Schambeck SFD GmbH

Solvent Delivery System

S 2100

User Manual

Version 0.1

1. Table of Contents

2. Standard Accessories

A. Solvent Delivery System S 2100 in Stainless Steel

1 pc.	Solvent Delivery System S 2100
1 pc.	Operation manual
1 pc.	Power cord
2 pc.	Fuses
1 pc.	Wrench 1/4" x 5/16"
1 pc.	Wrench SW 13 x 12
1 pc.	Allen wrench 3 mm
1 pc.	Allen wrench 2.5 mm
2 pc.	Fittings with ferrules
1 pc.	Plastic syringe
1 pc.	PTFE tubing 1.6 x 3.2 mm i.d. for the pump suction capillary tube
1 pc.	Stainless steel capillary (0.25 x 1.6 mm)

B.   Solvent Delivery System S 2100 in PEEK

1 pc.	Solvent Delivery System S 2100
1 pc.	Operation manual
1 pc.	Power cord
2 pc.	Fuses
1 pc.	Wrench 1/4" x 5/16"
1 pc.	Wrench SW 13 x 12
1 pc.	Allen wrench 3 mm
1 pc.	Allen wrench 2.5 mm
2 pc.	Hexagon fittings, PEEK
2 pc.	Double cone, PEEK
1 pc.	Plastic syringe
1 pc.	PTFE tubing 1.6 x 3.2 mm i.d. for the pump suction capillary tube
1 pc.	PEEK tubing 0.25 x 1.59 mm

C.   Solvent Delivery System S 2100 with Reagent Organizer S 7131

additionally to the above stated items:

1 pc.	Reagent Organizer S 7131
4 pcs.	Eluent glass bottles, 1 l, each with 4 integrated valves with tubing
4 pcs.	PTFE capillaries for the eluent supply

D.   Solvent Delivery System S 2100 with integrated Vacuum Degasser

additionally to the above stated items:

4 pcs.	Teflon capillaries (1.6 x 3.2 mm; 1.5 m long) with fittings and ferrules

3. Safety Instructions

The manufacturer, Schambeck SFD GmbH, does not warrant for any defects or damage resulting from incorrect operation and maintenance, non-observance of the manual's instructions and negligence during installation.

Before putting the instrument into operation, read carefully the manual and should there be any further questions, please get in contact with your supplier.

3.1.   General Electrical Hazards

1.   Check actual line voltage to confirm that the set voltage (on the rear side; voltage selector and fuse carrier) of the instrument is correct.

2.   Before changing the instrument's voltage or before changing defective fuses, disconnect the instrument from all power sources.

3.   The instrument has to be plugged into grounded wall sockets only

4.   This instrument can be used only with other instruments which comply with the general safety regulations**.**

3.2.   General Precautions

1.   In order to avoid any damages, perform periodic leak checks on all installed supply lines

2.   The instrument is only allowed to be used for applications with specifications described in this manual.

3.   For flammable and/or toxic solvent, follow a regulated approved waste disposal program. Never dispose of such products through the municipal sewage system.

4.   The instrument is suitable for operation between 10 °C and 35 °C surrounding temperature

4. Technical Specification

Dialogue: selectable English/German language

Control: through integrated processor (Montorola 68000)

Communication: RS 232 interface and interface for system control (remote control)
8 integrated Reed relays: inject marker and/or remote control of
external components

Flow rate: with the micro pump head   0.01 - 2.00 ml/min
with the analytical pump head   0.05 - 10.0 ml/min
with the semi-preparative pump head 0.20 - 40.0 ml/min
Pump heads available in stainless steel, PEEK or Titan

Pulsation: less than 1%

Pressure: selectable on the display in Bar, Mpa or psi
max. pressure: up to 40 Mpa (400 bar) equivalent to 6000 psi

Display: large LCD display

Compressibility: Programmable 0.7 - 1.00 for compressibility correction

Operation mode: - programmable flow rate
- programmable run time: 0 - 999.9 min
- programmable flow after the run time for continuously

  flushing of the system with reduced flowrate
- programmable start delay time 1 - 999 sec.
- programmable stop delay time 1 - 999 sec
- programmable pressure control
        min. pressure
        max. pressure
        purge pressure

Quaternary Gradient Mixing:

Gradient: Quaternary low pressure mixing

Programmable steps: 0.1%

Mixing Cycle: programmable 1 - 99 seconds

Operation: manual with constant mixing rate
automatic with time programming

Program storage:	up to 20 gradient programs can be stored

Program sequence:	chaining of existing programs in any sequence

Gradient profile display: graphic display of gradient profile selectable for A, B,C and D

Diagnostic: storage of a pressure profile and display of   irregularities during unattended operation
- short term pressure drop
- short term pressure increase
- unnormal constant pressure increase

RELAY SWITCHING

Function: free programmable 8 relay settings
programmable switching on-off or pulsed operation with programmable pulse duration

VACUUM DEGASSER OPTION:

Degasser: Built-in four channel vacuum degasser

Degassing Method: with applied vacuum, dissolved gases are continuously removed through a semi permeable membrane

Flow Rate: max. 10 ml/min for each degassing channel

Efficiency: 0.5 ppm oxygen at 0.5 ml/min

Applied Materials: All parts coming in contact with the solvent are made of PTFE or PEEK

Volume per each channel: about 8 ml

Power supply: 230 / 110 Vac 50 / 60 Hz

Fuses: for 230 Vac: 2 pcs. 1.0 AT-fuses
for 110 Vac: 2 pcs. 2.0 AT-fuses

Dimensions: 310 x 210 x 450 mm

Weight: approx. 16 kg

5. GENERAL DESCRIPTION

The Pump S 2100 is an extraordinarily flexible dosing system.
It also can be used for applications where under high pressure, fluids have to be dosed exactly and almost pulsation-free. To ensure low pulsation, the pump's mechanism is designed with short-piston stroke technology and only two check valves.

According to the stream of eluent which is required, the built-in pump head is easily replaced with another pump head.

Three different pump heads are available and meet nearly every application where low flow rates and high pressures are required.

1. Micro pump-head: 0.01 - 2.00 ml/min
2. Analytical pump-head. 0.05- 9.95 ml/min
3. Semi preparative pump-head: 0.2- 40 ml/min

All these pump heads are available in different materials depending on the application. They can be made in stainless steel, PEEK or titanium.

With the help of the integrated micro processor, the composition and/or the flow rate of the eluent can be automatically changed, according to the requirements. The low gradient mixing of up to 4 eluents is done with the help of the 4 integrated 2-way solenoid valves. The gradient mixing steps are programmable with 0.1 % steps for each eluent A, B, C and D. With the programmable mixing sequence of the valves, the solvent mixing and the baseline can be optimized. In addition, suitable stored solvent programs can be activated for sample sequences with different samples.
Analysis programs/analysis sequences are set via the large graphical display. According to the GLP regulations, a log book monitoring for various wear and tear parts and for diagnostic parameters (pressure irregularities and pressure runs) is integrated.

5.1 Functioning

The solvent delivery system S 2100 combines the dual piston technique with its advantage of low pulsation and reliable operation. The mechanism is designed with short piston stroke technology and only two check valves. This results in the low pulsation of a dual piston pump combined with the reliability of a single piston pump. Difficulties with solvent delivery systems, caused mainly by malfunctioning of the valves are reduced.

The delivery piston of the standard analytical unit works with a 2 mm stroke length, the compensation piston with 1 mm. The nearly pulse less solvent delivery of the S 2100 results from the high stroke frequency and the use of the compensation piston. The two pistons are contra rotated installed.
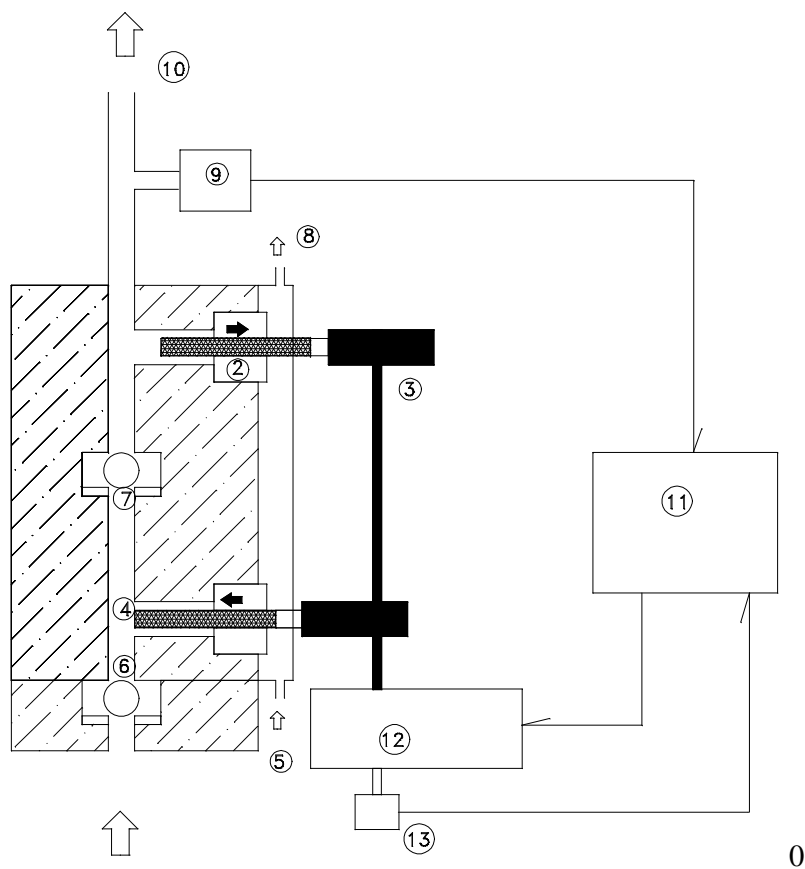
Function diagram of the pump

1. Dampening part of the pump
2. Plunger sealing
3. Camshaft
4. Pump piston
5. Inlet for back-valve flushing
6. First valve ball

7. Second valve ball
8. Outlet of back-valve flushing
9. Pressure sensor
10. Pump outlet
11. Microprocessor
12. D.C. Motor
13. Tachogenerator

While the delivery piston pushes the solvent volume out, the compensation piston, located on the pressure side, collects half of the volume. During return movement of the delivery piston, the collected volume is pumped from the compensation piston. The microprocessor controlled speed regulation leads to a highly stable speed of the d.c. motor. Contrary to standard regulators, the microprocessor is able to correct continuously the compressibility of the eluents through a computerized program. This results in a constant volume delivery throughout the entire delivery range.

The microprocessor technology also offers the possibility to handle the programming, application and controlling of an instrument in a simple manner. Through the alphanumeric display the instrument parameters are shown in clear letters. The user can easily control or change the data. To simplify operation, the function keys are kept at a minimum.

According to the individual modes, the following parameters can be programmed: constant flow in ml/min, constant pressure in MPa, minimum pressure level, maximum pressure limit, maximum flow, compressibility factor, maximum run time, delay time, programmable start delay time and stop delay time. The pump is equipped with a built-in diagnostic system. This continuously controls the following parameters: power failure, program memory, maximum and minimum pressure levels, maximum flow and the power supply. Illogical data, entered by the operator will be ignored by the processor's logic control and signalized.

5.2. Front Side of the SOLVENT DELIVERY SYSTEM S2100

All parts necessary for the operation of the system are positioned at the front.

