ÄKTA design

Pump P-960

User Manual

18-1172-73

Amersham Biosciences

Important user information

All users must read this entire manual to fully understand the safe use of Pump P-960.

WARNING!

The WARNING! sign highlights instructions that must be followed to avoid personal injury. Do not proceed until all stated conditions are clearly understood and met.

Caution!

The Caution! sign highlights instructions that must be followed to avoid damage to the product or other equipment. Do not proceed until all stated conditions are clearly understood and met.

Note

The Note sign is used to indicate information important for trouble-free and optimal use of the product.

CE certification

This product meets all requirements in applicable CE-directives. A copy of the corresponding Declaration of Conformity is available on request.

The **CE** symbol and corresponding declaration of conformity, is valid for the kit and instrument when:

- used as a stand-alone unit, or
- connected to other CE-marked Amersham Biosciences instruments, or
- connected to other products recommended or described in this manual, and
- used in the same state as it was delivered from Amersham Biosciences except for alterations described in this manual.

WARNING!

This is a Class A product. In a domestic environment this product might cause radio interference in which case the user might be required to take adequate measures.

Terms and Conditions of Sale

Unless otherwise agreed in writing, all goods and services are sold subject to the terms and conditions of sale of the company within the Amersham Biosciences group which supplies them. A copy of these terms and conditions is available on request.

Should you have any comments on this product, we will be pleased to receive them at:

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Trademarks

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About this manual

This manual comprises two parts; a practical part (sections 1–5) and a reference part (section 6). Sections 1–5 contain the necessary information for installing, operating and maintaining the instrument.

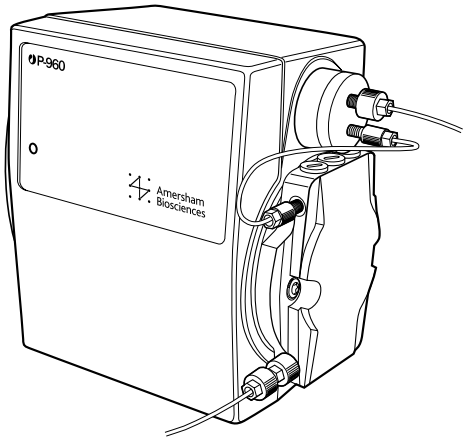
1 Introduction

1.1 General

Pump P-960 is a compact single-channel pump for use in liquid chromatography and other applications where constant flow rate is required. In ÄKTA™ design chromatography systems, it is used as a sample pump.

Pump P-960 features:

- Operating pressure up to 2.0 MPa (20 bar, 290 psi).
- Flow rates up to 50 ml/min.
- A pressure sensor connected to the pump outlet.
- Interface for connecting an air sensor directly to the pump.



Pump P-960 works with a wide range of columns and media supplied by Amersham Biosciences.

The pump is controlled from a PC running UNICORN™ control system, version 4.12 or later.

1.2 Safety

- The unit is designed for indoor use only.
- Do not use in a dusty atmosphere or close to spraying water.
- Do not block the outlet of the unit.

WARNING! HAZARDOUS CHEMICALS. When using hazardous chemicals, all suitable measures, such as wearing protective glasses, must be taken.

WARNING! CORROSIVE CHEMICALS. NaOH is corrosive and therefore dangerous to health. Avoid spillage and wear protective glasses.

WARNING! HAZARDOUS CHEMICALS. Incorrectly fitted tubing might loosen, causing a jet of liquid to spray out. This is especially dangerous if hazardous chemicals are being used. Connect the tubing by first inserting the tubing fully, then tightening the connector fingertight.

CAUTION! The mains power to the ÄKTAdesign chromatography system must be switched OFF before connecting the unit to the UniNet-2 link.

CAUTION! Always disconnect the UniNet-2 connectors before attempting to replace any item on the unit.

CAUTION! Before the start of each run, always ensure that there is an adequate supply of eluent in the reservoir. Avoid pumping without liquid, since this might affect the lifetime of the sealing parts in the pump.

2 Installation

2.1 Unpacking

Unpack the unit and check the items against the supplied packing list. Inspect the items for obvious damage that may have occurred during transportation.

Keep all packing materials if onward transport of the unit is expected.

CAUTION! Read the following information carefully to ensure that the unit is installed correctly.

2.2 General precautions

The unit should be installed in a non-corrosive atmosphere.

The unit should be located in a place of low temperature variations, away from heat sources, draught and direct sunlight.

The unit may be operated at normal ambient temperature in the range 4 °C to 40 °C.

2.3 Installing the pump

When installing P-960 as an accessory, refer to the *Optional Configurations User Manual* for detailed instructions on how to install the sample pump in your ÄKTAdesign system.

CAUTION! Make sure that the sample pump is installed and operated at an upright position.

2.4 Connecting UniNet-2 cables

Pump P-960 is controlled from a PC running UNICORN version 4.12 or higher via a UniNet-2 cable. Power is also supplied through this cable.

The UniNet-2 chain connects, in series, Pump P-900/Pump P-920 with Pump P-960 and other modules.

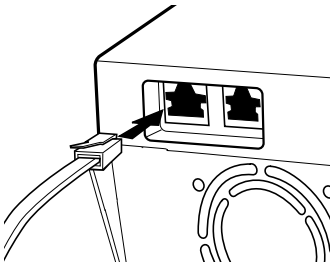
In ÄKTAdesign chromatography systems that include Pump P-960 as a standard component, the UniNet-2 cables are installed at delivery.

