HP 1050 Series Pumping Systems

User's Guide

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Warranty

For details of warranty, see *Installation and Maintenance Guide*.

Safety

For details of safety, see *Installation and Maintenance Guide*.

The apparatus is marked with this symbol when the user should refer to the instruction manual in order to protect the apparatus against damage.

Indicates dangerous voltages.

Indicates a protected ground terminal.

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Using This Handbook

Use this handbook when you want to *operate* your HP 1050 Series Pumping Systems.

Chapter 1 describes how to prepare your pump for operation. Chapter 2 describes how to set parameters and run your first analysis. Chapter 3 describes how to become an expert at using your pump. Chapter 4 gives supplementary information about your pump. Appendix A describes each key on the keyboard of your pump as a quick reference.

What Other Handbooks Are Available?

Your pump comes complete with 2 further handbooks.

The *Installation and Maintenance Guide* describes how to install, troubleshoot, and maintain your pump.

Getting It All Together is intended for chromatographic systems comprising only HP 1050 Series modules and shows you how to connect different modules to make a complete system.

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Getting Started

This chapter describes how to prepare your pump for operation.

Turning On Line Power

To turn on line power, press line power switch on front panel. When you press (PUMP ON/OFF) your pump initializes the mechanical parts to ensure they are functioning correctly and displays

```
HP 1050 pump
 ready for use
```

If your pump displays anything else or the NOT READY and ERROR lamps are on, refer to Chapter 3 "Troubleshooting" in your *Installation and Maintenance Guide*.

When you turn on line power, your pump checks the controller functions. When you press (PUMP ON/OFF) your pump initializes the mechanical parts to ensure they are functioning correctly. If you hold down the (CTRL) key and turn on line power, your pump will do a series of self-tests, testing the electronics, before initializing the mechanical parts.

During the self-tests, your pump tests the display

```
DISPLAY TEST
```

followed by

```
||||||||||||||||||||
||||||||||||||||||||
```

then tests the random access memory (RAM)

```
RAM TEST
```

the read only memory (ROM)

```
ROM TEST FIM
```

When you press (PUMP ON/OFF), the pump drives the first of its 2 pistons into the cylinder until the piston reaches its mechanical limit. The pump then withdraws the piston a predetermined amount, storing this position in electronic memory. This is the position from which the pump starts the pumping cycle that we will describe later.

During initialization, the pump displays

```
  initializing
```

If any of the self-tests fail, the pump displays an error message and the ERROR lamp is on. For example, if the ROM test fails, the pump displays

```
ROM TEST FIM
  failed at Ux
```

indicating by the Ux where the fault is ie. U4 is ROM 1, U5 is ROM 2, U6 is ROM 3.

If your pump displays this error message or any other error message during the self-tests and initialization, see *Installation and Maintenance Guide.*

Setting the Date and Time

To set the date and time, press (CTRL) to display

```
DATE & TIME
        (enter)
```

and press (ENTER) to display

```
DATE 28/May/1992
TIME    16:20:30
```

Now press (▶) to move cursor across to entry fields. To change the month, press (NEXT▼) or (PREV▲).

When you have set the date and time, press (ENTER).

NOTE

The date and time are not backed up by battery so that when you turn off line power to your pump, the clock pauses. When you turn on line power, the clock starts again. We recommend that each time you turn on line power, you set the date and time using the (CTRL) key. This ensures the entries in your logbook correspond to the actual time they occurred.

Priming the Pump

This procedure shows you how to start up your pump after it has been turned off for several hours. The procedure assumes that the pump chamber and all the solvent inlet lines are filled with liquid. If the pump has just been installed new or has been purged dry, use the start up procedure given in Chapter 1 of your *Installation and Maintenance Guide*.

As part of this procedure, you will use the pressure ripple monitor output to check that the pump is working correctly.

Quaternary Pump

This procedure is for the quaternary pump.

Stage 1: Preparing Solvents

1. If necessary, refill each solvent reservoir that you need for your application, with the mobile phase(s) of your choice.
2. Insert helium degassing and solvent inlet tubes into reservoirs.

NOTE

Do NOT use nitogen or compressed air as the degassing agent for your mobile phase.

3. Open valve on helium supply. Adjust the regulators on solvent cabinet so that helium flows vigorously through your mobile phases. Thoroughly degas the mobile phases, (10 minutes is usually enough for water, which is generally the most difficult mobile phase to degas.)
4. After a few minutes, reduce helium flow so that only a slow stream of helium flows through each mobile phase.
5. Disconnect green capillary between injector and column at the column inlet and place a beaker under open end of capillary.

Stage 2: Turning On Pump

To turn on pump, press [PUMP ON/OFF] to display

```
SWITCH PUMP ON  ?
          (enter)
```

and then press [ENTER].

You will hear the pump move its pistons to the starting position, but as the preset flow rate is 0, the pistons will remain in this position. The PUMP lamp will be on.

Stage 3: Purging Each Channel

1. Set pump to purge channel A (the solvent channel that holds the aqueous solvent).

   press [PURGE] to display

   ```
   PURGE MODE ON  ?
             (enter)
   ```

   Press [NEXT▼] to display

   ```
   PRmax   400 bar
     CHANNEL  A-only
   ```

   If channel A is not set, press [▶] [▶] and then [NEXT▼] to display A-only and press [ENTER].

2. Purge channel A; press [PREV▲] to display

   ```
   PURGE MODE  ON ?
             (enter)
   ```
   and press [ENTER].

3. Wait until a continuous stream of solvent comes out of capillary and then repeat purge for the other channels you need. Purge the aqueous channel again.

4. Turn off purge function,

   press [PURGE] to display

   ```
   PURGE MODE OFF?
             (enter)
   ```

   and press [ENTER].

Stage 4: Monitoring the Pressure

1. Set a flow no greater than 5 ml/min, but enough to obtain a system pressure of approximately 50 bar. Set the solvent composition as required.

   ```
   FLOW 5.000 ;5.000
   (press   50 bar)
   ```

2. Press [CTRL] [NEXT▼] [NEXT▼] to display

   ```
   TEST FUNCTIONS
             (enter)
   ```

3. Press (ENTER) to display

```
PUMP PRESSURE
RIPPLE    1.0%
```

The 1.0 % pressure ripple is for propanol, for other solvents with different compressibility the pressure ripple will be different. The ripple should stabilize after a few minutes to give a typical value of ±2%. Mobile phases with a high water content usually take longer to obtain a stable ripple.

Isocratic Pump

This procedure is for the isocratic pump.

Stage 1: Preparing the Solvent

1. If necessary, refill the solvent reservoir about one-third full with the mobile phase of your choice.
2. Disconnect capillary between injector and column at the column inlet and place a beaker under open end of capillary.

Stage 2: Turning On Pump

To turn on pump, press (PUMP ON/OFF) to display

```
SWITCH PUMP ON  ?
          (enter)
```

and then press (ENTER).

You will hear the pump move its pistons to the starting position, but as the preset flow rate is 0, the pistons will remain in this position. The PUMP lamp will be on.

Stage 3: Purging the Pump

1. Set pump to purge;

   press (PURGE) to display

```
 PURGE MODE ON  ?
          (enter)
```

   and press (ENTER).

2. Wait until a continuous stream of solvent comes out of capillary.
3. Turn off purge function,

   press [PURGE] to display

   ```
   PURGE MODE OFF?
              (enter)
   ```

   and press [ENTER].

Stage 4: Monitoring the Pressure

1. Set a flow of 5 ml/min, but enough to obtain a system pressure of approximately 50 bar.

   ```
   FLOW 5.000 ;5.000
   (press   50 bar)
   ```

2. Press [CTRL] [NEXT▼] [NEXT▼] to display

   ```
   TEST FUNCTIONS
            (enter)
   ```

3. Press [ENTER] to display

   ```
   PUMP PRESSURE
   RIPPLE    1.0%
   ```

The 1.0 % pressure ripple is for propanol, for other solvents with different compessibility the pressure ripple will be different. See “Setting the Flow” in Chapter 2. The ripple should stabilize after a few minutes to give a typical value of ±2%. Water usually takes longer than organic solvents to obtain a stable ripple.

More About Priming the Pump

If your pump chamber is dry and the inlet lines from the solvent reservoirs are empty, we recommend that you use an alcohol (such as methanol, ethanol or isopropanol) to prime the pump. We have found that alcohols have the best physical characteristics (viscosity, vapor pressure and surface-wetting) for priming. See Chapter 1 in the *Installation and Maintenance Guide* for the recommended priming procedure.

Preparing Solvents (Quaternary Pump)

Always degas your solvents thoroughly. Although the pump, by virtue of its design, is relatively insensitive to gas-saturated solvents, you need degassed solvents to ensure that the multi-channel gradient valve composes multi-solvent mixtures accurately and reproducibly.

There is no general rule for degassing solvents. The helium flow and purge duration will depend on which solvent you are using and how gas-saturated it is. It will also depend on the flow rate and solvent composition required for your application.

During operation we recommend that you continuously bubble helium at a low flow rate through each solvent. This prevents atmospheric gases diffusing back into the solvent reservoirs and dissolving in the solvents. A very high helium flow is *not* recommended as it oversaturates the solvents with helium.

