ALEXYS LC 100
Pump

service manual

CE

DECLARATION OF CONFORMITY

The manufacturer hereby declares that the product

ALEXYS LC 100 pump type 182

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

Safety (73/23/EEC)

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

EMC (89/336/EEC)

Electromagnetic compatibility, generic emission standard	EN50081-1/2
Electromagnetic compatibility, generic immunity standard	EN50082-2
Emission standard- Information Technology Equipment (ITE)	EN 55022,Class B (CISPR22)
Harmonic current emissions	EN 61000-3-2
Voltage fluctuations and flicker	EN 61000-3-3

Attention

Use manufacturer-supplied cable(s) only to connect all I/O's 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.

July 21, 2005

Symbols

The following symbols are used on the ALEXYS LC 100:

Consult the manual for further safety instructions

Frame or chassis ground terminal

The following pictograms are used in the ALEXYS LC 100 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 equipment.

Electrical hazards

Removal of panels may expose users to dangerous voltages. Disconnect the LC 100 from all power sources before removing protective panels. Untrained personnel should not open the instrument.

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

Always replace blown fuses with fuses of the size and rating indicated on the fuse panel and holder.

Replace or repair faulty insulation on power cords.

Check that the voltage on the mains selector is the same as the voltage of the power source. Check the position of the mains selector (is set to 230 V on delivery - if necessary set to 115 V). Check fuses. On delivery 0.25 AT (180 - 250 V) fuses are installed, it may be necessay to install 0.50 AT (90 - 130 V) fuses depending on local mains voltage.

The LC 100 must only be used with appliances and power sources with proper protective grounding.

Take precautions against electrostatic discharge during installation/removal of boards, EPROM's or other electrical components at all time to prevent damage of the circuit boards.

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 ‘as 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. Technical support and training can be provided by qualified chemists on both contractual or as-needed basis.

Table of contents

C H A P T E R 1

Tools

The list below gives an overview of the tools required to perform service and testing of the LC 100 pump:

Service tools

Tool for exchange of piston seals 1/16" or 1/8"
Wrench 1/4" – 5/16"
Allen key 2mm
Allen key 2.5mm
Allen key 4mm
Adjustable spanner (max. 20 mm)
1/4" open-end spanner
10mm open-end spanner
Phillips screwdriver
Normal precision screwdriver
Pair of pliers
Syringe 10 mL

Solvents / Tubing

HPLC grade water
1/16" PEEK restriction capillary L=3 m, ID: 0.125 mm (0.005")
1/8" FEP/PTFE tubing and 0.2 μm inline filter
Silicone tubing

Test equipment

Calibrated flow meter *or*
Graduated analytical pipette (5 mL +/- 0.030 mL)
stop watch (+/- 0.01 s)
AC 100 & ALEXYS data system/line-recorder
AC 100 analogue input cable for LC 100 (for analogue pressure monitor)
Voltmeter, must have a resolution equal or better than 0.1 mV
High pressure gauge (precision: +/- 1 bar, acc. +/- 0.1 bar)
RS232 test plug
Current loop test plug

C H A P T E R 2

Connections

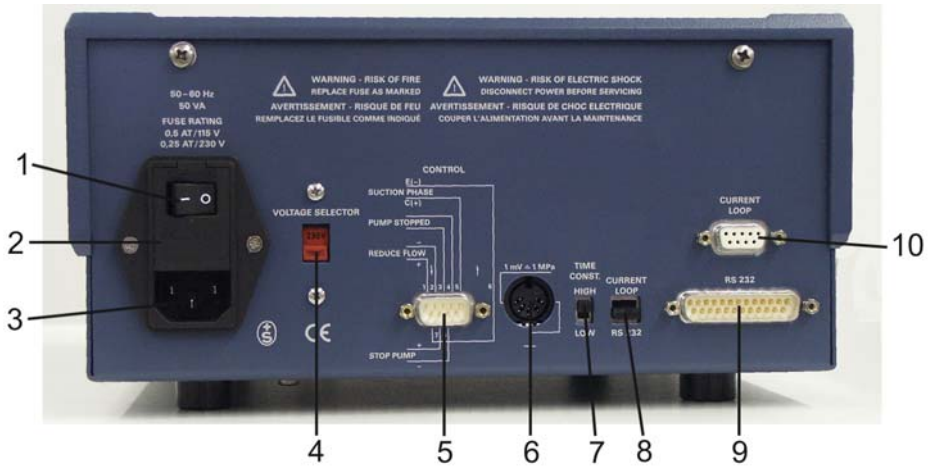


Fig. 1. Rear panel of LC 100.

1. Mains switch
2. Fuse holder
3. Mains inlet socket
4. Mains voltage selector (115/230 V)
5. Auxiliary controls connector
6. Analogue pressure monitor output (1 mV≈ 1MPa)
7. Time constant P monitor (20 ms / 2s)
8. Interface mode switch
9. RS 232 connector (25-pins)
10. Current loop connector (9-pins)

Analog pressure monitor output

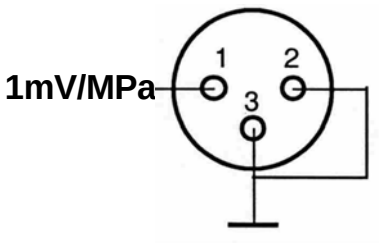
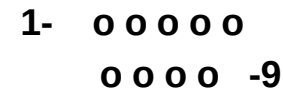


Fig. 2. Pressure output LC 100 (female connector).

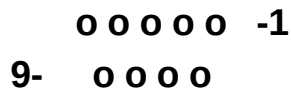
Auxiliary controls connector



9-pins subD connector, male

1	Reduce flow, anode (or ground: see P27, P28)
2	Reduce flow, cathode
3,4	Pump stopped output, relay contact
5	Suction phase collector
6	Suction phase emitter
7	Stop pump anode (or grond; see P29, P30)
8	Stop pump cathode
9	NC

Current loop connector



9-pins subD connector, female

1	NC
2	Send data collector
3	Send data emitter
4	Receive data cathode
5	Receive data anode
6	Ground
7	NC
8	450 Ohm to +15 V
9	450 Ohm to – 15 V

RS 232 connector

1- o o o o o o o o o o o o o
o o o o o o o o o o o o o -25

25-pins subD connector, male

1	NC
2	TxD
3	RxD
4	RTS
5	CTS
6	DSR
7	Ground
8	DCD
9-19	NC
20	DTR
21-25	NC

The RS232 test plug used for the RS232 communication test in the test instruction has the following configuration:

25-pins subD connector (male) with the following internal connections:

pin 2,3 and 8
pin 4 and 5
pin 6 and 20

C H A P T E R 3

Electronics

Opening the instrument

To open the instrument, remove the 4 screws located at point 1 and 4 in the figure below and remove top cover of the LC 100 housing.

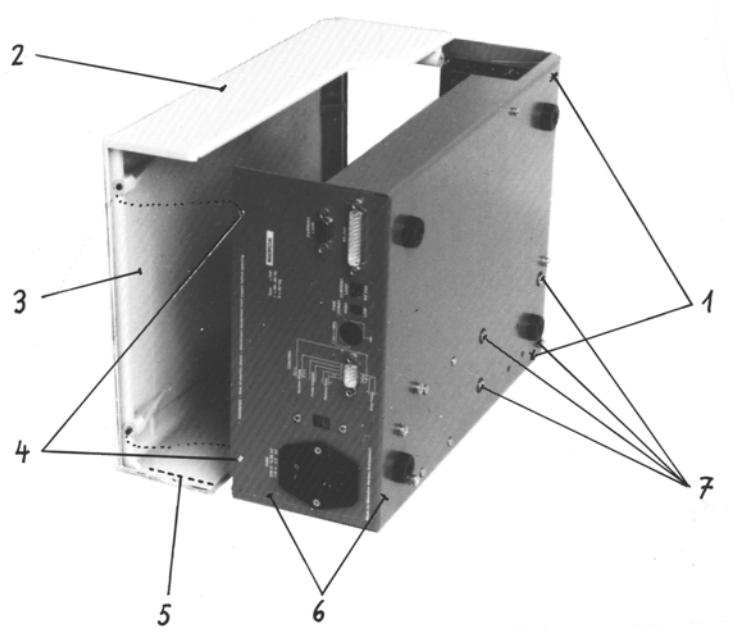


Fig. 3. Removing the top cover of the LC 100 housing.

1. 2 screws retaining the top cover to the bottom panel.
2. Top cover of housing.
3. Conductive lacquer at the inner side of the housing, together with the metallic bottom section (5) forming a faraday's cage to keep away interference.
4. 2 screws retaining the top cover to the rear panel of the LC 100.
5. Groove, guiding bottom section of housing (on front & back side).
6. Housing bottom section.
7. 4 screws retaining the motor drive block.