CAUTION! The mains power to the ÄKTAdesign chromatography system must be switched OFF before connecting the unit to the UniNet-2 link.

To connect the UniNet-2 cable:

1 Remove the termination plug from the last component in the UniNet-2 chain in the system.

2 Connect the supplied UniNet-2 cable between the last component and the UniNet-2 socket (the leftmost socket) underneath Pump P-960.



The pump is now connected at the end of the UniNet-2 chain. The termination plug is not required since the sample pump has an internal termination.

2.5 Connecting the tubing

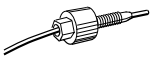
WARNING! HAZARDOUS CHEMICALS. Incorrectly fitted tubing might loosen, causing a jet of liquid to spray out. This is especially dangerous if hazardous chemicals are being used. Connect the tubing by first inserting the tubing fully, then tightening the connector fingertight.

If Pump P-960 is a standard component in the chromatography system, the tubings are installed at delivery.

The exact tubing dimensions required for different sample application techniques are described in the system documentation, or in the *ÄKTAdesign Optional Configurations User Manual*.

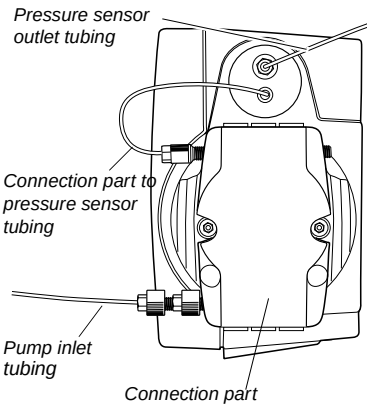
2.5.1 Connection part to pressure sensor tubing

This is a pre-bent tubing (PEEK, i.d. 1.0 mm, o.d. 1/16"), which is connected at delivery.

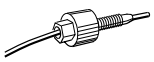


The tubing is connected with 1/16" finger-tight fittings between one of the connection part outlets and the pressure sensor inlet.

A stop plug is connected to the other connection part outlet.



2.5.2 Pump inlet tubing



1 Connect a 1/16" female/ M6 male union to the pump inlet.

2 Connect the pump inlet tubing (ETFE, i.d. 1.0 mm) to the union using a 1/16" finger-tight connector.

Note: *In ÄKTAexplorer™ systems, route this tubing through the Connection part to pressure sensor tubing loop. Otherwise, it might become entangled in nearby objects when closing the door.*

2.5.3 Pressure sensor outlet tubing

Connect the outlet tubing (ETFE, i.d. 1.0 mm) to the upper port on the pressure sensor housing. Use a 1/16" finger-tight PEEK connector or a connector with the same threading (UNF 10–32).

2.6 Connecting the flow restrictor

If the sample vessel is placed at a higher level than the end of the sample waste tubing, sample might flow to waste. Flow restrictor FR-902 supplied is used in the sample flow path to eliminate this siphon effect by creating a back-pressure of 0.2 MPa. Thereby, sample vessels can be placed, for example, on top of the system.

The position of the flow restrictor in the flow path depends on how the sample is applied with the sample pump (see Table 2-1). The injection valve position refers to when sample otherwise might flow straight through to waste.

Sample application type	*Flow restrictor port IN connected to*[1]	*Injection valve position*
Filling a sample loop	Sample pump P-960 outlet port	LOAD
Direct loading onto a column	Injection valve V1, port 4	INJECT
Loading a Superloop[2]	Injection valve V1, port 5	INJECT

[1] A tubing should be used between the flow restrictor and the port. See instruction below.

[2] The flow restrictor is required only if filling the Superloop several times during the run.

Table 2-1. Position of the flow restrictor

When connecting the flow restrictor to the sample pump (Filling a sample loop), use a 22 cm long tubing with suitable inner diameter between the pump outlet and the flow restrictor IN port. Route the tubing through the hole in the door and connect the flow restrictor **outside** the door.

When connecting the flow restrictor to the injection valve, use a 10 cm long tubing with suitable inner diameter between the flow restrictor IN port and the injection valve.

2.7 Initializing Pump P-960 in UNICORN

1 Make sure that the correct strategy is installed.

2 In **UNICORN Main menu**, select **Admininstration:System Setup**.

3 Select the system used and click **Edit**.

4 Click **Component**.

5 Select **Sample pump P-960** and click **OK**.

6 Click **OK** again and then **Close** to complete the initialization.

2.8 Removing air from the sample flow path

Note: *Make sure that any air in the sample flow path is removed before beginning to use Pump P-960. Air in the sample pump or in the flow path might cause pressure pulsation and inaccurate flow.*

The procedure for filling the sample flow path is decribed in section 5.2.2 Removing air using a purge tubing. You can also find this information in *ÄKTAdesign Optional Configurations User Manual*.

2.9 Connecting an air sensor to Pump P-960 (optional)

Air sensor Air-912N (standard), Air-912, Air-925 or Air-925N can be used at the sample inlet before the pump to prevent air from entering the flow path.

The signal cable from Air sensor Air-912N (or Air-925N) is connected directly to the air sensor socket underneath the pump. That minimizes the time required to stop the pump when air is detected.

For detailed instructions on how to install the air sensor in your ÄKTAdesign system, refer to the *ÄKTAdesign Optional Configurations User Manual*.

2.9.1 Initializing the air sensor in UNICORN

1 In **UNICORN Main menu**, select **Admininstration:System Setup**.

2 Select the system used and click **Edit**.

3 Click **Component**.

4 Select **Airsensor P-960** and click **OK**.

5 Click **OK** again and then **Close** to complete the initialization.

3 Operation

3.1 General

Pump P-960 switches on automatically when the chromatography system is switched on.