Via the large LC display all functions can be controlled at any time. The integrated keyboard makes it possible to program the pump via the menu for nearly all analytical applications.
On the right side of the pump, the important pump components like pump head, relief valve etc. are positioned. These are hidden by a magnetically closed door.
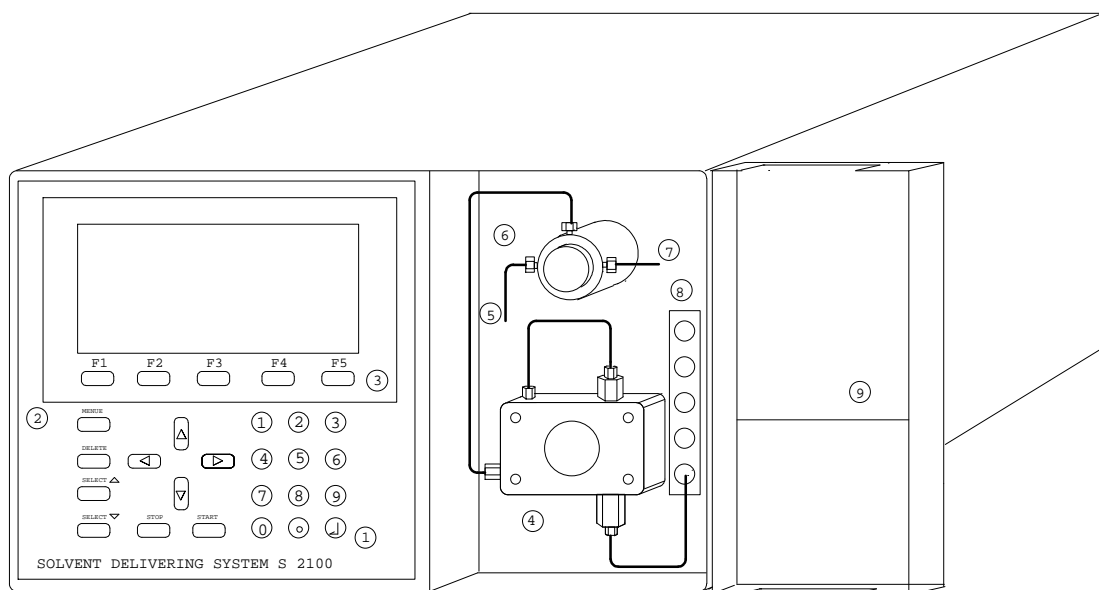
Front Side of the S 2100

1. Keyboard
2. Large graphical LC Display
3. Function Keys
4. Pump Head
5. Drain capillary relief valve

6. Relief Valve
7. Eluent Outlet
8. Connection for the Eluents
9. Door

5.2.2. Description of the Operation Panel

The programming and control of the pump S 2100 is done by a stepwise dialog using different menus. With the function keys F1 - F5, positioned below the display, different menus/functions can be selected directly depending on the actual menu. With the numeric keys, values are entered.
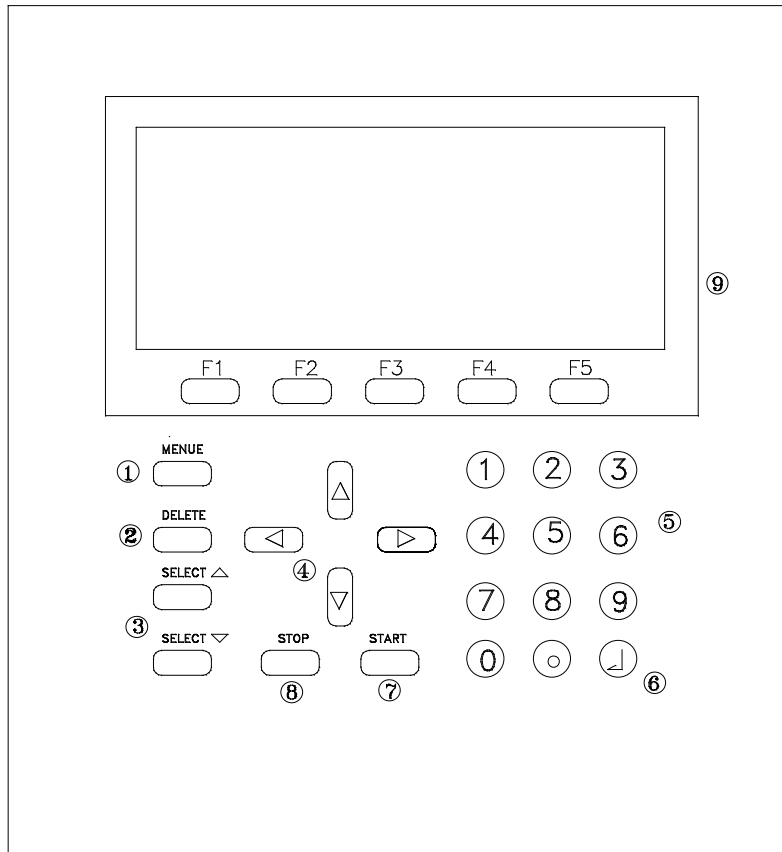
1. **MENU** key: With this function key, it is possible to select the main menue at any time.

2. **DELETE** key: Deletes the actual value

3. **SELECT** key: For selecting variable settings in the individual programs

4. **CURSOR** keys: For selecting the programmable fields described in the screen menus

5. **NUMERIC KEYS (0-9)**:   Used for numeric values

6. **ENTER** key: Used for entering the values

7. **START** key: Starts the automatic processing

8. **STOP** key: Stops the automatic processing,
HOLD (pressing stop key once): the system runs, the clock stops
STOP (pressing stop key twice): the system stops completely

9. **Function keys and display:**   the actual function of the keys is displayed. These are dependent on the menu selected

5.2.3. Pump Components positioned at the front
Opening the magnetically closed door reveals the important parts of the pump
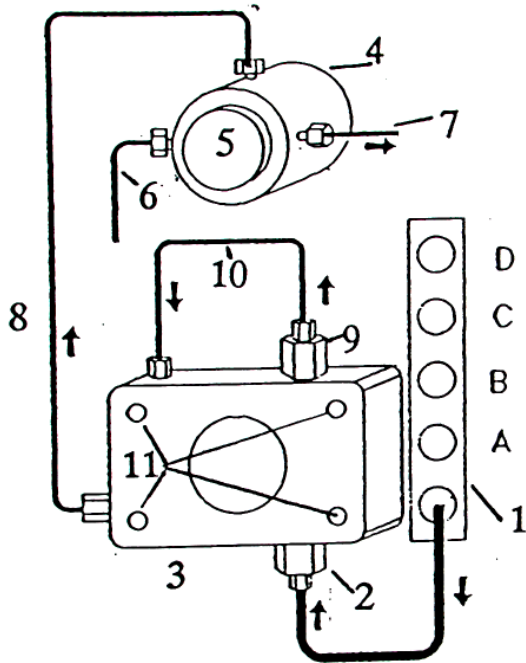
1.	Solvent connection block
2.	Suction valve housing
3.	Pump head
4.	Purge valve
5.	Venting screw
6.	Drain capillary purge valve
7.	Solvent outlet
8.	Connecting capillary pressure sensor
9.	Pressure valve housing
10.	Connecting capillary damping piston
11.	Mounting screws

Pump Head (3)	the pump head can be completely removed -with the integrated pistons. For this loosen the connections for the pressure sensor (8) and solvent inlet capillary. Remove the four mounting screws (11) and the pump head can be pulled out.
Relief Valve (4)	used for a fast solvent change or for flushing the pump head to remove any air. The purge/relief valve can be opened by rotating the knob (5) counter-clockwise and clockwise respectively; after opening the valve, the eluent leaves through the drain capillary due to gravity or with sucking on with the a syringe, connected to the capillary. Depending on the location of the pump, the eluent can be directed directly into a drain reservoir or via a teflon capillary directly into the main drain.
Pressure Sensor	The sensor (micro bourdon-tube type) is positioned behind the relief valve in the inner part of the pump. It has not only zero dead volume but also only an inside volume of 20 ìl. The pressure transfer is done through the inside connection to the relief valve.
Eluent Inlet Valve (2)	the inlet valve and the connecting capillary for the solvent is positioned on the lower part of the pump head.
Eluent Outlet Valve (9)	the pressure check valve is positioned on the upper part of the pump head and is connected through a capillary (10) to the damping piston. The eluent delivered from the delivery plunger streams into the second plunger space and therefore is directly connected with the pressure sensor and the relief valve.

(6)
help of

5.3. Sectional view of the system

After removing all screws, the top cover can be lifted. All parts of the solvent delivery system are then accessible.
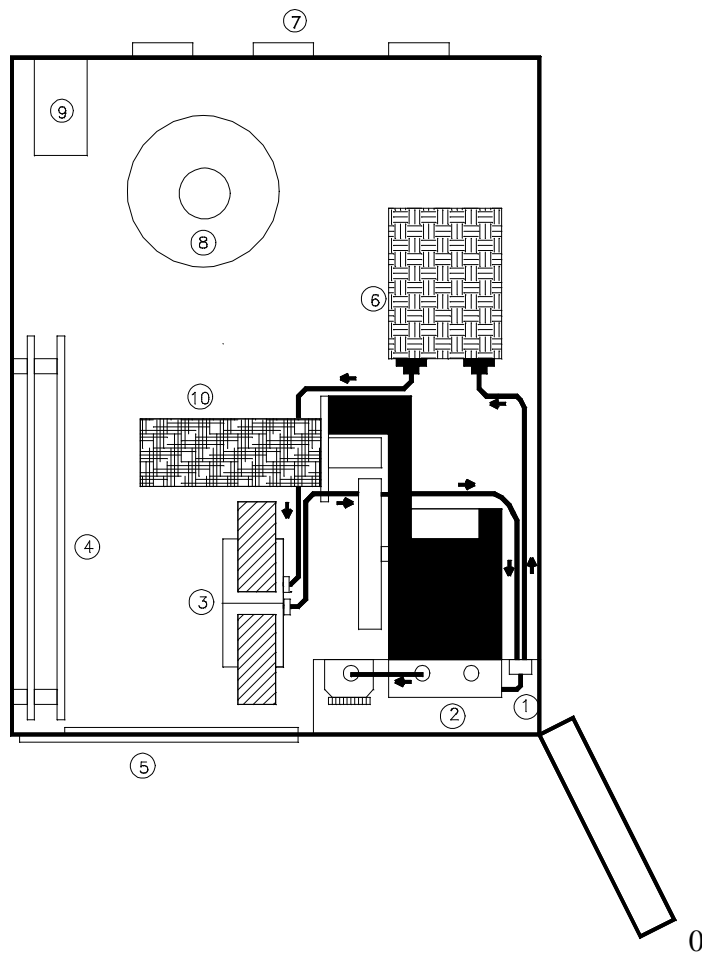
1. Eluent inlet
2. Pump Head
3. Valve Unit
4. PC-boards for System Control
5. Large graphical display
6. Four Channel Vacuum Degassing System (optional)
7. Signal in- and outputs
8. Transformer
9. Power Supply
10. Pump motor

5. 4. Description Rear Panel

At the rear side of the pump, the communication part is installed, like the serial communication port RS 232C, Interface for the operation with a PC and an additional connection for the remote control of external components. Due to these connection possibilities, the pump can be integrated into totally different analysis systems.

```
 1 Function 1 N.O.
 2 Function 1 COM
 3 Function 2 N.O.
 4 Function 3 N.O.
 5 Function 3 COM
 6 Function 4 N.O.
 7 Function 5 N.O.
 8 Function 5 COM
 9 Function 6 N.O.
10 Function 7 N.O.
11 Function 7 COM
12 Function 8 N.O.
13 No connect
14 Function 1 N.C.
15 Function 2 COM
16 Function 2 N.C.
17 Function 3 N.C.
18 Function 4 COM
19 Function 4 N.C.
20 Function 5 N.C.
21 Function 6 COM
22 Function 6 N.C.
23 Function 7 N.C.
24 Function 8 COM
25 Function 8 N.C.
```

```
 1 Input analogue ground
 2 Error relay closed contact
 3 Pump head code 1
 4 Pump head code 0
 5 Start / Stop signal
 6 Free
 7 Error relay common cont.
 8 TTL ground
 9 Input analogue signal
10 Free
11 Installation code
12 High pressure gradient version
13 External control code
14 Free
15 Error relay working contact
```

1   **2**   **3**   **4**   **5**   **6**   **7**   **8**

1. Sub-D connector (25pins) **AUX. FUNCTIONS** for the control of external components.
2. Sub-D connector (15pins) **REMOTE CONTROL** for system control
3. RS 232 C
4. Sub-D connector (9pins) **RS 232C** for digital signal transfer
5. Serial interface input for RS 232 signals (not in use)
6. Master switch
7. Power supply
8. Voltage selector and fuse carrier

*REMOTE CONTROL: The functions printed at the rear panel for remote control are not correct.
Corrected functions:

```
 1 Free
 2 Error relay N.C.
 3 GND
 4 GND
 5 Start
 6 Run relay COM
 7 Error relay COM
 8 GND
 9 Free
10 Run relay N.C.
11 GND
12 GND
13 Hold skip
14 Run Relay N.O.
15 Error relay N.O.
```

6. SETTING UP FOR OPERATION

Before connecting the pump to the mains, check the voltage shown on the typed plate. This voltage should be identical with the voltage of the existing power source. If the voltage is correct, connect the instrument with the enclosed power cord.

