Agilent SD-1 Isocratic Solvent Delivery Module

User Manual

Agilent Technologies

Notices

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In This Book

This manual contains information on:

- Agilent SD-1 Isocratic Solvent Delivery Module (G9302A)
- Agilent SD-1 Add-on Solvent Delivery Module (G9303A)

1 Introduction

This chapter gives an instrument overview.

2 Site Requirements and Specifications

This chapter provides information on environmental requirements, physical and performance specifications.

3 Installation

This chapter gives information about the installation of your instrument.

4 Using the SD-1 Solvent Delivery Module

This chapter explains the operational parameters of the instrument.

5 Optimizing Performance

This chapter gives hints on how to optimize the performance or use additional devices.

6 Troubleshooting and Diagnostics

This chapter gives an overview about the troubleshooting and diagnostic features.

7 Error Information

This chapter describes the meaning of error messages, and provides information on probable causes and suggested actions how to recover from error conditions.

8 Maintenance and Repair

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9 Parts

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Contents

1 Introduction

This chapter gives an instrument overview.

Introduction to the System

The Agilent SD-1 is an innovative HPLC solvent delivery system engineered with preparative chromatographers in mind. Corrosion-resistant titanium pump heads address the needs of biochemists for compatibility with salt-containing buffers and freedom from unwanted metal ions. Each pump head has a piston washing chamber to prevent deposition of abrasive salt residues behind the high-pressure seal, thereby greatly extending seal life.

Major new technology includes dual independent linear piston drives. Rather than operating both heads from cams attached to a single motor, as in conventional dual piston pumps, the Agilent SD-1 uses two independent stepper motors which connect to pistons via linear screw drives. The motors reciprocate, rather than running only in one direction. Independent drive frees the Agilent SD-1 from the operating constraints of mechanical cam profiles and makes it the first dual piston pump to produce entirely pulse-free flow under all operating conditions, without auxiliary hydromechanical pulse dampers. Totally pulse-free flow favors improved column performance and extended column life by saving expensive preparative columns from the constant pressure-pulse pounding typical of other large piston and diaphragm pumps.

In addition, the Agilent SD-1 meters flow at a constant rate independent of solvent compressibility and without the slight refill-associated flow deficits seen with conventional single-motor dual-piston models. In gradient operation, this produces more precise composition profiles without the time and volume delays introduced by large mixing chambers. Plus, flow rates extend well into the analytical HPLC range, permitting method development on smaller columns without interchanging heads.

Each Agilent SD-1 pump includes a standard serial interface for flow control. A built-in two-channel analog-to-digital converter allows the computer to collect data from HPLC detectors. Contact closure inputs and outputs are provided for system automation. Firmware includes Good Laboratory Practices (GLP) logging features.

Physical Layout

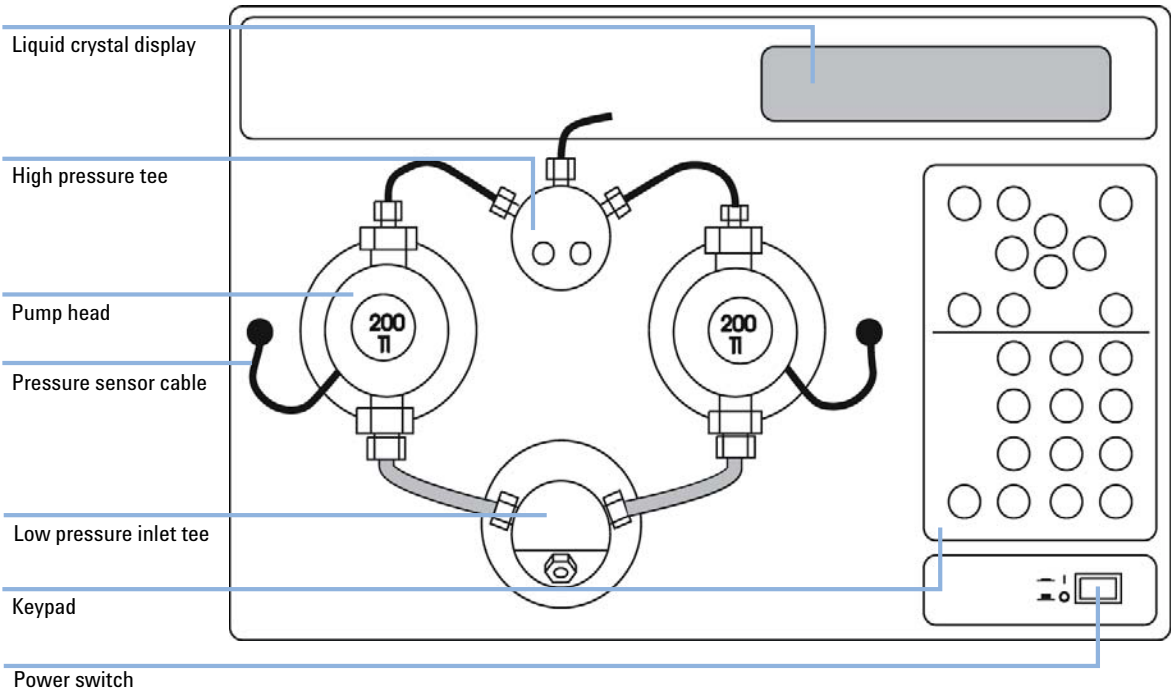


Figure 1 Agilent SD-1 Isocratic Solvent Delivery Module – front view

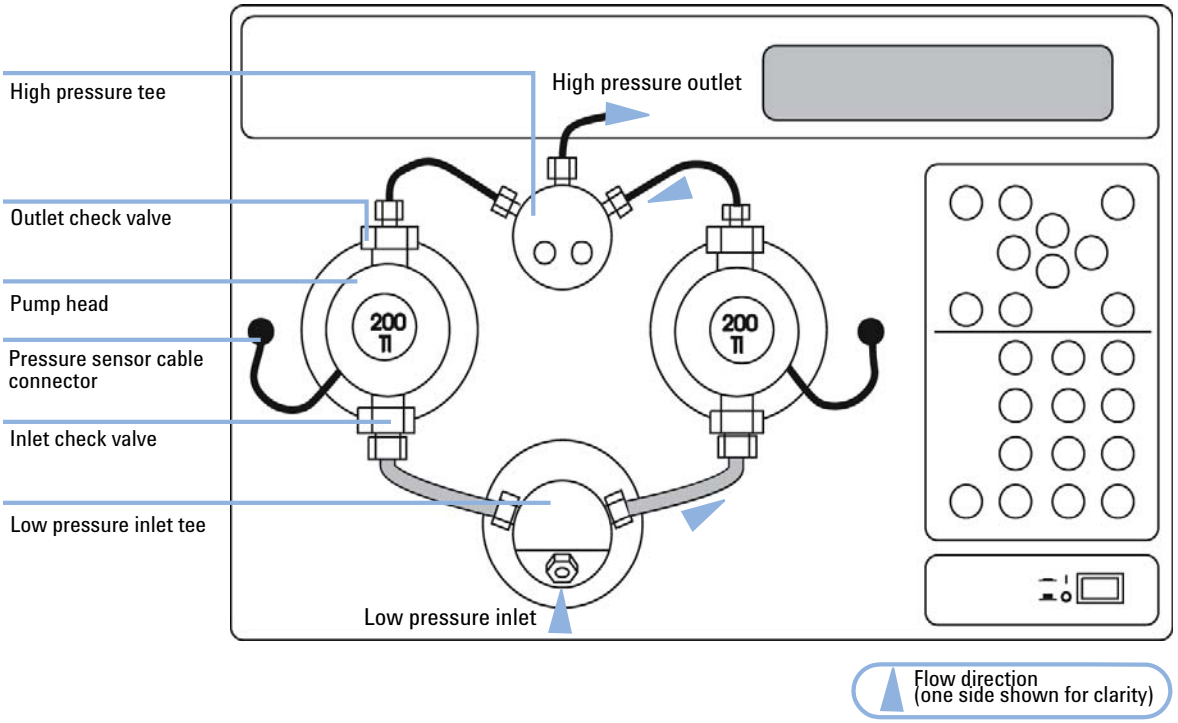


Figure 2 Agilent SD-1 Isocratic Solvent Delivery Module – liquid end detail

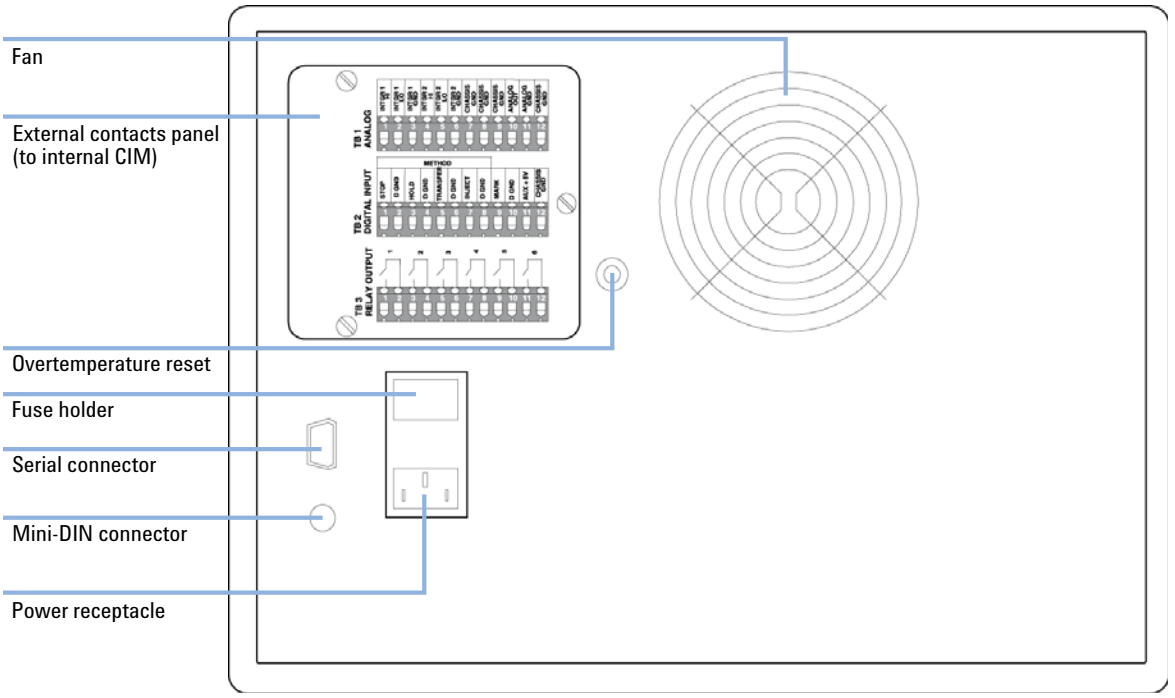


Figure 3 Agilent SD-1 Isocratic Solvent Delivery Module – rear panel

Table 1 Rear panel

Component	Function
Fan	Cooling fan draws cooling air into back of pump, blows warm air out of bottom of pump.
External contacts panel	Contains three terminal blocks (TB): • TB-1 Analog • TB-2 Digital input • TB-3 Relay output
Overtemperature reset switch	Safety feature cuts power to the SD-1 in case of overheating. The reset switch pops out. Restore power to the pump by pressing the reset switch back in place.
Fuse holder	Holds two fuses.
Serial connector	Miniature D-connector used only for remote pump control by compatible PC software.
Mini-DIN connector	8-pin miniature connector.
Power receptacle	Accepts standard grounded AC power cord.

Check Valves

The pump head has one inlet check valve and one outlet check valve.

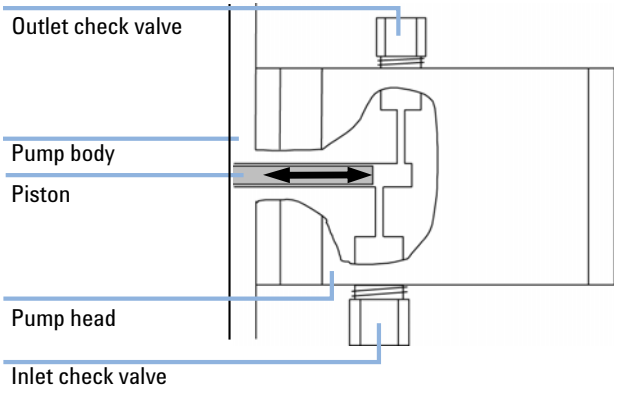


Figure 4 Cutaway view pump head

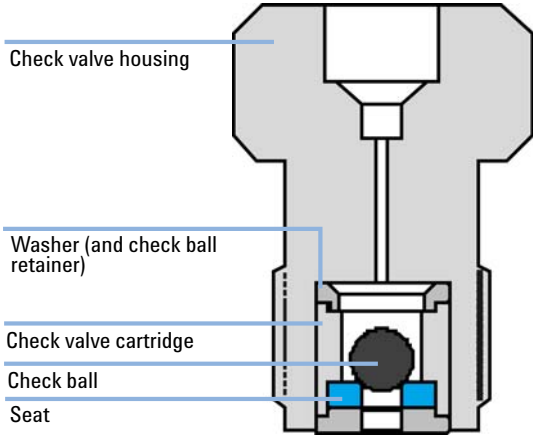


Figure 5 Outlet check valve – sectional view

Principle of Operation

The retracting piston creates a negative pressure in the piston chamber above the inlet check valve. Mobile phase flows upward past the check ball into the inlet check valve, then into the piston chamber.

As soon as the piston starts to move forward, gravity causes the ball in the inlet check valve to seat, preventing mobile phase from flowing back out the inlet check valve. At the same time, a positive pressure is created in the piston chamber which dislodges the outlet check valve check ball. Mobile phase flows upward through the outlet check valve while the piston is moving forward.

When the piston retracts again, gravity causes the ball in the outlet check valve to seat, preventing mobile phase flowing back out the outlet check valve, and the cycle is repeated.

NOTE During manufacture, each check valve is closely inspected and then individually assembled in a clean-room. Check valves should be kept clean and in good condition for reliable, reproducible flow.

Control

Keypad

Figure 6 Keypad

Table 2 Control keys

Key	Function
FLOW	**FLOW** opens the **Flow** window where the flow rate and ramp time are set. Maximum flow rate depends on the head size in use; maximum ramp time is 9999.99 min.
PRESS	**PRESS** opens the **Pressure** window where several pressure conditions can be set: Maximum pressure, pump action when maximum pressure is reached, minimum pressure, pressure units and analog pressure signal on/off.
~	~ opens the **Setup** and **Service Log** menus. The **Setup** menu is used to start the head change sequence, set the Pump ID, the CIM ID, and to set the internal clock. The Service log is used to log piston seal changes, check valve changes/service intervals, and show the pump drive status.
UP/DOWN ARROWS	**UP/DOWN ARROWS** are used to scroll up or down through preset values or toggle between choices. The **DOWN ARROW** key is also used to open menus.
LEFT/RIGHT ARROWS	**LEFT/RIGHT ARROWS** are used to move right and left in the display to access adjacent menus or values.
RUN	**RUN** starts the ramp to the flow rate set in the **FLOW** window. The ramp time is set in the **FLOW** window.
HOLD	**HOLD** keep the ramp at its current position. The time into ramp is displayed, with the flow rate and current pressure. This key is canceled by pressing **RUN**.
STOP	**STOP** cuts off the flow immediately.
Numeric keys	Used to set numeric values: flow rate, minimum and maximum pressure, ramp time, pump ID, CIM ID, date and time.
CLEAR	**CLEAR** cancels user-entered value or choice, leaving the previously entered setting intact. Also used when changing heads.
ENTER	**ENTER** accepts a new value or choice. Also used when changing heads.
Power switch	**Power switch** turns power to the pump on or off. Connected directly to the power module on the rear panel.