Interior of LC 100

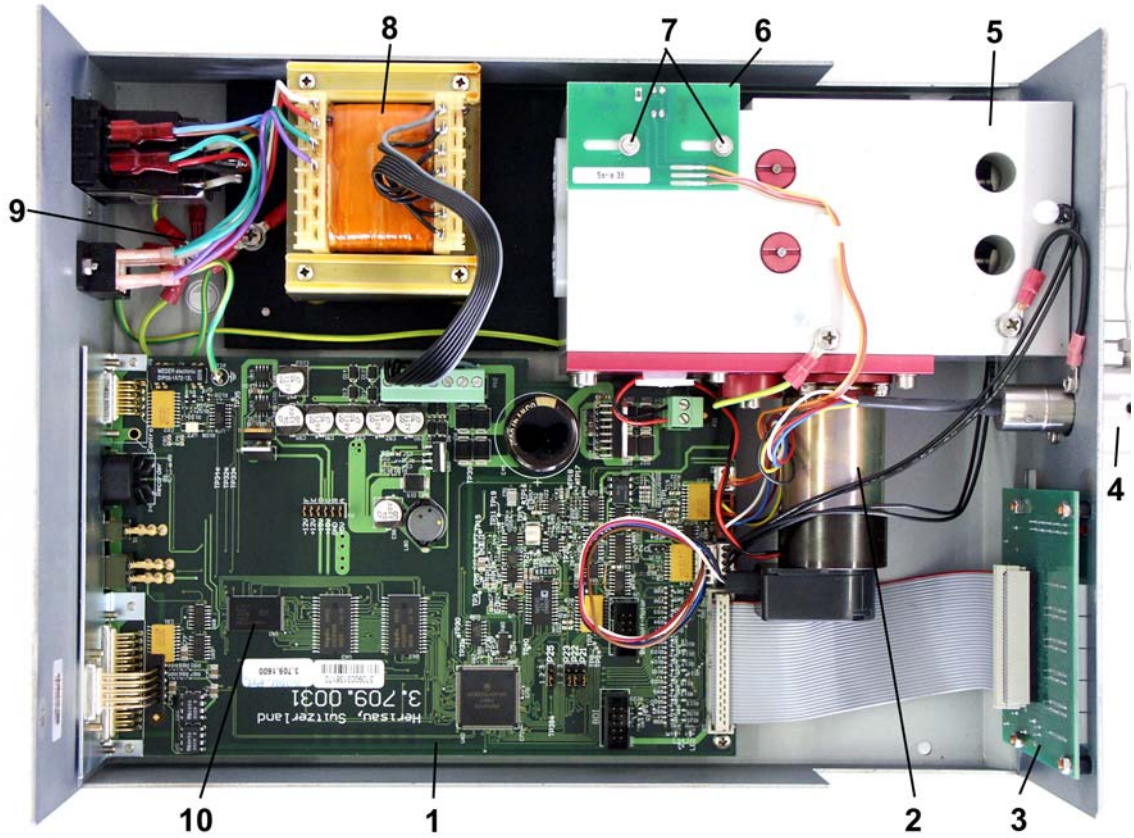


Fig. 4. Interior of the LC 100.

1. Main PCB
2. Motor with pulse generator
3. Display/keyboard PCB
4. Purge valve with pressure sensor
5. Drive block with gearbox
6. Marker PCB
7. Retaining screws for 6
8. Power transformer
9. Central earth connection
10. Flash EEPROM (firmware)

Location for settings & adjustments

Default jumper settings

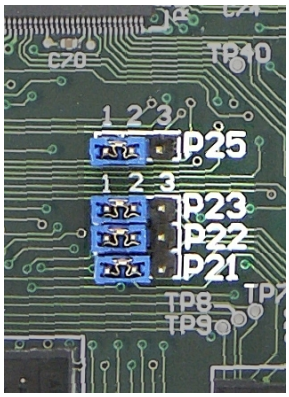


Fig. 5. Jumper settings on LC 100 main board.

1. P21-23: Baudrate (9600 baud)
2. P25: custom mode switch

All jumpers should remain at their factory default settings.

Marker PCB

On top of the motor/gearbox the marker PCB is located. This is an adjustable board (by means of the two retaining screws on top) with an opto-coupler which follows the cam rotation/motor speed by means of a chopper wheel.

Fig. *6. Marker PCB located on top of the LC 100 motor/gearbox.*

The marker board determines the point at which the pump will lower the cam speed to compensate the flow rate in the phase of the pump stroke at which both pistons are delivering solvent. A misaligned marker board can result in large pressure fluctuations.

The marker board is factory aligned and optimised for minimum pump pulsations. Only re-align the marker PCB in case:

1. **Motor or gearbox is replaced**
2. **The pressure fluctuations under specified test conditions exceed 3% (see test section of this service manual).**

Replacement of main board

To remove main board execute the following steps (see Fig. 4):

1 Disconnect all 7 cable connectors on the board.
2 Remove the screw of the earth connection on the black heat sink located at the top-left side of the board in Fig. 4.
3 Remove the 2 screws fixing the black heat sink to the bottom panel.
4 Release Fig. 4/15- soldered connection LV 1, Fig. 4/16 (#?#)
5 Remove the 3 retaining screws on the PCB.
6 Undo all 6 screws of the Sub D external plugs on the rear panel.
7 Remove main board.
8 Replace and assemble in reversed order.

Replacement of display and keyboard

To remove display/keyboard execute the following steps (see Fig. 4):

1 Disconnect keyboard/display flat cable from the main board.
2 Remove 4 nuts M3 with spring washer.
3 Remove display/keyboard PCB.
4 Replace and assemble in reversed order.

C H A P T E R 3

Mechanics

Purge valve/pressure sensor

The LC 100 is equipped with a purge valve with an integrated piezo-electric pressure sensor. The pressure sensor generates a voltage that is proportional to the pressure. It allows controlling and monitoring the drive pressure. The purge valve is used to prime the pump with eluent and to de-aerate the pump system. Disassembly and cleaning is necessary in case of contaminated or blocked purge valve.

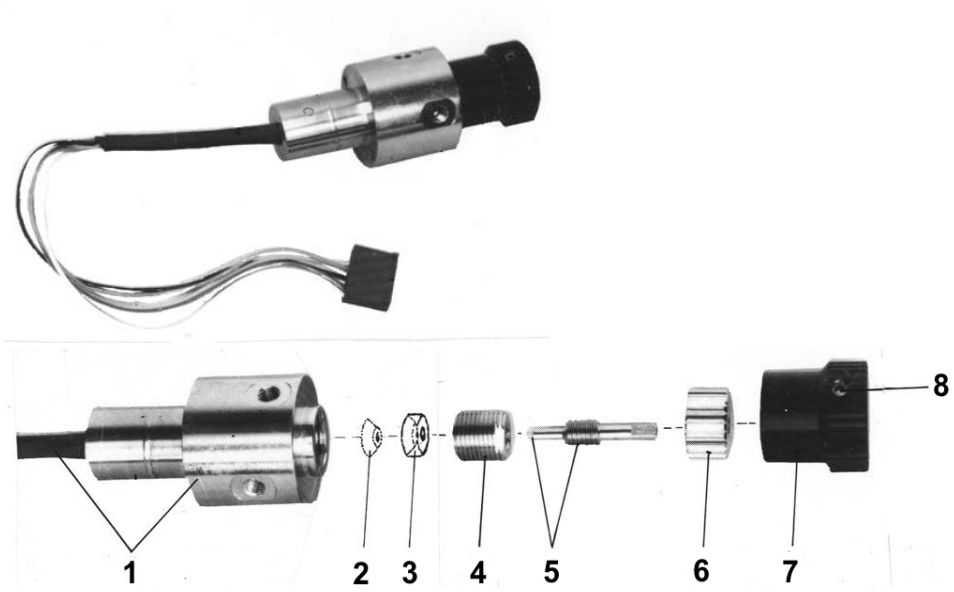


Fig. 7. Exploded view of the LC 100 purge valve with integrated piezo-electric pressure transducer.

1. Pressure sensor assembly
   (Piezo-electric pressure sensor with plug and valve body)
2. Gasket
3. Insert
4. Cock screw
5. Cock shaft assembly (with plastic tip)
6. Cock nut
7. Knurled knob
8. Grub screw

Disassembling the purge valve

To disassemble the purge valve execute the following steps

1 Slightly open the purge valve (turn knob 7 to the left).
2 Loosen grub screw 8 by means of 2 mm Allen key and remove knob 7.
3 Undo Remove cock nut 6 (e.g. using pliers).
4 Twist out cock shaft 5 (possibly by means of knob 6).
5 Remove cock screw 4 with 10mm open-end spanner.
6 Remove gasket 2 and insert 3.

Cleaning of purge valve

In case of a contaminated or blocked purge valve. Disassemble the valve as described in the previous section. Rinse or replace parts 2,3 and 5. Subsequently re-assemble the valve again.

The parts can be cleaned as described below. Depending on the type of impurities we recommend the following procedure:

1. All solvent resistant parts can be cleaned by putting them in a beaker with methanol in an ultrasonic bath for 10 min.
2. Clean with scouring powder and cloth. and/or
3. If the valve needle is corroded, replace it with a new one.
4. Check if the holes in the valve body are clean, if necessary blow through the holes with clean compressed air.
5. Finally rinse the parts free of any particles with distilled water.
6. Assemble valve as described in the following section.

Assembling the purge valve

To assemble the purge valve execute the following steps:

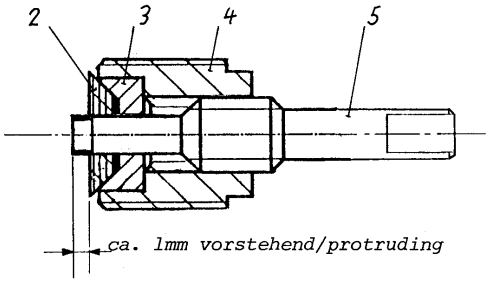


Fig. 8. Preparing subassembly of the parts 2-5 of the purge valve.

1 Assemble parts 2-5 as shown in Fig. 8. The tip of cock shaft 5 should protrude about 1mm.
2 Screw this subassembly (Fig. 8) into the valve body, and tighten moderately with 10mm open-end spanner.
3 Tightening will narrow the hole in the plastic gasket (2), preventing self-misalignment of the knob position. Moreover, when the purge valve is in “open” position, solvent cannot leak in direction of the knob. Make sure knob is fairly stiff to turn.
4 Screw in shaft 5 fully.
5 Put on cock nut 6 and screw down fully. Tighten gently with knob wrench.
6 Put on knob, tighten grub 8 and check for moderate stiffness of movement.