Turning On Pump

When you press (PUMP ON/OFF) the pump is turned on, a self check is done and the pump pistons move to their starting positions. (The same occurs when the preset flow rate is 0 and the pump is turned on after an error, system failure or a RESET is done). This is a good point at which to explain in more detail exactly how the pump works.

Figure 1-1 shows a cross section of the pump when it is in the starting position.

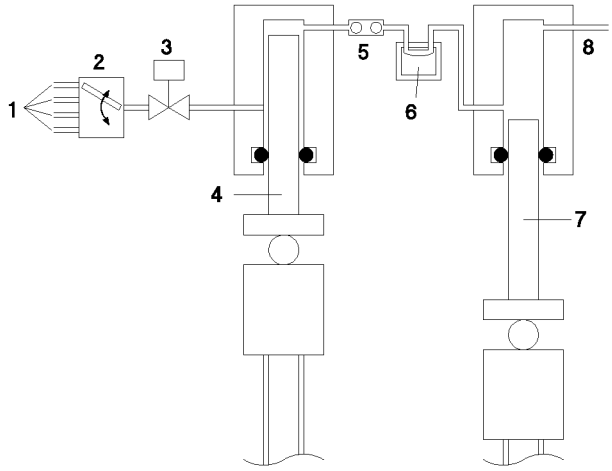

Figure 1-1. Cross Section of Pump

1 solvent inlets
2 gradient valve
3 inlet valve
4 first piston
5 outlet valve
6 damping unit
7 second piston
8 solvent outlet

At the beginning of the pump cycle the first piston is in its starting position. The pump now opens the active inlet valve and withdraws the first piston, drawing solvent into the pump head through the gap between the piston and cylinder wall.

When the first piston reaches the bottom of its stroke, the pump closes the active inlet valve. The pump motor reverses its direction of motion, driving the first piston into the cylinder and at the same time withdrawing the second piston.

In this phase of the pump cycle the first piston forces the solvent past the spring-loaded outlet valve, through the pressure damper (where the pressure is measured) into

the cylinder of the second piston. As the volume of the second is only half the volume of the first, half of the solvent flows straight through onto column, the other half fills the second cylinder.

The first piston has returned to its starting position, marking the end of the pump cycle. In the first phase of the next cycle, when the first piston is drawing in solvent, the second piston forces solvent onto the column.

Purging Each Channel

Use the purge function of the pump to drive any gas bubbles out of the pump cylinders. When you use the purge function, the pump delivers the maximum flow possible given the set pressure limit, using the maximum stroke length for the piston to ensure gas bubbles are driven out of the cylinders. Use the preset maximum flow setting of 5 ml/min, this flow is satisfactory for most solvents.

The maximum pressure limit for the purge function is preset to the same value as the pressure limit you set using the (PRESS) key. This is preset to 400 bar. If this is a safe limit for your column you can use the purge function straight away, without having to disconnect your column or set any other parameters. It is faster to purge gas bubbles out of the pump when the column is disconnected.

The pump's dual-piston in series design makes purging gas bubbles out of the cylinders easy. If there is a gas bubble in the first cylinder, the system pressure drops to near zero, allowing the first piston to drive out the bubble against minimum resistance. In contrast, a dual-piston in parallel designed pump must always compress gas and liquid to full system pressure, making it difficult to expel the bubble.

The damping unit measures the pressure, and also prevents pressure drops when the pistons change direction. The damping unit is synchronized with the pump motor so that it measures the pressure at specific points during the pumping cycle. For example, at the

beginning of the cycle, at the center of the piston's stroke, etc.

The pump uses these measurements to construct a profile of pressure against time. If this profile changes at any time, then the pump knows that there are probably bubbles in the system and will display an appropriate message. The pump can also distinguish between different profiles. The pressure profile when a bubble is in the first piston is different from the profile when the inlet valve leaks or when the outlet valve leaks.

Purging With Mobile Phase

If you are using your pump for the first time or you have not used it for some time, always prime the pump as described in Chapter 1 of your *Installation and Maintenance Guide*. If your pump has been left overnight with solvent in the reservoirs and inlet tubing, you can use the solvents from the previous day to prime the pump. Always degas first and purge with the aqueous solvent first and last.

When the inlet tube from the aqueous solvent is empty, we suggest that you prime the channel with an alcohol first because water has a high surface tension and it will take your pump a long time to draw the aqueous solvent into the pump head.

Monitoring Pressure

The pump's pressure output is not only an excellent tool when troubleshooting, it's also useful to check quickly whether the pump is working correctly. Simply move the analog signal cable from your detector's output to the pump's output.

Remember that the potential of the pressure output is 2 mV/bar and is offset by 30 mV. The offset means that 0 bar is equivalent to 30 mV.

NOTE

You can also monitor the pressure using the PUMP PRESSURE RIPPLE function which is located in the TEST functions. See Chapter 1 in your *Installation and Maintenance Guide*.

2

Your First Analysis

This chapter describes how to set up parameters and run your first analysis.

Setting the Pressure Limit

Choose an upper pressure limit at which the pump will turn itself off, protecting your column against over-pressure.

Press [PRESS] to display

```
UPPER LIMIT  400
  (press    0bar)
```

You can set the upper pressure limit to any value from 1 through 400 bar. For example, to set the limit to 200 bar, press [2] [0] [0] to display

```
UPPER LIMIT  200
  (press    0bar)
```

and then press [ENTER].

The actual pressure is displayed in the second line.

Lower Pressure Limit and Pressure Units

In addition to the upper pressure limit, the [PRESS] key also gives you access to two further functions; the lower pressure limit that turns off the pump when the pressure drops below this limit, and a choice of pressure units.

Press [PRESS] to display

```
UPPER LIMIT  400
  (press    0bar)
```

Now press [NEXT▼] to display

```
LOWER LIMIT  0
  (press    0bar)
```

You can set the lower pressure limit to any value from 1 through (P−1) bar, where P is UPPER LIMIT of the pressure setting. The lower limit setting becomes active when the actual pressure exceeds the lower limit by more than 10%.

Now press [NEXT▼] to display

```
PRESSURE UNITS
     bar (psi;MPa)
```

To change the units of pressure, press [▶], then [NEXT▼] or [PREV▲] and press [ENTER]. The pump will now display pressure values in the units you have selected. You can set the units of pressure to bar, psi (pounds per square inch) or MPa (megaPascal). Use Table 2-1.

Table 2-1. Conversion Table

Bar	psi	MPa	N/m^{-2}	$dynes/cm^{-2}$
1	14.5	0.1	$1.0x10^{5}$	$1.0x10^{6}$

Setting the Flow

Set flow rate for your analysis.

Press [FLOW] to display

```
FLOW 0.000 ;0.000
   (press    0bar)
```

If the upper pressure limit is less than 200 bar, you can set the flow to any value from 0 through 10 ml/min. If the upper pressure limit is greater than 200 bar, you can set the flow to any value from 0 through 5 ml/min. For example, to set the flow to 1.5 ml, press [1] [·] [5] to display

```
FLOW 1.5   ;0.000
    (press    0bar)
```

and then press [ENTER].

The actual flow is displayed after the semicolon (;) and the actual pressure is displayed in the second line.

NOTE

To increase the flow above 5 ml/min, reduce the maximum pressure to a value below 200 bar.

Compressibility Factor and Stroke Volume

In addition to the flow, the [FLOW] key also gives you access to two further functions; the compressibility factor and the stroke volume.

Press [FLOW] to display

```
FLOW  0.000;0.000
    (press    0bar)
```

Now press [NEXT▼] to display

```
 COMPRESSIBILITY
    100    E-6/bar
```

You can set the pump to compensate for the compressibility of the mobile phase. The pump compensates for the compressibility of the mobile phase by increasing the stroke volume. For example, if the stroke volume of the first piston is set to 100 μl, the actual stroke volume will be up to a maximum of 108 μl, depending on the compressibility factor that you set and the measured pressure. You can set the compressibility factor from 1×10^{-6} through 150×10^{-6} per bar, or you can turn off the compressibilty compensation by setting a value of 0.

Increasing the stroke volume compensates for the compressibility and ensures delivery of the correct volume of mobile phase, making the flow independent of the back-pressure.

Table 2-2 gives you compressibility values for common solvents used in HPLC. If you do not know the

compressibility of the mobile phase you are using, try varying the compressibility compensation until you find the best setting for your application. This can be determined by minimizing the pressure ripple, using the PUMP PRESSURE RIPPLE function which is located in the TEST functions.

Table 2-2. Compressibility Values

Solvent	Compressibility (10^{-6} per bar)
Acetone	126
Benzene	95
Carbon tetrachloride	110
Chloroform	100
Cyclohexane	118
Ethanol	114
Ethyl acetate	104
Heptane	120
Hexane	150
Isobutanol	100
Isopropanol (2-Propanol)	100
Methanol	120
1-Propanol	100
Toluene	87
Water	46

When you set the compressibility factor to 0, the pump makes no compensation for the compressibility of the mobile phase or for the elasticity of the system (piston seals, valve seats, etc.). Note that otherwise the pump compensates for the elasticity of the system.

Now press (NEXT▼) to display

```
STROKE   AUTO ul
         ;  42 ul
```

You can set the stroke volume of pump to AUTO (automatic) or a value up to 100 µl. When the stroke is set to AUTO, the pump selects a stroke volume based on the set flow rate (this stroke volume is displayed on the second line).

