KNAUER

AZURA

Pump P 2.1S/P 4.1S
User Manual

V6870

HPLC

Note: The contents of this user manual apply for all BlueShadow products. Please submit a request on any article numbers for BlueShadow.

Table of Contents

Note: For your own safety, read the manual and always observe the warnings and safety information on the device and in the manual!

Intended Use

Note: **Only use the device for applications that fall within the range of the intended use. Otherwise, the protective and safety equipment of the device could fail.**

Device Overview

The HPLC pumps P 4.1S/ P 2.1S with pump heads can be used as feed pumps or dosing pumps in analytical or preparative applications. Pumps transport solvents or dissolved samples through the HPLC system.

Fig. 1 P 2.1S with 10 ml pump head

Fig. 2 P 4.1S with 10 ml pump head

Legend

① Display
② Keypad
③ Pump head
④ Pressure sensor

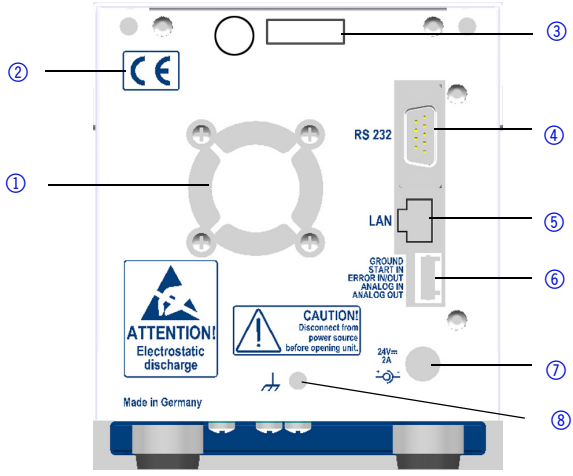


Fig. 3 Pump, rear view

Legend	
① Opening of the fan	⑤ LAN port
② CE mark	⑥ Pin header for remote control
③ Serial number	⑦ Power connection - bushing
④ RS-232 port	⑧ Hole for the ground connection

External devices like computers, fraction collectors, etc. can be connected in 3 different ways:

- Connected to LAN within a network
- Connected to RS232, alternately to LAN connection
- Control with pin header

Location

In laboratories the device can be used in the following areas:

- Biochemistry analyses
- Food analyses
- Pharmaceutical analyses
- Environmental analyses
- Chemical analyses
- Dosing applications

Features

- Analytical pump head with a flow rate range from 0.001 – 9.999 ml/min and a pressure of up to 400 bar
- Semi-preparative pump head with a flow rate range from 0.01 – 50 ml/min and a pressure of up to 150 bar
- Dual-piston technology for constant flow rates
- Setting a limit for minimum and maximum pressure to protect the columns and to avoid a dry run of the pump (only P 4.1S)
- Emergency stop, independent from control with chromatography software
- The pump can be controlled with the keypad in standalone mode or with the chromatography software.
- The pump heads can be easily removed and replaced via four front-accessible screws by the user.
- Unlike the pump P 2.1S, pump P 4.1S is equipped with a pressure sensor.

Features

- Liquid transport with stable flow rate and high flow accuracy
- Long service life

- Pump heads completely made of stainless steel or with Hastelloy-C or ceramic inlays
- Piston backflushing
- High physical and chemical stability
- Flexible control with LAN connection, RS-232 interface, and analog control signals
- Control with chromatography software

Options

A pump in combination with another pump can be used to set up a binary high pressure gradient system.

Pump Heads

Pump heads for use in analytical applications:

- Stainless steel with stainless steel inlays for standard applications
- Stainless steel with ceramics inlays for biocompatibility
- Stainless steel with Hastelloy-C inlays for aggressive media
- different pump head sizes: 10 ml or 50 ml

The front of the pump head is labeled with the specifications for the maximum pumping capacity (10 ml or 50 ml). Pump heads with inlays carry additional material labels (SST for stainless steel, C for ceramics, HC for Hastelloy-C).

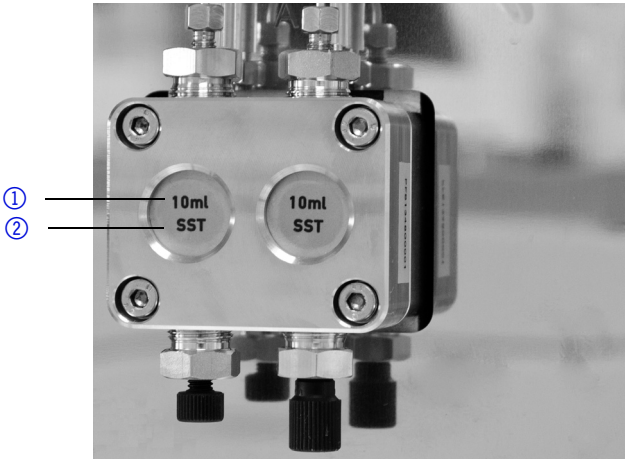


Fig. 4 Labeling on the pump heads

Legend

① flow rate performance

② material

Eluents

Even small quantities of other substances, such as additives, modifiers, or salts can influence the durability of the materials.

Note: **The list of selected solvents was compiled based on research in the pertinent literature and is only a recommendation. If there is any doubt, contact the Technical Support of the manufacturer.**

Not suitable eluents
▪ Halogenated hydrocarbons, e.g. Freon®
▪ Concentrated mineral and organic acids
▪ Concentrated bases
▪ Eluents containing particles
▪ Perfluorinated eluents, e. g. Fluorinert® FC-75, FC-40
▪ Perfluorinated polyether, e.g. Fomblin®

Less suitable eluents
▪ Dimethyl sulfoxide (DMSO)
▪ Slightly volatile eluents
▪ Methylene chloride
▪ Tetrahydrofuran (THF)
▪ Dilute phosphoric acid

Suitable eluents
▪ Acetone at 4°-25° C (39.2°-77.0° F)[1]
▪ Acetonitrile
▪ Benzene
▪ Chloroform
▪ Ethyl acetate
▪ Ethanol
▪ Hexane/heptane at 4°-25° C (39.2°-77.0° F)[1]
▪ Isopropanol
▪ Carbon dioxide (liquid 99.999% CO_2)
▪ MethanolPhosphate buffer solutions (0.5 M)
▪ Toluol
▪ Dilute ammonia solution

Suitable eluents
▪ Dilute acetic acid (10-50%), at 25° C/77.0° F ▪ Dilute sodium hydroxide (1M) ▪ Water

1. valid for the specified temperature range

Scope of Delivery

Note: Only use original parts and accessories made by KNAUER or a company authorized by KNAUER.