If necessary, the voltage has to be changed accordingly:

▼

e.g. 220 – 240 V
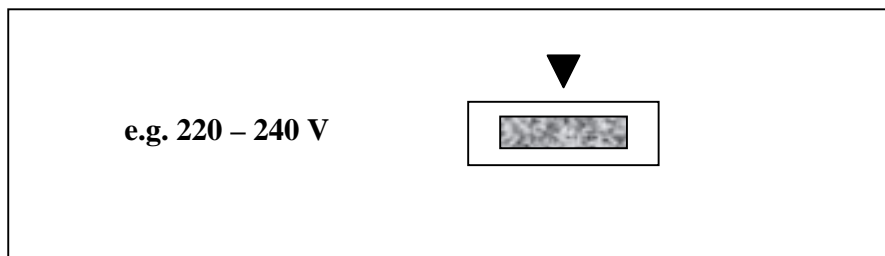
For resetting the voltage, pull the voltage selector out, turn 180° and push connector back.
When the voltage selector is pulled out, also the two fuses (either 0.5 A for 220V or 1.0A 110V) can be replaced if necessary.

Connect the 4 pcs. PTFE capillaries (1.6 i.d. x 3.2 mm o.d.) to the solvent connection block (1). Connect the relief valve outlet (7) to the injection valve and/or autosampler with the enclosed stainless steel/PEEK capillary. Then the pump can be switched on. Connect the enclosed syringe to the outlet capillary of the relief valve.

NOTE:
During the final quality control the pump is tested with propanol. When setting up for operation and later when changing solvents, care must be taken to ensure solvent miscibility to avoid malfunctioning of the check valves. When changing immiscible solvents e.g. methanol-hexane, the pump should be flushed with an intermediate solvent that is miscible with both, e.g. chloroform.
For the basic version of the system without integrated degassing unit, the solvents should be degassed carefully before use, as air bubbles within the pump head will create an unstable delivery of solvents by the pump. The most effective way of degassing is by bubbling helium through the solvent. Storing the solvents at 0.5 to 1 bar after degassing, a steady flow from the pump will be ensured. Under these conditions the solvents will be delivered to the pump inlet better than by gravity alone. Sucking of eluents by the pump may create air bubbles in the tubing. If helium is not available, heating of the solvent and stirring, as well as ultrasonic treatment are also very well tested methods for solvent degassing. Many problems associated with the analytical systems arise from insufficiently degassed solvents.

6.1. Priming the Pump

Always, before putting the pump into operation, all of the in- and outlet capillaries have to be filled bubble-free with the solvent. To do so, connect the enclosed plastic syringe to the outlet (6) of the relief valve. Display the menu for the manual operation (MAIN MENU - MANUAL OPERATION (1)).

During isocratic operation, the valves for the single channels (A, B, C and D) are switched one after another and after opening the relief valve (5) by one turn counter-clockwise, the eluent is sucked on (approx. 10 ml solvent). This should be done until the solvent is supplied without any air bubbles. For the version with the integrated degasser, approx. 20 ml solvent has to be sucked on. Afterwards, remove the syringe and activate the PURGE key (F3) approx. 20 ml solvent.

Close the relief valve (clockwise) and the pump is ready for operation. Above described priming of the pump with the help of a syringe will only work as long as the whole system is closed, e.g. the capillary tube between the pump head and the sample injection valve has to be in place and is not leaking.

In case air bubbles remain in the pump head (pressure drifting during operation), open the purge valve and activate the Purge function key several times. With a pressure of approx. 1 - 2 bar, air-bubbles will dissolve slowly in the eluent and are flushed out of the pump head.

NOTE: Only activate the PURGE function when the relief valve is in the open position!

MAIN MENU

STATUS FLOW	Manual Operation	ANALYSIS SEQUENCE	ANALYSIS PROGRAM	DIAGNOSTIC PROGRAM	PUMP SETUP	PRESSURE PROFILE
display actual parameter	for programming parameters for manual operation or testing purposes	for changing and repeating singel runs	for programming parameters for automatic operation	display of malfunctionings and operation time of wear and tear parts	setting time/date programming setting of the pump	for progamming a reference pressure profile

MENU LOCK

to lock the keyboard

MENU UNLOCK

to unlock the keyboard

GRADIENT GRAPHIC

display diagram of gradient

PRESSURE GRAPHIC

display diagram of pressure run in comparison to a reference pressure profile

DAIGNOSTIC REPORT

display diagram of pressure irregulaties

FLOW FUNCTION

display of actual parameters

PROG. FLOW

programm Composition of solvent

PROG. FUNCTION

programm relay and hold functions

PUMP CONFIGURATION

programming setting of the pump head and motor zero

7. Description of the Individual Screen Menus

All screens have an uniform design.

The upper part of the screen displays the actual values

- the flow rate of the solvent
- the pressure of the solvent
- the operation mode (manual, internal or external)
- the mode of running (Run, Stop, Hold)
- below the status remarks, (eventual) errors are described in abbreviations.

In the middle part of the screen all parameters, important for the operation of the system, can be adjusted. For that purpose the function keys and numeric keys at the front panel must be used.
The positions for entering the values can be selected either via arrow key of the operation panel or directly entered using the numeric keys and the ENTER key.
Change of values can be done by using the numeric keys or by pressing the selection keys.

In the lower part the names of the sub-menus available for the displayed screen are shown.
They can be entered by pressing the appropriate function buttons.

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)
STATUS				
GRAD. GRAPH	PRESS. GRAPH	DIAG. REPORT	FLOW/ FUNCT.	PURGE

7.1. MAIN MENU

This menu can be displayed at any time by pressing the function button **'MENU'** at the front panel. From the main menu, the single programs can be selected with the cursor key and pressing the ENTER key or typing the number 0 to 6.

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)
MAIN MENU VER 1.03 19-07.1999 INTERNAL CONTROL				
0 STATUS 1 MANUAL OPERATION 2 ANALYSIS SEQUENCE 3 GRADIENT PROGRAM 4 DIAGNOSTIC 5 INSTRUMENT SETUP 6 PRESSURE PROFILE				
STATUS	MODE M/P/S	MENU LOCK	INTERN/ EXTERN	PURGE

0	**STATUS**	Status display
1	**MANUAL OPERATION**	In this menu all functions can be operated manually
2	**ANALYSIS SEQUENCE**	Single programs which are already stored can be chained and repeated.
3	**GRADIENT PROGRAM**	The solvent's composition consisting of up to four different eluents can be set.
4	**DIAGNOSTIC**	All parameters documented for GLP can be displayed.
5	**INSTRUMENT SETUP**	All parameters for the configuration of the instrument can be adjusted.
6	**PRESSURE PROFILE**	For checking the pressure during the analysis, the pressure profile of single runs can be recorded and can be

used as a   reference profile.

Function keys:

These function keys do have different functions depending on the menu selected. With the function keys F1 - F5 additional information can be displayed or submenus can be selected directly.

F1	**STATUS**	The STATUS menu can be entered
F2	**MODE M/P/S**	The mode of the system can be set: **M**-manual program: the system can be controlled by using the keys at the front panel **P**-single program: the system runs according to the installed program **S**-program sequence: the system runs according to a program sequence
F3	**MENU LOCK**	The menu can be locked with a security code
F4	**INTERN/EXTERN**	The system can be controlled internally or externally via remote control.
F5	**PURGE**	For flushing the system the purge key can be pressed. **Only activate the PURGE function when the relief valve is in the open position!**

7.1.1. Main Menu Lock

To protect all menus and settings against any manipulations, the system can be locked with a special legitimation code. After entering the code in the special menu accessible from the MAIN MENU and pressing **F3 (Main Menu/Lock)** no changes can be done. Only after unlocking the system, the submenus can be entered and parameters can be changed.
With the cursor key '∇', the field where the legitimation code has to be entered can be reached.

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)
MAIN MENU / LOCK				
LEGITIMATION CODE				
		MAIN MENU		

The keyboard can be locked by typing the **code 23456** and pressing the ENTER key.

F3   **MAIN MENU**   The main menu can be entered. All submenus are locked, except the status menu.

7.1.2. Main Menu Unlock

Before any changes can be done, the keyboard has to be unlocked.
Press the function key F3 (MAIN MENU/UNLOCK). Use the cursor key '∇' and enter the same legitimating code (23456).

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)
MAIN MENU / UNLOCK				
LEGITIMATION CODE				
		MAIN MENU		

Now the system will be unlocked and accessible again.

Function keys:

F3   **MAIN MENU** display of the main menu

7.2. STATUS Display

After pressing the F1 key or the '0' key the status of the system is displayed.
All parameters important for the analysis are shown. We recommend that this menu is displayed during operation.

FLOW: 1.50 ML/MIN	PRESS: 125.0 BAR	MODE STOP (M)

STATUS FLOW   SINGLE PROGRAM   TIME: 13:15   DATE: 20-07-99

PROG. NO.:   0
TOTAL TIME: 0   SEC
STEP NO.:   1 / 10
STEP TIME: 2 / 4000 SEC   INTERNE CONTROL
SEQUENCE: 0 / 0
CYCLE: 0 / 0
FUNCTION: -----------
GRADIENT: 80.0 % A   5.0 % B   3.0 % C   12.0 % D

GRAD. GRAPH	PRESS GRAPH	DIAG. REPORT	FLOW/ FUNCT.	PURGE

FLOW   display of the actual flow rate

SINGLE
PROGRAM: The mode of operation is shown
                       - **Single Program:** the system is controlled by a stored program
                       - **Program Sequence**: the system can run a complete sequence,
                         programmed and stored in a submenu.
                       - **Manual Program**: the system can be run manually.

PROG. NO.:   Shows the number of the actual program

TOTAL TIME: Displays the total runtime of the system

STEP NO.:   The actual step and the total no. of steps is shown.

STEP TIME: The time since the beginning of the step and the total time of the
                       actual step is shown

SEQUENCE: The actual sequence and in case of chaining the total number of
                       sequences are shown.

FUNCTION: the active relays are shown

CYCLE: The actual run and the total numbers of cycles are shown.

GRADIENTS: The actual composition of the gradient delivered at the moment
                       is shown.

Function keys:

F1   GRAD GRAPH   Shows graphically the composition of the eluent.

F2   PRESS. GRAPH   Display of the pressure run.
                           This is only possible, if this has been programmed in the menu
                           PRESSURE PROFILE

F3   DIAG. REPORT   Displays any pressure irregularities

F4   FLOW/FUNCT.   Switching to the menu **STATUS FUNCTION**, the
                           programmed switching functions are displayed

F5   PURGE   Pressing this button, the system is flushed with the
                           eluent.

Pressing the START key, single programs can be skipped. The actual step is displayed.

7.2.1. Submenu: Gradient Graphic

This submenu is entered by pressing the function key **F1** in the STATUS Menu and displays the diagram of the gradient.
The complete curve of the gradient during the analysis run and also of the single solvents can be displayed.

FLOW: 1.50 ML/MIN	PRESS: 125.0 BAR	MODE STOP (M)

GRADIENT GRAPHIC　　　(ABCD)　　　　PROG.NO.: 4


```
100 %



  0 %
ZEIT: 0
       A %          127 SEC        3600 SEC
```

GRAD. ABCD	GRAD. A	GRAD. B	GRAD. C	GRAD. D
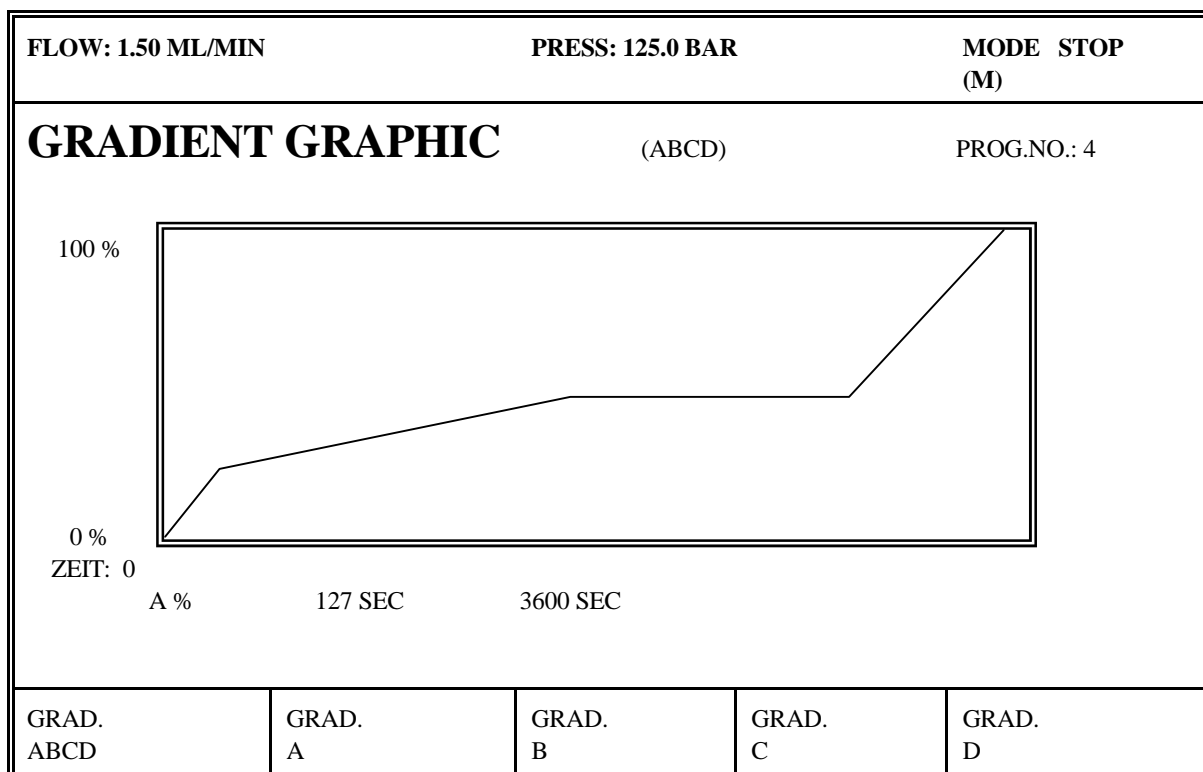
The X-axis shows the percentage of the single component A, B, C and D the eluent is consisting of. The Y-axis shows the time of the total run. The actual composition of the eluent is shown by the vertical mark in the graphic.