If you wish you can set the stroke volume yourself, up to a maximum of 100 µl, you cannot set stroke volumes to values less than the pump's AUTO value for the set flow rate).

The amplitude of the pressure pulsation is directly proportional to the stroke volume. Decreasing the stroke volume decreases the pulsation amplitude, giving a better signal-to-noise ratio with flow-sensitive detectors. To maintain the flow, the pumping frequency is increased, increasing the frequency of the pressure pulsation. Increasing the pump frequency gives better peak area reproducibility at low flow rates.

Pumps of fixed-stroke design give constant pressure pulsation at all flow rates. The HP 1050 Series pump, with its variable-stroke design, gives less pulsation at lower flow rates for better relative standard deviation of peak retention times and areas.

Smaller stroke volumes effect better mixing of solvents. For example, with an equivolume quaternary composition, 25 µl of each solvent must be mixed when the stroke volume is 100 µl. Decrease the stroke volume to 20 µl and only 5 µl of each solvent must be mixed; smaller volumes ensure better mixing. This gives a better signal-to-noise ratio with UV-absorbing mixtures.

A pump with a smaller stroke volume can also better follow a gradient profile than a pump with a larger stroke. This is because a smaller stroke volume creates smaller gradient steps (changes in composition) than a larger volume.

With the quaternary pump you cannot use small stroke volumes (< 100 µl) at high flow rates (> 5 ml/min). This restriction is a function of the multi-channel gradient

valve, that cannot switch fast enough between channels at such a high pump frequency.

Setting the Column Temperature

You can set a column heater temperature which is maintained for your column during an analysis.

To set the column temperature, press (COL TEMP) to display

```
COLUMN TEMP.
   OFF ; 24.6 C
```

You can set the column temperature to any value from 10 to 85°C and the corresponding value in °F and K. You can change the value by increments of 0.1°C.

Press (NEXT▼) to display

```
TEMP. UNITS
   C     < K F >
```

You can set the temperature units to °C, °F, or K.

The column heater lamp shows the column heater status.

Lamp State	Column Heater Status
off	Temperature control OFF
yellow	ON and not ready
green with flashing yellow	ON and ready, indicating power use
red	ERROR state

NOTE

If the column heater temperature is outside the ready range of ± 1.5°C the column heater lamp remains yellow.

Setting the Solvent Composition (Quaternary Pump)

Set solvent composition for your analysis.

Press (%) to display

```
%B 20 C 30 D 0
 ; 20  30  0    >
```

You can set the percentages of channel B, C and D to any value from 0 through 100%. To turn off a channel, move cursor to channel and press (NEXT▼) or (PREV▲). For example, to set the composition to 70% of channel B, press (7) (0) and press (ENTER).

Your pump will display

```
%B  70          C
 ;  0             >
```

The > at the end of the second line tells you to press the (▶) key to access the entry fields for channel C and D.

Channel A always delivers the remaining volume; 100 - (%B+ %C+ %D). The actual composition is shown in the second line.

CAUTION

If buffers are mixed with organic solvents, crystallization can take place at the mixing point in the multi-channel gradient valve, even if the saturation point is not reached. To avoid this problem, use the lowest buffer concentration possible. We recommend to premix the highest buffer concentration which is used in the organic channel.

VORSICHT

Wenn Puffer mit organischen Lösungsmitteln gemischt werden, kann es an der Mischstelle im Mehrkanal-Gradientenventil zur Kristallisation kommen, selbst wenn der Sättigungspunkt nicht erreicht ist. Um dieses Problem zu vermeiden, verwenden Sie die geringstmögliche Pufferkonzentration. Es empfiehlt sich, die höchste Pufferkonzentration, die im organischen Kanal verwendet wird, vorzumischen.

PRECAUCION

Si se mezclan soluciones tampón con disolventes orgánicos, puede producirse una cristalización en el punto de mezcla de la válvula de gradiente multi-canal, incluso aunque no se alcance el punto de saturación. Para evitar este problema, utilice la concentración de solución tampón lo más baja posible. Se recomienda mezclar previamente la máxima concentración de solución tampón que se utilice en el canal orgánico.

ATTENTION

Si les solutions tampons sont mélangées à des solvants organiques, une cristallisation peut avoir lieu à l'emplacement du mélange dans la valve à gradienet multicanaux, bien que le point de saturation ne soit pas atteint. Pour éviter ce problème, la concentration de la solution tampon doit être la plus faible possible. Il est conseillé de procéder à un prémélange de la solution tampon à la plus haute concentration utilisée dans le canal organique.

ATTENZIONE

Se i tamponi vengono mescolati con solventi organici, nel punto di miscelazione della valvola a gradiente multicanale può avere luogo una cristallizzazione, anche se non viene raggiunto il punto di saturazione. Per evitare questo problema, impiegare la minima concentrazine tampone possibile. Si consiglia di premescolare la massima concentrazione tampone, che viene utilizzata nel canale organico.

VOORZICHTIG

Wanneer de buffers worden vermengd met organische oplossingen kunnen kristallen op het mengpunt in de meerkanaals vervalklep worden gevormd, zelfs als het verzadigingspunt nog niet is bereikt. Om deze problemen te voorkomen, moet de laagst mogelijke bufferconcentratie worden gebruikt. Wij adviseren om de hoogste bufferconcentratie die in hete organische kanaal wordt gebruikt, vooraf te mengen.

The multi-channel gradient valve, located between the solvent reservoirs and the active inlet valve, controls

the composition of your mobile phase. On the intake stroke of the first piston, the gradient valve opens each port according to the % values that you have set. For example, with a stroke volume of 100 μl, the gradient valve makes an equivolume mixture by allowing 25 μl of each channel into the pump on the intake stroke.

A mixing chamber is not necessary; the fluid vortexes that occur between the pistons and cylinder walls and at the head of the pistons effect satisfactory mixing.

The (%) key also gives you access to a function that sets the order in which multi-solvent mixtures are composed.

Press (%) to display

```
%B25.C25 D25.
; --.-  --.-  --.-
```

Now press (NEXT▼) to display

```
PRIMARY
  CHANNEL    A
```

You can set the primary channel to A, B, C, D or AUTO. The primary channel is always the first channel from which solvent is drawn on the intake stroke of the pump. When you set the primary channel to AUTO, the first channel is always the channel with the highest %-value in the % line, minimizing composition errors caused by variations in fill rate when the inlet valve opens at the start of the intake stroke.

Setting Up An Elution Gradient (Quaternary Pump)

An elution gradient is a linear change in the solvent composition over a period of time. To set up an elution gradient, you need to do 2 things; first, set the initial solvent composition ([%] key), second, set the change in solvent composition and the time after injection when this composition must be reached ([TIMETABLE] key).

For example, let us set up a binary gradient, starting with 10% of channel B, changing to 90% of channel B after 5 minutes.

Setting the Initial Composition

Press [%] to display

```
%B   OFF       C
 ;   --.-       >
```

Now press [1] [0] and then [ENTER] to display

```
%B   10        C
 ;    0         >
```

Setting the Gradient

Press [TIMETABLE] to display

```
(timetable
          is empty)
```

followed by

```
NEW        0 min :
```

Now press [5] to set the time, and then [%] [9] [0] to set %B to 90 and press [ENTER]. Ensure that all time programmed channels are set to at least 0% in the % line.

```
AT    5.00 min :
   %B  90.0
```

Starting the Gradient

You can start the gradient by pressing (START) (ENTER). However, to synchronize operation of your chromatographic system, we recommend that your injector sends a start signal to the pump when it injects your sample. Refer to your *Installation and Maintenance Guide* for details of how to connect remote control cables.

Stopping the Gradient

You can stop the gradient by pressing (STOP) (ENTER) or by setting a time limit ((STOP TIME)). Or, you can set another module in your chromatographic system to send a stop signal.

When you stop the gradient, the pump reverts back to delivering the initial solvent composition (90% of A and 10% of B).

In our previous example we showed you how to set up a simple binary elution gradient, starting with 10% of channel B, changing to 90% of channel B after 5 minutes. This is an example of a ramp gradient, the composition changing continuously during the elution. Using the timetable you can also program gradients in which the composition is held constant at certain points of the gradient.

Let us suppose you want to start with an initial solvent composition of 90% of A and 10% of B, changing linearly to 50% of A and 50% of B over 2 minutes, remaining at this composition for 1 minute and finally changing to 10% of A and 90% of B after a total run time of 5 minutes.

For this example of a stepped gradient, set the initial composition ((%)) to display

```
%B    10.0   C
   ;   0.0   >
```

and the timetable as follows

(TIMETABLE)

```
AT     2.00 min:
   %B   50.0
```

(NEXT▼)

```
AT     3.00 min:
   %B   50.0
```

(NEXT▼)

```
AT     5.00 min:
   %B   90.0
```

Setting a Time Limit

To set a time limit for your analysis, press (STOP TIME) to display

```
STOPTIME   min
  5.00 ;  0.00
```

You can set the time limit to any value from 0 through 99999 min or to OFF, press (NEXT▼) or (PREV▲) for no limit. 0 is the same as OFF. The elapsed time during analysis is displayed after the semicolon.

