Antec®

LC 110 pump

User manual

193.0010, Edition 3, 2011

Antec .... Proven Performance!

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ISO 9001 certified

CE

DECLARATION OF CONFORMITY

The manufacturer hereby declares that the product

LC 110 pump	**type 193**

to which this declaration relates, is in conformity with the following directives & standards :

Safety, Low voltage (73/23/EEC) & Machine safety (89/392/EEC)

Safety requirements for laboratory equipment (Class I, Installation cat. II, Pollution degree 2)	EN61010-1

Electro-Magnetic Compatibility (89/336/EEC)

EMC requirements for electrical equipment for measurement, control and laboratory use	EN 61326-1
Harmonic current emissions	EN 61000-3-2
Voltage fluctuations and flicker	EN 61000-3-3

Attention

The product was tested in a typical configuration. Use manufacturer-supplied cable(s) only to connect all I/Os with other devices. Thoroughly connect the shielding to common. Manufacturer will not accept any liability for damage, direct or indirect, caused by connecting this instrument to devices, which do not meet relevant safety standards.

March 17, 2011

Intended use

For research purposes only. While clinical applications may be shown, this instrument is not tested by the manufacturer to comply with the In Vitro Diagnostics Directive.

WEEE directive

Antec Leyden is a Business-to-Business producer of analytical analysis equipment which fall under WEEE Annex IA categories 8 and 9 (includes medical devices and monitoring and control instruments). All equipment of Antec Leyden which are subjected to the WEEE directive (shipped after August 13, 2005) are labelled with the "crossed out wheelie".

The symbol on the product indicates that the product must not be disposed as unsorted municipality waste.

Collection & recycling information (business-to-business)
Antec Leyden offers the possibility for disposal and recycling of their instrument at an appropriate recycling facility if requested (there may be costs involved with this service). Please contact Antec Leyden for more information about this service and to register the return and disposal of end-of-life instruments (info@myantec.com). To assure hygienic & personal safety all instrument should be returned with a signed decontamination form which is available on the website.

Shipping address for end-of-life products:
Antec Leyden
Industrieweg 12
2382NV Zoeterwoude, The Netherlands

In case of questions, or if further information is required about the collection & recycling procedure, please contact Antec or your local distributor.

ROHS directive

Our instruments are currently exempt from the RoHS directive because they fall under WEEE Annex IA categories 8 and 9, which includes medical devices and monitoring and control instruments. Nevertheless, we have taken steps to eliminate all restricted substances from our products.

Antec Leyden is an ISO 9001:2008 certified company.

Symbols

The following symbols are used on the LC 110:

Consult the manual for further safety instructions

Frame or chassis ground terminal

The following pictograms are used in the LC 110 manual:

Caution

Caution, risk of electric shock or other electrical hazard (high voltage)

Safety practices

The following safety practices are intended to ensure safe operation of the instrument.

Electrical hazards

Removal of protective panels on the instrument can result in exposure to potentially dangerous voltages. Therefore, disconnect the instrument from all power sources before disassembly. Untrained personnel should not open the instrument.

WARNING - RISK OF FIRE REPLACE FUSE AS MARKED AVERTISSEMENT - RISQUE DE FEU REMPLACEZ LE FUSIBLE COMME INDIQUE	WARNING - RISK OF ELECTRIC CHOCK DISCONNECT POWER BEFORE SERVICING AVERTISSEMENT - RISQUE DE CHOC ELECTRIQUE COUPER L'ALIMENTATION AVANT LA MAINTENANCE

Place the LC 110 on a flat and smooth surface or inside a PR 110 pump rack. Connect the detector to a grounded AC power source, line voltage 100 ï 240 VAC, frequency 50/60 Hz. The instrument should be connected to a protective earth via a grounded socket.

The power source should exhibit minimal power transients and fluctuations. Replace faulty or frayed power cords.

General precautions

Perform periodic leak checks on LC tubing and connections. Do not close or block the drain. Do not allow flammable and/or toxic solvents to accumulate. Follow a regulated, approved waste disposal program. Never dispose of such products through the municipal sewage system.

Spare parts and service availability

Manufacturer provides operational spare parts of the instrument and current accessories for a period of five years after shipment of the final production run of the instrument. Spare parts will be available after this five years period on an ôas available basis.
Manufacturer provides a variety of services to support her customers after warranty expiration. Repair service can be provided on a time and material basis. Contact your local supplier for servicing. Qualified chemists on both contractual and as-needed basis can provide technical support and training.

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C H A P T E R 1

Introduction

Congratulations on your purchase of the LC 110 HPLC pump. The LC 110 is a vital component of the ALEXYS analyzers and ROXY EC/LC systems. The pump has a double-piston design with an advanced pulsation dampening mechanism, assuring the delivery of solvents with very low residual pulsations and smooth baselines. Furthermore ,it is equipped with a new motor drive that provides an extended pump lifetime and a low working temperature.

The LC 110 has a versatile 10 mL pump head which can deliver flow rates in the µL range up to 10 mL/min. High pressure gradient as well as flow rate programming is supported. Because the use of buffers and salts is indispensable in LC-EC the LC 110 is equipped with an automatic piston back flush module to maximize the piston and seal life span.

The LC 110 can also be used as a high quality stand-alone pump to be incorporated in any LC system.

Fig. 1. ALEXYS® Analyzer / ROXY EC/LC system equipped with two LC 110 pumps.

C H A P T E R 2

Installation guide

Unpacking

Inspect the *transport box* for possible damage as it arrives. Immediately inform the transport company in case of damage, otherwise they may not accept any responsibility. Keep the transport box as it is designed for optimum protection during transport and it may be needed again. Carefully unpack the instrument and inspect it for completeness and possible damage. Contact your supplier in case of damage or if not all marked items on the checklist are included.
Prior to shipment, your pump has been inspected and tested to ensure the best possible performance. A certificate of performance is included in the ship kit.

Pump head identification

The pump head is labelled on the top side with either the number ñ10ò or ñ50ò. These numbers indicate the maximum allowable flow rate for each type of pump head (i.e. 10 mL/min or 50 mL/min). The LC 110 is standard equipped with a 10 mL pump head.

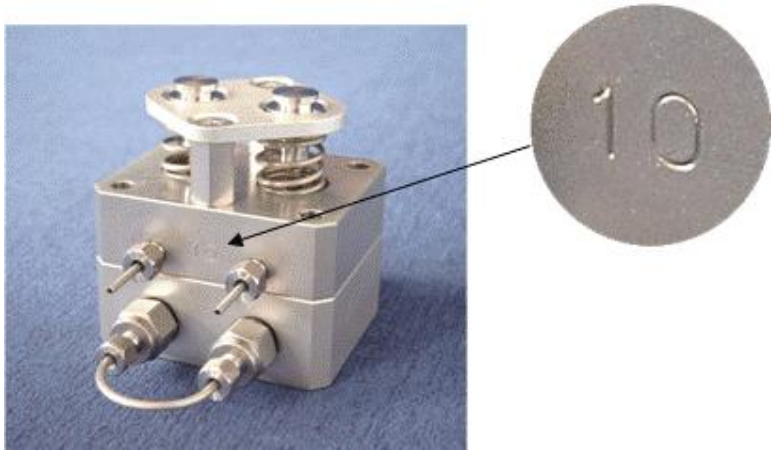

Fig. 2. Identification of pump head type.

Installation

The installation procedure consists of following steps:

1. electrical connections
2. tubing and fittings
3. priming system with water

To unpack the LC 110, lift it from its box by both hands. Install the pump in an area, which meets the environmental conditions listed in Table I. Place the LC 110 on a flat and smooth surface or inside the special PR 110 pump rack module (192.0042) which is part of the ALEXYS/ROXY system.

Table I. Environmental conditions.

Parameter	Requirement
Storage temperature	0 ï 50 °C
Storage humidity	0 ï 90%, non-condensing
Operating temperature	10 ï 40 °C
Operating humidity	20 ï 80%, non-condensing

Please operate the LC 110 and all accessories according to the instructions and operating procedures in this manual. This ensures proper operation and longevity of your equipment.

Use of this product outside the scope of this manual may present a hazard.

Avoid precipitation of buffer salts in organic solvents. Always start with flushing system with water when switching solvents.

Never switch off the LC 110 with mobile phase in it as salts will precipitate an clog the system. First flush with water, subsequently with water/methanol.

Fig. 3. Top: PR 110 with stacker removed to insert pump. Bottom: PR 110 with stacker assembled (arrows marking the allen screws to fix stacker on frame).

To insert LC 110 pump in the PR 110 pump rack perform the following steps (see Fig. 3):

- Loosen Allen screws to remove the stacker.
- Insert the pump in the PR 110 frame.
- Align front of the door with the front side of the PR 110 frame.
- Fix the stacker back on the frame.

Connection of drain

Make sure that the silicone waste tubing is connected to the drain on the back side of the PR 110 pump rack(Fig. 4, red circle), to collect any excess of mobile phase in case the pump head is leaking.

Fig. 4. Rear view of LC 110 in the PR 110 pump rack. The drain is encircled in red.

Execute periodic leak checks on LC tubing and connections. Do not allow flammable and/or toxic solvents to accumulate. Do not close or block drains. Follow a regulated, approved waste disposal program. Never dispose of such products through the municipal sewage system.

Step 1 - Electrical connections

Mains:

- In case the pump is not used in combination with an OR 110 organizer rack, connect the mains outlet of the pump to a mains wall socket using the LC 110 power cable (p/n 193.0408) supplied in the LC 110 accessory kit (see Fig. 4).
- In all other cases connect the mains outlet of the LC 110 pump and the OR 110 organizer rack using the OR110-LC 110 power cord (p/n 250.0144) supplied in the OR 110 accessory kit.

RS232 data connection:

- To make a serial data connection use the LC 110 RS232 cable (p/n 193.0412) supplied in the LC 110 accessory kit. Connect it to RS232 connector 1 (see Fig. 4) and a free PC COM port or USB-to-COM converter port.

For more detailed information about setting-up a serial connection for the LC 110 in a complete ALEXYS/ROXY system, please consult the installation checklists (p/n 180.0011A and 190.0011B) supplied with your system.

Step 2 - Tubing connections

The next section describes the connection of all tubing connections and priming procedure of the LC 110. For specific instructions about the LC connections in an ALEXYS analyzer or ROXY EC/LC system, please refer to the relevant section in the LC connection kit installation guide supplied with your system.

