Agilent 1200 Series Capillary Pump

User Manual

Agilent Technologies

Notices

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CAUTION

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WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

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Introduction to the Capillary Pump

Introduction to the Capillary Pump

The capillary pump consists of two identical pumping units in a single housing. It generates gradients by high-pressure mixing. A solvent selection valve provides flexibility in the choice of solvents.

The capillary pump is a binary pump. Mobile phase composition is produced by mixing the outputs of pump A and pump B. The solvent selection valve allows the pump A output to originate from either channel A1 or channel A2. The pump B output may originate from either channel B1 or channel B2.

Solvent degassing is not done directly in the pump. A 4-channel, low volume vacuum degasser, available as a separate module, provides degassed solvents to the pump channel inputs. Solvent degassing is required for best flow stability and detector stability, especially at the low flow rates required to run capillary LC applications.

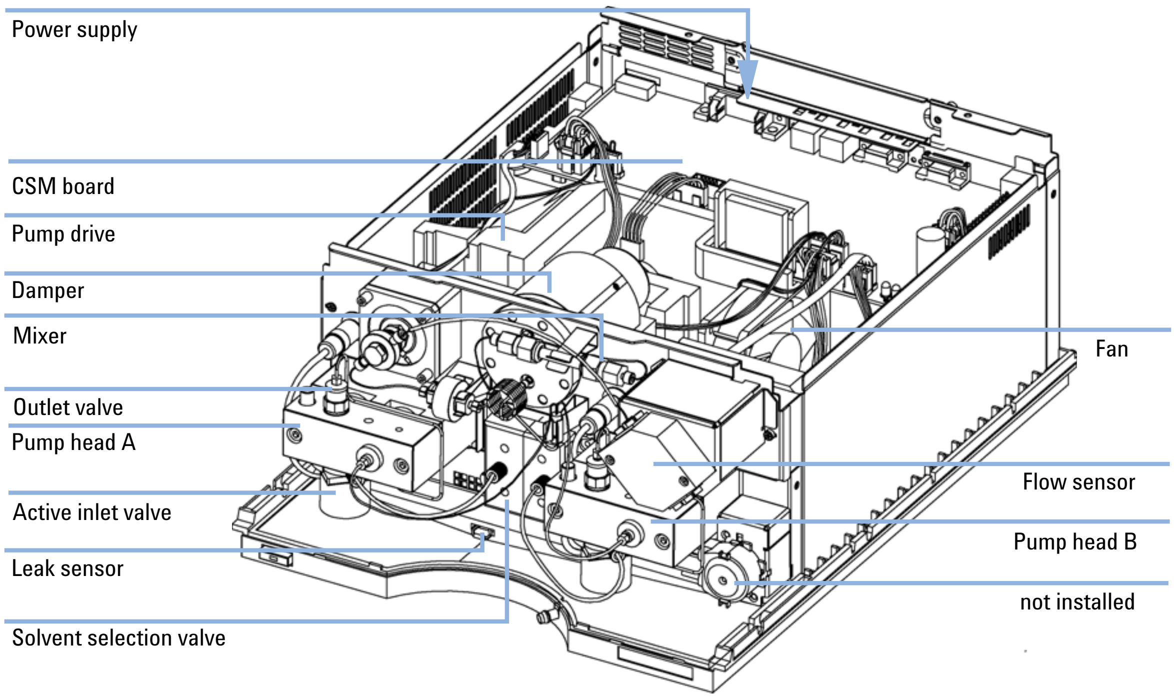


Figure 1 Overview of the Capillary Pump

Hydraulic Path Overview

The capillary pump is based on the Agilent 1200 binary pump, and performs all the functions necessary for a u-flow solvent delivery system. Basically, these functions are:

- Low Pressure Metering and High Pressure Delivery
- Solvent Compressibility Compensation
- Variable Stroke Volume
- Column Flow Measurement and Control

Low pressure solvent metering, and high pressure solvent delivery, are accomplished by two pump channels, each capable of delivering a maximum of 2.5 ml/min flow at up to 400 bar pressure.

Each channel consists of an identical, independently controlled pump unit Each pump unit includes a pump metering drive assembly and pump head assembly. The pamphlet assemblies both consist of two identical chambers, pistons and seals, plus an active inlet valve and an outlet ball valve.

The channel flow outputs are initially joined by a low volume pre-mixer, and are then connected by a capillary coil to a pressure pulse damper. The pressure pulse damper also serves as a pressure transducer, which sends system pressure information to the user interface.

The flow output of the pressure pulse damper is connected to a mixer. The standard mixer is a stainless steel tube filled with stainless steel balls. The mixer is where most of the mobile phase mixing is accomplished.

The mixer output flow, called main flow, is connected to the Electronic Flow Control (EFC) system. The EFC system consists of an Electro-Magnetic Proportioning Valve (EMPV) in series with a Flow Sensor. The EMPV is protected from particles in the mobile phase by a solvent filter frit. Responding to user-entered column flow setpoint, the EFC system determines how much of the main flow volume is ultimately delivered to the column. The remaining main flow volume, which is not required by the column, is diverted to waste by the EMPV.

Under user control, the EMPV can also function as a purge valve, for purposes of solvent changeover, etc. In this case, the EMPV is totally open, and the total main flow is diverted to waste.

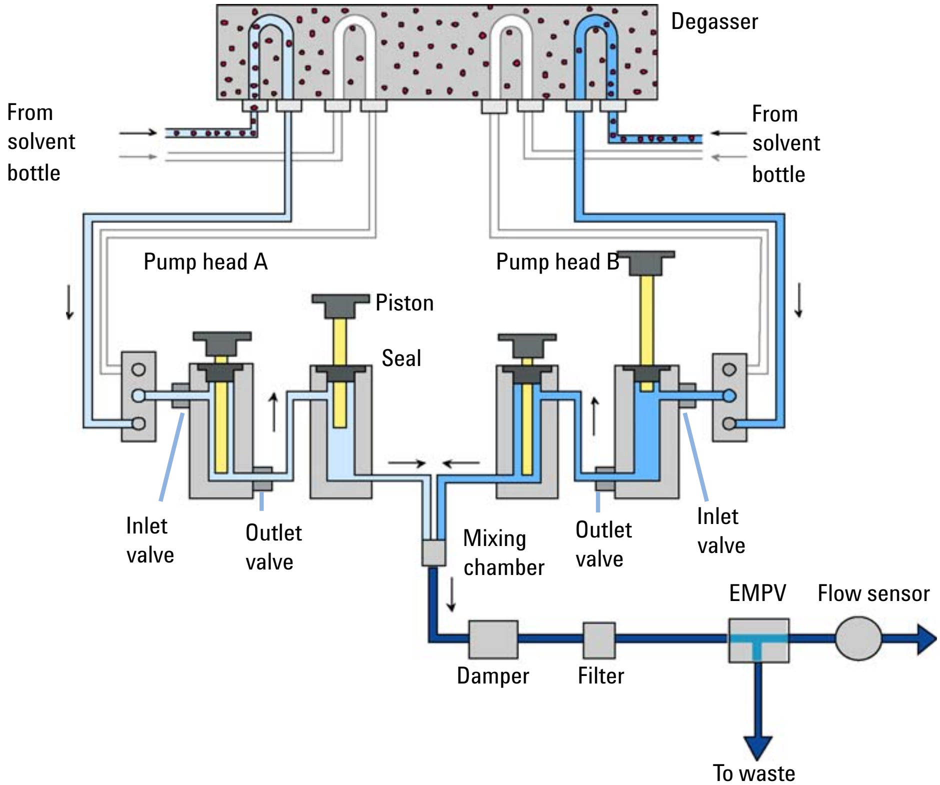


Figure 2 The Hydraulic Path

How Does the Pumping Unit Work?

Both pumping units (channel A and channel B) are identical with respect to parts and function. Each pumping unit consists of a pump head which is directly attached to a metering drive assembly.

In each metering drive assembly, a servo-controlled variable reluctance motor and gear train assembly are used to move two ball-screw drives. The gear train moves the two ball-screw drives in opposite directions (180 degree out of phase). The gear ratios are designed such that the first ball-screw drive constantly moves at twice the speed of the second ball-screw drive.

The servo motor includes a high resolution shaft-position encoder, which continuously reports the speed and direction of the motor in real time. This speed and direction information is used by the pump control electronics to ensure precise control of the servo motor movement.

Each pump head consists of two identical chambers, pistons and seals, plus an active inlet valve and an outlet ball valve. The solvent volume in each chamber is displaced by its piston. The pistons are directly moved by the reciprocating ball-screw drives of the metering drive assembly. Due to the gear design of the metering drive assembly, the pistons move in opposite directions, with piston 1 constantly moving at twice the speed of piston 2. The outer diameter of the piston is smaller than the inner diameter of the chamber, allowing solvent to flow in the gap between the piston and the chamber wall. The two chambers are connected by the pressure dependent outlet ball valve.

The position of the solvent selection valve determines which of two solvents will be sucked (low pressure) through the active inlet valve into chamber 1 during the intake stroke of piston 1. The active inlet valve is electrically opened and closed, making its operation more precise at low pressures. The stroke volume of piston 1 is between 2 µl and 100 µl, depending on flow rate.

When the capillary pump is first turned on, the user is prompted to initialize the pump. The initialization routine (occurring for both pump heads) first determines the precise movement limits for both pistons.These limits are then stored in the pump controller memory. Then, both pistons are set to their default initial positions.

When pumping begins, the active inlet valve is opened and piston 1 begins its intake stroke, sucking solvent into chamber 1. At the same time, piston 2 begins its delivery stroke, pumping (high pressure) the existing solvent in chamber 2 out of the pump head. The pressure produced by piston 2 also closes the outlet ball valve, preventing any chamber 2 solvent from back-streaming into chamber 1. After a predefined piston 1 stroke length, the servo motor is stopped, and the active inlet valve is closed. The pistons now reverse directions. Piston 1 begins its delivery stroke (high pressure), and piston 2 begins its intake stroke. Piston 2 is moving at only half the speed of piston 1. The outlet ball valve is forced open by the pressure generated by piston 1. Piston 1 begins to deliver the volume previously sucked into chamber 1. Because of the 2:1 speed ratio of the pistons, half of the solvent flow from chamber 1 is forced out of the pump head, continuing into the pump hydraulic path. The other half of the flow from chamber 1 simultaneously refills chamber 2.

When piston 1 has completed its delivery stroke, the pistons reverse direction, and the cycle is repeated.

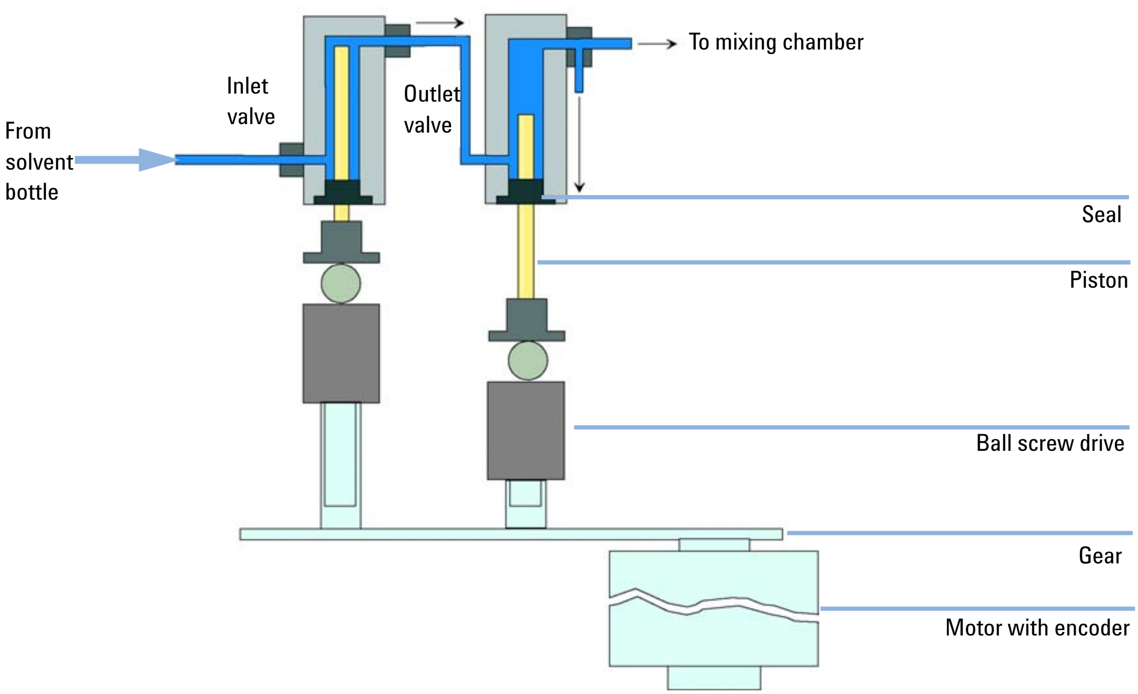


Figure 3 Operating Principle of the Pump Head

Table 1 Capillary Pump Details (continued)

Materials in contact with mobile phase	
Pump head	SST, gold, sapphire, ceramic
Active Inlet Valve	SST, gold, sapphire, ruby, ceramic, PTFE
Outlet Valve	SST, gold, sapphire, ruby, tantalum
Adapter	SST, gold
EMPV	SST, ruby, sapphire, PEEK
Flow Sensor	SST
Damping Unit	Gold, SST
Capillaries	Fused Silica

For pump specifications, see “Site Requirements” on page 24.

How Does Compressibility Compensation Work?

The compressibility of the solvents in use will affect retention-time stability when the back pressure in the system changes (for example, aging of column). In order to minimize this effect, the pump provides a compressibility compensation feature which optimizes the flow stability according to the solvent type. The compressibility compensation is set to a default value for each pump head independently. The compensation value for each pump head can be changed through the user interface.

Without a compressibility compensation the following will happen during a stroke of the first piston. The pressure in the piston chamber increases and the volume in the chamber will be compressed depending on backpressure and solvent type. The volume displaced into the system will be reduced by the compressed volume.

When a compressibility compensation value for a pump head is set, the pump processor calculates a compensation volume that depends on the system pressure and the selected compressibility value. This compensation volume is added to the delivery stroke of the first piston.

How Does Variable Stroke Volume Work?

Due to the compression of the pump-chamber volume each piston stroke of the pump will generate a small pressure pulsation, influencing the flow ripple of the pump. The amplitude of the pressure pulsation is mainly dependent on the stroke volume and the compressibility compensation for the solvent in use. Small stroke volumes will generate less pressure pulsations than higher stroke volumes at same flow rates. In addition the frequency of the pressure pulsations will be higher. This will decrease the influence of flow pulsations on quantitative results.

In gradient mode smaller stroke volumes resulting in less flow ripple will improve composition ripple.

The capillary pump uses a processor-controlled ball screw system to drive its pistons. The normal stroke volume is optimized for the selected flow rate. Small flow rates use a small stroke volume while higher flow rates use a higher stroke volume.

The stroke volume for the pump is set to AUTO mode. This means that the stroke is optimized for the flow rate in use. A change to larger stroke volumes is possible but not recommended.

When the pump is in the standard mode, the EMPV is fully closed. Total main flow, up to 2500 µl/min, is directed to the LC system. Column flow measurement/control is disabled. This mode is for non-capillary LC applications.

In the capillary mode, the standard flow sensor measures and controls column flow in the range of 0.01 µl/min to 20 µl/min. An extended range flow sensor (optional) provides flow measurement and control in the range of 0.01 µl/min to 100 µl/min. Flow measurement is based on the principle of mass flow temperature sensitivity. The flow sensor consists of a heated tube with two temperature sensors. As the mobile phase passes through the heated tube, the temperature characteristic distributed over the two temperature sensors is evaluated. From the temperature characteristic, flow rate accuracy is determined. The flow sensor measurement is calibrated for specific mobile phases, which are user-selectable.

Early Maintenance Feedback (EMF)

The early maintenance feedback (EMF) feature monitors the usage of specific components in the instrument, and provides feedback when the user-settable limits have been exceeded. The visual feedback in the user interface provides an indication that maintenance procedures should be scheduled.