Pump P 2.1S/P 4.1S
User manual
Power adapter 24 V
Installation Qualification Document
Accessories Kit Pump
Accessories Kit AZURA

Safety

Professional Group

The user manual addresses persons who are qualified as chemical laboratory technicians or have completed comparable vocational training.

The following knowledge is required:

- Fundamental knowledge of liquid chromatography
- Knowledge regarding substances that are suitable only to a limited extent for use in liquid chromatography
- Knowledge regarding the health risks of chemicals
- Participation during an installation of a device or a training by the company KNAUER or an authorized company.

If you do not belong to this or a comparable professional group, you may not perform the work described in this user manual under any circumstances. In this case, please contact your superior.

Safety Equipment

When working with the device, take measures according to lab regulations and wear protective clothing:

- Safety glasses with side protection

- Protective gloves
- Lab coat

What must be taken into account?

- All safety instructions in the user manual
- The environmental, installation, and connection specifications in the user manual
- National and international regulations pertaining to laboratory work
- Original spare parts, tools, and solvents made or recommended by KNAUER
- Good Laboratory Practice (GLP)
- Accident prevention regulations published by the accident insurance companies for laboratory work
- Filtration of substances under analysis
- Use of inline filters
- Once they have been used, never re-use capillaries in other areas of the HPLC system.
- Only use a given PEEK fitting for one specific port and never re-use it for other ports. Always install new PEEK fittings on each separate port.
- Follow KNAUER or manufacturer's instructions on caring for the columns

More safety-relevant information is listed in alphabetical order in the following table:

Topic	Explanations
flammability	Organic solvents are highly flammable. Since capillaries can detach from their screw fittings and allow solvent to escape, it is prohibited to have any open flames near the analytical system.
solvent tray	Risk of electrical shock or short circuit if liquids get into the device's interior. For this reason, place all bottles in a solvent tray.
solvent lines	Install capillaries and tubing in such a way that liquids cannot get into the interior in case of a leak.
leaks	Regularly check if any system components are leaking.
power cable	Defective power cables are not to be used to connect the device and the power supply system.

Topic	Explanations
self-ignition point	Only use eluents that have a self-ignition point higher than 150 °C under normal ambient conditions.
power strip	If several devices are connected to one power strip, always consider the maximum power consumption of each device.
power supply	Only connect devices to voltage sources, whose voltage equals the device's voltage.
toxicity	Organic eluents are toxic above a certain concentration. Ensure that work areas are always well-ventilated! Wear protective gloves and safety glasses when working on the device!

Where is use of the device prohibited?

Never use the system in potentially explosive atmospheres without appropriate protective equipment. For further information, contact the Technical Support of KNAUER.

Decommissioning the Device Securely

At any time, take the device completely out of operation by either switching off the power switch or by pulling the power plug.

Opening the Device

The device may be opened by the KNAUER Technical Support or any company authorized by KNAUER only.

Definition of Personal and Material Damage

Possible dangers related to the device are divided into personal and material damage in this user manual.

Category	Explanations
DANGER!	Lethal or very serious injuries can occur.
WARNING!	Serious or moderate injuries can occur.
CAUTION!	Moderate injuries can occur. Device defects can occur.

Decontamination

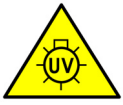
Contamination of devices with toxic, infectious or radioactive substances poses a hazard for all persons during operation, repair, sale, and disposal of a device.

DANGER!
Health danger if getting in contact with toxic, infectious or radio-active substances.
Before disposing of the device or sending it away for repair, you are required to decontaminate the device adequately.

All contaminated devices must be properly decontaminated by a specialist company or the operating company before they can be recommissioned, repaired, sold, or disposed of. All materials or fluids used for decontamination must be collected separately and disposed of properly.

Symbols and Signs

The following symbols and signs can be found on the device, in the chromatography software or in the user manual:

Symbol	Meaning
	High-voltage hazard
	Electric shock hazard
	Electrostatic discharge hazard, damages to system, device, or components can occur.
	General warning sign, moderate injuries can occur and also damages to system, device, or components.
	UV-light hazard, eye injuries can occur.
	Leak hazard, damages to device can occur.

Symbol	Meaning
	Hazardous substances.
CE	A device or system marked with CE fulfills the product specific requirements of European directives. This is confirmed in a Declaration of Conformity.
	Testing seals in Canada and the USA at nationally recognized testing centers (NRTL). The certified device or system has successfully passed the quality and security tests.

Unpacking and Setup

Contacting the Technical Support

You have various options to contact the technical support:

Phone: +49 30 809727-111

Fax: +49 30 8015010

E-mail: support@knauer.net

Location Requirements

Requirements

The location for the device must meet the following requirements:

CAUTION
Defect of the device due to overheating possible.
- Set up the device in such a way that it is protected against exposure to direct sunlight.
- Keep at least 15 cm clear at the rear and 5–10 cm at each side for air circulation.

- Weight 1.5 kg
- Dimensions 105 × 100 × 185 mm (Width × Height × Depth)
- Power supply 24 V DC

- Air humidity: < 90 %
- Temperature: 4 – 40 °C (39.2 – 104 °F)
- Space requirements
  - Side clearance to other devices:
    - If there is a device on one side, minimum clearance of 5 cm.
    - If there are devices on both sides, minimum clearance of 10 cm
  - At least 30 cm gap to the fan on the rear of the device.

Power supply

The device is intended for use with AC power networks of 100 – 240 V.

Power cable

Only the supplied power cable is to be used to connect the device to the mains supply. Replace defective power cables only with accessories from KANUER. Only use power cables with a permission for use from your country.

Power plug

Make sure that the power plug on rear of the device is always accessible, so that the device can be disconnected from the power supply.

Unpacking

Store all packing material. Retain included packing list carefully for repeat orders.

CAUTION
Damage to the device by carrying or lifting it on protruding housing parts.
Lift the device on the side of the housing only.

1. Setup the delivery so you are able to read the label. Using the utility knife, cut the adhesive tape. Open the delivery.
2. Remove the foam insert. Take out the accessories kit and the manual.
3. Open the accessories kit and take out all accessories. In case any parts are missing, contact the technical support. Grip the device at its side panels and lift it out of the packaging.
4. Remove the foam inserts from the device. Pull off the antistatic bag, if necessary.
5. Check for damages caused during transportation. In case you notice any damage, contact the technical support.

6. Set-up the device in its location.
7. Check the scope of delivery
8. Remove the protective foil.

Result

The device is complete and ready for use.