When the STOPTIME is reached, any parameter settings changed using a timetable revert back to their initial setting.

To stop an analysis you can set the STOPTIME or set another module in your chromatographic system to send a stop signal through remote control connections. See *Installation and Maintenance Guide* for details of how to connect remote control cables.

Using Posttime

The (STOP TIME) key also gives you access to the POSTTIME function.

Press (STOP TIME) to display

```
STOPTIME   min
  OFF  ;  0.00
```

Now press (NEXT ▼) to display

```
POSTTIME   min
  0.0  ;  0.00
```

You can set the POSTTIME to any value from 0 through 99999 min or to OFF, press (NEXT ▼) or (PREV ▲) for no limit. The remaining time during POSTTIME is displayed after the semicolon.

Use the POSTTIME to allow your column to equilibrate after changes in solvent composition (after gradient elution, for example). Or, use the POSTTIME to wait for your recording device to finish printing a report, if the device is not able to inhibit an injection through the REMOTE connector.

Saving Your Parameters

You can save the parameters UPPER LIMIT (pressure limit), FLOW, % (solvent composition for quaternary pump), STOPTIME and the TIMETABLE, that you have just set, with the parameters LOWER LIMIT, COMPRESSIBILITY, STROKE, PRIMARY CHANNEL (for quaternary pump), PRESSURE UNITS, POSTTIME, CONTACT1 and CONTACT2 and COLUMN TEMP. in a method.

To save your parameters, press (METHOD) to display

```
LOAD METH # 1
(actual is   #-*)
```

Press (NEXT▼) to display

```
STORE METH # 1
(actual is   #-*)
```

and then press (ENTER).

Your pump will save the current parameters in method #1. The pump has a battery so that stored methods are not lost when you turn off line power.

You can store up to 10 methods, numbered 1 through 10, in memory. Five test methods, numbered T1 through T5,

are stored in memory. You can load these test methods, but you cannot modify them.

The (METHOD) key also gives you access to other functions with which you can load, store, delete, modify and display methods.

Loading a Method

To load a method, press (METHOD) to display

```
LOAD   METH # 1
(actual is #--*)
```

Set number of method you want to load by pressing (▶) and then a number key or (NEXT ▼) or (PREV ▲) and press (ENTER).

```
LOAD   METH # 2
(actual is # 2 )
```

The current parameters are now the same as those in the stored method. The second line displays the number of the method that you loaded last. As soon as you change one of the current parameters, the second line will display an asterisk (*) after the number of the method you loaded last (actual is # 2*)

If you try to load a method that you have not already stored, your module displays

```
not existing
```

Storing a Method

To store a method, press (METHOD) to display

```
LOAD   METH # 1
(actual is #--*)
```

press (NEXT ▼) to display

```
STORE  METH # 1
(actual is #--*)
```

Set number of method you want to store by pressing (▶) and then a number key or (NEXT ▼) or (PREV ▲) and press (ENTER).

```
STORE  METH # 2
(actual is # 2 )
```

The stored method is now the same as the current parameters. The second line displays the number of the method that you stored last.

If you try to store a method under a number where a method is already stored, your pump displays

```
    existing
```

Either delete this method first, or store the method under a different number.

Under normal operating conditions the electronic memory available for method storage is adequate for 10 methods. If your methods have exceptionally long timetables, you might fill the memory before storing all methods and your pump will display

```
memory full
```

Deleting a Method

To delete a method, press (METHOD) to display

```
LOAD   METH # 1
(actual is #--*)
```

press (NEXT ▼) to display

```
STORE  METH # 1
(actual is #--*)
```

press (NEXT ▼) to display

```
DELETE METH # 1
(actual is #--*)
```

Set number of method you want to delete by pressing (▶) and then a number key or (NEXT ▼) or (PREV ▲) and press (ENTER).

```
DELETE METH # 2
(actual is #--*)
```

If you try to delete a method that you have not already stored, your pump displays

```
not existing
```

You can delete the current timetable using the DELETE key. Press DELETE to display

```
DELETE
 TIMETABLE
```

and press ENTER.

You can also use the DELETE key to delete all methods, press NEXT ▼ to display

```
DELETE
 ALL METHODS
```

and press ENTER.

Modifying a Method

To modify a stored method, press METHOD to display

```
LOAD   METH # 1
(actual is #--*)
```

press NEXT ▼ to display

```
STORE  METH # 1
(actual is #--*)
```

press NEXT ▼ to display

```
DELETE METH # 1
(actual is #--*)
```

press NEXT ▼ to display

```
MODIFY METH # 1
(actual is #--*)
```

Set number of method you want to modify by pressing ▶ and then a number key or NEXT ▼ or PREV ▲ and press ENTER.

```
MODIFY METH # 2
(actual is #--*)
```

You can now modify any of the parameters and timetable of the stored method number 2. To modify a parameter, simply press the appropriate key, for example, STOP TIME and make your changes.

Your pump displays the parameters in lowercase characters to remind you that you are modifying a stored method and not the current parameters.

For example, press STOP TIME to display

```
stoptime    min
  ON   ;  0.00
```

change the time and press ENTER.

When you have finished modifying the stored method, press METHOD then NEXT ▼ several times to display

```
end modify    1
(actual is #--*)
```

and press ENTER.

If you try to modify a method that you have not already stored, your pump displays

```
not existing
```

Displaying a Method

To display the actual method, press METHOD to display

```
LOAD   METH # 1
(actual is #--*)
```

press NEXT ▼ to display

```
STORE  METH # 1
(actual is #--*)
```

press NEXT ▼ to display

```
DELETE METH # 1
(actual is #--*)
```

press (NEXT▼) to display

```
MODIFY METH # 1
(actual is #--*)
```

press (NEXT ▼) to display

```
DISP ACTUAL
(actual is #--*)
```

and press (ENTER).

Your pump will now display the first line of the actual method. Press (NEXT ▼) repeatedly to display each line of the actual method. Press any other key to stop displaying the actual method.

Starting the Analysis

You can start the analysis by pressing (START) (ENTER) on your pump. However, to synchronize operation of your chromatographic system, we recommend that your injector sends a start signal to the pump when it injects your sample. See *Installation and Maintenance Guide* and *Getting It All Together* for details of how to connect remote control cables.

In a chromatographic system it is usually the injector that starts the system when it injects the sample. You can set your pump to be controlled by an injector through the REMOTE connector.

Press (CTRL) to display

```
DATE & TIME
          (enter)
```

and then (NEXT▼) to display

```
CONFIGURATION
          (enter)
```

Now press (ENTER) to display the first of the CONFIGURATION functions

```
PARAMETER LOCK
             OFF
```

and press (NEXT▼) to display

```
REMOTE:LOCAL
(no pulses out)
```

You can set the REMOTE function to LOCAL, GLOBAL or HPsystem.

Set to LOCAL to start the pump's timetable (does not generate start or stop signal's at the REMOTE connector).

Set to GLOBAL to synchronize the start of several instruments for a single analysis (generates start and stop signals at REMOTE connector).

Set to HPsystem to allow the HP 1050 Series autosampler to control single analyses and sequences (generates start request as well as start and stop signals at the REMOTE connector).

See *Installation and Maintenance Guide* and *Getting It All Together* for full details of the input and output signals of the REMOTE connector.

3

Becoming An Expert

This chapter describes how to become an expert and master all the functions of your pump.

Checking the Status

Your pump constantly gives you an indication of its status through the status lamps, located above the display. You can get additional information of the pump's status through the [STATUS] key.

For example, press [STATUS] to display

```
prerun
(diagnosis on)
```

This display shows you the status and condition of the pump.

Press [NEXT▼] to display

```
nRdy:
```

This display shows you the current not ready messages (if any).

NOTE

When the NOT READY and/or ERROR lamp is on, press [STATUS] [NEXT▼] to see the not ready or error message. Look for this message in the *Installation and Maintenance Guide* where we will explain what has happened and what to do next.

The Pump's Status

Press [STATUS] to display

```
prerun
(diagnosis on)
```

3

The pump's status can be leak, shutdown, error, pump off, init, purge, prerun, run, or postrun.

In the run status the elapsed time since injection is displayed, for example

```
run          3.50
```

In the postrun status the remaining time until the end of the POSTTIME is displayed, for example

```
postrun    0.50
```

and the RUN lamp will blink.

Not Ready and Error Messages

When a not ready and/or error condition occurs, the NOT READY and/or ERROR lamp will be on. Press [STATUS] and then [NEXT▼] to display the current not ready messages.

Using the Logbook

The logbook is an electronic record of any not ready and error messages and of any events detected by the pump's diagnostics.

To access the logbook, press [STATUS], then press [NEXT▼] several times until your pump displays either

```
(logbook  empty)
```

or the first line of the logbook, for example

```
E01 16:20 28 May
leak detected    >
```

Each entry in the logbook records the event leak detected and the time when the event occurred (16:20 28 May).

You can move through the entries of the logbook using the (NEXT▼) and (PREV▲) keys. You can clear the logbook with one of the reset functions that you access through the (CTRL) key.

Firmware and Hardware

If you press (NEXT▼) to key through the logbook, you will eventually come to

```
firmware 79852
 REV 3.0   3013
```

Always quote the model number (79851 for isocratic or 79852 for quaternary pump) and the firmware revision (3.0 3013) when talking to Hewlett-Packard service personnel.