Cursors

In the Agilent SD-1 displays, parameters which can be edited are indicated by one of four types of cursor. All types of cursors flash both sides of the parameter to be edited. Each type of cursor has a specific function.

Table 3 Specific cursor functions

Cursor	Name	Function
- -	NUMERIC ENTRY CURSOR	Used for numeric entry only. Values entered or edited while the cursor is flashing are temporary until accepted by pressing the **ENTER** key, the **RIGHT ARROW** key, the **LEFT ARROW** key, or the **RUN** key. If the edited value is not accepted by pressing one of the above keys, or cancelled by pressing the **CLEAR** key, the parameter reverts to its previous value after 60 seconds.
↓↑	SCROLL CURSOR	Used when there is a preset list of choices. Pressing the **UP ARROW** or the **DOWN ARROW** with this type of cursor is displayed scrolls up or down through the preset choices.
??	DUAL-MODE CURSOR	Used when there is a preset list and numeric entry. Used when the value can be set either by numeric entry or by scrolling through a preset list of choices, as described above.
| |	MENU CURSOR	Used when the selection is a menu. Pressing the **DOWN ARROW** or the **ENTER** key with this type of cursor displays the next level of the menu.

NOTE

The following are not cursors, but are described here for clarity.

*	ASTERISK	Used to show cursor position (for accessing HELP) when the parameter in question is a status indicator and cannot be edited.
←→	LEFT-RIGHT ARROWS	These indicators are used at the right or left edge of the display to indicate that more information can be seen by pressing either the **RIGHT** or **LEFT ARROW** key.

Home Display

The **Flow** display is also the home display. This display shows when the SD-1 starts up and can be accessed at any time by pressing the **FLOW** button. The top line of the display always shows current flow rate and pressures.

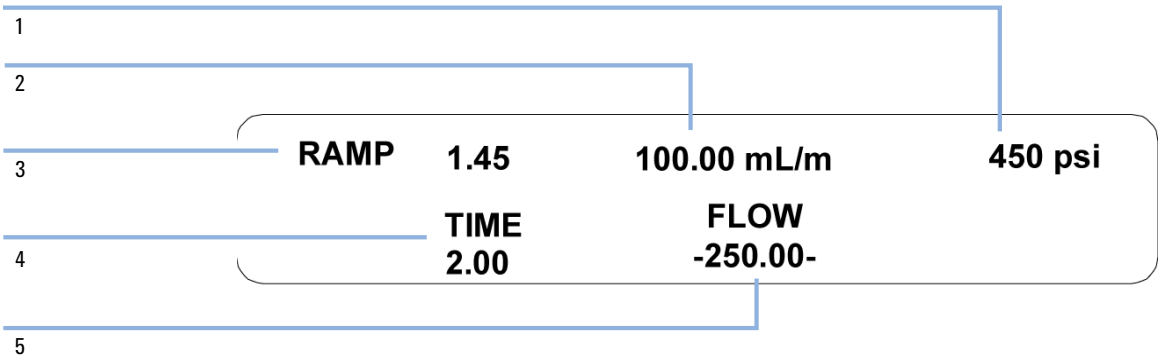


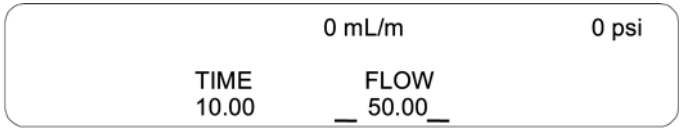
Figure 7 Home/flow display

Table 4 Structure of the home display

Area	Display
1	This area of the display shows the current state of operation (if any). Time is shown when ramping. **Stop** The pump is stopped because: • the **STOP** button has been pressed, or • a stop signal has been sent from the software, or • a pressure limit — stop action has been received, or • zero flow rate has been programmed. **Ramp** The **RUN** button has been pressed and the pump is ramping to a new value. The elapsed ramp time is also shown in this area. **Hold** The **HOLD** button has been pressed and the ramp has been interrupted. The pump continues at the flow rate reached when the **HOLD** button was pressed. The **HOLD** state can be canceled by pressing **RUN** or **STOP**.
2	Current flow rate is shown here.
3	Current system pressure is shown here.
4	Ramp time is set here, in minutes decimal format, (for example, 2 min15 s is set as 2.25). Ramp time is the time for a linear change from current to new flow rate.
5	The flow rate is set here. (–xxx.xx — indicates active cursor). Legal flow rates are from zero to the maximum for the pump head installed (200 , 500 , 800 or 3200 mL/min).

Main Displays

The main displays are accessed by pressing the function buttons on the front panel.



Use this display to set the flow rate and ramp time. Legal flow rates are from zero to the maximum for the pump head installed (200 , 500 , 800 or 3200 mL/min). Ramp time (in minutes; decimal format) is the time for a linear change from the current to the new flow rate. Legal ramp times are from 0.00 to 9999.99 min.

Pressing the **PRESS** key opens the **Pressure** display.

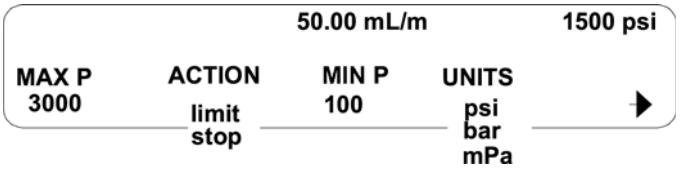


Figure 8 Pressure display 1

To reach the rest of this display, press the **RIGHT ARROW** key (indicated by the small arrow in the lower right corner). To reach the first part of the display again, press the **LEFT ARROW** key.

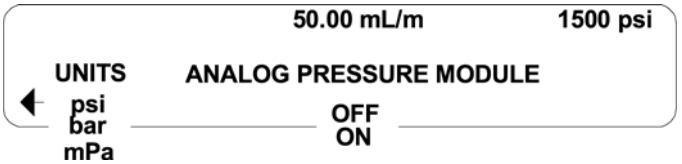


Figure 9 Pressure display 2

The main displays sets:

- **MAX P**: Maximum pressure
- **ACTION**: When maximum pressure is reached limit flow to maintain the maximum pressure, or press **STOP** to stop the pump
- **MIN P**: Minimum pressure;

Pressure below which the pump will stop – must go for about 10 s then stay below for 0.5 s to stop

- **UNITS**: Pressure units psi, bar or MPa
- **ANALOG PRESSURE MONITOR**: **ON** or **OFF**;

  Sends an analog signal (1000 psi/V) to an external pressure monitor, if the instrument control software is not controlling the detector wavelength through the ANALOG OUT contacts on the SD-1.

When controlling detector wavelength, the instrument control software may override this control. The SD-1 may need to be switched off and on to release the override.

Special displays

Pressing the ~ key opens the **Special** display, to access the **SETUP** and **SERVICE LOG** menus.

SETUP Display

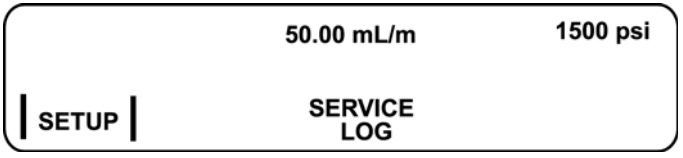


Figure 10 Special display

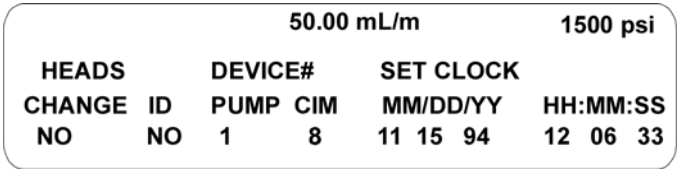


Figure 11 SETUP display

The **SETUP** menu sets:

- **HEADS**
  - **HEADS CHANGE**: Start the software-driven procedure to change pump heads.
  - **HEADS ID**: Display the size of pump head installed and pressure maximum.
- **DEVICE#**
  - **DEVICE# PUMP**: Set the ID number for the pump. (When under the control of instrument control software, each device in the HPLC system must have a unique ID number.)
  - **DEVICE# CIM**: Set the ID number for the built-in control interface.
- **SET CLOCK**
  - **SET CLOCK MM/DD/YY**: Set month/day/year with numeric keys.
  - **SET CLOCK HH:MM:SS**: Set hour/minute/second with numeric keys.

SERVICE LOG display

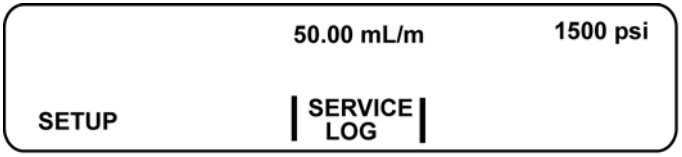


Figure 12 Special display

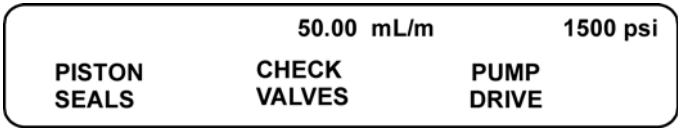


Figure 13 SERVICE LOG display

The **SERVICE LOG** menu opens three log displays:

- Piston seal log
- Check valves log
- Pump drive log

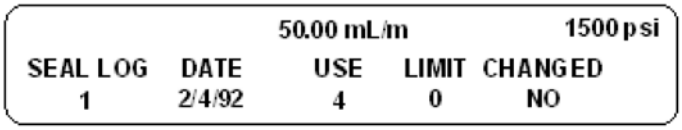


Figure 14 Piston seal log display

The piston seal log shows:

- **SEAL LOG**: Sequential number of last seal change. Previous log entries can be scrolled by pressing the **UP ARROW**.
- **DATE**: Date of last seal change.
- **USE**: Use units since last seal change. Use units are proportional to number of strokes and pump pressure.
- **LIMIT**: Number of units before another seal change. Set by user, depending on anticipated amount of use.
- **CHANGED**: Scroll to **YES** when seal change is performed.

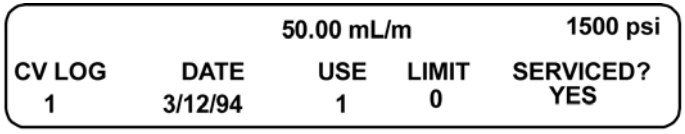


Figure 15 Check valve log display

The check valve log shows:

- **CV LOG**: Sequential number of last check valve service. Previous log entries can be scrolled by pressing the **UP ARROW**.
- **DATE**: Date of last check valve service.
- **USE**: Use units since last check valve service. Use units are proportional to number of strokes.
- **LIMIT**: Number of units before another service. Set by user, depending on anticipated amount of use.
- **SERVICED?**: Scroll to **YES** when check valve is serviced.

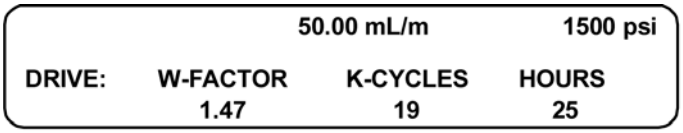


Figure 16 Pump drive log display

The pump drive log shows:

- **W-FACTOR**: Wear factor proportional to pressure.
- **K/CYCLES**: Number of piston strokes/1000.
- **HOURS**: Cumulative hours pump has been operating.

2
Site Requirements and Specifications

This chapter provides information on environmental requirements, physical and performance specifications.

Site Requirements

A suitable environment is important to ensure optimal performance of the instrument.

Power Considerations

The instrument power supply has wide ranging capability. It accepts any line voltage in the range described in *Physical Specifications*.

WARNING

Hazard of electrical shock or damage of your instrumentation

can result, if the devices are connected to a line voltage higher than specified.

➔ Connect your instrument to the specified line voltage only.

CAUTION

Inaccessible power plug.

In case of emergency it must be possible to disconnect the instrument from the power line at any time.

➔ Make sure the power connector of the instrument can be easily reached and unplugged.

➔ Provide sufficient space behind the power socket of the instrument to unplug the cable.

Power Cords

Different power cords are offered as options with the module. The female end of all power cords is identical. It plugs into the power-input socket at the rear. The male end of each power cord is different and designed to match the wall socket of a particular country or region.

WARNING

Absence of ground connection or use of unspecified power cord

The absence of ground connection or the use of unspecified power cord can lead to electric shock or short circuit.

➔ Never operate your instrumentation from a power outlet that has no ground connection.

➔ Never use a power cord other than the Agilent Technologies power cord designed for your region.

WARNING

Use of unsupplied cables

Using cables not supplied by Agilent Technologies can lead to damage of the electronic components or personal injury.

➔ Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.

WARNING

Unintended use of supplied power cords

Using power cords for unintended purposes can lead to personal injury or damage of electronic equipment.

➔ Never use the power cords that Agilent Technologies supplies with this instrument for any other equipment.

Bench Space

The module dimensions and weight (see Table 7 on page 28) allow you to place the module on almost any desk or laboratory bench.

It needs an additional 5 cm (2 in) of space on either side and approximately 15 cm (5.9 in) at the rear for air circulation and electric connections.

If the bench shall carry a complete HPLC system, make sure that the bench is designed to bear the weight of all modules.

The module should be operated in a horizontal position.

Condensation

CAUTION

Condensation within the module

Condensation will damage the system electronics.

➔ Do not store, ship or use your module under conditions where temperature fluctuations could cause condensation within the module.

➔ If your module was shipped in cold weather, leave it in its box and allow it to warm slowly to room temperature to avoid condensation.

Physical Specifications

Table 5 Specifications Agilent SD-1 Purification Solution

Type	Specification
Rated voltage	100 – 240 VAC (90 – 264 Absolute), 50 – 60 Hz
Weight	34 kg(75 lbs)
Dimensions (height x width x depth)	267 x 406 x 559 mm (10.5 x 16 x 22 in)
Power consumption	1000 VA
Ambient operating temperature	4 – 40 °C
Humidity	20 – 80 %
Operating altitude	up to 2000 m
	The module is suitable for indoor use only and is classified Pollution degree 2 and Installation Category II (EN 61010-1).