Pump P-960 is controlled from a PC running UNICORN version 4.12 or higher. It cannot be used as a stand-alone instrument. Control of the pump can be achieved automatically from a method, or manually via the functions available in UNICORN.

3.2 User interface

Pump P-960 is equipped with a green LED on the front panel. The LED indicates the following:

- Flashing light indicates that the power is on.
- Steady light indicates that UniNet-2 is connected.

3.3 Starting and stopping the pump

3.3.1 Preparation before starting the pump

CAUTION! Before a run, always make sure that there is a sufficient supply of liquid in the reservoirs. Avoid pumping without liquid, since this might affect the lifetime of the sealing parts in the pump.

1 Make sure that all liquid used in the pump is filtered.

2 Place the liquid vessels on the workbench or on top of the system then use the flow restrictor, see section 2.6 Connecting the flow restrictor).

Do not close the vessels off completely. The pump might not work if a vessel is sealed, or if it is placed too far below the pump inlet.

3 Check that there is enough liquid present for the run, and that the ends of the inlet tubings are fully immersed. If no solvent filter is used, fasten the tubings to keep the tubings ends at the bottom of the liquid vessel. To change liquid, see section *3.8 Changing liquid*.

4 Purge the pump before use as described in section 5.2 Removing trapped air bubbles from the sample pump or in *ÄKTAdesign Optional Configurations User Manual*.

5 Set the pressure limit as described in section *3.4 Setting the pressure limit*. If the pressure limit is exceeded, the pump is paused.

Note: *When applying the sample directly onto the column, some columns generate a back-pressure above 2.0 MPa (the upper pressure limit of Pump P-960) at their recommended flow rates. To maintain a back-pressure below 2.0 MPa when using these columns, we recommend decreasing the flow rate.*

Note: *We recommend decreasing the flow rate of the* ***system pump*** *during equilibration, before sample application, and before switching the sample pump in-line. The sample pump will not start if the back-pressure exceeds 2.0 MPa.*

3.3.2 Emergency stop

In case of emergency, switch off the power to the ÄKTAdesign system.

3.3.3 Setting the flow rate, starting and stopping the pump

To set the flow rate and start the pump manually:

1 In the **System Control** module, select **Manual:Pump**.

2 Select the instruction **SampleFlow_960** in the list.

3 Type the desired flow rate.

4 Click on the **Execute** button. The pump starts.

5 To stop the pump, set the flow rate to 0 and click on **Execute**.

The pump can be run without liquid, but this should be avoided since it might increase the mechanical wear.

3.4 Setting the pressure limit

When applying the sample directly onto the column, it is important to set the upper pressure limit of the sample pump according to the pressure specification of the column that is used.

To set the upper pressure limit:

1 In **System Control**, select **Manual:Alarm&Mon**.

2 Select the **Alarm_SamplePressure_P960** in the instruction list.

3 Select the **Enabled** mode.

4 Type the desired pressure limit in the **HighAlarm** field.

5 Click on the **Execute** button.

3.5 Calibration

The sample pump is calibrated at the factory.

If pressure pulsation or flow inaccuracy occur, first remove any trapped air from the sample flow path as described in section *5.2 Removing trapped air bubbles from the sample pump*. Alternatively, follow the instruction for your configuration in the *ÄKTAdesign Optional Configurations User Manual*.

If the flow rate remains out of specification, contact the local Amersham Biosciences service representative.

3.5.1 Calibrating the pressure offset

To calibrate the pressure offset:

1 Expose the pressure sensor to atmospheric pressure only.

2 In the **System Control** module in UNICORN, select **System:Calibrate**.

3 Select **P960Press**.

4 Click on the **Start Calibrate** button.
The system adjusts the pressure offset of the pump.

3.6 Filling the sample inlet tubings

We recommend using a purge tubing for filling the sample inlet tubings and the sample pump. When the tubings are empty or the pump is dry, the purge tubing must be used.

The procedure for using the purge tubing is described in section 5.2.2 Removing air using a purge tubing.

3.7 Using samples with high viscosity

When using samples with high viscosity (4–5 cP) at flow rates above 25 ml/min, it is necessary to use teflon tubings with i.d. 1.6 mm and o.d. 1/8" as inlet tubings to Air-912N and Pump P-960.

When using samples with very high viscosity (up to 10 cP) the maximum flow rate is 10 ml/min. We also recommend using teflon tubings with i.d. 1.6 mm and o.d. 1/8" as inlet tubings to Air-912N and Pump P-960.

3.8 Ending the run and storage

If no further runs are planned, Pump P-960 should be flushed immediately with at least 50 ml of pure, distilled water. If aqueous buffers have been in use, this is particularly important to prevent salt precipitation.

Note: *If buffers or water are stored at room temperature, there is a risk that bacterial growth might occur.*

3.8.1 Weekend and long-term storage

Flush the pump with at least 50 ml of pure and distilled water and then fill it with 20% ethanol.

3.9 Changing liquid

CAUTION! To prevent precipitation of crystals when changing from a salt-containing buffer to an organic solvent, always flush the pump with water as a intermediate liquid.

When changing from one liquid to another, it is important that the two liquids are totally miscible with one another. If the two are immiscible, the pump should be flushed first with an intermediate liquid, which is miscible with both liquids. Failure to do so will disrupt the flow from the pump.

