307 Piston Pump
User's Guide

Solutions at Work for You

GILSON®
SOLUTIONS AT WORK FOR YOU

307 Piston Pump
User's Guide

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CONTENTS

SAFETY

Please read this section carefully before installing and operating the equipment.

The instrument described in this User's Guide is a programmable piston pump that can give flow rate gradients and can synchronize with other instruments using rear panel input and output connections. It should only be used in the laboratory or similar indoor environment, by qualified personnel. If the instrument is used in a manner not specified by Gilson, the protection provided by the instrument may be impaired.

For safe and correct use of the instrument, it is essential that both operating and service personnel follow generally accepted safety procedures as well as the safety instructions given in this User's Guide.

Cleaning, installation, dismantling, maintenance, adjustment and repair should only be performed by personnel trained in such work, and who are aware of the possible dangers involved.

Voltages present inside the instrument are potentially dangerous. If there is a problem with the instrument, the power cable should be removed until qualified service personnel have repaired it. This is to prevent anyone from inadvertently using the instrument, thus causing possible harm to themselves or damage to the instrument itself.

The leakage current of this instrument is within the limits allowed by safety standards for laboratory equipment. ***An efficient ground connection is imperative for the physical protection of the user.***

Ensure that the ventilation fan on the Piston Pump operates and is not obstructed when the instrument is installed.

Power supply cord reference 500005 is for use in France and Germany. Power supply cord reference 500006 is for use in the USA and Canada. For other countries contact your local Gilson representative. You must only use the type of fuse described and specified in this document: 2.0 Amp type "T" slow blow for use where the power supply is between 100 V and 120 V, 1.0 Amp type "T" slow blow for use where the power supply is between 220 V and 240 V.

Adequate protection such as ventilation must be provided if dangerous liquids are used in the analytical work. If incidental spillage occurs, carefully clean-up the spillage, taking into account the nature of the spilled liquid including all required safety measures.

This instrument must not be sterilized, using an autoclave, or any other mechanical device. When you need to clean this instrument, use one of the three following methods:

1 - A clean dry cloth.
2 - A cloth dampened with water.
3 - A cloth dampened with soapy water.

If a cloth dampened with soapy water is used to clean the instrument, only domestic soap may be used. ***No other form of detergent or chemical may be used.***

Safety Symbols

The following electronic and hazard symbols appear on the 307 Module:

Symbol	Explanation
~	Alternating current
⏚	PROTECTIVE CONDUCTOR TERMINAL
I	On (Supply switch)
O	Off (Supply switch)
⚡	Caution, risk of electric shock
⚠	Caution (refer to accompanying documents)

INTRODUCTION 1

The Gilson 307 Piston Pump is designed to produce accurate and reproducible flow rates in the range 0.025 to 5 ml/min. It can be programmed to give flow rate gradients and to synchronize with other instruments using the inputs and outputs.

1 USING THIS MANUAL

The 307 Piston Pump is a precision instrument which is simple and easy to use. To gain the maximum from the instrument, you should:

- Read the description of the instrument in chapter 2.
- Install the instrument as shown in chapter 3.
- Follow the operating instructions given in chapter 4.

2 UNPACKING

The 307 Piston Pump is packed in a single carton. Upon receipt of your instrument, carefully unpack the unit and inspect it for possible damage. Check the contents of the carton against the parts list to verify that all parts are included and undamaged. The parts list is given in Appendix A. Do this now, even if the unit will not be used immediately. Report any damage to the responsible carrier immediately. Read the description in chapter 2 to become familiar with the instrument, its different parts and their names.

3 WARRANTY

If the instrument does not appear to function correctly, first verify the electrical connections are correct and that the instrument is switched ON. Contact your Gilson agent for technical advice or an eventual service visit. Any service required will be given within the warranty conditions assured by your Gilson agent.

4 CUSTOMER SERVICE

Gilson and its worlwide network of authorized representatives provide you with four types of assistance: sales, technical, applications and service.

The service personnel of Gilson's representatives are able to serve you more efficiently if you provide the following information:

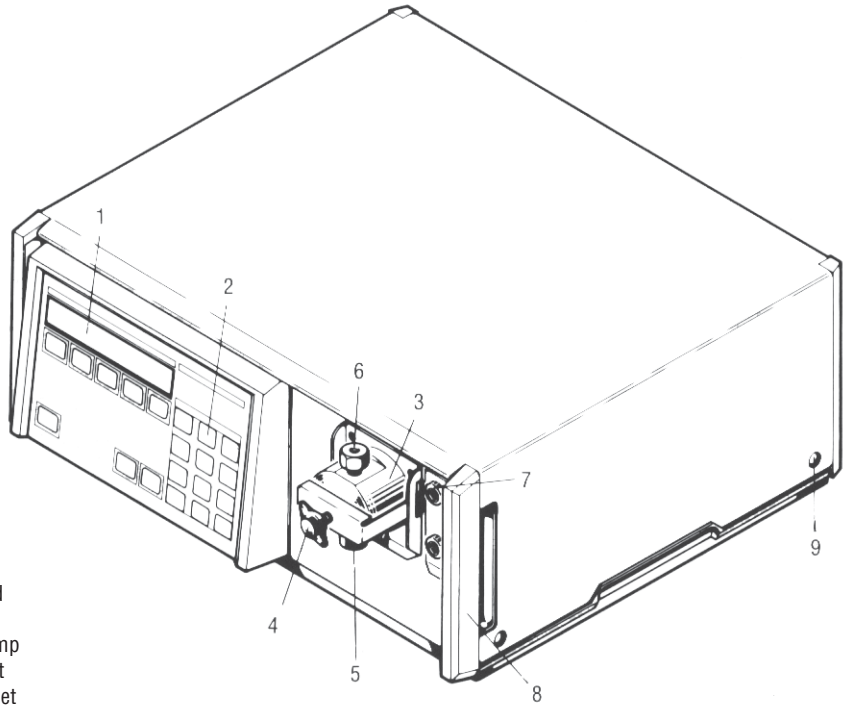
- The serial number and model number of the equipment involved.
- Computer model (if used), available memory, microprocessor and operating software version(s) in operation.
- The installation procedure you used.
- A concise list of the symptoms.
- A list of operating procedures and conditions you were using when the problem arose.
- A list of other devices connected to the system and a system diagram showing the connections.
- A list of other electrical connections in the room.

DESCRIPTION 2

This chapter describes the physical layout of the 307 pump. It describes the front panel of the pump and the position of the electrical connectors on the rear panel.

1 FRONT VIEW

Figure 1 shows a front view of the 307 pump with a pump head mounted. There is a keypad which consists of a display, a numeric keypad and soft keys for programming the 307. The pump head is mounted on the right hand side.



1 - Digital display
2 - Numeric keypad
3 - Pump head
4 - Pump head clamp
5 - Pump head inlet
6 - Pump head outlet
7 - Manometric module connections
8 - Side grip
9 - Side screws

Figure 1

2 KEYPAD

Figure 2 shows the keypad with the numeric keys, the display and the soft keys.

1) Power on indicator
2) Display: two 24-character lines are used to display parameters, commands and messages.
3) Softkeys: their functions are determined by the software and may change from menu to menu. The present functions are displayed above each softkey.
4) PRIME: the pump runs at its maximum flowrate until you press the STOP softkey.
5) HELP: displays advice and instructions at any time, with no effect on the operation of the pump.
6) CANCEL: cancels your last entry before it has been stored in the memory.
7) ENTER: confirms a selection or parameter value and stores t in the memory.
8) Numeric keypad: this is used to key in values during programming. The parameter being modified is always underlined with a flashing cursor.

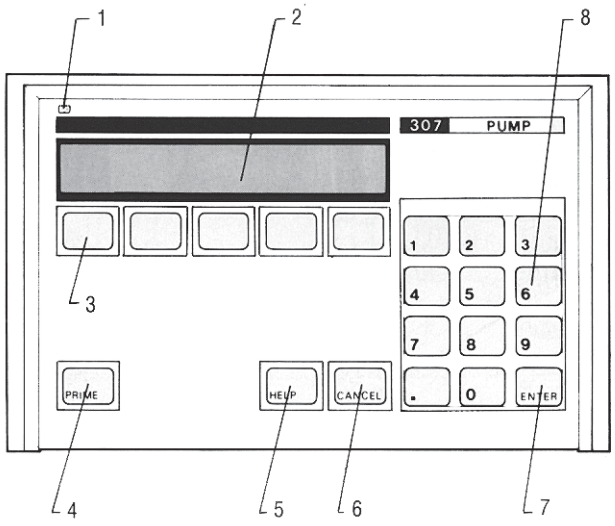
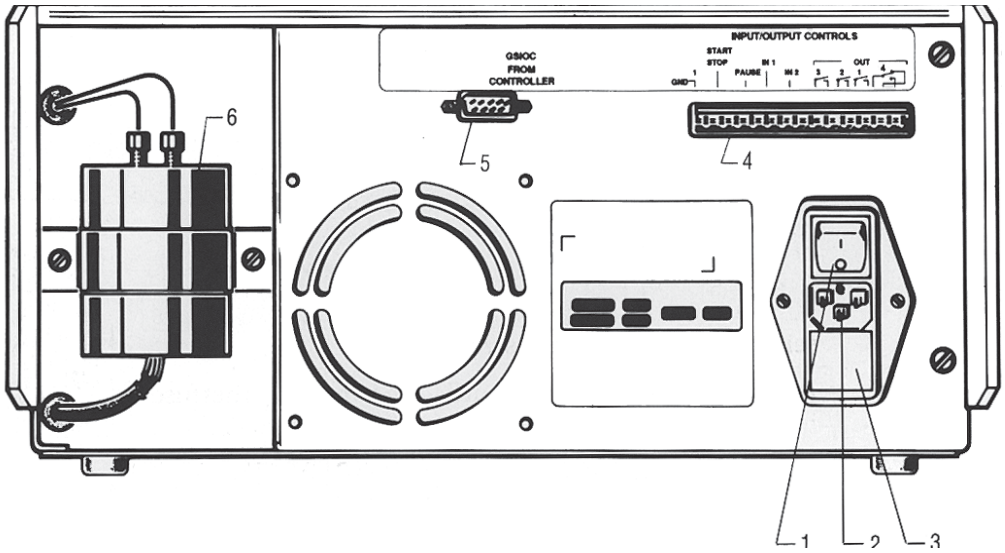


Figure 2

3 REAR VIEW

Figure 3 shows a rear view of the 307 Piston Pump with the electrical connectors. The function of each connector is as follows:

- **GSIOC FROM CONTROLLER** Connection to a computer.
- **INPUT/OUTPUT CONTROLS** Connector for the 307 inputs and outputs.
- **Power switch** On/off power switch.
- **Power receptacle** Voltage selector and fuse holder.



1 - Power switch
2 - Power socket
3 - Fuse holder and voltage selector
4 - Input/Output socket
5 - GSIOC from controller socket
6 - Manometric module

Figure 3 - Rear view

INSTALLATION 3

This chapter describes how to install the 307 pump. It is recommended that you follow the installation instructions in the order that they are presented in the manual.

1 ELECTRICAL INSTALLATION

The instrument requires two fuses to be installed. The type of fuses required are:
2.0 Amp type "T" slow blow for 100 - 120 V, 1.0 Amp type "T" slow blow for 220 - 240 V.

For safety reasons, Piston Pumps are delivered without fuses installed. Fuses must be installed by the user upon delivery.

1.1 INSERTING THE FUSES

Ensure that the power cord is not connected before starting to install the fuses. Follow the procedure below to install the **two** fuses.