Function keys:

F1   GRAD ABCD   The percentage of each component A, B, C, and D of the eluent are displayed in one graphic.

F2-F5 GRAD A - GRAD D Each single component of the eluent is shown in a separate diagram.

Pressing the START key, single programs can be skipped. The actual step is displayed.

The STATUS menu can be displayed by pressing the MENU key.

7.2.2. Submenu: Pressure Graphic

This submenu is displayed after pressing the function key **F2** in the STATUS Menu.
Especially with analysis where constant operation conditions are required, the pressure profile is of the utmost importance. During the analysis, the actual pressure can be compared to an already programmed pressure profile. For the reference pressure profile, the parameters have to be set in the submenu **PRESSURE PROFILE (Main Menu and [6])**.
During the analyses, the actual status is displayed by a vertical line on the reference diagram. The pressure difference of the actual pressure run is shown in numerical values.

FLOW: 1.50 ML/MIN	PRESS: 125.0 BAR	MODE STOP (M)

PRESSURE   (BASE LINE)   PROG.NO.: 4

400

BAR

0
 0
RECORDING   T= 127 SEC   T=3600 SEC

STATUS		REDRAW	+ERROR	-ERROR

PROG. NO.:   Number of the reference profile used for comparing the actual pressure run

The mode of the profile is displayed below the diagram:

RECORDING   displayed before the analyses is started (the data acquisition has been activated in the menu **PRESSURE PROFILE**)

PART   The data recording is not finished yet

COMPLETE   The recording process is finished

EMPTY   No reference diagram is stored

Below the diagram, also the actual run time and the total run time are displayed

Function keys:

Key	Name	Description
F1	**STATUS**	display or the **STATUS** menu
F3	**REDRAW**	the stored reference diagram is redrawn
F4	**+ERROR**	displayed when the pressure exceeds the max. pressure level
F5	**-ERROR**	displayed when the pressure remains under the min. pressure level

NOTE

In case of an error message caused by pressure irregularities (**PRS-AN**), the message has to be first deleted before starting the next analyses.
- go to **STATUS Menu**
- press the **F3 function key (DIAG. REPORT)**
- press the **F2 function key (CLEAR ERROR)**
Afterwards, the next analyses can be started.

Pressing the START key, single programs can be skipped. The actual step is displayed.
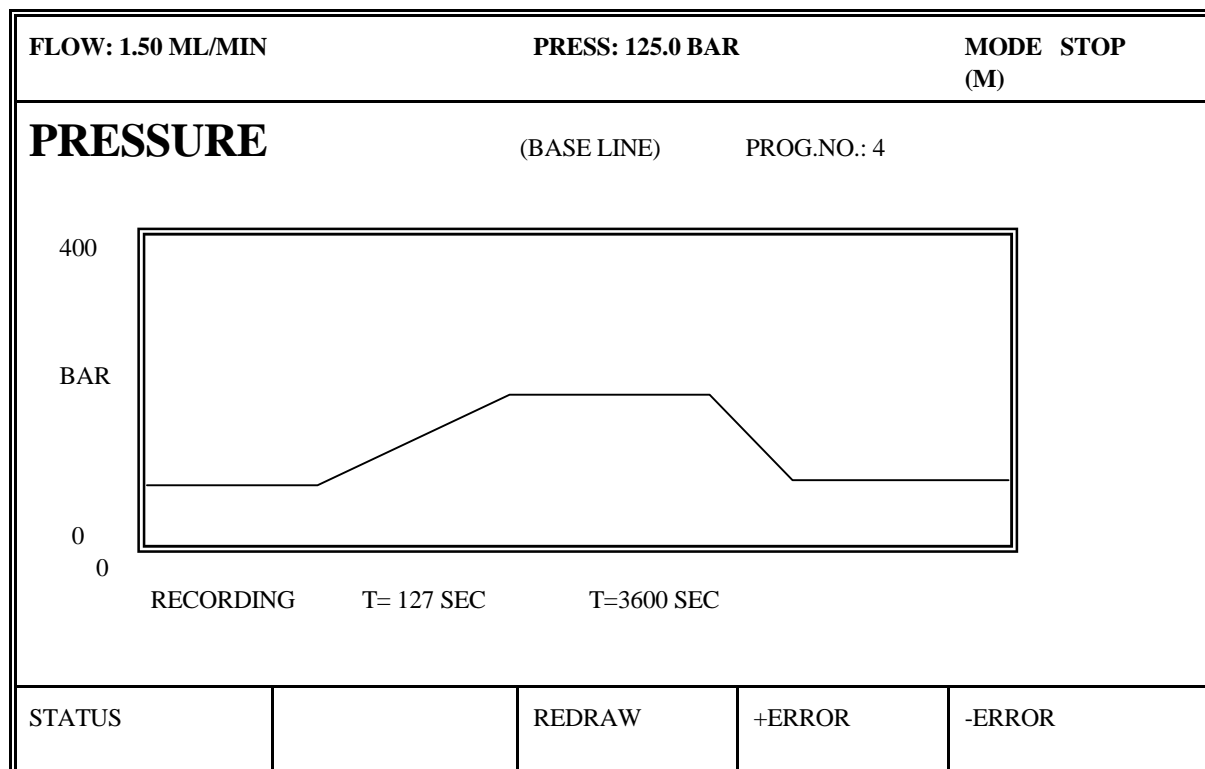
The STATUS menu can be displayed by pressing the MENU key.

7.2.3. Submenu Diagnostic Report

The submenu is displayed after pressing the function key **F3** in the STATUS Menu.
This menu is listing pressure values during a single run or a sequence which exceed or remain under the set pressure values.
The programming of the min. and max. pressure values and the duration of the irregularities have to be programmed in the menu **PRESSURE PROFILE** (Main Menu and [6])

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)
DIAGNOSTIC REPORT				
(ANALYSIS PRESS. ERROR)				
NO.:	ERROR	TIME		
2	+	21.4	ANALYSES W/O	
5	-	33.6	COMMENT ARE	
5	+	41.3	O.K.!	
13	+	55.3		
			-PRESSURE TOO LOW	
			+PRESSURE TOO HIGH	
STATUS	CLEAR ERRORS		+ERROR 0 SEC	-ERROR 0 SEC

NO.: Number of analyses where pressure irregularities happened

ERROR Describes the type of error:
+ the programmed max. pressure is exceeded
- the pressure remained under the programmed min. pressure

TIME shows the time, when the irregularities happened

Function keys:

F1 STATUS Display of STATUS menu

F2 CLEAR ERRORS Deletes the listed errors

F4 + ERROR O SEC counting meter; the duration (in sec.) are registered. If the pressure exceeding remains for a certain period of time, the pressure irregularity will be listed. If the pressure goes below the max. pressure within the programmed period of time, the counting meter will be reset and no error is listed.

F5 - ERROR 0 SEC counting meter; has the same function as F4, but for pressure remaining under the programmed min. pressure.

<u>**NOTE:**</u>
In case of any errors listed, these have to be deleted before starting renewed operation

The pump is equipped with a safety control to avoid any damage caused by a leakage. In case the duration of pressure irregularities (min. or max. pressure value) are longer than the programmed threshold value (entered in the menu PUMP SETUP), the pump switches off.

<u>**Attention**</u>
After initializing the instrument, various parameters are entered automatically for the self testing procedure. These parameters have to be deleted first before operation.

7.2.4. Submenu FLOW FUNCTION

The submenu is displayed after pressing the function key **F4** in the STATUS Menu.
The instrument is equipped with 8 relays with which the integrated micro processor can control an analyses system. The programming is done in the menu **PROG. FUNCTION (Main menu, [4] and F3)**
The display FLOW FUNCTION shows all important parameters of the actual analysis during operation

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)

STATUS FUNCTION   SINGLE   TIME:
   13:15   PROGRAM
              DATE: 20-07-99

PROG. NO.:   0
TOTAL TIME: 0   SEC
STEP NO.:   1 / 10
STEP TIME: 2 / 4000 SEC
SEQUENCE: 0 / 0
CYCLE: 0 / 0
FUNCTION: -----------
GRADIENT: 80.0 % A   5.0 % B   3.0 % C   12.0 % D

GRAD. GRAPH	PRESS GRAPH	DIAG. REPORT	FLOW/ FUNCT.	PURGE

The description of the individual functions can be found under STATUS FLOW (chapter 7.2). With the function key F4 (FLOW/FUNCT.), the menu can be switched between STATUS FLOW and STATUS FUNCTION.

7.3. MANUAL OPERATION

For maintenance or testing purposes or for special applications, the system must be run manually.

```
┌─────────────────────────────────────────────────────────────────────┐
│ FLOW: 1.50 ML/MIN          PRESS: 125.0 BAR          MODE  STOP      │
│                                                            (M)       │
├─────────────────────────────────────────────────────────────────────┤
│ MANUAL OPERATION                                                     │
│                                                                      │
│ TIME:              18 MIN                                            │
│ FLOW RATE   RUN:   0.75              END:      0.25 ML/MIN           │
│ FLOW RAMP    UP:   0.50              DOWN:     0.25 ML/MIN*          │
│ PRESS. FAIL  MIN.: 10.0              MAX:      300.0  BAR            │
│ GRAD. X:           10.0% A    20% B    30% C       40% D            │
│ RELAY FUNCTIONS:   1 - 3 - 5 - 8                                     │
│ MIX. SPEED:        2.0 SEC           COMPR.FACTOR:   1.00            │
│                                                                      │
│                                                                      │
├──────────────┬────────┬────────┬────────┬───────────────────────────┤
│ STATUS       │        │        │        │  PURGE                     │
└──────────────┴────────┴────────┴────────┴───────────────────────────┘
```

TIME: programming of the analysis time

FLOW RATE   **RUN**: programming of the flow rate during the analyses (ml/min.)

END: programming of the flow rate of the eluent after finishing the analyses.

The mode of the pump is displayed in the top right corner:

IDLE the pump delivers with the programmed flow rate (END)
STOP the pump stopped; (value entered under END: 0)

FLOW RAMP*	programmable start and stop delay time which protects and therefore prolongs column's durability as a careful pressure increase and decrease onto the column is possible.
UP:	programming of the flow rate ramp (ml/sec) before starting the analyses. The flow rate of the pump will increase linearly from 0 to the set flow rate during the time ramp entered. After reaching the programmed flow rate, the analyses will start
DOWN	programming of the flow rate ramp (ml/sec). The flow rate of the pump will be linearly decreased from the working flow rate down to zero during the time ramp entered. This will avoid a sudden pressure drop.