If you continue to press (NEXT▼), the pump displays the electronic hardware installed in each of the slots at the rear of the pump, for example

```
slot 1
   POWER SUPPLY
```

(NEXT▼)

```
slot 2
   PDC BOARD
```

(NEXT▼)

```
slot 3
   RAD BOARD
```

(NEXT▼)

```
slot 4
   EMPTY
```

(NEXT▼)

```
slot 5
   HRQ BOARD
```

(Quaternary pump only)

(NEXT▼)

```
slot 6
   EMPTY
```

(NEXT▼)

```
slot 7
   CMP BOARD
```


Using the Liquimeter

You access the logbook by pressing (STATUS) and then (NEXT▼). Behind the (STATUS) key there are also some functions that you access with the (PREV▲) key. For example, press (STATUS) (PREV▲) to display

```
total pumped
   liters 121.56
```

The liquimeter is a term we use to describe a function that measures the total volume of liquid delivered by the pump.

The number of liters displayed is the total volume of solvent that the pump has delivered since it was installed or since you reset the liquimeter.

You can reset the liquimeter to 0 with one of the reset functions that you access through the (CTRL) key.

Use the liquimeter as an aid to setting up a preventive maintenance schedule for your pump. For example, make a note of the total number of liters pumped when you change the piston seals. This volume is a benchmark, reflecting the lifetime of the seals for your solvents and application. Check the liquimeter values at regular intervals and change the seals when the value approaches the benchmark. Changing the seals in advance will prevent you having to repeat analysis, because of leaking seals.

Monitoring the Active Channel (Quaternary Pump) and Active Piston

To monitor the active piston and channel, press [STATUS] [PREV▲] [PREV▲] to display

```
currently active
   piston
```

This function shows the currently active piston.

and then press [PREV▲] to display

```
currently active
   channel A
```

This function shows the channel of the multi-channel gradient valve that is currently drawing solvent from the reservoir. If an asterisk (*) is displayed, this means that the gradient valve is switching at a higher frequency than the pump can update the display.

Controlling External Devices

RELAY CONTACT 1 provides fused 24 V DC voltage, 0.25 Amp DC maximum. You can set this output at any time using the [CONTACT] key, or you can program the output to change during a run by a timetable entry. The same applies to RELAY CONTACT 2 that provides a fused 30 V AC/DC 0.25 Amp rated contact closure. For details of how to connect the RELAY CONTACT connectors, see *Installation and Maintenance Guide.*

You can control external devices through the RELAY CONTACT connectors on the rear of your pump.

To set RELAY CONTACT 1, press [CONTACT] to display

```
CONTACT1
  OFF   ; OFF
```

then press [▶] followed by [NEXT▼] or [PREV▲] to set ON or OFF and press [ENTER].

To set RELAY CONTACT 2, press [CONTACT] [NEXT▼] to display

```
CONTACT2
  OFF   ; OFF
```

then press ▶ followed by NEXT▼ or PREV▲ to set ON or OFF and press ENTER.

You can also program RELAY CONTACT 1 and 2 to be ON or OFF at specific times during an analysis by using the timetable. For example, in the timetable press 2 to set the time, and then CONTACT ▶ NEXT▼ and press ENTER.

```
AT 2.00 min :
  CONTACT1    ON
```

This will turn on RELAY CONTACT 1 at 2 min after the start of your analysis.

What External Devices Can Be Controlled?

You can use the 24 V DC output of RELAY CONTACT 1 to switch a relay. You can use the 30 V AC/DC 0.25 Amp rated contact closure of RELAY CONTACT 2 to drive valve solenoids.

Before you use RELAY CONTACT 1 or 2, ensure that the voltage and current ratings of your device match the ratings of the outputs.

Setting Up a Flow Gradient

A flow gradient is a linear change in the flow rate over a period of time. To set up a flow gradient, you need to do 2 things; first, set the initial flow rate (FLOW key), second, set the change in the flow and the time after injection when this flow must be reached (TIMETABLE key).

For example, let us suppose that all but one of your peaks elute satisfactorily within 2 minutes at a flow of 1.5 ml/min, but that the last peak elutes much later. To shorten the total analysis time you can increase the flow after 2 minutes.

NOTE

The flow is updated at the end of each stroke, at low flow rates the flow update rate is slow. If a flow rate of 0 is entered in the timetable, the pump will stop when this setting is reached in the timetable.

Setting the Initial Flow

Press (FLOW) to display

```
FLOW  0.000;0.000
    (press  0bar)
```

Press (1) (.) (5) to display

```
FLOW  1.5  ;0.000
    (press  0bar)
```

and press (ENTER).

Setting the Gradient

The flow should remain constant for the first 2 min; in the timetable press (2) to set the time and then (FLOW) (1) (.) (5) to set the flow and press (ENTER).

```
 AT 2.00 min :
FLOW 1.500ml/min
```

Set next line of timetable to display

```
 AT 3.00 min :
FLOW 3.500ml/min
```

After 2 min the flow will increase linearly, reaching 3.5 ml/min after a further 1 minute.

Flow gradients have fairly limited use. They are used mainly to shorten the retention time of late eluting peaks by increasing the flow after the early-eluting peaks have passed through the column.

Securing the Keyboard

To secure the keyboard, press (CTRL) to display

```
DATE & TIME
          (enter)
```

(NEXT▼) to display

```
CONFIGURATION
          (enter)
```

(ENTER) to display

```
PARAMETER LOCK
            OFF
```

Press (▶) (NEXT▼) to display ON and press (ENTER).

To release the keyboard, set

```
PARAMETER LOCK
            OFF
```

and press (ENTER).

Securing your keyboard protects your analysis from inadvertent parameter changes by yourself or others in your laboratory. When you set the PARAMETER LOCK to ON, you cannot change any of the current parameters or stored methods and timetables.

You still have access to the PARAMETER LOCK function so that you can set it to OFF when you resume operation. Turning off line power to your module resets the PARAMETER LOCK function to OFF.

Controlling the Flow Diagnostics

To control the flow diagnostics, press CTRL to display

```
DATE & TIME
          (enter)
```

NEXT▼ to display

```
CONFIGURATION
          (enter)
```

ENTER to display

```
PARAMETER LOCK
            OFF
```

NEXT▼ to display

```
REMOTE: LOCAL
(no pulses out)
```

NEXT▼ to display

```
COMMUNICATION
        (enter)
```

NEXT▼ to display

```
DIAGNOSIS
        LEVEL 1
```

Diagnosis Function

You can set the diagnosis function to 0, 1, 2 or 3.

If set to 0, the diagnosis function is OFF.

The flow diagnostic function is preset to 1, entering a message in the logbook when a diagnosed error such as `gas bubble found` occurs.

If the diagnostic function is set to 2, a logbook entry is made, the not-ready lamp is on and a not ready signal occurs. This prevents further injections during automated operation.

We recommend that you only set the flow diagnostic function to 2, when you are sure that you have optimized

the compressibility compensation. If you have not optimized the compensation, the pump could falsely diagnose a gas bubble or leak and generate a not-ready signal unnecessarily.

3

If the diagnostic function is set to 3, only the piston's reference position and available stroke are measured.

Checking the Pressure Offset

To check the pressure offset, press [CTRL] to display

```
DATE & TIME
           (enter)
```

[NEXT▼] to display

```
CONFIGURATION
           (enter)
```

[NEXT▼] to display

```
TEST FUNCTIONS
           (enter)
```

Press [ENTER] [NEXT▼] to display

```
CHECK
PRESSURE OFFSET
```

Press [ENTER] to display

```
OPEN OUTLET
and hit    (enter)
```

Remove fitting at pump outlet to release pressure and then press [ENTER] to display

```
PRESSURE OFFSET
VALUE IS -8
```

Adjust the pressure offset value using the pressure offset adjustment function, see "Adjusting the Pressure Offset"

Adjusting the Pressure Offset

The pressure offset function allows you to set the pump so that it compensates for electronic drift in the measurement of the pressure.

To adjust the pressure offset, press (CTRL) to display

```
DATE & TIME
          (enter)
```

(NEXT▼) to display

```
CONFIGURATION
          (enter)
```

(ENTER) to display

```
PARAMETER LOCK
            OFF
```

Press (NEXT▼) until you display

```
SET PRESSURE
OFFSET -8;   0
```

You can set the pressure offset to any value from −150 through +150. Set the pressure offset so that the pressure reading is 0 with no flow.

When the flow rate is 0, the pressure reading should also be 0. However, the characteristics of the pressure transducer that measures the pressure might change over time, causing the pressure reading to drift positively or negatively away from 0.

If the pressure reading is higher or lower than 0 with no flow, adjust the pressure offset to bring the reading to 0.

Before adjusting the pressure offset, make sure that the pressure in the pump is 0 by disconnecting the outlet capillary from the pump and waiting until the pressure has stabilized.

Resetting Your Pump

Your pump has several reset functions.

To access these functions, press (CTRL) to display

```
DATE & TIME
        (enter)
```

Press (NEXT▼) until you display

```
RESET FUNCTIONS
        (enter)
```

and press (ENTER).