3.10 Restart after power failure

If the power to the pump is interrupted, it automatically performs a selftest when the power is restored. The calibration values are retained. The default settings for flow rate and pressure limit are reset automatically. The pump is then ready for operation.

4 Maintenance

The flow path components in Pump P-960 have a limited lifetime, which depends on the flow rate, pressure and eluents used.

WARNING! Always disconnect the power supply before attempting to replace any item on the unit.

WARNING! HAZARDOUS CHEMICALS. Incorrectly fitted tubing might loosen, causing a jet of liquid to spray out. This is especially dangerous if using hazardous chemicals. Connect the tubing by first inserting the tubing fully, then tightening the connector fingertight.

CAUTION! Only spare parts approved or supplied by Amersham Biosciences may be used for maintaining and servicing the pump.

4.1 Periodic maintenance

Interval	***Action*** *(see procedures below)*
Daily	General care
When required	Replace the O-rings in the connection part. Clean the check valves. If necessary, replace the O-rings or the check valves.

4.2 General care

Inspect the pump daily for liquid leaks.

If you suspect that air bubbles are trapped in the sample flow path, go through the air removal procedure for your configuration described in section 5.2 Removing trapped air bubbles from the sample pump, or in *ÄKTAdesign Optional Configurations User Manual*.

4.2.1 General recommendations for all eluents

It is essential that all liquids passing through the pump are clean and pure. Impure or dirty liquid might block the channels in the pump assembly, and hence shortening their lifetime. Degassing prevents formation of air bubbles, which can cause pressure pulsation and inaccurate flow rate.

4.2.2 Additional recommendations for aqueous liquids

After a run with an aqueous liquid, the pump should always be thoroughly washed with pure, distilled water to prevent salt precipitation.

4.3 Cleaning-in-place

Pump a cleaning or sanitizing agent through the pump. The standard recommendation is to use 1 M NaOH and then wash out immediately with buffer and distilled water.

WARNING! CORROSIVE CHEMICALS. NaOH is corrosive and therefore dangerous to health. Avoid spillage and wear protective glasses.

CAUTION! NaOH might damage the wetted parts in the pump if left for longer periods. After cleaning using NaOH, flush the pump immediately with buffer and distilled water.

4.4 Removing and installing the connection part

The connection part should be removed to make it easier to remove the check valves and the O-rings.

4.4.1 Required tools

- Hex wrench, 4 mm

4.4.2 Removing the connection part

Before disassembling the pump, move the input liquid bottle below the level of the pump to prevent siphoning.

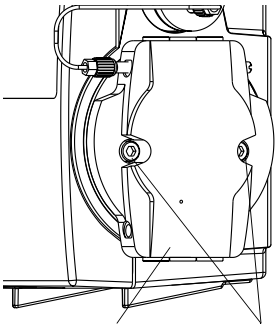
1 Switch off the system with the mains power switch.

2 Disconnect the UniNet-2 cable from the sample pump.

3 Disconnect the inlet and the outlet tubing from the connection part.

4 Release the pump from the system.

5 Unscrew the two attachment screws to remove the connection part. Use the 4 mm hex wrench.



4.4.3 Installing the connection part

1 Wipe the rear side of the connection part and the other parts behind the connection part with a clean cloth.

2 Check that none of the seven O-rings on the rear side of the connection part has come loose.

3 Fit the connection part in position. Fasten the two attachment screws using the 4 mm hex wrench.

4 Reinstall the sample pump in the system.

5 Reconnect the inlet and the outlet tubing.

6 Reconnect the UniNet-2 cable.

7 Purge the pump carefully and check that the fault is corrected. See section 5.2 Removing trapped air bubbles from the sample pump.

4.5 Replacing the connection part O-rings

Liquid appearing between the connection part and the pump assembly, irregular flow, or unstable pressure might indicate that an O-ring in the connection part is damaged.

4.5.1 Required spare parts and tools

- O-ring kit (see Ordering information for code no.)

4.5.2 Replacing an O-ring

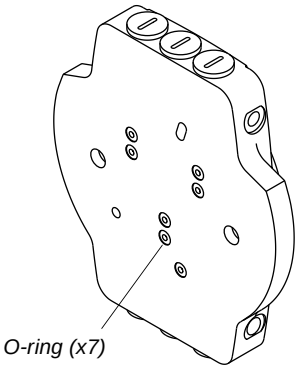
To replace an O-ring:

1 Remove the connection part according to section 4.4.2 Removing the connection part.

2 Remove the faulty O-ring carefully to avoid making scratches on the connection part.

3 Fit the new O-ring in position.

4 Reinstall the connection part according to section 4.4.3 Installing the connection part.



4.6 Cleaning and replacing the check valves

Faulty operation of the check valves is usually indicated by irregular flow, very low flow, or unstable pressure traces. Probable causes are air, dirt, or a damage in a check valve preventing it from closing to seal and hold the pressure. Liquid appearing at a banjo fitting might indicate that a check valve O-ring is damaged.

First try to clean the check valves in-place by pumping 100% ethanol for approximately 10 min. If this does not correct the problem, follow the instructions to remove and then clean the valves. If necessary, a check valve or O-rings might need to be replaced.