Replacement of the complete purge valve

To replace the complete purge valve completely execute the following steps:

1 On main board disconnect cable connector P 19.
2 Detach capillary connections (1/4" wrench).
3 Remove the 2 screws fixing the purge valve in the front panel of the LC 100 and take out the valve from the front side.
4 Install new purge valve.
5 Carry out a pressure calibration & adjustment as described in the test and adjustment section.

Motor/gear block

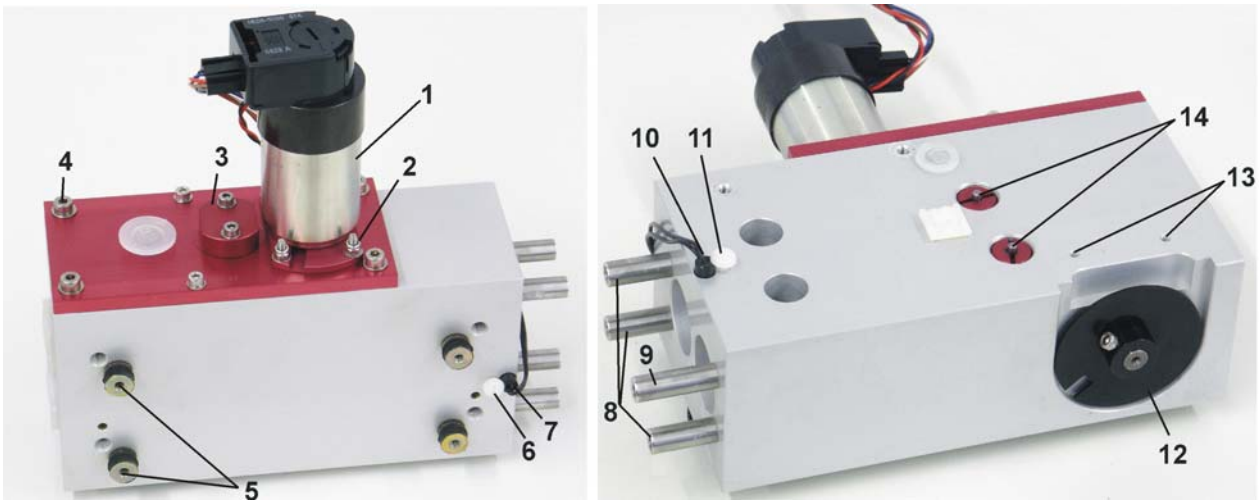


Fig. 9. *Motor/gear block. Left-side: bottom view, Right-side: top view. Note: motor assembly shown in example picture is a different model as used in the LC 100 pump.*

1. Motor assembly with pulse generator.
2. 4 fixing nuts for motor
3. Bearing plate for spur wheel attached with 2 screws
4. 6 fixing screws for gear cover.
5. 4 rubber buffers with female threads to receive the fixing screws.
6. Thread for fixing screw of reed contact embedded in hole 7
7. Hole for lower reed contact for pump head identification.
8. Shorter fixing bolts for pump head.
9. Longer fixing bolt for pump head. This bolt is placed on the right top side.
10. Hole for upper reed contact, as 7.
11. Thread for fixing screw, as 6.
12. Position disc indicating position of cam.
13. Thread for fixing the marker board containing opto-couplers for disc 13. For adjustment see procedure at the end of the manual.
14. Gear adjustment screws.

Replacement of the motor/gear block

To replace the complete motor/gear block execute the following steps:

1 Detach all cable connections going away from the motor/gear block, excepted the connection from the marker PCB.
2 Mark with a pencil on the gear block the exact position of the marker PCB.
3 Disengage Take the cable from its holder and lay the board outside the instrument.
4 Undo Remove the screws of the 2 ground/earth connections.
5 Lay the instrument on its side and remove the 4 fixing screws in the bottom panel. While undoing the screws hold the gear block and remove it.

Replacement of motor only

To replace the motor only remove the four nuts (2 inFig. 9) and take off motor (
Fig. 10).

Fig. 10. *Motor of LC 100.*

1 Motor control connection
2 cable from pulse generator connect to F/V convertor board.
3 O-ring.

During installation or fitting a new motor pay attention to ply between motor pinion and spur wheel during alignment (to minimize noise). See 4 and 5 in Fig. 11.

Construction and arrangement of gearbox

Function and construction of the drive mechanism are shown in Fig. 12. The motor drive is transmitted from the motor pinion 4 via the spur wheel with pinion 5 to wheel 17 which is firmly attached to the camshaft. The excentrical cams transmit their kinetic energy via the supporting rolls 12 to the ram assembly 11 and the piston(s). The roll 19 is entered into the groove 22 and belongs to the compression device 18...21. It prevents the ram bolt from rotating and/or from tumbling which would cause excessive wear of cam and supporting rolls.

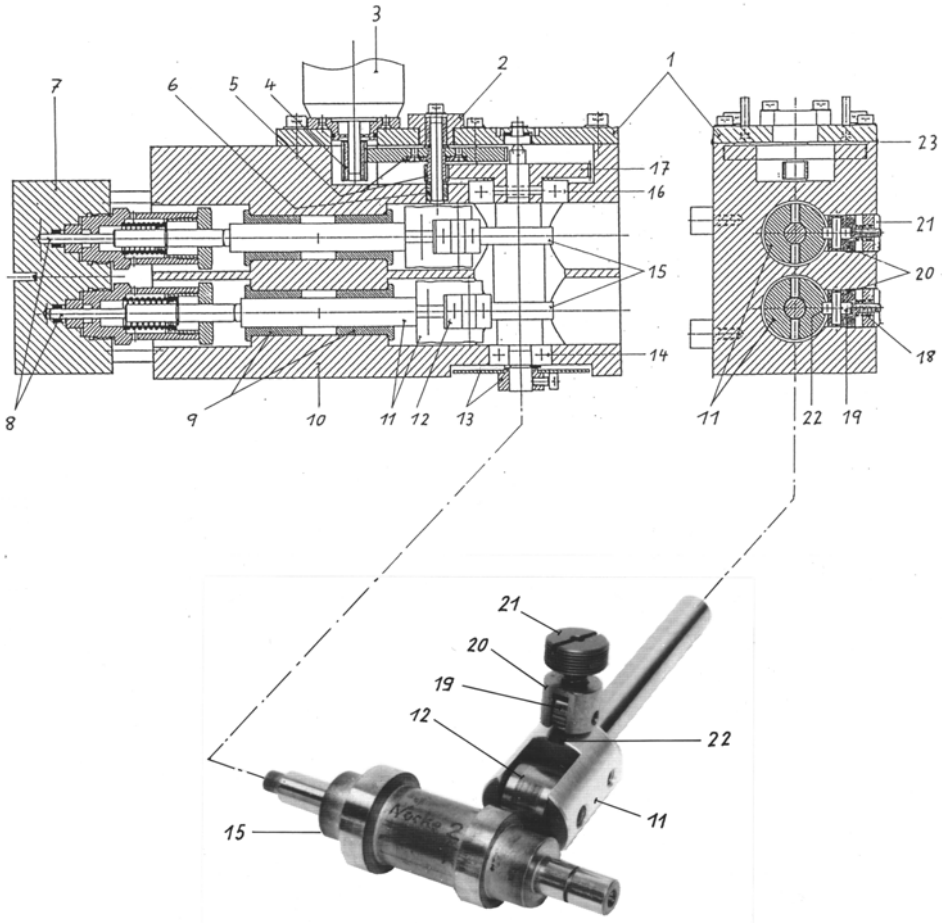


Fig. 11. *Construction of LC 100 gear box.*

To avoid leakage, the contact surfaces of the cover plate 1 and gear body are sealed by means of a sealing compound. Note: if the cover plate 1 of Fig. 11 must be removed take away the old sealing compound and put new one. When fastening the screws take care of the play between motor pinion and spur wheel (5).

Identification of parts of gearbox in Fig. 11:

1 Cover plate for gear, fixed with 6 screws; its position is adjusted, the joints are sealed (23). Do not loosen screws unless required, only!
2 Bearing plate for spur wheel (5).
3 Motor.
4 Pinion (cannot be detached from motor).
5 Spur wheel with pinion.
6 Counter bearing for spur wheel (5).
7 Pump head (see instructions for use).
8 Piston system (see instructions for use).
9 Ram guide (bronze bearing).
10 Aluminium body.
11 Ram assembly with supporting roll (12).
12 Supporting roll for (11).
13 Position disk &transmits the position of the cam or piston, respectively).
14 Ball bearing for camshaft.
15 Camshaft.
16 Ball bearing for camshaft.
17 Gear wheel attached to camshaft.
18 Compression spring.
19 Guide roller.
20 Forked bolt for guide roller.
21 Red setting screw, adjusted at works only.
22 Guide groove for roller (19).
23 Sealing compound “Dow Corning” (prevents leakage of lubricants).

In normal operation, gear and piston drive system are not subject to wear. With the exception of replacement of motor with pinion, field repairs can be troublesome. We therefore strongly recommend to replace a complete block according to the instruction.

Lubrication

The gearbox is self lubricating. Further greasing is not necessary.

With newer instruments it can happen in certain cases that oil leaks at the pump head or inside the unit at the gearbox. It is excess oil or fat which liquefied when the instrument was warming up during operation. We recommend to remove the escaped oil with a cloth. The pressure inside the gearbox will reduce automatically and thus leakage will be hold off. At works gear and moving parts are greased with OKS 418 (viscous fat).

Severe noise produced by motor gear

If the motor drive is producing severe noise during operation. Optimise position of bearing plate (3 in Fig. 9). Loosen the 2 screws, find suitable position and re-tighten the screws.