To access the LC 110 pump head and purge valve slide the drawer of the PR 110 module to the front as depicted in the figure below Subsequently open the front door of the LC 110 by pulling it on the right side (the hinge is locate on the left side of the door):

Fig. 5. Accessing the LC 110 pump.

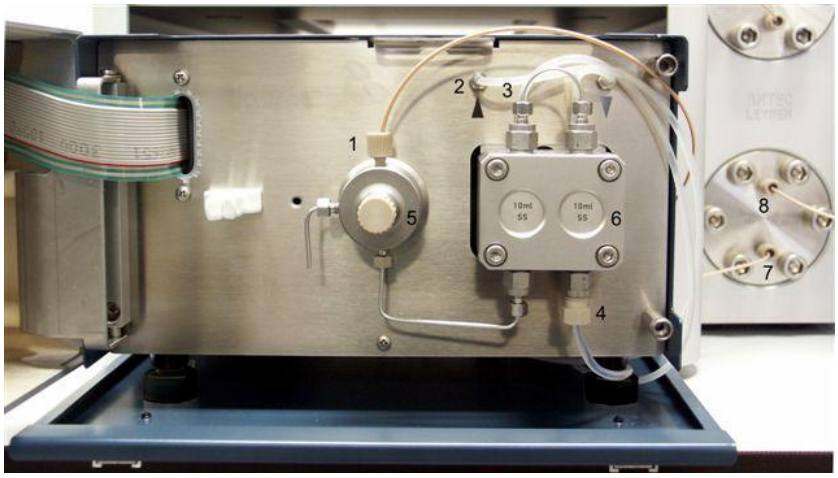

Fig. 6. Front side of LC 110 pump with open door: 1. High pressure outlet, 2. Piston wash inlet, 3. Piston wash outlet, 4. Low pressure inlet, 5. Purge valve, 6. Pump head assembly, 7. Pulse damper inlet, 8. Pulse damper outlet.

- The unit is equipped with an automatic piston wash unit. Connect the piston wash tubing (silicone tubing, O.D. 3 mm) to the piston wash inlet and outlet (Fig. 6., number 2 and 3) In case the pump was purchased without dedicated LC connection kit use part 193.0404 from the LC 110 accessory kit, otherwise use part 180.0208A from the LC connection kit. For aqueous mobile phases the wash liquid is usually water. In case modifier is used in the mobile phase, the wash liquid may contain 10 ï 25% modifier).

- Priming piston wash: Insert the tubing end connected to the inlet of the pump inside the bottle of wash liquid and connect a syringe to the other tubing end (connected to the outlet). Prime the piston wash flow path with the syringe till all tubing is filled with wash liquid. Subsequently insert the outlet in the bottle containing wash liquid.

Always connect the piston wash and make sure that the low pressure compartment of the LC 110 is filled with wash liquid. The piston wash seals need to be lubricated at all time. If not, damage may occur of the wear and tear parts inside the pump head.

- Switch on the pump by means of the power switch on the back side of the unit. The unit will initialize and the internal piston wash pump will start flushing automatically for a short time. The pump will flush with regular intervals during operation.

Refresh the wash solution every week. Check the piston wash fluid regularly, in case the solution gets turbid or contains particles please refresh the liquid immediately. The presence of a large quantity of black particles in the solution could indicate that the piston seals need to be replaced.

- Set the pump flow rate & P max to the desired value using the keypad of the LC 110.
- Connect the FEP tubing from the OR 100 degasser outlet assembly, between the outlet of the degasser and the inlet of the pump (Fig. 6, number 4) . Insert the tubing in the slits on the aluminum frame of the PR 110 module to fix them.
- The solvent filter should be placed between degasser and mobile phase reservoir (only water or MeOH:water 20:80 v/v% mixture for first use), part 180.0204. Never use a metal inlet filter in mobile phase bottle!

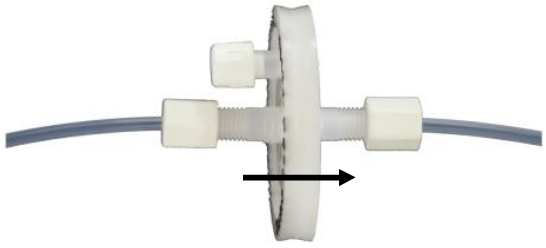

Fig. 7. In-line filter, arrow indicates flow direction. The white knob on top is an air vent which should be opened for filling the filter with mobile phase.

Read specifications on solvent filter. Aqueous type of filters are:
- NOT suitable for high percentages modifier and are
- NOT acid resistant.
Use another type of filter in these cases.

- Connect the pump outlet (Fig. 6, number 1) to the pulse dampener using a piece of 50 cm orange PEEK (ID 0.5 mm)

or the corresponding tubing assembly (OR 100 pulse damper inlet assembly) from the LC connection kit.

- Depending on your configuration connect pulse dampener to a manual or electrically actuated injector or auto sampler. Consult the manual of auto sampler and detector for further installation instructions.
- Make sure all connections are leak free.

Step 3 - Priming system

To prime the system execute the following steps:

- Position the mobile phase bottle at a height well above the level of the pump.
- Open purge valve (Fig. 6, number 5).
- The FEP inlet tubing should fill itself spontaneously with mobile phase due to gravity. If it doesn't please check if the inline filter is clogged or in case of a new filter, wet the filter with a small amount of MeOH:water solution (50:50 v/v%).
- At the moment the solvent supply lines are filled with solvent, press the purge key to enable rapid self-priming.
- When primed with sufficient liquid stop purging and shut the purge valve, **apply only gentle force**.
- Check if the correct flow rate is set and start pumping by pressing the Run/Stop key. The actual pump pressure is displayed in the top line of the LCD display.

Clarity HPLC software control

For control via the Clarity data system software stop the flow (Run/Stop) and open the control driver window in Clarity. The actual flow rate, when not running a method (single injection or sample sequence), can be altered by changing the stand bye flow (make sure the Standbye checkbox is active. By pressing the 'apply' button the entered flow rate will become active.

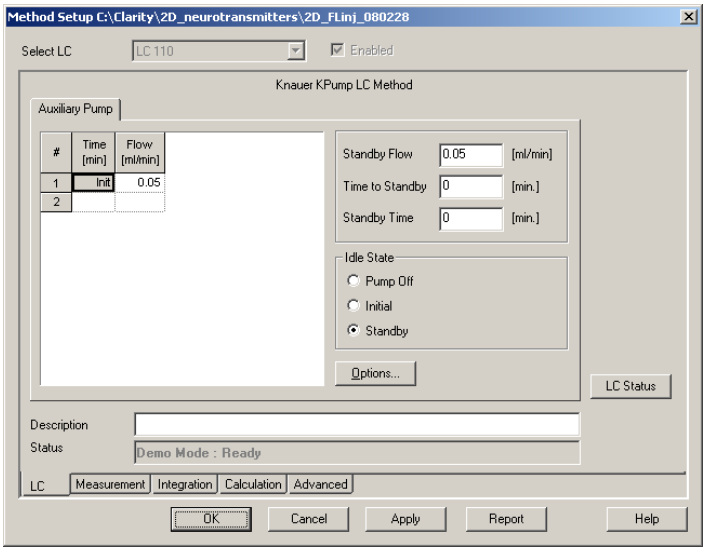

Fig. 8. Control of the LC 110 from the Clarity data system software.

ALEXYS HPLC software control

For control via the Clarity data system software stop the flow (Run/Stop) and open the LC 110 device driver window in the ALEXYS datasystem software. The flow rate can be set in the ñNew flowòinput field (value can be typed in or changed by means of the slider). By pressing the ósetôbutton the entered flow rate will become active.

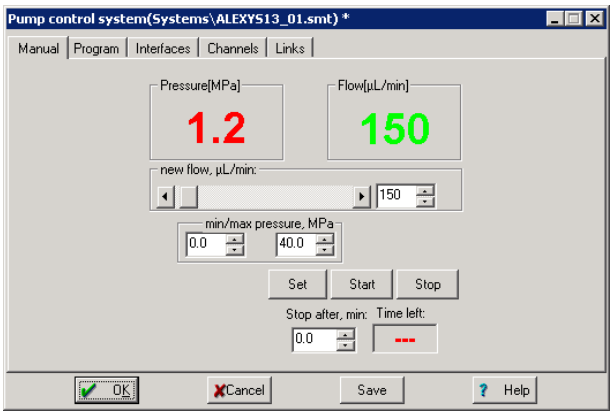

Fig. 9. Control of pump from ALEXYS data system. Use the slider to set the flow rate and click ósetô button.

For detailed information about software control please refer to the ALEXYS and Clarity data system manuals.

The pump is now ready for use. Continue with installation procedure of other parts of HPLC system, following instructions in corresponding manuals. In combination with electrochemical detection a passivation step with 15% HNO_3 is recommended (see installation guide of the detector and in case of a complete ALEXYS analyzer in the LC connection kit installation guide).

First remove all parts that are not acid-resistant such as nylon inlet filters, column and flow cell.

See installation guide of detector for passivation procedure with 15% HNO_3.

C H A P T E R 3

Description of instrument

Front panel

Fig. 2 shows the front view of the LC 110. On the front of the door are the keyboard and display panel located. The pump head, pressure transducer, and capillaries are located behind the front door.

Fig. 10. Front view of the LC 110.

Fig. *11* on the next page shows the display panel and foil key touchpad of the LC 110. The explanation of position numbers is given in Table 2.

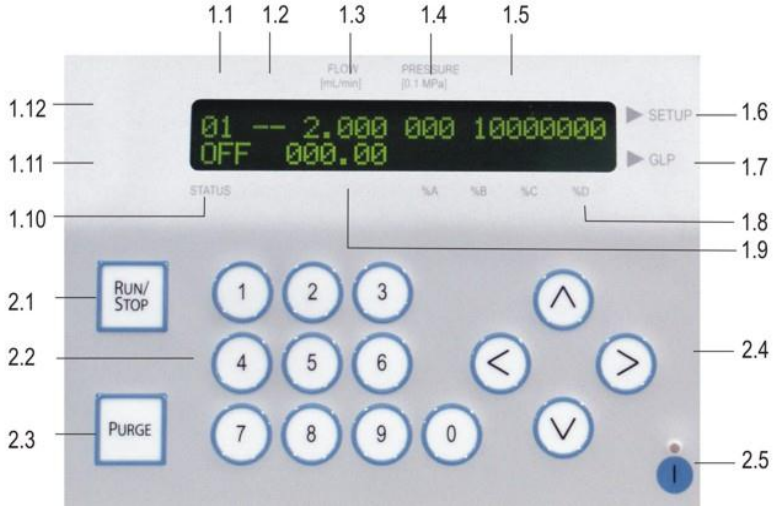

Fig. 11. Display panel and keyboard in detail.