For details on EMF counters and how to use them, see Agilent Lab Advisor.

Instrument Layout

The industrial design of the module incorporates several innovative features. It uses Agilent's E-PAC concept for the packaging of electronics and mechanical assemblies. This concept is based upon the use of expanded polypropylene (EPP) layers foam plastic spacers in which the mechanical and electronic boards components of the module are placed. This pack is then housed in a metal inner cabinet which is enclosed by a plastic external cabinet. The advantages of this packaging technology are:

- virtual elimination of fixing screws, bolts or ties, reducing the number of components and increasing the speed of assembly/disassembly,
- the plastic layers have air channels molded into them so that cooling air can be guided exactly to the required locations,
- the plastic layers help cushion the electronic and mechanical parts from physical shock, and
- the metal inner cabinet shields the internal electronics from electromagnetic interference and also helps to reduce or eliminate radio frequency emissions from the instrument itself.

The Electronics

The electronics are comprised of four main components:

- *The capillary separation main board* (CSM).
- *Power supply*.

Optional:

- *Interface board*(BCD/external contacts).
- *LAN Communication Interface Board*.

Capillary Separation Main Board (CSM)

The board controls all information and activities of all assemblies within the capillary pump. The operator enters parameters, changes modes and controls the capillary pump through interfaces (CAN, GPIB or RS-232C), connected to the user-interfaces.

The Main Power Supply Assembly

The main power supply comprises a closed assembly (no component-level repair possibility).

The power supply provides all DC voltages used in the binary pump module. The line voltage can vary in a range from 100 – 120 or 220 – 240 volts AC ± 10 % and needs no manual setting.

Optional Interface Boards

The Agilent 1200 Series modules have one optional board slot that allows addition of an interface board to the modules. Optional interface boards for the Agilent 1200 Series are:

- BCD Board
- LAN Communication Interface Board

Electrical Connections

- The GPIB connector is used to connect the capillary pump with a computer. The address and control switch module next to the GPIB connector determines the GPIB address of your capillary pump. The switches are preset to a default address which is recognized once after power on.
- The CAN bus is a serial bus with high-speed data transfer. The two connectors for the CAN bus are used for internal Agilent 1200 Series module data transfer and synchronization.
- One analog output provides a signal for integrators or data handling systems.
- The REMOTE connector may be used in combination with other analytical instruments from Agilent Technologies if you want to use features such as common shut down, prepare, and so on.
- The RS-232 connector may be used to control the capillary pump from a computer via RS-232 connection, using appropriate software. This connector needs to be activated by the configuration switch module next to the GPIB connector. The software needs the appropriate drivers to support this communication. See your software documentation for further information.
- The power input socket accepts a line voltage of 100 – 240 volts AC ± 10 % with a line frequency of 50 or 60 Hz. Maximum power consumption is 220 VA (Volt-Amps). There is no voltage selector on your capillary pump because the power supply has wide-ranging capability. There are no externally accessible fuses, because automatic electronic fuses are implemented in the power supply. The security lever at the power input socket prevents that the capillary pump cover is taken off when line power is still connected.
- The interface board slot is used for BCD output, LAN and for future use.

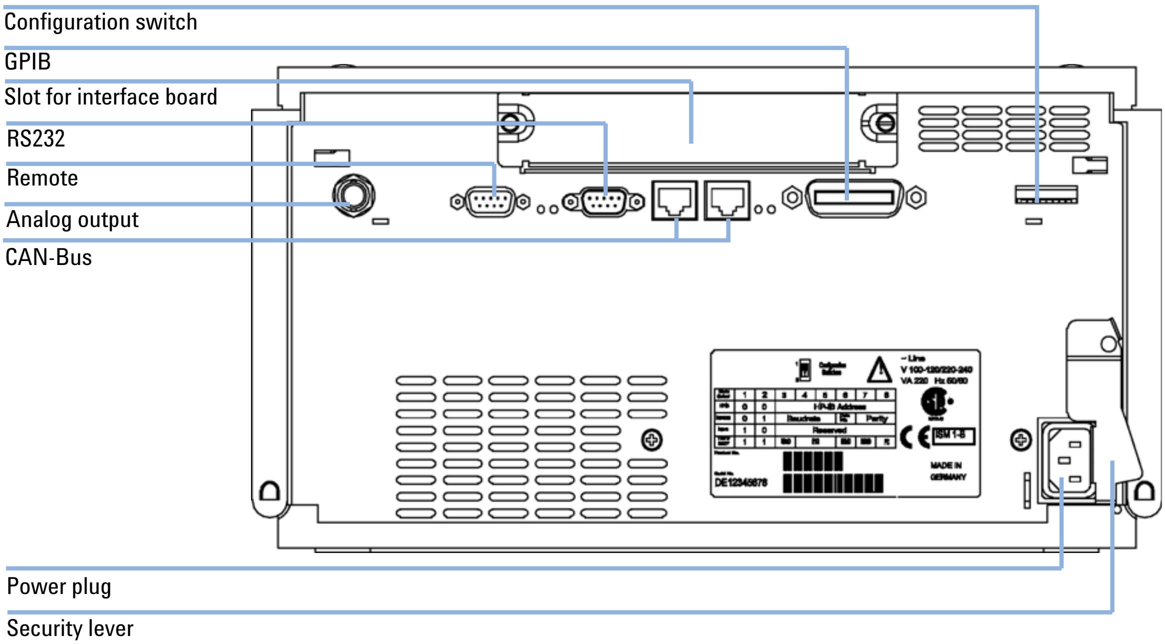


Figure 4 Electrical Connections to the Capillary Pump

Agilent 1200 Series Interfaces

The Agilent 1200 Series modules provide the following interfaces:

Table 2 Agilent 1200 Series Interfaces

Interface Type	Pumps	Autosampler	DA Detector MW Detector LC Detector	DA Detector MW Detector G1315C/ G1365C	VW Detector RI Detector	Thermostatted Column Compartment	Vacuum Degasser
CAN	Yes	Yes	Yes	Yes	Yes	Yes	No
LAN(on-board)	No	No	No	Yes	No	No	No
GBIP	Yes	Yes	Yes	No	Yes	No	No
RS-232C	Yes	Yes	Yes	Yes	Yes	Yes	No
Remote	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Analog	Yes	No	2x	2 ×	1 ×	No	Yes[1]
(LAN/BCD/Ext)[2]	Yes	Yes	Yes	Yes	Yes	No	No

1 The vacuum degasser will have a special connector for specific use. For details see description of main board.

2 Interface slot for specific interfacing (external contacts, BCD, LAN and so on)

For details on the available interfaces, see service manual.

2
Site Requirements and Specifications

Site Requirements

Site Requirements

A suitable environment is important to ensure optimal performance of the pump.

Power Cords

Different power cords are offered as options with the module. The female end of all power cords is identical. It plugs into the power-input socket at the rear of the module. The male end of each power cord is different and designed to match the wall socket of a particular country or region.

WARNING **The absence of ground connection and the use of an unspecified power cord can lead to electric shock or short circuit.**

Electric Shock

→ Never operate your instrumentation from a power outlet that has no ground connection.

→ Never use a power cord other than the Agilent Technologies power cord designed for your region.

WARNING **Use of unsupplied cables**

Using cables not supplied by Agilent Technologies can lead to damage of the electronic components or personal injury.

→ Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.

Power Considerations

The power supply of the pump has wide ranging capabilities and accepts any line voltage in the range mentioned in Table 3 on page 27. Consequently, there is no voltage selector at the back of the instrument. There are also no externally accessible fuses, as automatic electronic fuses are implemented in the power supply.

WARNING

Module is partially energized when switched off, as long as the power cord is plugged in.

Repair work at the module can lead to personal injuries, e.g. shock hazard, when the cover is opened and the module is connected to power.

→ Make sure that it is always possible to access the power plug.

→ Remove the power cable from the instrument before opening the cover.

→ Do not connect the power cable to the Instrument while the covers are removed.

WARNING

Incorrect line voltage at the instrument

Shock hazard or damage of your instrumentation can result, if the devices are connected to a line voltage higher than specified.

→ Connect your instrument to the specified line voltage.

CAUTION

Unaccessable power plug.

In case of emergency it must be possible to disconnect the instrument from the power line at any time.

→ Make sure the power connector of the instrument can be easily reached and unplugged.

→ Provide sufficient space behind the power socket of the instrument to unplug the cable.

Bench Space

The module dimensions and weight (see Table 3 on page 27) allow to place the module on almost any laboratory bench. It needs an additional 2.5 cm (1.0 inches) of space on either side and approximately 8 cm (3.1 inches) in the rear for the circulation of air and electric connections.

If the bench should carry a complete Agilent 1200 Series system, make sure that the bench is designed to carry the weight of all the modules.

NOTE The module should be operated in a horizontal position!

Environment

Your module will work within specifications at ambient temperatures and relative humidity as described in Table 3 on page 27.

CAUTION Condensation within the module

Condensation will damage the system electronics.

→ Do not store, ship or use your module under conditions where temperature fluctuations could cause condensation within the module.

→ If your module was shipped in cold weather, leave it in its box and allow it to warm slowly to room temperature to avoid condensation.

Physical Specifications

Table 3 Physical Specifications

Type	Specification	Comments
Weight	17 kg (38 lbs)	
Dimensions (width × depth × height)	180 x 345 x 435 mm (7 x 13.5 x 17 inches)	
Line voltage	100 – 240 VAC, ± 10%	Wide-ranging capability
Line frequency	50 or 60 Hz, ± 5%	
Power consumption	180 VA / 75 W / 256 BTU	Maximum
Ambient operating temperature	4 to 55 °C (41 to 131 °F)	
Ambient non-operating temperature	-40–70 °C (-4–158 °F)	
Humidity	< 95%, at 25–40 °C (77–104 °F)	Non-condensing
Operating Altitude	Up to 2000 m (6500 ft)	
Non-operating altitude	Up to 4600 m (14950 ft)	For storing the module
Safety standards: IEC, CSA, UL	Installation Category II, Pollution Degree 2	For indoor use only. Research Use Only. Not for use in Diagnostic Procedures.

Performance Specifications

Table 4 Performance Specification Agilent 1200 Series Capillary Pump

Type	**Specification**
Hydraulic system	Two dual piston in series, with proprietary servo-controlled variable stroke drive, floating piston, active inlet valve, solvent selection valve and electronic flow control for flow rates up to 100 µl/min
Settable column flow range	0.01 – 20 µl/min 0.01 – 100 µl/min (with the extended flow range kit) 0.001 – 2.5 µl/min (with the electronic flow control bypassed)
Recommended column flow range	1 – 20 µl/min 10 – 100 µl/min (with extended flow range kit) 0.1 – 2.5 ml/min (with the electronic flow sensor bypassed)
Column flow precision	< 0.7 % RSD or 0.03 % SD (typically 0.4 % RSD or 0.02 % SD), at 10 µl/min and 50 µl/min column flow (based on RT, default setting)
Optimum composition range	1 to 99% or 5 µl/min per channel (primary flow), whatever is greater
Composition precision	< 0.2 % SD, at 10 µl/min (20 µl flow sensor), 50 µl/min (100 µl flow sensor) and 1 ml/min (normal mode) default setting
Delay volume	Typically 3 µl from the electronic flow control to the pump outlet for flow rates up to 20 µl/min. Typically 12 µl from the electronic flow control to the pump outlet for flow rates up to 100 µl. for flow rates up to 100 µl/min and electronic flow control active: primary flow path 180 - 480 µl without mixer, 600 - 900 µl with mixer (system pressure dependant) Typically 180 to 480 µl (system pressure dependent) without mixer for flow rates up to 2.5 ml/min. (Mixer delay volume 420 µl)
Pressure range	20 to 400 bar (5880 psi) system pressure
Compressibility compensation	User-selectable, based on mobile phase compressibility
Recommended pH range	1.0 – 8.5, solvents with pH < 2.3 should not contain acids which attack stainless steel. Upper pH range is limited by fused silica capillaries.

Table 4 Performance Specification Agilent 1200 Series Capillary Pump

Type	Specification
Control and data evaluation	Agilent Control Software (Chemstation, EZ-Chrom, OL, etc.)
Analog output	For pressure monitoring, 2 mV/bar, one output
Communications	Controller-area network (CAN), GPIB, RS-232C, APG Remote: ready, start, stop and shut-down signals, LAN optional
Safety and maintenance	Extensive diagnostics, error detection and display (through instant pilot and Agilent Lab Monitor & Diagnostic Software), leak detection, safe leak handling, leak output signal for shutdown of pumping system. Low voltages in major maintenance areas.
GLP features	Early maintenance feedback (EMF) for continuous tracking of instrument usage in terms of seal wear and volume of pumped mobile phase with user-settable limits and feedback messages. Electronic records of maintenance and errors.
Housing	All materials recyclable.

3
Installing the Pump

Unpacking the Capillary Pump

Damaged Packaging

Upon receipt of your module, inspect the shipping containers for any signs of damage. If the containers or cushioning material are damaged, save them until the contents have been checked for completeness and the instrument has been mechanically and electrically checked. If the shipping container or cushioning material is damaged, notify the carrier and save the shipping material for the carrier's inspection.

Delivery Checklist

Ensure all parts and materials have been delivered with the capillary pump. The delivery checklist is shown in Table 5 on page 32. To aid in parts identification, please see "Parts and Materials for Maintenance" on page 145. Please report missing or damaged parts to your local Agilent Technologies sales and service office.

Table 5 Capillary Pump Checklist

Description	**Quantity**
Capillary pump	1
Solvent cabinet	1 (**5062-8591**)
Solvent bottle	1X**9301-1450** amber bottle, 3X**9301-1420** transparent bottle
Bottle head assembly	4 (**G1367-60003)**
Capillary	**G1375-87310**
Power cable	1
CAN cable, 1 m	1
Remote cable	As ordered
Signal cable	As ordered

Table 5 Capillary Pump Checklist

Description	Quantity
Service Manual	1
Accessory kit (see Table 6 on page 33)	1

Accessory Kit Contents - Capillary Pump

Table 6 Accessory Kit Contents G1376-68705

Description	Part Number	Quantity
Seal insert tool	**01018-23702**	1
Wrench 1/4 – 5/16 inch	**8710-0510**	1
Wrench 14 mm	**8710-1924**	1
Wrench 7/16 inch	**8710-0806**	2
ESD wrist strap[1]	**9300-1408**	1
Hex key 3 mm	**8710-2411**	1
Hex key 2.5 mm	**8710-2412**	1
Waste tube	**0890-1760**	2 m

[1] ESD: Electrostatic Discharge

Optimizing the Stack Configuration

If your capillary pump is part of a complete 1200 series system, you can ensureoptimum performance by limiting the configuration of the system stack to the following configuration. This configuration optimizes the system flow path, ensuring minimum delay volume.

NOTE For a detailed view of the flow connections refer to the section “Flow connections” in chapter 1 of the product information of the individual modules.

NOTE If a single stack configuration becomes too high, e.g. if an additional module like a G1327A ALS Thermostat is added or if your bench is too high, a two stack configuration may be a better setup. Separate the stack between pump and autosampler and place the stack containing the pump on the right side of the stack containing the autosampler.