Pump head

Exploded view of pump head

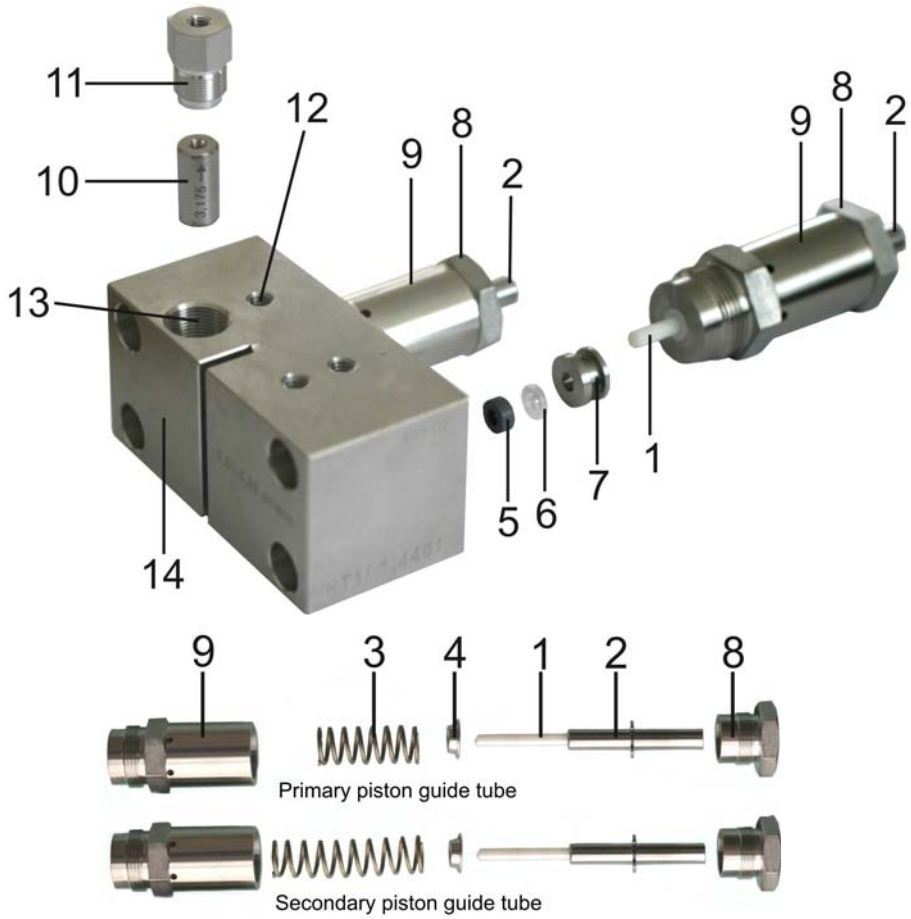


Fig. 12. Exploded view of piston guide tube and pump head.

1. Piston
2. Piston shaft
3. Spring
4. Spring plate
5. Piston seal
6. Sapphire support ring
7. Piston guide piece /flushing tube

8. Piston cartridge screw
9. Piston cartridge
10. Check valve
11. Valve setting screw
12. Inlet for piston wash solvents
13. Check valve seat
14. Pump head body

Check valves

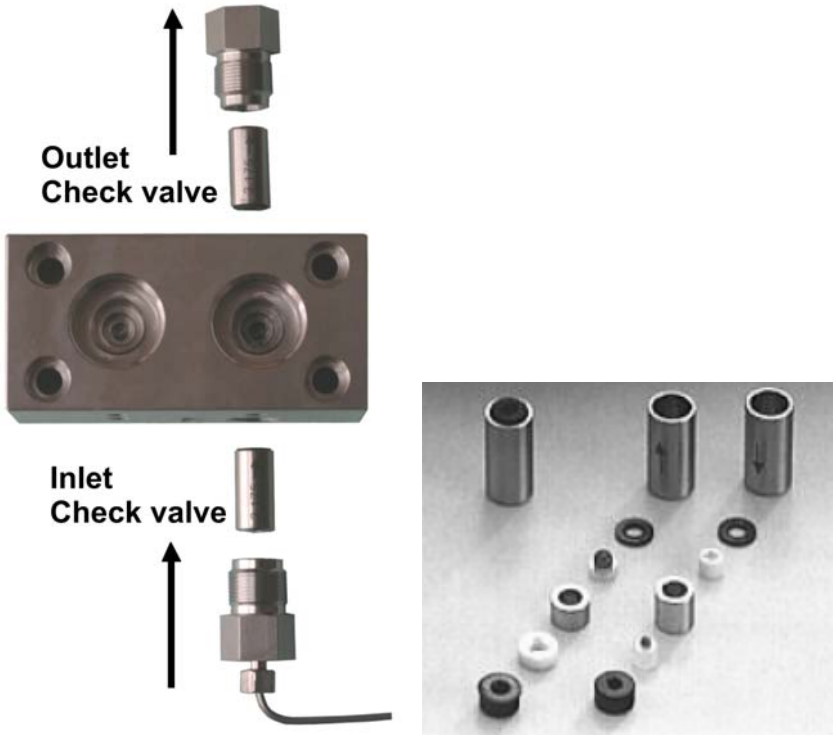


Fig. 13. Exploded view of pump head and check valves. Note the arrows on the check valves should point the direction as indicated.

Piston wash assembly, analytical

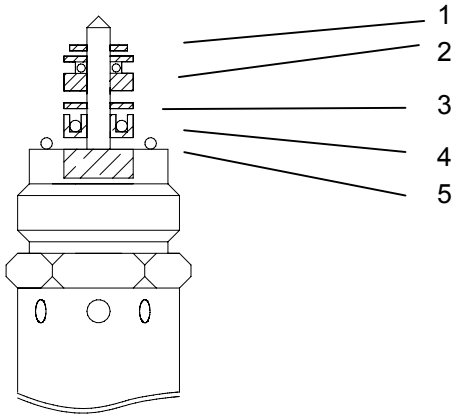


Fig. 14. Piston wash assembly, analytical

1. Sapphire support ring 1/8"
2. Flushing tube 1/8"
3. Kel-F ring 1/8"
4. Piston seal for piston wash 1/8"
5. O-ring

Piston wash assembly, micro

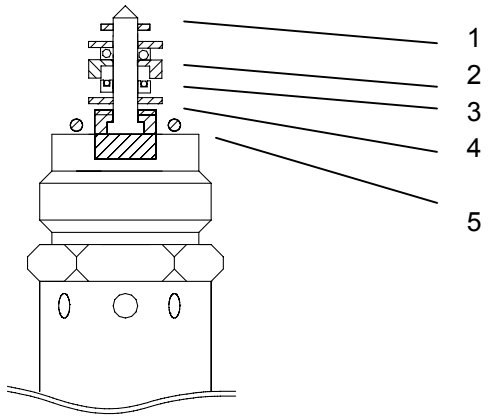


Fig. 15. Piston wash assembly, micro

1. Sapphire support ring 1/16"
2. Flushing tube 1/16"
3. Piston seal for piston wash 1/16"
4. Teflon ring 1/16"
5. O-ring

C H A P T E R 5

Test instructions

Set-up & preparation

To perform all tests and adjustments the following set-up is required:

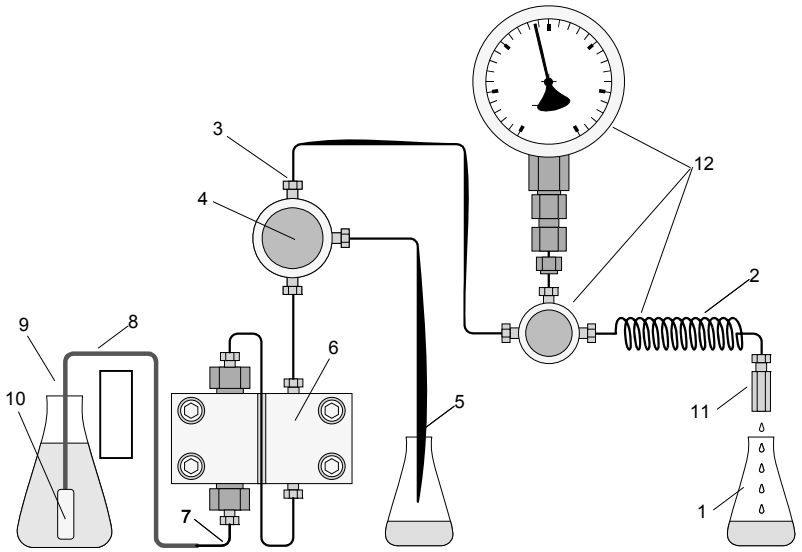


Fig. 16. Schematic representation of the test and calibration set-up

1	Calibrated flow meter or graduated analytical pipette (5mL)
2	Restriction capillary PEEK 1/16" OD, 0.005" ID, (pressure > 100 bar)
3	High pressure outlet
4	Purge valve
5	Outlet capillary
6	Pump head
7	Aspirating capillary
8	0.2 µm inline filter, aqueous
9	Teflon/FEP tubing with
10	Vessel with well- degassed HPLC-grade water
11	Stopper (low-dead union & plug)
12	High pressure gauge
13	RS232 cable (182.0544) and LC 100 service program (software)

For a complete listing of all necessary tools see chapter 1.

Use the following pump settings:

1. Set min. pressure (Pmin) to 00.0 MPa.
2. Set max. pressure (Pmax) to 30.0 MPa (30.0 MPa = 300 bar).
3. Set kappa value to κ = 45

Make sure that you perform all adjustments with a pump head which is in optimal condition. Check if the pump head is not leaking and make sure that the check valves are closing properly. Take into account that after installation of new seals, the new seals need to set themselves. In that case the pump always has to stabilize for at least 30 minutes at a flow rate of 1 mL/min (200µL/min in case of micro pump head) and a high system pressure (150 - 200 bar) .

Use properly degassed HPLC-grade water. Make sure that the pump head is purged sufficiently and that the suction line is air-bubble free. If the pump does not prime by itself, use a syringe to draw solvent through the outlet capillary of the purge valve.