- The voltage selector and fuse holder is located below the power socket. See Figure 4. Pull the voltage selector out of the power receptacle. This is done by gently levering the selector out using a small screwdriver.
- Pull out the drawer as shown in Figure 4. Insert the first fuse into the clips.
- Push the drawer back into position.
- Pull out the drawer for the second fuse which is on the other side of the voltage selector. Insert the second fuse into the clips.

The following fuse ratings are used, depending on the voltage selected. The two fuses are included in the standard accessory package.

Voltage selection (V)	Fuse value (A)
100-120	2.0
220-240	1.0

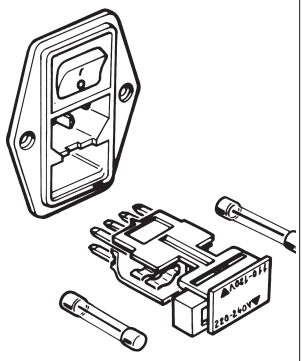


Figure 4

1.2 SELECTING THE VOLTAGE

The 307 Piston Pump can be set to operate at 100/120 volts or 220/240 volts. The different voltages are selected depending on the orientation of the fuse holder.

- **To set the voltage to 100/20 volts:** Insert the fuse holder with the numbers 110/120 on the bottom, facing the small white arrow.
- **To set the voltage to 220/240 volts:** Insert the fuse holder with the numbers 220/240 on the bottom, facing the small white arrow.

For safety reasons, do not connect the power cord until you have finished assembling the instrument.

2 MECHANICAL INSTALLATION

This section explains how to install the pump head, the mast clamp and mast. The pump head and mast clamp for each pump should be installed before positioning the modules.

2.1 PUMP HEAD INSTALLATION

The pump head is shipped in a hard case to protect it during transit. Unpack the pump head from its case and check that all of the parts are included. Follow the procedure below to install the pump head.

- Insert the pump head into the front aperture of the pump. See Figure 5. The notch at the bottom of the pump head body must be fitted on to the matching pin on the pump, just below the aperture. This notch ensures that the inlet port is on the bottom and the outlet port is on the top.
- Holding the pump head in place with one hand, set the clamp diagonally over the head.
- Turn the clamp clockwise into position in the slots on both sides of the pump head.
- Tighten the thumb screw until the clamp holds the pump head securely. Make sure that the clamp ends are secured in their slots on both sides.

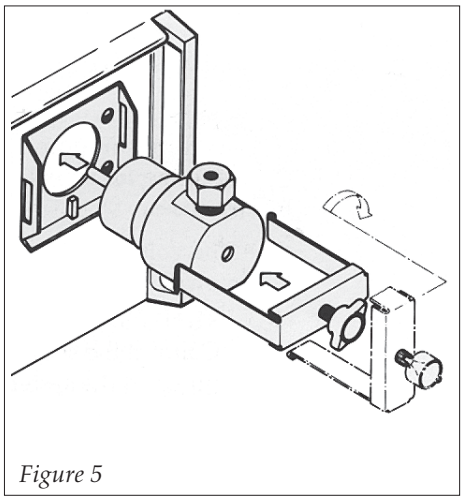


Figure 5

See the pump head User's Guide for more information.

2.2 MAST INSTALLATION

The mast is used to stabilise a system when several modules are stacked on top of each other. It is used to hold the prime/purge valve and a manual injection valve. The mast clamp should be installed before positioning the 307 pump in a system. The mast is added after all of the modules have been put in place. Follow the procedure below to install the mast clamp.

- Remove the side screw holding the module cover. See Figure 6.
- Screw on the mast clamp.

Fix one clamp onto each module in the system. After all the modules have been positioned, the stainless steel mast can be secured within the clamps.

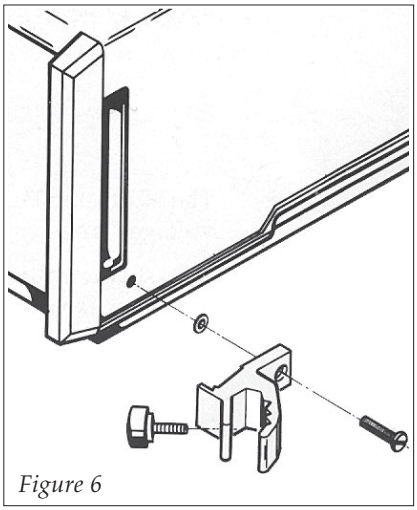


Figure 6

3 POSITIONING THE MODULES

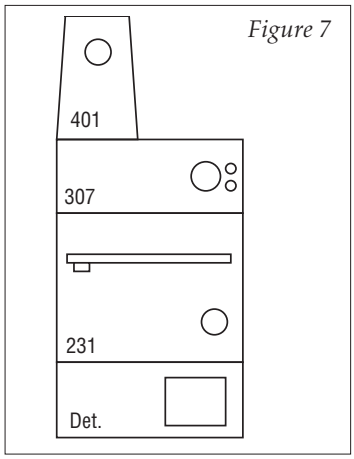


Figure 7

Before putting each module in position, make sure that each module is ready, i.e. that the fuses have been installed and that any mechanical installation is finished.

The physical positioning of each of the modules in your system will depend on your type of system. A suggested layout is given below for a 307 pump and a Gilson 231-401 auto-sampler. This is an auto-analytical system with 1 pump, 1 detector and 1 auto-sampler. The 307 should be on top. This makes it easy to read the display and to use the keypad.

4 CONTROL CONNECTIONS

The 307 pump and the other modules in a Gilson system communicate using the Gilson Serial Input/Output Channel (GSIOC). Each module in a system has a GSIOC connector on its rear panel and is connected to a system controller using a GSIOC cable. This is the case when a 307 pump is controlled by a computer with a Gilson HPLC software package.

- **To connect the 307 pump to a system controller:**
  Connect the socket marked GSIOC FROM CONTROLLER on the rear panel of the 307 pump to the system controller using a GSIOC cable.

5 HYDRAULIC CONNECTIONS

The hydraulic connections for the 307 pump head are made using the tubing provided in the standard accessory package. Connect the 307 pump head input with the inlet tubing assembly provided with the pump head. The connections to the 307 pump head output should be made using stainless steel tubing. The outlet of the pump head should be connected to one of the two ports of the internal dampener/transducer. The other port is then connected to the rest of the system.

6 INPUT/OUTPUT CONNECTIONS

For coordination with surrounding equipment, electrical contacts are used.

The Input/Output connector is a 14-pin terminal block connector. Connections are made to the inputs and outputs using the connector supplied in the standard accessory package.

Inputs	Outputs
Start/Stop	Out# 1
Pause/Resume	Out# 2
IN #1	Out# 3
IN #2	Out# 4

The function and pin numbers for each input and output are as follows.

6.1 Operation of the Inputs

Pin #	Function
1	Ground
2	Start / Stop Input
3	Pause/Resume Input
4	IN # 1 Input
5	IN # 2 Input
6	Out # 3 Output
7	Out # 3 Output
8	Out # 2 Output
9	Out # 2 Output
10	Out # 1 Output
11	Out # 1 Output
12	Out # 4 Common
13	Out # 4 Normally closed
14	Out # 4 Normally open

To activate an input, you must connect it to ground or 0 Volts. This is usually done using a relay output, with one side connected to 0 Volts (Pin 1) and the other side connected to the input. When the output is closed, the input is connected to 0 Volts and is activated. See Fig. 8. Each of the four inputs are described below in detail.

☞ *In the Program mode, Stop does **NOT** stop the flow, it only stops the program from continuing. The flow will continue with the flow rate which existed when the stop input was activated. The program will restart from the beginning when the contact is opened.*

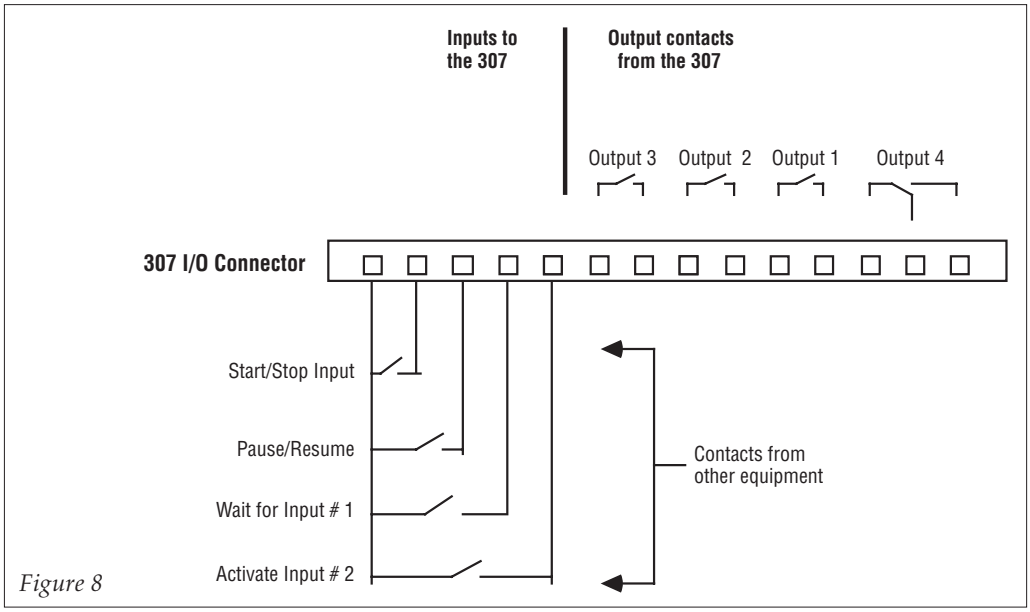


Figure 8

◆ The Start/Stop input

Mode	Input	Result
Flow	Closed	Start flow
	Open	Stop flow
Dispense	Closed	Start Dispense
	Open	Stop Dispense
Program	Closed	Start program
	Open	Stop program

The start/stop input is used to start and stop the 307 pump using an external relay contact. This input is only activated when the input changes from open to closed or from closed to open. The operation for each mode is given in the table opposite.

☞ *In Dispense mode, the Start input can be activated with a pulse.*

◆ THE PAUSE/RESUME INPUT

Mode	Input	Result
Flow	Closed Open	Pause flow Resume flow after Pause
Dispense	Closed Open	Pause flow Resume flow after Pause
Program	Closed Open	Pause program Restart program

The pause/resume input is used to pause and restart the 307 pump using an external contact. This input is only activated when the input changes from open to closed or from closed to open. The operation for each mode is given in the table opposite.

In the Program mode, this input can be configured to obtain a pause with or without flow. This choice is offered inside the software branch I/O, within the screen ;

```
I. Pause/Prog      is w. flow
Next  Prev  Change  Quit
```

The default value is with (w) flow, press change to obtain a pause without (w.o) flow. During a pause with flow, the flow will continue with the flow rate and composition which existed when the pause input was activated. The program will continue from the same point in the program when the resume contact is opened. The pause without input is particular interest when the 307 is used as a metering pump to feed a reagent in high pressure reactors. In this application, the 307 can wait for correct values of external parameters (temperature, pressure, composition) before adding more reagent.

◆ THE IN # 1 INPUT

Timed event	Input	Result
Wait input # 1 Closed	Open	Wait IN #1 is closed
Wait input # 1 Closed	Closed	Continue with program
Wait input # 1 Open	Open	Continue with program
Wait input # 1 Open	Closed	Wait IN #1 is open

This input only operates in the Program mode. It is fully programmable. It can be used to make the program wait until a piece of equipment is ready. An example for this input is when the pumping system is waiting for a signal from a sample injector. See programming the inputs in chapter 4 for more information.