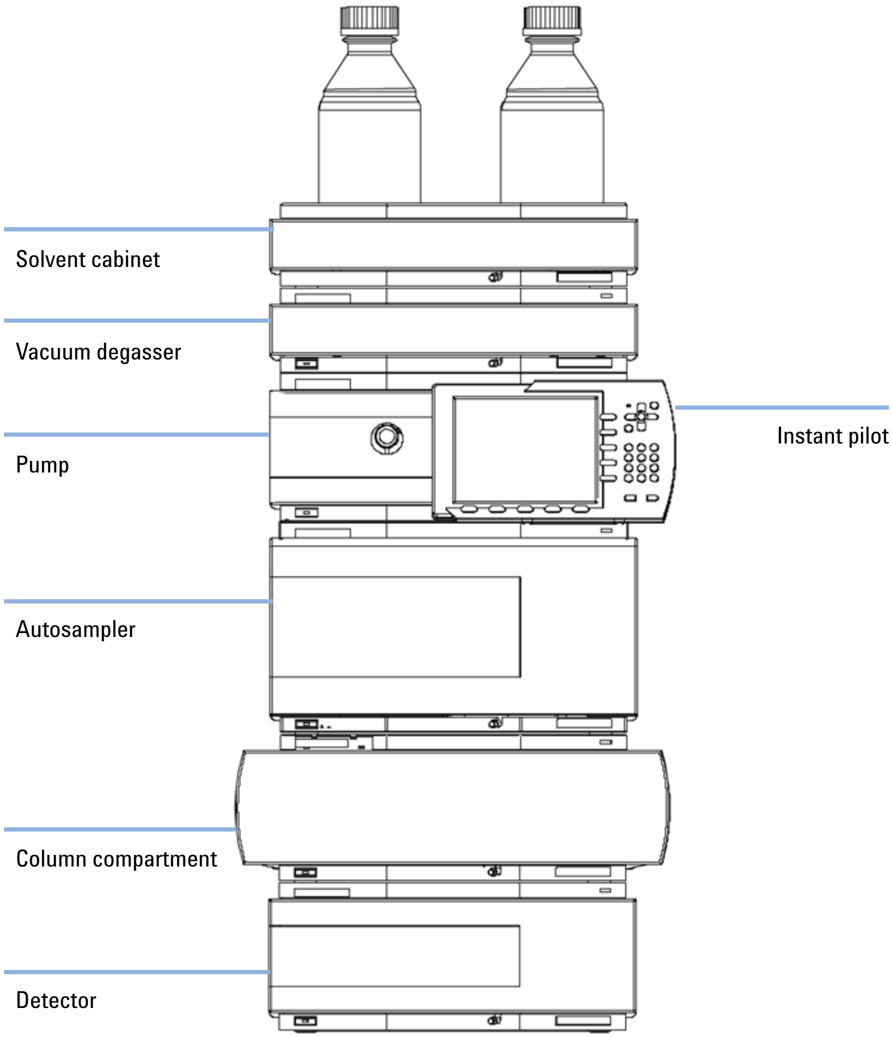


Figure 5 Recommended Stack Configuration (Front View)

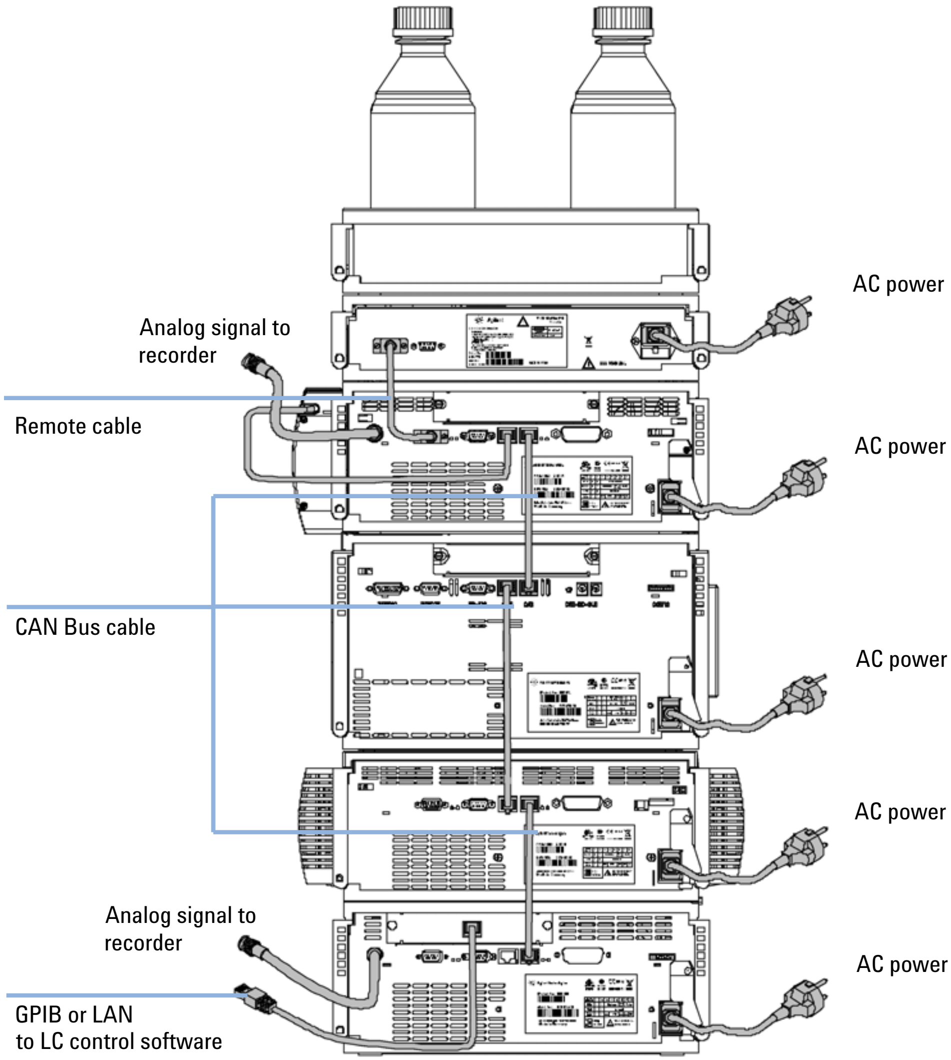


Figure 6 Recommended Stack Configuration (Rear View)

Installing the Capillary Pump

Parts required

#	Part number	Description
1		Pump
1		Power cord, for other cables see text below and “Cable Overview” on page 158
1	G4208A	Control Software (ChemStation, EZChrom, OL, etc.)
1	G1323B	and/or a handheld controller (Instant Pilot or Control Module)

Preparations

- Locate bench space.
- Provide power connections.
- Unpack the pump.

WARNING

Module is partially energized when switched off, as long as the power cord is plugged in.

Repair work at the module can lead to personal injuries, e.g. shock hazard, when the cover is opened and the module is connected to power.

→ Make sure that it is always possible to access the power plug.

→ Remove the power cable from the instrument before opening the cover.

→ Do not connect the power cable to the Instrument while the covers are removed.

CAUTION

"Defective on arrival" problems

If there are signs of damage, please do not attempt to install the module. Inspection by Agilent is required to evaluate if the instrument is in good condition or damaged.

→ Notify your Agilent sales and service office about the damage.

→ An Agilent service representative will inspect the instrument at your site and initiate appropriate actions.

1 Place the Pump horizontally on the bench.

2 Ensure the power switch on the front of the capillary pump is OFF (switch stands out).

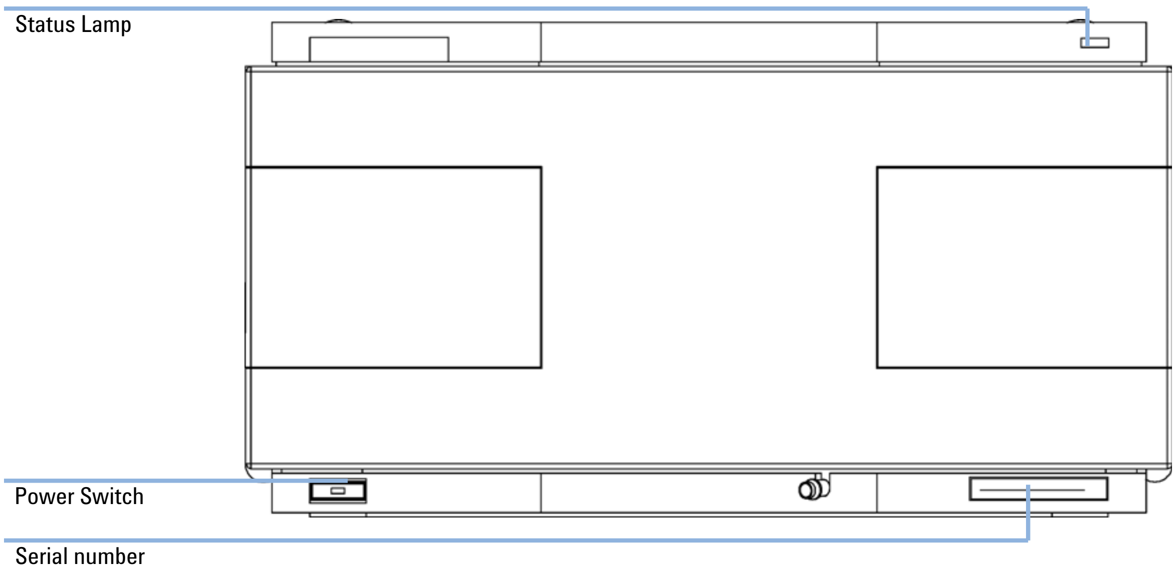


Figure 7 Front of Capillary Pump

3 At the rear of the module move the security lever to its maximum right position.

4 Connect the power cable to the power connector at the rear of the module. The security lever will prevent that the cover is opened while the power cord is connected to the module.

5 Connect the required interface cables to the rear of the capillary pump, see "Connecting Agilent 1200 Series modules" on page 40.

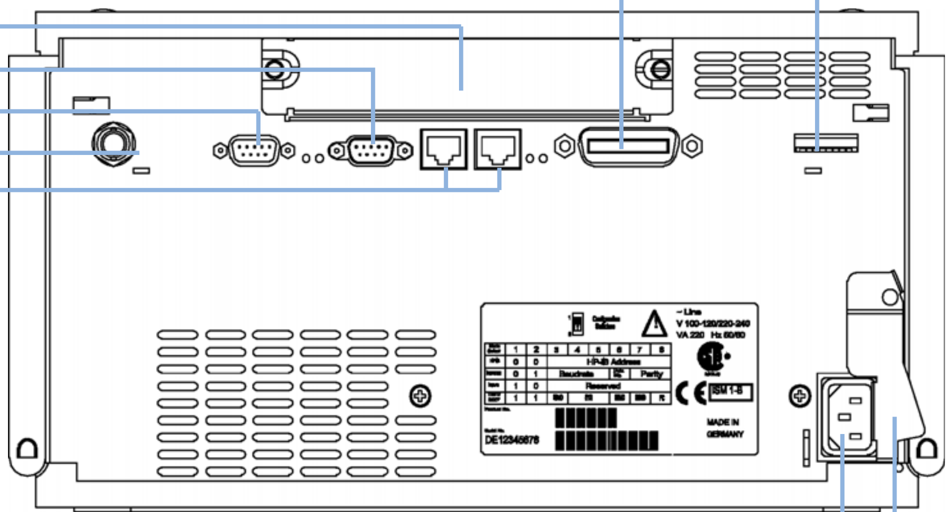


Figure 8 Rear of Capillary Pump

6 Connect the capillary, solvent tubes and waste tubings (see "Flow Connections of the Capillary Pump" on page 42).

7 Press the power switch to turn the pump on.

NOTE The power switch stays pressed in and the green indicator LED in the power switch is on while the pump is turned on. When the line power switch stands out and the green light is off, the pump is turned off.

8 Purge the capillary pump (see "Priming your capillary LC system with the pump" on page 46).

NOTE The pump was shipped with default configuration settings. To change these settings, see configuring the capillary pump in the service manual.

Connecting Modules and Control Software

WARNING

Use of unsupplied cables

Using cables not supplied by Agilent Technologies can lead to damage of the electronic components or personal injury.

→ Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.

Connecting Agilent 1200 Series modules

1 Place the individual modules in a stack configuration as shown in Figure 5 on page 35.
2 Ensure the power switches on the front of the modules are OFF (switches stand out).
3 Plug a CAN cable into the CAN connector at the rear of the respective module (except vacuum degasser).
4 Connect the CAN cable to the CAN connector of the next module, see Figure 6 on page 36.
5 Press in the power switches to turn on the modules.

Connecting an Agilent 1200 Series Vacuum Degasser

1 Place the vacuum degasser in the stack of modules as shown in Figure 5 on page 35.
2 Ensure the power switch on the front of the vacuum degasser is OFF (switch stands out).
3 Plug an APG cable into the APG remote connector at the rear of the module.
4 Connect the APG cable to the APG remote connector of the pump, see Figure 6 on page 36.
5 Press in the power switches to turn on the vacuum degasser.

NOTE The AUX output allows the user to monitor the vacuum level in the degasser chamber.

Connecting control software and/or control modules

1. Ensure the power switches on the front of the modules in the stack are OFF (switches stand out).
2. Plug a GPIB cable into the GPIB connector at one of the modules, preferably at the detector (MUST for the DAD).
3. Connect the GPIB cable to the Agilent control software in use.
4. Plug a CAN cable into the CAN connector of the control module.

NOTE Do not connect the Agilent control software or the control module with the vacuum degasser.

5. Connect the CAN cable to the CAN connector of one of the modules.
6. Press in the power switches to turn on the modules.

NOTE The Agilent control software (e.g. ChemStation, EZChrom, OL, etc.) can be also be connected to the system through a LAN cable, which requires the installation of a LAN-board. For more information about connecting the control module or Agilent control software refer to the respective user manual. For connecting the Agilent 1200 Series equipment to non-Agilent 1200 Series equipment, see “Introduction to the Capillary Pump” on page 8.

Flow Connections of the Capillary Pump

Parts required	#	Part number	Description
			Other modules
		G1376-68705	Parts from accessory kit (see “Accessory Kit Contents - Capillary Pump” on page 33)
	2		wrenches 1/4 - 5/16 inch for capillary connections

Preparations Pump is installed in the LC system

WARNING

When opening capillary or tube fittings solvents may leak out.

The handling of toxic and hazardous solvents and reagents can hold health risks.

→ Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.

1 Remove the front cover by pressing the snap fasteners on both sides.

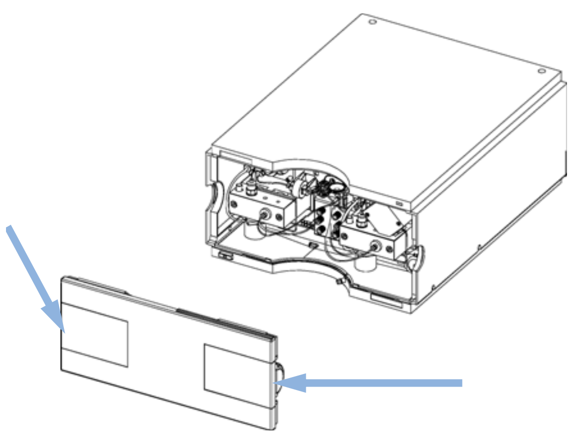


Figure 9 Removing the Front Cover

2 Place the solvent cabinet on top of the capillary pump.

3 Place the bottles into the solvent cabinet and place a bottle head assembly into each bottle.

4 Connect the solvent tubes from the bottle head assemblies to the inlet connectors A1, A2, B1 and B2 of the solvent selection valve and label the tubes accordingly. Fix the tubes in the clips of solvent cabinet and capillary pump.

5 Using a piece of sanding paper connect the waste tubing to the EMPV and place it into your waste system.

6 If the micro pump is not part of a Agilent 1200 System stack or placed on the bottom of a stack, connect the corrugated waste tube to the waste outlet of the pump leak handling system.