Make sure that the restriction capillary in the set-up has such dimensions that the back pressure of the test set-up is at least 100 bar at the given flow rates in the flow adjustment section.

All tests in the adjustment and test instructions are based on a LC 100 with analytical pump head. In case of a LC 100 with micro pump head all flow rates mentioned in the tests should be changed accordingly. The flow rate of the micro head should correspond to the same flow rate in % FS as the analytical pump head.

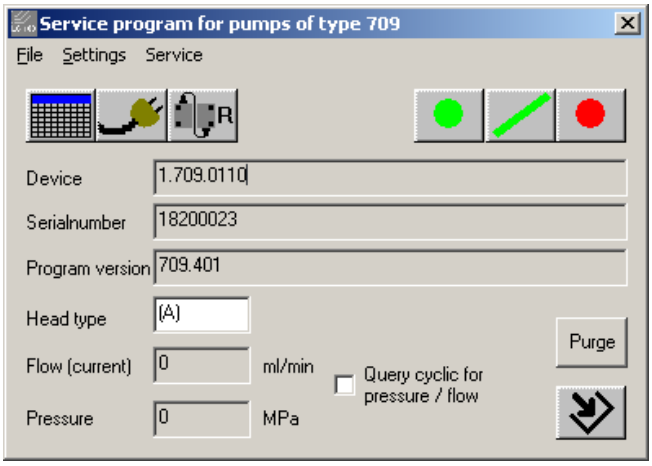
Max. flow rate LC 100 analytical = 5 mL/min
Max. flow rate LC 100 micro = 0.999 mL/min

So for a LC 100 analytical a flow rate of 1 mL/min corresponds 20 % FS.
20 % FS for a LC 100 micro corresponds to 200 µL/min .

Service program

All electronic adjustments and a part of the hardware tests are performed digitally by means of a PC software interface. The so called LC 100 service program. To install this service software perform the following steps:

1. Download LC 100 service software from the Antec distributor support site (www.antecleyden.com).
2. Install software on a PC with the Windows 98/ME/2000/XP OS.
3. Connect LC 100 pump directly to a free COM port on the PC using the supplied RS232 cable.
4. Switch on the LC 100 pump.
5. Start the LC 100 service program. The program will automatically detect any available LC 100 pump and will start-up with the window shown below.



6. If no communication could be established. Push <  > and specify COM port and the correct baud rate (9600). Do **not** activate cyclic pressure check at this moment.

The service mode (calibration routines and settings) in the software is password protected. To access the service mode use the password:

ANL2382

Do NOT perform any adjustments if the deviations (flow rate deviation and residual pressure pulsations) are within the specified tolerances.

Visual inspection

1. Switch off the instrument before removing the mains cable.
2. Check the outer condition of the instrument:
   - Check the outer parts of the instrument for visual damage.
   - Check completeness of all parts.
   - If necessary, clean with soap-water and a moist wiping cloth. Do not use any other solvents to clean the outer surface
3. Check the inner condition of the instrument:
   - Open the instrument and check the general condition.
   - Are there any damaged or loose parts visible?
   - Is there any sign of liquid in the instrument?
   - Check the micro-fuses F1 and F2 on the main board (2x 1.0AT).
4. Close the instrument.

LED display test

1. Start the LC 100 service program (see page 33 of this manual).
2. To start the display test select "Display" in the "Service --> Test program" menu.
3. Click "OK" in pop-up window

   - The display shows the start-up test pattern for about 3 s and all the 6 LED's come on.

     8.8.8.8.8.8

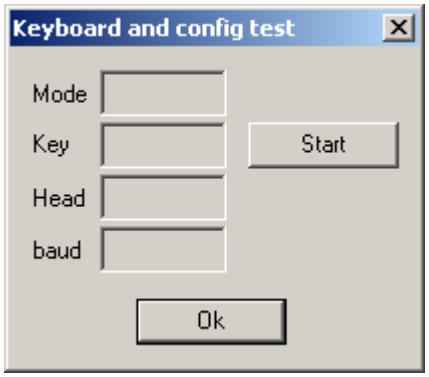
   - The display shows for about 3 s the number of the program installed:

     4 0 1

4. If instrument fails test please contact the manufacturer.

Keyboard test

1. Start the LC 100 service program (see page 33 of this manual).
2. To start the keyboard test select "Keyboard" in the "Service --> Test program" menu.



3. Press "Start".
4. Press <Run/Stop>. On the right-side of the display a 1 will appear.

1	1

5. Press <SELECT>. On the right-side of the display a 2 will appear.

1	2

6. Press < ↓ >.

1	3

7. Press < ↑ >

1	4

8. Press <EXT>

1	5

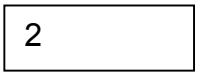
9. Press <PURGE>

1	6

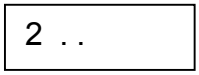
10. If instrument fails test please contact the manufacturer.

RS232 interface test

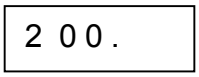
1. Switch off the instrument
2. Insert RS232 test plug at rear panel of LC 100
3. Set selector switch at rear panel to “RS232”
4. Press <SELECT> (keep pressed) and switch power on:

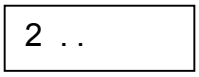
5. Release <SELECT> now:

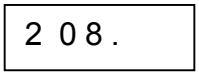
   

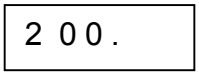
6. The test runs automatically and checks several functions in succession. After successful completion the following screen is shown:

   If one of the tests generate an error the “2 00” screen is not shown directly, but an error code is shown for a short time period. If for instance no test plug is connected the following screens will appear:

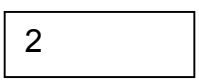
   

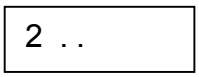
7. If instrument fails test please contact the manufacturer.

Current loop test

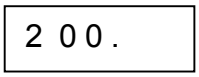
1. Switch off the instrument
2. Insert RS232 and current loop test plug at rear panel of LC 100
3. Set selector switch at rear panel to “Current loop”
4. Press <SELECT> (keep pressed) and switch power on:

5. Release <SELECT> now:



6. The test runs automatically and checks several functions in succession. After successful completion the following screen is shown:

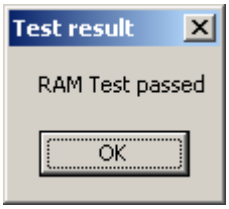


If one of the tests generate an error the “2 00” screen is not shown directly, but an error code is shown for a short time period.

8. If instrument fails test please contact the manufacturer.

RAM test

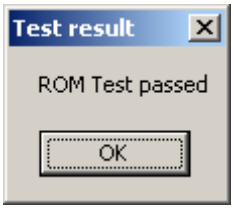
1. Start the LC 100 service program (see page 33 of this manual).
2. To start test select "RAM" in the "Service-->Test program" menu.
3. If RAM test was successful the following pop-up window will appear.



4. If instrument fails test please contact the manufacturer.

ROM test

1. Start the LC 100 service program (see page 33 of this manual).
2. To start test select "ROM" in the "Service --> Test program" menu.
3. If RAM test was successful the following pop-up window will appear.



4. If instrument fails test please contact the manufacturer.

Pressure stability test

For the pressure and flow rate tests in the following paragraphs the test set-up as described in the first paragraph of this chapter is required (*Fig. 16*). Please refer to this section for details about this set-up.

1. Run the pump at a low flow rate of 1.0 mL/min.
2. Firmly tighten the outlet of the restriction capillary by means of the stopper (low-dead union with plug).
3. Press <Run/Stop> button to actuate the pump.
   - In this particular test set-up the upper pressure value at which the safety shutdown is activated is greatly depending on the position of the piston; i.e. the shutdown can occur between 30 ... 50 MPa.
   - After a safety shutdown the high pressure may sometimes slightly push back the piston. The pressure indicated by the gauge may therefore slightly decrease after shut down. However, it must remain more or less stable.
   - With the <Select> button set display to P_{actual}
4. Read the actual pressure at the LC 100 display or the high pressure gauge when available.
5. After 5 minutes read the pressure value from the LED display or high pressure gauge again. Decrease of pressure within 5 minutes must not exceed 1 MPa = 10 bar.
6. If instrument fails test check the pump head (seals, pistons, check valvesetc).

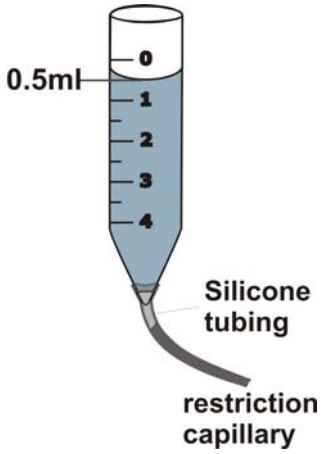
Pressure transducer check

1. Connect voltmeter or line-recorder to the analogue pressure monitor on the rear panel of the pump.
2. Run the pump at a flow rate of 1 mL/min,
3. Select „Pactual“ to show the shows the actual pressure value in the LED display.
4. Compare the displayed value with the reading on the high pressure valve. The difference must be smaller than +/- 5%.
5. Compare the Pressure monitor output (1mV =1MPa) with the reading at the high pressure gauge. The difference must be smaller than +/- 5%.
6. Open purge valve.
7. Check the pressure zero value at the LCD display 00.0 MPa. Tolerance.: +/- 0.1 Digit.

8. Check the pressure zero value at the Pressure monitor output. Tolerance.: +/- 0.1 mV.
9. If instrument fails test please consult the adjustments section.

Flow rate check

1. Set the flow rate to 1 mL/min and check if purge valve is closed.
2. Connect the inlet of the graduated analytical pipette to the outlet of the restriction capillary using a short piece of silicon tubing (see figure 17). Or connect the restriction capillary to a calibrated flow meter.
3. Press <Run/Stop> to start the pump.



Correct volume reading from the pipette is at the lowest point of the meniscus.