◆ THE IN # 2 INPUT

Mode	Input	Result
Program	Open	No effect
Program	Closed	Start File 13

This input is activated when closed. Activating this input while Program mode is selected, causes File 13 to run. If nothing is programmed in File 13 or if File 13 is already running, this input will be ignored. This input is only activated when the input changes from open to closed or from closed to open. This input can be used to start a special program if an external signal is received, for example a warning signal from a temperature measuring system.

6.2 OUTPUT CONTROLS

The 307 pump has four output relays. Outputs 1, 2 and 3 consist of two terminals. These terminals can be connected together (contacts closed) or not connected together (contacts open). Output 4 consists of a common, a normally closed and a normally open contact. All of the outputs are electrically isolated from each other and from ground. These contacts can be used to control other equipment, e.g. to turn on or off another piece of equipment. See programming the outputs in chapter 4 for more information.

OPERATION 4

1 SWITCHING ON THE PUMP

After switching on the Model 307, a display appears for one second.

Pump Model 307 V x.xx

This indicates the software version (currently V2.1). After this step, one of the Ready-to-Run Screens is displayed.

1.1 HYDRAULIC PRIMING

Check that the solvent bottle is filled with HPLC grade, degassed solvent or buffer. Immerse the inlet tubing filter into the solvent reservoir. Make sure that all of the hydraulic connections are properly made.

Do not run the pump head dry, severe pump head damage can result.

Use the syringe supplied with the pump head to prime the pump.

- Attach the syringe to the luer fitting of the low pressure prime valve. See Fig. 9.
- Draw liquid into the syringe with the low pressure prime valve in the SYRINGE LOAD position.
- Turn the valve to the SYRINGE-INJECT position. Press the PRIME key on the front panel of the 307, the pump will start running at its maximum speed. Depress the syringe until the pump inlet is clear of bubbles and some liquid has passed through the pump outlet.
- Turn the valve to the RUN position. Remove the syringe from the low pressure prime valve. When no bubbles can be seen at the outlet tubing, press the STOP soft key to end the priming procedure.

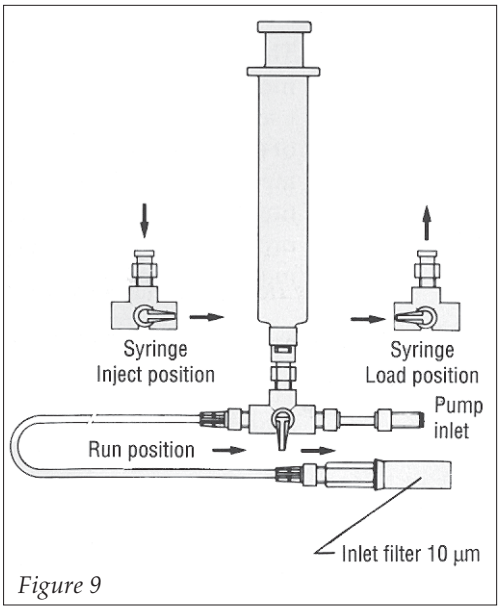


Figure 9

1.2 USING THE KEYPAD

The keypad consists of numeric keys, dedicated keys such as Enter and Prime, a two-line 24 character display and five white soft keys. The function of each part of the keypad is as follows.

Numeric keys: Used to enter numeric values.
PRIME: Runs the pump at maximum speed.
HELP: Displays help messages.
CANCEL: Cancels a value before it is entered into the memory.
ENTER: Enter a value into the memory.

The 24 character display is used to show flow rates and input/output operations. The bottom line of the display is used to present soft key options above the 5 white soft keys. Pressing one of the white soft keys selects the option displayed directly above it. The following soft key options will occur frequently and should be noted.

Quit: Return to the Ready-to-Run screen.
Next: Brings you to the next screen.
Prev: Brings you to the previous screen.

Time is expressed in minutes and hundredths of a minute. For example 2.50 minutes is 2 minutes and 30 seconds.

The words 'Key in' mean enter a numerical value. A flashing cursor underlines the current parameter being modified.

The symbol # is used to show the factory set value.
The symbol • is used to show a key which must be pressed or a value which must be entered.

2 SETTING UP THE PUMP

The software for the 307 pump will be explained with the help of the flow chart in Figure 10. The flow chart has 4 software branches.

Pump: This is used to enter data about the pump.
I/O: This is used to enter data about the overall system.
File: This is used to write a program.
Mode: This is used to select the mode of operation.

As can be seen from the flowchart, the Ready-to-Run screens give the choice of Run or Menu. Run will start the pump with the parameters that were last used. Menu gives you the choice of going to one of the four menus.

With a new pump, you must enter data about the pump and the solvent being used. This is done using the Pump branch of the software. You must also enter data about the overall pumping system, for example high pressure limit, low pressure limit etc. This is done using the I/O branch of the software.

This is only necessary for a new system or when the physical setup of the pumping system is changed. An explanation of the Pump and I/O menus follows.

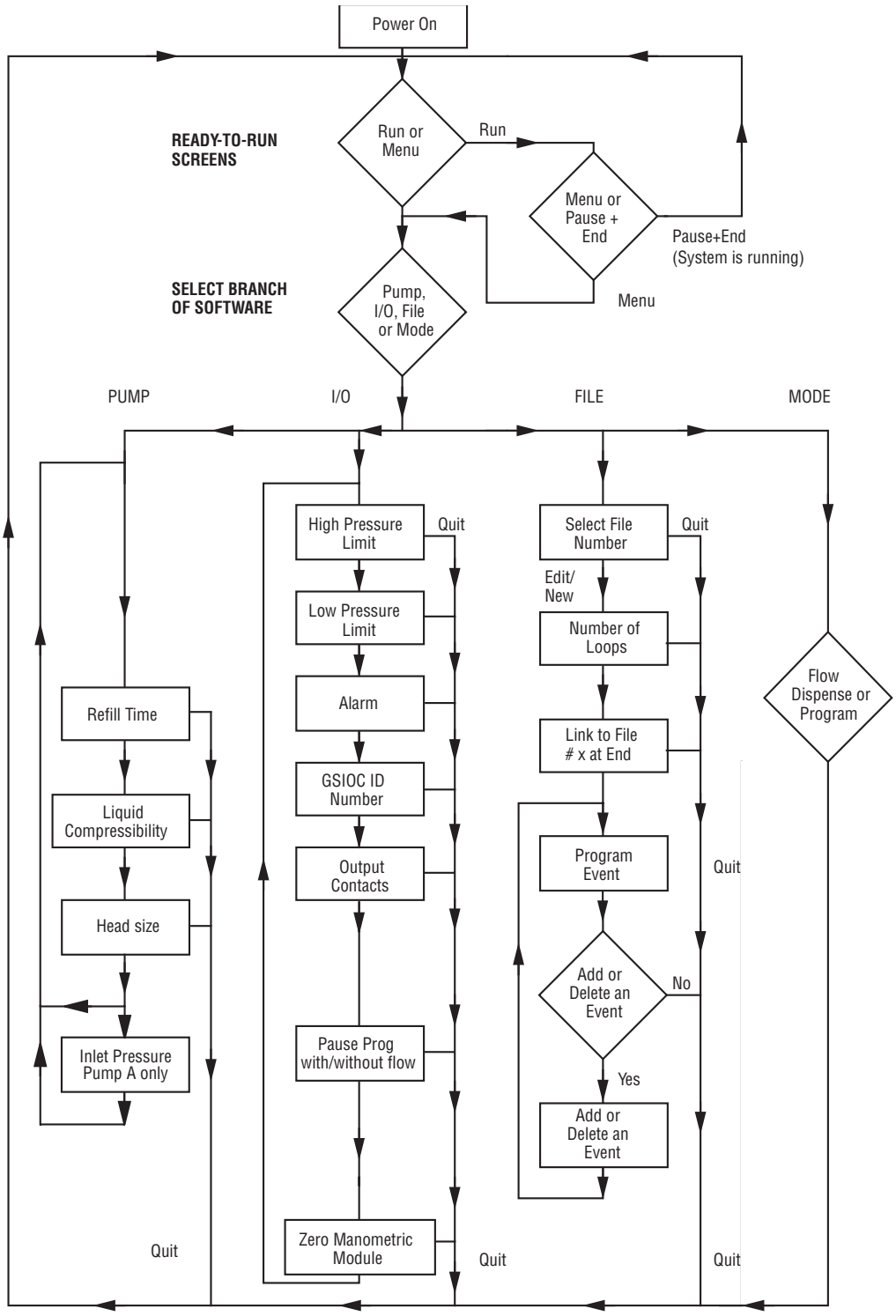

Power On
READY-TO-RUN SCREENS
Run or Menu
Run
Menu or Pause + End
Pause+End (System is running)
Menu
SELECT BRANCH OF SOFTWARE
Pump, I/O, File or Mode
PUMP
I/O
FILE
MODE
High Pressure Limit
Quit
Low Pressure Limit
Alarm
GSIOC ID Number
Output Contacts
Pause Prog with/without flow
Zero Manometric Module
Quit
Select File Number
Quit
Edit/ New
Number of Loops
Link to File # x at End
Program Event
Quit
Add or Delete an Event
No
Yes
Add or Delete an Event
Quit
Flow Dispense or Program
Refill Time
Liquid Compressibility
Head size
Inlet Pressure Pump A only
Quit

Figure 10

OPERATION 4

2.1 SETUP PUMP HARDWARE (PUMP)

To go to the setup pump hardware menu:

- press **Menu**
- press **Pump**

The sequence of parameters is:

1. Refill time
2. Liquid Compressibility
3. Head size

A value for each parameter is keyed in using the keypad and is stored in memory by pressing Enter. Pressing Enter automatically brings you to the next menu. If you do not want to change the value already stored in memory, press **Next**.

◆ PUMP REFILL TIME

The Refill time is the time required for the piston return stroke. Normally it is set at the lowest value (125 ms). If cavitation or degassing occurs, then a higher value must be used. The minimum value is 125 ms and the maximum value is 1000 ms.

☞ *The maximum flow rate depends on the refill time. If the refill time is too long, a message **Invalid settings** flashes when you run the program. The refill time or flow rate must be lowered. Figure 11 shows a curve of refill times versus flow rate.*

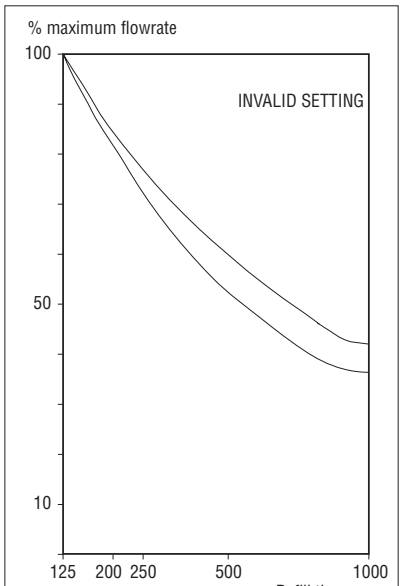


Figure 11

The default value is 125 ms.
- Key in the refill time and press Enter.

◆ PUMP COMPRESSIBILITY

This data is used to calculate the flow rate compensation for the compressibility of the solvent. The minimum value is 0 and the maximum value is 2000 $Mbar^{-1}$. Compressibility values for the common solvents at atmospheric pressure are listed in Appendix D. For CO_2, a compressibility of 1150 $Mbar^{-1}$ should be entered for a pressure of 6 MPa at 7°C. The values for the most common solvents are:

Solvent	X_0 ($Mbar^{-1}$)
Carbon Dioxide	1150
Water	46
Methanol	123
Acetonitrile	99

The default value is 46 for water.
- Key in the value for the solvent being used with pump A and press Enter.