4.6.1 Required spare parts and tools

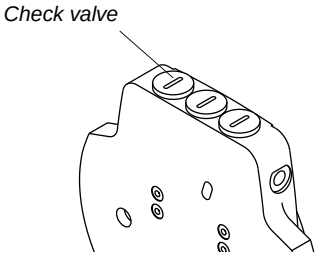
- Check valve (there are four different check valves. See Ordering information for code nos.)
- O-ring kit (see Ordering information for code no.)
- Hex wrench, 4 mm
- Screwdriver, flat-headed, width 5.0–5.5 mm

4.6.2 Removing the check valves

If the condition of the check valve is not improved by cleaning, remove it as follows:

1 Remove the connection part according to section 4.4.2 Removing the connection part.

2 The check valves in the connection part are locked in position with banjo fittings. Remove the check valves using the screwdriver.



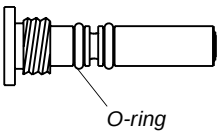
4.6.3 Cleaning the check valves

1 Immerse the check valves in 100% ethanol and place in an ultasonic bath for 5–10 minutes.

2 Repeat the ultrasonic bath with distilled water.

4.6.4 Replacing the check valve O-rings

Liquid appearing at a banjo fitting might indicate that a check valve O-ring is damaged. It might also cause reduced flow or pressure fluctuation.



Carefully replace both old O-rings on the check valve with new ones if you suspect that an O-ring is damaged.

4.6.5 Installing the check valves

Note: *An inlet check valve can be installed incorrectly in an outlet check valve position, and vice versa. Make sure that the check valves are installed in their correct positions.*

If cleaning of the check valve as decribed in section 4.6.3 Cleaning the check valves does not correct the fault, replace the check valve with a new one.

The check valves are of four different types (see Fig. 4-1):

- Inlet check valve short (1 pc.)
- Inlet check valve long (2 pcs.)
- Outlet check valve short (2 pcs.)
- Outlet check valve long (1 pc.)

The inlet check valves have line-shaped holes.
The outlet check valves have round holes.

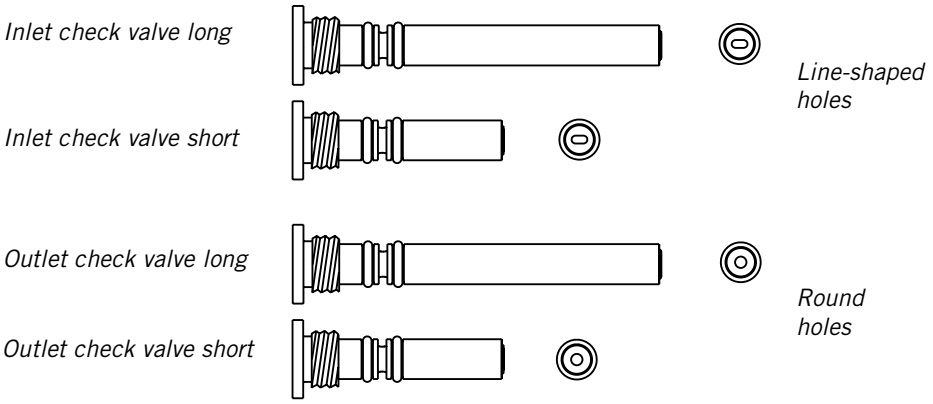


Fig 4-1. Check valves in Pump P-960

To install a check valve:

1 Carefully insert the check valve fully.

Note: *Make sure that the inlet check valves are installed next to the inlet (lower) port on the connection part, and the outlet check valves next to the outlet (upper) port.*

2 Fasten the check valve using the screwdriver.

3 Reinstall the connection part according to section 4.4.3 Installing the connection part.

5 Troubleshooting

WARNING! LETHAL VOLTAGE. Always disconnect the power supply before attempting to replace any item on the unit.

WARNING! HAZARDOUS CHEMICALS. Incorrectly fitted tubing might loosen, causing a jet of liquid to spray out. This is especially dangerous if hazardous chemicals are being used. Connect the tubing by first inserting the tubing fully, then tightening the connector fingertight.

CAUTION! Only spare parts approved or supplied by Amersham Biosciences may be used for maintaining and servicing the pump.

5.1 Error symptoms and corrective actions

If the suggested actions do not correct the fault, contact your local service organisation.

Error symptom	*Possible cause*	*Corrective action*
Leakage	A tubing connector is tightened poorly, or damaged	Check all tubing connectors for leakage. Tighten or replace if necessary.
	The pump inlet or outlet tubings are pinched or damaged	Check the pump tubing. Replace if necessary.
	A check valve is clogged or damaged	Remove the check valve according to section 4.6.2. Clean the check valve in an ultrasonic bath. If the leakage persists, replace the check valve.
	An O-ring in a check valve or in the connection part is damaged	Examine the O-rings. If necessary, replace them according to the sections 4.5 or 4.6.4.

Error symptom	*Possible cause*	*Corrective action*
Measured volume too low	Air bubbles are trapped in the pump	Purge the pump according to section 5.2
	Cavitation might occur due to too high flow rate for the sample application technique used	See the *ÄKTAdesign Optional Configurations User Manual* for the recommended flow rates
	A check valve is clogged or damaged, causing leakage	Remove the check valve according to section 4.6.2. Clean the check valve in an ultrasonic bath. If the leakage persists, replace the assembly.
	The flow rate is not calibrated properly	Contact Amersham Biosciences for advice
Erratic flow or pressure pulsation	Leaking tubing connector	Check the tubing connectors. Tighten or replace if necessary.
	The solvent filter is clogged	Check the solvent filter. Clean if necessary.
	The pump inlet or outlet tubing is pinched or damaged	Check the pump tubing. Replace if necessary.
	Air bubbles are trapped in the pump	Purge the pump according to section 5.2
	A check valve is clogged or damaged, causing leakage	Remove the check valve according to section 4.6.2. Clean the check valve in an ultrasonic bath. If the leakage persists, replace the assembly.