Fig. 17. Flow measurement with graduated 5 mL pipette.

4. Measure the flow rate with the pipette using the following procedure: start the stopwatch exactly at the moment that the liquid meniscus in the pipette passes the 4 mL line (for a good reading it is important that the pipette is kept perfectly vertical).
5. Stop the flow rate exactly at the moment that the liquid meniscus in the pipette passes the 0 mL line.
6. Calculate the actual flow rate. Flow rate = 4 mL/ stopwatch time (min). In case of using a calibrated flow meter complete 5 flow meter readings and calculate the average. Subsequently calculate the flow deviation:

$$\text{Flow deviation \%} = \frac{(\text{actual flowrate} - \text{set flow rate})}{\text{set flow rate}} * 100$$

The flow deviation should be smaller than +/- 3%.

7. Repeat this experiment at 2 mL/min.
8. Also at a flow rate of 2 mL/min the flow deviation should be smaller than +/- 3%.

Check residual pressure pulsations

1. Connect AC 100 (controlled by ALEXYS software) or line-recorder to the analogue pressure monitor (1mV/MPa) to monitor the pump pressure .
2. Set the compressibility Kappa to 45.
3. Set TIME CONST. to HIGH (2s).
4. Set the flow rate to 1 mL/min.
5. Press <R/S> to start the pump.
6. Record the pressure signal for 10 minutes via the pressure monitor output at 1 mL/min.
7. After 10 minutes stop the flow and record the pressure signal for 5 more minutes to determine the pressure at 0 mL/min.

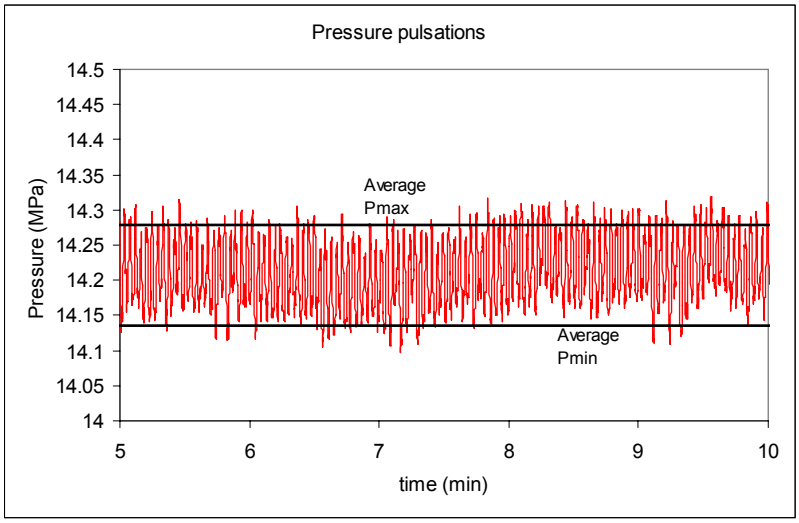


Fig. 18. Pressure signal with lines indicating Pmax and Pmin.

8. When using a line recorder determine the average maximum and minimum pressure values at 1 mL/min, as depicted in figure 18. . Draw straight parallel lines through minimum and maximum. Subsequently, determine c (c = Pmax-Pmin).

When recording a pressure profile with the AC 100, export the data to excel, and determine the average pressure signal at 0 and 1 mL/min, and the standard deviation σ of the pressure signal at 1 mL/min. Use the standard deviation to calculate c ($c=4\sigma$).

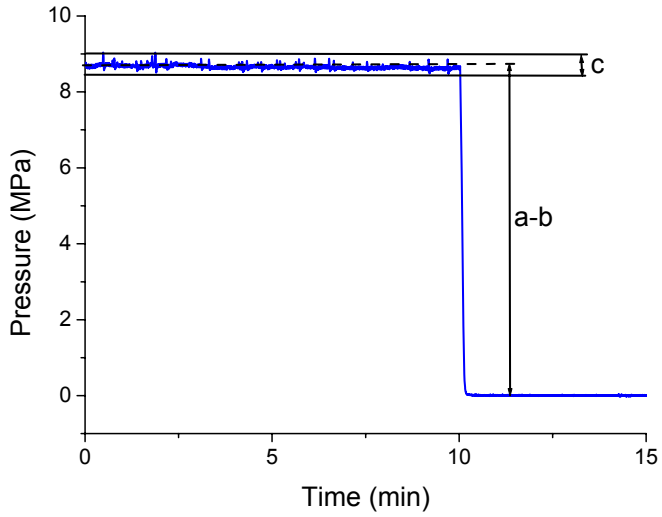


Fig 19. Calculation of pressure pulsations %P.

9. Calculate the residual pressure pulsations in the following way (see figure 19):

$$\%P = \frac{c}{(a-b)} * 100$$

Where:

c = Pmax - Pmin (MPa) *or* 4σ .

a-b = Actual system pressure (average pressure at 1 mL/min - average pressure at 0 mL/min)

Pressure pulsations %P must be smaller than < 3%.

10. If instrument fails test please consult the adjustment section.

C H A P T E R 5

Adjustment instruction

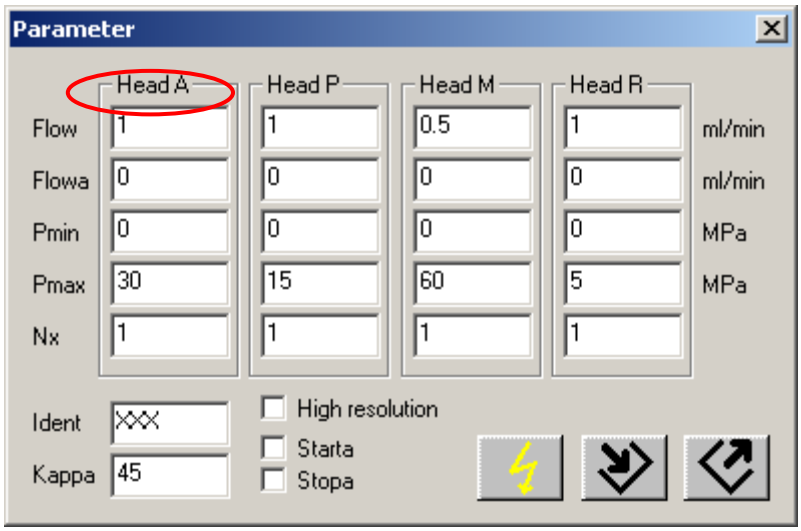
To perform all adjustments in this section a test set-up as described in the first paragraph of the test instruction is required (figure 17). Please refer to this section for details about this set-up.

All electronic adjustments are performed digitally by means of the LC 100 service program. Please refer to page 33 of this manual for software installation instructions.

Use the following initial pump settings:

1. Set the LC 100 'Time constant switch on the rear panel to 'Low'.
2. Set min. pressure (Pmin) to 00.0 MPa.
3. Set max. pressure (Pmax) to 30.0 MPa (30.0 MPa = 300 bar).
4. Set kappa value to κ = 45
5. Flow correction factor Nx = 1.00.
6. Flow rate to 1 or 2 mL/min (or 200/ 400 µL/min for micro head).

The pump settings (2 - 5) should be set in the parameter window. To enter the parameter window click the <  > button.



Make sure that the settings are entered in the corresponding column. In the case of an analytical pump head us the column "Head A" . For the micro pump us the column "head M".

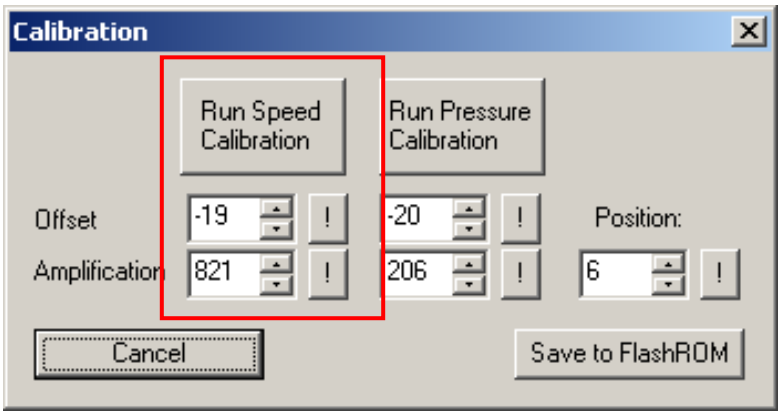
After entering the correct values send parameters to the LC 100 pump by pushing <  >.

Do not perform any adjustments in case that the observed deviation are within specifications/tolerances. Have the instrument running for at least 5 minutes before starting with any of the adjustment instructions.

Software calibration of motor

To calibrate the motor speed follow the procedure below.

1. If pump head is installed, open the purge valve and place a vessel below the purge capillary. No back pressure is allowed during this procedure.
2. Goto menu <Service> --> <Calibration>.



3. Push <Run Speed Calibration> to start the calibration procedure.
4. The adjustment procedure will proceed completely automatic and takes about 1 Minute.
5. If the adjustment was successful a "Calibration OK" window will appear.
1. Save new settings to LC 100 Flash ROM memory.

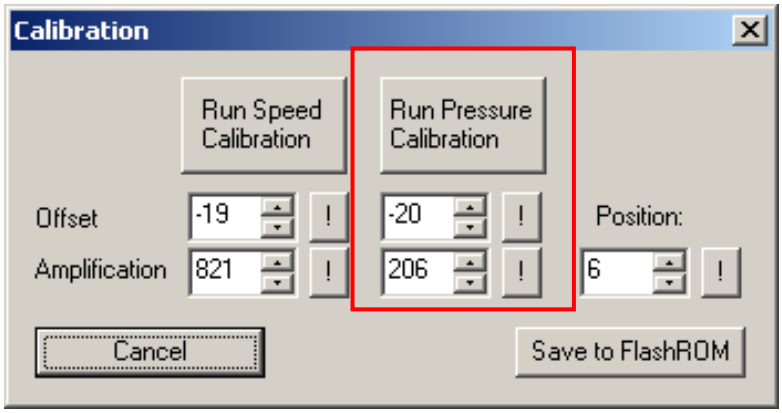
The values for the Offset and Amplification parameters should fall within the following ranges:

Offset: -128 to +128,
Amplification: 500 to 2000.