Table 2. Display panel and foil key touchpad functions.

1	LCD display	2	Keyboard
1.1	Program to be loaded	2.1	Pump START / STOP
1.2	Program to be edited	2.2	Purge START / STOP
1.3	Flow rate	2.3	Numeric key pad
1.4	actual system pressure or |preset maximum|	2.4	Arrow keys
1.5	Event status	2.5	Standby key
1.6	Go to the SETUP menu		
1.7	Go to the GLP menu		
1.8	Gradient mixing ratios		
1.9	elapsed run time		
1.10	Status of program or pump		
1.11	Go to the VIEW menu		
1.12	Go to the LINK menu		

The display shows information about the current status of the pump, such as the flow rate, the measured pressure or the current status of the running program. It also serves to display input values while running parameters are being modified.

- START/STOP key {2.1}. Once the flow rate has been entered and set, the pumping process can be either started or stopped by pressing the START/STOP key.
- The PURGE key {2.2} allows immediate access to the purging function of the pump.
- The numeric keypad {2.3} allows for the entering of running parameters as well as for the control of program cycles. Detailed information is given in the sections ñControl of the LC 110ñ on page 28 and ñProgramming the LC 110ñ on page 21.
- The standby key {2.5} allows for the pump to be easily shut off as well as restarted. By pressing down on the standby key for more than 2 seconds, the pump will be completely shut down. Once the pump has shutdown, the standby key will light up and remain lit. The pump can then be restarted by again pressing on the standby key for more than 2 seconds.

Pump head

All hydraulic connections including those of the optional integrated mixing chamber are on the front side of the LC 110 behind the door (see Fig. 4). For information on how to connect all eluent tubing to the pump head as well as on how to remove and install the pump head, please refer to the previous chapter.

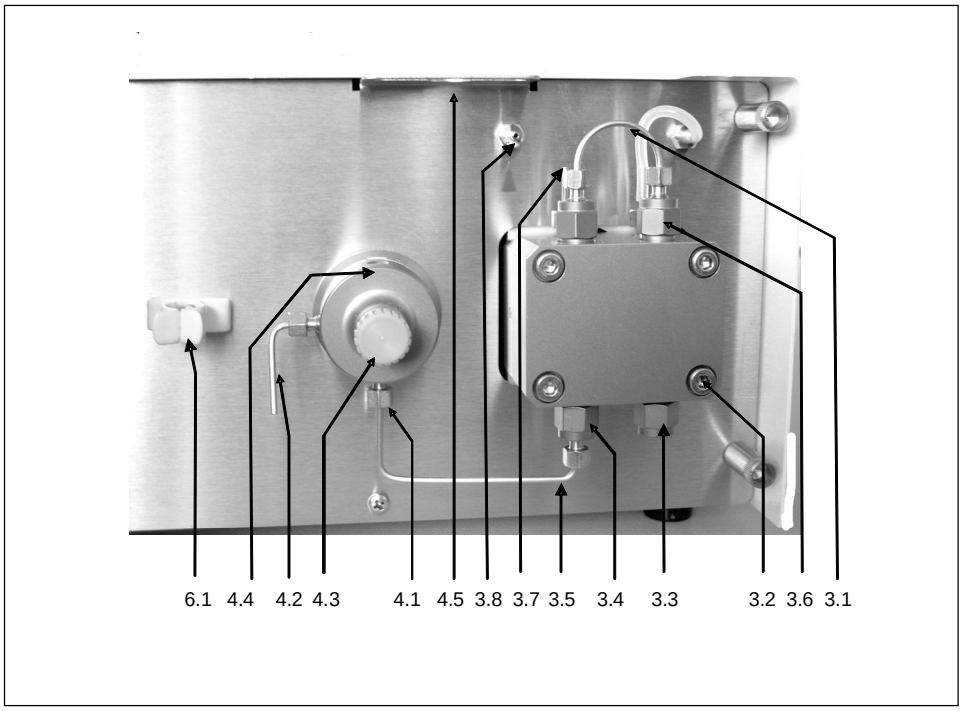

Fig. 12. Pump head and pressure transducer with purge valve.

3	**Pump Head**	**4**	**Pressure Transducer**
3.1	Capillary connection	4.1	Inlet to transducer
3.2	Pump head set screws	4.2	Purge outlet
3.3	Pump head inlet	4.3	De-areation screw
3.4	Eluent outlet to transducer	4.4	Eluent outlet to column
3.5	Capillary to tranducer	4.5	Tubing guide
3.6	Outlet valve housing		
3.7	Outlet to piston wash pump	**6**	**Mixing chamber (optional)**
3.8	Inlet of piston wash	6.1	clamp for static mixing chamber

The possibility exists for a static mixing chamber to be affixed to the metal plate behind the front door of the pump. The fastening clamp (item {4.1} in Fig. 12) is incorporated for this purpose.

Rear panel

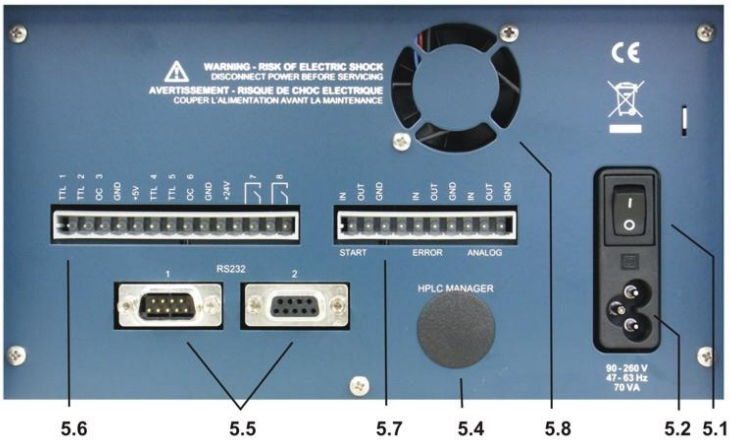

Fig. 13. Rear Panel of the LC 110.

5	Rear panel elements
5.1	ON/OFF switch
5.2	Power connector
5.4	Socket for optional connection with HPLC manager for low pressure gradient mixing
5.5	RS-232 interfaces
5.6	EVENT terminal strip connections
5.7	REMOTE terminal strip connections
5.8	Ventilator

C H A P T E R 4

Operation

Electrochemical detection is a sensitive detection technique characterised by extremely low detection limits. A detection limit of 100 pmol/L for catecholamines is no exception. Improving detection limits will always be limited by the weakest link in an LC-EC system. Therefore, in the ALEXYS analyzer or ROXY EC/LC system all hardware is carefully selected to warrant optimum performance.
In daily practice a couple of órulesô must be obeyed to fully exploit the incredible linear dynamic range and low detection limits of an EC detector. These are not only hardware related, but also refer to mobile phase composition, degassing, temperature and pH stability and several other issues.

Mobile Phase

Mobile phase requirements

- Electrochemically clean, HPLC grade or better
- Ion strength 20 - 200 mmol/L
- Buffer pH near pKa
- In-line 0.2 µm filter & degassing of mobile phase
- EDTA for trapping of metal ions

Mobile phase must be clean as it is in direct contact with the working electrode in EC detection. High purity chemicals including water is a pre requisite. In some applications EDTA is added to the mobile phase to traps electrochemically metals such as Fe^{2+} by forming an inactive complex. However at higher working potentials (typically > 1.2 V vs. salt bridge AgCl ref) also EDTA can become electrochemically active and is not recommended. In that case only a passivation step with 15% HNO_3 is recommended (see installation guide).
Electrolytes assure contact between 3 electrodes in an electrochemical flow cell. Low ion strength destabilises an EC system and noise will increase. Extremely high buffer concentrations cause problems of salt formation. Therefore concentrations between 20 and 200 mmole/L are recommended.

Also constant pH is important for baseline stability and reproducible results. Stability of pH is best when close to pK_a of a buffer ion. Often used buffers are phosphate, carbonate, acetate and citrate. Modifiers such as

methanol, propanol and acetonitril can be used without problems in DC amperometry, but not in pulsed amperometric detection as peaks are strongly attenuated. In our experience the quality and expiration date of organic modifiers can be a problem resulting in increased noise levels. Metal inlet frits in mobile phase bottles are not advised as metal ions are introduced that increase baseline noise. Instead 0.2 µm nylon inlet filters are recommended.

Vacuum degassing

Considerable amounts of the gases N_2, O_2 and CO_2 may be dissolved in HPLC mobile phases. Whenever the temperature changes, solvents are mixed or a pressure reduction occurs, these gases may show up as very small air bubbles. To avoid noisy baselines an in-line vacuum degasser has been integrated in the ALEXYS analyzer/ ROXY EC/LC system. It has a very low dead volume (less than 0.5 mL) and a high degassing efficiency. The advantage over helium degassing is that the degasser does not change the mobile phase composition.

Helium degassing

Degassing using helium is an effective and universally applicable method but only recommended when working in reductive electrochemical detection. All gases except helium are removed completely. Helium is not EC active and does not change the mobile phase properties significantly.
To prevent mobile phase contamination, only high-purity helium must be used.

Power On and Self test

Upon powering up the instrument the display will present the text ñAntec Leyden LC 110 pumpòand the software version, e.g. ñVERSION 1.0Xòor higher. The instrument performs a self test, including firmware validation and tests of the RAM memory and motor unit. After completion of this routine, the message ñSYSTEMTEST OKòindicates that the pump is ready for operation and the ID of the last active program is displayed.

To avoid damage to the pump head and pump head seals, never run the LC 110 without eluent in the pump head as well as in the rear seal washing compartment. To set up the piston back wash, follow the instructions in chapter 2.

Software control

The LC 110 can be controlled either by the Clarity HPLC software from DataApex and the ALEXYS data system software from Antec. For computer control see the Clarity an ALEXYS data system user manuals how to change pump settings. When working stand-alone all operational parameters are set using the LC 110 keyboard. See the section below.

Cursor control

The green arrow keys on the foil key touchpad can be used for positioning the blinking cursor on any field of the menu screen.
The cursor appears as an underscore character while entering values (see Fig. 6, below).