Error symptom	*Possible cause*	*Corrective action*
High pressure limit exceeded	The pump inlet or outlet tubing is pinched or damaged	Check the pump tubing. Replace if necessary.
	A check valve is clogged or damaged	Remove the check valve according to section 4.6.2. Clean the check valve in an ultrasonic bath. If the leakage persists, replace the assembly.
	The pressure offset in the sample pump is not calibrated properly	Calibrate the pressure offset according to section 3.5.1
	The flow rate is too high	Decrease the flow rate
	The pressure limit is too low	Increase the pressure limit
Not running	No power to the system	Check that the power to the system is switched on
	No UniNet-2 communication. (The green indicator on the sample pump shows a steady light when the communication is established.)	Check the UniNet-2 cable. Check that Pump P-960 is initialized in UNICORN (see section 2.7.
Large spillage over/into the unit		Unplug the UniNet-2 cable. Clean and dry the unit with a dry cloth or paper. If necessary, drain the unit by tilting it. Contact Amersham Biosciences for advice.

5.2 Removing trapped air bubbles from the sample pump

During routine operation, the presence of air bubbles in the pump heads is seen as an erratic flow, a flow that is lower than expected, or an irregular pressure recording. If the sample pump is completely dry, it might fail pumping liquid.

If the air has accumulated due to a leaking tubing connector, tighten the connector or replace it if necessary.

To remove small amounts air from the sample flow path, try running the pump manually with buffer according to section 5.2.1.

If the pump is dry or if there is plenty of air in the sample inlet tubing, it must be purged with a purge tubing according to section 5.2.2.

5.2.1 Removing air by running the sample pump manually

If there are only small amounts of air in the sample flow path, remove the air as follows:

1 Immerse the end of the sample inlet tubing in a suitable buffer.

2 If using sample valve V5, set the valve to port 8 (buffer inlet).

3 Set the injection valve according to Table 5-1.

System tubing configuration	*Injection valve position*	*Flow rate [ml/min]*	*Time [min]*
Filling a sample loop	LOAD	5	1
Direct loading onto a column	WASTE	40	1
Loading a Superloop	INJECT	40	1

Table 5-1. Settings for purging Pump P-960 automatically

WARNING! OVER-PRESSURE. The injection valve must be set to position INJECT in the "Loading a Superloop" configuration. If not, the Superloop might rupture due to over-pressure when running the sample pump, resulting in injury.

4 Run the pump at the flow rate and time shown in Table 5-1.

If the pump fails pumping liquid, remove the air using a purge tubing according to section 5.2.2 Removing air using a purge tubing.

5.2.2 Removing air using a purge tubing

If there is plenty of air in the sample inlet tubings or if the sample pump is dry, use a purge tubing to fill the tubings and the pump.

Procedure for system including sample valve V5

This procedure describes how to first fill the sample inlet tubings and then the buffer inlet tubing.

To fill the sample inlet tubings in port 1–7:

1 Put the chosen sample inlet tubings from port 1–7 in sample valve V5 into the sample tubes.

2 Immerse the tubing from port 8 in V5 in a buffer vessel.

3 Set the valve to any of the chosen sample inlet ports 1–7.

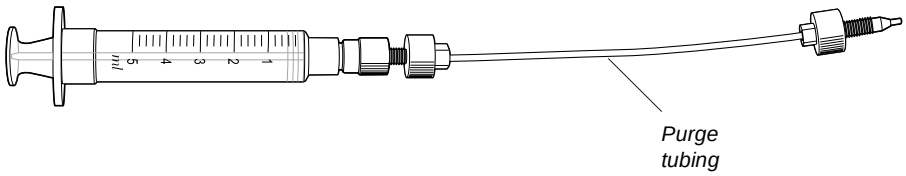
Note: The sample inlet tubings should be filled before filling the buffer tubing connected to port 8.

4 Disconnect the connector fitted to the port that will be used for the purge tubing (see Table 5-2).

System tubing configuration	*Injection valve position*	*Purge tubing connection port*
Filling a sample loop	LOAD	Pump P-960, outlet port on the connection part, i.e. before the pressure sensor
Direct loading onto a column	LOAD	Injection valve V1, port 3
Loading a Superloop	LOAD	Injection valve V1, port 2

Table 5-2. Settings for using a purge tubing

5 Connect the purge tubing to the same port.



6 Set the injection valve V1 to LOAD.

7 Draw sample with the syringe until the liquid level has passed through the sample valve.

8 Switch sample valve V5 to the next sample inlet tubing to be filled.

Note: To empty the syringe, switch valve V5 ***before*** *removing the syringe to prevent sample from flowing back to the vessel.*

9 Repeat step 6 and 7 for the remaining sample inlet tubings.

To fill the buffer inlet tubing in port 8:

1 Set the sample valve V5 to port 8.

2 Draw buffer with the syringe until the liquid level has passed through the sample pump.

The check valves in the sample pump will prevent the liquid from being withdrawn when removing the purge tubing.

3 Disconnect the purge tubing.

4 Fit the original connector to the port.

5 Flush the sample flow path tubing with buffer to remove any trapped air bubbles according to the procedure in section 5.2.1.

Procedure for system not including sample valve V5

1 Put the sample inlet tubing in a buffer vessel.

2 Disconnect the connector fitted to the port that will be used for the purge tubing (see Table 5-2).

3 Connect the purge tubing to the same port.

4 Set the injection valve V1 to LOAD.

5 Draw buffer with the syringe until the liquid level has passed through the sample pump.

The check valves in the sample pump will prevent the liquid from flowing back when removing the purge tubing.

