C module, if present. Switch power off and remove the power cord from the rear of the pump.
2. Remove all external connectors (LABNET, External Con trols) from the rear of the instrument.

3. Remove the top cover as described earlier.

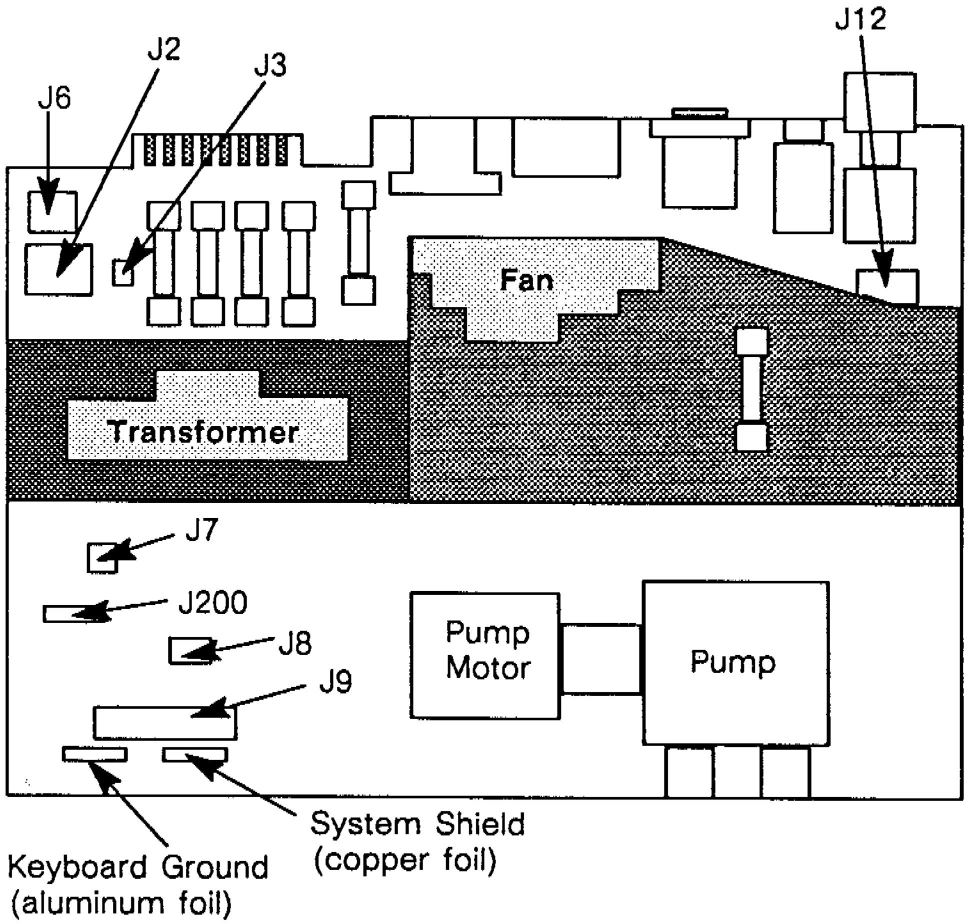


Fig. C.3 PCB Connector Locations

4. Remove the following connectors from the system PCB. Refer to Fig. C.3 for connector locations (proceeding in a counter clockwise manner from the right rear of the instrument as viewed from the front):

J12	Transformer primary
J3	9 volt dc battery
J2	Transformer secondary
J6	Pump motor
J7	Cam marker
J200	Pressure transducer
J8	Ternary proportioning valve
J9	Keyboard interconnect (gray ribbon)

Keyboard ground (aluminum foil)
System shield (copper foil)

5. Remove the fan and filter by lifting them up out of the cavity in which they rest at the rear of the instrument and placing them on top of the black fan plenum.
6. Slide the PCB out the back of the instrument.