**** The displayed measures (ml/min.) are not correct.
   The time ramps are programmed in ml/sec.****

PRESS. FAIL:	If the pressure exceeds and/or drops under the programmed pressure values (minimum or maximum value) for a certain period of time (programmed in the menu PUMP SETUP) the pump stops automatically.
	MIN Value for min. pressure
	MAX Value for max. pressure

| **ISOCR. X**: | The mode of the system can be adjusted by pressing the SELECT buttons. Each single eluent can be delivered. In ISOCR. mode after pressing the SELECT button, the corresponding valve opens and the single eluent will be delivered. |
| or **GRAD. X**: | The gradient can be adjusted for manual use of the instrument. Due to the SELECT button, the gradient for the different solutions can be selected. If a gradient is chosen, the concentrations of all the other components can be set and the concentration of the selected gradient will be calculated automatically. |

| **RELAY FUNCTIONS:** | Here, up to eight integrated relays can be manually activated |
| **MIXING SPEED**: | For preparing the mixture of the gradient, the valves open in the frequency which is adjusted here. In some cases, depending on the flow rate (pressure pulsation), the signal shows a typical pulsation. To avoid this disturbance the mixing speed should be adjusted (0,1 - 99 sec.) |

| **COMPR. FACTOR** | Especially organic eluents can be compressed by the high pressure of the pump during delivery. For an accurate flow rate the system needs a factor which can be set here. (refer to Compressibility; chapter 8) |

Function keys:

| **F1** | **STATUS** | The STATUS of the system is shown |
| **F5** | **PURGE** | The system will be flushed with the eluent (in general this will be the max. flow rate) |

7.4. ANALYSIS SEQUENCE

The different single programs can be chained, repeated and combined in sequences. Up to 14 different steps can be stored.

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)

ANALYSIS SEQUENCE   MAX. SEQUENCE: 2

	COUNT	PROGR. / NAME		COUNT	PROGR. / NAME
1:	2	4 PROG# 4#	8:	0	1 PROG# 1#
2:	3	2 PROG# 2#	9:	0	1 PROG# 1#
3:	5	3 PROG# 3#	10:	0	1 PROG# 1#
4:	0	1 PROG# 1#	11:	0	1 PROG# 1#
5:	0	1 PROG# 1#	12:	0	1 PROG# 1#
6:	0	1 PROG# 1#	13:	0	5 PROG# 5#
7:	0	2 PROG# 2#	14:	0	3 PROG# 3#

STATUS				PURGE

MAX. SEQUENCE: Here, the number of the last step has to be entered to which the sequence program should be processed automatically.

COUNT: Here, the number of repetitions of the single steps must be set.
If the number 0 is set, the sequence is stopped at that point.

PROG./NAME Here, the number and name of the single program which is to be chained must be set.

Function keys:

F1   STATUS   The STATUS menu can be entered.

F5   PURGE   The system is flushed with the max. flow rate

7.5. ANALYSIS PROGRAM

In this menu the programming of the gradients is done. In more than 100 steps the flow with max. and min. pressure can be set. With the relay function, the relays can be switched in pulse or permanent mode.

FLOW: 1.50 ML/MIN		PRESS.:125.0 BAR		MODE STOP (M)
ANALYSIS PROGRAM		SINGLE PROGRAM NO.:		1
		EDIT PROGRAM NO:		2
GRADIENT:	GRAD A	STEPS FLOW:		12
HEAD:	ANALYT:	STEPS FUNCT.:		2
COMPR: FACTOR:	1,00	MIX. SPEED:		6 SEC
RAMP UP:	1,00 ML/MIN (MAX.)			
RAMP DOWN:	1,00 ML/MIN (MAX.)			
P.-MIN:	0 BAR			
P.-MAX:	100 BAR	FUN.# 1 2 3 4 5 6 7 8		
FUNCTION	(STATIC/PULS):	P S P S P S S S		
STATUS	PROG./ FLOW	PROG./ GLOBAL	CLEAR STEP	INSERT STEP

SINGLE PROGRAM NO   Shows the actual program which will be activated after pressing the START key

EDIT PROGRAM NO   Shows the number of a different program which can be edited while the other program is running

ISOCR./GRADIENT

With the SELECT buttons, the mode can be adjusted.
ISOCR. mode; each single eluent can be delivered
GRADIENT mode; after selecting a gradient, the concentrations of all the other components can be set and the concentration of the selected gradient will be calculated automatically.

STEPS FLOW   number of programming steps entered in the submenu
PROG. FLOW

HEAD   **ANALYT./MICRO/PREP:**
Shows, which pump head is installed
In the menu **PUMP CONFIGURATION** the parameters for the appropriate pump head are entered

STEPS FUNCT.   number of relay functions, programmed in the submenu
PROG. FUNCTION

COMPR. FACT.   Especially organic eluents can be compressed by the high pressure of the pump during delivery. For an accurate flow rate the system needs a factor which can be set here. (refer to Compressibility; chapter 8)

FLOW RAMP*   programmable start and stop delay time which protects and therefore prolongs column's durability as a careful pressure increase and decrease onto the column is possible.

UP: programming of the flow rate ramp (ml/sec) before starting the analyses. The flow rate of the pump will increase linearly from 0 to the set flow rate during the time ramp entered. After reaching the programmed flow rate, the analyses will start

DOWN   programming of the flow rate ramp (ml/sec). The flow rate of the pump will be linearly decreased from the working flow rate down to zero during the time ramp entered. This will avoid a sudden pressure drop.

** The displayed measures (ml/min.) are not correct. The time ramps are programmed in ml/sec.**

PRESS. FAIL: If the pressure exceeds and/or drops under the programmed
P.-Min.   pressure values (minimum or maximum value) for a certain
P.-Max.   period of time (programmed in the menu PUMP CONFIGURATION) the pump stops automatically.
    MIN   Value for min. pressure
    MAX   Value for max. pressure

FUNCTION
(Static/Pulse)   The 8 installed relays make a remote control of external instruments (photometer or additional pumps) possible.
    Pressing the arrow keys and the SELECT key, each relay can
    be set on pulse mode or as a static signal.

Function keys:

F1   **STATUS**   The STATUS menu is displayed

F2   **PROGRAM FLOW**   For programming the composition of the solvent

F3   **PROGRAM FUNCTION**   For programming automatically HOLD periods and relay functions

F4   **CLEAR PROGRAM**   Deletes the active program

7.5.1. ANALYSIS PROGRAM; Submenu PROG./FLOW

This menu is used for programming the composition of the solvent.
In this submenu, entered with pressing the F2 key in the ANALYSIS PROGRAM MENU, up to 25
programs with more than 100 steps each can be created.

FLOW: 1.50 ML/MIN			PRESS.:125.0 BAR		MODE STOP (M)	
ANALYSIS PROGRAM				SINGLE PROGRAM NO.: 1		
<25.0> <59.0>				EDIT PROGRAM NO: 2		
NO	SEC	ML/MIN	GR:A%	GR.B%	GR.C%	GR.D%
0		0.50	100.0	0.0	0.0	0.0
1	4.0	1.00	20.0	10.0	20.0	50.0
2	21.0	1.25	50.0	20.0	15.0	25.0
3	34.0	1.25	30.0	10.0	20.0	40.0
4	50.0	1.25	20.0	30.0	32.0	18.0
5	0.1	1.25	0.0	0.0	0.0	100.0
6	10,0	1.25	0.0	0.0	0.0	100.0
STATUS		PROG./ FLOW	PROG./ GLOBAL	CLEAR STEP	INSERT STEP	

SINGLE PROGRAM NO   Shows the actual program which will be activated after pressing the START key

EDIT PROGRAM NO   Shows the number of a different program which can be edited while the other program is running

NO.   The number of the programming step

SEC   The duration of this step in seconds. During this time, the mixing ratio changes linearly until reaching the programmed value.
A gradient change in steps can be achieved by programming between the eluent change 0.1 min. In the next program step, the duration of the constant delivery of the programmed mixing ratio has to be entered.

ML/MIN   The flow rate of the eluent

Gr.A% (B,C,D)   For programming the single eluents in VOL%.
A selected choice of the gradient makes the programming process easier, as the selected gradient will be calculated automatically.

ISOCRAT A% (B,C,D)   For the selection of the single eluent in VOL%.

Function keys:

F1   STATUS   The STATUS menu is shown

F2   PROG./GLOBAL   Switches between the menu of the actual analysis program

(7.5.) and the submenu for programming

F3   PROG./FUNCT.   Switches to the menu PROG/FUNCT. for programming the relay functions (7.5.2.)

F4   CLEAR STEPS   Single programming steps can be selected and deleted by pressing the F4 function key

F5   INSERT STEPS   To save time, a selected program step can be copied with the function key F5

7.5.2. ANALYSIS PROGRAM; Submenu PROG./FUNCT.

In this submenu, the relay functions and hold functions for the analysis program can be entered. The submenu is displayed by pressing the F3 function key or in the submenu PROG./FLOW by pressing the submenu PROG./FUNCT. [F3].

FLOW: 1.50 ML/MIN					PRESS.:125.0 BAR					MODE STOP (M)

ANALYSIS PROGRAM   SINGLE PROGRAM NO.: 1
EDIT PROGRAM NO: 2

NO	SEC	HOLD	F1	F2	F3	F4	F5	F6	F7	F8
0		NO	-	2	-	-	-	6	7	-
1	0.1	YES	-	-	-	4	-	-	-	-
2	7.0	NO	-	2	-	-	-	6	7	-
3	11.8	NO	-	-	-	-	-	-	-	-
4	24.8	NO	-	-	3	-	-	-	-	8
5	30.0	NO	-	2	-	-	5	6	7	-

STATUS	PROG./ FLOW	PROG./ GLOBAL	CLEAR STEP	INSERT STEP

SINGLE PROGRAM NO	Shows the actual program which will be activated after pressing the START key.
EDIT PROGRAM NO.	Shows the number of a different program which can be edited while the other program is running
NO.	The number of the step with the described parameters
SEC.	The time when the programmed event will start
HOLD	YES/NO after a programmed start time (e.g. 0.1 min.), the pump will stop (YES) until pressing the START key or through an external start signal. For automatic processing, the HOLD function has to be deactivated (NO).
F1 - F8	Number of the active relay; Slash: inactive relay

Function keys

F1	**STATUS**	The STATUS menu is shown
F2	**PROG./FLOW**	Switches to the menu PROG./FLOW for programming the gradient composition (7.5.1.)
F3	**PROG./GLOBAL**	Switches between the menu of the actual analysis program (7.5) and the submenu for programming
F4	**CLEAR STEPS**	Single programming steps can be selected and deleted by pressing the F4 function key
F5	**INSERT STEPS**	To save time, a selected program step can be copied with the function key F5

7.6. DIAGNOSTIC PROGRAM

This menu shows the most important parameters of the system necessary for GLP and for fast checks in case of malfunctioning. The menu displays the important power supplies of the single PC boards, the actual vacuum (optionally) and the operating hours of various wear and tear parts.

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)
DIAGNOSTIC ROGRAM (GLP)				
VACUUM: -889 mBAR U1: 5.14 U2: 15.3 U3: -15.4 U4: 24.9 U5: 33.5 INLET CHECK VALVE: 785 h OPERATION TIME DELIVERY PISTON: 785 h DAMPING PISTON: 1082 h PISTON SEAL: 762 h SECONDARY SEAL: 897 h				
STATUS	H/S		CLEAR TIMER	CONFIRM

VACUUM: The present vacuum applied on the eluent is shown (only with built-in vacuum degasser option)

U1, U2, U3, U4: Various controlled power supplies for the PC-boards

INLET CHECK VALVE
DELIVERY PISTON
DAMPING PISTON
PISTON SEAL
SECONDARY SEAL counting meter for the operating hours of the individual part.

Function keys:

F1 STATUS The STATUS menu is displayed

F2 H/S Using this button the runtime can be displayed in seconds and/or hours

F4 CLEAR TIMER If any of the parts are replaced and the timer must be set to zero again, this can be done by pressing this button.

F5 CONFIRM After setting the timer back to zero, this has to be confirmed with the F5 function key.

7.7. PUMP SETUP

In this menu all parameters for setting up the pump can be entered.

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)
PUMP SETUP			TIME: 11:49 DATE: 20-7-99	
CONTROL MODE:	INTERNAL			
PUMP HEAD:	ANALYT.			
PURGE PRESS MAX:	100 BAR			
VACUUM DEGASSER:	YES/NO			
TIME BASE:	1 SEC			
PRESSURE UNIT:	BAR			
MIX. SPEED:	6 SEC	RELAY PULSE: 7 SEC		
PRESS. FAIL MIN:	55 SEC	MAX: 0 SEC		
STATUS	PUMP CONFIG.	DIALOGUE GERMAN		

**DATE/
TIME**   The date (refer to 7.9) and time can be set, selecting the number to be changed, -with the arrow key- and is replaced by typing the correct number. The new numbers must be confirmed with the ENTER key.