7 Purge your system before first use (see “Priming your capillary LC system with the pump” on page 46).

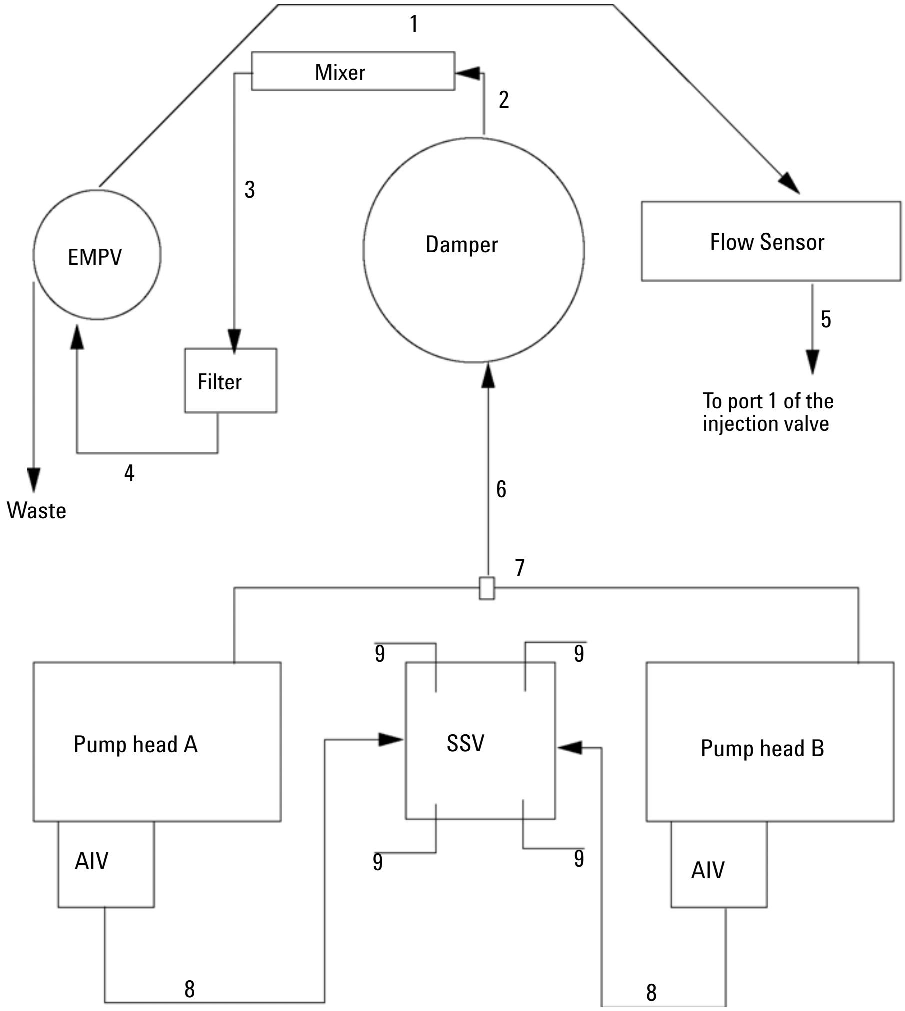


Figure 10 Flow connection of the capillary pump

1	**G1375-87301**
2	**01090-87308**
3	**01090-87308**
4	**G1375-87400**

5	**G1375-87310**
6	**G1312-67304**
7	**G1312-67302**
8	**G1311-67304**
9	**G1311-60003**

Get the System Ready for the First Injection

When you are using the system for the first time it is recommended to prime it to remove all the air and the possible contamination introduced in the flow path during the installation.

NOTE

The pump should never be used for priming empty tubings (never let the pump run dry). Use the syringe to draw enough solvent for completely filling the tubings to the pump inlet before continuing to prime with the pump.

Priming your capillary LC system with the pump

WARNING

When opening capillary or tube fittings solvents may leak out.

The handling of toxic and hazardous solvents and reagents can hold health risks.

➔ Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.

1 At the pump, activate the *Purge Mode* and set the flow rate to 2.5 ml/min.
2 Flush the vacuum degasser and all tubes with at least 5 ml of solvent.
3 Set flow to required value of your application and activate the pump *micro mode*.
4 Pump for approximately 5 minutes before starting your application.
5 Repeat step 1 on page 46 through step 2 on page 46 for the other channel(s) of the capillary pump.

NOTE

When the pumping system has been turned off for a certain time (for example, overnight) oxygen will re-diffuse into the solvent channel between the vacuum degasser and the pump. Solvents containing volatile ingredients will slightly lose these, if left in the degasser without flow for a prolonged period of time. Therefore purging each channel at 2.5 ml/min for 1 minute is required before starting an application.

4
Using the Capillary Pump

Hints for Successful Use of the Capillary Pump

Pump issues

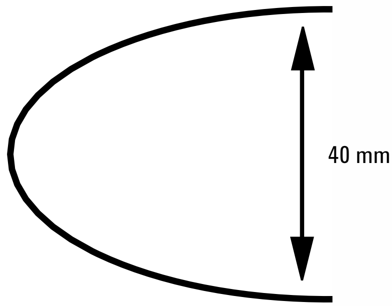
- Flush the pump extensively. First with in the “*purge mode*”, second with a pressure applied to remove all the gas bubbles. It is recommended to do this first with 100% A and than 100% B.
- The system pressure must be higher than 20 Bar at the pump outlet.
- In “*micro mode*” unexpected high column flow variation is an indication for dirt within the system, blocked frits or leaking pump valves.
- Place solvent cabinet with the solvent bottles always on top (or at a higher level) of the capillary pump.
- Prevent blocking ofsolvent inlet filters (never use the pump without solvent inlet filter). Growth of algae should be avoided.
- When using buffer solutions, flush the system with water before switching it off.
- Check the pump plungers for scratches when changing the piston seals. Scratched plungers will lead to micro leaks and will decrease the lifetime of the seal.
- After changing the plunger seals apply the seal wear-in procedure.
- Place the aqueous solvent on channel A and the organic solvent on channel B. The default compressibility and flow sensor calibration settings are set accordingly. Always use the correct calibration values.
- For generation of fast gradients on short columns remove the mixer, enter the new pump configuration and select the fast gradient range for the primary flow rate (chromatographic performance will not be impacted).
- When running the “*Micro mode*” check the correct instrument setup (flow sensor type, used mixer and filter).

Fused Silica Capillary issues

- When you connect a capillary (especially at the column) press it smoothly into the fitting to avoid air gaps. Incorrect setting will result in dispersion causing tailing or footing peaks.

NOTE Do not overtighten the Fused Silica Capillaries. Refer to the capillaries and fittings Chapter in this manual for correct installation.

- Be careful when you bend a Fused Silica Capillary. The diameter must not be smaller than 40 mm.



- When you replace a part, especially a capillary, clean it with Acetone.
- If a fused silica capillary leaks, do not retighten under flow. Set column flow to zero, reinsert the capillary, tighten and set new column flow.
- Avoid the use of alkaline solutions (pH > 8.5) which can attack the fused silica from the capillaries.
- Be careful not to crush capillaries when applying module doors.
- A broken capillary can release silica particles into the system (e.g. cell) causing problems in the system down-stream of the break.
- A blocked capillary can be often cleaned by flushing it back. Acetone is recommended for this.

Solvent Information

Always filter solvents through 0.4 µm filters, small particles can permanently block the capillaries and valves. Avoid the use of the following steel-corrosive solvents:

- Solutions of alkali halides and their respective acids (for example, lithium iodide, potassium chloride, and so on).
- High concentrations of inorganic acids like sulfuric and nitric acid, especially at higher temperatures (replace, if your chromatography method allows, by phosphoric acid or phosphate buffer which are less corrosive against stainless steel).
- Halogenated solvents or mixtures which form radicals and/or acids, for example:

  $2CHCl_3 + O_2 \rightarrow 2COCl_2 + 2HCl$

  This reaction, in which stainless steel probably acts as a catalyst, occurs quickly with dried chloroform if the drying process removes the stabilizing alcohol.
- Chromatographic grade ethers, which can contain peroxides (for example, THF, dioxane, di-isopropylether). Such ethers should be filtered through dry aluminium oxide which adsorbs the peroxides.
- Solvents containing strong complexing agents (e.g. EDTA).
- Mixtures of carbon tetrachloride with 2-propanol or THF dissolve stainless steel.
- Avoid the use of alkaline solutions (pH > 8.5) which can attack the fused silica from the capillaries.

Prevent Blocking of Solvent Filters

Contaminated solvents or algae growth in the solvent bottle will reduce the lifetime of the solvent filter and will influence the performance of the module. This is especially true for aqueous solvents or phosphate buffers (pH 4 to 7). The following suggestions will prolong lifetime of the solvent filter and will maintain the performance of the module.

- Use a sterile, if possible amber, solvent bottle to slow down algae growth.
- Filter solvents through filters or membranes that remove algae.
- Exchange solvents every two days or refilter.
- If the application permits add 0.0001-0.001M sodium azide to the solvent.
- Place a layer of argon on top of your solvent.
- Avoid exposure of the solvent bottle to direct sunlight.

NOTE Never use the system without solvent filter installed.

Algae Growth in HPLC Systems

The presence of algae in HPLC systems can cause a variety of problems that may be incorrectly diagnosed as instrument or application problems. Algae grow in aqueous media, preferably in a pH range of 4-8. Their growth is accelerated by buffers, for example phosphate or acetate. Since algae grow through photosynthesis, light will also stimulate their growth. Even in distilled water small-sized algae grow after some time.

Instrumental Problems Associated With Algae

Algae deposit and grow everywhere within the HPLC system causing:

- Deposits on ball valves, inlet or outlet, resulting in unstable flow or total failure of the pump.
- Small pore solvent inlet filters to plug, resulting in unstable flow or total failure of the pump.
- Small pore high pressure solvent filters, usually placed before the injector to plug resulting in high system pressure.
- Column filters to plug giving high system pressure.
- Flow cell windows of detectors to become dirty resulting in higher noise levels (since the detector is the last module in the flow path, this problem is less common).

Symptoms Observed with the Agilent 1200 Series HPLC

In contrast to the HP 1090 and HP 1050 Series HPLC systems which use helium degassing, algae have a better chance to grow in systems such as the Agilent 1200 Series where helium is not used for degassing (most algae need oxygen and light for growth).

The presence of algae in the Agilent 1200 Series can cause the following to occur:

- PTFE frits, part number 01018-22707, (purge valve assembly) and column filter blockage causing increased system pressure. Algae appear as white or yellowish-white deposits on filters. Typically black particles from the normal wear of the piston seals do not cause the PTFE frits to block over short-term usage. Please refer to the section “Exchanging the Solvent Selection Valve” on page 132 in this manual.

- Short lifetime of solvent filters (bottle head assembly). A blocked solvent filter in the bottle, especially when only partly blocked, is more difficult to identify and may show up as gradient performance problems, intermittent pressure fluctuations etc.
- Algae growth may also be the possible source for failures of the ball valves and other components in the flow path.

How to Prevent and/or Reduce the Algae Problem

- Always use freshly prepared solvents, especially use demineralized water which was filtered through about 0.2 µm filters.
- Never leave mobile phase in the instrument for several days without flow.
- Always discard “old” mobile phase.
- Use the amber solvent bottle (part number 9301-1450) supplied with the instrument for your aqueous mobile phase.
- If possible add a few mg/l sodium azide or a few percent organic solvent to the aqueous mobile phase.

Inject the Check-out Sample

The purpose of the instrument check is to demonstrate that all modules of the instrument are correctly installed and connected. It is not a test of the instrument performance.

A single injection of the Agilent Technologies isocratic test standard is made under the conditions given below.

Conditions

Table 7 Conditions

Flow:	15.0 µl/minute
Stoptime:	~ 7.00 minutes
Solvent A:	30% (HPLC grade Water)
Solvent B:	70% (HPLC grade Acetonitrile)
Wavelength DAD/MWD:	Sample: 254/4 nm, Reference: 360/80 nm
Injector Volume:	200 nl
Column Temperature:	25.0 °C or ambient
Agilent 1200 Series Capillary LC Instrument	Degasser Capillary pump - 20 µl/minute sensor installed Micro Autosampler Column Compartment - optional Detector - DAD with 500 nL flow cell installed ChemStation Controlling Software (Chemstation, EZ-Chrom, OL, etc.)
Column:	ZORBAX SB C18, 5 µm, 150 x 0.5 mm Agilent Part No. 5064-8256
Standard:	Agilent Part No. 01080-68704 0.15 wt.% dimethylphthalate, 0.15 wt.% diethylphthalate 0.01 wt.% biphenyl, 0.03 wt.% o-terphenyl in methanol Diluted 1:10 in Acetonitrile

For instrument configurations other than shown above the conditions are altered to match the specifications of the instrument.

Procedure

1 Make a single injection of the isocratic test standard under the conditions given below.
2 Compare the resulting chromatogram with the typical chromatogram shown in Figure 11 on page 57.

Typical Chromatogram

A typical chromatogram for this analysis is shown in Figure 11 on page 57. The exact profile of the chromatogram will depend on the chromatographic conditions. Variations in solvent quality, column packing, standard concentration and column temperature will all have a potential effect on peak retention and response.

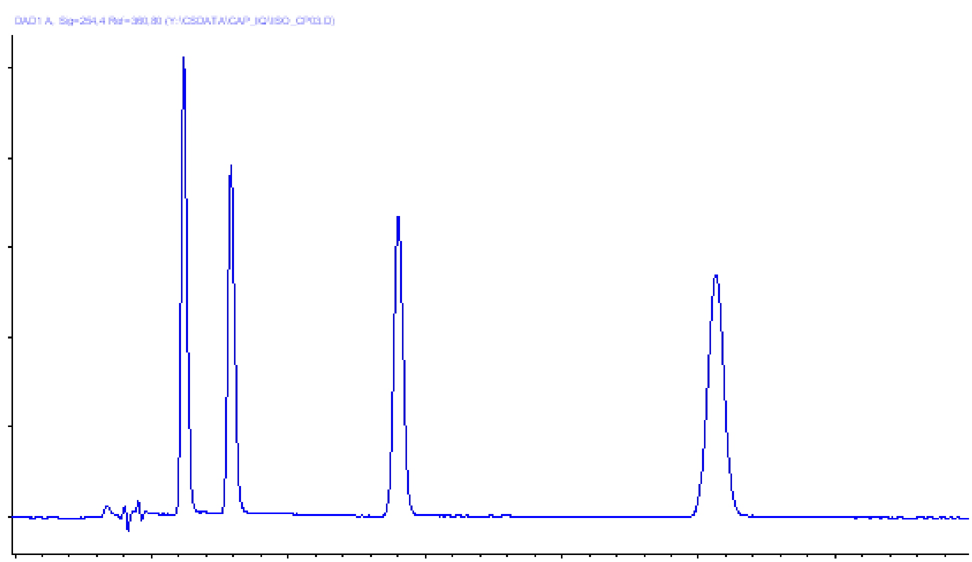


Figure 11 Chromatogram

5
Optimizing Performance

Hints for the Micro Vacuum Degasser

If you are using the vacuum degasser for the first time, if the vacuum degasser was switched off for any length of time (for example, overnight), or if the vacuum degasser lines are empty, you should prime the vacuum degasser before running an analysis.

The vacuum degasser can be primed by pumping solvent with the capillary pump at high flow rate (2.5 ml/min). Priming the degasser is recommended, when:

- vacuum degasser is used for the first time, or vacuum chambers are empty.
- changing to solvent that are immiscible with the solvent currently in the vacuum chambers.
- capillary pump was turned OFF for a length of time (for example during night) and volatile solvent mixtures are used.

For more information see the Reference Manual for the Agilent 1200 series micro vacuum degasser.

When to Use Alternative Seals

The standard seal for the pump can be used for most applications. However applications that use normal phase solvents (for example, hexane) are not suited for the standard seal and require a different seal when used for a longer time in the pump.

For applications that use normal phase solvents (for example, hexane) we recommend the use of the polyethylene seals, part number 0905-1420 (pack of 2). These seals have less abrasion compared to the standard seals.

NOTE Polyethylene seals have a limited pressure range 0–200 bar. When used above 200 bar their lifetime will be significantly reduced. **DO NOT** apply the seal wear-in procedure performed with new standard seals at 400 bar.

How to Choose the Primary Flow

The primary flow can be sets in three ranges:

- The default range

  The default range is the best compromise between performance and solvent consumption.

- The low solvent consumption range

  The low solvent consumption range, is recommended for long shallow gradient runs (e.g. peptide maps). It is not privileged when the application requires fast gradient. The selection of this range can result in less performance.

- The fast gradient range

  This range is recommended for running fast gradient (e.g. < 3 min). The equilibration time is optimized.