Installation

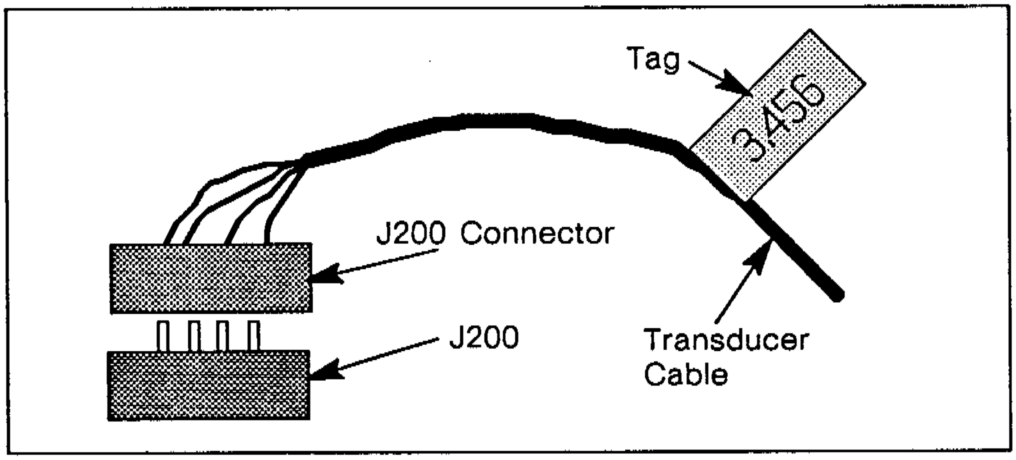


Fig. C.4 Transducer Tag

1. Install the replacement PCB by reversing the removal steps. Make sure that all of the cables are properly connected. Record the 4-digit (X.XXX) number printed on the pressure transducer tag (Fig. C.4). It will be necessary to re-enter this number into instrument memory when power is switched back on.
   a. Replace cover and power cord, etc.
2. Switch on power to the pump. Press [TEST] and then [ENTER]. Cursor down to Transducer range 209 and press [ENTER] (or type **209** and press [ENTER]). The display will show:
   `Enter full scale output (x.xxx mv/v):`
   Enter the value on the pressure transducer tag as noted in step 1. This test sets the full scale range of the pressure transducer. For example, press
   [3][.][4][5][6] and then [ENTER].
   Cursor down one space to test 210, Transducer auto zero. Press the [ENTER] key twice. This step causes the circuitry to establish zero pressure.
3. Verify the condition of the replacement PCB by pressing the [TEST] key followed by pressing [ENTER]. Press the up arrow key ([↑]) once and press [ENTER] (or type **220** and

press [ENTER]). Follow the displayed directions to initialize the test. The pump executes a series of hardware and circuitry diagnostics. It reports HARDWARE SERIES TESTS COMPLETE - PASSED if no faults are found. If a PCB failure message is reported, refer to Section 5, "TROUBLESHOOTING" for further explanation.

NOTE: Pump files, options, Maintenance Log, and RS-232 parameters must be reprogrammed if the system PCB is re placed.

The pump is now ready for use.

Ternary Proportioning Valve (TPV) (for SP8800 only)

Removal

1. Switch power off and remove the power cord from the rear of the pump.
2. Remove the top cover as described at the beginning of this section.

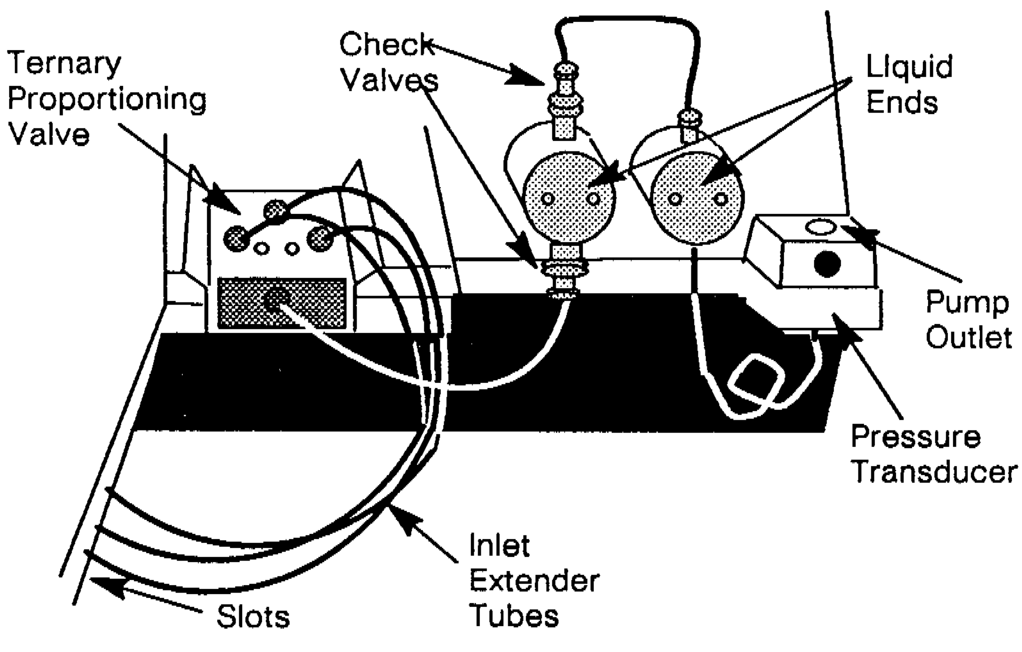


Fig. C.5 TPV Solvent Connections

3. Remove the three inlet extender tubes and the one outlet 1/8-inch solvent tube from the ternary proportioning valve.
4. Disconnect the TPV cable at J8 on the PCB (see Fig. D-3).

5. Remove the two phillips mounting screws from the front of the TPV.
6. Extract the TPV from between the pump motor and the front bezel.

Installation

1. Reverse the steps taken for valve removal. Make sure to re attach the ground strap to the valve mounting bracket.

Pressure Transducer

Removal

1. Switch power off and remove the power cord from the rear of the pump.
2. Remove the top cover as described earlier.
3. Remove the inlet and outlet tubings from the transducer (see Fig. C.5).
4. Disconnect the4 transducer cable at J200 on the system PCB (see Fig. C.3).
5. Remove the transducer mounting screw and pull the transducer out of the bezel.

Installation

1. Position the replacement transducer in the front bezel and secure with the phillips head screw.
2. Connect the transducer cable at J200 on the system PCB. Record the number printed on the cable tag. It will be needed for setting the transducer range (see Fig. C.4).
3. Connect the outlet tubing.
4. Replace the top cover.
5. Switch the pump's power to on and follow the installation instructions in "SYSTEM PCB INSTALLATION," in step 2, to set the transducer range.

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