Fig. 14. Blinking Cursor Cursor during data input

The display of the LC 110 has one main menu screen which shows the status information of the instrument. From the main menu screen, four additional menu screens are accessible. By default, the LC 110 main menu screen displays the parameters of the first program line of the currently active program. An example of the main menu screen is shown in Fig. 7.

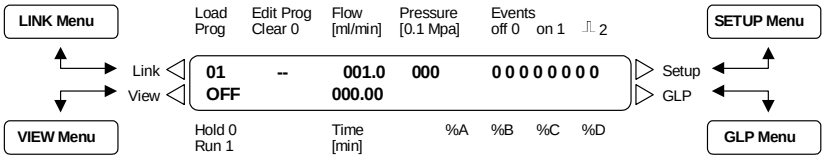

Fig. 15 Menu structure of the LC 110

Note that the text information (Load/Prog, Edit program etc..) surrounding the LC 110 display deviates from Fig. 15. In Fig. 15 more info is shown to identify all parameter/menus described in this section.

Selecting Menus

The four menus of the LC 110 can be accessed with the following procedure:

- Place the cursor in a field in one of the four corners of the main screen, e.g. on OFF in the lower left corner of the main menu.
- Depending on the selected corner, press the corresponding left or right arrow key for longer than 2 seconds. In the example above, selection of the ε key will activate the VIEW Menu on the display.
- Select the rhombus ♦ in the lower left corner of the display if you want to access additional pages of the selected menu. You can access all menu pages by scrolling using the ≠ or Σ arrow keys.
- Select the rhombus ♦ and use ε or ζ to return to the main screen.

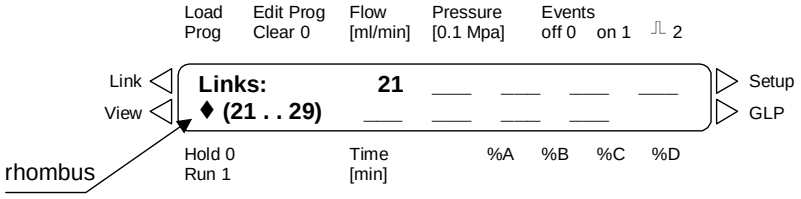

Fig. 16. Example of a multi-page menu: VIEW menu.

Menus without a rhombus ♦ in the lower left corner of the display are single page menus.

Entering Data:

- Place the cursor at the desired position of the main screen.
- Press a numeric key to start data input. The appearance of the cursor changes to a underscore character (see Fig. 6 on page 10).
- Press the numeric keys to enter the desired numeric values. Incorrect entries can be simply overwritten by continuing the entry.
- Confirm the value by pressing any of the arrow keys. This finishes data entry mode and moves the cursor to the next field according to the arrow key direction.

SET-UP menu

Enter the set-up menu using the Arrow keys in the SETUP Menu
In Fig. 18 the structure of the SETUP menu is given. The ʒ key can be used to access menus, use the ƶ and ƹ arrow keys for scrolling through the list of parameters of any individual menu. The SETUP menu of the LC 110 enables access to the following features and functions:

Gradient mode

The LC 110 is capable of isocratic (none), high pressure gradient (HPG) and low pressure gradient (LPG) operation.

Setting up the gradient mode:

- Select ñGRADIENT MODEñ from the SETUP Menu.
- Select the desired mode of operation (none/HPG/LPG).
- If you select either the high or low pressure gradient (i.e. HPG or LPG) you need to specify the channels used by each of the solvents:
  LPG: Choose up to 4 channels (valves), from A to D
  HPG: Choose names for each pump, from HPG A to HPG D
- Move to the second line by pressing the ʒ key and choose valves A to D (for LPG mode) or names for each pump actually present (for HPG mode) for each of the corresponding positions by pressing either the ƶ or ƹ key. It is important to turn ON channels indicating gradient composition (e.g. %A; %B; %C; %D) for all pumps which are set in HPG mode, e.g. if 2 pumps will be used and named as HPG A and HPG B, channels corresponding to both pumps (%A and %B) should be ON in both pumps (See Fig.1).This selection will apply for programs and define the number and names of solvents used in any gradient.

Fig. 17. Pump display when gradient mode for 2 pumps (HPG A and HPG B) is properly set. The first pump was configured as HPG A and both channels indicating %A and %B are ON.

If after leaving this setting the message ñConflict with existing programsò appears, this means that programs with a different valve or pump configuration already exist. In this case, either delete these other programs according or change your valve or pump configuration correspondingly.

Pump head

Here the type of pump head installed on the pump can be defined. The pump head selection serves as the basis for how the flow rate is calculated and sets the maximum system pressure in accordance with that maximum flow rate. The maximum pressure applies to all modes of operation and cannot be exceeded. Two parameters are available (10 mL and 50 mL, corresponding to the 10 mL and 50 mL pump heads) for setting the maximum volume of the pump head installed.

Pressure Autozero

An offset correction for the pressure measurement on the display can be made from here. First, open the purge valve by turning the de-aeration screw (see item {4.3} in Fig. 12) one turn to the left. Select the menu with the Ȝ key and start the autozero routine by pressing the ȥ or Ȟ key. Offset correction is then carried out automatically.

Flow

You can enter a correction constant for the selected flow rate in a preset range [4000 - 6000]. This correction changes the number of pump cycles at a selected flow rate. This option allows for compensation of the flow rate when using solvents with differing compressibility.

Only trained users should change this setting! Select the menu with the Ȝ key, adjust the values using the ȥ or Ȟ keys. The correction parameter (see Fig. 18) is not accessible and normally need not be modified. This parameter can be accessed by authorized maintenance personnel only.

Pressure limits

The minimum and maximum system pressure limits can be set here. The pump will stop automatically when the system pressure exceeds these set limits. By setting the minimum system pressure, damage to the pump

caused by ñrunning dryòcan be avoided. When the system pressure is below the set limit, for example when a leak in the system is present, the pump will stop automatically after 30 seconds. By setting the minimum pressure limit to ñÒòthe minimum system pressure will not be monitored. The absolute maximum pressure is limited by the pump head chosen and the selected flow rate.

The specified maximum pressure applies to all modes of operation and cannot be exceeded. Units: 0.1 MPa (1 bar).

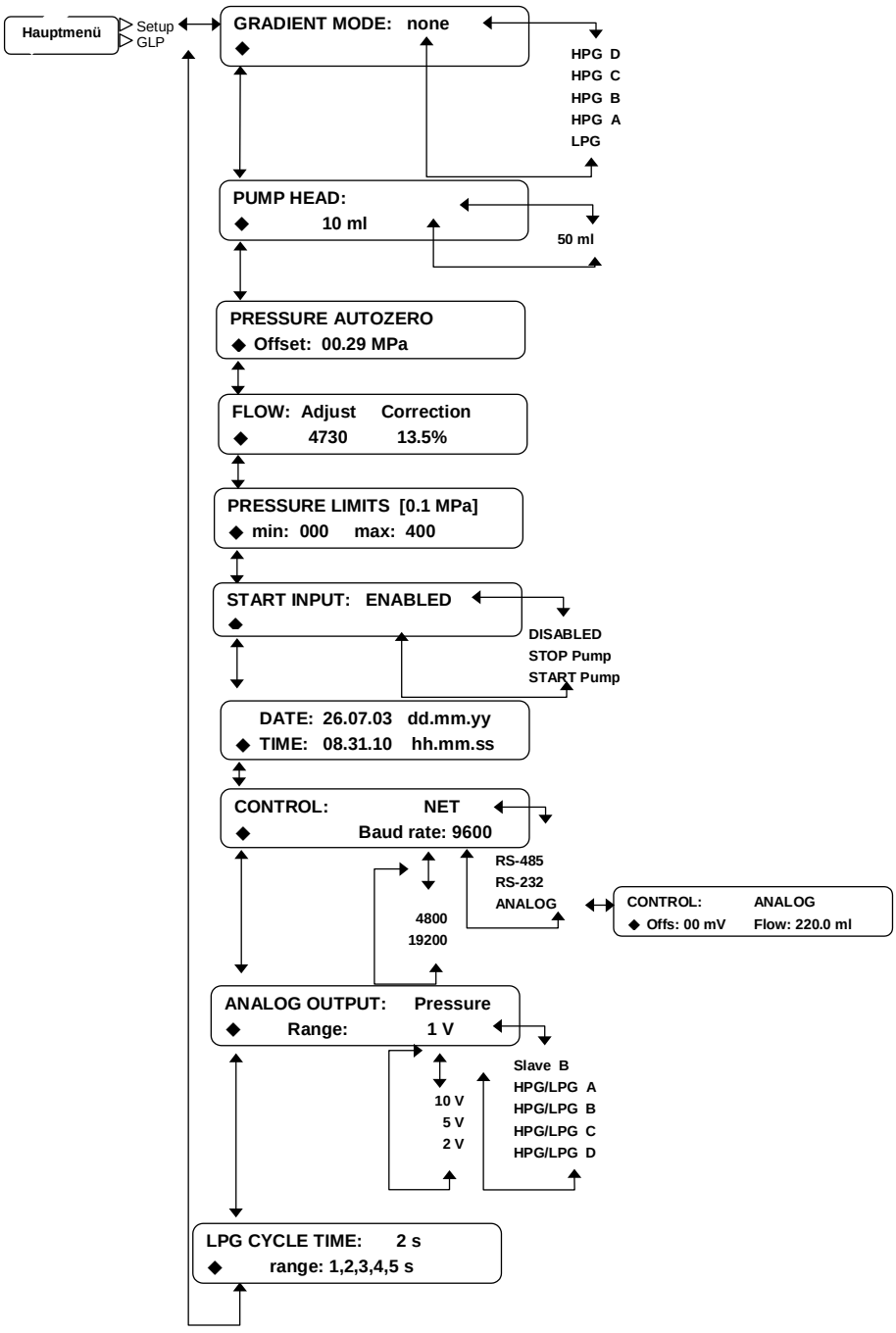

Fig. 18. Structure of the SETUP menu.

START input

If the START INPUT is set to ENABLED, a program can be started by an external digital signal from the START IN input on the rear side of the pump (see the section ñConnecting the Analog/Error/Start Socketñ). The setting STOP Pump will cause the pump to stop pumping if an external digital signal is applied on the START IN input. The setting START Pump enables the pump to start pumping by using an external signal. If the START INPUT is set to DISABLED, no program runs can be started and network control is inactivated.

Date/time

Setting of the system date and time.

Control

The instrument can be set to different external control modes. The options available are RS232, RS485 and ANALOG. RS232 and RS485 allow for external digital control by a suitable terminal program. In contrast, ANALOG output allows for external control through an analog input signal.