6 Disconnect the purge tubing.

7 Fit the original connector to the port.

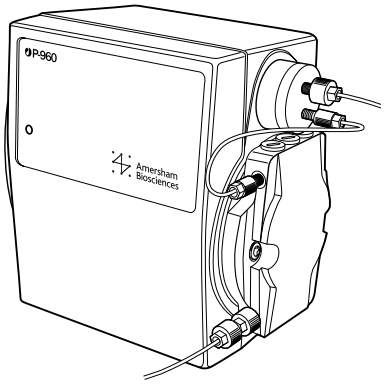
8 Flush the sample inlet tubing with buffer to remove any trapped air bubbles according to the procedure in section 5.2.1.

9 Gently move the sample inlet tubing to the sample vessel.

6 Reference information

6.1 Description

Pump P-960 is a single-channel laboratory pump for use as a sample pump in ÄKTAdesign liquid chromatography systems.



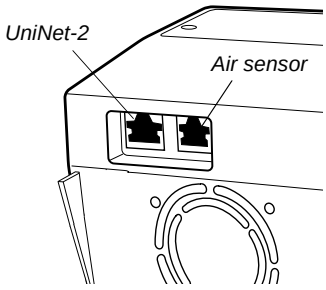
Liquid in an external vessel is drawn into the pump by three plunger pumps. They are actuated in a sequential order by a stepper motor. In combination with check valves in the connection part, it results in a smooth flow from the pump.

The pressure generated by the sample pump is continuously monitored by the pressure sensor located above the connection part. The signal, which is proportional to the pump pressure, is monitored by UNICORN via the UniNet-2 connection.

The connection part is made of PEEK.

6.2 Cable connections

The pump has a connector underneath (the leftmost) for connection to the UniNet-2 communication network. This enables control of the pump from UNICORN, version 4.12 or higher, via Pump P-900 or Pump P-920. The UniNet-2 cable also supplies power to the pump.



The pump is also equipped with a connector (the rightmost) for connecting an air sensor, Air-912N or Air-925N, directly to the pump.

6.3 Liquid delivery

Pump P-960 has one inlet port and one outlet port. In the connection part, the inlet flow path as well as the outlet flow path are split into three separate flow paths – one to each plunger pump chamber. All six flow paths are equipped with non-return check valves.

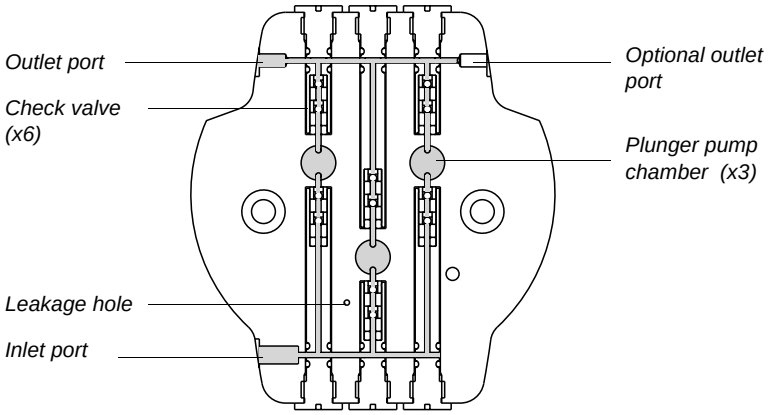


Fig 6-1. Cross section of the flow path in the connection part

Consequently, each one of the three plunger pump chambers has one inlet and one outlet. Liquid is drawn up into the chamber through a check valve by the pump plunger being withdrawn from the chamber. On the delivery stroke of the plunger, the inlet check valve is sealed by the pressure developed and liquid is forced out through a similar check valve in the outlet flow path.

After exiting the connection part through the pump outlet, the flow passes the pressure sensor where the pressure is measured.

The three plunger pumps are actuated by pistons in a sequential order, meaning that the pump phases are displaced by 120°. The sequential pumping action of the pistons is provided by a rotating stepper motor assembly through an axial bearing. The bearing is slightly inclined, which results in a sequential motion of the plunger pumps, and hence a smooth and continuous liquid delivery.

The stepper motor has automatic speed control to reduce pulsation. The pump is also equipped with pressure compensation.

Leakage between the connection part and the pump chambers is prevented by O-rings. Any leakage behind the plungers is diverted through the drainage hole in the front of the connection part. The check valves are also equipped with O-rings.

6.4 Technical specifications

6.4.1 Operating data

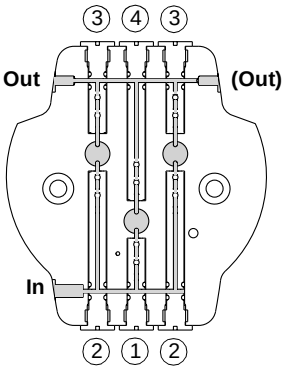
Flow rate range	0.1–50 ml/min in steps of 0.1 ml/min
Pressure range	0–2.0 MPa (20 bar, 290 psi)
Pressure pulsation	≤±10% of mean value in entire operating range
Flow rate accuracy	-5 – +3% or ±0.02 ml/min whichever is greater
Volume reproducibility	rsd < 1%
Viscosity	Max. 5 cP for complete flow range. At reduced flow rate (≤10 ml/min): max. 10 cP.
Pressure sensor *resolution* *accuracy* *offset drift*	 0.02 MPa ±0.05 MPa Max. 0.01 MPa/week