CONTROL MODE   The system can be controlled internally by its built-in microprocessor or externally with a separate PC. The mode can be changed using the SELECT key.
INTERNAL control through internal microprocessor
EXTERNAL (Remote Control) control through external signals (FLAGS)
SERIEL after connecting the pump to a RS232 interface, the system can be controlled via a data software

PUMP HEAD   For selecting the pump head in use. After exchanging the pump head, the appropriate pump head must be selected with the SELECT key. In addition, the head constant in the Menu **PUMP CONFIGURATION** has to be changed.

PURGE PRESS MAX.   For some applications the purge pressure should be limited.
Here the maximum pressure can be set.

**VACUUM DEGASSER
(OPTIONAL)**   The built-in vacuum degasser can be switched on or off, pressing the SELECT button.

TIME BASE   The time base can be selected by pressing the SELECT button.
                       Alternatives: 1 SEC, 0.1 MIN, 1 MIN

PRESSURE UNITS   The pressure unit can be selected by pressing the SELECT button.
                       Alternatives: BAR, MPA, PSI

MIXING SPEED   The mixing speed of the built-in valves can be adjusted. In some cases the
                       frequency of opening and closing the valves and the pump frequency
can   cause problems. The baseline shows a typical pulsation.
                       After changing the mixing speed (from 0.1 - 99 sec) the pulsation can be
                       avoided.

RELAY PULSE   The pulse duration of the signal relays can be set (1-99 sec) by typing the
                       new number.

PRESS. FAIL: In case of pressure irregularities over a certain period of time, the
                       pump will switch off to avoid any damage caused by leakage.
                       MIN.: period in case of minimum pressure failure (0-999 sec).
                       MAX.: period in case of maximum pressure failure (0-999 sec).

NOTE: It is strongly recommended to set the Max. Pressure Failure to 0 Sec.

Function keys:

F1   STATUS   The STATUS menu is displayed

F2   PUMP CONFIGURATION   The menu for configuration (head constant, motor,
                                       span etc.) can be entered

F3   DIALOGUE GERMAN   The dialogue language can be selected by pressing
                                       the SELECT button (GERMAN / ENGLISH)

7.7.1. PUMP CONFIGURATION

In this submenu the settings for the different pump heads are programmed. Before changing the values, a note of the old values should be made and if necessary, the manufacturer of the pump should be contacted.

After an initializing process (should be only done on manufacturer's approval)
or after exchanging the pump head, the head constant and Motor zero value should be checked and if necessary, changed.

FLOW: 1.50 ML/MIN	PRESS: 125.0 BAR	MODE STOP (M)

PUMP CONFIGURATION

LEGITIMATION: 0

HEAD CONSTANT: 3.00   MOTOR ZERO: 10

HEAD	PARAMETER	SPAN	FLOW
MICRO:	1.00	1.00	4.00 ML/MIN
ANALYT:	1.00	1.00	10.00 ML/MIN
PREP:	1.00	1.00	40.00 ML/MIN

STATUS	PUMP SETUP	MOTOR ZERO		

ATTENTION!!!!!   **Settings in this menu should be changed only on request.**

LEGITIMATION   Enter the legitimating code (123)

HEAD CONSTANT   The head constant of the pump head delivered with the pump can be found in the inside of the system. After removing the pump's cover, a label is fixed on the left sided mounting plate (used for the processor boards). There the head constant and the motor zero value are recorded. After the initializing process, the displayed head constant and motor zero value has to be checked and in case of discrepancies, changed.
After exchanging the pump head (analytical, micro, prep. version), in general the following head constancies are used:

Stainless steel version:	analytical:	head constant 3.00
	micro:	head constant 0.80
	preparative:	head constant 5.00

PEEK version:	analytical:	head constant 1.25
	further head constancies on request.	

MOTOR ZERO   Motor value of the pump motor.
                                   Each pump has a different motor value. The exact value is recorded
                                   in the inside of the system (refer to Head Constant). The displayed
                                   value should be identical to the listed value.

The following values for **PARAMETER**, **SPAN** and **FLOW** should be checked and if necessary, corrected.

	Head MICRO	PARAMETER:	1.00
		SPAN.	1.00
		FLOW:	4.00 ML/MIN

	ANALYT.	PARAMETER:	1.00
		SPAN.	1.00
		FLOW:	10.00 ML/MIN

	PREP.	PARAMETER:	1.00
		SPAN.	1.00
		FLOW:	40.0 ML/MIN

Function keys:

F1   **STATUS**   The STATUS MENU is displayed

F2   **PUMP SETUP**   Switching to the PUMP SETUP menu for programming

F3   **MOTOR ZERO**   For adjusting the starting output of the motor
                                     (changes only on manufacturer's approval)

7.8. PRESSURE PROFILE

If the column's packing material changes during the analyses, unexplainable drifts or peaks are the result. For comparing the pressure profiles, a reference profile should be monitored before starting the analysis sequence. For programming the profile parameters, the menu PRESSURE PROFILE has to be used

FLOW: 1.50 ML/MIN	PRESS: 125.0 BAR	MODE STOP (M)	
PRESSURE PROFILE			
PROGRAM NO. FOR BASE LINE:	6		
USE PRESSURE PROFILE:	NO		
OVERPRESSURE:	1% FOR 15 SEC		
UNDERPRESSURE:	1% FOR 15 SEC		
PROFILE RECORDED:	15:32 12-07-99		
STATUS: PART	PROGRAM: 2		
STATUS		CLEAR PROFILE	NEW PROFILE	

PROGRAM NO. FOR BASE LINE

The no. of the analyses program is selected where this reference pressure profile should be applied to

USE PRESSURE PROFILE

YES/NO

After recording the reference profile, it is up to the operator if he wants to use the profile for comparison of other analysis sequences or not.

OVERPRESSURE programming of the max. pressure [%] and the duration of the max. pressure [sec.] until the overpressure is registered as error.

UNDERPRESSURE programming of the min. pressure [%] and the duration of the min. pressure [sec.] until the under pressure is registered as error.

PROFILE RECORDED Date and time of the reference profile monitored

STATUS **EMPTY** no reference profile is stored
COMPLETE the reference profile can be used for comparison
PART displayed while the reference profile is monitored

PROGRAM No. of program where the reference profile was recorded.

Function keys:

F1 STATUS The STATUS MENU is displayed

F3 CLEAR PROFILE Deletes a recorded pressure profile

F4 NEW PROFILE Activates a new profile recording process. The monitoring will start, when the pump starts and is displayed in the menu STATUS-PRESSURE GRAPHIC.

7.9. Setting Time and Date

For changing the date and time of the instrument, the menu PUMP SETUP (Main Menu and Pos. 5) has to be activated

FLOW: 1.50 ML/MIN		PRESS: 125.0 BAR		MODE STOP (M)
PUMP SETUP			**TIME: 11:49** DATE: 20-7-99	
CONTROL MODE: INTERNAL				
PUMP HEAD: ANALYT.				
PURGE PRESS MAX: 100 BAR				
VACUUM DEGASSER: YES/NO				
TIME BASE: 1 SEC				
PRESSURE UNIT: BAR				
MIX. SPEED: 6 SEC	RELAY PULSE: 7 SEC			
PRESS. FAIL MIN: 55 SEC	MAX: 0 SEC			
STATUS	PUMP CONFIG.	DIALOGUE GERMAN		

Setting the Time: With the arrow key, go to DATE and change the date requested (day-month-year). This has to be confirmed with the ENTER key

Setting the Time: Also with the arrow key, go to TIME and change the hour/minutes as requested. Confirm with the ENTER key.

8. Compressibility

A general problem for constant flow delivery with piston pumps is the compressibility of the solvents under pressure. Any liquid shows a specific volume elasticity. If the liquid is influenced by pressure changes dp, the volume will change by dV. The volume V will become the same as before, if the pressure will be reduced to the original value again. The dimension of the change in volume is the compressibility.

This can be shown as:

Compressibility = relative change of the volume
the necessary pressure change

therefore: **K = (-1/V) dV / dp**

The constant volume delivery can be seen as a stepwise displacing of liquid out of the pump head. The dimension for the volume delivery is the amount of piston volume during a period of time. But this is only correct as long as the delivery is done without any added pressure. As soon as the liquid delivery has to be done against a back pressure, a specific amount of the piston volume has to be used for compressing the liquid first, before the delivery can start.

This can be described by the following diagram:
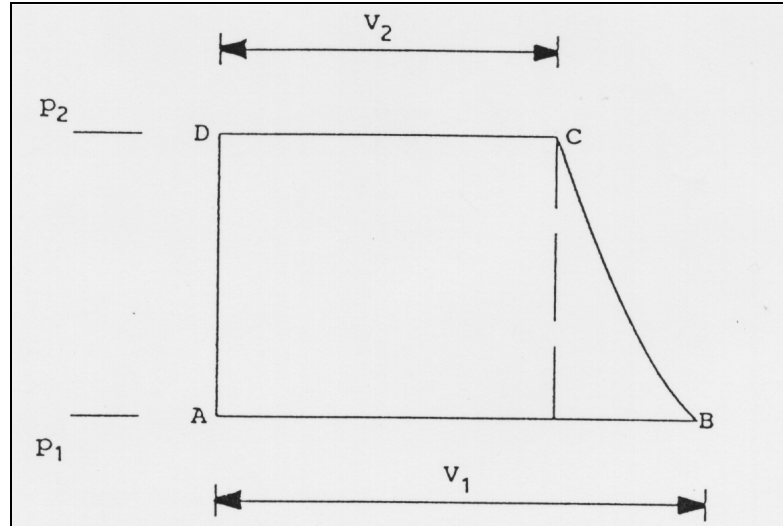
V_1 = suction volume p_1 = suction pressure

V_2 = delivery volume p_2 = suction pressure

A to B   means   suction of liquid during pressure p1

B to C means   compressing the liquid from p1 to p2

C to D   means   delivery against pressure p2

D to A   means   changing from delivery to suction

The compressibility will effect the constant of the liquid delivery depending on the   pressure. To overcome this problem, the S 2100 pump is using a calculation program to correct the pressure depending change of the flow rate. This calculation program corrects the compressibility as well as the always existing leaking rate of the check valves, in relation to the actual pressure. The processor is checking the back pressure every 0.1 seconds and corrects accordingly the piston speed.

The calculation program is using the liquid with the smallest compressibility - water - for the factor 1.

As different organic solvents are showing a different compressibility, the processor needs this information for the most accurate delivery rate.

This information can be added through the compressibility factor in the programming dialog.

As water has been normalized for the factor 1, all the others have to be below 1.

The following table is showing the factors of the mostly used solvents.

Solvent	Compressibility factor
water	1
methanol	0,63
ethanol	0,74
propanol	0,72
butanol	0,75
acetonitril	0,68
chloroform	0,58
methanol/water 1:1	0,79
ethanol/water 1:1	0,88
ethanol/water 3:1	0,79
buffer solutions	1

For solvent mixtures of different organic solvents, the constant can be calculated by adding the constants of the different solvents in relation to their percentage in the mixture.

For example: 50 % H2O / 20 % methanol / 30 % acetonitril

$F = 0,5\ F\ (H2O) + 0,2\ F\ (methanol) + 0,3\ F\ (acetonitril)$
$F = 0,5\ x\ 1\ +\ 0,2\ x\ 0,63\ +\ 0,3\ x\ 0,68$
$F = 0,5\ + 0,126\ + 0,204$

$F = 0,83$

For other solvents with an unknown factor, an average factor of 0.7 can be used.
The difference from the correct delivery rate won't be higher than 5%.
If this accuracy is good enough, a medium factor of 0.7 for all organic solvents and 1 for water can be used.

9. Service and Maintenance

The need of maintenance is limited to the mechanic of the pump. It is recommended to oil all the mechanic moving parts, as bearings and slide plates with sewing machine oil.