Software Version for Interchangeable Pump Heads

Table 6 Software requirements for interchangeable pump heads

Pump head	Software version
200 mL/min and 800 mL/min	all software revisions
500 mL/min	Rev 2.0.N or above
3.2 L/min	Rev 2.1.G or above

Performance Specifications

Table 7 Performance specifications Agilent SD-1 Purification Solution

Type	Specification
Display	Backlit LCD with 4 lines, 160 characters

Interface	• 1 digital serial input/output channel (RS-422)
	• 6 contact-closure relay outputs (1 A, 24 V)
	• 5 high-speed CMOS contact-closure logic inputs
	  • high: 3.5 – 6.5 V
	  • low: –1.5 – 1 V1.5
	  • max. input voltage 25 V
	  • min. input voltage –20 V
	  • min. on time for recognition 48.9 ms
	• 1 programmable analog (D to A) output (0 – 10 V)
	• 12 bit
	• Absolute maximum error ±4.1 mV
	• Test load impedance 100 kΩ
	• 2 analog (A to D) inputs (–0.5 – 2.5 V)
	• 60 Hz max. sample rate combined

CPU Board Voltages	• 5 V (4.75 – 5.25 V) • –15 V • 15 V • 48 V
RAM Backup Battery Voltage	• 3.1 – 3.3 V

Table 8 Pressure limits pump heads

Nominal flow	Range	Maximum pressure	Maximum pressure
200 mL/min	0.01 – 200 mL/min	41.4 MPa 414 bar	6000 psi
500 mL/min	0.02 – 500 mL/min	17.2 MPa 172 bar	2500 psi

Table 8 Pressure limits pump heads

Nominal flow	Range	Maximum pressure	Maximum pressure
800 mL/min	0.02 – 800 mL/min	10.3 MPa 103 bar	1500 psi
3.2 L/min	0.1 – 3200 mL/min	2.6 MPa 26 bar	375 psi

Table 9 Performance specifications pressure modules

Pump head	Material in fluid contact	Inlet fittings (flatbottomed)	Outlet fittings (ferrule)
200 mL/min	Titanium, sapphire, ruby, FEP, PEEK, ETFE, UHMWPE, NiMo28, TZP Zirconia	½—13 in	¼—28 in
500 mL/min	Titanium, sapphire, ruby, FEP, PEEK, ETFE, UHMWPE, NiMo28, TZP Zirconia	½—13 in	¼—28 in
800 mL/min	Titanium, sapphire, ruby, FEP, PEEK, ETFE, UHMWPE, NiMo28, TZP Zirconia	½—13 in	¼—28 in
3.2 L/min	Titanium, sapphire, ruby, FEP, PEEK, ETFE, UHMWPE, NiMo28, TZP Zirconia	½ in	¼ in

3
Installation

This chapter gives information about the installation of your instrument.

Installation

For details on installation of the module, refer to Agilent SD-1 Purification Solution - System Manual (G9302-90301).

4
Using the SD-1 Solvent Delivery Module

This chapter explains the operational parameters of the instrument.

Hints for Successful Use of the Pump

- Use only HPLC-grade solvents. Impurities present in other solvents may clog the frits in the check valves and column. Always use a solvent inlet filter, to prevent particulate material from entering the Agilent SD-1 and clogging the frits.
- The Agilent SD-1 piston washing feature is useful when using high-salt buffers. Piston washing prevents salt crystallization behind the seal. If salt residues were to accumulate, seal life would be greatly reduced (see “Cleaning Check Valves” on page 95).
- As well as washing the pistons, after using high-salt buffers always pump at least 50 mL of HPLC-grade water through the pumping system to flush away salt deposits from the pump heads and outlet lines.
- Never let the Agilent SD-1 stand overnight with high-salt buffer solution in the pump heads. If this should happen, it is important to wash the pistons and flush the pump heads with water at a low flow rate before starting work.
- Do not change directly between immiscible solvents; any resulting precipitation would be extremely difficult to remove from the pump heads, check valves, and tubing (see “Solvent Miscibility” on page 120). If the solvent you wish to use is immiscible with the solvent in the system change to it via another solvent (or a series) that is miscible with both.
- Always use the Agilent SD-1 pressure-limiting feature to protect the HPLC column from overpressure which could damage the column and impair performance (see “Setting the Maximum Pressure” on page 44). The dynamic pressure is always shown in the top line of the display. It is good practice to monitor this value and be prepared to stop the pump should pressure rise rapidly.

- Always use the ramp time feature when changing flow rates, especially if there is a large change. A ramp is a linear change from the current flow rate to the new flow rate, over the set duration. The Agilent SD-1 can handle large abrupt changes in flow rate without any problem, but the HPLC column may be damaged by pressure shock resulting from such abrupt changes.
- If the flow rate ramp up is very rapid or the outlet plumbing is suddenly blocked, for instance by the operation of the sample inject valve, a pressure spike well in excess of the set pressure limit may be generated. This spike may even exceed the capacity of the outlet tubing and/or fittings.

Introduction

The Agilent SD-1 Purification Solution can be used in several different modes of operation, including operation as a master pump in an automated HPLC system. This section explain how to use the LC system if the SD-1 pump is configured as master controller. If your LC system is controlled by OpenLAB CDS ChemStation as master controller, please refer to the OpenLAB CDS online help system.

NOTE If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Power On

1 Press the power switch on each module.

The following display is screened and a diagnostic check begins. **OK** appears when the check is complete.

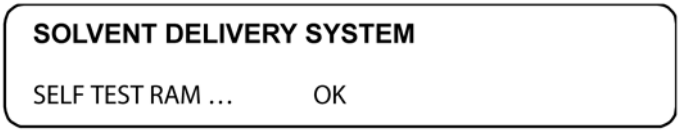


Figure 17 Diagnostic display

2 The **Diagnostic** display disappears. This flow display is used to set flow rate: it can be accessed at any time by pressing the **FLOW** button.

The **Flow** display is displayed.

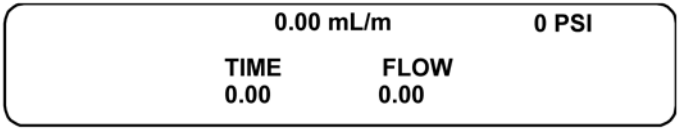


Figure 18 Flow display

Initial Operation

Switching on the Instrument

1 Press the power switch.

The following display is screened and a diagnostic check begins. **OK** appears when the check is complete.

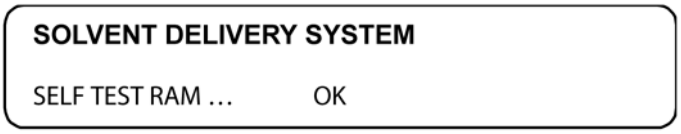


Figure 19 Diagnostic display

2 The **Diagnostic** display disappears. This flow display is used to set flow rate: it can be accessed at any time by pressing the **FLOW** button.

The **Flow** display is displayed.

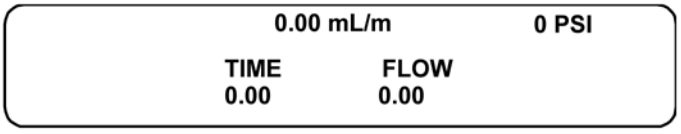


Figure 20 Flow display

Editing the Flow Rate

1 Press the **RIGHT** or **LEFT ARROW** to move the cursor on the **FLOW** field.

NOTE

The values used in the following procedure assume that a 200 mL/min pump head is in use.

- For 500 mL/min pump heads multiply the flow values by 2.5.
- For 800 mL/min pump heads multiply the flow values by 4.
- For 3.2 L/min pump heads multiply the flow values by 16.

2 To set the flow rate, type in the desired value and confirm with **ENTER**. For example set the flow rate to 40 mL/min, type in 40 and confirm with **ENTER**.

Editing the Ramp Time

1 Press the **RIGHT** or **LEFT ARROW** to move the cursor on the ramp **TIME** field.

2 To set the ramp time, type in a decimal value and confirm with **ENTER**.

Start Pumping

1 Press the **RIGHT** or **LEFT ARROW** to move the cursor on the ramp **TIME** field.

2 To set the ramp **TIME** to 30 s, type in .5 and confirm with **ENTER**.

3 Press the **RIGHT ARROW** to move the cursor on the **FLOW** field.

4 To set the flow rate to 25 mL/min, type in the 25 and confirm with **ENTER**.

5 Press **RUN** to start the pump.

You will hear the pump begin its 30 s ramp, and on the top line of the display you can see flow and pressure values increasing. The elapsed ramp time will also be shown.

Changing the Flow

1 Press the **RIGHT** or **LEFT ARROW** to move the cursor on the **FLOW** field.

2 To set the flow rate to 45 mL/min, type in 45 and confirm with **ENTER**.

3 Press the **LEFT ARROW** to move the cursor on the **TIME** field.

4 To set the ramp **TIME** to 1 min, type in 1 and confirm with **ENTER**.

5 Press **RUN** to start the pump.

You will hear the pump begin its 1 min ramp, and on the top line of the display you can see flow and pressure values increasing. The elapsed ramp time will also be shown.

6 After 15 – 20 s, press **HOLD**.

The pump continues pumping at the flow reached when the **HOLD** key was pressed. The “frozen” elapsed ramp time, flow, and pressure values are displayed. **HOLD** is shown.

7 Press **RUN** to restart the pump.

The pump will start a new 1 min ramp from current flow to the set flow (45 mL/min).

8 After 15 – 20 s, press **STOP**.

The pump stops immediately. Pressing **STOP** always stops the pump and overrides any other key press or remote input. Flow will be zero.

Maximum Flow Test

WARNING

Leaking solvents

Damage to the instrument or injury due to toxic, corrosive or stimulative solvent.

➔ Make sure that the outlet tee connection is tightened ¼-turn past finger-tight and the other end of the outlet tubing is firmly taped into the solvent reservoir.

1 Press the **RIGHT** or **LEFT ARROW** to move the cursor on the **FLOW** field.

2 To set the flow rate for example for the 200 mL/min pump head, type in 200 and confirm with **ENTER**.

3 Press the **LEFT ARROW** to move the cursor on the **TIME** field.

4 To set the ramp **TIME** to 1 min, type in 1 and confirm with **ENTER**.

5 Press **RUN** to restart the pump.

The pump will start a 1 min ramp to maximum flow. You will hear the pump motors wind up and will see the flow and pressure indicators rapidly changing. You should see the solvent streaming into the solvent reservoir.

6 Press **STOP** to stop the pump immediately.

Operation

Flushing the HPLC System

Before pumping solvent through an HPLC system, it is important to flush all tubing to prevent impurities or particulates from the new tubing (such as dust, cutting oils, metal swarf, etc.) from clogging the column frit or contaminating the column.

WARNING

Chemical Hazard

➔ Danger of burns. To avoid injury to personnel or damage to equipment, always follow appropriate safety guidelines when using chemicals and always wear appropriate safety equipment and clothing.

1 Disconnect the tubing fitting at the column inlet and place the fitting into a waste container. It is vital that the tubing is thoroughly flushed before flow is introduced to the column.

2 To set the **FLOW** to 15 mL/min on each Agilent SD-1 pump, press 15 and confirm with **ENTER**.

3 Press **RUN** to start each pump.

4 Pump solvent through the tubing for several minutes.

The tubing is thoroughly flushed before flow is introduced to the column.

Checking for Leaks Against System Backpressure

So far the pump has been operated without solvent flowing through the column. Before using the Agilent SD-1 pump in actual chromatography you should check all connections for leaks by pumping against column backpressure.

1 Immerse the solvent inlet filter into a suitable HPLC-grade solvent for the column in use. Ensure that the solvent is miscible with the last-used solvent (water if you have followed the procedures so far in this manual). If the

solvent you wish to use is not miscible with the last-used solvent, change via an intermediate solvent(s) miscible to both.

2 For each Agilent SD-1, ensure that the outlet fitting at the outlet tee has been tightened to ¼-turn past finger-tight.

3 Make sure that all connections in the HPLC system downstream of the pump are tightened to ¼-turn past finger-tight.

4 With all connections checked, switch the drain valve so that the flow is directed to the column.

5 Ensure that the effluent from the column or detector is directed to waste.

6 To set the medium flow rate, type in 40 mL/min for 200 mL/min pump heads and confirm with **ENTER**.

OR

To set the medium flow rate, type in 200 mL/min for 500 mL/min pump heads and confirm with **ENTER**.

OR

To set the medium flow rate, type in 160 mL/min for 800 mL/min pump heads and confirm with **ENTER**.

OR

To set the medium flow rate, type in 640 mL/min for 3.2 L/min pump heads and confirm with **ENTER**.

7 Press the **LEFT ARROW** to move the cursor on the **TIME** field.

8 To set the ramp **TIME** to 30 s, type in .5 and confirm with **ENTER**.

9 Press **RUN** to start the pump.

The **FLOW** and pressure values on the top line of the display increase.

10 Check all fittings for leaks, especially at the outlet check valves and outlet tee.

11 If no leaks are seen, let the pump continue for several minutes. Press **STOP** to stop the pump(s).

12 If you notice any leaks, stop the pump(s) by pressing the **STOP** key. Tighten the affected fitting by 1/8-turn, and start the pump again.

OR

If the fitting still leaks, slow the pump(s) to a low flow rate and tighten the fitting by another 1/8 turn.

Continue in this manner until the fitting no longer leaks.

Setting the Maximum Pressure

In the Agilent SD-1, the maximum pressure control can be programmed to either stop the pump or limit the flow when the set pressure is reached. The minimum pressure below which the pump will stop can also be programmed. To set the maximum and minimum pressure:

1 Press the **PRESS** key.

2 Press the **RIGHT** or **LEFT ARROW** to move the cursor on the **MAX P** field.

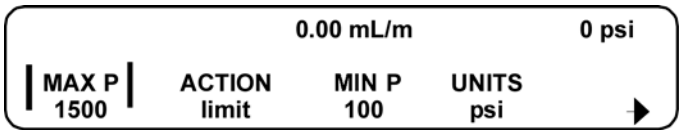


Figure 21 Pressure display

3 Set an appropriate maximum pressure for your HPLC column using the numeric entry keys and the **ENTER** key. If you make a mistake or want to change maximum pressure, simply re-enter the correct value.

When using very high flow rates (greater than 75 % of the head size) with the 200 , 500 and 800 mL/min liquid heads, the maximum pressure will be limited (see "Maximum Pressure versus Flow" on page 54). If you set **MAX P** in this window too high, an alert message will display the maximum pressure available with the flow rate set.

4 To move the cursor to the **ACTION** field, press the **RIGHT ARROW** key.

5 To select the action required (**limit** or **stop**), press the **DOWN ARROW** key.

Selecting **stop** will stop the module. **Limit** will automatically reduce the flow from the set level to prevent the pressure limit from being exceeded.

NOTE

For Good Laboratory Practices (GLP) and gradient operation it is recommended to use **stop** for the maximum pressure action. A stop signal from the maximum pressure action will stop the run and the pressure limit situation will be recorded. If **limit** were used for the maximum pressure action, the run would continue with no recorded warning for the limit action. Composition would be unreliable in this situation.

6 To move the cursor to the **MIN P** field, press the **RIGHT ARROW** key.

7 Press the **DOWN ARROW** key, to set the minimum pressure to a value below which you want the pumps to stop.

If the system develops a leak or the solvent reservoir runs dry, the pumps will stop. It is good safety practice to use this feature.

8 To change the pressure units, move the cursor to the **UNITS** field by pressing the **RIGHT ARROW** key.

   a Scroll through the units with using the **DOWN ARROW** key. The units are: psi, bar, and MPa.