ANALOG output

On activation of the PRESSURE option, the output from the ANALOG OUT will deliver the actual measured pressure value for external monitoring or control. By activating SLAVE B, an analog signal is given out via the output that can be used for controlling any second pump, e.g. in a binary high pressure gradient. In this case the control signal (voltage) corresponds to the percentage amount % B, whereas % A will be provided automatically by the LC 110 itself.
Generally, the voltage range can be chosen from between 0-1 V, 0-2 V, 0-5 V and 0-10 V. In any case, the maximum value corresponds to 100 % B (SLAVE B) or to 40 MPa (PRESSURE).

LPG Cycle Time

The LPG Cycle Time represents the time that the valves on the optional HPLC manager require to go through one switching cycle; the factory default is normally 2 seconds. At higher flow rates and simultaneously low mixing chamber volumes, the switching times should be decreased to provide for better mixing of the mobile phases.

VIEW menu

The VIEW menu lists existing programs and program links. An example is given in Fig. 19: Programs 1, 2, 3, 4, 11 and link 21 have been created.

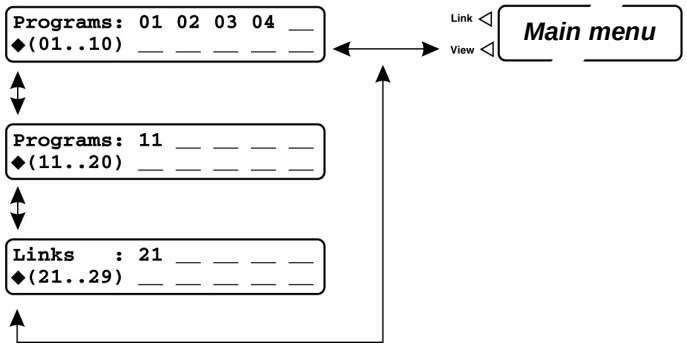

Fig. 19. The VIEW menu with programs 1-4, 11 and link 21

The LINK menu reports status information of the currently active program links. It is activated only if a link is running.

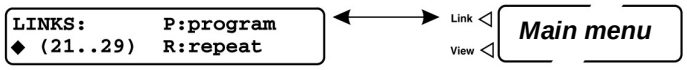

Fig. 20. LINK menu without running link.

If a link is active, the menu shows the following structure:

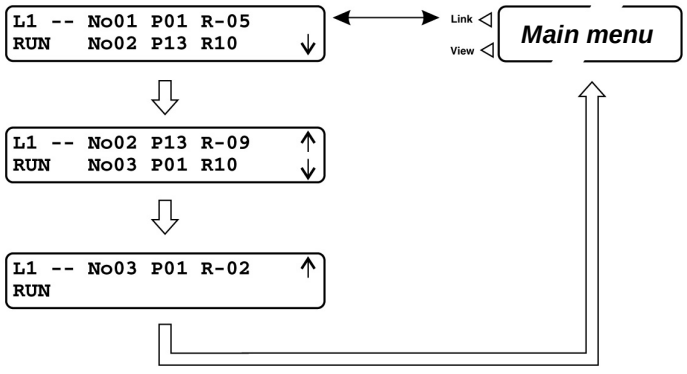

Fig. 21. LINK menu with running link.

In case a link is running, the first line of the menu gives the current status of the links. The field R-xx shows the number of program runs still to be performed. The value of R-xx decreases according to the number of runs remaining.

The second line shows the next step of the link to be performed. Up and down arrows at the right hand side of the display indicate the existence and position of additional program steps.

GLP Menu

The GLP menu reports statistical data for essential parameters of the LC 110.

Fig. 22 gives an overview of the GLP menu. For an overview of error codes refer to the section Display messages at the end of the manual.

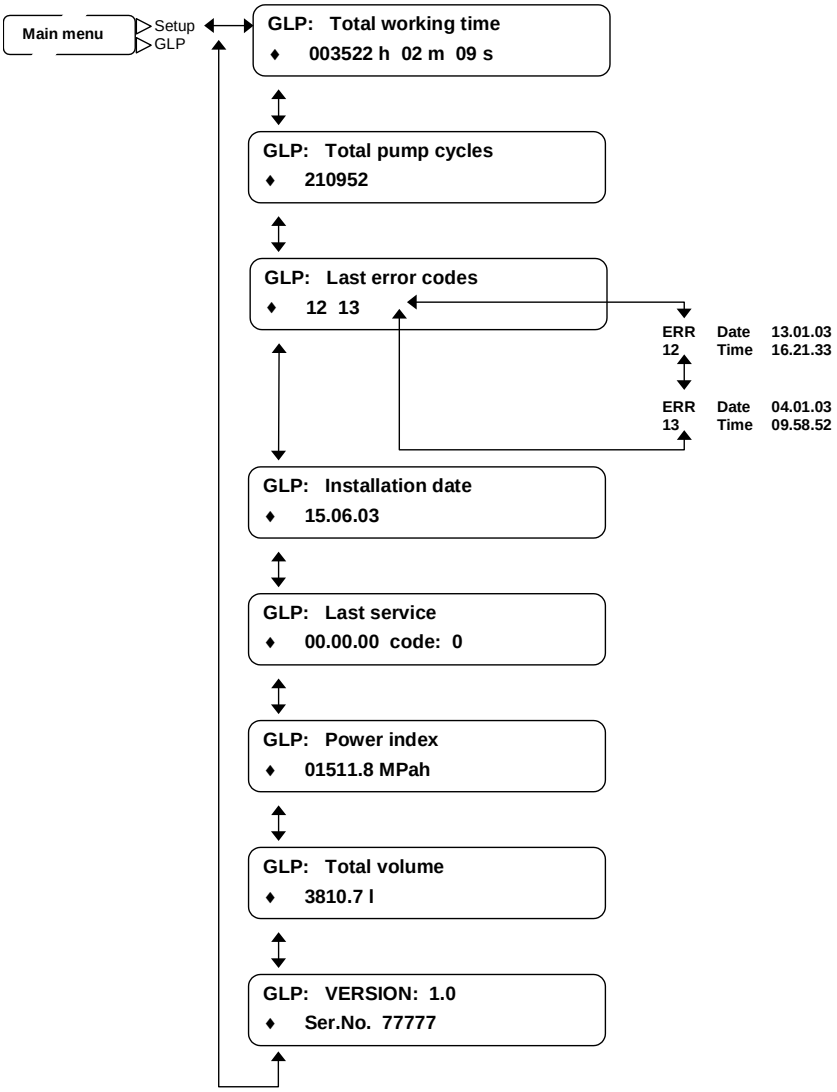

Fig. 22. Structure of the GLP menu.

C H A P T E R 5

LC 110 programs

The LC 110 can be programmed to perform the following actions:

- Control of flow rates
- Control of solvent compositions
- Output of control signals (Events)

The LC 110 can store up to twenty programs with a maximum of 100 program lines in total. Up to nine links can be created between existing programs.

In the program menu the time display units are shown in minutes with a decimal representation of seconds, i. e. 0.5 min = 30 sec. Time values precise to 1/10 min can be entered into programs but the time displayed on the pump will be in 1/100 min steps during program execution. All programs are saved in the pump's memory and are permanently available. Programming of the solvent composition is identical for both gradient modes, i. e. HPG or LPG.

New program lines are added by positioning the cursor on the asterisk in the time field on the display. Program lines can be rearranged manually by changing the time values.

When a new program line is generated, all of its parameters are automatically set to status NO CHANGE and appears as a row of underscore characters (see part D of Fig. 23). The NO CHANGE feature allows for modification of single parameters without having to re-enter the values for the other parameters.

When parameters have different values in different time lines, their value will be calculated and changed linearly in the time span in between. This is important e.g. if programming linear gradients.

Creating a Program

Position the cursor on the EDIT PROG field. Enter the number of the desired program. Press any arrow key to go to the edit mode for the new program.

The cursor is positioned at Time 000.0 (fixed start time). Trying to change the start time will produce the message Start Time Is Fixed in the display.

- Position the cursor on the desired field.
- Enter the desired values into the appropriate fields.
- Position the cursor on the time field and press the ξ key to create an additional time step.

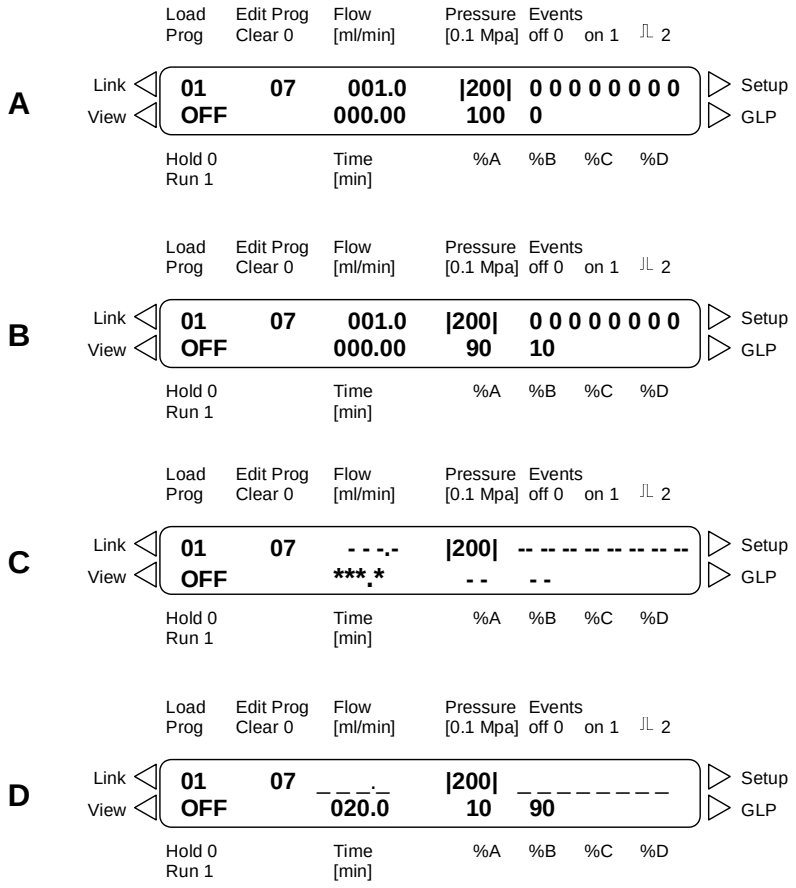

Fig. 23. Display of single steps, when creating a program.