Now press (NEXT▼) or (PREV▲) to display the reset function that you need.

```
RESET PUMP
(data remains)
```

Turns off the pump and clears compensation and pressure history from memory.

```
RESET LOGBOOK
(clear history)
```

Clears any messages in the logbook. If an error or not ready condition remains, the error or not ready lamp will remain on although the corresponding error message has been cleared.

```
RESET DIAGNOSIS
(clears history)
```

Resets online pressure monitor.

```
RESET LIQUIMETER
(seals changed?)
```

Sets volume-pumped counter to 0. The liquimeter should be reset after new seals have been installed.

Testing Your Pump

Your pump has several test functions. To access these functions, press (CTRL) to display

```
DATE & TIME
        (enter)
```


Press (NEXT▼) until you display

```
TEST FUNCTIONS
        (enter)
```

and press (ENTER).

Now press (NEXT▼) or (PREV▲) to display the test function that you need.

```
PUMPS PRESSURE
RIPPLE   --.-%
```

Displays amplitude of pressure pulsation as a percentage of the system pressure.

```
CHECK
PRESSURE OFFSET
```

Measures and displays current pressure offset value.

```
LOAD FLOW
TEST METHOD
```

Loads special test method for verifying the flow performance of the pump. See Chapter 3 in your *Installation and Maintenance Guide* for details of how to use this test method.

```
LOAD GRADIENT
TEST METHOD
```

Loads special test method for quaternary pump to verify the performance of the multi-channel gradient valve. See Chapter 3 in your *Installation and Maintenance Guide* for details of how to use this test method.

Monitoring the Pressure Ripple

Connecting the pressure monitoring output of your pump to a recording device allows you to monitor the pressure graphically. The display

```
PUMPS PRESSURE
RIPPLE    0.8%
```

gives you the current amplitude of the pressure pulsation as a percentage of the system pressure (note that 0.8% is just a typical value and is merely an example).

Use this reading when you are optimizing the stroke volume and compressibility compensation—it saves you having to measure and calculate the ripple from your recorder chart.

Using the Flow Test Method (Quaternary Pump)

The flow test method has been designed so that you can check the performance of the pump quickly, without needing a complete chromatographic system (injector, column, detector, etc.).

Connect the pressure monitoring output of the pump to a recording device. The plot of the pressure signal gives information about the performance of the pump.

Use this test method as a troubleshooting tool to identify the source of leaks in your pump, refer to Chapter 3 in your *Installation and Maintenance Guide*.

Using the Gradient Test Method (Quaternary Pump)

The gradient test method has been designed so that you can check the performance of the multi-channel gradient valve. To do this test you need an absorbance detector such as the HP 1050 Series variable wavelength detector or multiple wavelength detector.

The gradient test method uses acetone (0.5% in isopropanol) as a tracer to run first a step gradient, testing the step reproducibility and composition precision, and then a linear gradient, testing the linearity of the gradient.

Use this test method as a troubleshooting tool to check the performance of the multi-channel gradient valve,

refer to Chapter 3 in your *Installation and Maintenance Guide*.

Turning Off Automatically

Your pump has two functions that will turn it off automatically, if an error occurs in your pump or in another HP 1050 Series module connected to it.

Press (CTRL) to display

```
DATE & TIME
       (enter)
```

(ENTER) to display

```
DATE 28/May/1992
   TIME   16:20:30
```

(NEXT▼) to display

```
ON ERROR
       SWITCH OFF
```

Set to SWITCH OFF or to USE METHOD#. Set the METH# to any of the stored methods 1 through 10.

If the ON ERROR function is set to USE METH# and error messages for example E04 (time-out occured) occur, your pump loads the specified method.

Now press (NEXT▼) to display

```
TIME-OUT
   60.00     min
```

Set the time to any value from 1 through 99999 min or to OFF.

Turning On Automatically

You can set your pump to be turned on automatically or load a method at a set date and time.

Press (CTRL) to display

```
DATE & TIME
      (enter)
```

Press (NEXT▼) until you display

```
AUTO-ON 0.00 min
   28/May  0.02
```

Set AUTO-ON to the date and time at which you want to turn on your pump.

Press (NEXT▼) to display

```
ON AUTO-ON
    USE METHOD #1
```

Set USE METHOD# to any of the stored methods 1 through 10. If you enter a minus sign (−), a method is not loaded. If AUTO-ON occurs during a run or there is a leak or shutdown, no method is loaded.

Setting the Interface Control

You can set HP-IB or Serial as the pump control interface.

press (CTRL) to display

```
DATE & TIME
      (enter)
```

Press (NEXT▼) to display

```
CONFIGURATION
      (enter)
```

Press (ENTER) and then (NEXT▼) until you display

```
COMMUNICATION
      (enter)
```

Press (ENTER) to display

```
INTERF.:HPIB
  (instr. control)
```

Press (▶) (NEXT▼) to set the pump control interface as HP-IB or Serial.

Press (NEXT▼) to display

```
HPIB ADDR.: 16
  (select address)
```

Press (▶) (NEXT▼) to set the HP-IB address.

Press (NEXT▼) to display

```
SERIAL MODE: A
  (7bit/even/2stp)
```

Press (▶) (NEXT▼) to set serial configuration parameters.

Press (NEXT▼) to display

```
BAUD RATE: 9600
  (serial only)
```

Press (▶) (NEXT▼) to set the baud rate. The baud rate can be 1200, 2400, 4800, 9600 or 19200.

Press (NEXT▼) to display

```
XON/XOFF:    ON
     (enable)
```

Press (▶) (NEXT▼) to set to XON or XOFF.

4

Supplementary Information

This chapter contains supplementary information for your HP 1050 Series Pumping Systems.

For details of warranty and safety, see *Installation and Maintenance Guide*.

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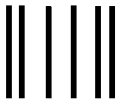

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A

Key Reference

This appendix describes each key on the keyboard of your pump. The description includes the key, the display which appears when you press the key and a short description of the key function.

NEXT▼ PREV▲	If flashing cursor on left of display, NEXT▼ or PREV▲ displays next or previous line of list. If cursor in entry field, enter numeric value, or press NEXT▼ or PREV▲ to display next or previous choice (Apr, May, Jun, etc.), or press NEXT▼ or PREV▲ to turn on or off a function (contact 1 off or contact 1 on).
▶	Moves cursor to next entry field on right.
◀	Moves cursor to previous character or entry field on left.
ENTER	Enters value of parameter or function currently displayed. Press ESC to display original value of parameter or function.
ESC	Displays original value of parameter or function.
0 to 9	Displays number 0 to 9 in numeric entry field.
.	Displays decimal point (·) in numeric entry field.
−	Displays minus sign (−) in numeric entry field.

(START)

```
START
   LOCAL   (enter)
```

(ENTER) starts timetable.

```
START
   GLOBAL  (enter)
```

(ENTER) starts timetable, sends start signal (makes contact between pins 1 and 3 of REMOTE connector for 125 ms).

```
START
  HPsystem (enter)
```

(ENTER) sends start request signal (makes contact between pins 1 and 9 of REMOTE connector for 125 ms.

A

(STOP)

```
STOP
   LOCAL    (enter)
```

(ENTER) stops timetable. Parameters revert back to initial settings.

```
STOP
   GLOBAL   (enter)
```

(ENTER) stops timetable. Parameters revert back to initial settings, sends stop signal (makes contact between pins 1 and 8 of REMOTE connector for 125 ms.)

```
STOP
   HPsystem (enter)
```

(ENTER) stops timetable. Parameters revert back to initial settings, sends stop signal (makes contact between pins 1 and 8 of REMOTE connector for 125 ms).

PUMP ON/OFF	If pump off:
	`SWITCH PUMP ON ?`
	`(enter)`
		ENTER turns on pump.

	If pump on:
	`SWITCH PUMP OFF ?`
	`(enter)`
		ENTER turns off pump.

PURGE	`PURGE MODE ON ?` `(enter)`	ENTER turns on purge.
	NEXT▼ displays	
	`PRmax 400 bar` `CHANNEL ALL`	Set pressure limit PRmax to safe limit for your column between 0 and 400 bar. Press NEXT▼ or PREV▲ to set CHANNEL to be purged to ALL, A, B, C or D.
	NEXT▼ displays	
	`FLmax 5.000` `ml min`	Set maximum flow.

A

FLOW	FLOW 0.000;0.000 (press 0bar)	Set flow to value between 0 and 10 ml/min. If pressure is greater than 200 bar, set flow between 0 and 5 ml\min. Actual flow displayed after semicolon (;) Actual pressure (press) displayed on second line.
	NEXT▼ displays	
	COMPRESSIBILITY 100 E-6/bar	Set pump to compensate for compressibility of mobile phase to 0 or from $1x10^{-6}$ through $150x10^{-6}$ per bar.
	NEXT▼ displays	
	STROKE AUTO ul ; 20 ul	Set stroke volume of pump to AUTO or a value up to 100 μl. For a given flow, you cannot set stroke volumes to values less than pump's AUTO value.
COL TEMP	COLUMN TEMP. OFF ; 24.6 C	Sets column heater to required column temperature from 10 to 85 °C.
	NEXT▼ displays	
	TEMP. UNITS C < K F >	Sets temperature units to °C ° F or K.

A

(%)

```
%B 0.0C 0.0D 0.0
 ;  0.0  0.0  0.0
```

Set each channel to value from 0 to 100% or to OFF. Actual composition shown on second line.