9 To move the cursor to the **ANALOG PRESSURE MONITOR** and to reach the hidden part of the display, press the **RIGHT ARROW** key.

   The **ANALOG PRESSURE MONITOR** allows to send an analog pressure signal to a suitable device. (Not available with all instrument control software programs to control the pumping system.)

Removing the Pump Head

When

The pumps are shipped without the pump head installed. You will have to install the pump head before beginning to run. You can also change pump heads at any time.

Tools required

Description
Wrench, open-ended, 5/16 inch
Wrench, open-ended, ½ inch
Wrench, 9/64 inch hexagonal, T-handle
Wrench, 5/32 inch hexagonal, T-handle
Wrench, 3/16 inch hexagonal, T-handle

Preparing the removal in the menu

1 To stop the module, press the **STOP** key.

   Do not switch off the Agilent SD-1; power must be on for the heads to be removed.

2 To release pressure from the HPLC system, open the drain valve.

3 To open the **SETUP** menu, press the ~ key.

Figure 22 Special display

4 Press the **DOWN ARROW** key to access the setup functions.

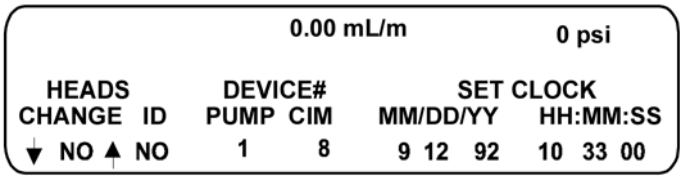


Figure 23 SETUP display

5 Place the cursor on **HEADS CHANGE** and press the **DOWN ARROW** key to scroll to **YES**.

The following message will be displayed:

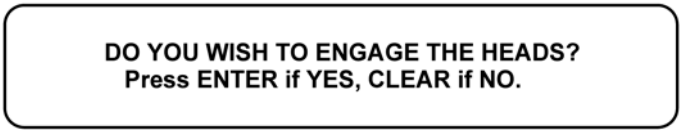


Figure 24 Engage the heads change

6 To confirm the pump head removal, press **ENTER**.

The following message will be displayed:

Figure 25 Removing mounting parts

7 Remove the pump heads as a complete assembly as described in the following procedure.

OR

Disconnect the tubing from the inlet and outlet check valves.

Disassembling the pump head

1 Remove the high pressure fitting at the outlet tee using a 5/16 inch open-ended wrench.

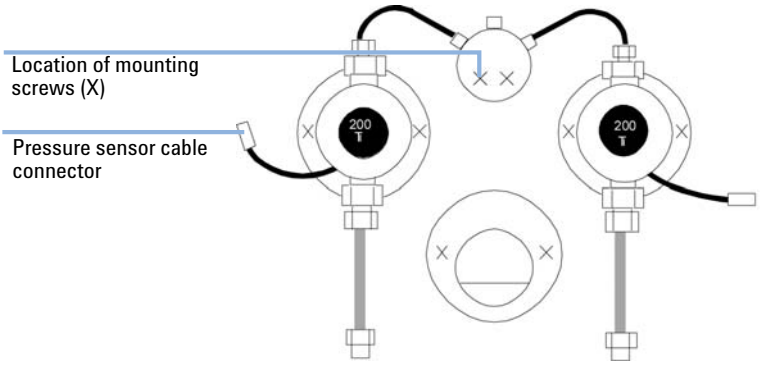


Figure 26 Pump head set

2 Cap the outlet tee with the cap you removed during initial installation.

3 Remove the solvent inlet fitting at the inlet tee with a ½ inch open-ended wrench.

4 Cap the inlet tee with the cap you removed during initial installation.

5 Remove the other two fittings in the inlet tee, for access to the mounting screws. Leave the tubing attached to the inlet check valves.

6 To disconnect each pressure sensor cable from the socket on the front panel, grasp the knurled collar and pull it back gently.

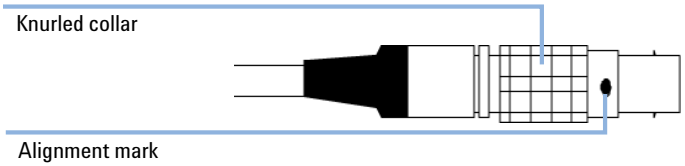


Figure 27 Pressure sensor cable connector

You will feel a slight “give” as the spring-loaded ring is pulled back, then the connector will disengage.

NOTE Do not pull the cable or any part of the connector except the knurled ring.

7 Remove the two mounting screws in the outlet tee with a 9/64 inch T-handle wrench.

   a Put the mounting screws aside for mounting the replacement pump head set.

8 Remove the two mounting screws in the inlet tee with a 5/32 inch T-handle wrench.

   a Put the mounting screws aside for mounting the replacement pump head set.

9 Remove the two mounting screws in both pump heads with a 3/16 inch T-handle wrench. Put the mounting screws aside for mounting the replacement head set.

   a Put the mounting screws aside for mounting the replacement pump head set.

Preparation of removing the pump head is completed. The Agilent SD-1 software can disengage the heads.

Starting the disengagement sequence

1 Press **ENTER** to confirm the removal of mounting screws and support the weight of the pump heads during disengagement.

After pressing **ENTER**, the disengagement sequence will start. One at a time the pump heads will be pushed out from the front panel. When the heads are fully disengaged, the display will read as follows:

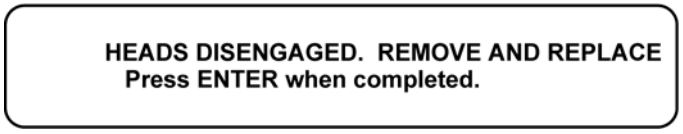


Figure 28 Disengaged heads

2 To remove each pump head, pull it away from the front panel and thereby overcome the slight resistance from the spring in the collet.

   a At the same time, remove the inlet and outlet tees.

   b Put the complete assembly aside.

Replacing the Pump Head

When

The pumps are shipped without the pump head installed. You will have to install the pump head before beginning to run. You can also change pump heads at any time.

Tools required

Description
Wrench, open-ended, 5/16 inch
Wrench, open-ended, ½ inch
Wrench, 9/64 inch hexagonal, T-handle
Wrench, 5/32 inch hexagonal, T-handle
Wrench, 3/16 inch hexagonal, T-handle

1 Take the replacement pump head set assembly and hold both heads in position, with the piston cups inside the open piston collets.

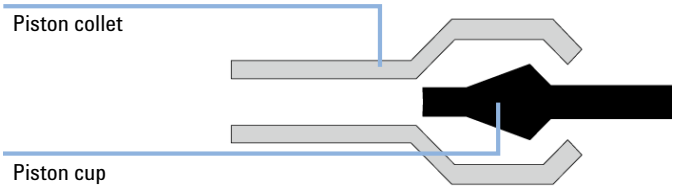


Figure 29 Piston cup and piston collet

2 To begin the pump head engagement sequence, press **ENTER**.

The collets will close over the piston cups and when fully closed will draw the pump heads into place. When both pump heads are in place the following message will appear: **Replace and tighten screws on both heads. Plumb connections. Press ENTER when completed.**

WARNING

Leaking out solvent

Injuries and damage to the instrument occurred due to solvent leaks if the pump is operated with not properly mounted pump heads.

➔ To prevent leaks it is extremely important that the mounting screws are properly attached before attempting to operate the instrument.

➔ Please observe appropriate safety procedures (for example saftey glasses, gloves and protective clothing) according to the safety data sheets when handling solvents.

3 Replace and tighten the mounting screws in each pump head with a 3/16 inch wrench.

4 Replace and tighten the mounting screws in the inlet tee with a 5/32 inch wrench.

5 Replace and tighten the mounting screws in the outlet tee with a 9/64 inch wrench.

6 Replace the low pressure inlet fitting in the inlet tee with the ½ inch open-ended wrench and tighten ¼-turn past fingertight.

7 Connect the inlet tubing (tee to inlet check valves).

8 Replace the high pressure outlet fitting in the outlet tee with the 5/16 inch open-ended wrench and tighten ¼-turn past finger-tight.

9 Press **ENTER** to confirm the mounting screws and plumbing are connected.

The following message will appear: **Plug in BOTH connectors. Press ENTER when completed.**

10 Connect the pressure sensor cables.

11 Press **ENTER** to complete the head replacement procedure.

The following display will read (with appropriate values for the actual head size):

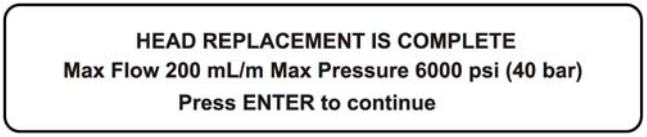


Figure 30 Pump head replacement

Priming the Pump Heads

All pump heads are self-priming.

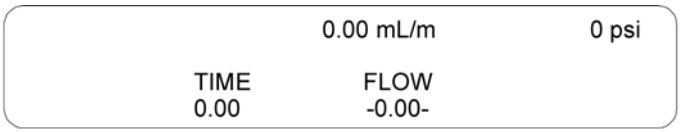
Preparations

- The detector is bypassed.
- If a prime purge valve is connected, open the prime purge valve to relieve the pressure.

1 Tighten the outlet tee fitting ¼-turn past finger-tight.

2 To switch on the pump power, press the power switch.

After a few moments the **Flow** display is displayed:



3 If the **Flow** field is not flashing, press the **RIGHT ARROW** key to get the cursor to the flow field.

4 To prime the 200 mL/min pump head, type in 150 and confirm with **ENTER**.

OR

To prime the 500 mL/min pump head, type in 400 and confirm with **ENTER**.

OR

To prime the 800 mL/min pump head, type in 600 and confirm with **ENTER**.

OR

To prime the 3.2 L/min pump head, type in 2000 and confirm with **ENTER**.

5 Start the pump by pressing **ENTER**.

The pump will start to run and solvent will be drawn into the solvent inlet line. After the inlet line is full, let the pump continue to run for a few moments until the pressure display is steady.

6 Press **STOP** to stop the pump.

The SD-1 pump is now primed.

7 Switch off the SD-1 by pressing the power switch.

Remote Control

This section provides a brief introduction to remote control by your instrument control software. For complete information you should also read the instrument control software manual.

1 Connect the Agilent SD-1 Solvent Delivery Module to your computer with the serial interface cable (see Agilent SD-1 Purification Solution - System Manual (G9302-90301)).

2 Connect the AC power cord and the external contacts panel (see Agilent SD-1 Purification Solution - System Manual (G9302-90301)).

3 Press the ~ key to open the **Special** display.

4 Press the **DOWN ARROW** key to open the **SETUP** display.

5 Press the **RIGHT ARROW** to move the cursor on the **DEVICE #** field.

For your instrument control software to control your pumps, each device must have a unique **DEVICE #** ID number. The ID numbers are shown on the bottom line, in this case **PUMP** ID is 1 and **CIM** ID is 8.

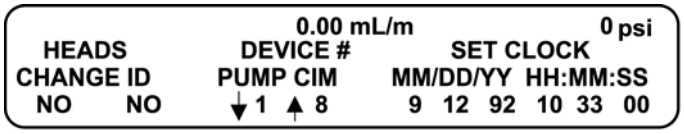


Figure 31 SETUP display

6 Set the **DEVICE #** as desired by scrolling with the **UP** or **DOWN ARROW** keys.

NOTE If you have two pumps, only one of the built-in CIM (Control Interface Modules) should be used if required. Set the second **CIM** ID number to – –, first enter a 63, and then press the **DOWN ARROW** key. Internal CIM ID number is set only when the internal CIM is used to start data collection or another instrument.

7 When you have set **DEVICE #** for all devices in your system, refer to your instrument control software manual for details on how to use remote operation and how to set up additional electrical connections, depending upon your particular system requirements.

For example connections for wavelength control of a detector, fraction collector contacts out, and so forth.

5
Optimizing Performance

This chapter gives hints on how to optimize the performance or use additional devices.

Maximum Pressure versus Flow

The following diagram shows the maximum pressure/flow curve for each size of pump head.

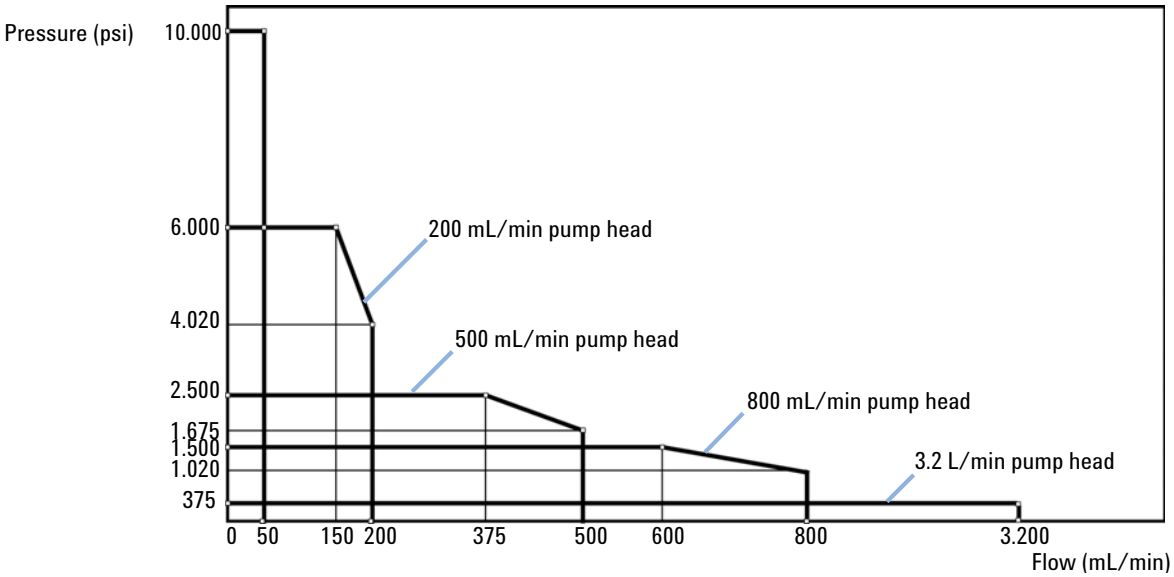


Figure 32 Maximum pressure and flow diagram

Scale-Up

Scientists and manufacturers are frequently faced with the dilemma of completely changing their method of sample purification when switching from analytical to preparative scale.

The Agilent SD-1 was developed to overcome the objections to prep-HPLC with high performance. High performance prep chromatography is accomplished with axial compression preparative columns, pulse-free high pressure pumps capable of up to 800 mL/min, and a unique UV detector. Now, both method development and preparative chromatography can be accomplished with 5 – 10 µm columns. There is no need to develop two methods and be satisfied with less resolution, capacity and throughput.