Running a Program

Execute the following steps to run a program:

- Load the program you want to execute by entering the program number in the LOAD PROG field. Confirm by pressing any arrow key.
- Press START key to start the pump. The display changes to ON and the pump begins continuous operation with the parameters specified in the first program line.
- Position the cursor onto the ON field.
- Start the program by pressing the numeric key 1. The display will show that the program is running by indicating RUN on the lower left side of the display.
- While a sequence of programs is being executed, it is possible to freeze the current status of the pump by pressing the 0 key. The display will indicate HOLD in the lower left corner and the TIME field will blink.
- By pressing again on the 1 key the active program sequence will continue running again. You can also press STOP to abort execution.

During program execution the current solvent composition can be observed in the display fields % A and % B. At the end of the program the pump returns to the first line of the program and continues pumping and the display will indicate ON in the lower left corner.

Modifying & Deleting Programs

To modify a program execute the following steps:

- Enter the number of the program to be modified in the EDIT PROG field.
- Move the cursor to the value to be modified.
- Enter the new values to overwrite the old values. Incorrect entries can also be corrected in the same way.
- Confirm your entries by pressing any arrow key.

Delete program lines as follows:

- Enter 0 (zero) in the TIME FIELD and press any arrow key. The message ñDelete this line? Confirm by cursorò appears.
- Pressing any arrow key deletes the program line. Pressing any numeric key or none at all for several seconds aborts the process of deletion.

Deletion of programs or program links:

- Select field EDIT PROG.
- Enter 0 in the field EDIT PROG.
- Confirm deletion by pressing any arrow key. Pressing any numeric key or none at all for several seconds aborts the process of deletion.

Example Program

Generation of program no. 7 with the following functions: Constant þow rate of 100.0 mL/min. Linear gradient changing composition from 90 % A and 10 % B at start time to 10 % A and 90 % B at time 20 minutes. Remember, underscored characters indicate that the corresponding parameter is continuously calculated.

Execute the following steps:

- Go to the main menu screen.
- Move the cursor to the Edit Prog field and press 7 to create program no. 7.
- Press the ξ key to enter the Edit mode for the new program.
- The cursor is positioned at Time 000.0.
- Press the ≠ key to set the flow rate: Press 1, 0, 0 and then the ξ key to enter the value 100.0 mL/min. The display should look like part A Fig. 23 and the cursor should be blinking in the TIME field.
- Press the ζ key to go to the % A field, then press 9 and 0 and the ξ key to confirm the input. The amount for % B is automatically calculated and will be indicated as 10 %. The display should now look like part B in Fig. 23.
- Now press the ξ key again to create the next program line and define a new time step. The display now should look like part C in Fig. 23 and the cursor should blink on the first asterisk.

- Now press 2 and 0 and then ʒ to define time step 20.0 min as well as to enter field % A.
- Press 1 and 0 for 10 % A and then the ε key to confirm the input. The amount for % B is automatically calculated and indicated as 90 %. Enter now at the end a flow rate of 1 mL/min again. The display now should look like part D in Fig. 23.

After loading, the program can be executed.

Wake-Up Program

The LC 110 can execute a program at a preset time. Make sure that the date and time of the LC 110 are set up properly in the SET-UP menu.

Execute the following steps to create a Wake-Up Program:

- Enter the program number 30 (specifically reserved for this purpose) in the EDIT PROG field.
- Enter the desired program for Wake-Up in the P: field and the desired time and date in the fields at: and on:.
- Load reserved program 30.
- If necessary, switch the pump to OFF with the START/STOP key.

While waiting for the programmed time, the display will blink. The pump will start program execution with the selected program at the preset time and switch into RUN mode.

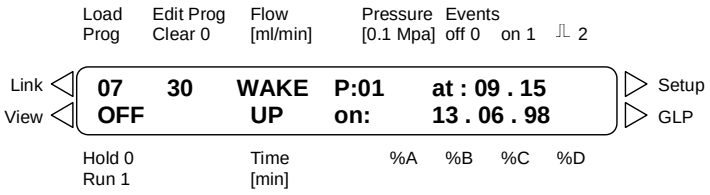

Fig. 24. Wake-Up program.

Execution of Wake-Up Program can be aborted by entering the number of another program.

Emergency program

The running of an emergency program is recommendable when the pump is to run for longer periods of time, for example, when the pump is to run unsupervised overnight. An emergency program could be written such that when an ERROR signal is given out by the pump, the emergency program would then shut off the pump.

Execute the following steps to create an emergency program:

- From the EDIT PROG field, enter the program no. 20, specifically reserved for the emergency program.
- Create the emergency program.
- Start another program.
- Create a connection between the ERROR IN and GND contact on the REMOTE terminal strip (see item {5.7} in Fig. 13) to produce an error signal.
- Emergency program no. 20 will then start automatically.

Program Links

Program links are combinations of existing programs and can be created and edited like any other program.

Links use the reserved program numbers **21 - 29**. These numbers are automatically converted, e.g. **21 = L1**, **22 = L2**, etc. The LC 110 can store up to 9 different links.

Links use line numbers from number 01 to 99, each line being a reference to a linked program. The parameter R denotes the number of runs to be performed with that program. A Wait command can also be programmed. The maximum number of programs referenced in all links is limited to 100.
Any program can be referenced multiple times within a link. A program link can not reference other links.

Creating Program Links

Links between existing programs can be created in the following way:

- Enter the desired number for the link in the EDIT PROG field and press the ↵ key for confirmation.
- Press any numeric key to create a line number. Lines are numbered automatically and can be interchanged by renumbering.
- Use the ↵ key to move the cursor to field **P** and choose the desired program number.
- Press the ↵ key again to select field **R**.
- Enter the number of runs to be performed for the selected program.
- Select the **Wait** field and enter either the value 1 or 0.

If Wait is set to 1, the pump waits for an external start signal or for the user to press the numeric key 1 before this line is executed. While waiting the pump switches to wait-status.

If Wait is set to 0, the program lines of the link are processed continuously.

Example Program Link

Part A in Fig. 25 shows the first step, after entry of the link number, cursor blinking at No**. Part B in Fig. 25 shows the programming of the first line.

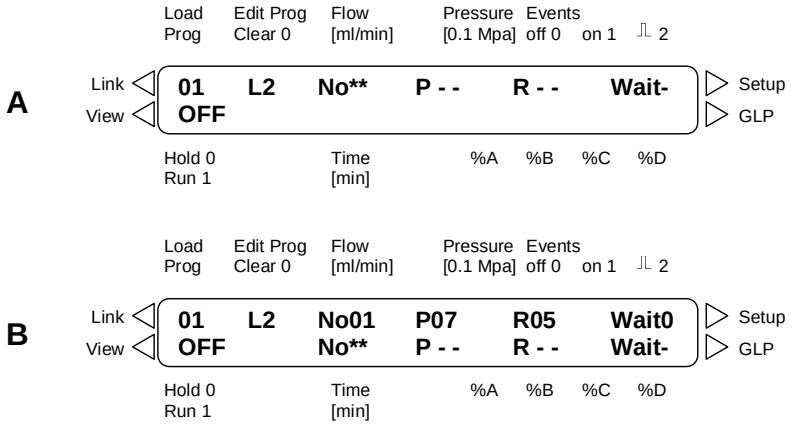

Fig. 25. Display while editing a program link.

During the execution of a link, the LINK menu is available in addition to the common display. Within the LINK menu the current status of the running link is shown. Move the cursor to the LOAD PROG field and press the ε key to enter this menu page. For more information refer to Fig. 10 on page 17.
Press the ζ key to exit link menu.

Executing Program Links

To execute program links execute the following steps:

- Enter the desired link number into the field LOAD PROG and confirm by pressing any arrow key.
- Press START to start the pump. The display switches to ON.
- Position the cursor on the ON field.
- Start the link by pressing numeric key 1. The display switches to RUN.
- After execution of a link the LC 110 stops solvent delivery and the display switches to OFF.

C H A P T E R 6

Maintenance

All moving parts are subject to normal wear and tear. It is therefore unavoidable that certain parts have to be replaced once in a while. The LC 110 is constructed in a way that worn out parts can easily be reached and replaced with a minimum of downtime. In this section maintenance of most common parts is described:

- replacement of seals
- replacement of pistons
- maintenance of check valves

Removing the pump head

Perform the following steps to remove the pump head:

- Purge the pump head with distilled water.

Danger of skin irritation may exist if organic solvents remain in the pump head.

- Remove the inlet tubing from the pump head inlet [2].
- Remove tubing from the piston wash capillaries.

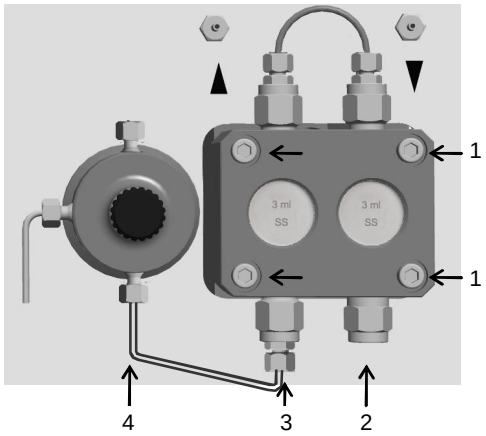

Fig. 26 Removal of pump head: [1] pump head screws, [2] pump head inlet, [3] pump head outlet and [4] purge valve inlet.

- Loosen and remove the tubing assembly connecting the pump high pressure outlet [3] and the inlet on the pressure transducer/purge valve [4].
- Use an Allen key no. 4 (4 mm) to loosen only two (diagonally opposite) pump head screws [1] and remove them completely.
- Carefully loosen the two remaining screws, alternating from one to the other, approx. half of one turn. This prevents the pump head from tilting and becoming damaged. Once the spring tension has been reduced, hold the pump head firmly in one hand while removing the screws completely with the other hand.
- Carefully remove the pump head.

Disassembly of the pump head

All IDs of the pump head parts mentioned below refer to Fig. 29. Please execute the following steps to disassemble the pump head:

- The pistons [19] can be removed using pliers. Grasp the tip of the piston using the pliers and pull it out carefully in a straight line.

In case the pistons are broken or damaged replace them and always check the <u>entire</u> pump head for damage.