NOTE The primary flow is strongly dependant on the system pressure and the configuration of the pump, namely which filter, flow sensor and mixer are installed in the pump.

Table 8 on page 62 gives approximate primary flow values in function of the system pressure, and the set primary flow range.

Table 8 Primary flow overview for standard pump configuration

	0 bar System pressure	100 bar System pressure	200 bar System pressure	300 bar System pressure	400 bar System pressure
Low consumption range	200	225	250	275	300
Default range	500	570	640	710	780
Fast gradient range	800	995	1190	1385	1580

NOTE In any case the standard configuration is changed, the primary flow could be higher compared to the values in above table.

Static Mixer and Filter

The capillary pump is equipped with a static mixer and an inline filter in front of the EMPV.

The Standard Static Mixer

The standard static mixer has a volume of typically 420 µl. In order to reduce the delay volume of the pump you can remove the mixer.

Conditions to remove the static mixer:

- The delay volume of the pump should be reduced to a minimum for fastest gradient response.
- The detector is used at medium or low sensitivity.

NOTE Removing the mixer will result in an increase of the composition wander and higher detector noise.

The Standard Filter

The standard filter has a volume of typically 100 µl. If the application needs a reduced volume (e.g. for fast gradient) the 20 µl low volume filter (01090-68703) is recommended. Be aware that the filter efficiency and capacity is significantly reduced compared to the standard one.

NOTE Never run the capillary pump without an inline filter.

How to Optimize the Compressibility Compensation Setting

The compressibility compensation default settings are 50×10^{-6} /bar (best for most aqueous solutions) for pump head A and 115×10^{-6} /bar (to suit organic solvents) for pump head B. The settings represent average values for aqueous solvents (A side) and organic solvents (B side). Therefore it is always recommended to use the aqueous solvent on the A side of the pump and the organic solvent on the B side. Under normal conditions the default settings reduce the pressure pulsation to values (below 1 % of system pressure) that will be sufficient for most applications. If the compressibility values for the solvents used differ from the default settings, it is recommended to change the compressibility values accordingly. Compressibility settings can be optimized by using the values for various solvents described in Table 9 on page 66. If the solvent in use is not listed in the compressibility table, when using premixed solvents and if the default settings are not sufficient for your application the following procedure can be used to optimize the compressibility settings:

NOTE Use the capillary pump in the *Normal Mode* at least 100 µl/min.

1 Start channel A of the capillary pump with the adequate flow rate. The system pressure must be between 50 and 250 bar
2 Before starting the optimization procedure, the flow must be stable. Use degassed solvent only. Check the tightness of the system with the pressure test.
3 Your pump must be connected to a control software (e.g. ChemStation, EZChrom, OL, etc.) or handheld controller with which the pressure and %-ripple can be monitored, otherwise connect a signal cable between the pressure output of the pump and a recording device (for example, 339X integrator) and set parameters.

   Zero 50%

   Att 2^3 Chart

   Speed 10 cm/min
4 Start the recording device with the plot mode.

5 Starting with a compressibility setting of 10×10^{-6} /bar increase the value in steps of 10. Re-zero the integrator as required. The compressibility compensation setting that generates the smallest pressure ripple is the optimum value for your solvent composition.

6 Repeat step 1 on page 65 through step 5 on page 66 for the B channel of your capillary pump.

Table 9 Solvent Compressibility

Solvent (pure)	Compressibility (10-6/bar)
Acetone	126
Acetonitrile	115
Benzene	95
Carbon tetrachloride	110
Chloroform	100
Cyclohexane	118
Ethanol	114
Ethyl acetate	104
Heptane	120
Hexane	150
Isobutanol	100
Isopropanol	100
Methanol	120
i-Propanol	100
Toluene	87
THF	95
Water	46

6
Troubleshooting and Diagnostics

Agilent Lab Advisor Software

The Agilent Lab Advisor Software is a standalone product that can be used with or without data system. Agilent Lab Advisor helps to manage the lab for high quality chromatographic results and can monitor in real time a single Agilent LC or all the Agilent GCs and LCs configured on the lab intranet.

Agilent Lab Advisor provides diagnostic capabilities for all Agilent 1200 Series HPLC modules. This includes tests and calibrations procedures as well as the different injector steps to perform all the maintenance routines.

Agilent Lab Advisor also allows users to monitor the status of their LC instruments. The Early Maintenance Feedback (EMF) feature helps to carry out preventive maintenance. In addition, users can generate a status report for each individual LC instrument. The tests and diagnostic features as provided by the Agilent Lab Advisor Software may differ from the descriptions in this manual. For details refer to the Agilent Lab Advisor help files.

This manual provides lists with the names of Error Messages, Not Ready messages, and other common issues.

Overview of the Pump’s Indicators and Test Functions

Status Indicators

The capillary pump is provided with two status indicators which indicate the operational state (prerun, run, and error states) of the capillary pump. The status indicators provide a quick visual check of the operation of the capillary pump (see “Status Indicators” on page 72).

Error Messages

In the event of an electronic, mechanical or hydraulic failure, the instrument generates an error message in the user interface. For details on error messages and error handling, please refer to the Agilent Lab Monitor & Diagnostic Software.

Pressure Test

The pressure test is a quick test designed to determine the pressure tightness of the system. After exchanging flow path components (e.g., pump seals or injection seal), use this test to verify the system is pressure tight up to 400 bar (see “Description” on page 95 and “Capillary Pump Normal Mode Pressure Test” on page 98).

Leak Test

The leak test is a diagnostic test designed to determine the pressure tightness of the capillary pump. When a problem with the capillary pump is suspected, use this test to help troubleshoot the capillary pump and its pumping performance (see “Capillary Pump Leak Test Description” on page 101).

Flow Sensor Calibration

The flow sensor calibration procedure is designed to generate customized calibration data. This procedure should be run whenever the flow rate is suspected of being inaccurate, or the desired solvent combination is not listed in the predefined calibration table.

EMPV Test

The EMPV test is designed to verify the performance of the EMPV. This test must always be done when the EMPV valve is exchanged. The test should also be done if column flow stability problems occur (micro mode only).

EMPV Cleaning

Depending on the application, sometimes particles can be collected in the EMPV valve. This cleaning procedure is designed to remove the particle deposits. This procedure should always be performed when the EMPV is suspected of being leaky, or contaminated with particles.

Status Indicators

Two status indicators are located on the front of the capillary pump. The lower left one indicates the power supply status, the upper right one indicates the instrument status.

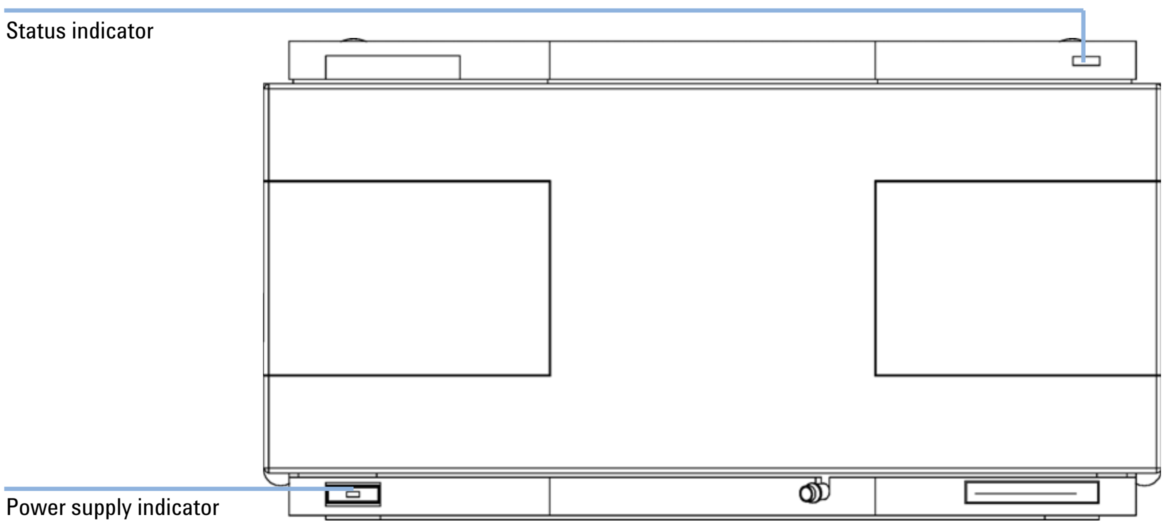


Figure 12 Location of Status Indicators

Power Supply Indicator

The power supply indicator is integrated into the main power switch. When the indicator is illuminated (*green*) the power is ON.

When the indicator is off, the module is turned OFF. Otherwhise check power connections, availability of power or check functioning of the power supply.

Instrument Status Indicator

The instrument status indicator indicates one of four possible instrument conditions:

- When the status indicator is *OFF* (and power switch light is on), the capillary pump is in a *prerun* condition, and is ready to begin an analysis.
- A *green* status indicator, indicates the capillary pump is performing an analysis (*run* mode).
- A *yellow* indicator indicates a *not-ready* condition. The capillary pump is in a not-ready state when it is waiting for a specific condition to be reached or completed (for example, immediately after changing a setpoint), or while a self-test procedure is running.
- An *error* condition is indicated when the status indicator is *red*. An error condition indicates the capillary pump has detected an internal problem which affects correct operation of the instrument. Usually, an error condition requires attention (for example, leak, defective internal components). An error condition always interrupts the analysis.
- A *flashing yellow* status indicator indicates that the module is in its *resident mode*. Call your local service provider for assistance upon observing this error condition.
- A *flashing red* status indicator indicates a severe error during the *startup* procedure of the module. Call your local service provider for assistance upon observing this error condition.

User Interfaces

Depending on the User Interface, the available test vary. Some descriptions are only available in the Service Manual.

Table 10 Test Functions available vs. User Interface

Test	ChemStation	Instant Pilot G4208A	Control Module G1323B	Agilent Lab Monitor & Diagnostic Software
Micro Mode Pressure Test	Yes	Yes	Yes	Yes
Normal Mode Pressure Test	Yes	Yes	Yes	Yes
Leak Test	Yes	Yes	Yes	Yes
Flow Sensor Solvent Calibration	Yes	No	Yes	Yes
EMPV Test	Yes	No	Yes	Yes
EMPV Cleaning	Yes	Yes	Yes	Yes

Error Messages

Error messages are displayed in the user interface when an electronic, mechanical, or hydraulic (flow path) failure occurs which requires attention before the analysis can be continued (for example, repair, frit exchange or exchange of consumables required). In the event of such a failure, the red status indicator at the front of the module is switched on, and an entry is written into the instrument logbook.

`Timeout`

The timeout threshold was exceeded.

Probable cause	Suggested actions
1 The analysis was completed successfully, and the timeout function switched off the module as requested.	Check the logbook for the occurrence and source of a not-ready condition. Restart the analysis where required.
2 A not-ready condition was present during a sequence or multiple-injection run for a period longer than the timeout threshold.	Check the logbook for the occurrence and source of a not-ready condition. Restart the analysis where required.

Shut-Down

An external instrument has generated a shut-down signal on the remote line.

The module continually monitors the remote input connectors for status signals. A LOW signal input on pin 4 of the remote connector generates the error message.

Probable cause	Suggested actions
1 Leak detected in another module with a CAN connection to the system.	Fix the leak in the external instrument before restarting the module.
2 Leak detected in an external instrument with a remote connection to the system.	Fix the leak in the external instrument before restarting the module.
3 Shut-down in an external instrument with a remote connection to the system.	Check external instruments for a shut-down condition.
4 The degasser failed to generate sufficient vacuum for solvent degassing.	Check the vacuum degasser for an error condition. Refer to the *Service Manual* for the Agilent 1200 Series vacuum degasser.

Remote Timeout

A not-ready condition is still present on the remote input.

When an analysis is started, the system expects all not-ready conditions (e.g. a not-ready condition during detector balance) to switch to run conditions within one minute of starting the analysis. If a not-ready condition is still present on the remote line after one minute the error message is generated.

Probable cause	Suggested actions
1 Not-ready condition in one of the instruments connected to the remote line.	Ensure the instrument showing the not-ready condition is installed correctly, and is set up correctly for analysis.
2 Defective remote cable.	Exchange the remote cable.
3 Defective components in the instrument showing the not-ready condition.	Check the instrument for defects (refer to the instrument's reference documentation).

Synchronization Lost

During an analysis, the internal synchronization or communication between one or more of the modules in the system has failed.

The system processors continually monitor the system configuration. If one or more of the modules is no longer recognized as being connected to the system, the error message is generated.

Probable cause	Suggested actions
1 CAN cable disconnected.	• Ensure all the CAN cables are connected correctly. • Ensure all CAN cables are installed correctly.
2 Defective CAN cable.	Exchange the CAN cable.
3 Defective main board in a different module.	Switch off the system. Restart the system, and determine which module or modules are not recognized by the system.

Leak

A leak was detected in the module.

The signals from the two temperature sensors (leak sensor and board-mounted temperature-compensation sensor) are used by the leak algorithm to determine whether a leak is present. When a leak occurs, the leak sensor is cooled by the solvent. This changes the resistance of the leak sensor which is sensed by the leak-sensor circuit on the main board.

Probable cause	Suggested actions
1 Loose fittings.	Ensure all fittings are tight.
2 Broken capillary.	Exchange defective capillaries.
3 Loose or leaking active inlet valve, outlet ball valve, or EMPV.	Ensure pump components are seated correctly. If there are still signs of a leak, exchange the appropriate seal (active inlet valve, outlet ball valve, or EMPV).
4 Defective pump seals.	Exchange the pump seals.

Leak Sensor Open

The leak sensor in the module has failed (open circuit).

The current through the leak sensor is dependent on temperature. A leak is detected when solvent cools the leak sensor, causing the leak-sensor current to change within defined limits. If the current falls outside the lower limit, the error message is generated.

Probable cause	Suggested actions
1 Leak sensor not connected to the main board.	Ensure the leak sensor is connected correctly.
2 Defective leak sensor.	Exchange the leak sensor.

Leak Sensor Short

The leak sensor in the module has failed (short circuit).

The current through the leak sensor is dependent on temperature. A leak is detected when solvent cools the leak sensor, causing the leak-sensor current to change within defined limits. If the current increases above the upper limit, the error message is generated.

Probable cause	Suggested actions
1 Defective leak sensor.	Exchange the leak sensor.
2 Leak sensor incorrectly routed, being pinched by a metal component.	

Compensation Sensor Open

The ambient-compensation sensor (NTC) on the main board in the module has failed (open circuit).

The resistance across the temperature compensation sensor (NTC) on the main board is dependent on ambient temperature. The change in resistance is used by the leak circuit to compensate for ambient temperature changes. If the resistance across the sensor increases above the upper limit, the error message is generated.

Probable cause	Suggested actions
1 Defective main board.	Exchange the main board.

Compensation Sensor Short

The ambient-compensation sensor (NTC) on the main board in the module has failed (short circuit).

The resistance across the temperature compensation sensor (NTC) on the main board is dependent on ambient temperature. The change in resistance is used by the leak circuit to compensate for ambient temperature changes. If the resistance across the sensor falls below the lower limit, the error message is generated.

Probable cause	Suggested actions
1 Defective main board.	Exchange the main board.

Fan Failed

The cooling fan in the module has failed.

The hall sensor on the fan shaft is used by the main board to monitor the fan speed. If the fan speed falls below 2 revolutions/second for longer than 5 seconds, the error message is generated.

Probable cause	Suggested actions
1 Fan cable disconnected.	Ensure the fan is connected correctly.
2 Defective fan.	Exchange fan.
3 Defective main board.	Exchange the main board.
4 Improperly positioned cables or wires obstructing fan blades.	Ensure the fan is not mechanically blocked.

Open Cover

The top foam has been removed.

The sensor on the main board detects when the top foam is in place. If the foam is removed, the fan is switched off, and the error message is generated.

Probable cause	Suggested actions
1 The top foam was removed during operation.	Reinstall the top foam.
2 Foam not activating the sensor.	Replace the top foam.
3 Sensor defective.	Exchange the main board.
4 Rear of the module is exposed to strong direct sunlight.	Ensure that the rear of module is not directly exposed to strong sunlight.