System Requirements for High Performance Prep Chromatography

High performance prep chromatography requires long lasting, high efficiency preparative columns and a properly designed HPLC system. Scaling-up HPLC pumps and detectors is not as direct as scaling-up a column. For example, pulsating pumps are common for analytical chromatography, but are not recommended as much for preparative chromatography. Pulsations can affect all columns and they can be largely dampened, but no one wants to potentially decrease the life of a prep column. For preparative columns a pulse-free pump is favored. There are three common ways to make a pulse-free pump. Peristaltic pumps can be used for low pressure, low flow rate applications, but are of little use for preparative chromatography. Syringe pumps will deliver even flow at high temperatures, but high flow rates and pressures for extended periods of time are not obtainable. The most feasible way to develop high pressure, pulseless flow with a wide flow range is with a dual piston pump where one starts to pump as the other stops pumping. Using stepper motors with pressure compensation feedback assures constant flow and pressure.

The pressure capacity for an Agilent SD-1 pump with 200 mL/min pump heads at increasing flow rates is presented.

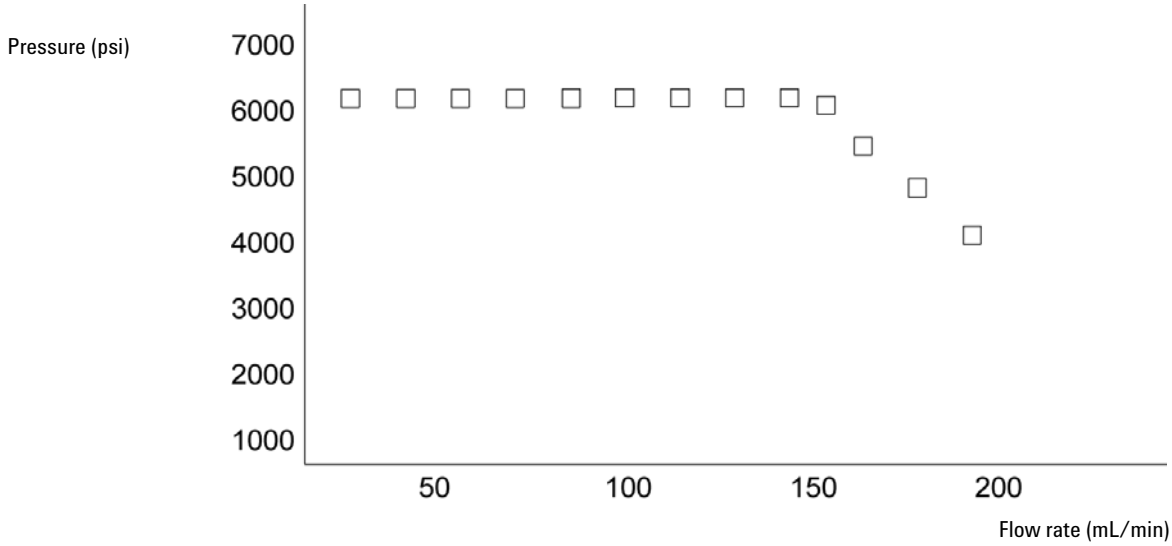


Figure 33 Pressure capacity and flow rate diagram

A pressure capacity of 6000 psi (410 bar) is maintained up to 150 mL/min where it decreases to 4000 psi (274 bar) by 200 mL/min - more than ample for HPLC.

Not only are high flow and pressure required for prep HPLC, linear flow and adequate mixing are also required for reproducible chromatography of proteins and peptides.

Agilent SD-1 pump with 200 mL/min heads works well at both high and low flow rates. The following figures reveals that excellent flow rate linearity for low flow rates is achieved, and just as important is the excellent flow reproducibility for flow rates from 80 – 150 mL/min.

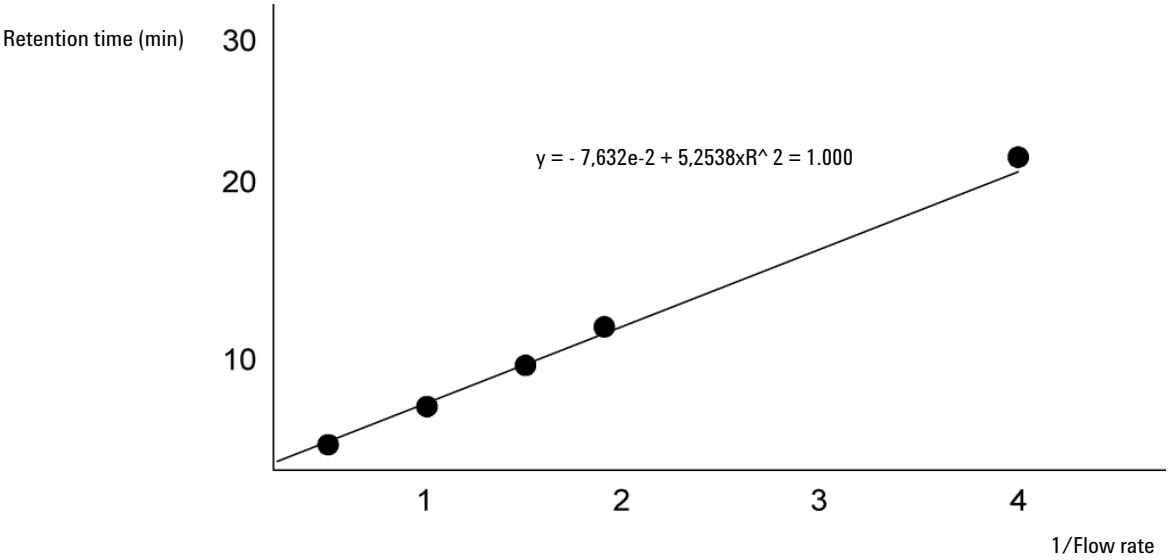


Figure 34 Retention time versus flow rate for low flow rates

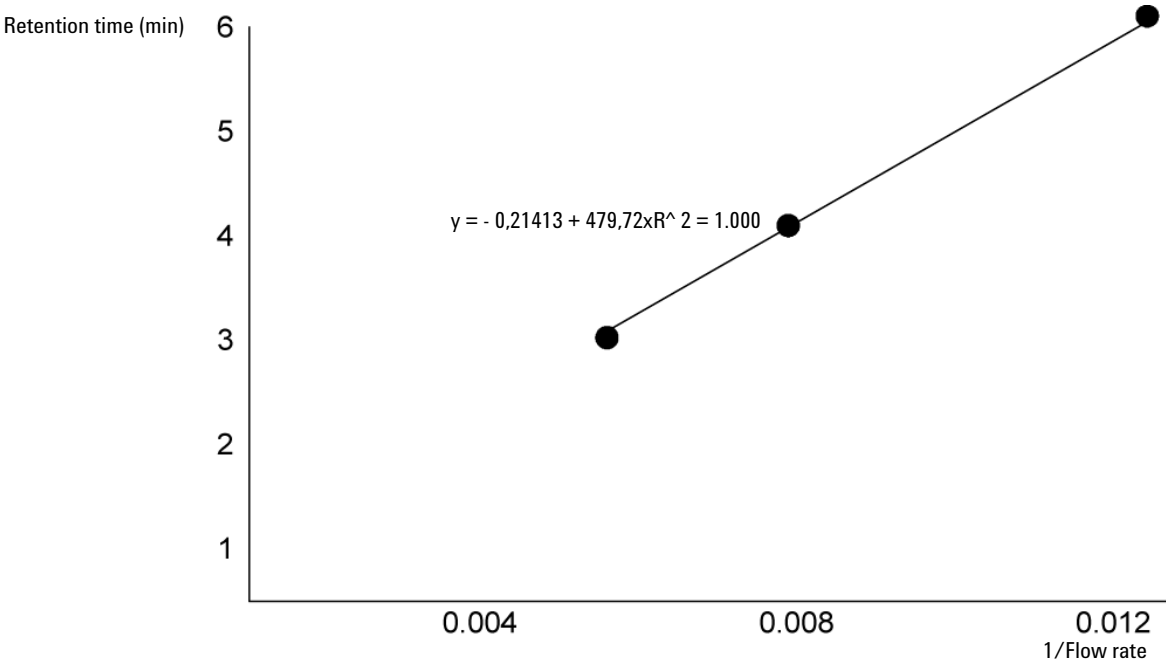


Figure 35 Retention time versus flow rate for 80 – 150 mL flow rates

6
Troubleshooting and Diagnostics

This chapter gives an overview about the troubleshooting and diagnostic features.

Introduction to Troubleshooting and Diagnostics

Troubleshooting an HPLC system requires a methodical approach to be effective.

To correct a given problem, proceed step-by-step, eliminating each variable in turn before moving to the next. Some problems have more than one cause, and can be difficult to locate and correct. The troubleshooting guide lists some common pump and HPLC system symptoms, with possible causes and suggested corrective actions.

In most cases, you will be able to correct the problem. However, sometimes the symptom will remain after you have tried the corrective action. In these cases, please contact your local Agilent office.

Using the Pressure Display as Diagnostic Tool

The sensitivity of the pressure display is within 68.9 kPa (10 psi). The pressure display can be used as a diagnostic tool. Following issues cause characteristic pressure fluctuations in HPLC systems (parameters valid for HPLC operating at normal pressure):

- Zero to several hundred kPa: Bubbles in the solvent
- 68.9 – 275.8 kPa Sticking check valve

HINT

If fluctuations > 68.9 kPa try to eliminate bubbles in the solvent (see "Clearing Air Bubbles from the Liquid Head" on page 84).

If this does not solve the problem, a check valve is probably sticking. It may be possible to rectify this problem by cleaning the check valve (see "Cleaning Check Valves" on page 95).

Troubleshooting Guide

Troubleshooting Guide

The troubleshooting guide is divided into sections, related to symptoms observed in the following units:

- Electronics
- Liquid flow system
- Detector signals

Electrical Symptoms

Pump Dead

Table 10 Pump dead

Probable cause	Solution
Power cord disconnected	Plug in power cord
Power switched off	Switch power on
Fuse dead	Replace fuse

External Symptoms of Liquid Flow System

Leaks

Table 11 Leaks

Probable cause	Suggested actions
Loose fitting(s)	Tighten all plumbing connections no more than 1/4 turn past finger-tight.
Worn ferrule or fitting	Replace fitting and ferrule.
Damaged seal	Replace seal.
Loose check valve	Tighten 1/16 turn past the leak-point.
Incorrect fitting(s)	Reconnect with correct fittings.

No flow or pressure

Table 12 No flow or pressure

Probable cause	Suggested actions
Pump is not operating	**1** Plug in power cord **2** Switch pump on **3** Check fuses and replace if necessary
Air in pump	**1** Disconnect outlet fittings **2** Degas solvent. **3** Divert flow to waste and pump at a high flow rate to prime pump.
Clogged solvent inlet filter	Check and replace if necessary.

Low flow

Table 13 Low flow

Probable cause	Suggested actions
Pump is pressure limiting	Reset MIN P setting to higher value.

Table 13 Low flow

Probable cause	Suggested actions
Clogged solvent inlet filter	Check and replace if necessary.
Drain valve leaking	Repair leak in drain valve.

Erratic pressure

Table 14 Erratic pressure

Probable cause	Suggested actions
Leak	Check and repair leaks.
Air in pump	**1** Disconnect outlet fittings. **2** Degas solvent. **3** Divert flow to waste and pump at a moderately high flow rate to prime pump.

Air bubble in tubing

Table 15 Air bubble in tubing

Probable cause	Suggested actions
Loose inlet tubing connection	Tighten inlet fittings.
Worn flange in inlet tubing	Remake inlet tubing flange.
Loose inlet check valve	Tighten 1/16 turn past the leak-point.
Inlet filter partially clogged	Clean or replace.
Loose outlet tubing connection	Tighten outlet fittings.

Detection Symptoms

Noisy baseline

Table 16 Noisy baseline

Probable cause	Suggested actions
Air bubbles through flow cell	• Install backpressure regulator • Divert flow to waste and pump at a moderately high flow rate to prime pump • Check tubing fittings • Degas solvent
Leak in system plumbing	Check for deposits around fittings and check that all fittings are tight.
Contaminated flow cell	Attach a syringe to the flow cell inlet and try to clear blockage by drawing on the syringe. Or attach to outlet and back-flush to clear blockage by gentle pressure on the syringe. Do not apply pressure to the flow cell inlet.
Detector lamp failing	Check and replace if necessary.
Bad grounding	Check all grounding connections on pump and ensure grounded AC power is supplied to all devices in HPLC system.
Electronic interference	• Check for loose connections • Ensure instruments are not in direct contact with each other or with vibrating parts
Localized temperature effects	• Wrap tubing, column • Remove or cover heat or cooling source

Drifting baseline

Table 17 Drifting baseline

Probable cause	Suggested actions
Contaminated flow cell	Attach a syringe to the flow cell inlet and try to clear blockage by drawing on the syringe. Or attach to outlet and back-flush to clear blockage by gentle pressure on the syringe. Do not apply pressure to the flow cell inlet.
Localized temperature effects	• Wrap tubing, column • Remove or cover heat or cooling source
Contamination in column	• Wash or replace column • Change mobile phase
Leak in system	Locate leak and repair.
Bubble trapped in flow cell	• Flush flow cell • Degas solvent • Add back-pressure device to flow cell
Column not equilibrated	Flush system until column is equilibrated.
Mobile phase contamination	Use fresh HPLC-grade solvents.
Weak detector lamp	Replace detector lamp.

Flat-top peaks

Table 18 Flat-top peaks

Probable cause	Suggested actions
Saturated electronics	Reduce sample volume.
Recorder adjusted incorrectly	Adjust diameter offset or range.
Bad grounding	Check all grounding connections on the module and ensure grounded AC power is supplied to all devices in HPLC system.

Baseline spikes

Table 19 Baseline spikes

Probable cause	Suggested actions
Air bubbles through flow cell	• Degas solvent • Pump to waste at a moderately high flow rate to prime pump • Check tubing fittings
Bad connections	Check all grounding connections on pump and ensure grounded AC power is supplied to all devices in HPLC system.
Electronic interference	• Check for loose connections. • Ensure instruments are not in direct contact with each other or with vibrating parts.
Electrical equipment in circuit cycling on and off	Isolate equipment which cycles on and off to a different circuit.

7
Error Information

This chapter describes the meaning of error messages, and provides information on probable causes and suggested actions how to recover from error conditions.

What are Error Messages

Error messages are displayed in the user interface when an electronic, mechanical, or hydraulic (flow path) failure occurs which requires attention before the analysis can be continued (for example, repair, or exchange of consumables is necessary). In the event of such a failure, the red status indicator at the front of the module is switched on, and an entry is written into the module logbook.

If an error occurs outside a method run, other modules will not be informed about this error. If it occurs within a method run, all connected modules will get a notification, all LEDs get red and the run will be stopped. Depending on the module type, this stop is implemented differently. For example, for a pump the flow will be stopped for safety reasons. For a detector, the lamp will stay on in order to avoid equilibration time. Depending on the error type, the next run can only be started, if the error has been resolved, for example liquid from a leak has been dried. Errors for presumably single time events can be recovered by switching on the system in the user interface.

Special handling is done in case of a leak. As a leak is a potential safety issue and may have occurred at a different module from where it has been observed, a leak always causes a shutdown of all modules, even outside a method run.

In all cases, error propagation is done via the CAN bus or via an APG remote cable (see documentation for the APG interface).