(NEXT▼) displays

```
 PRIMARY
     CHANNEL A
```

Set primary channel to A, B, C, D or AUTO (highest % value) for first channel from which solvent is drawn on intake stroke.

(PRESS)

```
UPPER LIMIT   200
   (press     0bar)
```

Set upper pressure limit at which pump should turn off between 1 and 400 bar.

(NEXT▼) displays

```
LOWER LIMIT     0
   (press     0bar)
```

Set lower pressure limit at which pump should turn off between 0 and 1 less than upper limit.

(NEXT▼) displays

```
PRESSURE UNITS
   bar  (psi;MPa)
```

Set pressure units to units of your choice; bar, psi or MPa.

CONTACT

```
CONTACT 1
      OFF    ; OFF
```

Set contact 1 to on or off. When on, relay contact 1 provides fused 24 V DC voltage, 0.1 Amp DC maximum.

NEXT▼ displays

```
CONTACT 2
      OFF    ; OFF
```

Set contact 2 to on or off. When on, relay contact 2 provides a fused 30 V AC/DC 0.1 Amp rated contact closure.

STOP TIME

```
STOPTIME   min
    0.00  ; 0.00
```

Set time limit for analysis from 0 to 99999 min. Press NEXT▼ or PREV▲ to set stoptime to off (no limit). 0 is same as off. Elapsed time during analysis dispalyed after semicolon.

NEXT▼ displays

```
POSTTIME   min
    0.00  ; 0.00
```

Set posttime from 0 to 99999 min. Press NEXT▼ or PREV▲ to set posttime to off (no limit). Remaining time during posttime displayed after semicolon.

(METHOD)

```
LOAD   METH # 1
  (actual is #--*)
```

(ENTER) loads method.

(NEXT▼) displays

```
STORE  METH # 1
  (actual is #--*)
```

(ENTER) stores method.

(NEXT▼) displays

```
DELETE METH # 1
  (actual is #--*)
```

(ENTER) deletes method.

(NEXT▼) displays

```
MODIFY METH # 1
  (actual is #--*)
```

(ENTER) allows you to modify parameters of stored method.

(NEXT▼) displays

```
DISP ACTUAL # 1
  (actual is #--*)
```

(ENTER) displays first line of actual method. Press (NEXT▼) to display further lines. Press any to stop.

STATUS

```
prerun
  (diagnosis on  )
```

Status of pump.

NEXT▼ displays

```
nRdy:
```

Current not ready messages.

NEXT▼ displays

```
logbook empty
```

Or first line of logbook. Press NEXT▼ to key through logbook.

NEXT▼ displays

```
firmware 79852
    rev 3.0   3013
```

Model number and firmware revision.

NEXT▼ displays

```
slot 1
POWER SUPPLY
```

Hardware in slot 1.

NEXT▼ displays

```
slot 2
   PDC BOARD
```

Hardware in slot 2.

NEXT▼ displays

```
slot 3
   RAD BOARD
```

Hardware in slot 3.

A

(NEXT▼) displays

`slot 4` `EMPTY`	Hardware in slot 4.

(NEXT▼) displays

`slot 5` `HRQ BOARD`	Hardware in slot 5.

(NEXT▼) displays

`slot 6` `EMPTY`	Hardware in slot 6.

(NEXT▼) displays

`slot 7` `CMP BOARD`	Hardware in slot 7.

(STATUS) (PREV▲) displays

`total pumped` `liters 121.56`	Total volume of liquid pumped since liquimeter reset.

(PREV▲) displays

`currently active` `piston`	Displays currently active piston.

(PREV▲) displays

`currently active` `channel A`	Displays A, B, C, D or * if switching frequency higher than display update.

CTRL

```
DATE & TIME
          (enter)
```

ENTER to access date & time functions, see below.

NEXT▼ displays

```
CONFIGURATION
          (enter)
```

ENTER to access configuration functions, see below.

NEXT▼ displays

```
TEST FUNCTIONS
          (enter)
```

ENTER to access test functions, see below.

NEXT▼ displays

```
RESET FUNCTIONS
          (enter)
```

ENTER to access reset functions, see below.

A

DATE & TIME

```
DATE 10/Feb/1989
   TIME   16:20:30
```

Set date and time.

NEXT▼ displays

```
ON ERROR
       SWITCH OFF
```

Sets module to switch off or load a method when an error occurs.

NEXT▼ displays

```
TIME-OUT
   0.00      min
```

Sets timeout when not ready condition present for specified time.

CONFIGURATION

```
PARAMETER LOCK
              ON
```

(ENTER) to lock keyboard.

(NEXT▼) displays

```
REMOTE: LOCAL
(no pulse out  )
```

Set to LOCAL, GLOBAL or HPsystem.

(NEXT▼) displays

```
COMMUNICATION
         (enter)
```

Sets the HP-IB or Serial interface.

(NEXT▼) displays

```
DIAGNOSIS
       LEVEL   1
```

Set to 1 or 2. 1 enters events in logbook. 2 enters events in logbook and sends not ready signal.

(NEXT▼) displays

```
SET PRESSURE
  OFFSET   0;    0
```

Set offset from −150 to +150.

A

TEST functions

PUMPS PRESSURE RIPPLE --.-%	Displays amplitude of pressure pulsation as percentage of system pressure.
(NEXT▼) displays	
CHECK PRESSURE OFFSET	(ENTER) and follow instructions displayed.
(NEXT▼) displays	
LOAD FLOW TEST METHOD	Loads flow test method.
(NEXT▼) displays	
LOAD GRADIENT TEST METHOD	Loads gradient test method.

A

RESET functions	RESET PUMP (data remains)	(ENTER) turns off pump and clears compensation and pressure history from memory and restarts pump.
	(NEXT▼) displays	
	RESET LOGBOOK (clear history)	Clears any messages from logbook.
	(NEXT▼) displays	
	RESET PARAMETER (default values)	Resets parameters to default values.
	(NEXT▼) displays	
	RESET DIAGNOSIS (clear history)	Resets online pressure monitor.
	(NEXT▼) displays	
	RESET LIQUIMETER (seals changed?)	Sets volume-pumped counter to 0.

B

Using The Injection Valve

In this appendix we will describe how to use the injection valve. If your solvent/injector cabinet does not have an injection valve, you can ignore this appendix .

If you are about to use the injection valve for the first time, we recommend that you clean the needle port and then clean the passages of the valve.

A Quick Look Inside

The injection valve has six ports and can be moved manually between 2 positions. In the LOAD position, the mobile phase is led from the pump directly to the column, allowing you to inject your sample into the sample loop. In the INJECT position, the mobile phase is led through the sample loop, flushing the contents of the loop onto the column.

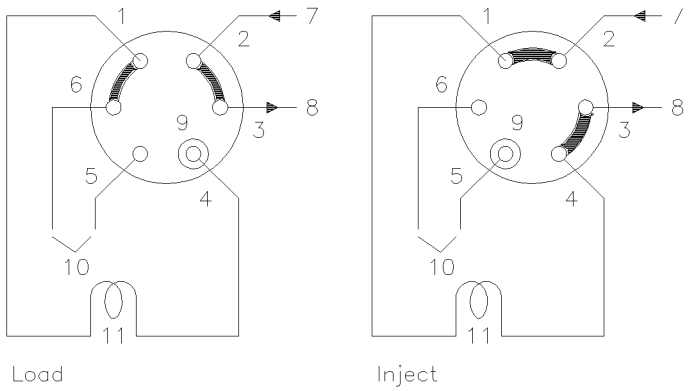

Figure B-1. Valve Positions

1-6 valve ports
7 inlet (from pump)
8 outlet (to column)
9 needle port
10 vents
11 sample loop

B

Cleaning the Needle Port

1. Connect needle port cleaner to a Luer tip (not Luer lock) syringe of at least 2 ml capacity.
2. Fill syringe with mobile phase.
3. Move injector lever to INJECT position.
4. Push tip of needle port cleaner into conical opening of needle guide.
5. Slowly inject mobile phase.

WARNING

Do not press too hard on syringe plunger. The injected liquid can squirt back at you.

WARNUNG	**Drücken Sie nicht zu fest auf den Spritzenkolben. Die injizierte Flüssigkeit könnte auf Sie zurückspritzen.**
CUIDADO	**No apriete demasiado el mbolo de la jeringa. El líquido inyectado puede proyectarse hacia usted.**
ATTENTION	**N'appuyez pas trop fort sur le piston de la seringue, la liquide inject peut gicler hors de la vanne.**
ATTENZIONE	**Non premete bruscament lo stantuffo della siringa: il liquido contenuto potrebbe schizzarvi addosso.**
WAARSCHUWING	**Druk niet te hard op de spuitplunjer. De geïnjecteerde vloeistof kan er dan uit worden gespoten.**

Cleaning the Valve Passages

1. Disconnect column and place beaker under open end of capillary that comes from injection valve (port 3).
2. Move valve to INJECT position and turn on pump (this flushes ports 1 and 2, sample loop and ports 3 and 4 of valve).
3. Using needle port cleaner, flush needle port with about 1 ml of mobile phase (this flushes port 5 of valve and vent tube connected to port 5). Use the small waste vial to collect any mobile phase that drips from port 5.
4. Move valve to LOAD position and flush needle port with about 1 ml of mobile phase (this flushes sample loop, port 6 of valve and vent tube connected to port 6).