◆ PUMP HEAD SIZE

This parameter is the size of the pump head. Possible values are 5, 10, 25, 50, 100 and 200. It is possible to use any head size with the Gilson 307 pump. However to ensure accuracy, reproducibility and efficient pulse dampening, the flow rate should not exceed 5ml/min.

The default value is 5.
- Key in the value for the pump head size and press Enter.

Press **Info** to display the operating time for the pump head. This time can be reset to zero by pressing **Reset**. This is used to remember how many hours the pump head has been working since the last reset. It should be reset every time the pump head has routine maintenance or when a new pump head is installed.

Press **Quit** to return to the Ready-to-Run screen.

◆ INLET PRESSURE

The inlet pressure, P0, is the pressure at the inlet of the pump head. This allows the accurate pumping of liquefied gas. It must be set to the same value as the pressure of the aspirated liquid, that is the saturating vapor pressure at the ambient temperature for liquefied gas delivered from a pressurized cylinder. When using carbon dioxide at a temperature of 22°C, the value of the inlet pressure should be defined as 6 MPa. A table of inlet pressures is shown below.

Ambient Temperature (°C)	15	20	22	25	30	31	(T_c)
Pressure P0 (MPa)	5.1	5.8	6.0	6.5	7.2	7.4	(P_c)

- Key in the desired inlet pressure, the default value is 0 MPa.
- Press **ENTER**.

2.2 INPUT/OUTPUT PARAMETER SETUP (I/O)

The I/O menu is used to enter data about parameters associated with the complete system.

To go to the Input/Output parameter setup:

- press **Menu**
- press **I/O**.

The sequence of parameters is:

1. High pressure limit
2. Low pressure limit
3. Alarm
4. GSIOC identification number
5. Output contacts
6. Pause/Prog with or without flow
7. Zero pressure reading

◆ HIGH PRESSURE LIMIT

If the pressure reading from the manometric module rises above this limit, the pump will stop. The sequence following a high pressure error is described later in this chapter.

The pressure can be displayed in three different units, bar, MPa or kpsi. Change the units by pressing the soft key below the units display, bar, MPa or kpsi.

The maximum value is 600 bars.

The default value is 600.
- Key in the pressure limit that applies to your system and press Enter.

◆ LOW PRESSURE LIMIT

If the pressure reading from the manometric module drops below this limit, the pump will stop. The sequence following a low pressure error is described later in this chapter.

OPERATION 4

The minimum value is 0.

The default value is 0.
• Key in the value that applies to your system and press Enter.

◆ ALARM

The alarm is a buzzer which sounds every time there is an error or an invalid setting. It can be programmed to be either **On** or **Off**. This function only controls the operation of the buzzer, it does not affect the operation of the pump when there is an error.

If the alarm is **On**, the warning buzzer will sound every time there is an error. An error can be a pressure limit, or an invalid setting. This parameter can be changed from **On** to **Off** and vice versa by pressing the soft key **Change**.

• Select the option that you want and press **Next** to go to the next menu.

◆ GSIOC UNIT IDENTIFICATION NUMBER

A Gilson system can be controlled from a computer using a GSIOC interface and GSIOC cables. Each instrument in a system must have a unique identification number to distinguish it from other equipment connected to the GSIOC communications channel.

The GSIOC identification number in the 307 can be set between 0 and 63.

The default value is 1.
• Key in the identity number for the pump and press ENTER.

◆ OUTPUT XX IS OPEN / CLOSED

There are four relay outputs in the 307 pump numbered 1, 2, 3 and 4. These outputs are used to control other instruments. They can be programmed to open and close during a method run. They can also be opened and closed manually.

To change the state of an output, key in the number of the output. For example output #2. When you press Enter, the display will show the present state of output 2, i.e. open or closed. Press the soft key **Change** to change the state of the output. By using this procedure, each of the 4 outputs can be manually set to be open or closed. The outputs will remain in this state until a method program is run and a change in the outputs is programmed.

☞ *This is a manual method for setting the outputs to be open or closed at the start of a run. Setting the outputs manually is useful to check that output # 1 turns on the integrator, for example. However, when repeating the same operation many times, it is better to program the output operations as part of a method program. In this way, the outputs will follow the same sequence each time the method program is run. Refer to programming the outputs later in this chapter.*

The default state is open.
• Press **Next** to go to the next menu.

◆ PAUSE PROG WITH/WITHOUT FLOW

This option runs in Program mode only. It enables the system to be controlled from an external sensor. For example, a temperature sensor can be used to pause the system if the temperature is outside a desired range. The program and flow can be paused together, or the program can be paused whilst the flow rate continues. External parameters such as temperature, pressure, or composition can be monitored to control the system.

◆ ZERO PRESSURE READING

The **Zero** soft key is used to set the pressure reading to zero when there is zero pressure in the system. This ensures accurate pressure readings when the pump is running.

Before pressing **Zero**, make sure that the pump has stopped and the pressure has dropped to zero, otherwise further pressure indications will be incorrect. If the operation is successful, the message 'Pressure reading is zero' is displayed. If the operation is not successful due to pressure in the system, the message 'Not done, check pressure' is displayed.

You have now completed the Input/Output parameter setup. Press **Quit** to leave this section of the software. This will bring you back to the Ready-to-Run Screens.

◆ LEAVING THE SETUP MENUS

The two menus, pump parameter setup and I/O parameter setup are now completed. The 307 pump has all of the information that it needs. The next step is to operate the 307 pump.

After entering the data about the pumping system, the pump is ready to run. The 307 pump can operate in 3 different modes. These modes are:

Flow: *The 307 pump provides a constant flow rate. The pump starts when the Run key is pressed and stops when the Stop key is pressed.*

Dispense: *The 307 dispenses a specified volume. The pump starts when the Start key is pressed and stops when the specified volume has been dispensed.*

Program: *The 307 controls a complete system. In this mode, the 307 pump can create gradients of flow rate, open and close outputs to control other instruments and wait for signals from other instruments.*

The operation of each mode is explained separately.

3 USING THE FLOW MODE

3.1 RUNNING THE PUMP IN FLOW MODE

In this mode, the pump provides a constant flow rate, beginning when the **Run** key or start input is activated and stopping when the **Stop** key or stop input is activated.

To go to the Flow mode:

- press **Menu**
- press **Mode**
- press **Flow**

This brings you to the Flow mode Ready-to-Run Screen.

The flow rate can be set between 0.01% and 100% of the pump head size. A flow rate value will not be accepted if it is larger than the pump head size. If the selected flow rate is incompatible with the refill time or compressibility, the message **Invalid settings** blinks after pressing **Run**. In this case, you must lower the refill time or the flow rate.

- Key in the flow rate in ml/min and press Enter. The pump is now ready to run.

Pressing **Run** will start the pump. Pressing **Stop** will stop the pump.

3.2 MODIFYING PARAMETERS DURING A RUN

During a run, the flow rate can be modified at any time by keying in a new value. During a run it is possible to review and change the setup parameters without stopping the pump. Press **Menu** and follow the procedure as already described to modify the setup parameters.

3.3 OPERATION OF THE PRESSURE LIMITS IN THE FLOW MODE

If there is a high pressure error, the pump will stop and the message **High pressure limit** will flash on the screen. The pump will start again when the pressure drops below the limit. This cycle will continue indefinitely. If it is programmed to be on, the alarm will sound.

If there is a low pressure error, the pump will stop and the message **Low pressure limit** will flash on the screen. The pump will stay in this condition until the **Stop** key is pressed. If it is programmed to be on, the alarm will sound.

The maximum limits depend on the Refill time and Compressibility. If the values are not compatible with the flow rate entered, the message **Invalid settings** will flash on the screen after the Run key is pressed. In this case you must lower the refill time or the flow rate.

The Flow mode can be simulated in the Program mode, with the advantage of having safety error files and being able to program timed events.

4 USING THE DISPENSE MODE

4.1 RUNNING THE PUMP IN DISPENSE MODE

In this mode the pump delivers a specified volume beginning when the **Run** key or start input is activated and finishing when the specified volume of liquid is delivered. The parameters are dispense volume, dispense flow rate or time of dispense.

To go to the Dispense mode :

- press **Menu**
- press **Mode**
- press **Disp**

This brings you to the Dispense mode Ready-to-Run Screen.

Two parameters are displayed on the top line, the dispense volume and the dispense rate.

Key in the dispense volume (ml) and press Enter. The flashing cursor moves from below the dispense volume to below the dispense rate.

Key in the rate at which the specified volume will be delivered (ml/min). Press Enter. The second parameter can be changed from flow rate to time by pressing the soft key directly below **Time**. In this case you enter the time in which the liquid is to be dispensed.

The limits for each of the parameters are as follows.

Maximum dispense volume:	100 X head size (ml).
Maximum dispense rate:	1 X head size (ml/min).
Maximum dispense time:	9999 minutes.
Minimum dispense volume:	0.0001 X head size (ml).
Minimum dispense flow rate:	0.0001 X head size (ml/min)

The maximum dispense rate depends on the Refill time and Compressibility. If the values are not compatible with the dispense flow rate or volume entered, the message **Invalid settings** will flash on the screen after the Run key is pressed. In this case you must lower the refill time or the flow rate.

If the dispense flow rate or volume is not compatible with the head size, the software will not accept the value and you must key in a new value. If the head size is modified so as to be too small, after the dispense volume and flow rate have been entered, the **Run** soft key will not appear in the menu when you return to the dispense Ready-to-Run Screen.

Press **Run** to start the delivery of the liquid. The delivery will stop when the specified volume is delivered.

After pressing **Run**, the display changes to **Roll - Pause**.

Press **Pause** to interrupt the dispense operation. The display changes to **End-Continue**. Press **End** to terminate the delivery without dispensing any more liquid. Press **Continue** to finish delivering the specified volume of liquid.

Press **Roll** to view the programmed dispense volume and the volume already dispensed. Press **Roll** again to view the programmed time for the dispense and the time already elapsed. Press **Roll** again to view the flow rate.

4.2 MODIFYING THE VALUES

During a run it is not possible to change the dispense volume or delivery rate. The setup parameters can be reviewed and modified during a run. Press **Menu** and follow the procedure as already described to modify the setup parameters.

4.3 OPERATION OF THE PRESSURE LIMITS

If there is a high pressure error, the pump will stop and the message **High pressure limit** will flash on the screen. The pump will start again when the pressure drops below the limit. This cycle will continue indefinitely. If it is programmed to be on, the alarm will sound.

If there is a low pressure error, the pump will stop and the message **Low pressure limit** will flash on the screen. The pump will stay in this condition until the **End** key is pressed. If it is programmed to be on, the alarm will sound.

The Dispense mode can be simulated in the Program mode, with the advantage of having the safety error files and being able to program timed events.

5 USING THE PROGRAM MODE

5.1 OVERVIEW

In this mode, the 307 pump can create flow rate gradients, open and close outputs and wait for inputs. The 307 pump controls instruments such as auto-samplers and fraction collectors using the input/output contacts on the rear panel of the 307. The Program mode can also simulate the Flow and Dispense modes, with the advantage of safety error files and the ability to program timed events.

Before creating a method program in the 307 pump, it is necessary to understand how the method programs are stored in memory.

5.2 MEMORY LAYOUT

There are 14 files, numbered 1 to 14. Each file can store one program. There are 10 files available for method programs, 1 to 10. Files 11 to 14 are for error/safety programs.

A file contains timed events. A timed event is a flow rate, the operation of an input or the operation of an output. One file stores a maximum of 25 timed events which make up the method program.

The error files, 11 to 14, do not contain pre-stored programs. You write each error program in exactly the same way as a method program. This allows you to program the sequence of events that will happen when an error occurs. If an error occurs during a run, the method program stops and the error program starts. See later in this chapter for the exact operation of the error files.