Next steps

Connect the device to power supply to prepare the initial startup.

Connecting the Eluent Line to the Pump Head

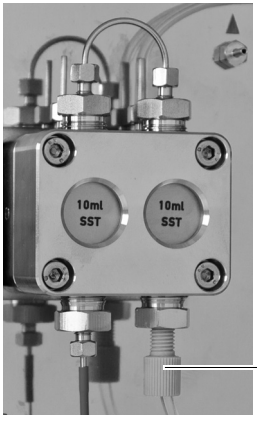
Prerequisites

- The device has been switched off.
- The power plug has been pulled.

Material

Flangeless fitting

CAUTION
Damage to the pump head possible!
Remove the cap fittings from the inlet and outlet of the pump head prior to use!

Process	Figure
1. Slide the flangeless fitting onto the tubing. 2. Insert the tubing into the free inlet ① on the bottom of the pump head. 3. Tighten the fitting by hand.	 Fig. 5 Solvent line on the pump head

Next steps

Integrate the pump into the HPLC flow system.

Control

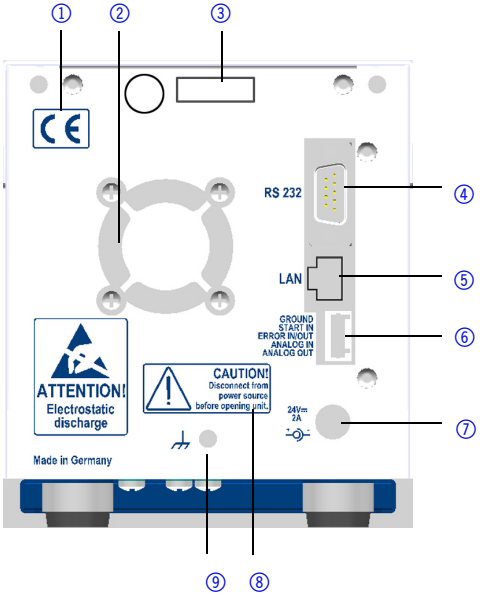


Fig. 6 Pump, rear view

Legend	
① CE mark	⑤ LAN port
② Opening of the fan	⑥ Pin header for remote control
③ Serial number	⑦ Power connection - bushing
④ RS-232 port	⑧ Warning 1
	⑨ Hole for the ground connection

Pin Header for Remote Control

Contact data	Explanation
GROUND	Reference point of the voltage at the signal inputs.
START IN	**TTL-compatible input** ▪ min. 10 mA ▪ Low active After receiving a signal from an external device, the device starts. If controlled with software, an electronic trigger is send through the LAN.

Contact data	Explanation
ERROR IN/OUT	**TTL-compatible input** ▪ min. 10 mA ▪ Low active After receiving a signal (e. g. short-circuit to ground) from an external device, an error message appears and the device stops.
ANALOG IN	Flow rate is controlled through external control voltage (0 – 10 V).
ANALOG OUT	Analog output signal for reproducing the measured system pressure.

Connecting the Pin Header

To control one device through another, you use the multi-pin connector. To use remote control, you have to connect cables to the terminal strip (everything comes included with delivery). The single ports are used to exchange control signals.

Prerequisites

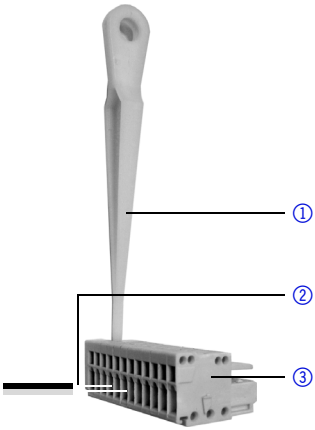
- The device has been turned off.
- The power plug has been pulled.

Tools

Depressor tool

CAUTION
Short-circuit hazard.
- Turn off the device before connecting it to the multi-pin connector.
- Pull the power plug.

CAUTION
Electrostatic discharge can destroy the electronics.
Wear a protective bracelet against electrostatic discharge and ground.

Process	Figure
1. Place the terminal strip ③ on a suitable surface. 2. Push the depressor tool ① into the opening on the upper side. 3. Continue pushing the depressor tool down and lead the cable ② into the front end of the terminal strip. 4. Remove the depressor tool. 5. Check whether the cables are tightly attached. 6. Plug the terminal strip onto the multi-pin connector.	 Fig. 7 terminal strip

Next steps

Finish the installation and perform the initial startup.

Controlling with a Computer in a Local Area Network (LAN)

This section describes how to set up an HPLC system in a local area network (LAN) and how a network administrator can integrate this LAN into your company network. The description applies to the operating system Windows® and all conventional routers.

Note:

To set up a LAN, we recommend to use a router. That means the following steps are required:

Process

1. On the computer, go to the control panel and check the LAN properties.
2. Hook up the router to the devices and the computer.
3. On the computer, configure the router to set up the network.
4. Install the chromatography software from the data storage device.
5. Switch on the device and run the chromatography software.

Configuring the LAN Settings

The LAN uses only one server (which is normally the router) from that the devices automatically receive their IP address.

Prerequisite

- In Windows®, power saving, hibernation, standby, and screen saver must be deactived.
- In case you use an USB-to-COM box, the option "Allow the computer to turn off ths device to save power" in the devicemanager must be deactivated for all USB hosts.
- Only for Windows 7: For the network adapter, the option "Allow the computer to turn off this device to save power" in the Device Manager must be deactivated.

Procedure

1. In Windows 7 choose *Start* ⇒ *Control Panel* ⇒ *Network and Sharing Center*.
2. Double-click on *LAN Connection*.
3. Click on the button *Properties*.
4. Select *Internet Protocol version 4 (TCP/IPv4)*.
5. Click on the button *Properties*.
6. Check the settings in the tab *General*. The correct settings for the DHCP client are:
   a) *Obtain IP address automatically*
   b) *Obtain DNS server address automatically*
7. Click on the button *OK*.

Connecting the Cables

A router has several LAN ports and one WAN port that can be used to integrate the LAN into a wide area network (WAN), e.g. a company network or the Internet. In contrast, the LAN ports serve to set up a network from devices and a computer. To avoid interference, we recommend operating the HPLC system separately from the company network.

You will find patch cables for each device and the router in the accessories kit. To connect the router to a WAN, an additional patch cable is required, which is not supplied within the scope of delivery.