Making An Injection

When making an injection, you can fill the sample loop either completely or partially. The method you choose will depend on the amount of sample you have.

Completely Filling the Sample Loop

This is the conventional method in which you use an excess of sample to fill the sample loop completely. The volume of the loop determines the injection volume.

1. Fill syringe with sample.
2. Move valve to LOAD position.
3. Insert needle of syringe into needle port until needle touches stator face. Do not press too hard.
4. Slowly inject sample.
5. Leave syringe in position and move valve to INJECT position.
6. Remove syringe.

Partially Filling the Sample Loop

Use this method when you have only small quantities of sample available. In this method the syringe determines the injection volume.

1. With valve in INJECT position, use needle port cleaner to flush needle port with about 1 ml of mobile phase (this will reduce residual contamination from previous injection).
2. Move valve to LOAD position.
3. Fill syringe with required volume of sample (not more than half of loop volume).
4. Insert needle of syringe into needle port until needle touches stator face. Do not press too hard.
5. Slowly inject sample.
6. Leave syringe in position and move valve to INJECT position.
7. Remove syringe.

How Much Sample Is Actually Injected?

When you completely fill the sample loop, the amount of sample you inject is equal to the volume of the sample loop plus the volume of the valve passages (1 in rotor and 2 in stator). This means that the actual amount of sample injected will be different to the nominal value designated to your sample loop. However, since you will usually analyze both standards and samples using the same loop, you rarely need to know the absolute volume of the loop.

If you do need to know the actual volume of a sample loop, we recommend you calibrate it fitted to the valve, so that you also take the valve passages into account.

How Much Sample Do I Need?

When you completely fill the sample loop, you need an excess of sample. But how much is an excess? You need about 2 to 3 loop volumes of sample to achieve 95% of the maximum loop volume (the remainder is residual mobile phase in the sample loop). Determine the optimum number of loop volumes experimentally for your particular application.

When you partially fill the sample loop, do not inject more than half of the sample volume. As you inject your sample into the loop, the sample mixes with the solvent already in the loop and some of the sample could be lost through port 6 if you try to inject too much.

An Alternative Way To Fill The Loop

When you completely fill the sample loop, you can either inject the sample into the loop or you can use the syringe to draw the sample through the loop.

1. Move valve to LOAD position.
2. Place vent tube from port 6 into sample vial.
3. Insert needle of syringe into needle port until needle touches stator face. Do not press too hard.
4. Slowly draw sample into syringe.
5. Leave syringe in position and move valve to INJECT position.
6. Remove syringe.

If you use this method, always flush the loading passages (vent tube on port 6) after each injection to prevent cross-contamination between injections. Remember: to flush port 6 and the vent tube, the valve must be in the LOAD position.

Cross-Contamination Between Injections

Under normal operating conditions, the residual sample left in the needle cavity and on the needle seal surface after an injection varies between 0.001 and 0.01 μl. This represents 0.01 to 0.1% of a 10 μl injection. If you can accept this amount of cross-contamination, then you can eliminate step 1 (flushing the needle port) when partially filling the loop.

We recommend that you check periodically the amount of cross-contamination and flush the needle port between injections when you are in doubt. When flushing the loop, use 5 to 8 loop volumes to avoid cross-contamination.

Excessive cross-contamination can be caused by:

- the needle being too short so that the needle tip does not touch the stator face (minimum length from hub to needle tip must be at least 5 cm);
- not holding the syringe in place with the needle tip touching the stator face when moving the valve from LOAD to INJECT.
- dirt particles or needle seal shavings preventing the needle tip from touching the stator face.

Even when cross-contamination is not a problem, we recommend that you flush the valve about once every 10 injections. This prevents a build-up of contaminants and also keeps the needle port and vent tube at port 5 filled with solvent, preventing air from inadvertently entering the sample loop.

Using Buffers or High pH Solutions

To prevent the formation of salt crystals in the valve, thoroughly flush the flow passages and needle port with water, after using aqueous buffers or salt solution.

The standard rotor seal is made of VESPEL^{R}, a polyimide that is exceptionally resistant to wear. However, it is susceptible to alkaline attack, deteriorating rapidly when used with solutions of pH higher than 10. An alternative rotor seal made of TEFZEL^{R} (part number 0101-0620) is available for alkaline applications.

Sample Loops

We have already explained that it is not usually necessary to know the absolute volume of a sample loop, see "How Much Sample Is Actually Injected?". We will now give you some further hints and information about sample loops.

Nominal Volume

The nominal value designated to a sample loop can vary by up to 20%, because of the ±0.001 in tolerance on the inside diameter. The resulting volume tolerance is ±17% for 0.012 in i.d. tubing, ±10% for 0.020 in i.d. tubing and ±7% for 0.030 in i.d. tubing.

Using Large Sample Loops

When you use large sample loops (larger than 100 µl), moving the valve from the INJECT to LOAD position will expel a few microliters of mobile phase from the needle port and vent tube at port 6. Place a small test tube or piece of absorbent tissue at the needle port to catch the expelled liquid.

Moving the valve from INJECT to LOAD releases the pressure and the compressed liquid in the sample loop expands. The compressibility of most solvents is about 10^{-4} per bar. This means that the sample in a 1 ml sample loop will expand about 20 µl when decompressing from 200 bar.

Changing Sample Loops

The depth of the tubing holes in the valve ports may vary slightly from port to port and from valve to valve. A fitting made in one valve may leave a dead space in another port. To eliminate dead spaces, we recommend to label sample loops so that if you remove them, you can replace them in the same orientation in the same valve. For information about how to change the sample loop see your *Installation and Maintenance Guide*.

Syringes

In both methods of loading sample into the sample loop, you must insert a syringe needle into the needle port. In the complete filling method you can use the needle supplied with any Luer tip syringe. In the partial filling method you can use any conventional syringe (see "Accessories").

Before you use a syringe from another supplier, check that the needle dimensions are 0.028 inch o.d. × 2 inch long, without electro taper, and that the point style is 90° (square end).

CAUTION

Using a needle with incorrect dimensions or shape could damage the injector.

VORSICHT

Wenn Sie eine Nadel mit falschen Abmessungen verwenden, könnte der automatische Probengeber beschädigt werden.

PRECAUCION

La utilizacíon de una aguja de dimensiones incorrectas puede estropear el inyector.

AVERTISSEMENT

L'utilisation d'une aiguille de dimension et de forme non appropiées peut entrainer unr déterioration de l'injecteur.

PRECAUZIONE	Usate solo aghi di forma e dimensioni corrette, per evitare danni all'iniettore.
VOORZICHTIG	Wanneer een naald met een onjuiste afmeting of vorm wordt gebruikt, kan dit schade aan de straalpomp veroorzaken.

Overnight or Long-Term Shutdown

If you are not going to be using your injection valve, such as overnight or at weekends, we recommend that you leave the needle inserted fully in the needle port. This will keep the needle seal (sleeve in rotor seal) in proper shape and prevent the spring loaded needle tube squeezing the needle seal and deforming it.

Accessories

The following accessories are available for your injection valve.

Table B-1. Stainless Steel Series

Description	Part Number
Rheodyne 7125 Valve	0101-0607
10 µl sample loop	0101-0376
20 µl sample loop	0101-0377
50 µl sample loop	0101-0378
100 µl sample loop	0101-0379
500 µl sample loop	0101-0282[1]
1000 µl sample loop	0101-0299[1]
2000 µl sample loop	0101-0300[1]
5 µl syringe (removable needle)	9301-0807
10 µl syringe (removable needle)	9301-0808
10 µl syringe (fixed needle)	9301-0402
25 µl syringe (fixed needle)	9301-0809
50 µl syringe (fixed needle)	9301-0875
100 µl syringe (fixed needle)	9301-0401
250 µl syringe (fixed needle)	9301-0816
500 µl syringe (fixed needle)	9301-0817
Rotor seal (VESPEL^{R})	0101-0623
Rotor seal (TEFZEL^{R})	0101-0620
Stator face assembly	0101-0624
Sample loop fitting kit contains Two fittings Two ferrules	5061-3325

1 These loops have no ferrules and nuts.

Table B-2. Ti Series

Description	Part Number
Rheodyne 7125 Ti Valve	0101-0641
20 µl sample loop (Ti)	0101-0655
100 µl sample loop (Ti)	0101-0656
200 µl sample loop (Ti)	0101-0657
500 µl sample loop (Ti)	0101-0658
1000 µl sample loop (Ti)	0101-0659
2000 µl sample loop (Tantalum)	01079-87308
5 µl syringe (removable needle)[1]	9301-0807
10 µl syringe (removable needle)	9301-0808
10 µl syringe (fixed needle)	9301-0402
25 µl syringe (fixed needle)	9301-0809
50 µl syringe (fixed needle)	9301-0875
100 µl syringe (fixed needle)	9301-0401
250 µl syringe (fixed needle)	9301-0816
500 µl syringe (fixed needle)	9301-0817
Rotor seal (TEFZEL^{R})	0101-0620
Stator face assembly (Ti)	0101-0663

1 All syringe needles are stainless steel.

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