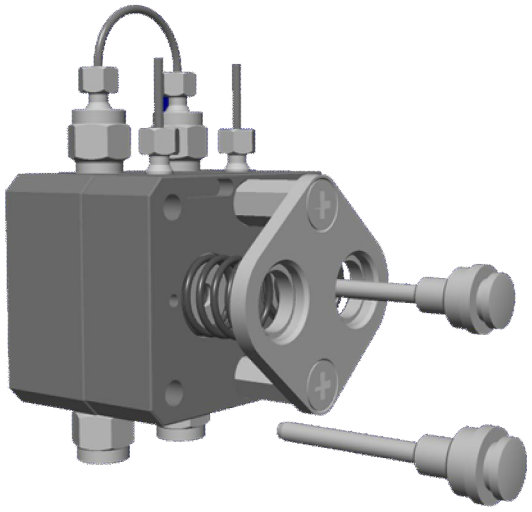

Fig. 27 Removing the pistons from the pumphead.

- Loosen the two retaining plate screws [21] half of one turn, alternating from one to the other to avoid damaging the retaining plate. Because the two screws are very tight, it may be helpful to either clamp the pump head or to press one of its side surfaces against a table with one hand while loosening the screws.
- Unscrew the two screws strictly alternating due to the strong force of the springs [17] behind the plate and remove them.

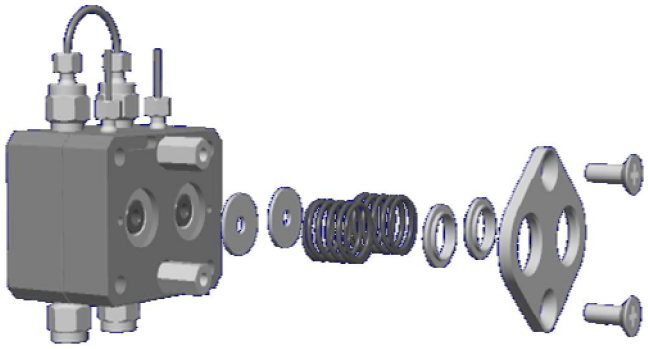

Fig. 28 Retaining plate construction with springs.

- Remove the retaining plate [20].
- Remove the springs [17].
- Use a SW 5/16 spanner to loosen the spacing bolts [15].These bolts are seated very tightly. Follow the advice given in step 3.
- Remove the pressure plate [14]. Loosen the two retaining plate screws [21] half of one turn, alternating from one to the other to avoid damaging the retaining plate. Because the two screws are very tight, it may be helpful to either clamp the pump head or to press one of its side surfaces against a table with one hand while loosening the screws.
- The pump head housing [6] can now be separated from the pressure plate [14] and all seals are accessible now.

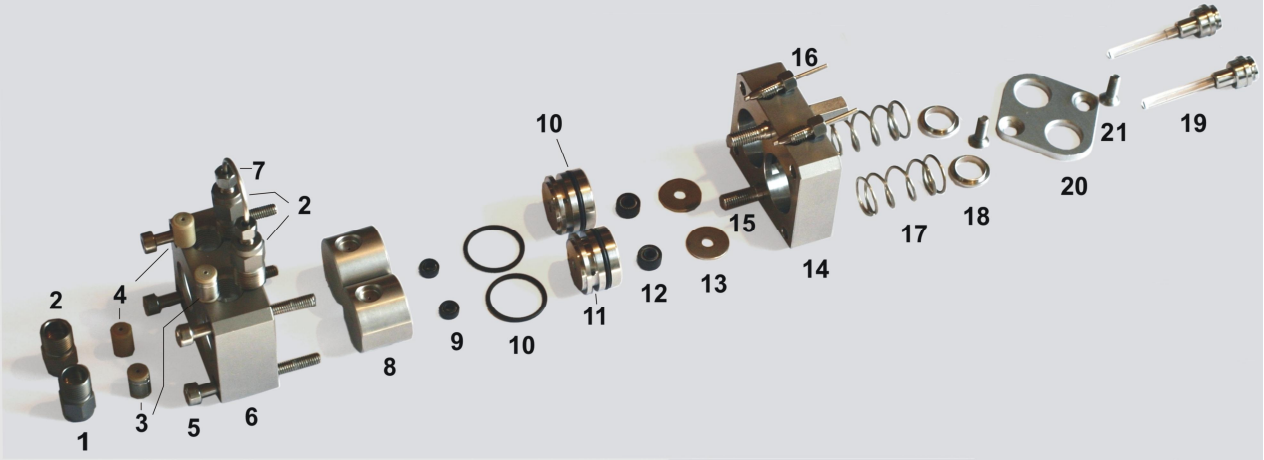

Fig. 29. Exploded view of the pump head.

ID	partnumber	Description	Qty
1	193.0324	LC 110 check valve nut 1/8", inlet	1
2	193.0326	LC 110 check valve nut 1/16"	3
3	193.0302	LC 110 check valve	2
4	193.0328	LC 110 distance holder	2
5	193.0344	LC 110 pump head screw	4
6	193.0304	LC 110 pump head housing, front	1
7	193.0342	LC 110 capillary connection	1
8	193.0314	LC 110 inlay, 10 mL, stainless steel	2
9	193.0308	LC 110 piston seal, high pressure, PTFE*	2
10	193.0316	LC 110 O-ring	4
11	193.0332	LC 110 seal holder, piston wash	2
12	193.0310	LC 110 piston seal, piston wash, PTFE*	2
13	193.0346	LC 110 cover disc, wash seals	2
14	193.0330	LC 110 pressure plate	1
15	193.0334	LC 110 spacing bolts	2
16	193.0348	LC 110 capillary piston wash	2
17	193.0322	LC 110 spring	2
18	193.0340	LC 110 spring plate	2
19	193.0318	LC 110 piston, Sapphire	2
20	193.0336	LC 110 retaining plate	1
21	193.0338	LC 110 retaining plate screws	2

Replacing seals

The lifetime of seals is limited and depending on the LC conditions. Under normal wear and tear conditions & proper usage of the piston wash the approximate lifetime is 6 ï 10 months. Leakage of solvent around the pump head usually indicates damage to seals and replacement is necessary. In this section the replacement of seals is described. The identification numbers of the parts described in this section refer to

Fig. 29. On the left side in

Fig. 29 the pump head housing [6] with inlays [8] is shown were the high pressure seals [9] are located. On the right side the pressure plate [6] is shown were the wash (low pressure) seals [12] are located:

To replace seals, the pump head should be removed from the pump and opened. Seals should be replaced using the piston removal tool (p/n 193.0424) available in the LC 110 accessory kit. Execute the following procedure to replace the seals:

High pressure seals

- Lay the pump head housing [6] flat on a table with the seals facing upwards.

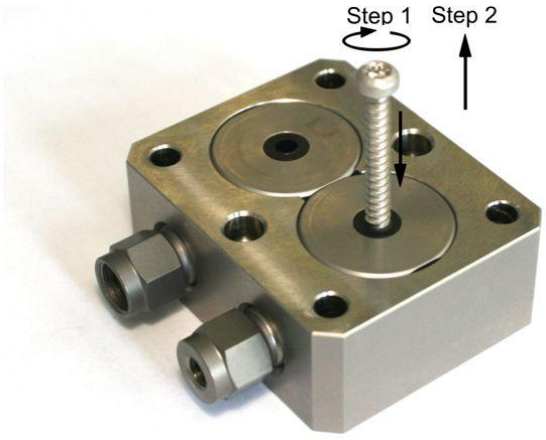

Fig. 30 Removal of high pressure seals located in the pump head housing [6] using a seal removal screw. Step 1: turn the screw one turn in, step 2: move the screw upwards to remove seal.

- Turn the seal removal screw one turn in the middle of the seal.
- Move the screw upwards to remove the seal from the pump head housing.

Removing the seal is destructive, therefore the seal must only be taken out when worn out or damaged by salt abrasion. A removed seal must not be used anymore and should be replaced.

- Insert the high pressure seals [9] into the housing with the spring facing the inlays.
- Gently push the seals in place using your fingers. The high pressure seals (p/n 193.0308) can be recognized by the smaller thickness in comparison to the piston wash seals.
- In case of exchange/cleaning of check valves (not necessary when only exchanging seals). Remove the check valve nuts containing the check valves & distance holders [1 and 2].
- When the check valve nuts [1 and 2] are removed the seal holder/inlays [8] are not constrained anymore and can be removed from the housing.

Piston wash seals

- Take the pressure plate [14] and lay it flat on the table with the piston wash seals [12] facing upwards (Fig. 31).
- Remove the cover discs [13] out of the pressure plate [14].

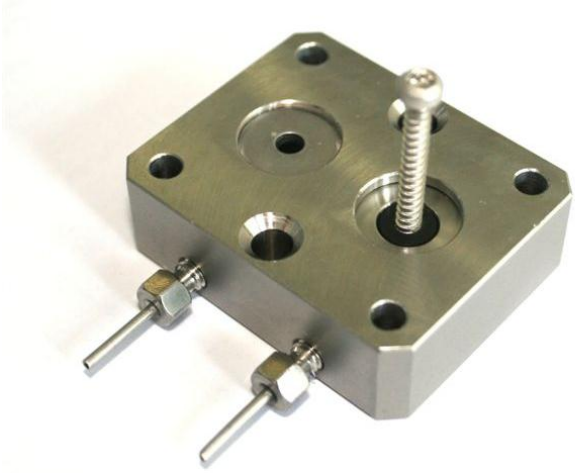

Fig. 31 Removal of piston wash seals located in the pressure plate [14] using a seal removal screw. Note: on the left-side the seal still has the cover disc [13] on top.

- Remove the piston wash seals [12] in the pressure plate [14] in the same manner as the high pressure seals using the seal removal tool, screw the thread inside the seal and pull the seal out.
- Insert the new piston wash seals [12] into the housing with the spring facing the pressure plate. Gently push the seals in place using your fingers. The Piston wash seals (193.0310) can be recognized by its larger thickness and diameter in comparison to the high pressure seals.

O-rings

There are 4 black O-rings [10] present in the pressure plate to seal off the Piston wash compartment. Two of the O-rings are located on the outside of the pressure plate [14] on the opposite site the seals are located.

- Inspect the two O-rings [10] on the outside of the pressure plate on visual damage. In case these O-rings are damaged replace them with new ones.
- In case of leakage of the piston wash compartment it is necessary to check all four O-rings and replace them if necessary. The O-rings on the inside can be accessed by pushing the seal holders [11] out of the pressure plate [14]. Push from the side where the low pressure seals are located.