① Modules	④ WAN port
② Router	⑤ Workstation
③ LAN ports	

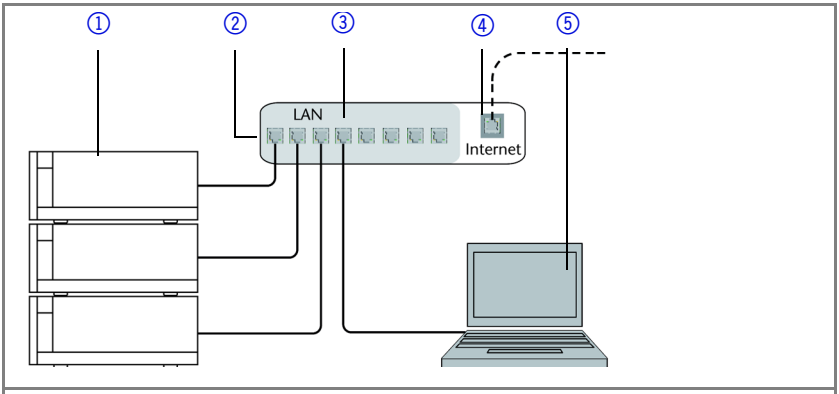


Fig. 8 Cabling system LAN

Prerequisite

- The computer has been switched off.
- There is a patch cable for each device and the computer.

Procedure

1. Use the patch cable to connect the router and the computer. Repeat this step to connect all devices.
2. Use the power supply to connect the router to the mains power system.

Configuring the Router

The router is preset at the factory. You will find a label at the bottom side of the router, on which IP address, user name, and password are printed. These information help to open the router configuration.

Procedure

1. To open the router configuration, start your Internet browser and enter the IP address (not for all routers).
2. Enter user name and password.
3. Configure the router as DHCP server.
4. In the router configuration, check the IP address range and make changes if necessary.

Result

Once the router has assigned IP addresses to all devices, the chromatography software can be used to remotely control the system.

Integrating the LAN into a Company Network

A network administrator can integrate the LAN into your company network. In this case you use the WAN port of the router.

Prerequisite

There is a patch cable for the connection.

Procedure

1. Check that the IP address range of the router and of the company network do not overlap.
2. In case of an overlap, change the IP address range of the router.
3. Use the patch cable to connect the router WAN port to the company network.
4. Restart all devices, including the computer.

Controlling Several Systems Separately in a LAN

Devices connected to a LAN communicate through ports, which are part of the IP address. If more than one HPLC system is connected to the same LAN and you plan on controlling them separately, you can use different ports to avoid interference. Therefore, the port number for each device must be changed and this same number must be entered into the device configuration of the chromatography software. We recommend to use the same port number for all devices in the same system.

Note:

The port is set to 10001 at the factory. You must use the same numbers in the device configuration of the chromatography software as in the device, otherwise the connection fails.

Procedure

1. Find out port number and change it on the device.
2. Enter the port number in the chromatography software.

Result

The connection is established.

Ground

CAUTION!
Electronic hazard when using an identically constructed power adapter from another manufacturer.
Before establishing a power connection, call the Technical Support.

The ground connection for the pump has a designated hole with a thread M3 on the back of the device.

- If the supplied power adapter is used, then the ground connection remains unused.

- Please contact the technical support of KNAUER, if the pump along with other devices should be connected to the power supply with a 6-prong power adapter; a pump needs to be grounded exclusively.

Operation

Switching on the Pump

CAUTION!
Damage to the pump head in case it runs dry.
Ensure that liquids runs through pump head and piston backflushing.

Procedure

1. Connect the power adapter to the power supply.
2. Connect the pump with plug from the external power adapter.
3. Switch on the power adapter.
4. Wait until the pump has completed the self-test.

Result

After the device is switched on, the display shows *Pump* and the *Firmware* version. The device performs a self-test. After all tests have been successfully completed, the status of the pump with its current flow rate is displayed. The pump is ready for operation.

Selecting the Pump Head

Procedure	Figure
1. Press both arrow keys simultaneously until the correct display appears. 2. Let go of the arrow keys. 3. Using the arrow keys, scroll until 10 ml/50 ml.	 Fig. 9 Pump head selection

Result

When setting is finished, the status display appears.

Flushing the Pump

The display shows vertical arrows while the pump is flushing.

Legend

① Flushing symbol
② Pressure
③ Flow rate

Prerequisites

- Pump with pressure sensor:
  - Venting screw of the pressure sensor is open.
  - Syringe is connected to venting capillary.
- Pump without pressure sensor:
  - Blind fitting in the outlet to the pressure sensor is removed.
  - Syringe is connected to the capillary on the pump-head outlet.

Note: **The flow rate can be changed while being purged. The change takes effect immediately.**

Process	Figure
1. Prime liquid with the syringe. 2. Hold down start/stop key until flushing starts.	

Control

The pump can be operated in two ways:

- Using the buttons at the device
- Using the software ClarityChrom® or ChromGate®

Note: **Operator errors and clogged capillaries can cause high pressure spikes.**

The status display shows the flow rate and also the pressure for pumps with pressure sensor.

Fig. 10 Status display

Legend

① Pressure in 0,1 MPa

② Flow rate in ml/min

Keypad

The keypad consists of 3 keys, which allow monitoring the device or changing the settings.

Figure	Function
 Fig. 11 Arrow keys	Press both keys simultaneously to scroll. Press any of the arrow keys to set values and to change settings.
 Fig. 12 Start/stop key	▪ Starting and stopping the pump. ▪ Flushing the pump.

Setting the Flow Rate

In case of the pump without pressure sensor the actual required flow rate is dependent on the resulting counter pressure. The absolute deviation is dependent on the compressibility and the viscosity of the used solvent and on the pump. Therefore, it must be determined individually for each pump.

The flow rate can be altered while the pump is in operation.

Practical Tip! **Hold down both arrow keys to expedite changing the values.**

Process	Figure
1. Use the arrow keys to set a value for the flow rate. 2. Check if the right value appears on the display.	 Fig. 13 Display control

Result

The setting is completed and the pump runs at the set flow rate.

Setting the Pressure Switch Off

- Set maximum pressure to avoid damaging the pump or pump head.
- Set minimum pressure to avoid running the pump dry.