Restart Without Cover

The module was restarted with the top cover and foam open.

The sensor on the main board detects when the top foam is in place. If the module is restarted with the foam removed, the module switches off within 30 s, and the error message is generated.

Probable cause	Suggested actions
1 The module started with the top cover and foam removed.	Reinstall the top cover and foam.
2 Rear of the module is exposed to strong direct sunlight.	Ensure that the rear of module is not directly exposed to strong sunlight.

Zero Solvent Counter

Pump firmware version A.02.32 and higher allow to set solvent bottle fillings at the ChemStation (revision 5.xx and higher). If the volume level in the bottle falls below the specified value the error message appears when the feature is configured accordingly.

Probable cause	Suggested actions
1 Volume in bottle below specified volume.	Refill bottles and reset solvent counters.
2 Incorrect setting of limit.	Control setting of limit.

Pressure Above Upper Limit

The system pressure has exceeded the upper pressure limit.

Probable cause	Suggested actions
1 Upper pressure limit set too low.	Ensure the upper pressure limit is set to a value suitable for the analysis.
2 Blockage in the flowpath (after the damper).	Check for blockage in the flowpath. The following components are particularly subject to blockage: purge-valve frit, needle (autosampler), seat capillary (autosampler), sample loop (autosampler), column frits and capillaries with low internal diameters (e.g. 0.12 mm id).
3 Defective damper.	Exchange the damper.
4 Defective main board.	Exchange the main board.

Pressure Below Lower Limit

The system pressure has fallen below the lower pressure limit.

Probable cause	Suggested actions
1 Lower pressure limit set too high.	Ensure the lower pressure limit is set to a value suitable for the analysis.
2 Air bubbles in the mobile phase.	• Ensure solvents are degassed. Purge the module. • Ensure solvent inlet filters are not blocked.
3 Leak.	• Inspect the pump head, capillaries and fittings for signs of a leak. • Purge the module. Run a pressure test to determine whether the seals or other module components are defective.
4 Defective damper.	Exchange the damper.
5 Defective main board.	Exchange the main board.

Pressure Signal Missing

The pressure signal from the damper is missing.

The pressure signal from the damper must be within a specific voltage range. If the pressure signal is missing, the processor detects a voltage of approximately -120mV across the damper connector.

Probable cause	Suggested actions
1 Damper disconnected.	Ensure the damper is connected correctly to the main board.
2 Defective damper.	Exchange the damper.

Valve Failed

Valve 0 Failed: valve A1

Valve 1 Failed: valve A2

Valve 2 Failed: valve B2

Valve 3 Failed: valve B1

One of the solvent selection valves in the module failed to switch correctly.

The processor monitors the valve voltage before and after each switching cycle. If the voltages are outside expected limits, the error message is generated.

Probable cause	Suggested actions
1 Solvent selection valve disconnected.	Ensure the solvent selection valve is connected correctly.
2 Connection cable (inside instrument) not connected.	Ensure the connection cable is connected correctly.
3 Connection cable (inside instrument) defective.	Exchange the connection cable.
4 Solvent selection valve defective.	Exchange the solvent selection valve.

Missing Pressure Reading

The pressure readings read by the pump ADC (analog-digital converter) are missing.

The ADC reads the pressure readings from the damper every 1ms. If the readings are missing for longer than 10 seconds, the error message is generated.

Probable cause	Suggested actions
1 Damper not connected.	Ensure the damper is connected, clean and seated correctly.
2 Defective damper.	Exchange the damper.
3 Defective main board.	Exchange the main board.

Pump Configuration

At switch-on, the pump has recognized a new pump configuration.

The pump is assigned its configuration at the factory. If the active-inlet valve and pump encoder of channel B are disconnected, and the pump is rebooted, the error message is generated. *However, the* pump *will function as an isocratic pump in this configuration*. The error message reappears after each switch-on.

Probable cause	Suggested actions
1 Active-inlet valve and pump encoder of channel B disconnected.	Reconnect the active-inlet valve and pump encoder of channel B.

Valve Fuse

Valve Fuse 0: Channels A1 and A2

Valve Fuse 1: Channels B1 and B2

One of the solvent-selection valves in the pump has drawn excessive current causing the selection-valve electronic fuse to open.

Probable cause	Suggested actions
1 Defective solvent selection valve.	Restart the capillary pump. If the error message appears again, exchange the solvent selection valve.
2 Defective connection cable (front panel to main board).	Exchange the connection cable.
3 Defective main board.	Exchange the main board.

Inlet-Valve Fuse

Inlet-Valve Fuse 0: Pump channel A

Inlet-Valve Fuse 1: Pump channel B

One of the active-inlet valves in the module has drawn excessive current causing the inlet-valve electronic fuse to open.

Probable cause	Suggested actions
1 Defective active inlet valve.	Restart the module. If the error message appears again, exchange the active inlet valve.
2 Defective connection cable (front panel to main board).	Exchange the connection cable.
3 Defective main board.	Exchange the main board.

Temperature Out of Range

Temperature Out of Range 0: Pump channel A

Temperature Out of Range 1: Pump channel B

One of the temperature sensor readings in the motor-drive circuit are out of range.

The values supplied to the ADC by the hybrid sensors must be between 0.5 V and 4.3 V. If the values are outside this range, the error message is generated.

Probable cause	Suggested actions
1 Defective main board.	Exchange the main board.

Temperature Limit Exceeded

Temperature Limit Exceeded 0: Pump channel A

Temperature Limit Exceeded 1: Pump channel B

The temperature of one of the motor-drive circuits is too high.

The processor continually monitors the temperature of the drive circuits on the main board. If excessive current is being drawn for long periods, the temperature of the circuits increases. If the temperature exceeds the upper limit, the error message is generated.

Probable cause	Suggested actions
1 High friction (partial mechanical blockage) in the pump drive assembly.	Ensure the capillaries and frits between the pump head and damper inlet are free from blockage.
2 Partial blockage of the flowpath in front of the damper.	Ensure the outlet valve is not blocked.
3 Defective pump drive assembly.	• Remove the pump head assembly. Ensure there is no mechanical blockage of the pump head assembly or pump drive assembly. • Exchange the pump drive assembly.
4 Defective main board.	Exchange the main board.

Motor-Drive Power

Motor-Drive Power: Pump channel A

B: Motor-Drive Power: Pump channel B

The current drawn by the pump motor exceeded the maximum limit.

Blockages in the flow path are usually detected by the pressure sensor in the damper, which result in the pump switching off when the upper pressure limit is exceeded. If a blockage occurs before the damper, the pressure increase cannot be detected by the pressure sensor and the module will continue to pump. As pressure increases, the pump drive draws more current. When the current reaches the maximum limit, the module is switched off, and the error message is generated.

Probable cause	Suggested actions
1 Flow path blockage in front of the damper.	Ensure the capillaries and frits between the pump head and damper inlet are free from blockage.
2 Blocked outlet ball valve.	Exchange the outlet ball valve.
3 High friction (partial mechanical blockage) in the pump drive assembly.	Remove the pump-head assembly. Ensure there is no mechanical blockage of the pump-head assembly or pump drive assembly.
4 Defective pump drive assembly.	Exchange the pump drive assembly.
5 Defective main board.	Exchange the main board.
6 Restriction capillary blocked at pre-mixing union.	Exchange restriction capillary.

Encoder Missing

Encoder Missing: Pump channel A

B: Encoder Missing: Pump channel B

The optical encoder on the pump motor in the module is missing or defective.

The processor checks the presence of the pump encoder connector every 2 seconds. If the connector is not detected by the processor, the error message is generated.

Probable cause	Suggested actions
1 Defective or disconnected pump encoder connector.	Ensure the connector is clean, and seated correctly.
2 Defective pump drive assembly.	Exchange the pump drive assembly.

Inlet-Valve Missing

Inlet-Valve Missing: Pump channel A

B: Inlet-Valve Missing: Pump channel B

The active-inlet valve in the module is missing or defective.

The processor checks the presence of the active-inlet valve connector every 2 seconds. If the connector is not detected by the processor, the error message is generated.

Probable cause	Suggested actions
1 Disconnected or defective cable.	Ensure the pins of the active inlet valve connector are not damaged. Ensure the connector is seated securely.
2 Disconnected or defective connection cable (front panel to main board).	Ensure the connection cable is seated correctly. Exchange the cable if defective.
3 Defective active inlet valve.	Exchange the active inlet valve.

Electro-Magnetic-Proportional-Valve (EMPV) Missing

EMPV Missing

The EMPV in the micro pump is missing or defective.

Probable cause	Suggested actions
1 Disconnected or defective cable.	Ensure the connection cable is seated correctly.
2 Defective solenoid.	Exchange the solenoid of the EMPV.

Flow Sensor Missing

Probable cause	Suggested actions
1 Flow sensor disconnected.	Ensure the sensor is seated correctly.
2 Defective flow sensor.	Exchange the flow sensor.

Leak Sensor Missing

Probable cause	Suggested actions
1 Disconnected or defective cable.	Ensure the connection cable is seated correctly.
2 Defective leak sensor.	Exchange the leak sensor.

Servo Restart Failed

Servo Restart Failed: Pump channel A

B: Servo Restart Failed: Pump channel B

The pump motor in the module was unable to move into the correct position for restarting.

When the module is switched on, the first step is to switch on the C phase of the variable reluctance motor. The rotor should move to one of the C positions. The C position is required for the servo to be able to take control of the phase sequencing with the commutator. If the rotor is unable to move, or if the C position cannot be reached, the error message is generated.

Probable cause	Suggested actions
1 Disconnected or defective cables.	Ensure the pump-assembly cables are not damaged or dirty. Make sure the cables are connected securely to the main board.
2 Mechanical blockage of the module.	Remove the pump-head assembly. Ensure there is no mechanical blockage of the pump-head assembly or pump drive assembly.
3 Defective pump drive assembly.	Exchange the pump drive assembly.
4 Defective main board.	Exchange the main board.

Pump Head Missing

Pump Head Missing: Pump channel A

B: Pump Head Missing: Pump channel B

The pump-head end stop in the pump was not found.

When the pump restarts, the metering drive moves forward to the mechanical end stop. Normally, the end stop is reached within 20 seconds, indicated by an increase in motor current. If the end point is not found within 20 seconds, the error message is generated.

Probable cause	Suggested actions
1 Pump head not installed correctly (screws not secured, or pump head not seated correctly).	Install the pump head correctly. Ensure nothing (e.g. capillary) is trapped between the pump head and body.
2 Broken plunger.	Exchange the plunger.

Index Limit

Index Limit: Pump channel A

B: Index Limit: Pump channel B

The time required by the plunger to reach the encoder index position was too short (pump).

During initialization, the first plunger is moved to the mechanical stop. After reaching the mechanical stop, the plunger reverses direction until the encoder index position is reached. If the index position is reached too fast, the error message is generated.

Probable cause	Suggested actions
1 Irregular or sticking drive movement.	Remove the pump head, and examine the seals, plungers, and internal components for signs of wear, contamination or damage. Exchange components as required.
2 Defective pump drive assembly.	Exchange the pump drive assembly.

Index Adjustment

Index Adjustment: Pump channel A

B: Index Adjustment: Pump channel B

The encoder index position in the module is out of adjustment.

During initialization, the first plunger is moved to the mechanical stop. After reaching the mechanical stop, the plunger reverses direction until the encoder index position is reached. If the time to reach the index position is too long, the error message is generated.

Probable cause	Suggested actions
1 Irregular or sticking drive movement.	Remove the pump head, and examine the seals, plungers, and internal components for signs of wear, contamination or damage. Exchange components as required.
2 Defective pump drive assembly.	Exchange the pump drive assembly.

Index Missing

Index Missing: Pump channel A

B: Index Missing: Pump channel B

The encoder index position in the module was not found during initialization.

During initialization, the first plunger is moved to the mechanical stop. After reaching the mechanical stop, the plunger reverses direction until the encoder index position is reached. If the index position is not recognized within a defined time, the error message is generated.

Probable cause	Suggested actions
1 Disconnected or defective encoder cable.	Ensure the encoder cable are not damaged or dirty. Make sure the cables are connected securely to the main board.
2 Defective pump drive assembly.	Exchange the pump drive assembly.

Stroke Length

Stroke Length: Pump channel A

B: Stroke Length: Pump channel B

The distance between the lower plunger position and the upper mechanical stop is out of limits (pump).

During initialization, the module monitors the drive current. If the plunger reaches the upper mechanical stop position before expected, the motor current increases as the module attempts to drive the plunger beyond the mechanical stop. This current increase causes the error message to be generated.

Probable cause	Suggested actions
1 Defective pump drive assembly.	Exchange the pump drive assembly.

Initialization Failed

Initialization Failed: Pump channel A

B: Initialization Failed: Pump channel B

The module failed to initialize successfully within the maximum time window.

A maximum time is assigned for the complete pump-initialization cycle. If the time is exceeded before initialization is complete, the error message is generated.

Probable cause	Suggested actions
1 Blocked active inlet valve.	Exchange the active inlet valve.
2 Defective pump drive assembly.	Exchange the pump drive assembly.
3 Defective main board.	Exchange the main board.

Wait Timeout

When running certain tests in the diagnostics mode or other special applications, the pump must wait for the plungers to reach a specific position, or must wait for a certain pressure or flow to be reached. Each action or state must be completed within the timeout period, otherwise the error message is generated.

Possible Reasons for a Wait Timeout:

· Pressure not reached.

· Pump channel A did not reach the delivery phase.

· Pump channel B did not reach the delivery phase.

· Pump channel A did not reach the take-in phase.

· Pump channel B did not reach the take-in phase.

· Solvent volume not delivered within the specified time.

	Probable cause	Suggested actions
1	System still in purge mode.	Ensure that purge valve is closed.
2	Leak at fittings, EMPV, active inlet valve, outlet ball valve or plunger seals.	Ensure pump components are seated correctly. If there are still signs of a leak, exchange the appropriate seal (purge valve, active inlet valve, outlet ball valve, plunger seal).
3	Flow changed after starting test.	Ensure correct operating condition for the special application in use.
4	Defective pump drive assembly.	Exchange the defective pump drive assembly.

Micro Mode Pressure Test

Description

This is a fast test to verify the tightness of a micro system, where the pump is operating in the micro mode and no manual purge valve is installed. The flow path of the system which is tested for tightness is blocked by a blank nut. The pressure is increased up to 380 bar and the remaining flow is measured in the flow sensor while the system is blocked.

Step 1

The test begins with the initialization of both pump heads. Next, pump A begins pumping solvent until a system pressure of 380 bar is reached.

Step 2

The pump is operating in the pressure control mode at 380 bar for several minutes. The remaining flow in the column flow path between the EMPV and the blank nut is measured.

Running the Test from the Agilent Lab Monitor & Diagnostic Software

1 Select the Micro Mode Pressure Test from the test selection menu.

2 Start the test and follow the instructions

NOTE For detailed instructions refer to the Agilent Lab Monitor & Diagnostic Software.

NOTE In step 10 of following procedure, if you block the flow sensor outlet use the PEEK blank nut provided in the accessory kit. Don´t connect a SST blank nut to the flow sensor outlet, this could damage the flow sensor.

Micro Mode Pressure Test Results

The test results are evaluated automatically. The sum of all leaks within the column flow path from the EMPV to the blank nut must be lower than 1000 nl/min.

NOTE Small leaks, with no visible leaks in the flow path can cause the test to fail.

If the pressure test fails

Ensure all fittings between the pump and the blank nut are tight and repeat the pressure test. If the test fails again, insert the blank nut at the outlet of the previous module in the stack, and repeat the pressure test. Exclude each module one by one to determine which module is leaky.

Potential Causes of Pressure Test Failure

After isolating and fixing the cause of the leak, repeat the pressure test to confirm the system is tight.