9.1. Trouble Shooting

Fault	Cause	Elimination
No flow **No pressure**	no solvent	check the level of the reservoir
	gas bubbles in the inlet tubing or pump head	flush the inlet tubing and the pump head by activating the purge function
	solvent line interrupted	check the solvent inlet tube and the solvent filter, clean or exchange the tube or the filter
	pump is not running	check the fuses on rear panel check the main connections check the display concerning error messages check if a start delay time is programmed
	failure of the check valves	clean the check valve by using an ultrasonic bath, or exchange the check valves
	broken piston	exchange the piston

Pressure fluctuation	gas bubbles in the pump head	flush the pump head with purge function
	leak in the chromatography system	exchange or fasten the leaking parts
	faulty check valve	clean the check valves by using an ultrasonic bath or replace the check valve
	piston seal leaking	exchange the piston seal
	immiscible solvents in the pump	use an intermediate solvent which mixes with both solvents
pump runs but doesn't build-up pressure	failure of the check valves	activate purge function or clean the valves by using an ultrasonic bath, or exchange the valves
	leak in the chromatography system	change or correct the leaking part

9.2. Exchange and Repair of the Pump Head

9.2.1. Exchange of the Pump Head

- disconnect the capillary tube (4.1) between the pump head and the relief valve

- remove the solvent suction tubing (4.2)

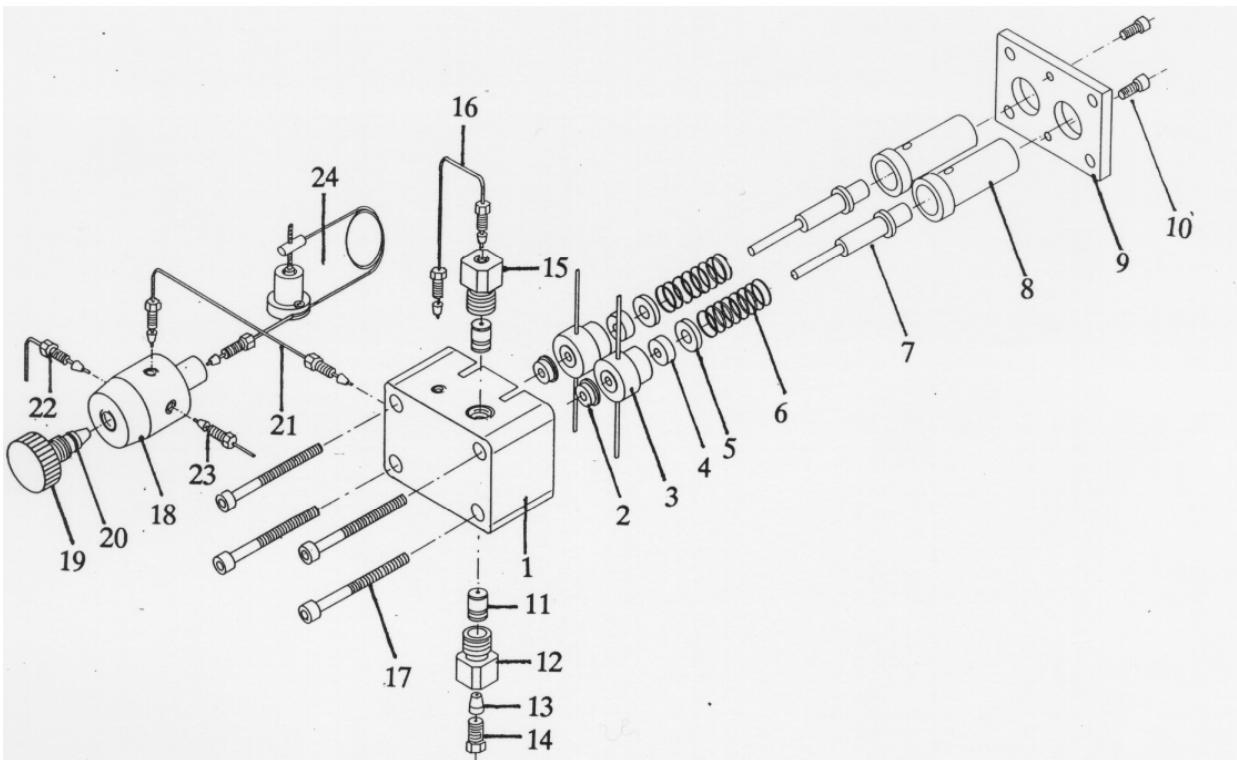- loosen the four hollow screws (4.4), and remove the head
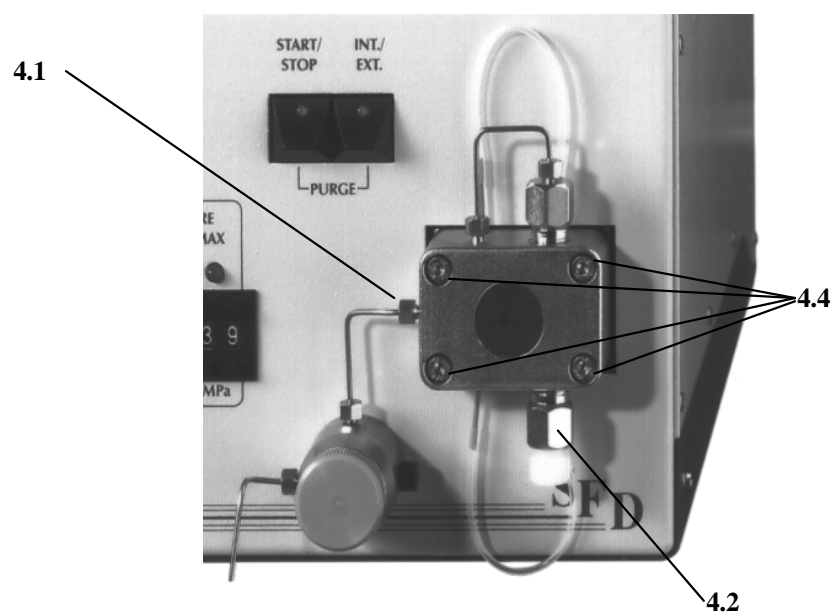
Pump head

The assembling of the head is done in the opposite sequence.

The pump heads are indicated by the characters stated on the pump head:

    a for the analytical head
   m   for the micro head
    p   for the preparative head

9.2.2. Pump Head Assembly

The following diagram shows all the components of the dismantled pump head:

Pump Head assembly
1   Pump head body
2   Piston sealing ring
3   Piston guide with piston back flushing
4   Secondary sealing ring
5   Centering disk
6   Pressure spring
7   Ceramic piston assembly
8   Guide bearing
9   Mounting plate
10   Hollow screw
11   Check valve cartridge
12   Suction valve housing
13   Peek ferrule 1/8"
14   Thrust bolt
15   Outlet valve housing (pressure)
16   Capillary tube for connecting the damping piston
17   Hollow screws M4 x 45
18   Relief valve block
19   Venting screw
20   Sealing ring relief valve
21   Capillary for connecting relief valve and pump head
22   Drain capillary from relief valve block
23   Solvent outlet
24   Pressure sensor
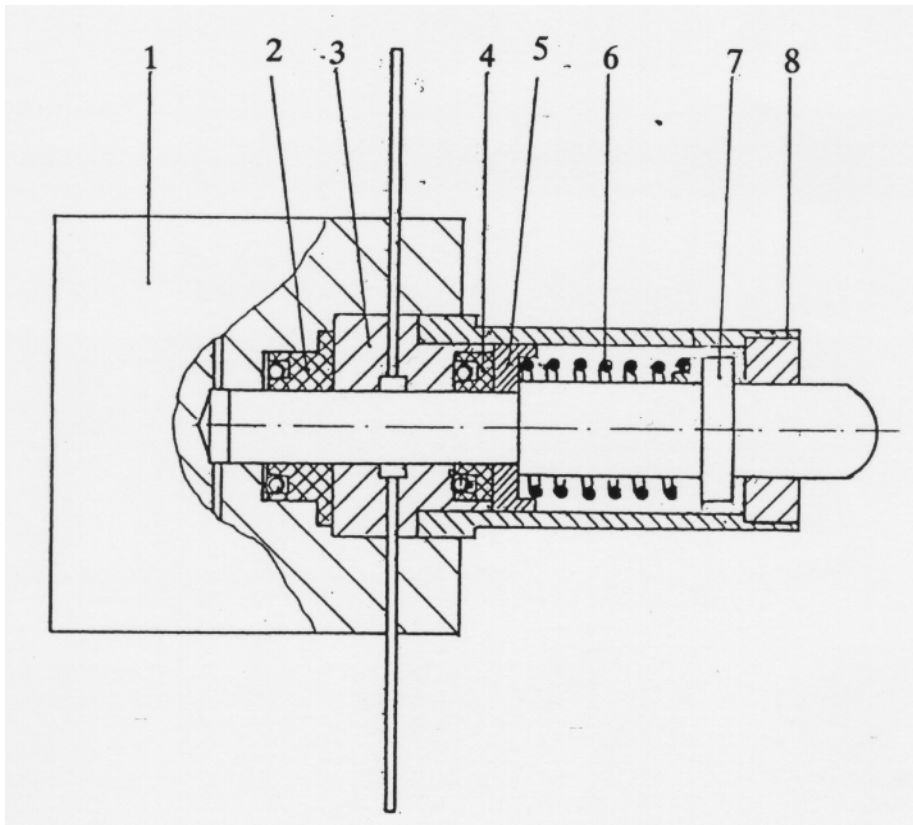
Cross-cut of pump head's piston

1   Pump head body
2   Piston sealing ring (mini flange)
3   Piston guide with piston back flushing
4   Secondary sealing ring
5   Centering disk
6   Pressure spring
7   Ceramic piston assembly
8   Guide bearing

9.2.3. Piston back flushing

When using saliferous eluents, a growth of salt crystals behind the piston
ring on the sapphire piston is possible.
Under unfavorable working conditions, these salt crystals can lead to a higher
wearing of the piston ring.

Generally, it is sufficient to rinse the rinsing chamber (between piston ring and secondary sealing
ring) with distilling water once a week. The water remaining in the rinsing chamber stops the
crystallization of salt crystals. Therefore; the lower capillary tubes
should be connected together with a PTFE tubing so that the water remains in the rinsing chamber.

The rinsing of the chamber should be done with the plastic syringe delivered with the pump.

9.2.4. Change of parts subject to wear

As the piston and piston rings are constantly in use, a natural process of wearing takes place dependent on the flow rate, operation pressure as well as on solvents used. As these variables have a different influence on the wearing no statement concerning durability of the parts subject to wear can be made. When a change of piston sealing rings is necessary, the surface of the pistons have to be checked, too. If the surface shows small grooves in longitudinal direction, it is absolutely necessary to change these pistons too, as this damaged surface will lead to a higher wearing of the sealing rings.

9.2.4.1 Change of piston ring

- Loosen the two hollow screws (10) for removing the mounting plate (9)

- take off the guide bearing, piston assembly, pressure springs and centering discs

- pull out the piston guide

- pull out very carefully the piston rings with the help of a tweezers

- insert completely the new sealing rings into the opening (flange upwards); the small spring has to show in direction of the pump head

- insert upwards the piston guide with the secondary sealing ring (white)

- put the ceramic piston into the guide bearing, insert the spring with the centering disks in the piston and place the whole unit on the piston guide.

- put the mounting plate on top and fasten it with the hollow screws (10)

- push down completely both pistons by hand for several times in order to check if the pistons were jammed during the process of assembling.

9.2.5. Replacing the pump valves

The valves are constructed as cylindrical cartridges. On the top and bottom of theses cartridges are Peek sealing rings mounted. These sealing rings have to ensure that the solvent will not bypass the check valve. Both valves, on the high and on the low pressure side of the pump, are identical and therefore can be used for both sides of the pump. Place the cartridge in the valve housing and fasten first by hand and then turn another half of a turn by using a SW13 spanner. If the pump is not delivering the correct flow rate, the valve housing might not be tightened enough. Before tighter fastening, make sure that the pump was carefully flushed.

9.2.5.1. Cleaning the Valve Cartridges

Generally, the check valve cartridges don't wear. However, a deposit of dirt in the valve can influence the function. In this case, only a limited improvement will be achieved when cleaning the fully assembled valve cartridge. The more dependable method is to dismantle the valve for cleaning

Attention: In order to avoid any loss of valve parts, it is recommendable, to use a small container for the process of dismantling.

- pull out both of the sealing disks (5) (in case, the careful usage of a knife is possible)

- push out very carefully the valve contents

- clean the valve parts depending on their degree of dirtiness either with a washing bottle or with an ultrasonic bath

- insert first the sealing disc which is next to the ring marker

- then insert the sapphire seat with the rough side showing downwards in the valve bearing (it is absolutely necessary that the polished side shows in the direction of the ruby ball)

- place the ruby ball in the deeper side of the check guide made of ceramic and put both into the bearing. The ball has to show in the direction of the the sapphire seat

- press the second sealing disk on top.