5.3 FILE MANAGEMENT

One complete method is stored in a file. In order to read/edit/write a method, you have to go to the file.

To go to a file:

- press **Menu**
- press **File**.

This brings you to the **Select file** menu.

Key in the number of a file, for example 1, and press Enter.

There are five soft key options available.

◆ DIRECTORY

Press this key to go to each stored file, e.g. File 1, File 3 etc. This displays all of the files where method programs are stored. If no programs are stored, as in the case of a new pump, **Select file # —** will be displayed. Key in the file number that you want to use and press Enter.

◆ COPY

Press this key to make a copy of a complete file. This is useful if you want to make a small modification to an existing program and keep a copy of the original program. After pressing **copy**, key in the file number where the copy will be stored and press Enter. The software indicates if the file where you want to store the copy is empty (**New**) or if there is a program already stored there (**Exists**). You have the choice of completing the copy procedure, **Yes**, or ending the procedure without making a copy, **No**. The copy of the program can then be modified without destroying the original.

◆ DELETE

Press this key to delete a complete file. The deleted file is the file currently shown on the upper line of the display. After pressing **Del, Delete file # xx ?** is displayed. This is a safeguard against accidental erasure. There are two options: **Yes** deletes the file, **No** brings you back to the original menu.

◆ EDIT/NEW

If there is no program stored in the file number that is displayed on the top line, the display will be **New**, if there is a program stored in the file, the display will be **Edit**. Both of these options will bring you to the first step in writing/editing a method program.

◆ QUIT

Pressing **Quit** brings you back to the Ready-to-Run Screens.

Pressing the **Edit/New** key brings you to the first menu in the programming sequence, **Number of loops**. You are now ready to write a method program.

5.4 PROGRAMMING A METHOD

A complete method program is written by programming flow rates and the operation of the inputs and outputs. The method program run time starts at time 0.00, i.e. when the start key is pressed, and ends at the time of the last timed event. For example, if you program the last event at time 20.00, then the run time is 20 minutes.

You must program every event for your method, starting at time 0.00. If you do not program a flow rate at 0.00 minutes, the pump will assume the current flow rate. For a pump which is stopped, the software will assume a flow rate of 0 ml/min. If the pump is running, it will assume the current flow rate for time 0.00. It will then operate on a gradient between this value and the first flow rate in your program.

◆ MENU: NUMBER OF LOOPS

The number of loops is the number of times that the program will repeat itself before stopping. The minimum value is 1 and the maximum value is 999.

The default value is 1.
• Key in the number of loops and press Enter.

This brings you to the **When finished, use** menu.

◆ MENU: WHEN FINISHED, USE

At the end of a program, you can link the current file to any of the 14 files. If you do not want to link to any other file, press the soft key below **None** on the display.

If you link to the current file, i.e. link File 3 to File 3, the program will continue to run until the **Pause** key is pressed.

If both looping and linking are programmed, the software will complete the programmed number of loops, then link to the new file.

The default is None.
• Key in the number of the file you want to link to and press Enter, or press **None.**

☞ *One complete method program is stored in a file. The values for the five parameters; Refill time, Compressibility, Pump Head Size, High pressure limit and Low pressure limit for that program are also stored in the same file. If you link two or more files together, you must ensure that they all have the same values for these parameters.*

If you link files together which have different values, the pump will not start. After pressing **Run** the display will give you the message **Note ! Setup has changed since file creation**. Pressing **Ok** gives you the choice of which setup parameters to keep by asking the question **Keep original setup ? Yes - No**. If you choose **Yes**, the values which are stored in the first file in the sequence of files will be loaded into all of the files which are linked together. If you choose **No,** the values which are currently stored in the setup parameter memory will be loaded into all of the files which are linked together.

☞ *In the case of linking to an error file which has different setup parameters to the method file, the parameters for the method file automatically replace the values which were written in the error file. This brings you to the* ***Choose an event type*** *screen.*

◆ MENU: CHOOSE AN EVENT TYPE

There are three different types of timed events. You choose one of the different events by pressing the soft key below it. The three timed event types are:

- Flow rate Program the flow rate, ml/minute.
- Wait Wait for an input
- Out Activate an output

◆ FLOW

In this menu you set the flow rate, for example, 2 ml/min. There are two pieces of data for this menu.

- Time at which flow rate occurs
- Flow rate in ml/min

Example: 0.00 min 0.00 ml/min
5.00 min 3.0 ml/min

To program this example:

- press the **Add** soft key
- press **Flow**
- key in the time for the first flow rate, 0.00, and press Enter
- key in the value for the flow rate, 0, and press Enter
- press **Add** to add a second timed event
- key in the time for the second flow rate, 5, and press Enter
- key in the value for the flow rate, 3, and press Enter.

☞ *There will be a linear gradient between any two programmed flow rates. With the above example, the flow rate will linearly increase from 0.0 ml/min to 3.0 ml/min in 5.00 minutes.*

If you try to enter a flow rate value which is too high for the pump head, the entry is refused by the software.

If you do not program a flow rate at 0.00 minutes, the software will assume the current flow rate for time 0.00 minutes, i.e. for a stopped pump, a flow rate of 0 ml/min. There will then be a gradient between 0 ml/min and the first programmed flow rate. With the example programmed, the flow rate will be as shown in Figure 12.

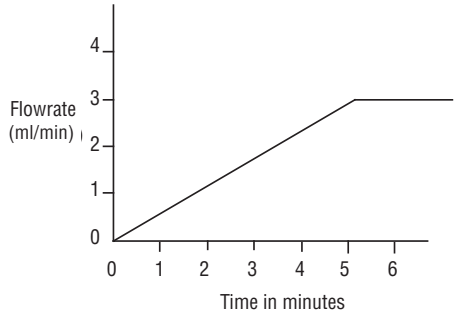


Figure 12

To stop the flow of solvent at the end of a run, you must program a flow rate of 0 ml/min. Otherwise, the pump will continue to run with the last programmed flow rate, even after the last timed event.

If the system is set up to do more than one sample, the initial flow rate for the method can be maintained between method runs by programming this flow rate at the end of the program, for example 2 ml/min.

At the end of all the samples, link to another file to completely stop the flow of liquid. See Figure 13.

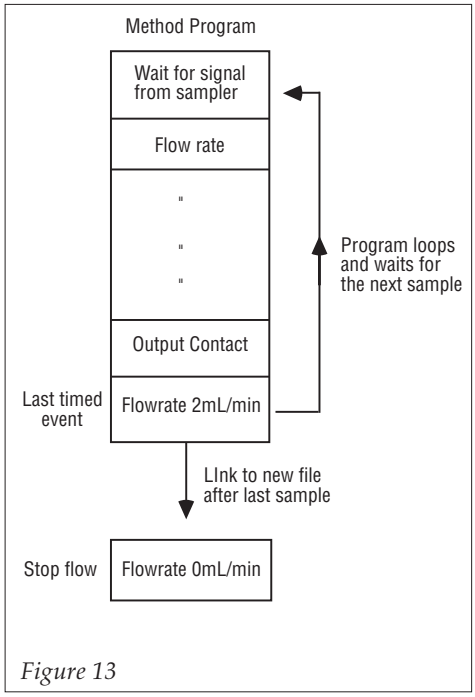


Figure 13

◆ WAIT

In this menu you can make the program wait until Input # 1 is activated. This is used to stop the program until another piece of equipment is ready, for example an auto-sampler or a fraction collector. There are two pieces of data for this menu.

- Time at which the pump will wait for an input
- Waiting for an open contact or a closed contact

Example: 2.00 min Wait #1 Closed.

To program this example:

- press the **Add** soft key
- press **Wait**
- key in the time for the wait to begin, 2.00, and press Enter
- press **close**

The program waits at time 2.00 minutes until input #1 is closed. If input #1 is already closed at time 2.00 mins, the program will continue. If input # 1 is not closed, the program will wait. During the time that the program is waiting, the display will show the total run time and the time that it has been waiting.

If a pump is waiting for an input, pressing **Cancel** will simulate an input and the program will continue.

◆ OUT

In this menu, you can program each of the outputs in the system to open or close. The outputs are numbered 1, 2, 3 and 4 and are used to send signals to other equipment in the system, for example an auto-sampler or a chart recorder. By having the output operations as part of the method program, the same sequence of contacts is repeated every time the method program is run.

There are three pieces of data for this menu.

- Time at which output is operated
- Output number
- Output opened, closed or pulsed

Each of the outputs can be made to open, close or pulse. Pulse means that the output will change its current state for 0.6 of a second.

Example: Screen 1 3.00 min Output 2
Screen 2 Open Close Pulse

To program this example:

- press the **Add** soft key
- press **Out**.
- key in the time for the output to operate, 3.00, and press Enter.
- key in the output number, 2, and press Enter.

The display will change to **Open**, **Close** or **Pulse**.

- press the soft key below **close**

◆ READING/WRITING/EDITING TIMED EVENTS

The three different types of timed event have been explained above. At the end of programming each event, the menu gives you five options. These options are explained below.

Next: displays the next timed event in the sequence. If there are no more events, it displays **End of file**.

Prev: displays the previous timed event in the sequence. If there are no more previous events, it displays **Beginning of file**.

Add: brings you to the **Choose an event type** menu to allow you to add another event to the present program.

Del: deletes one timed event in the program. As a safeguard it asks you, **Delete this point**? Press **Yes** to delete the event or **No** to return to the original menu.

End: leaves the software for programming timed events. The pump displays **Solvent consumption** in ml for one complete run of the method program. The minimum value is < 0.1ml and the maximum value is > 999ml.

Press **Quit** to go to the Ready-to-Run Screen. You have now finished creating a program method file. Before running a method program, you should program each of the four safety/error files.

6 PROGRAMMING THE ERROR FILES

The error/safety files are used to control the pumping system if there is an error. If an error occurs, the method program is stopped and the safety/error program is started. The number and function of each file is listed opposite.

File	Name	Function
11	Low	File runs after a low pressure error
12	High	File runs after a high pressure error
13	Input	File runs if input # 2 is activated
14	Power	File runs after a power failure

These programs are created in exactly the same way as a method program. To program the low pressure safety error file, select file 11 and enter the sequence of flow rates and input/output operations that you require when there is a low pressure error. Similarly, enter a program for the high pressure error file, Input # 2 error file and the power failure error file. The Input # 2 contact can be connected to an external safety device such as a temperature or pressure measurement system.

An example of simple programs for the high and low pressure error files are given in program examples at the end of this section.

6.1 LOW PRESSURE ERROR FILE

If the pressure goes below the low pressure limit the sequence of events is as follows.

If the low pressure error file (11) contains no program, the method program will stop and cannot resume until the operator presses the **Pause** soft key followed by **End**.

If the low pressure error file contains a program, the method program will link to this file and will run it. After file 11 is finished, if there is a link to another file, this new file will start to run. If there is another low pressure error during file 11, the pump will stop and cannot resume until the operator presses the **Pause** soft key followed by **End**.

6.2 HIGH PRESSURE ERROR FILE

If the pressure goes above the high pressure limit, the sequence of events is as follows:

If the high pressure error file (12) contains no program, the pump stops at the instant the pressure rises above the limit. If the pressure drops below the limit again, the pump will restart. This cycle will continue indefinitely.

If the high pressure error file contains a program, the pump stops and waits for the pressure to drop below the high pressure limit contained in File 12. When the pressure is below this limit, file 12 will begin to run. After file 12 is finished, if there is a link to another file, this new file will start to run. If there is another high pressure error during file 12, the pump will stop until the pressure drops below the limit and will then restart. This cycle will continue indefinitely.