Pump Error Messages

These errors are pump specific.

PUMP STALLED

Probable cause	Suggested actions
1 Pump is stalled.	Press any key to continue.

NOTE: EFFECTIVE MAX PRESSURE = XXXX AT CURRENT OR SET FLOW RATE

Probable cause	Suggested actions
1 The legal maximum internal pressure is less than you have set in the pressure window. The maximum internal pressure decreases as flow rate increases.	Press **CLEAR** to continue.

PUMP MOTOR DRIVE FAILED CALL CUSTOMER SERVICE

Probable cause	Suggested actions
1 Pump motor drive failed.	Press **CLEAR** to continue.

MUST STOP PUMP TO DISENGAGE HEADS

Probable cause	Suggested actions
1 To disengage the heads, the pump must be stopped.	Press **STOP**, or **CLEAR** to cancel.

DISENGAGE FAILED ON HEAD 1

Probable cause	Suggested actions
1 Disengage failed on head 1.	Press **ENTER** to continue.

DISENGAGE FAILED ON HEAD 2

Probable cause	Suggested actions
1 Disengage failed on head 2.	Press **ENTER** to continue.

HEADS DO NOT MATCH

RIGHT HEAD: XXX mL/min, xxxxxx psi LEFT HEAD: XXX mL/min, xxxxxx psi

Probable cause	Suggested actions
1 Heads don't match.	Press **ENTER** to continue.

HEADS DO NOT MATCH

MAX P: XXXXX USED RIGHT HEAD: XXX mL/min, xxxxxx psi LEFT HEAD: XXX mL/min, xxxxxx psi

Probable cause	Suggested actions
1 Heads don't match. Wrong MAX P used.	Press **ENTER** to continue.

INVALID MAX= xxxxx, MIN = xxxxx

Probable cause	Suggested actions
1 This is the message for an invalid MAX P value. Its value cannot be greater than MAX P for that head nor less the MIN P value.	Enter a value equal or less than the MAX P value for the used pump head.

8
Maintenance and Repair

This chapter describes the maintenance of the instrument.

Introduction to Maintenance

The pumps have been carefully designed with continuous, unattended operation in mind. Rugged construction and sophisticated electronics mean a minimum of routine maintenance and years of trouble-free service if treated carefully and if replacement parts are changed when they show signs of wear. This section of the manual describes a maintenance schedule, service logs, changing the piston seals, changing the check valve cartridges and changing the mixer seals and frits.

You should take advantage of the Service Logs. Software in the pump automatically tracks seal wear, check valve use, and pump drive wear. The software also allows the user to enter and record seal and check valve changes. Make it a point to check the Service Log area frequently and make sure to record seal changes and check valve replacements into the software.

Warnings and Cautions

WARNING

Toxic, flammable and hazardous solvents, samples and reagents

The handling of solvents, samples and reagents can hold health and safety risks.

- ➔ When working with these substances observe appropriate safety procedures (for example by wearing goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the vendor, and follow good laboratory practice.
- ➔ The volume of substances should be reduced to the minimum required for the analysis.
- ➔ Do not operate the instrument in an explosive atmosphere.

WARNING

Electrical shock

Repair work at the module can lead to personal injuries, e.g. shock hazard, when the cover is opened.

- ➔ Do not remove the cover of the module.
- ➔ Only certified persons are authorized to carry out repairs inside the module.

WARNING

Personal injury or damage to the product

Agilent is not responsible for any damages caused, in whole or in part, by improper use of the products, unauthorized alterations, adjustments or modifications to the products, failure to comply with procedures in Agilent product user guides, or use of the products in violation of applicable laws, rules or regulations.

- ➔ Use your Agilent products only in the manner described in the Agilent product user guides.

CAUTION

Safety standards for external equipment

➔ If you connect external equipment to the instrument, make sure that you only use accessory units tested and approved according to the safety standards appropriate for the type of external equipment.

Maintenance Schedule

User maintenance on the Agilent SD-1 Pump is generally limited to the pump head, as follows:

- Cleaning the check valves and filter.
- Replacing components subject to wear and tear: piston seals, check valves, piston assembly, seal back-up, return spring.

Continuous, unattended operation is common with HPLC components. A general guideline for the replacement frequency of consumable components is indicated in the table below. The table assumes the pump is working at half its maximum flow rate and pressure. Replacement frequency is indicated for intensive, regular, and occasional pump use.

The solvent used also effects replacement frequency. Mobile phases with buffers and high ionic strength will cause the seals to fail more frequently.

Table 20 Frequency of component replacement

Component/Use	Intensive (168 hrs/wk)	Regular (40 hrs/wk)	Occasional (10 hrs/wk)
Piston seal	4–6 months	1 year	2 years
Check valves	6–12 months	2 years	4 years
Piston assembly	1–2 years	4–6 years	8–10 years
Seal back-up	1–2 years	4–6 years	8–10 years
Return spring	2 years	4–6 years	8–10 years

NOTE

This table is only a guideline; pump head components may need to be replaced more or less often than indicated.

Changes in performance, or visible leaks, give more precise indication that a part should be replaced.

Seals need to be replaced every so often. This is because friction from the moving pistons eventually abrades the seal and pressurized liquid in the piston chamber seeps past the seal. Seal wear may be indicated by leaks from

the notch at the bottom of the liquid head, although this sign may not be present if the solvent leak evaporates quickly.

Seal wear is accelerated under adverse conditions, such as pumping at high flow rates or pressures, using aggressive or aqueous solutions, or dirty or contaminated mobile phase. Moderate operation (low flow, low pressure, organic solutions, and fresh clean HPLC-grade mobile phases) will result in longer seal life. However, every seal will eventually need replacing. Software in the Agilent SD-1 Pump allows you to both check the seal wear and to log when the seals are changed. Your pump uses either a standard liquid head or a washing liquid head.

Service Logs

Agilent SD-1 software automatically tracks seal wear, check valve use, and pump drive wear. The software also allows the user to enter and record seal and check valve changes.

The SERVICE LOG menu opens three log displays (see “SERVICE LOG display” on page 20):

- Piston seal log
- Check valves log
- Pump drive log

Pressing the ~ key opens the **Special** display, to access the **SERVICE LOG** menu.

Clearing Air Bubbles from the Liquid Head

If you notice pressure fluctuations from zero to several hundred kPa when the HPLC system is operating at normal pressure, there is probably a bubble in the liquid head.

WARNING

Chemical burns to eyes, skin, and/or respiratory tract

The mobile phases in the system may be hazardous.

➔ Observe all standard laboratory safety precautions.

➔ Always wear personal protective equipment.

1 Operate the pump at moderate flow (10 % of maximum) with the system pressurized.

2 Carefully loosen the outlet check valve fitting; just enough to make it leak (also known as *crack the fitting*).

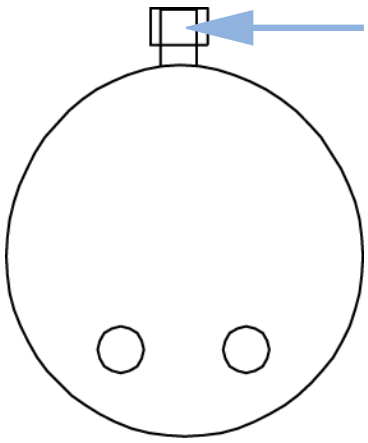


Figure 36 Outlet check valve fitting

You should see solvent sputtering at the fitting as the bubble leaks past the fitting.

3 When the bubble is clear, the sputtering will stop and the solvent will ooze past the fitting. At this point tighten the fitting.

Replacing Seals

Seals need to be replaced every so often because friction from the moving pistons causes the seals to wear. Seal wear is accelerated under adverse conditions, such as pumping at a high flow rate or pressure, pumping aqueous solutions, or dirty or contaminated mobile phase. More gentle operation (low flow, low pressure, organic solutions, fresh clean HPLC-grade mobile phases) will result in longer seal life. However, every seal will eventually need replacing. Software in the Agilent SD-1 allows you to both check the seal wear and to log when the seals are changed. Each pump head in the Agilent SD-1 has one high-pressure piston seal, one washing section seal, and one o-ring.

Seals and o-rings are supplied in pairs. Both high pressure seals should be replaced at the same time, both washing section seals should be replaced at the same time, and both o-rings should be replaced at the same time. However, you do not have to replace different types of seal at the same time. For example, it is not necessary to replace the o-ring because you are changing the washing section seal. Seals will wear at different rates: in general, you will need to replace the high-pressure seals more often than the washing section seals or the o-rings.

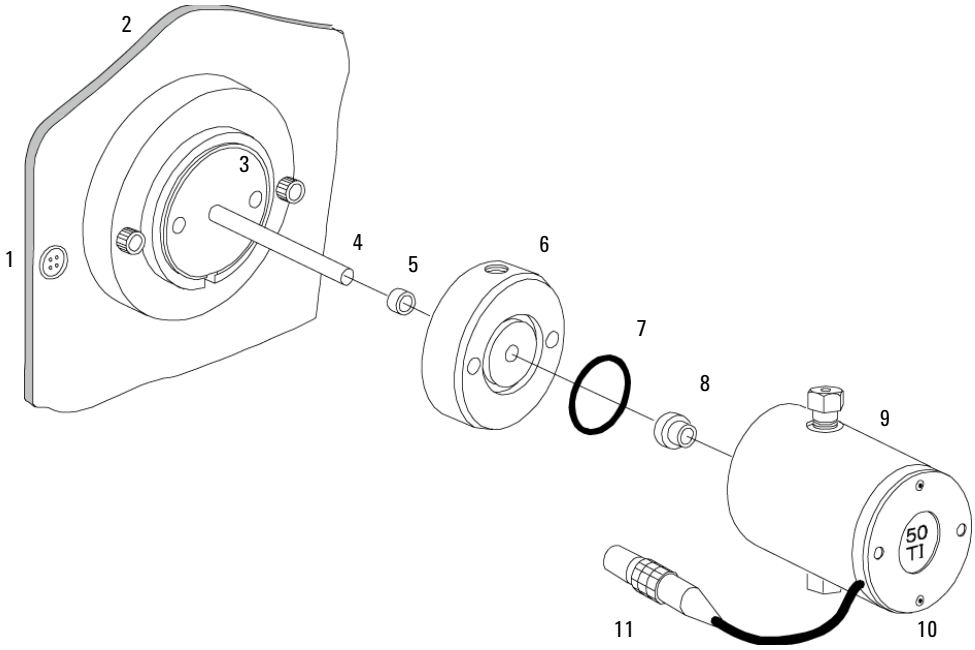


Figure 37 Pump head exploded view

1	Pressure sensor cable socket
2	Pump front panel
3	Backing disk
4	Piston
5	Washing section seal
6	Washing section
7	O-ring
8	High-pressure seal
9	Pump head
10	Front plate
11	Pressure sensor cable connector

When Seal worn out.

Tools required **Description**

Wrench, 3/16 inch hexagonal, T-handle

Dismantling the pump head

1 Press **STOP** to stop the pump and switch off the power switch.

2 Unplug the AC power cord.

3 Remove the fittings at the inlet and outlet check valves.

4 To disconnect the pressure sensor cable from the socket on the front panel, grasp the knurled collar and pull it back gently.

You will feel a slight “give” as the spring-loaded ring is pulled back, then the connector will disengage.

NOTE Do not pull the cable or any part of the connector except the knurled ring.

5 Insert a 3/16 inch T-handle wrench into one of the screw holes in the 3 o'clock and 9 o'clock positions at the front plate of the pump head.

a Turn the wrench gently until you feel it engage the socket in the mounting screw.

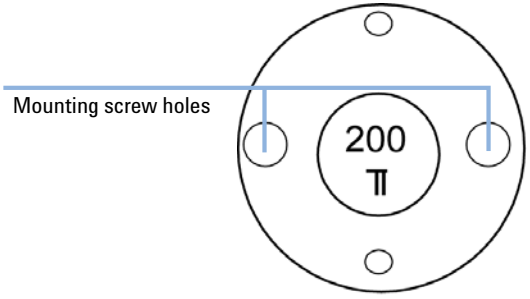


Figure 38 Location of the pump head mounting screws

6 The mounting screw is a tight fit. Turn the wrench a small amount counter-clockwise to begin loosening the mounting screw.

CAUTION

Damage of pump piston

If the pump piston is unsupported, the weight of the pump head could break the piston.

➔ Support the weight of the pump head body as you remove the mounting screws.

7 Hold the pump head and repeat steps 4 and 5 on the other mounting screw.

The mounting screws will remain captive behind the front plate.

8 Carefully slide the pump head straight out from the pump until it clears the piston. Do not apply any sideways or up and down pressure to the piston while removing the pump head.

9 Support the weight of the washing section and carefully slide it off the piston.

Do not dismantle the pump head assembly any further; the backing disk should remain in place.

Removing seals/o-ring

The high pressure seal will remain in the recess at the back of the pump head. The o-ring will remain in its groove at the front of the washing section. The washing section seal will remain in the recess at the back of the washing section.

1 Carefully remove the seal from its recess using the end of the piston to pry it out. Do not use a sharp metal tool, such as a penknife, which could scratch the sealing area of the pump head or washing section.

2 Remove the o-ring if necessary.

Replacing seals/o-ring

1 Slide the replacement washing section seal along the piston until it reaches the backing disk.

The seal spring must be facing out, as shown in below.

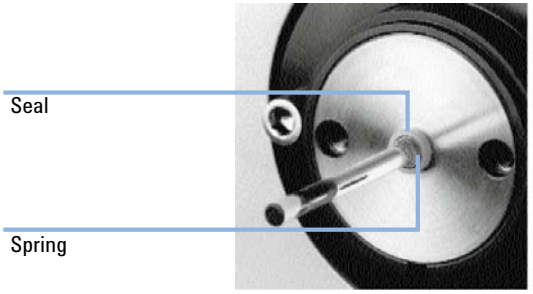


Figure 39 Washing section seal

2 Support the weight of the washing section and slide it over the piston as far as possible.

The seal fits into the recess in the washing section.

3 Place the o-ring into the groove at the front of the washing section.

4 Slide the high-pressure seal along the piston until it reaches the washing section.

The seal spring must be facing out, as shown in below.

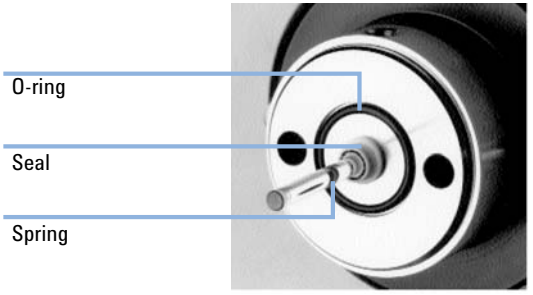


Figure 40 O-ring and high-pressure seal

5 Align the pump head so that the slot at the bottom is lined up with its matching slot in the housing on the front panel (see Figure 37 on page 87).

a Supporting the weight of the pump head, carefully slide it along the piston until it stops.

6 Hold the pump head and insert a 3/16 inch T-handle wrench into one of the mounting screw holes and tighten the mounting screw until you feel some resistance.