After assembling, check the functioning of the valve by blowing air through it. It is possible to blow the air from this side of the ring marker through the valve and it should lock when blowing the other direction.
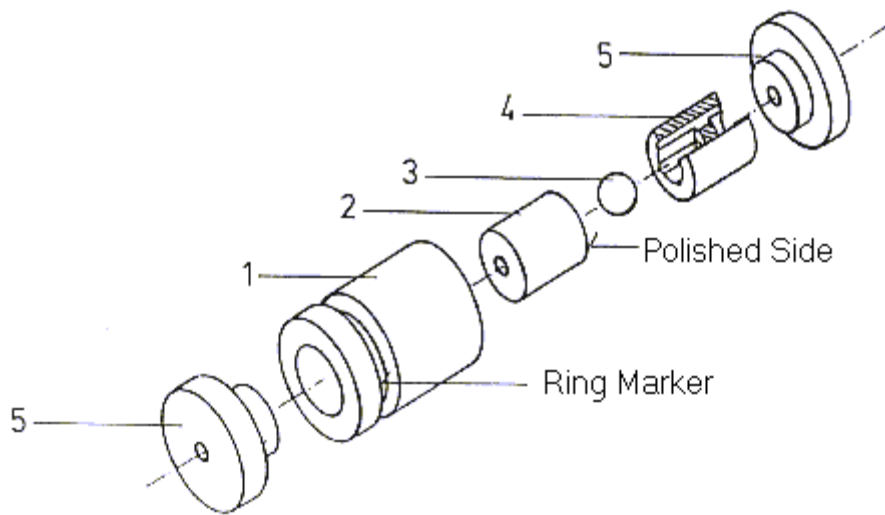
Valve cartridge assembly

1. Valve bearing with ring marker
2. Sapphire seat
3. Ruby ball
4. Check guide made of ceramic
5. Peek sealing disk
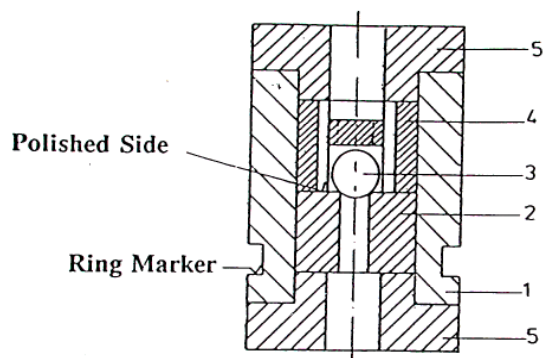
Cross-cut of valve cartridge

1 Valve bearing
2 Sapphire seat
3 Ruby ball
4 Check guide made of ceramic
5 Peek sealing disk

Appendix 1:

AUXILLIARY FUNCTION
25 Pin Connections of the Interface

No connect	13	o		
			o	25 Function 8 N.C.
Function 8 N.O.	12	o		
			o	24 Function 8 COM
Function 7 COM	11	o		
			o	23 Function 7 N.C.
Function 7 N.O.	10	o		
			o	22 Function 6 N.C.
Function 6 N.O.	9	o		
			o	21 Function 6 COM
Function 5 COM	8	o		
			o	20 Function 5 N.C.
Function 5 N.O.	7	o		
			o	19 Function 4 N.C.
Function 4 N.O.	6	o		
			o	18 Function 4 COM
Function 3 COM	5	o		
			o	17 Function 3 N.C.
Function 3 N.O.	4	o		
			o	16 Function 2 N.C.
Function 2 N.O.	3	o		
			o	15 Function 2 COM
Function 1 COM	2	o		
			o	14 Function 1 N.C.
Function 1 N.O.	1	o		

N.O.: normally open
N.C.: normally closed
COM: common

Appendix 2

REMOTE CONTROL
15 Pin Connections of the Interface

Free	1	◎			
			◎	9	Free
Error relay N.C.	2	◎			
			◎	10	Run Relay N.C.
GND	3	◎			
			◎	11	GND
GND	4	◎			
			◎	12	GND
Start	5	◎			
			◎	13	Hold skip
Run Relay COM	6	◎			
			◎	14	Run Relay COM
Error relay COM	7	◎			
			◎	15	Error relay COM
GND	8	◎			
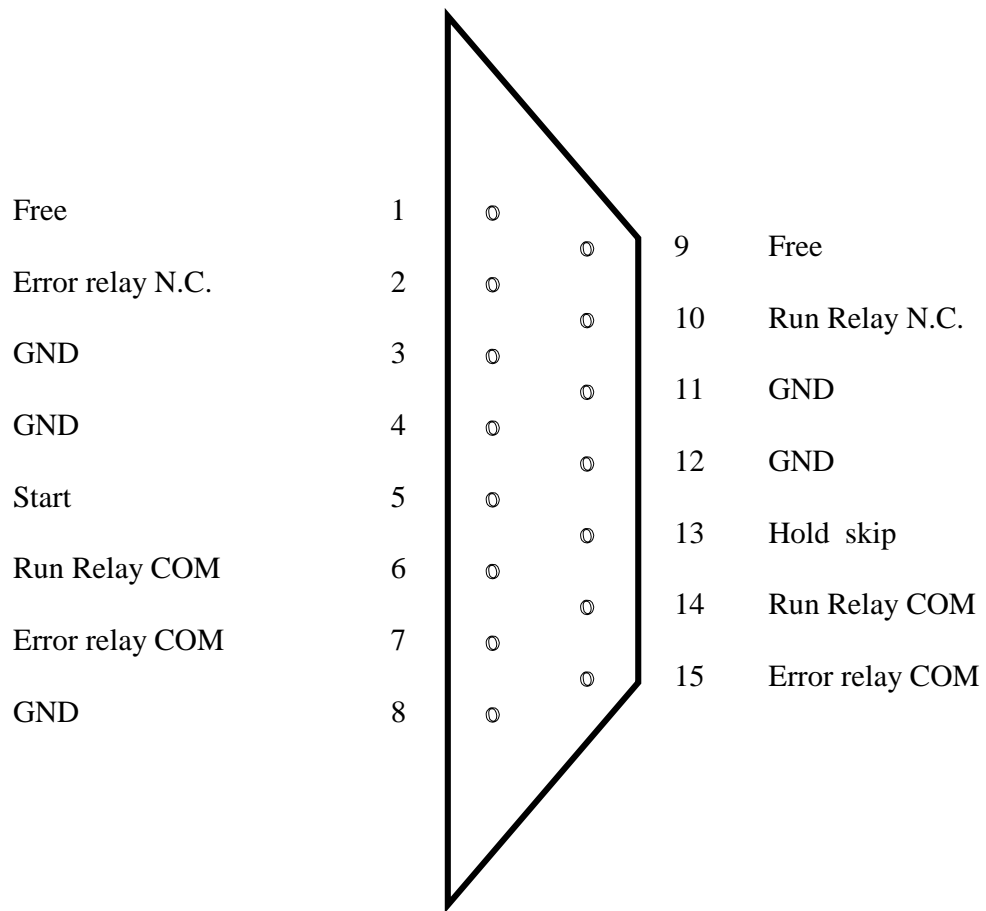
N.O.: normally open
N.C.: normally closed
COM: common

9. Spare parts

Description	Reference	Catalog No.
A.	**General**	
Processor board compl.	---	30 80 029
Li-Battery Tel/P	---	30 49 001
Front board compl.	---	3080031
Power supply board compl	---	30 80 030
Power-line filter	---	30 61 007
Transformer	---	31 02 001
LCD Module	---	30 50 001
Power cord	---	30 68 030
Cable processor board -Power supply	---	30 68 031
Cable Front board -Power supply	---	30 68 012
Pressure sensor compl.	---	30 70 001
DC-Motor-Tacho combination	---	31 01 002
Interface cable (Pump - Programmer)	---	30 68 032
Geared belt	---	23 02 001
Ball bearing	---	23 04 002
Sinter bearing	---	23 04 003
Driving piston	---	25 01 044
Dual camshaft	---	25 01 045
Relief valve, compl. PEEK	---	20 31 003
Relief volve, compl. Steel	---	20 31 002
Relief valve block, steel	Fig. 5.18	25 01 065
Relief valve block, PEEK	Fig. 5.18	26 01 066
Venting screw, steel	Fig. 5.19	25 01 066
Venting screw, PEEK	Fig. 5.19	26 01 067
Sealing ring, Viton	Fig. 5.10	24 01 008
Sealing ring, Zalak	Fig. 5.20	24 01 009
Drain capillary, steel	Fig. 5.22	21 90 032
Drain capillary, PEEK	Fig. 5.22	21 90 035

B. Pump head analytical (steel)

Pump head complete	Fig. 4	20 20 038
Pump head body	Fig. 5.1	25 01 068
Piston sealing ring	Fig. 5.2	24 10 015
Piston guide	Fig. 5.3	26 01 032
Secondary sealing ring	Fig. 5.4	24 10 016
Centering disk	Fig. 5.5	26 01 033
Pressure spring	Fig. 5.6	25 50 005
Sapphire piston assembly	Fig. 5.7	20 20 018
Guide bearing	Fig. 5.8	20 20 033
Mounting plate	Fig. 5.9	25 01 047
Hollow screw M 3 x 6	Fig. 5.10	25 20 003
Check valve cartridge	Fig. 5.11	20 30 001
Suction valve housing	Fig. 5.12	25 01 048
Peek ferrule	Fig. 5.13	26 01 035
Thrust bolt	Fig. 5.14	25 01 049
Outlet valve housing (pressure)	Fig. 5.15	25 01 050
Capillary tube for connecting damping piston	Fig. 5.16	2190 051
Capillary for connecting the relief valve with the pump head	Fig. 5.21	21 90 052
Hollow screws M4 x 40	Fig. 5.17	25 20 004

C. Pump head analytical (Peek)

Pump head compl	Fig.5	20 20 039
Pump head body	Fig. 5.1	26 01 068
Piston sealing ring	Fig. 5.2	24 10 015
Piston guide	Fig. 5.3	26 01 032
Seconday sealing ring	Fig. 5.4	24 10 016
Centering disk	Fig. 5.5	26 01 033
Pressure spring	Fig. 5.6	25 50 005
Sapphire piston assembly	Fig. 5.7	20 20 018
Guide bearing	Fig. 5.8	20 20 033
Mounting plate	Fig. 5.9	25 01 047
Hollow screw M 3 x 8	Fig. 5.10	25 20 005
Check valve cartridge	Fig. 5.11	20 30 001
Suction valve housing	Fig. 5.12	26 01 038
Peek ferrule	Fig. 5.13	26 01 035
Thrust bolt, PVDF	Fig. 5.14	26 01 069
Outlet valve housing	Fig. 5.15	26 01 039
Capillary tube for connecting the damping piston	Fig. 5.16	21 90 059
Capillary for connecting relief valve with pump head	Fig. 5.21	21 90 054

D.   **Pump head preparative (steel)**
only parts which differ from table B:

Pump head complete	Fig. 4	20 20 042
Pump head body	Fig. 5.1	26 01 069
Piston sealing ring	Fig. 5.2	24 10 018
Piston guide	Fig. 5.3	26 01 043
Secondary sealing ring	Fig. 5.4	24 10 019
Centering disk	Fig. 5.5	26 01 044
Sapphire piston assembly	Fig. 5.7	20 20 020

E.   **Pump head preparative (Peek)**
only parts which differ from table C:

Pump head complete	Fig. 4	20 20 043
Pump head body	Fig. 5.1	26 01 070
Piston sealing ring	Fig. 5.2	24 10 018
Piston guide	Fig. 5.3	26 01 043
Secondary sealing ring	Fig. 5.4	24 10 019
Centering disk	Fig. 5.5	26 01 044
Sapphire piston assembly	Fig. 5.7	20 20 020

F.   **Pump head micro (steel)**
only parts which differ from table B:

Pump head complete	Fig. 4	20 20 040
Pump head body	Fig. 5.1	25 01 070
Piston sealing ring	Fig. 5.2	24 10 020
Piston guide	Fig. 5.3	26 01 047
Secondary sealing ring	Fig. 5.4	24 10 021
Centering disk	Fig. 5.5	26 01 048
Sapphire piston assembly	Fig. 5.7	20 20 019

G.   **Pump head micro (Peek)**
only parts which differ from table C:

Pump head complete	Fig. 4	20 20 041
Pump head body	Fig. 5.1	26 01 071
Piston sealing ring	Fig. 5.2	24 10 020
Piston guide	Fig. 5.3	26 01 047
Secondary sealing ring	Fig. 5.4	24 10 021
Centering disk	Fig. 5.5	26 01 048
Sapphire piston assembly	Fig. 5.7	20 20 019

H.   **Valve cartridge**

Valve bearing	Fig. 7.1/6.1	25 01 056
Sapphire seat	Fig. 7.2/6.2	40 20 003
Ruby ball	Fig. 7.3/6.3	40 21 002
Check guide made of ceramic	Fig. 7.4/6.4	40 22 001
Peek sealing disk	Fig. 7.5/6.5	26 01 024