Potential Cause (Pump)	Corrective Action
Loose or leaky fitting.	Tighten the fitting or exchange the capillary.
Untight EMPV	Run the EMPV test
Damaged pump seals or plungers.	Run the leak test to confirm the leak.
High flow sensor offset	Run the flow sensor accuracy calibration and correct the flow sensor offset

Potential Cause (Autosampler)	Corrective Action
Loose or leaky fitting.	Tighten or exchange the fitting or capillary.
Needle seat.	Exchange the needle seat.
Rotor seal (injection valve).	Exchange the rotor seal.
Damaged metering seal or plunger.	Exchange the metering seal. Check the plunger for scratches. Exchange the plunger if required.

Normal Mode Pressure Test

Capillary Pump Normal Mode Pressure Test

The pressure test is a quick, built-in test designed to demonstrate the pressure-tightness of the system. The test involves monitoring the pressure profile as the capillary pump runs through a predefined pumping sequence. The resulting pressure profile provides information about the pressure tightness of the system.

Step 1

The test begins with the initialization of both pumpheads. After initialization, plungers A1 and B1 are both at the top of their stroke. Next, pump A begins pumping solvent with a flow rate of 510 µl/min and stroke of 100 µl. The capillary pump continues to pump until a system pressure of 390 bar is reached.

NOTE For this test only channel A2 is active. To test the pressure tightness of the pump use the leak test, see “Capillary Pump Leak Test Description” on page 101.

Step 2

When the system pressure reaches 390 bar, the capillary pump switches off. The pressure drop from this point onwards should be no more than 2 bar/minute.

Positioning the Blank Nut

If a specific component is suspected of causing a system leak, place the blank nut immediately before the suspected component, then run the pressure test again.If the test passes, the defective component is located after the blank nut. Confirm the diagnosis by placing the blank nut immediately after the suspected component. The diagnosis is confirmed if the test fails.

Running the Pressure Test

When When problems with leaks are suspected, or after maintenance of flow-path components (e.g., pump seals, injection seal) to prove pressure tightness up to 400 bar

Tools required Wrench 1/4 inch

Parts required

#	Part number	Description
1	01080-83202	Blank nut
		500 ml Isopropanol

Preparations Place a bottle of LC-grade isopropanol in the solvent cabinet and connect it to channel A2

NOTE Make absolutely sure that all parts of the flow path that are part of the test are very thoroughly flushed with IPA before starting to pressurize the system! Any trace of other solvents or the smallest air bubble inside the flow path definitely will cause the test to fail!

Running the test from the Agilent Lab Monitor & Diagnostic Software

1 Select the pressure test from the test selection menu.
2 Start the test and follow the instructions.

TIP "Evaluating the Results" on page 100 describes the evaluation and interpretation of the pressure test results.

TIP For detailed instructions refer to the Agilent Lab Monitor & Diagnostic Software Tool.

Evaluating the Results

The sum of all leaks between the pump and the blank nut will be indicated by a pressure drop of >2 bar/minute at the plateau. Note that small leaks may cause the test to fail, but solvent may not be seen leaking from a module.

NOTE Please notice the difference between an *error* in the test and a *failure* of the test! An *error* means that during the operation of the test there was an abnormal termination. If a test *failed*, this means that the results of the test where not within the specified limits.

NOTE Often it is only a damaged blank nut itself (poorly shaped from overtightening) that causes a failure of the test. Before investigating on any other possible sources of failure make sure that the blank nut you are using is in good condition and properly tightened!

Leak Test

Capillary Pump Leak Test Description

The leak test is a built-in troubleshooting test designed to demonstrate the leak-tightness of the capillary pump. The test involves monitoring the pressure profile as the capillary pump runs through a predefined pumping sequence. The resulting pressure profile provides information about the pressure tightness and operation of the capillary pump components.

Ramp 1

The test begins with the initialization of both pumps. After initialization, plungers A1 and B1 are both at the top of their stroke. Next, the capillary pump begins pumping solvent with a flow rate of 150 µl/min, stroke of 100 µl, and a composition of 51 %A, 49 %B. Both pumps deliver for one complete pump cycle. At the end of this step, plungers A1 and B1 are at the top of their stroke.

Ramp 2

The capillary pump continues pumping solvent with a flow rate of 150 µl/min. Channel A delivers for one pump cycle (first, plunger A2 delivers, then plunger A1), followed by channel B (plunger B2, then plunger B1), both channels with a stroke of 20 µl.

Ramp 3

Just before the start of the first plateau, plunger A2 delivers with a flow rate of 50 µl/min for approximately 8 seconds.

Plateau 1

At plateau 1, plunger A2 delivers with a flow rate of 3 µl/min for 30 seconds.

Ramp 4

Plunger B2 delivers 50 µl/min for approximately 8 seconds.

Plateau 2

Plunger B2 delivers with a flow rate of 3 µl/min for 30 seconds.

Ramp 5

Plunger A1 delivers 50 µl/min for approximately 8 seconds.

Plateau 3

Plunger A1 with a flow rate of 3 µl/min for 30 seconds.

Ramp 6

Plunger B1 delivers 50 µl/min for approximately 7 seconds.

Plateau 4

Plunger B1 delivers with a flow rate of 3 µl/min for approximately 30 seconds. At the end of the fourth plateau, the test is finished and the capillary pump switches off.

Running the Leak Test

When	When problems with the capillary pump are suspected
Tools required	Wrench 1/4 inch

Parts required

#	Part number	Description
1	G1313-87305	Restriction Capillary
1	01080-83202	Blank nut
		500 ml Isopropanol

Preparations Place two bottles of LC-grade isopropyl alcohol in channels A2 and B2

NOTE Make absolutely sure that all parts of the flow path that are part of the test are very thoroughly flushed with IPA before starting to pressurize the system! Any trace of other solvents or the smallest air bubble inside the flow path definitely will cause the test to fail!

Running the test from the Agilent Lab Monitor & Diagnostic Software

1 Select the leak test from the test selection menu.
2 Start the test and follow the instructions.

NOTE Make sure to release the pressure by slowly opening the purge valve when the test has finished.

TIP “Evaluating the Results” on page 104 describes the evaluation and interpretation of the leak test results.

TIP For detailed instructions refer to the Agilent Lab Monitor & Diagnostic Software Tool.

Evaluating the Results

Defective or leaky components in the pump head lead to changes in the leak-test pressure plot. Typical failure modes are described below.

NOTE Please notice the difference between an *error* in the test and a *failure* of the test! An *error* means that during the operation of the test there was an abnormal termination. If a test *failed*, this means that the results of the test where not within the specified limits.

NOTE Often it is only a damaged blank nut itself (poorly shaped from overtightening) that causes a failure of the test. Before investigating on any other possible sources of failure make sure that the blank nut you are using is in good condition and properly tightened!

`No pressure increase or minimum pressure of plateau 1 not reached`

Probable cause	Suggested actions
1 Pump not running.	Check the logbook for error messages.
2 Wrong solvent-line connections to solvent selection valve.	Ensure the solvent lines from the degasser to the solvent selection valve are connected correctly.
3 Loose or leaky fittings.	Ensure all fittings are tight, or exchange capillary.
4 Large leaks (visible) at the pump seals.	Exchange the pump seals.
5 Large leaks (visible) at active inlet valve, outlet valve, or EMPV.	• Ensure the leaky components are installed tightly. Exchange the component if required. • Run the EMPV cleaning procedure.

Pressure limit not reached but plateaus horizontal or positive

Probable cause	Suggested actions
1 Degasser and pump channels A and/or B not flushed sufficiently (air in the channels).	Purge the degasser and pump channels thoroughly with isopropanol under pressure (use the restriction capillary).
2 Wrong solvent.	Install isopropanol. Purge the degasser and pump channels thoroughly.

All plateaus negative

Probable cause	Suggested actions
1 Loose or leaky fittings.	Ensure all fittings are tight, or exchange capillary.
2 Leaky mixer (if installed).	Tighten the mixer fittings and nuts.
3 Contaminated EMPV.	Run the EMPV cleaning procedure.
4 Loose pump head screws in channel A or B.	Ensure the pump head screws in channels A and B are tight.
5 Leaking seal or scratched plunger in channel A2 or B2.	Exchange the pump seals in both channels. Check the plungers for scratches. Exchange if scratched.
6 Leaking outlet valve in channel A or B.	Exchange the outlet valve.
7 Leaky damper.	Exchange damper.

First plateau negative or unstable, and at least one other plateau positive

Probable cause	Suggested actions
1 Leaking outlet valve in channel A.	Clean the outlet valve in channel A. Ensure the sieve in the outlet valves are installed correctly. Tighten the outlet valve.
2 Loose pump head screws in channel A.	Ensure the pump head screws in channel A are tight.
3 Leaking seal or scratched plunger in channel A2.	Exchange the pump seals in channel A. Check the plunger for scratches. Exchange if scratched.

Second plateau negative or unstable, and at least one other plateau positive

Probable cause	Suggested actions
1 Leaking outlet valve in channel B.	Clean the outlet valve in channel B. Ensure the sieve in the outlet valves are installed correctly. Tighten the outlet valve.
2 Loose pump head screws in channel B.	Ensure the pump head screws in channel B are tight.
3 Leaking seal or scratched plunger in channel B2.	Exchange the pump seals in channel B. Check the plunger for scratches. Exchange if scratched.

Third plateau negative or unstable and at least one other plateau positive

Probable cause	Suggested actions
1 Air in channel A or new seals not yet seated.	Flush channel A thoroughly with isopropanol under pressure (use restriction capillary).
2 Loose active inlet valve in channel A.	Tighten the active inlet valve in channel A (14mm wrench). Do not overtighten!
3 Loose pump head screws in channel A.	Ensure the pump head screws in channel A are tight.
4 Loose outlet valve in channel A.	Ensure the sieve in the outlet valve is installed correctly. Tighten the outlet valve.
5 Leaking seal or scratched plunger in channel A1.	Exchange the pump seals in channel A. Check the plungers for scratches. Exchange if scratched.
6 Defective active inlet valve in channel A.	Exchange the active inlet valve in channel A.

Fourth plateau negative or unstable and at least one other plateau positive

Probable cause	Suggested actions
1 Air in pump chamber of channel B or seals not yet seated.	Flush channel B thoroughly with isopropanol under pressure (restriction capillary).
2 Loose active inlet valve in channel B.	Tighten the active inlet valve in channel B (14mm wrench). Do not overtighten!
3 Loose pump head screws in channel B.	Ensure the pump head screws in channel B are tight.
4 Loose outlet valve in channel B.	Ensure the sieve in the outlet valve is installed correctly. Tighten the outlet valve.
5 Leaking seal or scratched plunger in channel B1.	Exchange the pump seals in channel B. Check the plungers for scratches. Exchange if scratched.
6 Defective active inlet valve in channel B.	Exchange the active inlet valve in channel B.

Flow Sensor Solvent Calibration

Description

This routine is designed to generate customized calibration data.The routine should be run whenever the flow rate is suspected of being inaccurate, or the desired solvent combination is not listed in the predefined calibration table.

NOTE Salts and small amounts of organic modifiers don´t have a significant influence on the calibration data. In this cases the pre-defined aqueous curves can be used.

NOTE Check the flow sensor accuracy at the upper flow rate with water.

NOTE A system with inaccurate calibration data will still produce reproducible results.

NOTE Before starting the calibration routine, the pump must pass the leak test.

The routine is set up to calibrate “unknown” solvents in channel A1 and B1 of the solvent selection valve.

First the system is equilibrated with pure water from channel A2. At 15 µl/min the system switches to pressure control and keeps the pressure constant for the procedure. A step to 100 % A1 is done (results response of the aqueous phase relative to water) and then a step gradient from 0 % A1 to 100 % B1 (results response of unknown mixtures).

Solvents

- A1: Aqueous solvent (to be calibrated)

- B1: Organic solvent (to be calibrated)
- A2: Pure water (reference solvent)

Running the Calibration Routine

1 Fill vacuum degasser with appropriate solvents and purge each channel at 2500 µl/min for 3 minutes.
2 Remove the capillary at the flow sensor outlet.
3 Check that the standard flow sensor is installed (20 µl flow sensor).
4 Disconnect the damper to mixer capillary at the damper upper port.
5 Disconnect the mixer to filter capillary at the mixer.
6 Connect the capillary from the filter into the upper port of the damper.
7 Connect the mixer with the capillary to the flow sensor outlet. Position the mixer into a vertical position. The flow inlet must be up.
8 Pump pure water (channel A2) at 1000 µl/min (normal mode) for at least 10 min. Be sure the whole pump and mixer is flushed sufficiently. Keep an eye on the waste.
9 Connect a column at the outlet of the mixer which provides a pressure of 30 to 200 bar at 15 µl/min water (e.g. 150 x 0.3 x 5um) or a restriction capillary (e.g. Fused silica, 50 µm ID, 2.5 m).
10 Pump pure water (channel A2) at 15 µl/min (micro mode) until the pressure is absolutely stable (at least 5 min).
11 Set the compressibility for A1 and B1.
12 Execute the calibration.

NOTE The flow sensor responses for the composition steps are stored in a file and plotted on the screen.

13 Take an average reading of each step and enter it into the calibration table.
14 Save the calibration table.
15 Remove the column or the restriction capillary and the mixer at the flow sensor outlet.
16 Re-install the mixer between the damper and the filter.

NOTE For water non-miscible solvents like Hexane or isopropanol the corresponding values for the mixtures can be linearly interpolated from known values of the single solvents end edited to a new table.

NOTE Unknown isocratic solvent mixtures can be calibrated by setting the calibration table to aqueous-aqueous (non calibrated) and determining the flow rate by volumetric measurement (e.g. filling a calibrated glass syringe for 5 to 10 min).

NOTE Afterwards the response factor is calculated according the following equation:

Calibration factor = entered flow / measured flow

Example for Chloroform-Methanol

Entered flow: 15 µl/min

Measured flow: 35 µl/min

Calibration factor: 15 µl/min / 35 µl/min = 0428

Enter this calibration factor into a calibration table and save it.

EMPV Test

EMPV Test Description

The test is designed to verify the performance of the EMPV. The test must always be done when the EMPV valve is exchanged. The test should also be done if column flow stability problems occur (micro mode only).

The EMPV test is not a substitute for the leak test or pressure test. The leak and pressure tests should also be done when leaks within the pump heads might be the problem.

The test starts with a short flushing sequence and a cleaning procedure for the EMPV. Afterwards, low and high pressure is controlled by the EMPV and the appropriate current is monitored. Finally, a linear pressure ramp is performed.

Running the EMPV Test

1 Fill vacuum degasser with
   - A1: aqueous solvent
   - B1: organic solvent (acetonitrile / methanol / isopropanol, etc.)
2 If vacuum degasser is totally empty use syringe to draw solvent into the vacuum chamber or flush vacuum degasser before test is executed (test requires filled degasser chambers).
3 Plug the pump outlet with blank nut at EMPV outlet
4 Disconnect the EMPV to flow sensor capillary (G1375-87301) at EMPV outlet and plug the EMPV outlet port with blank nut (01080-83202).
5 Execute test.
6 Remove the blank nut.
7 Reconnect the EMPV to flow sensor capillary. Do not overtighten!

EMPV Cleaning

Capillary Pump EMPV Cleaning Description

Depending on the application, particles can sometimes be collected in the EMPV. This fast cleaning routine is designed to remove such particle deposits. The routine should always be performed when the EMPV is suspected of being leaky or contaminated with particles.

The outlet of the EMPV is plugged with an SST blank nut. After a short flushing routine the EMPV is closed and the pressure is increased to approximately 380 bar. The EMPV is then opened and the pressure is released very quickly. This procedure is repeated several times in a sequence.

Running the Test

1 Fill vacuum degasser channel A1 and B1 with solvents (the test requires filled vacuum chambers). We recommend that you use channel A with aqueous solvent. If you use a different channel, you must ensure
   - the miscibility of the solvent
   - that no precipitation of buffer occurs
2 Plug the pump outlet with blank nut at EMPV outlet.
3 Disconnect the EMPV to flow sensor at the EMPV outlet. Plug the EMPV outlet port with blank nut (01080-83202).
4 Execute test.
5 Check result with *Pressure Test* if necessary.
6 Remove the blank nut.
7 Reconnect the EMPV to flow sensor capillary. Do not overtighten!