7 Tighten the other mounting screw until you feel resistance.

8 Tighten each mounting screw in turn a little at a time until both screws are tight.

9 Replace the fittings at the outlet and inlet check valves.

10 Repeat the procedure for the other pump head.

Replacing Piston

Each piston in the Agilent SD-1 can be replaced, using a replacement kit. Both pistons should be replaced at the same time, unless one of the pistons has been broken, chipped or scratched.

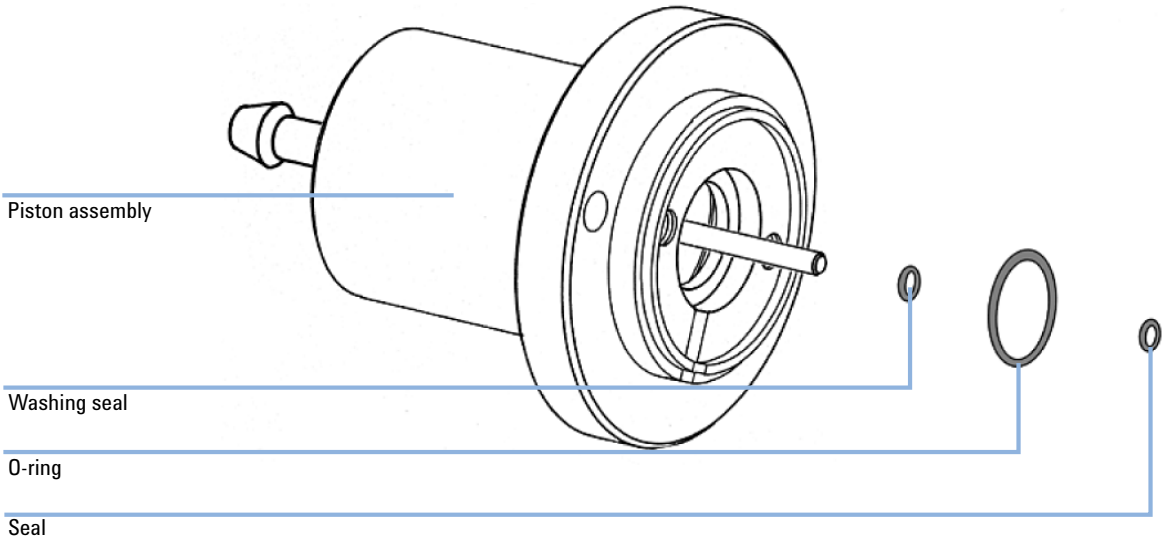


Figure 41 Piston replacement kit (200 mL/min pump head)

Tools required	Description
	Wrench, 3/16 inch hexagonal, T-handle

Removing the pump head

1 Press **STOP** to stop the pump and switch off the power switch.

2 Unplug the AC power cord.

3 Remove the pump head (see "Removing the Pump Head" on page 45).

Removing the old piston assembly

1 Insert a 3/16 inch T-handle wrench into one of the screw holes in the 3 o'clock and 9 o'clock positions at the front plate of the pump head.

   a Turn the wrench gently until you feel it engage the socket in the mounting screw.

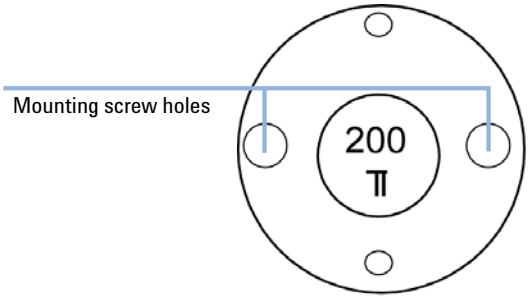


Figure 42 Location of the pump head mounting screws

2 The mounting screw is a tight fit. Turn the wrench a small amount counter-clockwise to begin loosening the mounting screw.

CAUTION

Damage of pump piston

If the pump piston is unsupported, the weight of the pump head could break the piston.

➔ Support the weight of the pump head body as you remove the mounting screws.

3 Hold the pump head and repeat steps 1 and 2 on the other mounting screw.

   The mounting screws will remain captive behind the front plate.

4 Carefully slide the pump head straight out from the pump until it clears the piston. Do not apply any sideways or up and down pressure to the piston while removing the pump head.

   The pump head with washing section is separated from the piston assembly. The old seals and old o-ring generally remain on the washing section.

5 Remove the backing disk from the old piston assembly.

Installing the new piston assembly

1. Take the replacement piston assembly and slide the backing disk over the piston.
2. Align the holes with the screw holes on the piston assembly (see Figure 39 on page 90).
3. Slide the washing section over the piston and install the new o-ring and seal (see Figure 40 on page 90).
4. Carefully slide the pump head over the piston.
5. Align the pump head so that the slot at the bottom is lined up with its matching slot in the housing on the front panel (see Figure 37 on page 87).
   a. Supporting the weight of the pump head, carefully slide it along the piston until it stops.
6. Hold the pump head and insert a 3/16 inch T-handle wrench into one of the mounting screw holes and tighten the mounting screw until you feel some resistance.
7. Tighten the other mounting screw until you feel resistance.
8. Tighten each mounting screw in turn a little at a time until both screws are tight.
9. Repeat the procedure for the other pump head.

Cleaning Check Valves

A pressure drop may indicate that one of the check balls has become coated with gummy or particulate matter or that a small particle has become lodged on the seat; in either case the check ball will not seat correctly and pressure will be lost. It may be possible to rectify this problem using isopropanol to dissolve the foreign matter.

When Occasionally, especially in case of drop in backpressure.

Cleaning Check Valves with Isopropanol

1. Disconnect the outlet tubing and connect a line to a waste bottle.
2. Check miscibility of solvent in the pump head with isopropanol.
3. Isopropanol and solvent in pump head miscible: Pump isopropanol in the pump head

   OR

   Isopropanol not miscible with solven in the pump head:

   1. Pump an intermediate solvent in the pump head (see "Solvent Miscibility" on page 120)
   2. Pump isopropanol in the pump head.
4. With the pump head filled with isopropanol, stop the flow for approximately 15 min to dissolve deposits.
5. Flush the isopropanol from the head and return to operating conditions. (Using an intermediate solvent if necessary.)

Cleaning Check Valves with 20 % Nitric Acid

If the above cleaning procedure does not restore normal performance, you can try using 20 % nitric acid to dissolve the deposits.

1 Remove the check valve from the pump head.

WARNING

Chemical burns to eye, skin and respiratory tract

A 20 % nitric acid solution is a strong acid. Strong acids are extremely corrosive and pose severe risks.

➔ Observe all standard laboratory safety precautions when using strong acids.

➔ Always wear appropriate personal protective equipment.

2 Soak check valve in 20 % nitric acid for ten minutes.

3 Carefully remove the check valve from the acid bath and rinse thoroughly with deionized water.

4 Reinstall the check valve on the pump head.

NOTE

If this procedure fails to correct the problem you should replace the check valve as described in "Replacing Check Valves" on page 97.

Replacing Check Valves

Check valve failure may be indicated by a severe loss in flow rate. However, a leaking piston seal can also result in low flow rate and is more common than check valve failure. Inspect for a leaking seal before replacing the check valve.

Tools required	Description
	Appropriately sized open ended wrench (delivered with the pump head).
Preparations	Pump head is already removed.

CAUTION

Damage to check valve cartridges

➔ Do not disassemble check valve cartridges. Reassembly requires strict cleanroom conditions and great expertise. Sub-assemblies are not available for check valve cartridges.

1 Remove the inlet and outlet check valves; they are threaded into the liquid head.

2 Remove the check valve cartridge. If needed, use compressed air to remove the cartridge. Do not use a sharp tool that could damage the check valve or the support.

3 Insert the new check valve cartridge into the support.

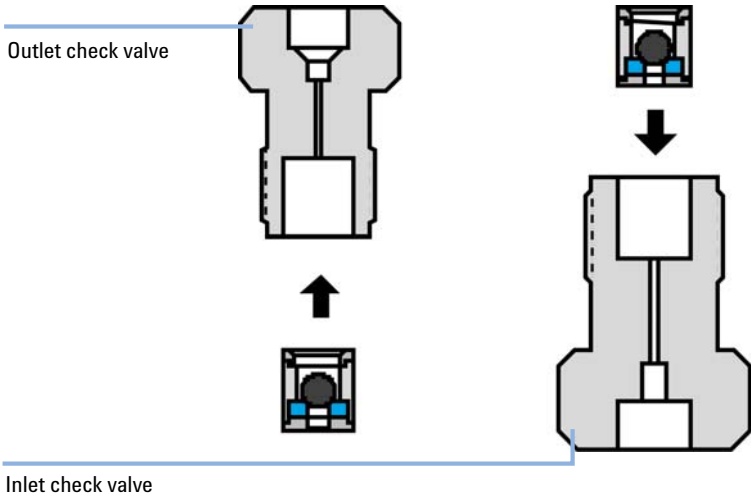


Figure 43 Orientation of check valve cartridges

NOTE The outlet check valve housing is smaller than the inlet check valve housing, and threads into the top of the liquid head. The cartridge must be inserted in the check valve housing as shown below. The check ball must be above the seat in both types of check valve housing so that it will seat by gravity.

4 Tighten the check valves into the liquid head by hand, then tighten each liquid head a further 1/8th turn with an appropriately-sized open-ended wrench.

CAUTION Damage to the liquid head and the check valve

➔ Do not overtighten the check valve into the liquid head.

5 Run the pump and inspect for leaks around each check valve. If leaks are present, tighten the check valve only enough to stop the leak. Check for leaks again, tightening only if necessary.

Checking and/or Changing Power Fuses (F1)

When

If the Agilent SD-1 does not operate when the power cord is connected and the power switch is on, replace the fuse(s). Fuses are located in the power module on the back of the Agilent SD-1.

Tools required

Description
Flat hat screwdriver

Parts required

p/n	Description
R005100022	Fuse, 3AG 10 AMP NORMAL-BL
R005100029	Fuse, 5 X 20 mm, 5 A, 250 V

Preparations

Check following probable causes for the power fail before starting exchanging the fuses:

- Power cord properly connected
- Power at the wall receptacle

WARNING

Electrical shock

➔ Always disconnect power cord from the module before replacing a fuse.

CAUTION

Wrong fuse

Damage to the module and loss of warranty.

➔ Set voltage properly.

➔ Use only the correct fuses.

1 Switch off the pump power and remove the AC power cord.

2 Use a screwdriver to pry the spring tab open at the base of the fuse holder and release the fuse holder.

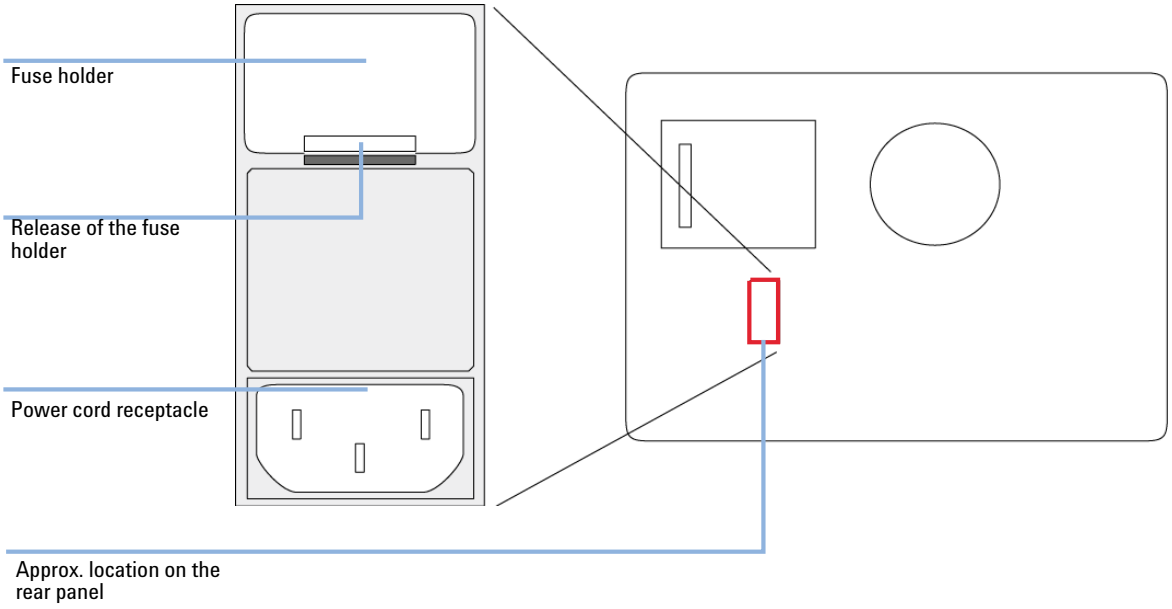


Figure 44 Rear panel of the module

3 Pull the fuse holder out and replace the fuse(s) as needed.

4 Push the fuse holder in until the spring tab locks into place.

5 Connect the AC power cord and switch on the power.

9 Parts

This chapter provides information on parts for the instrument.

Modules

p/n	Description
G9302A	Agilent SD-1 Isocratic Solvent Delivery Module
G9303A	Agilent SD-1 Add-on Solvent Delivery Module

Pump Heads

p/n	Description
R007105064	Pump head, max. flow: 200 mL/min, material: Ti
R007105066	Pump head, max. flow: 500 mL/min, material: Ti
R007105065	Pump head, max. flow: 800 mL/min, material: Ti
R007105068	Pump head, max. flow: 3.2 L/min, material: Ti

Accessories

p/n	Description
R000048601	Preparative column hanger for ½ in. OD
R000048602	Preparative column hanger for 1 in. OD
R000048605	Injection valve bracket
R000048606	Prime purge valve bracket
R000048607	Mast clamp
393593591	HPLC tool kit

Pump Head Replacement Parts

Replacement Parts for 200 mL/min Pump Head

p/n	Description
R007105620	High pressure seals, 200 mL, 2 EA
R007105621	Washing seals, 200 mL, 2 EA
R007105622	O-rings, 50 mL/200 mL/500 mL, 2 EA
R007105623	Inlet tube assy, 200 mL, 2 EA
R007105624	Inlet filter tube, 200 mL, 6 ft
R007105625	Complete seal kit, 200 mL
R007105626	Inlet check valve, 200 mL
R007105627	Outlet check valve, 50 mL/200 mL
R007105706	Piston replacement kit, 200 mL
R007105603	Outlet fittings, 50 mL/200 mL, 5 EA
R007105612	Inlet filter tube, 200 mL, 10 ft
R007105617	Outlet tube, ss 50 mL/200 mL, 2 EA
R007105629	Inlet filter, 50 mL/200 mL

Replacement Parts for 500 mL/min Pump Head

p/n	Description
393548991	High pressure seals, 500 mL, 2 EA
393549091	Washing seals, 500 mL, 2 EA
R007105622	O-rings, 50 mL/200 mL/500 mL, 2 EA
R007105683	Inlet tube assy, 500 mL/800 mL, 2 EA
R007105684	Inlet filter tube, 500 mL/800 mL, 6 ft
R007105686	Inlet check valve, 500 mL/800 mL
R007105687	Outlet check valve, 500 mL/800 mL
R007105708	Piston replacement kit, 500 mL
R007105605	Outlet fittings, 500 mL/800 mL, 5 EA
R007105613	Inlet filter tube, 500 mL/800 mL, 10 ft
R007105616	Inlet filter tube, 500 mL/800 mL, 15 ft
R007105618	Outlet tube, peek 500 mL/800 mL, 2 EA
R007105689	Inlet filter, 500 mL/800 mL

Replacement Parts for 800 mL/min Pump Head

p/n	Description
R007105680	High pressure seals, 800 mL, 2 EA
R007105681	Washing seals, 800 mL, 2 EA
R007105682	O-rings, 800 mL, 2 EA
R007105683	Inlet tube assy, 500 mL/800 mL, 2 EA
R007105684	Inlet filter tube, 500 mL/800 mL, 6 ft
R007105685	Complete seal kit, 800 mL
R007105686	Inlet check valve, 500 mL/800 mL
R007105687	Outlet check valve, 500 mL/800 mL
R007105707	Piston replacement Kit, 800 mL
R007105605	Outlet fittings, 500 mL/800 mL, 5 EA
R007105613	Inlet filter tube, 500 mL/800 mL, 10 ft
R007105616	Inlet filter tube, 500 mL/800 mL, 15 ft
R007105618	Outlet tube, peek 500 mL/800 mL, 2 EA
R007105689	Inlet filter, 500 mL/800 mL

Replacement Parts for 3.2 L/min Pump Head

p/n	Description
R007105734	High pressure seals, 3.2 L/min, 2 EA
R007105733	Washing seals, 3.2 L/min, 2 EA
R002535045	O-rings, 3.2 L/min, 2 EA
393518702	Inlet tubing assembly, gradient, 3.2 L/min
393518802	Outlet tubing assembly, gradient, 3.2 L/min
393518301	Inlet check valve, 3.2 L/min
393518501	Outlet check valve, 3.2 L/min
R007105747	Piston cup assembly, 3.2 L/min

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Cables

This chapter provides information on cables used with the instrument.