6.4.2 Physical data

Tubing connectors *pump inlet* *pump outlet* *pressure sensor inlet* *pressure sensor outlet*	 male M6 male 1/16" finger-tight male 1/16" finger-tight male 1/16" finger-tight
Internal volume	1.0 ml including pressure sensor housing
Control	Via UniNet-2 cable connection
Degree of protection	IP 21
Wetted materials *connection part and pumping parts* *check valve* *pressure sensor housing* *pressure sensor* *flow restrictor*	 PEEK (polyetheretherketone), UHMWPE (ultra-high molecular weight polyethylene), glass (borosilicate), ceramic (Al_2O_3), Simriz titanium, sapphire, Simriz PEEK titanium PEEK, PTFE (polytetrafluorethylene), ETFE (ethertetrafluorethylene), gold

Chemical resistance	The wetted parts are resistant to the chemicals listed below (synergistic effects have not been taken into account; room temperature and limited over-pressure is assumed). Unless otherwise stated, all concentrations are 100%: Acetic acid, 0.1 M Acetone, 1% Aqueous buffers, pH 2–12 Decon 90, 10% (for washing only) Ethanol, 20% Ethanol, 96% (for washing only) Ethylene glycol, 20% Glycerol, 50% Guanidine, 6 M HCl, 0.1 M HCl, 1 M (for washing only) Isopropanol, 30% Lysozyme, 2 mg/ml Methanol, 20% NaOH, 0.1 M NaOH, 1 M (for washing only) SDS, 10% TFA, 0.2% Triton-X, 2% Urea, 8 M
Power requirement	32 V DC
Environment	+4 to +40 °C 10–95% relative humidity 84–106 kPa (840–1060 mbar)
Dimensions, H × W × D	120 × 100 × 140 mm

6.5 Ordering information



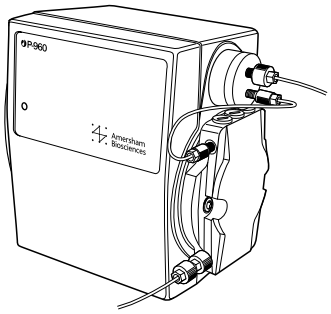
Connection part, (schematic drawing) See also section 4.6.5.

Item	*Quant./pack*	*Code no.*
Pump P-960 kit, including Pump P-960, holders for ÄKTA systems, UniNet cable, flow restrictor, purge kit, union, connectors, and tubing	1	18-6727-00
Sample valve kit, including valve PV-908, UniNet cable, Sample holder SH-900, unions, connectors, and tubing	1	18-1175-86
Air sensor Air-912N kit, including Air sensor Air-912N, holder for ÄKTAexplorer, connectors, and tubing	1	18-1175-84
Air sensor Air-925N	1	18-1174-16
UniNet cable, 0.7 m	1	18-1109-74
Inlet check valve, short (1)	1	18-1172-43
Inlet check valve, long (2)	1	18-1172-44
Outlet check valve, short (3)	1	18-1172-45
Outlet check valve, long (4)	1	18-1172-46
O-ring kit, P-960, incl. 1.42 × 1.52 mm (for connection part) 4 × 1.2 mm (for inlet and outlet check valves)	 7 12	18-1172-53
Flow restrictor FR-902, 0.2 MPa	1	18-1121-35
Purge kit P-950	1	18-1153-28
Pre-bent tubing P-960, PEEK, (from connection part to pressure sensor)	1	18-1173-07
Finger-tight connector 1/16", for o.d. 1/16" tubing (1.6 mm)	10	18-1112-55
Tubing connector, male, for o.d. 1/8" tubing (3.2 mm)	10	18-1112-17
Ferrule for o.d. 1/8" tubing (yellow)	10	18-1112-18
Tubing connector, male, for o.d. 3/16" tubing (4.8 mm)	10	18-1121-49
Ferrule for o.d. 3/16" tubing (blue)	10	18-1121-48

Item	*Quant./pack*	*Code no.*
Union 1/16" female/M6 male, PEEK (from finger-tight connector 1/16" to P-960 inlet port)	6	18-1112-57
Union 5/16" female/M6 male, PEEK (from o.d. 1/8" and 3/16" tubing connector to P-960 inlet port)	3	18-1127-76
Stop plug, 5/16", PEEK	5	18-1112-50
Stop plug, 1/16", PEEK	5	18-1112-52
PEEK tubing, i.d. 0.75 mm, o.d. 1/16"	2 m	18-1112-53
Tefzel tubing, i.d. 1.0 mm, o.d. 1/16"	3 m	18-1142-38
PEEK tubing, i.d. 1.0 mm, o.d. 1/16"	2 m	18-1115-83
Teflon tubing, i.d. 1.6 mm, o.d. 1/8"	3 m	18-1121-16

Short instructions

The following short instructions are intended as a guide for users who are fully familiar with the safety precautions and operating instructions described in this manual. The instructions assume that the unit is installed according to the installation instructions.



Pump P-960 is controlled from UNICORN. For manual control, use the instructions found in **System Control:Manual:Pump.**

1 **Switch on the pump** by switching on the power to the chromatography system.

2 Set the flow rate by selecting the instruction **SampleFlow_960**.

3 Start the pump by clicking **Execute**.

4 Stop the pump by setting the flow rate to 0 and clicking **Execute**.

Amersham Biosciences

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