Legend

① Maximum value
② Minimum value

Note: **If the minimum is set to *0*, the minimum pump pressure is not monitored.**

Process	Figure
1. Press both arrow keys simultaneously until the correct display appears. 2. Let go of the arrow keys.	
3. When the cursor flashes, use the arrow keys again to set the value for the maximum pressure. 4. Hold down left arrow key. Press right arrow key once.	 Fig. 14 Maximum pressure
5. When the cursor flashes, use the arrow keys again to set the value for the minimum pressure. 6. Hold down left arrow key. Press right arrow key once to return to the start display.	 Fig. 15 Minimum pressure

Result

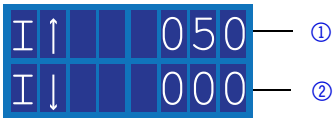
The setting is completed. If the maximum pressure is exceeded, the pump switches off. If the minimum pressure is undercut, the pump switches off after 30 s. The display shows an error message in both cases.

Setting the Power Consumption

The power consumption is dependent on the flow rate and the counter pressure. It increases with higher flow rates and stronger counter pressure.

- Exceeding or undercutting the values for the maximum or minimum power consumption leads to the pump being automatically shutdown.
- Set the maximum power consumption for the pump without pressure sensor to limit the pump pressure.
- Set the minimum power consumption so as to avoid a dry run of the pump at highly reduced maximum power consumption (e. g. if leaking).

The pump is preset to a standard value for the maximum power consumption. KNAUER recommends that with smaller flow rates the standard value for the maximum power consumption should be insignificantly decreased.



Legend

① Maximum value

② Minimum value

Note: **If the minimum is set to *0*, the minimum power consumption is not monitored.**

Process	Figure
1. Press both arrow keys simultaneously until the correct display appears. 2. Let go of the arrow keys.	
3. When the cursor flashes, use the arrow keys again to set the value for the maximum power consumption. 4. Hold down left arrow key. Press right arrow key once.	 Fig. 16 Minimum power consumption
5. When the cursor flashes, use the arrow keys again to set the value for the minimum power consumption. 6. Press start/stop key once to return to the start display.	 Fig. 17 Maximum power consumption

Result

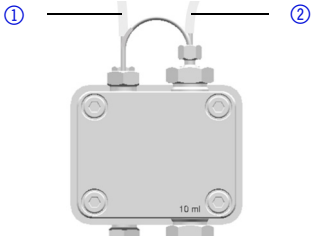
The setting is completed. If the value for maximum power consumption is exceeded, the pump switches off.

Flushing the Pistons

When you flush the pistons regularly, the service life of the seals and pistons increases. While flushing, contaminants are washed from the rear piston area.

The following solvents are recommended for flushing the columns:

- Water
- Mixture of 80 % water and 20 % ethanol
- Isopropanol

Process	Figure
1. Connect the outlet to the waste container with a hose ①. 2. Connect the inlet to the syringe with a hose ②. 3. Fill up flushing solution with the syringe through the pump head until there are no more air bubbles running through the waste bottle. 4. Afterwards, remove the hoses and connect inlet and outlet with a hose.	 Fig. 18 Flushing rear piston area

Software

To be able to control the pump using chromatography software, the computer must be connected to the device either with a RS232 cable or a LAN cable.

Via Local Area Network (LAN)

A device connected to a LAN is recognized by the software and automatically receives an IP address because it is set to Dynamic Host Configuration Protocol (DHCP) at the factory.

Prerequisite

- Device has been connected to LAN.
- Status display is active.

Process	Figure
1. Press both arrow keys simultaneously until the correct display appears. 2. Let go of the arrow keys. 3. Using the arrow keys, scroll until LAN.	 Fig. 19 Display control

Results

When setting is finished, the status display appears.

Via RS-232 Port

Prerequisite

- Interface RS-232 is connected.
- Status display is active.

Process	Figure
1. Press both arrow keys simultaneously until the correct display appears. 2. Let go of the arrow keys. 3. Using the arrow keys, scroll until RS-232 is displayed.	 Fig. 20 Display control

Results

When setting is finished, the status display appears.

Changing to Analog Control

Prerequisite

- Interfaces ANALOG IN and ANALOG OUT on the pin header are connected.
- Status display is active.

Process	Figure
1. Press both arrow keys simultaneously until the correct display appears. 2. Let go of the arrow keys. 3. Using the arrow keys, scroll until ANALOG is displayed.	 Fig. 21 Display control

Results

When setting is finished, the status display appears.

Control commands

The control commands listed below are considered for the communication with RS-232 and LAN. When entering a parameter, you must place a colon or space between command and parameter value, e. g. PMIN10:100.

Consider the following specifications for data transfer with RS-232 interface:

- 9600 baud
- 8 bit
- 1 stop-bit
- no parity check

Control command	Range and specification	Description
ADJ10(?)	RD/WR 100 – 2000	Adjust parameter for 10 ml pump head
ADJ50(?)	RD/WR 100 – 2000	Adjust parameter for 50 ml pump head
CORR10(?)	RD/WR 0 – 300	Correction parameter for 10 ml pump head
CORR50(?)	RD/WR 0 – 300	Correction parameter for 50 ml pump head
FLOW(?)	RD/WR 0 – 50000	Writing/reading the flow in µl/min
PRESSURE?	RD 0 – 400	Pressure readout in 0.1 MPa
PMIN10(?)	RD/WR 1 – 400	Minimum pressure for 10 ml pump head (in 0.1 MPa)
PMIN50(?)	RD/WR 150	Minimum pressure for 50 ml pump head (in 0.1 MPa)
PMAX10(?)	RD/WR 0 – 400	Maximum pressure for 10 ml pump head (in 0.1 MPa)
PMAX50(?)	RD/WR 0 – 150	Maximum pressure for 50 ml pump head (in 0.1 MPa)
IMIN10(?)	RD/WR 0 – 100	Minimum motor current for 10 ml pump head
IMIN50(?)	RD/WR 0 – 100	Minimum motor current for 50 ml pump head
IMAX10(?)	RD/WR 0 – 100	Maximum motor current for 10 ml pump head

Control command	Range and specification	Description
IMAX50(?)	RD/WR 0 – 100	Maximum motor current for 50 ml pump head
HEADTYPE(?)	RD/WR 10, 50	Writing/reading the pump-head type
STARTLEVEL(?)	RD/WR 0,1	Sets logical level of the START-IN input to start the flow delivery
ERRIO(?)	RD/WR 0,1	Writing/reading the ERROR input/ output, OUT (0) or IN (1)
STARTMODE(?)	RD/WR 0,1	0 = Pump pauses after switch on 1 = Pump starts with last used flow rate at switch on
EXTCONTR	WR 0,1	0 = Prevents external flow control 1 = Allows flow control through analog input (1 V = 1(5) ml/min)
EXTFLOW?	RD	
IMOTOR?	RD 0 – 100	Motor current in relative units
LOCAL	WR	Put the instrument in local mode
REMOTE	WR	Put the instrument in remote mode
ERRORS?	RD	Returns 5 last saved errors
ON	WR	Start flow
OFF	WR	Stop flow

Controlling the Flow Rate

To control the flow rate by an external control voltage, you need to select ANALOG control in the menu.