6.3 INPUT # 2 ERROR FILE

When input # 2 is activated, it causes the following sequence of events.

If there is no program in file 13, activating input # 2 will have no effect and the method program will continue.

If there is a program stored in File 13, when input # 2 is activated, File 13 will start. File 13 will start to run even if the system was not previously running. If there is a link to another file at the end of the program, the linked file will start to run.

6.4 POWER FAILURE ERROR FILE

The power failure error file will only operate if there is a power failure while a method program is running. The sequence of events after a power failure is as follows:

If there is no program stored in File 14: after the power is restored, the program will go back to the start of the method file and wait for a start input. If there is more than one file in the method, i.e. one file is linked to another, the program will go back to the beginning of the first file in the method.

If there is a program stored in file 14: after the power is restored, the program in file 14 will be run. If there is a link to another program at the end of file 14, the linked file will start to run. If the alarm is on, it will sound.

If there is a power failure in the Flow or Dispense modes, it has the same effect as if the pump was turned off and turned on again. The screen presented will be the Ready-to-Run Screen of the last used mode.

7 RUNNING A METHOD PROGRAM

At the end of programming the method and error files, the software returns to a Ready-to-Run Screen. The top left corner will indicate which Ready-to-Run screen you are in. To go to the Program mode Ready-to-Run Screen:

- press **Menu**
- press **Mode**
- press **Prog**

The pressure can be displayed in 3 units, bar, MPa or kpsi. To change the units , press the soft key directly below **bar**. The units will change to **MPa**. Press the soft key again to change the units to **kpsi**. Press the soft key again to change the units back to **bar**.

The Ready-to-Run Screen displays the present file number, the pressure, and gives you 3 soft key options, Cond, Menu and Run. You can go to any file by keying in a new number and pressing Enter.

- The **Cond** soft key brings you to the part of the software which is used to condition the column. You program a ramp time and a flow rate. The initial conditions are the existing conditions for the pump, i.e. for a pump which is not running 0 ml/min. The flow rate programmed should be the flow rate that is required at the start of the method program. The flow rate is then ramped from 0 ml/min to the initial flow rate for your method program.
- press **Cond**
- Enter the ramping time and press Enter
- press **Flow**
- Enter the flow rate for the end of the ramp time

Press **Run** to start the conditioning of the column. The pump will ramp to the flow rate that is programmed in the time programmed. The values for time, flow rate can be changed during the conditioning. At the end of the ramp time, the flow rate will remain constant. Note that you can leave the conditioning of the column and create a program without interfering with the conditioning of the column.

After pressing **Run**, the display changes to give you the choice of **Roll**, **Stop** or **Quit**. Pressing Roll displays in turn the time for the ramp and the flow rate.

This part of the software is also used at the end of a method program to clean the column. The initial conditions will be the final flow rate which existed at the end of your method program. You can ramp the flow rate down to 0 ml/min to completely clean the column.

- The **Quit** soft key brings you to the **Select Menu Item** menu. This gives you access to the pump setup parameters, the pump I/O parameters and the method file. Press this key to verify or change the value of any parameters in these sections.
- The **Run** key starts the program running. When this key is pressed, the display changes. The figure in the top left hand corner is the file number. The number in parentheses is the loop number. If there is more than one loop in your program, the present loop number will be displayed here. The first time displayed is the actual running time. The second time displayed is the total running time for the method program.

OPERATION 4

☞ *One complete method program is stored in a file. The values for the five parameters; Refill, Compressibility, Pump Head Size, High pressure limit and Low pressure limit for that program are also stored in the same file. If you link two or more files together, you must ensure that they all have the same values for these parameters.*

If you link files together which have different values, the pump will not start. After pressing **Run** the display will give you the message **Note ! Setup has changed since file creation**. Pressing **Ok** gives you the choice of which setup parameters to keep by asking the question **Keep original setup ? Yes - No**. If you choose **Yes**, the values which are stored in the first file in the sequence of files will be loaded into all of the files which are linked together. If you choose **No,** the values which are currently stored in the setup parameter memory will be loaded into all of the files which are linked together. In the case of linking to an error file which has different setup parameters to the method file, the parameters for the method file automatically replace the values which were written in the error file.

If a program has a link to a file which has nothing stored in it, the program will not start when **Run** is pressed. The message **Link file does not exist** is displayed and the alarm will sound.

After pressing Run, the bottom line of the display changes to **Roll/Menu/Pause**.

Pressing **Roll** will display in turn:

- current file/loop number/running time and program time
- current file/loop number/ flow rate
- current file/current loop/total number of loops
- the time that the 307 is waiting on an input

Pressing **Roll** once more brings you back to the Run screen.

The **Menu** soft key has the same function as before.

Press **Pause** to freeze the program. The pump will continue to run, keeping a constant flow rate. The pump will stay in this state until another key is pressed. When **Pause** is pressed the screen changes to **Stop/End/Cont**.

- **Stop** will cause the pump to stop. The method file remains in the Pause state.
- **End** will cause the termination of the method file without stopping the pump. The pump will continue with the flow rate that existed when it was paused. The screen returns to the Program mode Ready-to-Run Screen.
- **Cont** will cause the program to restart from the point where it was paused.

N.B. To terminate a program completely and stop the flow, you must press **Stop** followed by **End**. More brings you back to the previous screen. If a method program has terminated and the pumping system is still running, press **Cond** followed by **Stop**.

☞ *The input Start/Stop has the same effect as the **End** soft key in the Program mode.*

During a method run, the setup parameters and the method program can be modified. Modify a parameter in the same way that you program it. If the flow rate is modified during a run, the new value will take effect from the instant it is programmed.

If a flow rate is modified while the pump is running, the new flow gradient will be between the next programmed point and the flow rate which existed at the instant the modification was made.

After a method program has finished, the display returns to the Ready-to-Run screen.

8 PROGRAMMING EXAMPLE

An example program is given below. Before running this example program, ensure that the hydraulic circuit is properly connected.

◆ EXAMPLE

In the example given in List 1, the flow rate will start at 1 ml/min and increase to 4 ml/min after 2 minutes. An output will close at 0.00 minutes to start the integrator. The method will only operate once and will not link to another file when it is finished. Enter this program following the steps given in Program list 1.

Note that it is necessary to program a flow rate of 0 ml/min at the end of the program to stop the flow, the flow does not automatically stop when the program is finished. It will continue with the last programmed flow rate. To stop the flow at 4.00 minutes you must program a flow rate of 4ml/minute at 3.99 minutes and 0.00 ml/min. at 4.00 minutes.

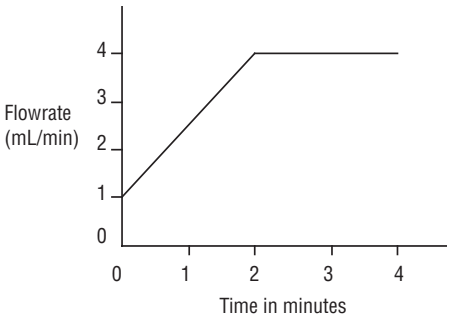


Figure 14

Note on programming sheet

Appendix G contains a programming sheet which can be copied. An example of how to use the programming sheet is also given. The sequence you should follow is:

- Fill in the File Number and name
- Fill in the SETUP parameters for your system
- Draw the flow rate gradients on the graphs provided, remembering to mark the axes
- Fill in the table for Input/Output operations
- Write the programming steps. Finish one section before going on to the next, i.e. program all of the flow rate time points before going on to the input/output time points. The 307 software will arrange all of the time points in the correct sequence.

After writing the method program, it is necessary to write the programs for the safety/error files. Simple programs are given in list two and three for the Low pressure error file and the High pressure error file. In both programs, the flow rate is programmed to be 0 ml/min. This is a simple example of an error file.

Enter these two error programs before running Example 1. After entering the two pressure error programs, the system is ready to run. Press Run. The display will look like Figure 15. When the method program is finished, the Ready-to-Run screen is displayed.

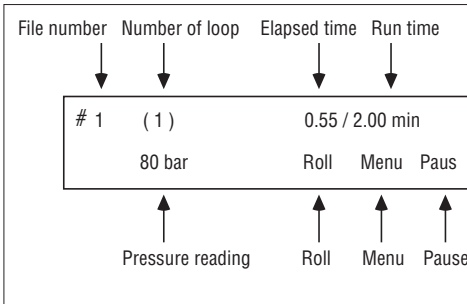


Figure 15

OPERATION 4

Program List 1

Key to press	Notes
Menu	
File	
1/ENTER	Select file 1
New/Edit	Go to file
1/ ENTER	1 Loop
None	No link at end of method
Out	Program the output
0/ ENTER	At 0.00 minutes
1/ENTER	Output # 1
Close	Close output # 1
Add	Add the next timed event
Flow	Enter the flow rate
0/ENTER	At 0.00 minutes
1/ENTER	Flow rate = 1 ml/min.
Add	Add the next timed event.
Flow	Enter the flow rate
2/ENTER	At 2.00 minutes.
4/ENTER	Flow rate = 4 ml/min
End	Finish writing method file Solvent consumption: 5 ml
Quit	Go to Ready-to-Run screen

Program List 2

Key to press	Notes
Menu	
File	
11/ENTER	Low pressure error file
New/Edit	Go to file
1/ENTER	1 Loop
None	No link to other files
Flow	Enter the flow rate
0/ENTER	At 0.00 minutes
0/ENTER	Flow rate = 0 ml/min
End	Finish writing error file
Quit	

Program List 3

Key to press	Notes
Menu	
File	
12/ENTER	High pressure error file
New/Edit	Go to file
1/ENTER	1 Loop
None	No link to other files
Flow	Enter the flow rate
0/ENTER	At 0.00 minutes
0/ENTER	Flow rate = 0 ml/min
End	Finish writing error file
Quit	

MAINTENANCE 5

The 307 pump has been designed to require a minimum level of care and maintenance. In practice, maintenance is limited to cleaning and replacing parts of the pump head.

Check valves and filters can be cleaned. Piston seals, check valves, piston assemblies, anti-extrusion gaskets and return springs can be replaced. A maintenance kit is available for each model of pump head. For details about maintenance kits and procedures, see the *User's Guide* for your pump head.

The use of equipment for continuous, unattended operation is becoming more and more important. For this reason, Table I gives an indication of replacement periods of maintenance parts according to the type of use, intensive, regular or occasional. The data in Table I assumes that the pump is working at half of its maximum flow rate and pressure. The nature of the liquid and the pump head model have only a small influence on these figures. The time between each maintenance operation can be viewed by using the **Info** soft key in the **Pump** menu.

Table I: Indication of replacement periods of maintenance parts according to the type of use.

Parts/Use	Intensive (168 h/week)	Regular (40 h/week)	Occasional (10 h/week)
Piston seal	2 - 3 months	6 - 9 months	1 year
Set of check valves	3 - 6 months	1year	2 years
Piston assembly	6 - 12 months	2 - 3 years	5 years
Anti-extrusion gasket	6 - 12 months	2 - 3 years	5 years
Return spring	1 year	2 - 3 years	5 years

TROUBLESHOOTING 6

1 ELECTRICAL PROBLEMS

Problem	Possible cause	Solution
Pump does not operate and power indicator does not light. Incorrect voltage setting.	Power cord unplugged. Fuse blown.	Check for power. See 'electrical installation' in chapter 3.
Invalid settings flashing	Refill time is too long for the flow rate programmed	Lower the Refill time or flow rate.
Pump does not stop at end of program	Not programmed	To stop the flow at the end of a method program, you must program a flow rate of 0 ml/min.