Adjustment of Pressure sensor reading

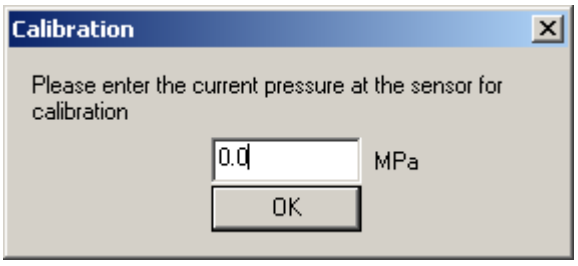
To calibrate the pressure sensor reading execute the following procedure:

2. Prepare the instrument as described at the beginning of this chapter.
3. Switch on the Query for cyclic pressure flow check in the LC 100 service progam main screen.
4. Goto to the parameter window, and set the maximum allowed pressure (Pmax) to **29 MPa**.
5. Apply Pmax setting by pushing < > button.
6. Goto menu <Service> --> <Calibration>.



Offset adjustment (at 0 MPa)

7. Open the purge valve. The pressure on the external pressure meter should show 0 MPa / 0 bar.
8. Push <Run Pressure calibration> to start the calibration procedure.
9. Type in 0.0 MPa in the pop-up window.

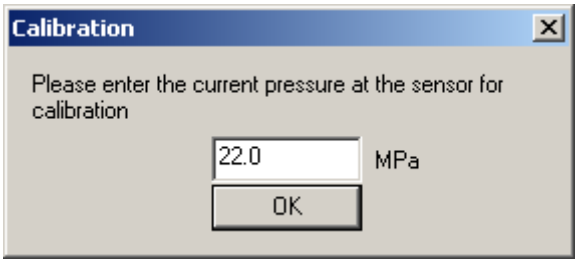


10. Start the procedure by clicking OK. The procedure is automatic and takes between 30 - 60 s, during that period a LED is blinking.

11. If the adjustment was successful a "Calibration OK" window will appear.
12. Close Calibration window to return to the main screen.

Amplification adjustment (at pressure > 10MPa/100 bar)

13. Close the restriction capillary using an end cap/stopper.
14. Close the purge valve.
15. Start the pump (use button with green circle).
16. Stop the pump when the pressure reaches a value between 18 - 25 MPa (use button with red circle).
17. Goto menu <Service> --> <Calibration>.
18. Push <Run Pressure calibration> to start the calibration procedure.
19. Wait until the pressure on the external manometer is stable.
20. Read the pressure of external manometer and type value in the pop-up window (for example 22 MPa).



21. Start the procedure by clicking OK. The procedure is automatic and takes between 30 - 60 s, during that period a LED is blinking.
22. If the adjustment was successful a "Calibration OK" window will appear.
23. Save new settings to LC 100 Flash ROM memory.
24. Close Calibration window to return to the main screen.

Check of analogue pressure monitor output

25. Connect voltmeter or recorder to the pressure monitor output (1 mV/1Mpa), make sure that dipswitch TIME CONST is switched to position low.
26. Check if voltage reading of the voltmeter corresponds with pressure value on the external manometer.
27. Open purge valve and make sure that the external manometer pressure is 0.0 MPa.
28. Check if voltage reading of the voltmeter is 0.0 mV.

Flow rate adjustment

Only re-adjust the flow electronically in case:

[1] The following hardware is replaced: main board, marker PCB, motor and gearing.

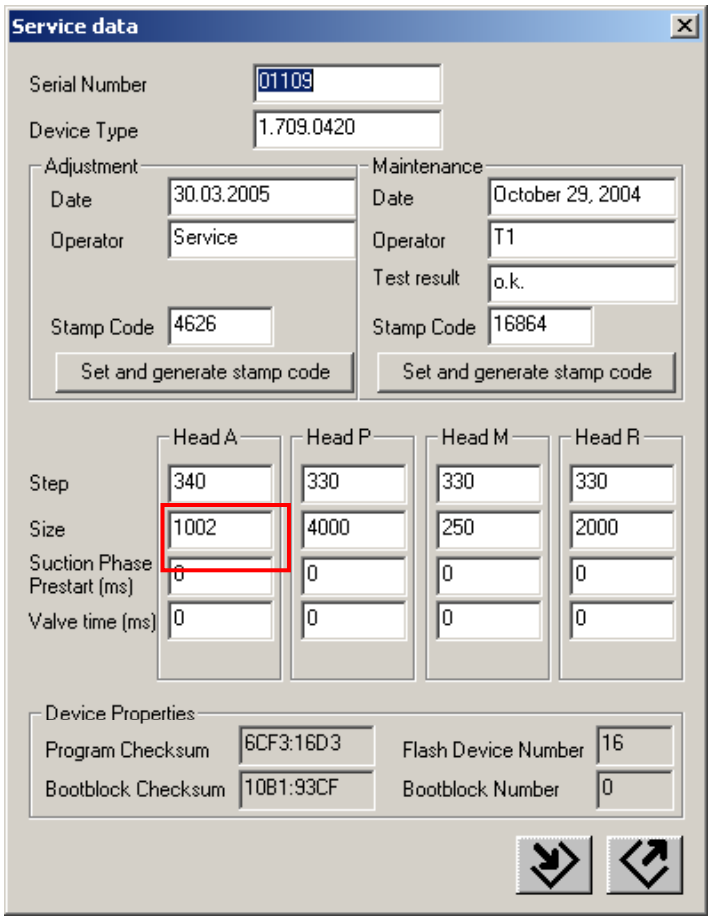
[2] When the absolute flow rate deviation exceeds +/- 3% (flow deviation measured with the software flow correction factor Nx set to 1.00)

For flow rate adjustments execute the following procedure:

1. Set flow correction factor Nx (do not confuse with flow rate!) to 1.00. See the preparation section on page 43 at the beginning of this chapter.
2. Check if the purge valve is close and the pump head is primed properly.
3. Set flow rate to 1 ml/min.
4. Start the pump (use the button with green circle).
5. Measure the flow rate at 1 mL/min as described in the section "flow rate check" in the previous chapter.
6. If the flow deviation is more than +/- 3% please check first if the pump head is operating properly. (Check valves, tubing and for signs of leakage).
7. If pump head is not operating properly, service the pump head and let the pump run for at least half an hour at a system pressure of 15 - 20 MPa. Subsequently, repeat the flow rate deviation test again.
8. If pump head is okay and the flow deviation is still more than +/- 3% continue with the adjustment procedure.
9. Goto menu <Service> --> <Parameter>.

10. Flow rate calibration is achieved by means of adjustment of the size parameter. Size value typically in the range between 200 - 5000 for the different pump heads. Increasing the size value will result in a lower flow rate. Lowering the value will increase the flow rate.

    Default values: Head A = 1000, Head M = 250



11. Change the size value until the actual flow rate is 1.00 mL/min. To apply new setting press < > button after changing the size value.
12. Set flow rate to 2 mL/min. And follow the same procedure as described in step 11 until the actual flow rate is 2.00 mL/min.
13. Take the average of the size value obtained at 1.00 mL/min and 2.00 mL/min (so $(Size_{1mL/min} + Size_{2mL/min})/2$) and use this as the final setting.
14. Recheck the actual flow rate at 1 and 2 mL/min as described in the section "flow rate check" in the previous chapter.
15. If the flow rate deviation is still more than +/- 3%, repeat step 6 - 14.

Marker board adjustment

The marker board is off factory aligned correctly. Only adjust the marker bord in case:

[1] Motor or gearbox is replaced.
[2] The pressure fluctuations under specified test conditions exceeds 3%.

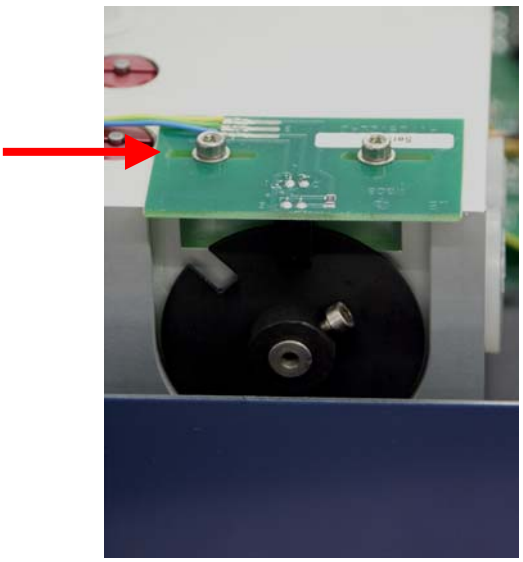


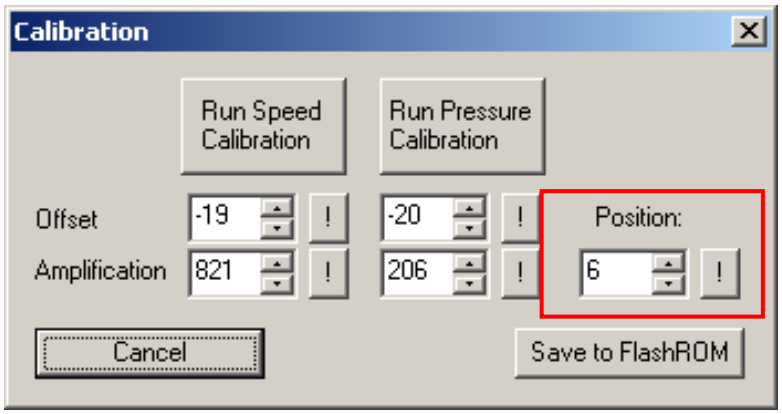
Fig. 20. Adjustment of marker PCB..