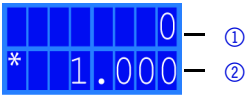


Fig. 22 Status display

Legend

① Pressure in 0,1 MPa

② Flow rate in ml/min

Prerequisite

The pump is connected to the power supply.

Procedure

1. Apply control voltage.
2. Press the Start/Stop button, so as to start the pump. The star symbol on the display of the pump indicates that the pump is working with an externally controlled flow rate.
3. To stop the pump, press the start/stop key again.

Starting with a Short-Circut

Connection for the short circuit (or TTL-low) for interrupting and continuing the operation of the pump. The operation of the pump is dependent on the STARTLEVEL setting:

- STARTLEVEL 1 *(standard setting RS-232, LAN)*: The pump does not operate during the time of short-circuit.
- STARTLEVEL 0 *(standard setting Analog)*: The pump operates during the time of short-circuit.

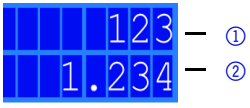


Fig. 23 Status display

Legend

① Pressure in 0,1 MPa

② Flow rate in ml/min

Enter *STARTLEVEL:1* in the terminal program, to stop the pump during short-circuit.

Prerequisite

The pump is connected to the power supply.

Note: During the interruption, the horizontal arrow remains in the display, because the pump is still in operation status.

Procedure

1. Connect the pump to a suitable terminal program.
2. Connect the pump using a LAN or RS-232.
3. Enter *STARTLEVEL:1*.

Starting Directly after Connecting to Power Supply

By default the pump is stopped and started using the start/stop button. The STARTMODE setting allows you to start the device right after connecting it to power supply.

- STARTMODE 0 *(default setting RS-232, LAN)*: The pump does not start operating right after being connected to power supply.
- STARTMODE 1 *(default setting Analog)*: The pump starts operating right after being connected to power supply.

Enter in the terminal program using RS-232 *STARTMODE:1*, so that the pump is in operation directly after being connected to the power supply.

Prerequisite

The pump is connected to the power supply.

Procedure

1. Connect the pump to a suitable terminal program.
2. Connect the pump using a LAN or RS-232.
3. Enter *STARTMODE:1.*

Switching Off the Pump

If you want to switch off the pump for a longer term, flush the pump head with isopropanol.

Functionality Tests

Installation Qualification (IQ)

The customer may request the Installation Qualification, which is free of charge. In case of a request, the Technical Support of KNAUER or from a provider authorized by KNAUER performs this functionality test during the installation. The Installation Qualification is a standardized document that comes as part of the delivery and includes the following:

- confirmation of flawless condition at delivery
- check if the delivery is complete
- certification on the functionality of the device

Operation Qualification (OQ)

The Operation Qualification includes an extensive functionality test and must be purchased from the manufacturer. Contact the KNAUER Sales Department to request an offer. The Operation Qualification is a standardized KNAUER document and includes the following:

- definition of customer requirements and acceptance terms
- documentation on device specifications
- device functionality check at installation site

Test Intervals

To make sure that the device operates within the specified range, you should test the device using the Operation Qualification at following intervals:

Average Useful Life	OQ Test
1 to 5 days/week:	Every 6 months
More than 5 days/week or 24 hours/day:	Every 3 months
Operation with buffer solutions or other salt solutions:	Every 3 months

Execution

The test can be carried out either by the Technical Support of KNAUER or from a provider authorized by KNAUER.

Troubleshooting

First measures for troubleshooting:

- Check all screw fittings
- Check whether air has gotten into the supply lines
- Check device for leaks

Further measures:

- Check errors against error list
- Contact the technical support of KNAUER

LAN

Go through the following steps, in case no connection between the computer and the devices can be established. Check after each step if the problem is solved. If the problem cannot be located, call the Technical Support.

1. Check the status of the LAN connection in the Windows task bar: -  Connected -  Connection not established If no connection was established, test the following: ▪ Is the router switched on? ▪ Is the patch cable connected correctly to the router and the computer?	☐

2. Check the router settings: ▪ Is the router set to DCHP server? ▪ Is the IP address range sufficient for all the connected devices?	☐
3. Check all connections: ▪ Are the patch cable connected to the LAN ports and not the WAN port? ▪ Are all cable connections between devices and router correct? ▪ Are the cables plugged in tightly?	☐
4. If the router is integrated into a company network, pull out the patch cable from the WAN port. ▪ Can the devices communicate with the computer, even though the router is disconnected from the company network?	☐
5. In case you own a Control Unit, check the settings in the menu *Setup* > *Network*. ▪ Is *LAN-DHCP* set for controlling? ▪ Did the device receive an IP address?	☐
6. Turn off all devices, router, and computer. Firstly, turn on the router and secondly turn on the devices and the computer. ▪ Has this been successful?	☐
7. Replace the patch cable to the device with that no connection could be established. ▪ Has this been successful?	☐
8. Make sure that the IP port of the device matches the port in the chromatography software.	☐

Error List and Solutions

Problem	Solution
Pump will not turn on	Power cable needs to be connected to power supply and power adapter has to be turned on. • Inspect the power cable to ensure that it is plugged into the power supply.

Problem	Solution
When purging, the pump switches off	The venting screw on the pressure sensor must be turned up. • Check if the venting screw on the pressure sensor is turned open.
Pump does not transport solvent	Check the following options: • Purge the pump head so as to remove the air bubbles • Inspect the eluent inlet and filter of the HPLC column and change when blocked. • Replacing the pump head • Clean the check valves • Exchange the check valves • If the pump head seals are defective, solvent enters the piston backflushing; inform the technical support of KNAUER.
Pressure or flow rate fluctuations	Check the following options: • Purge the pump head so as to remove the air bubbles • Always tighten the inlet screw and outlet screw on the pump head with a torque wrench and 7.5 Nm. Clean the check valves • Exchange the check valves
Pump head leaks	Check the following options: • Inspect the inlet and outlet screw fittings of the pump head • Replacing the pump head • If the pump head seals are defective, solvent enters the piston backflushing; inform the technical support of KNAUER.