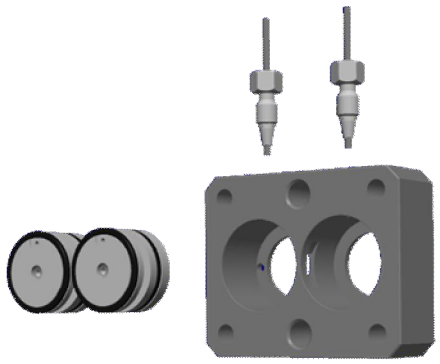

Fig. 32. Exploded view of the pressure plate. On the left-side the seal holders are shown.

Check valves

If check valves are contaminated they will no longer open and close correctly, which leads to pressure fluctuations or loss of pressure & flow completely. You can remove the check valves for cleaning. Please follow the steps below to remove and disassembling the check valves:

- Remove the connection from the pump head to the solvent reservoir.
- Loosen the check valve nut on the inlet side [1]. The lower check valve [3] can now be removed together with the check valve nut.
- Remove the complete capillary connection [7] between the two pump chambers. Loosen the nuts by alternating from one to the other, to avoid bending of the capillary.
- Remove the check valve nut from the outlet side [2].
- Remove the upper check valve [3] using a pair of tweezers.
- Place the check valve in a suitable cleaning solution (iso-propanol). Use an ultrasonic bath to clean the check valve.

Only in case malfunction persists, follow the procedure below or replace the check valve by a new one.

- Using a razor blade or similar sharp object, remove the check valve seals carefully from the housing.
- Remove the individual components by gently tapping the housing on the table.

The valve ball and seating are adjusted in pairs. An exchange of one these parts leads to malfunction of the check valve. Therefore care must be taken when cleaning more than one check valve simultaneously so that the matching parts cannot be exchanged.

- Clean the individual parts in iso-propanol (or ethanol) in an ultrasonic bath.
- Assemble the check valves in reverse order. Make sure that the glossy side of the seating is facing the valve ball, see Fig. 33 and assemble the check valve properly. Wrong assembly can lead to damage and leakage of the check valve.

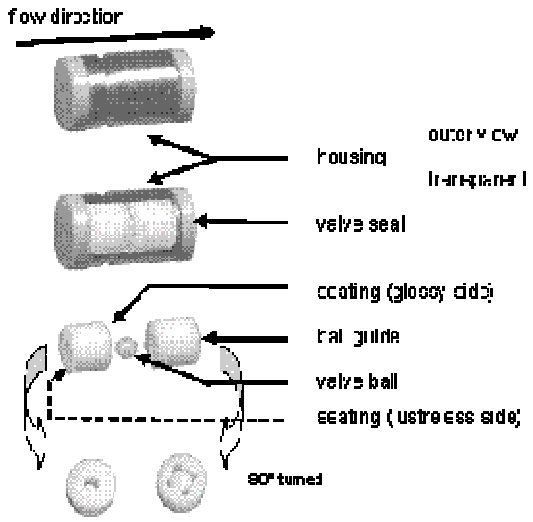

Fig. 33. Check valve, single parts.

Put the check valves into the bushing holes on the pump head. Orient the check valves according to the flow direction required for that position. Screw in the check valve nut by hand. Tighten the check valve nut carefully with a spanner by about ½ - ¾ turns.

To avoid destruction of the ceramic seal holders, tighten the screws of the ceramic seal holder [1] and [2] with 8 Nm using a torque wrench.

Assembling the pump head

Follow the steps below to assemble the pump head in the appropriate way. See
Fig. 29 for an exploding view of the pump head.

- If you have removed the inlays/seal holders [8] from the housing [6], insert them carefully with the plane sides facing each other in the centre of the pump head housing.
- Lock the seal holder in place by attaching the check valves [3] and distance holder [4].
- Place the O-rings [10] on the inner side of the pressure plate [14].

- Install the pressure plate [14]. Assure the proper orientation of the housing and pressure plate and tighten the spacing bolts [15] firmly using the SW 5/16 spanner .
- Cover the piston wash seals with the cover discs [13].
- Install the two spring plates [18] and springs [17].
- Install the retaining plate [20].
- Insert and tighten the two screws [21] strictly alternating due to the strong force of the springs [17] behind the plate.
- Insert the piston rods [19] carefully without bending or breaking the rods.
- The spacing bolts [15] and the retaining plate screws [21] must be tightened so that they are seated securely.

Installing the pump head

Follow the steps below to install the pump head back on to the pump body:

- Make sure that the pump head has been properly assembled.
- Position the pump head straight onto the pump housing.
- Tighten all four pump head screws [5] a few turns by hand.
- Alternating from one to the next, tighten two diagonally opposed screws half a turn at a time, until the pump head is correctly seated.
- Tighten the two remaining screws. Make sure that all four pump head screws [5] are securely tightened.
- Mount the capillary connection between the pump head outlet and the pressure transducer.
- Connect the inlet tubing and piston wash tubing.

C H A P T E R 7

Trouble shooting

LC 110 Error Codes

The following error codes can appear in the LCD display:

Table 3 Error codes in GLP Menu

Error code	Description
5*	Motor failure
9*	ERROR IN signal detected
10*	Switch off due to exceeding maximum current
12	Switch off due to exceeding maximum pressure
13	Switch off due to falling below minimum pressure
23*	Motor blocked
33*	Calibrating values re-initialized
34*	Calibrating curve re-initialized
35*	Combination of error codes 33 and 34

*) In case errors marked with an asterix occur, please contact your local supplier for support/service.

In case of error 12 or 13 check the flow path of your LC system for possible blockage or leakage.

Power status LED off

Possible cause	Remedy
No power	Plug in power cord, if OR 110 is used check power on this device
Power off	Switch on device using the on/off button at the front panel

No RS232 communication

Possible cause	Remedy
No RS232 connection	Plug in RS232 cable(s) or replace faulty RS232 cable.
Wrong COM port assigned	Reconfigure LC 110 in the Clarity configuration. See Clarity software manual.
RS232 converter driver not installed of the USB connection kit	(Re-) install the necessary RS232 converter driver from the installation CD supplied in the USB connection kit (p/n 190.0200/0202/0204)

Excessive pump pulsations

Possible cause	Remedy
Detector related problem	See detector trouble shooting guide
Back pressure too low for pulse damper	For optimal dampening of flow pulsations a backpressure of at least (7 MPa = 70 bar =1000 psi) is needed. Use backpressure regulator or restriction capillary *between pulse damper and injector* to increase pressure
Check valve	Clean or replace check valves.
Seal	Replace seal
Piston	Remove pump head, clean or replace pistons

Leakage

Possible cause	Remedy
Connectors	Check connectors, replace if necessary
Leakage of seal	Replace seal and/or damaged piston

When trouble shooting is not successful and problems persist please contact your local supplier for service.

A P P E N D I X 1

Specifications LC 110 Pump

General specifications	Delivery system	Double-piston pump with main and auxiliary piston in a serial configuration, automatic piston back flush.
	Power	Auto-sensing power supply, 90 ï 260V, 47 ï 63 Hz, 70 VA
	Operating conditions	10ï 40°C, 20 ï 80% RH, non-condensing
	Flow rate	0.001 ï 9.999 mL/min, 0 - 40 MPa
	Flow rate accuracy	Ò1.5 % at 2 - 20% FS
	Ripple	Residual pressure pulsation < 3% (H_20 as eluent and P = 12 MPa)
	Displacement volume	primary piston 21.4 µL secondary piston 9.7 µL
	Pressure protection shut down	Minimum pressure stop: $P_{min,}$:0 (off) - 40 MPa (FS), switch-off time 30 seconds. Maximum pressure stop: P_{mzx} :0.1 - 40 MPa, switch-off time < 1 s
	Operating modes	Isocratic, gradient (High Pressure, up to 4 eluents)
	Instrument control	Stand alone: via Numerical keypad & LCD (2 x 24 ch) display. Digital control: via RS232C connector (null-modem cable). Analog control: via REMOTE connector (stop, flow, pressure, error)
	GLP features	Report of number of pump cycles, working time, delivered volume and service information
Physical specifications	Dimensions	412 (D) x 226 (W) x 135 (H) mm 16.2 ñ(D) x 8.9ò(W) x 5.3ò(H)
	Weight	5.3 kg (11.7 lbs)

A P P E N D I X 2

Accessories and Spare parts

The following set of accessories is supplied with each LC 110 :

Partnumber	Description
193.0400	LC 110 connector strips
193.0402	LC 110 open-ended IO cable
193.0404	LC 110 set for manual piston wash
193.0406	LC 110 tool set
193.0408	LC 110 power cable, EUR
193.0410	LC 110 power cable, US
193.0412	LC 110 RS232 cable
193.0414	Syringe 10 mL
193.0416	LC 110 1/8" nut, inlet
193.0418	LC 110 1/8" ferrule, inlet
193.0420	LC 110 PTFE eluent filter
193.0422	LC 110 ferrite
193.0424	LC 110 seal removal tool
193.0426	LC 110 piston wash tubing, 2 meter

The following pump head parts are available for the LC 110:

Partnumber	Description
193.0300	LC 110 pumphead 10 mL with SS inlays
193.0302	LC 110 check valve
193.0304	LC 110 pump head housing, front
193.0306	LC 110 piston seal & O-ring set
193.0308	LC 110 piston seal, high pressure, PTFE*
193.0310	LC 110 piston seal, piston wash, PTFE*
193.0312	LC 110 piston seal, high pressure, PE
193.0314	LC 110 inlay, 10 mL, stainless steel
193.0316	LC 110 O-ring
193.0318	LC 110 piston, Sapphire
193.0320	LC 110 piston, Zirconium
193.0322	LC 110 spring
193.0324	LC 110 checkvalve nut 1/8", inlet
193.0326	LC 110 checkvalve nut 1/16"
193.0328	LC 110 distance holder
193.0330	LC 110 pressure plate
193.0332	LC 110 seal holder, piston wash

Partnumber	Description
193.0334	LC 110 spacing bolts
193.0336	LC 110 retaining plate
193.0338	LC 110 retaining plates screws
193.0340	LC 110 spring plate
193.0342	LC 110 capillary connection
193.0344	LC 110 pumphead screw
193.0346	LC 110 cover disc, wash seals
193.0348	LC 110 capillary piston wash
193.0350	LC 110 capillary pumphead - transducer
193.0352	LC 110 pressure transducer
193.0354	LC 110 purge valve screw, PEEK
193.0356	LC 110 purge tubing assembly
250.1566	LC 110 1/8" ferrule, inlet
250.1568	LC 110 1/8" nut, inlet

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