Cable Overview

Necessary cables

p/n	Description	
	392612901	Ethernet cable (for use in a *network*)
OR	5023-0203	Ethernet cable (cross-over, for *standalone* use)
	392607969	Inject marker cable
	392607975	Next injection cable
	393546291	Serial communication ribbon
	393597601	Converter RS-232 to RS-422
	7910046300	Serial cable

Optional cables

p/n	Description
110743800	Relay interface cable (for relay interface board, one relay contact per cable)
110744200	Analog signal cable

Cable Connections

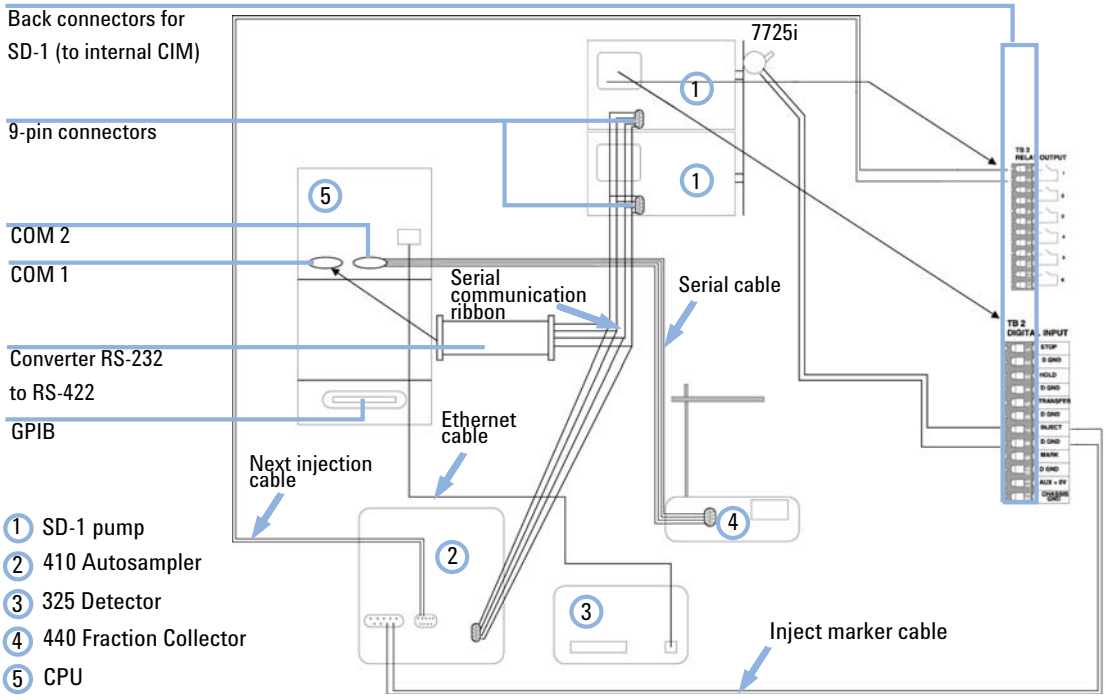

Figure 45 Cable connections for workstation control of Agilent SD-1 Solvent Delivery Modules, Agilent 325 Detector, Agilent 410 Autosampler and Agilent 440 Fraction Collector

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Appendix

This chapter provides addition information on safety, legal and web.

General Safety Information

General Safety Information

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

WARNING

Ensure the proper usage of the equipment.

The protection provided by the equipment may be impaired.

➔ The operator of this instrument is advised to use the equipment in a manner as specified in this manual.

Information Symbols

The following is a list of symbols that appear with warnings in this manual or on the liquid chromatograph. The hazard they describe is also shown.

A triangular symbol indicates a warning. The meanings of the symbols that may appear alongside warnings in the documentation or on the instrument itself are as follows:

Table 21 Warning symbols

 Broken glass	 Chemical hazard	 Electrical shock
 Explosion hazard	 Eye hazard	 Fire hazard
 Heavy weight (danger to feet)	 Heavy weight (danger to hands)	 Hot surface
 Moving parts	 Respiratory hazard	 Attention[1]

[1] The symbol may be used on warning labels attached to the instrument. When you see this symbol, refer to the relevant operation or service manual for the correct procedure referred to by that warning label.

Table 22 Information symbols

Symbol	Description
I	Mains power on
o	Mains power off
	Fuse
	Single phase alternating current
	Direct current
	Confirms that the product complies with the requirements of all applicable European Community directives

Solvent Hazards

WARNING

Explosion, fire, asphyxiation

This instrument is not explosion-proof.

Certain solvents may cause weakening and leaks of tubings or fitthings with possible bursting.

Even small leaks in solvent supply systems can be dangerous.

- ➔ Only use solvents compatible with the HPLC system tubings and fittings.
- ➔ Employ static measuring and static discharge devices to safeguard against the buildup of static electricity.
- ➔ In unattended operation, do not use organic solvents having an ignition point below 70 °C.
- ➔ Do not bring a heat or flame source near the instrument.
- ➔ The area in which solvents are stored and the area surrounding the instrument must be adequately ventilated to prevent accumulations of gas.
- ➔ Always check the condition of the instrument (leakage of solvent or waste solution, leakage of solvent inside the instrument). If an abnormality is found, stop operation immediately.
- ➔ When using flammable chemicals, be careful about possible ignition due to static electricity. To prevent the build-up of static electricity, use a conductive container for waste.
- ➔ Use only approved regulator and hose connectors (refer to the supplier's instructions).
- ➔ Keep solvents cool and properly labeled. Ensure that you have the correct solvent before connecting it to the instrument.

WARNING

Inflammation or injury due to toxic, corrosive or stimulative solvent

- ➔ Do not contact toxic, corrosive or stimulative solvent.
- ➔ For details of the properties of each solvent and how to handle it, refer to the relevant Material Safety Data Sheets (MSDS).
- ➔ Be sure to handle each solvent properly.
- ➔ Wear proper personal protective clothes (e.g., safety goggles) so that a solvent will not come into direct contact with the skin.
- ➔ Ventilate the laboratory room adequately to prevent accidental inhalation of harmful solvent vapor.

WARNING

Cuts

- ➔ When working with glass or quartz parts take care to prevent breakage.

Other Precautions

Airflow to the cooling fans of the liquid chromatograph must be unobstructed. Do not block the ventilation grills on the liquid chromatograph and accessories.

Consult the manuals supplied with your PC, monitor and for their specific ventilation requirements.

High Pressure Hazards

WARNING

High velocity stream of volatile and/or toxic liquids.

If a line ruptures, a relief device opens, or a valve opens accidentally under pressure, potentially hazardous high liquid pressures can be generated by the pump.

- ➔ Wear personal protective equipment when you inject samples or perform routine maintenance.
- ➔ Never open a solvent line or valve under pressure. Stop the pump first and let the pressure drop to zero.
- ➔ Always keep the doors and covers closed during operation.
- ➔ Read and adhere to all Notes, Cautions, and Warnings in the manual.

Solvent Miscibility

Solvents should mix with each other in all proportions. This is important during elution and during solvent changeover. Refer to Figure 46 on page 120 for miscibility of some common HPLC solvents.

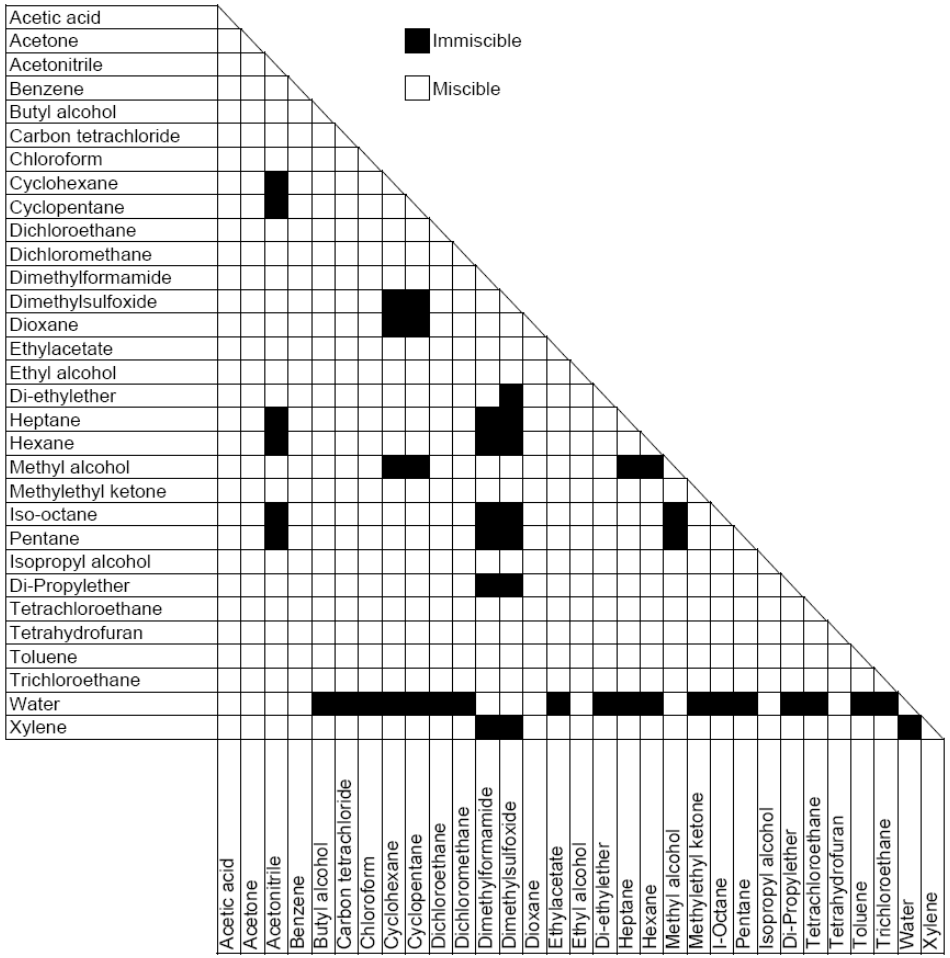

Figure 46 Solvent miscibility of some common solvents

The Waste Electrical and Electronic Equipment (WEEE) Directive (2002-96-EC)

Abstract

The Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC), adopted by EU Commission on 13 February 2003, is introducing producer responsibility on all electric and electronic appliances starting with 13 August 2005.

NOTE

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category:

With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a Monitoring and Control Instrumentation product.

NOTE

Do not dispose off in domestic household waste

To return unwanted products, contact your local Agilent office, or see www.agilent.com for more information.

Batteries Information

WARNING **Lithium batteries may not be disposed-off into the domestic waste. Transportation of discharged Lithium batteries through carriers regulated by IATA/ICAO, ADR, RID, IMDG is not allowed.**

Danger of explosion if battery is incorrectly replaced.

➔ Discharged Lithium batteries shall be disposed off locally according to national waste disposal regulations for batteries.

➔ Replace only with the same or equivalent type recommended by the equipment manufacturer.

WARNING **Lithiumbatteri - Eksplosionsfare ved fejlagtig håndtering.**

Udskiftning må kun ske med batteri af samme fabrikat og type.

➔ Lever det brugte batteri tilbage til leverandøren.

WARNING **Lithiumbatteri - Eksplosionsfare.**

Ved udskiftning benyttes kun batteri som anbefalt av apparatfabrikanten.

➔ Brukt batteri returneres appararleverandoren.

NOTE Bij dit apparaat zijn batterijen geleverd. Wanneer deze leeg zijn, moet u ze niet weggooien maar inleveren als KCA.

Radio Interference

Cables supplied by Agilent Technologies are screened to provide optimized protection against radio interference. All cables are in compliance with safety or EMC regulations.

Test and Measurement

If test and measurement equipment is operated with unscreened cables, or used for measurements on open set-ups, the user has to assure that under operating conditions the radio interference limits are still met within the premises.

Electromagnetic Compatibility

EN55011/CISPR11

Group 1 ISM equipment: group 1 contains all ISM equipment in which there is intentionally generated and/or used conductively coupled radio- frequency energy which is necessary for the internal functioning of the equipment itself.

Class A equipment is equipment suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

This device complies with the requirements of CISPR11, Group 1, Class A as radiation professional equipment. Therefore, there may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances.

Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try one or more of the following measures:

- Relocate the radio or antenna.
- Move the device away from the radio or television.
- Plug the device into a different electrical outlet, so that the device and the radio or television are on separate electrical circuits.
- Make sure that all peripheral devices are also certified.
- Make sure that appropriate cables are used to connect the device to peripheral equipment.
- Consult your equipment dealer, Agilent Technologies, or an experienced technician for assistance.
- Changes or modifications not expressly approved by Agilent Technologies could void the user's authority to operate the equipment.

ICES/NMB-001

This ISM device complies with Canadian ICES- 001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

Agilent Technologies on Internet

For the latest information on products and services visit our worldwide web site on the Internet at:

http://www.agilent.com

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In This Book

The manual describes the following:

- Introduction,
- Site requirements and specifications,
- installation,
- configuration,
- using and optimizing,
- troubleshooting and diagnostic,
- error information,
- test functions,
- maintenance and repair,
- parts identification,
- hardware information,
- safety and related information.

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