Problem	Solution
Flow rate is not correct	Check the following options: • Inspect the inlet and outlet screw fittings of the pump head • Clean the check valves • Exchange the check valves • Replacing the pump head • Pump without pressure sensor: Pay attention to the influence of the pressure on the flow rate (will not be compensated). • Inform the Technical Support of KNAUER.
Pump will not turn on	Power cable needs to be connected to power supply and power adapter has to be turned on. • Inspect the power cable to ensure that it is plugged into the power supply.

Maintenance and Care

Proper maintenance of your HPLC device will ensure successful analyses and reproducible results.

CAUTION!
Intruding liquids can cause damage to the device.
- Place solvent bottles next to the device or in a solvent tray.
- Moisten the cleaning cloth only slightly.

All smooth surfaces of the device can be cleaned with a mild, commercially available cleaning solution, or with isopropanol.

Users may perform the following maintenance tasks themselves:

- Replacing the pump head
- Exchanging the check valves

Contacting the Technical Support

If you have any technical questions regarding the hardware or software of the manufacturer, please use one of the contact options below:

European Technical Support Hotline:

Languages: German and English
Available by telephone: 8 am to 5 pm (CET)

Phone: +49 30 809727 111
Fax: +49 30 8015010

E-mail: support@knauer.net (manufacturer)

Proper maintenance of your HPLC device will ensure successful analyses and reproducible results.

Maintenance Contract

The following maintenance work on the device may only be performed by KNAUER or a company authorized by KNAUER and is covered by a separate maintenance contract:

- Opening the device or removing housing parts.

Pump Head

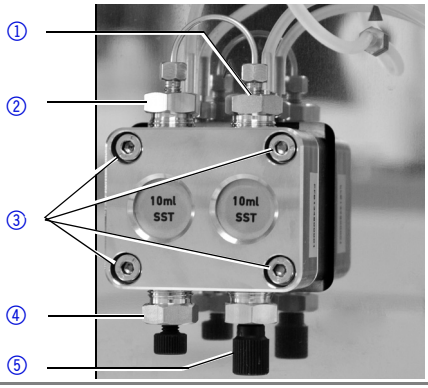
Removing the Pump Head

Requirements

The pump head has been flushed with suitable solvent.

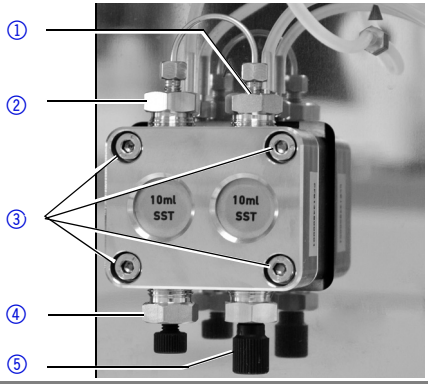
WARNING!
Aggressive or toxic solvent residue can irritate the skin!
Wear protective gloves.
Flush the pump head before exchanging it.

CAUTION!
Piston rods can break.
Before disassembling the pump head, remove the two piston rods and deposit in the correct orientation. When assembling the pump head, the piston rods must be inserted on the same side they have been removed from.

Process	Figure
1. Unscrew inlet fitting ② and outlet fitting ① . 2. Unscrew the inlet fitting ⑤ to the eluent. 3. Unscrew the outlet fitting ④ to the pressure sensor. 4. Alternately unscrew the 4 fastening screws ③ . 5. Hold the pump head and consecutively pull out all fastening screws.	

Installing the Pump Head

CAUTION!
Damage to the pump head caused by overtightened capillary fittings!
Note the torque of the fittings:
- 5 Nm for stainless-steel fittings
- 0.5 Nm for PEEK fittings

Process	Figure
1. Insert the fastening screws ③ and tighten alternately. 2. Tighten the outlet fitting ④ to the pressure sensor. 3. Tigthen the inlet fitting ⑤ to the eluent. 4. Tighten the inlet fitting ② and the outlet fitting ① of the piston.	

Check Valves

Dirty check valves do not open and close properly. They cause pressure fluctuations and irregular flow.

Note:

Insert the valves in the direction of flow!

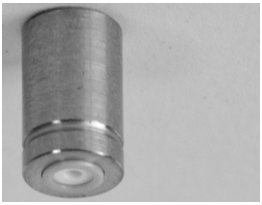


Fig. 24 Check valve

Removing the Check Valves

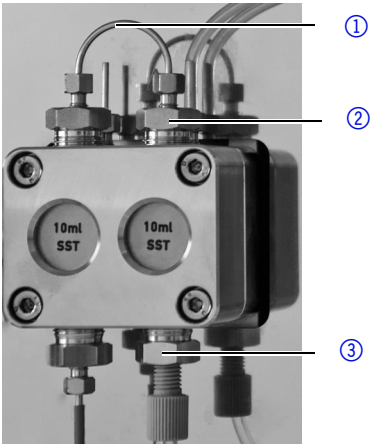
The pump head is equipped with two check valves.

Prerequisite

- The pump head has been purged.
- The capillary and tubing have been removed.
- The pump head has been removed.

Tools

Open-end wrench, size 13

Process	Figure
1. Unscrew and remove the capillary connector ①. 2. Loosen the outlet fitting ② with the open-end wrench. 3. Remove the first check valve. 4. Loosen the inlet fitting ③ with the open-end wrench. 5. Remove the second check valve.	 Fig. 25 Check valve in pump head

Next steps

Clean the check valves.

Cleaning the Check Valves

1. Fill a beaker with solvent.

2. Place the valve in the beaker.
3. Put the beaker in an ultrasonic bath for at least 10 minutes.

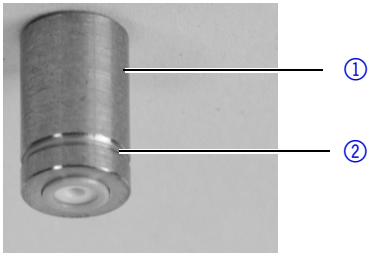
Installing the Check Valves

Insert the check valves in the direction of the flow. The notch of the check valve points downward. Insert the NP check valves in the direction of the flow. The arrow on the NP check valve points upward.

Prerequisite

The check valves have dried.

CAUTION
Damage to components caused by overtightened fittings!
Note the torque of the fittings:
- For stainless-steel fittings: 5 Nm
- For PEEK fittings: maximum 1 Nm or finger-tight and an additional quarter of a turn with appropriate pliers.

Process	Figure
1. Insert the check valves ① in such a way that the notch of the check valve ② points downward. 2. Screw in inlet and outlet fittings and tighten them with a torque wrench and the respective torque.	 Fig. 26 Check valve

Next steps

Re-install the pump head.