In order to minimize pressure pulsations follow the procedure below:

Only perform point [1] and [2] below, when the gearbox was replaced.

1. Remove cover of LC 100 (4 screws) and check the position of the marker board. The marker board should be positioned as far as possible to the back of the pump (direction of the red arrow).
2. If necessary un-tighten the two retaining screws a little to move the board to the correct position.
3. Connect an AC 100 (controlled by ALEXYS software) or line-recorder to the analogue pressure monitor (1mV/MPa) to monitor the pump pressure.
4. Set kappa κ = 45.
5. Set TIME CONST. to LOW (20 ms).

6. Set flow rate to 0.2-0.3 mL/min and make sure that the back pressure P > 100 bar. If the pressure is too low increase the flow rate accordingly (in case P> 175 bar reduce flow rate).
7. Let pump run for at least 5 minutes.
8. Goto menu <Service> --> <Calibration>.



9. Change the parameter <Position> step-by-step to optimize/minimize the pressure pulsations. With the button [!] the parameter can be transferred to the memory of the pump. Please wait 30 seconds every time the Position parameter is changed to let the pump stabilize. Continue the variation of the <Position> parameter until the minimal P amplitude is found.

The value for the marker board position parameter should fall within -50 to + 50

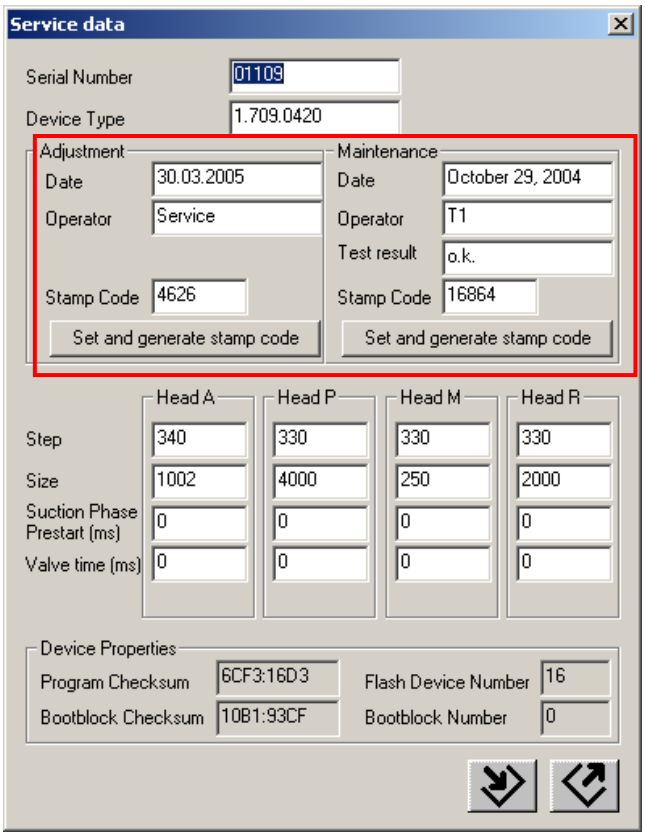
10. Save new settings to LC 100 Flash ROM memory.

Generation of Calibration & Service stamp code

In the LC 100 service program the possibility exists to sign off LC 100 calibration & maintenance sessions. Unique time stamps will be generated for identification and stored in non-volatile memory of the LC 100 for reference for service engineers. When changing any calibration parameter, in the <service> <calibration> screen, any existing previous calibration stamp code will be automatically set to default (0).

To generate new stamp codes follow the procedure below:

1. Go to the <Service> <parameter> menu.



2. Enter the calibration or maintenance date.
3. Enter the name of the operator/service engineer.
4. Save the new data with <Set and generate new stamp code>
5. Confirm changes with <yes> in pop-up window.
6. New Stamp code will be displayed in Stamp code box and saved into non-volatile memory of the LC 100 pump.

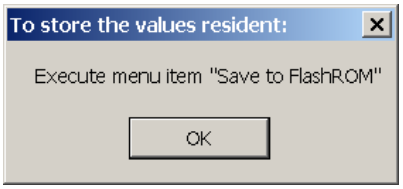
RAM reset

In rare occasions large disturbing electrical signals (e.g. mains spikes, lightning etc.) can have a severe effect on the processor functions and hence lead to a system crash. After such a crash the RAM area must be initialized.

The RAM initialization will erase all stored user data (flow rate, Pmin, Pmax, kappa etc.) . So before performing a RAM initialization write down all user settings. Service and calibration data are not erased during this procedure.

To perform a RAM reset execute the following steps:

1. Start the LC 100 service program. If no automatic RS232 connection is established with the pump consult page 33 of this manual.
2. Click menu <Service> <Set defaults>.



3. Save data to FlashROM by pushing <OK>.
4. The instrument is now reinitialized with the factory default settings and is ready for use again.

C H A P T E R 6

List of accessories

Recommended spare parts

Below a selection of the most important wear and tear parts of the LC 100 pump head are listed:

LC 100 pump, analytical (182.0035):

Part no.	Description
182.0312	Piston spring analytical (sec.)
182.0318	Piston spring micro & analytical (prim.)
182.0346	Zirconium piston 1/8"
182.0348	Sapphire support ring for piston 1/8"
182.0350	Piston seal for 1/8"
182.0352	Check valve cartridge 1/8" (inlet)
182.0354	Check valve cartridge 1/8" (outlet)
182.0364	O-ring for washing unit an. or micr.
182.0368	S-link capillary pump head
182.0382	Piston wash assembly, analytical

LC 100 pump, micro (182.0036):

Part no.	Description
182.0318	Piston spring micro & analytical (prim.)
182.0320	Zirkonium piston 1/16"
182.0322	Sapphire support ring for piston 1/16"
182.0324	Piston seal 1/16"
182.0326	Check valve cartridge 1/16" (inlet)
182.0328	Check valve cartridge 1/16" (outlet)
182.0364	O-ring for washing unit an. or micr.
182.0384	Piston wash assembly, micro
182.0368	S-link capillary pump head

All LC 100 accessories

List of all LC 100 accessories available:

Part no.	Description
182.0200	LC 100 ship kit
182.0302	Pump head body microbore
182.0304	Piston system microbore, complete,p,s
182.0306	Piston guide piece 1/16"
182.0308	Piston cartridge screw
182.0310	Seeger circlip ring for piston 1/8", 1/16"
182.0312	Piston spring analytical (sec.)
182.0314	Piston cartridge
182.0316	Spring plate for sapphire piston
182.0318	Piston spring micro & analytical (prim.)
182.0320	Zirkonium piston 1/16"
182.0322	Sapphire support ring for piston 1/16"
182.0324	Piston seal 1/16"
182.0326	Check valve cartridge 1/16" (inlet)
182.0328	Check valve cartridge 1/16" (outlet)
182.0330	Piston seal for 1/16" for washing unit
182.0332	Kel-F ring for washing unit
182.0334	washing tube micro
182.0336	Pump head body analytical
182.0338	Piston system analytical, complete,pri
182.0340	Piston guide piece analytical
182.0342	Hexagon socket screw M5, 35 mm
182.0344	Piston system analytical, complete,sec
182.0346	Zirconium piston 1/8"
182.0348	Sapphire support ring for piston 1/8"
182.0350	Piston seal for 1/8"
182.0352	Check valve cartridge 1/8" (inlet)
182.0354	Check valve cartridge 1/8" (outlet)
182.0356	Inlet/outlet valve screw
182.0358	Piston seal 1/8" for washing unit
182.0360	Kel-F ring for washing unit
182.0362	washing tube analytical
182.0364	O-ring for washing unit an. or micr.
182.0366	Capillary inlet ID 1.0 mm
182.0368	S-link capillary pump head, analytical

Part no.	Description
182.0380	Micro pump head
182.0382	Piston wash assembly,analytical
182.0384	Piston wash assembly,micro
182.0386	Hollow needle
182.0388	Silicone tubing
182.0400	Teflon tubing
182.0402	Stainless steel capillary 1.6 / 0.25mm
182.0404	Fitting screws
182.0406	Ferrules
182.0370	Valve screw with inlet capillary, 1/8"
182.0372	Capillary complete, pv - outlet, LC 100
182.0374	Capillary complete, pv - pump head, LC 100
182.0376	Purge valve w. pressure transducer, LC 100
182.0378	Analytical pump head
182.0408	Syringe
182.0410	PTFE tubing for piston wash assembly
182.0412	Screws for piston wash assembly
182.0414	Ferrules for piston wash assembly
182.0416	Piston seal 1/8", aqueous
182.0418	Piston seal 1/16", aqueous
182.0420	Piston wash seal 1/16", aqueous
182.0422	Piston wash seal 1/8", aqueous
182.0502	Tool for exchange of piston seals 1/16"
182.0504	Tool for exchange of piston seals 1/8"
182.0506	Motor for LC 100
182.0508	Motor with complete drive unit and camshaft
182.0510	Drive unit with gear and camshaft
182.0512	Main board for LC 100
182.0514	Display PCB for LC 100
182.0516	LC 100 - AC 100 top cover, Pantone 5405C
182.0518	LC 100 bottom cover, Pantone 5405C
182.0524	Wrench 1/4” – 5/16”
182.0526	Allen key 4mm/DIN 911
182.0528	Power cord EUR
182.0530	Power cord USA
182.0532	Fuse 0.25 AT (EUR)
182.0534	Fuse 0.5 AT (USA)
182.0536	Allen screws, pump head
182.0544	LC 100 serial cable, 9F-25F pins
182.0546	Shipping box