2 HYDRAULIC PROBLEMS

Problem	Possible cause	Solution
Leaks from the hole at the bottom of the pump head.	Defective piston seal.	Replace piston seal. Refer to User's Guide for the pump head.
Low flow rate.	Leaks. Plugged inlet filter. Defective check valve. Pump head not mounted properly.	Check for leaks. Clean or replace the inlet filter. Refer to User's Guide for the pump head. Clean or replace the check valve. Refer to User's Guide for the pump head. Check that the pump head is properly mounted.
Air bubbles appear in both inlet and outlet tubing.	Loose connection of inlet tubing. Worn flange of inlet tubing. Inlet filter partly clogged. Refill time is too short for the solvent.	Tighten the connection (but do not overtighten). Replace the inlet tubing. Clean or replace the inlet filter. Increase the refill time.
Air bubbles appear only in outlet tubing.	Loose connection of outlet tubing.	Tighten the connection (but do not overtighten).
Poor dampening effect	Defective membrane in the manometric module.	Return to Gilson.
Eluent from the column is coloured blue.	Manometric module membrane is broken.	Return to Gilson.

APPENDIX A ACCESSORY PARTS LIST

1 STANDARD ACCESSORY PACKAGE

Ref.	Qty	Description
E45388	1	Pump head clamp
506341	1	Terminal block connector, 14 pin
610101	1	Double-ended wrench, 1/4''- 5/16''
502046	4	Fuses 2.0 Amp type "T" slow blow for 100-120 V (5 x 20 mm)
500006	1	Power cord for 100-115 V
502145	4	Fuses 1.0 Amp type "T" slow blow for 220-240 V (5 x 20 mm)
500005	1	Power cord for 220-240 V
801171	1	Model 307 User's Guide
410085	3	Nut, 316L, 1/16" hdc, 1/4 - 28 TPI
410086	3	Ferrule, 316L, 1/16" hdc
430019	1	Tubing, 316L, 200 x 1.6 x 0.5 mm

☞ *Only one power cord and one set of fuses are supplied. The standard accessory package that you receive will contain suitable parts for your voltage.*

2 SPECIFIC ADDITIONAL ACCESSORIES

Ref.	Description
500933	GSIOC cable
500944	Four-wire electrical cable, 1.7 m length, for I/O connections. Several units may be required according to the system configuration.
267020	Mast clamp
267022	Mast, aluminum, 450 x 16 mm, hexagonal

APPENDIX B GSIOC CONTROL

This section explains how to control the 307 from a computer using Gilson HPLC system controller software.

1 GSIOC FEATURES

GSIOC stands for Gilson Serial Input Output Channel. This communications channel links all of the Gilson modules in a system together. The system controller controls all of the modules in a system by sending GSIOC commands to the slave modules, for example pumps or detectors. Each device connected to the GSIOC channel is distinguished by a GSIOC identity number between 0 and 63. The GSIOC identity number is set by switches inside each module or by the modules software. The controller communicates with one slave device at a time. The hardware and software requirements to control a module from a computer using the GSIOC are as follows:

- An IBM PC AT, XT, PS 2 computer or compatible.
- A Gilson interface module, 506B or 605.
- A Gilson HPLC system controller software package.

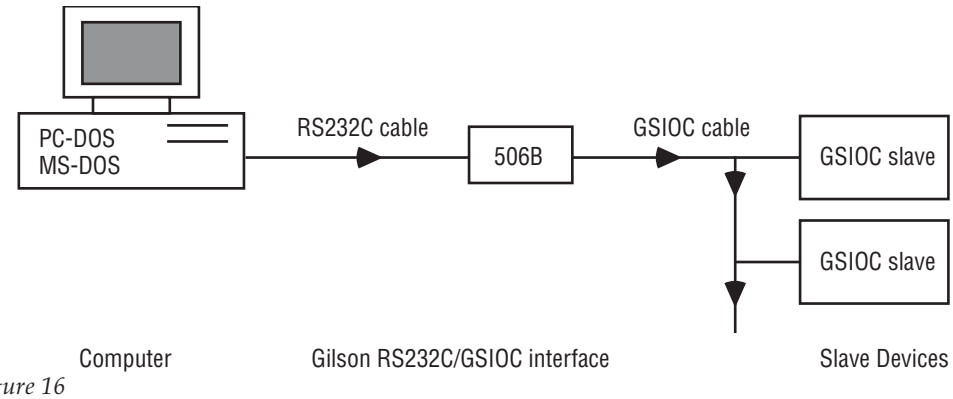


Figure 16

To get started you must:

- Install the Gilson HPLC system controller software into the computer.
- Connect the computer to the Gilson interface using the cable provided with the interface.
- Connect the output from the interface to the Gilson module using a GSIOC cable.
- Start the Gilson HPLC system controller software.

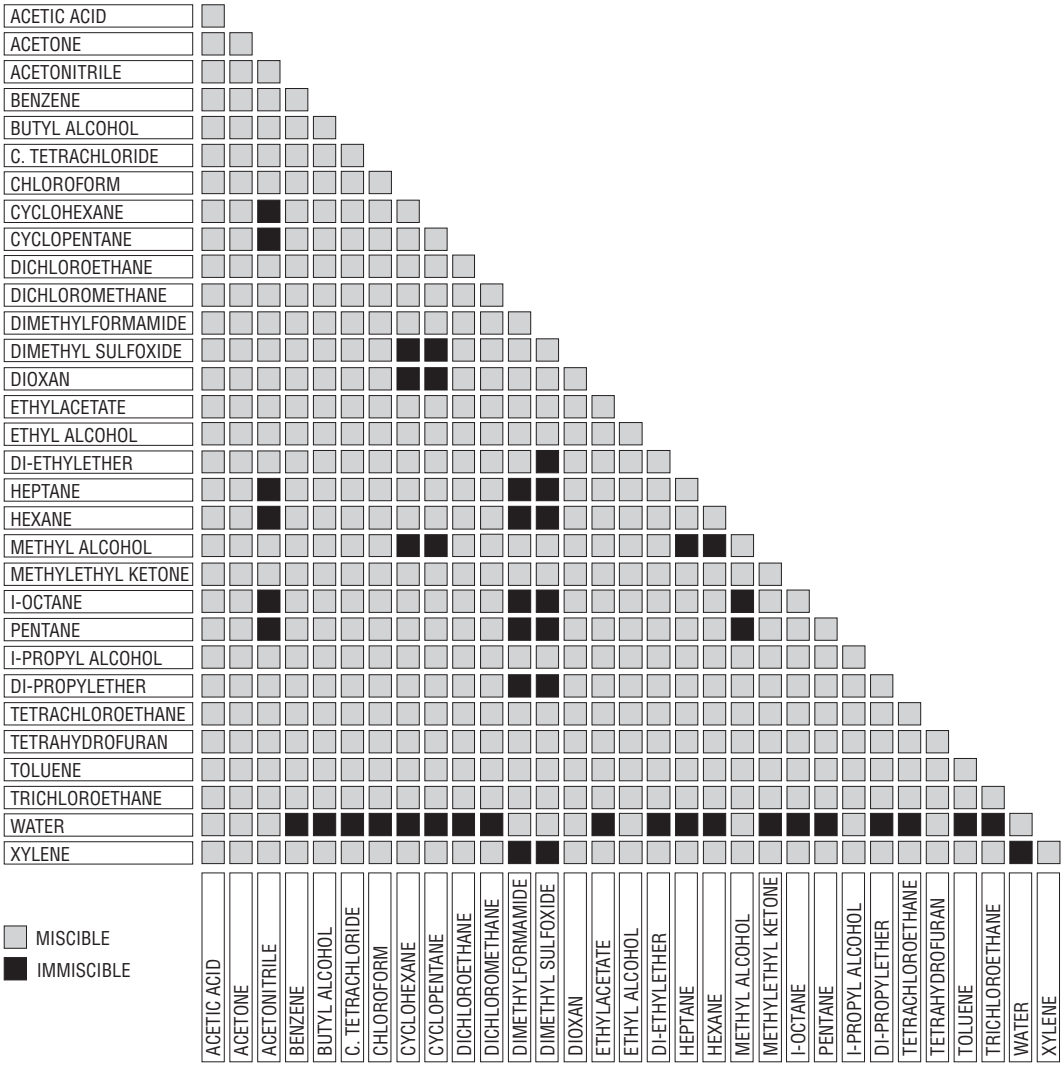
Consult the GSIOC technical manual and the interface manual for more details.

2 GSIOC COMMANDS

The GSIOC commands can be used to control Gilson modules directly from a computer or from a Gilson HPLC system controller software package. The use of the GSIOC commands is completely detailed in the 307 technical manual.

1 SOLVENT MISCIBILITY TABLE

Solvents should be miscible, that is, they should mix with each other in all proportions. This is important during elution, but also during solvent changeover. For your convenience, a solvent miscibility table is provided.



APPENDIX D LIQUID COMPRESSIBILITY VALUES

1 BIBLIOGRAPHY DATA

The values of isothermal compressibility given below can be used for the Compressibility value in the pump setup menu. These values are given under atmospheric pressure (X_0) and are expressed in Mbar $^{-1}$.

The following table refers to Handbook of Chemistry and Physics, CRC Press, 60th Ed. (1979).

Liquid	Temperature (°C)	Compressibility (Mbar $^{-1}$)
Water	20 25 30 40	46 46 45 44
Benzene	20 25 30 40	94-95 96-97 101-103 110
Chloroform	20 25 30 40	97-101 97 108-110 118-119
Methylene chloride	25	97
Carbon tetrachloride	20 25 30 40	103-105 106-108 112-113 120-122
Ethanol	20 25 30 40	110-112 114-116 118-119 126-127
Acetone	20 25 30 40	123-127 124 133 144-156
Methanol	20 25 30 40	121-123 125-127 129-130 138
n-Heptane	20 25 30 40	140-145 142-149 150-155 160
n-Hexane	20 25 30 40	150-165 161-171 165-180 183
Diethyl ether	20 25 30	184-187 195-200 208-209

2 OTHER DATA

For other currently used liquids at ambient temperatures (20-25°C), the following data is given. This data is a result of experiments done using the 307 pump, the figures are not presented as physical constants of scientific value.

If no data is available in this Appendix for the liquid you use, and if you wish an accuracy error within the specifications, you can experimentally determine a value to reach this goal.

Liquid	Liquid Compressibility (Mbar $^{-1}$)
Acetonitrile	99
Tetrahydrofuran	93
Water-methanol, 10-90(v-v)	117
Water-methanol, 20-80 "	86
" 40-60 "	56
" 50-50 "	52
" 60-40 "	46
" 80-20 "	40

To do so, use a trial-and-error empirical method. Select the initial value for Liquid Compressibility according to the following guide-lines

- For an organic solvent, take a value given for the same, or similar, chemical family
- For a mixture, including salt aqueous solutions, take the value of the dominant solvent.

Pump your liquid under high pressure to obtain a significant error, preferably use a gravimetric method if you know the density of the liquid.

Then, with a few successive approximations, adjust the Liquid Compressibility value by assuming a linear relationship between this parameter and the resulting error.

APPENDIX E FLOWRATE ACCURACY PRINCIPLE

To generate the selected flow rate with high accuracy, maintained under high pressure and for a variety of liquids, the 307 software adds two complementary corrections to the basic 'piston flow rate'. Defined from the piston stroke volume only, the piston flow rate is theoretically accurate at atmospheric pressure only.

The objective flow rate, F, is considered as the sum of three components

$$F = F_0 + F_1 + F_2$$

$\mathbf{F_0}$, the piston flow rate decreases when pressure increases;
$\mathbf{F_1}$, the compensation flow rate for the liquid compressibility, increases with pressure; and
$\mathbf{F_2}$, the compensation flow rate for all other factors, also increases with pressure.