Technical Data

Solvent delivery	Pump type	Dual-piston pump with main and auxiliary piston
	Flow rate range	▪ 10 ml pump head: 0.001 - 10 ml/min ▪ 50 ml pump head: 0.01 - 50 ml/min
	Maximum pressure	▪ 10 ml pump head: 40 MPa to 10 ml/min Imax = 70 ▪ 50 ml pump head: 15 MPa to 50 ml/min Imax = 80
	Flow rate accuracy	▪ ± 1%, measured at 5 - 50% of flow range using ethanol/water 10:90 ▪ For pumps without a pressure sensor dependent on pressure
	Flow rate precision	Relative standard deviation RSD: < 0.5 % (1 ml/min)
	Gradients	▪ Isocratic HPLC pump ▪ Expandable to a binary high pressure gradient system (controlled by software)
	System protection	▪ Pump with pressure sensor: - P_{min} and P_{max} adjustable - I_{min} and I_{max} adjustable ▪ Pump with pressure sensor: I_{min} and I_{max} adjustable

Communication	Operation	▪ LAN ▪ RS-232 ▪ Analog ▪ Buttons on the device
	Analog inputs	0 – 10 V
	Supply frequency	50-60 Hz
	Active power consumption	maximum 40 W
	Protection	IP-20
Technical parameters	Temperature range	4 – 40 °C; 39.2 – 104 °F
	Humidity	below 90 % non-condensing
General	Power supply	100 – 240 V; 50 – 60 Hz
	Dimensions	▪ Pump without pressure sensor: 220 × 121 × 138.1 mm ▪ Pump with pressure sensor: 121 × 138.1 × 227.8 mm (width x height × depth)
	Weight	▪ Pump without pressure sensor: 2.3 kg ▪ Pump with pressure sensor: 2.4 kg
	Height above sea level	maximum 2000 m

Accessories and Spare Parts

For repeat orders of spare parts use the enclosed packing list. Contact the Technical Support in case there are any questions on spare parts or accessories.

Device and Accessories

Name	Order number
Pump	APG20
Accessories kit AZURA	FZA01
Accessories kit P 2.1S/P 4.1S	FPGA
User manual	V6870

Device Variations

Bezeichnung	Bestellnummer
Pump P 4.1S with 10 ml pump head (stainless steel)	APG20EA
Pump P 4.1S with 10 ml pump head (ceramic)	APG20EB
Pump P 4.1S with 50 ml pump head (stainless steel)	APG20FA
Pump P 4.1S with 50 ml pump head (ceramic)	APG20FB
Pump P 2.1S with 10 ml pump head (stainless steel)	APG90EA
Pump P 2.1S with 10 ml pump head (ceramic)	APG90EB
Pump P 2.1S with 10 ml pump head (Hastelloy-C)	APG90EC
Pump P 2.1S with 50 ml pump head (stainless steel)	APG90FA
Pump P 2.1S with 50 ml pump head (ceramic)	APG90FB

Available Pump Heads

Name	Order number
10 ml pump head with stainless-steel inlay	AHB40
10 ml pump head with ceramic inlay	AHB32
10 ml pump head with Hastelloy-C inlay	AHB43
50 ml pump head with ceramic inlay	AHC22
50 ml pump head with stainless-steel inlay	AHC20

Disposal

Hand in old devices or disassembled old components at a certified waste facility, where they will be disposed of properly.

AVV Marking in Germany

According to the German "Abfallverzeichnisverordnung" (AVV) (January, 2001), old devices manufactured by KNAUER are marked as waste electrical and electronic equipment: 160214.

WEEE Registration

KNAUER as a company is registered by the WEEE number DE 34642789 in the German "Elektroaltgeräteregister" (EAR). The number belongs to category 8 and 9, which, among others, comprise laboratory equipment.

All distributors and importers are responsible for the disposal of old devices, as defined by the WEEE directive. End-users can send their old devices manufac-

tured by KNAUER back to the distributor, the importer, or the company free of charge, but would be charged for the disposal.

Solvents and Other Operating Materials

All solvents and other operating materials must be collected separately and disposed of properly.

All wetted components of a device, e. g. flow cells of detectors or pump heads and pressure sensors for pumps, have to be flushed first with isopropanol and then with water before being maintained, disassembled or disposed.

Legal Information

Warranty Conditions

The factory warranty for the device is valid for 12 months after the date of dispatch. All warranty claims shall expire in the event that any unauthorized changes are made to the device.

During the warranty period, any components with material or design-related defects will be replaced or repaired by the manufacturer free of charge.

This warranty excludes the following:

- accidental or willful damage
- damage or errors caused by third parties that are not contractually related to the manufacturer at the time the damage occurs
- wear parts, fuses, glass parts, columns, light sources, cuvettes and other optical components
- damage caused by negligence or improper operation of the device and damage caused by clogged capillary
- packaging and transport damage

In the event of device malfunctions, directly contact the manufacturer.

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Hegauer Weg 38
14163 Berlin, Germany
Phone: +49 30 809727-111
Telefax: +49 30 8015010
e-mail: info@knauer.net
Internet: www.knauer.net

Transport Damage

The packaging of our devices provides the best possible protection against transport damage. Check the devices for signs of transport damage. In case you notice any damage, contact the Technical Support and the forwarder company within three workdays.

Abbreviations and Terminology

Here you can find information on the abbreviations and terminology used in this manual.

Term	Explanations
GLP	Good Laboratory Practice - quality assurance for laboratories
HPG	High Pressure Gradient. Operating mode of an HPLC system. The solvent is mixed on the high pressure side of the pump.
HPLC	High Performance Liquid Chromatography.
Solvent	Mobile phase (eluent) or carrier for liquid chromatography
Remote	External control with chromatography software or analog control signals

Index

Declaration of Conformity

Producer	KNAUER Wissenschaftliche Geräte GmbH Hegauer Weg 38 14163 Berlin, Deutschland		
Model/Type Reference	Pump	1. P 2.1S	Product No.: EPG90
		2. P 4.1S	Product No.: EPG20

The product complies with the following standards:

Machinery	Machinery Directive 2006/42/EC IEC 60799:1998
EMC	EMC Directive 2004/108/EC IEC 61000-3-2:2009 IEC 61326-10.2006
Disposal	RoHS Directive 2011/65/EU WEEE Directive 2012/19/EU
Safety	Low Voltage Directive 2006/95/EC IEC 61010-1:2001

CE The product was tested with a typical configuration. The mark of conformity has been applied to the rear panel.

Date Berlin, 01.10.2014

Alexanda Knauer (CEO and owner)

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Last manual update: 2015-07-03
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