The piston flow rate, F_0 , is defined by

$$F_0 = N_0 V_S$$

with $\mathbf{N_0}$, number of piston cycles per unit time; and V_S , piston stroke volume.

The compensation flow rate for the liquid compressibility, F_1 , is calculated as a function of five variables

$$F_1 = f_1 (F_0, V_S, V_D, P, X)$$

where $\mathbf{V_D}$ is the volume of the dead space inside the compression chamber;
P, the operating pressure; and
X, the compressibility of the liquid under the pressure P.

In the 307 software, X is calculated using the simplified Tait equation

$$X = \frac{c}{P + d}$$

Coefficient **c** varies only slightly with the nature of the liquid. It is a constant included in the software.
Coefficient **d** is calculated from the Liquid Compressibility at atmospheric pressure, X_0 (for P=0), entered by the user as a «set-up» parameter.
Values of $\mathbf{X_0}$ for some common solvents are tabulated in Appendix D.
Operating pressure, **P**, is continuously transmitted to the pump by the Manometric Module (pressure feedback).

The complementary compensation flow rate for all other factors, F_2, is defined as the difference

$$F_2 = F - (F_0 + F_1)$$

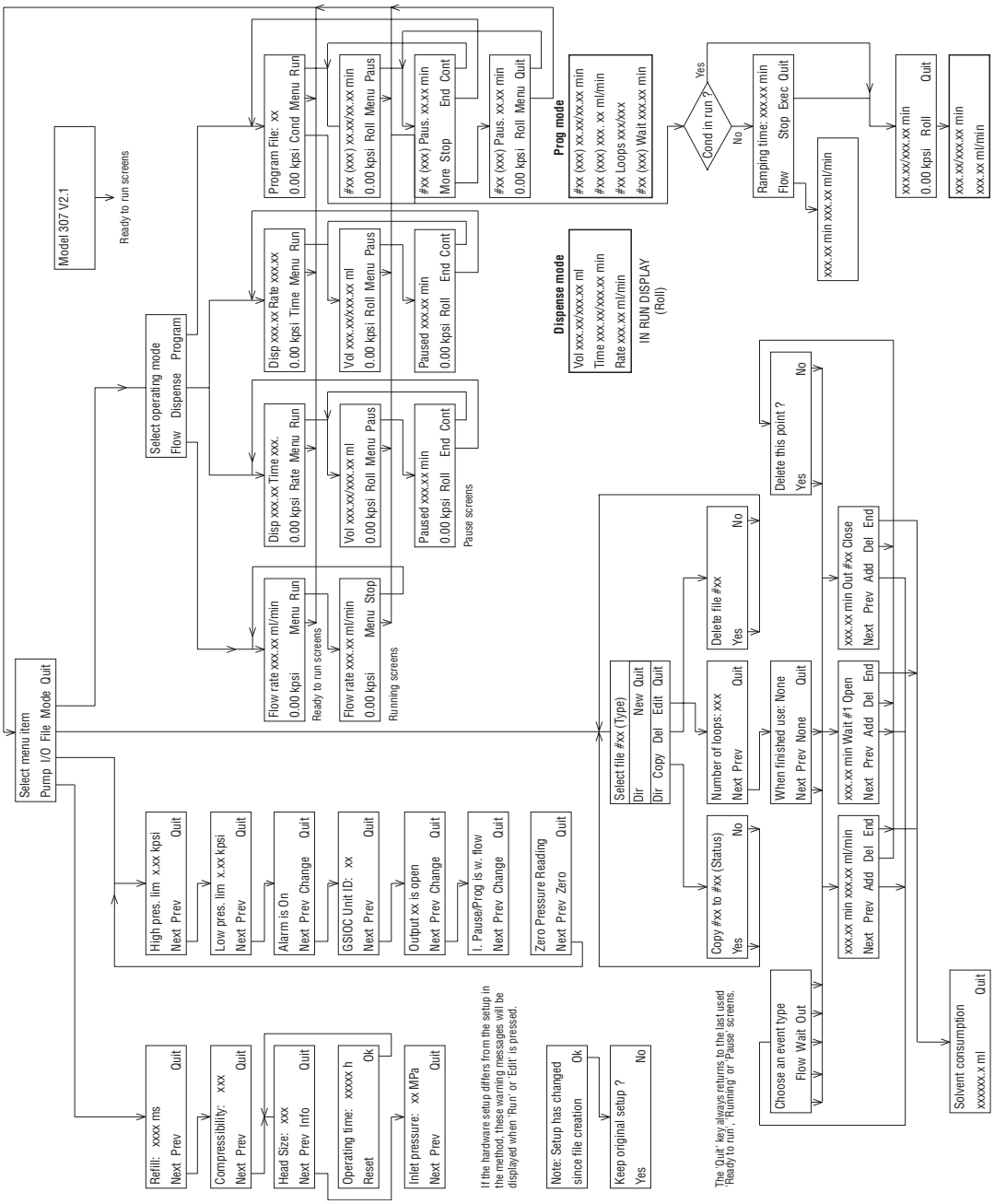
It was measured and the experimental results were expressed using a simple function of operating pressure P

$$F_2 = f_2 (a, b, P)$$

Coefficients a and b were determined for each pump head. They are manufacturing constants attached to the parameter Head Size, a second 'setup' parameter entered by the user.

All of these factors taken together allow the 307 to deliver a highly accurate flow rate, independent of the pump head size, type of liquid and pressure.

APPENDIX F 307 PROGRAMMING CHART



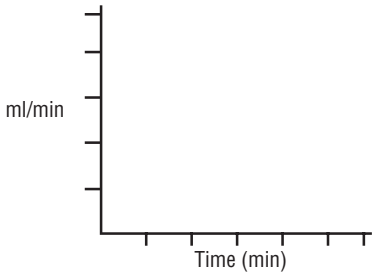
APPENDIX G 307 PROGRAMMING SHEET

File Number:	Method Name

SETUP PARAMETERS

Pressure: High limit =		Low limit =	Units:
Loops =		Link file =	
Solvent	Refill	Comp	Headsize

FLOW



I/O OPERATIONS

Time	Contact	State	Function

PROGRAM STEPS

Step No	Time	Event	Operation	Step No	Time	Event	Operation
1				14			
2				15			
3				16			
4				17			
5				18			
6				19			
7				20			
8				21			
9				22			
10				23			
11				24			
12				25			
13							

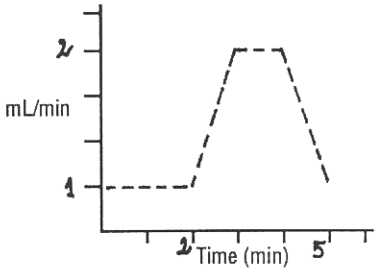
APPENDIX G — 307 PROGRAMMING SHEET (EXAMPLE)

File Number: 1	Method Name Test

SETUP PARAMETERS

Pressure: High limit = 600	Low limit = 10	Units: Bar	
Loops = 10	Link file = none		
Solvent	Refill	Comp	Headsize
Methanol	125	123	5

FLOW



I/O OPERATIONS

Time	Contact	State	Function
0.05	IN # 1	wait	wait for signal from auto-injector
0.1	1	Pulse	Start integrator

PROGRAM STEPS

Step No	Time	Event	Operation	Step No	Time	Event	Operation
1	0	Flow	1mL/min	14			
2	2	Flow	1mL/min	15			
3	3	Flow	2mL/min	16			
4	4	Flow	2mL/min	17			
5	5	Flow	1mL/min	18			
6				19			
7				20			
8				21			
9				22			
10				23			
11				24			
12				25			
13							

APPENDIX H TECHNICAL DATA

TYPE: Programmable reciprocating pump, with single piston interchangeable head, constant stroke and fast refill motion, internal pulse dampener, and pressure feedback.

WORKING RANGE

- **Flow rate**: 0.010 - 5 ml/min (programmable down to 0.5 µl/min).
- **Pressure**: 0.1 - 60 MPa.
- **Temperature**: 0 - 40°C for the module.

PUMP HEADS: Any Gilson model working in the above range, specifically the 5SC for standard applications and the 10 WSC for salt-concentrated solutions (> 0.1M).

LIQUID CONTACT MATERIALS: 316L stainless steel, sapphire, ruby, PCTFE, PTFE/HDPE.

PULSE DAMPENING

- **Pulsation**: less than 1% with water at 1 ml/min and pressure higher than 8 MPa.
- **Dampener volume**: 0.6 ml at atmospheric pressure, and 1.6 ml at 60 MPa.

FLOW RATE PRECISION AND ACCURACY AT 20°C OVER FULL WORKING RANGE

- **Coefficient of variation**: 0.1 - 0.6% with aqueous solutions or hydro-organic polar solvent mixtures, and 0.3 - 1% with hydrocarbons or chlorinated volatile solvents.
- **Maximum accuracy error**: ± 1% with water over the full flow rate and pressure ranges.

OPERATING MODES: Constant flow rate (Flow), constant volume (Dispense), and time-based sequence (Program).

PROGRAM MODE AND SYSTEM CONTROL

- **Time**: adjustable from 10^{-2} to 10^{4} min, with increment from 0.01 to 1 min depending on the range used.
- **Program points**: up to 25, including flow rate and external events.
- **Flow rate**: adjustable in ml/min, from 0.01% to 100% of the head maximum flow rate.
- **External events**: 4 outputs contact closures to activate auto-sampler, integrator, fraction collector and detector autozero, and 1 input to wait for injection.
- **Up to 999 program loops and program linking.**
- **Safety functions**: 4 dedicated programs, for pressure outside of selected limits, input of an emergency signal (temperature threshold, leak detection, etc), and power failure.

MEMORY CAPACITY: 10 user's programs and 4 safety programs.

DISPENSE MODE: Volume adjustable in ml from 10^{-4} to 10^{2} times the pump head size. For a 5 SC head, from 0.5 µl to 500 ml. Dispense time or flow rate can be selected.

PUMP PARAMETERS: Head number (5 or 10), liquid compressibility (0 to 2000 $Mbar^{-1}$), refill time (125 to 1000 ms) and inlet pressure (0 to 10 MPa).

USER INTERFACE: 2 x 24 character LCD display. Front panel keypad. Built-in help messages. Information display for use and maintenance.

DIGITAL INTERFACE: Gilson Serial Input Output Channel (GSIOC) slave connector on rear panel.

ELECTRICAL INTERFACE: 4 inputs and 4 relay outputs on rear panel.

CONFORMITY TO NORMS (*From serial 168001)*:

Gilson's 307 Piston Pumps conform to EEC Directive 89/336/EEC for electromagnetic compatibility: Standard EN 50081-1 for emission, Standard EN 50082-1 for immunity.
Gilson 307 Piston Pumps conform to EEC Directive 73/23/EEC for safety: Standards EN 61010-1, UL 3101-1, and CAN/CSA C22.2 N° 1010-1.
Each Piston Pump is subjected to a Dielectric Test (1500 V between live/neutral and earth) and an Earth Bonding Impedance Test (≤ 0.1 Ω).

APPENDIX H — *TECHNICAL DATA*

ENVIRONMENT:

Dimensions (W x D x H):	330 x 330 x 150 mm.
Temperature range:	4-40°C.
Humidity:	Up to 80 %.
Altitude:	Up to 2000 m.
Voltage range:	100-120 V : 220-240 V, 50-60 Hz.
Electrical power:	120 VA.
Weight:	11.5 kg (with pump head).
Pollution:	Pollution degree 2.
Installation:	Category II.

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