7
Maintenance

Introduction to Maintenance and Repair

Simple Repairs - Maintenance

The capillary pump is designed for easy repair. The most frequent repairs such as plunger seal change and filter frit change can be done with the capillary pump in place in the system stack. These repairs are described in Table 11 on page 123.

Exchanging Internal Parts

Some repairs may require exchange of defective internal parts. Exchange of these parts requires removing the module from the stack, removing the covers, and disassembling the module. The security lever at the power input socket prevents that the module cover is taken off when line power is still connected.

Warnings and Cautions

WARNING

Module is partially energized when switched off, as long as the power cord is plugged in.

Risk of stroke and other personal injury. Repair work at the module can lead to personal injuries, e. g. shock hazard, when the module cover is opened and the instrument is connected to power.

➔ Never perform any adjustment, maintenance or repair of the module with the top cover removed and with the power cord plugged in.

➔ The security lever at the power input socket prevents that the module cover is taken off when line power is still connected. Never plug the power line back in when cover is removed.

WARNING

When opening capillary or tube fittings solvents may leak out.

The handling of toxic and hazardous solvents and reagents can hold health risks.

➔ Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.

CAUTION

Electronic boards are static sensitive and should be handled with care so as not to damage them. Touching electronic boards and components can cause electrostatic discharge (ESD).

ESD can damage electronic boards and components.

➔ Be sure to hold the board by the edges and do not touch the electrical components. Always use an ESD protection (for example, an ESD wrist strap) when handling electronic boards and components.

Using the ESD Strap

1 Unwrap the first two folds of the band and wrap the exposed adhesive side firmly around your wrist.
2 Unroll the rest of the band and peel the liner from the copper foil at the opposite end.
3 Attach the copper foil to a convenient and exposed electrical ground.

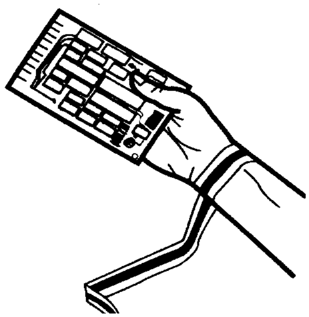


Figure 13 Using the ESD Strap

Cleaning the Module

WARNING

Liquid dripping into the electronic compartment of your module.

Liquid in the module electronics can cause shock hazard and damage the module.

→ Do not use an exessively damp cloth during cleaning.

→ Drain all solvent lines before opening any fittings.

The module case should be kept clean. Cleaning should be done with a soft cloth slightly dampened with water or a solution of water and a mild detergent. Do not use an excessively damp cloth that liquid can drip into the module.

Early Maintenance Feedback (EMF)

Maintenance requires the exchange of components in the flow path which are subject to mechanical wear or stress. Ideally, the frequency at which components are exchanged should be based on the intensity of usage of the instrument and the analytical conditions, and not on a predefined time interval. The early maintenance feedback (EMF) feature monitors the usage of specific components in the instrument, and provides feedback when the user-settable limits have been exceeded. The visual feedback in the user interface provides an indication that maintenance procedures should be scheduled.

EMF Counters

The pump provides a series of EMF counters for the pump head. Each counter increments with pump use, and can be assigned a maximum limit which provides visual feedback in the user interface when the limit is exceeded. Each counter can be reset to zero after maintenance has been done. The pump provides the following EMF counters:

- liquimeter pump A,
- seal wear pump A,
- liquimeter pump B,
- seal wear pump B.

Liquimeters

The liquimeters display the total volume of solvent pumped by the left and right pump heads since the last reset of the counters. Both liquimeters can be assigned an EMF (maximum) limit. When the limit is exceeded, the EMF flag in the user interface is displayed.

Seal Wear Counters

The seal wear counters display a value derived from pressure and flow (both contribute to seal wear). The values increment with pump usage until the counters are reset after seal maintenance. Both seal wear counters can be assigned an EMF (maximum) limit. When the limit is exceeded, the EMF flag in the user interface is displayed.

Using the EMF Counters

The user-settable EMF limits for the EMF counters enable the early maintenance feedback to be adapted to specific user requirements. The wear of pump components is dependent on the analytical conditions, therefore, the definition of the maximum limits need to be determined based on the specific operating conditions of the instrument.

Setting the EMF Limits

The setting of the EMF limits must be optimized over one or two maintenance cycles. Initially, no EMF limit should be set. When performance indicates maintenance is necessary, take note of the values displayed by pump liquimeter and seal wear counters. Enter these values (or values slightly less than the displayed values) as EMF limits, and then reset the EMF counters to zero. The next time the EMF counters exceed the new EMF limits, the EMF flag will be displayed, providing a reminder that maintenance needs to be scheduled.

Overview of Maintenance and Repair

Figure 14 on page 121 shows the main assemblies of the capillary pump. The pump heads and its parts do require normal maintenance (for example, seal exchange) and can be accessed from the front (simple repairs). Replacing internal parts will require to remove the module from its stack and to open the top cover.

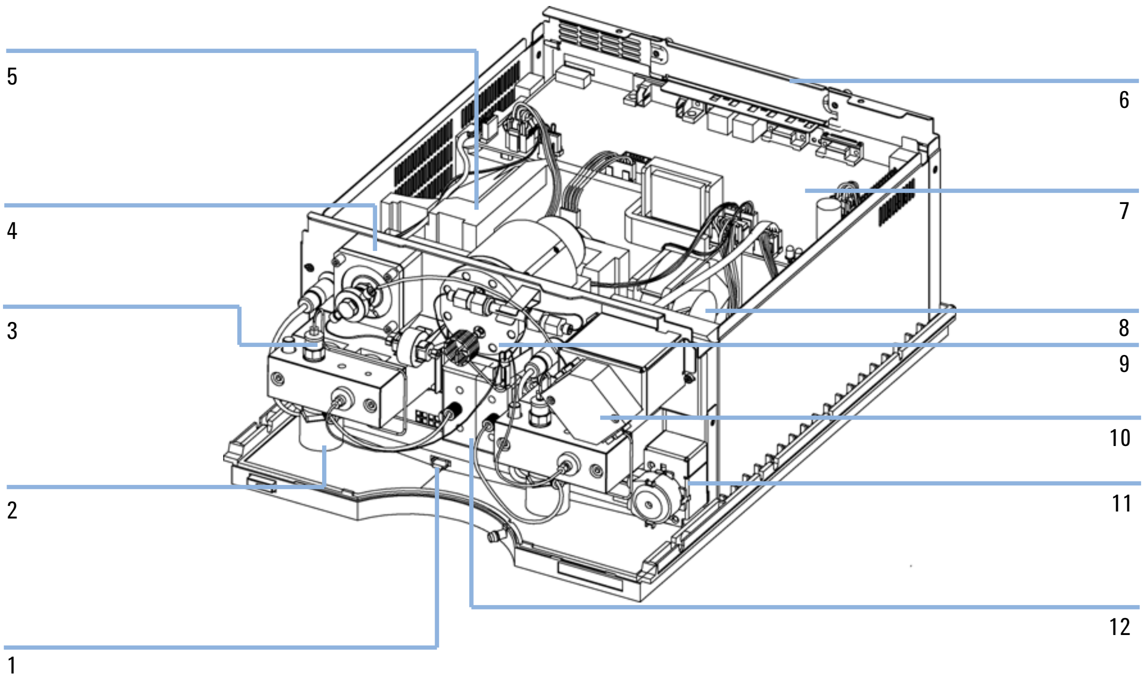


Figure 14 Overview of Repair Procedures

1	Leak sensor, see service manual
2	Active inlet valve, see “Removing the Active Inlet Valve” on page 126
3	Outlet ball valve, see “Exchanging the Outlet Ball Valve Sieve or the Complete Valve” on page 130

4	EMPV, see service manual
5	Pump drive, see service manual
6	Power supply, see service manual
7	CSM board, see service manual
8	Fan, see service manual
9	Damper, see service manual
10	Flow sensor, see “Exchanging the Flow Sensor” on page 141
11	not installed
12	Solvent selection valve, see “Exchanging the Solvent Selection Valve” on page 132

Simple Repair Procedures

The procedures described in this section can be done with the capillary pump in place in the system stack.

Table 11 Simple Repair Procedures

Procedure	Symptom	Notes
"Removing the Active Inlet Valve" on page 126	If internally leaking	Pressure ripple unstable, run leak test for verification
"Exchanging the Outlet Ball Valve Sieve or the Complete Valve" on page 130	If internally leaking	Pressure ripple unstable, run leak test for verification
"Exchanging the Solvent Selection Valve" on page 132	Unstable column flow or system pressure	
"Exchanging the Solvent Selection Valve" on page 132	Column flow and system pressure drops from time to time.	A pressure drop of > 10 bar across the frit (2.5 ml/min H2O with purge open) indicates blockage
"Exchanging the Pump Seals and Seal Wear-in Procedure" on page 136	If pump performance indicates seal wear	Leaks at lower pump head side, unstable retention times, pressure ripple unstable — run leak test for verification
"Exchanging the Plungers" on page 139	If scratched	Seal life time shorter than normally expected — check plungers while changing the seals
"Exchanging the Flow Sensor" on page 141	Extended flow range (100 ul) needed. Leak on the flow sensor. Unstable column flow Flow sensor blocked	

Checking and Cleaning the Solvent Inlet Filters

When If solvent filter is blocked

Parts required

#	Description
	Concentrated nitric acid (65%)
	Bidistilled water
1	Beaker

Preparations Remove the solvent inlet tube from the inlet port of the solvent selection valve or the adapter at the active inlet valve

WARNING

When opening capillary or tube fittings solvents may leak out.

The handling of toxic and hazardous solvents and reagents can hold health risks.

→ Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.

CAUTION

Small particles can permanently block the capillaries and valves of the module.

Damage of the module.

→ Always filter solvents.

→ Never use the module without solvent inlet filter.

NOTE

The solvent filters are located on the low-pressure side of the capillary pump. A blocked filter therefore does not affect the pressure readings of the capillary pump. The pressure readings cannot be used to check whether the filter is blocked or not.

NOTE

If the filter is in good condition the solvent will freely drip out of the solvent tube (due to hydrostatic pressure). If the solvent filter is partly blocked only very little solvent will drip out of the solvent tube.

Cleaning the Solvent Filters

1. Remove the blocked solvent filter from the bottle-head assembly and place it in a beaker with concentrated nitric acid (35%) for one hour.
2. Thoroughly flush the filter with bidistilled water (remove all nitric acid, some capillary columns can be damaged by nitric acid).
3. Replace the filter.

Exchanging the Active Inlet Valve Cartridge or the Active Inlet Valve

Removing the Active Inlet Valve

When If internally leaking (backflow)

Tools required Wrench 14 mm

Parts required

#	Part number	Description
1	G1312-60025	Active inlet valve body
1	5062-8562	Valve cartridge (400 bar)

1 Unplug the active inlet valve cable from the connector.
2 Disconnect the solvent inlet tube at the inlet valve (beware of leaking solvents).
3 Using a 14-mm wrench loosen the active inlet valve and remove the valve from pump head.

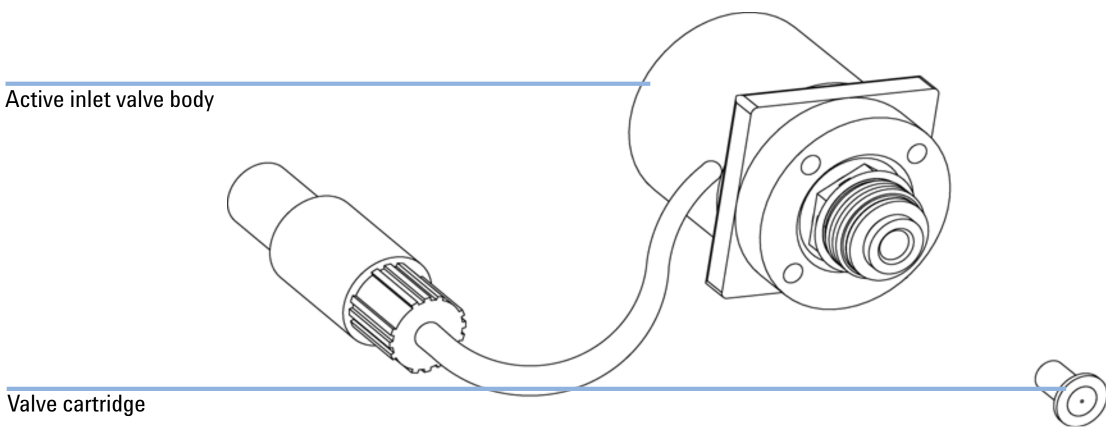


Figure 15 Active Inlet Valve Parts

Exchanging the Valve Cartridge

When If internally leaking (backflow)

Tools required Wrench 14 mm

Parts required

#	Part number	Description
1	G1312-60025	Active inlet valve body
1	5062-8562	Valve cartridge (400 bar)

1 Using a pair of tweezers remove the valve cartridge from the actuator assembly.
2 Before inserting the new valve cartridge clean the area in the actuator assembly. Fill a syringe with alcohol and flush the cartridge area thoroughly.
3 Insert a new valve cartridge into the actuator assembly (make sure the valve cartridge is fully inserted into the actuator assembly).

Replacing the Active Inlet Valve

When If internally leaking (backflow)

Tools required Wrench 14 mm

Parts required

#	Part number	Description
1	G1312-60025	Active inlet valve body
1	5062-8562	Valve cartridge (400 bar)

1 Insert the new valve into the pump head. Using the 14 mm wrench turn the nut until it is hand tight.
2 Position the valve so that the solvent inlet tube connection points towards the front.
3 Using the 14 mm wrench tighten the nut by turning the valve in its final position (not more than a quarter turn). Do not overtighten the valve. The solvent inlet tube connection should point to the right corner of the pump head.
4 Reconnect the inlet tube and the active inlet valve cable to the connector at the Z-panel.

NOTE Make sure you are in *normal mode*.

5 After an exchange of the valve cartridge it may take several mL of pumping with the solvent used in the current application, before the flow stabilizes at A%-ripple as low as it used to be, when the system was still working properly.

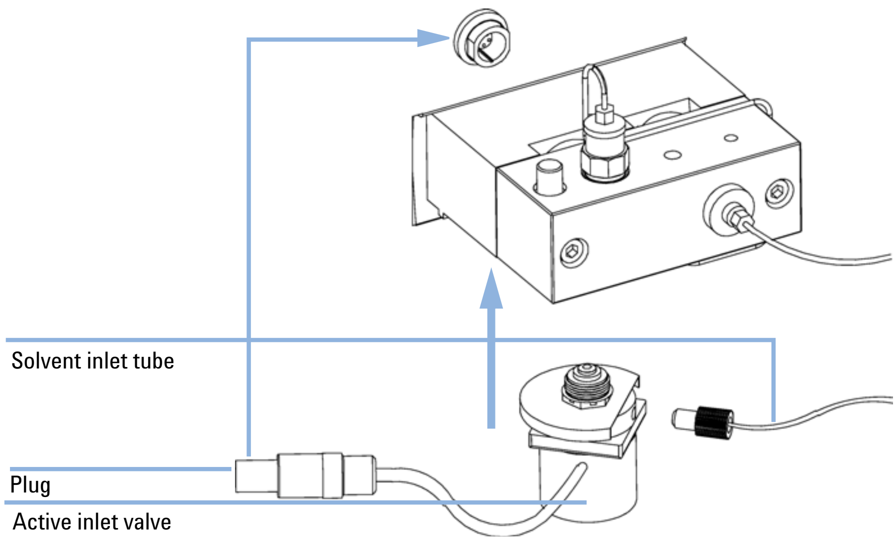


Figure 16 Exchanging the Active Inlet Valve

Exchanging the Outlet Ball Valve Sieve or the Complete Valve

When

Sieve — whenever the pump seals will be exchanged

Valve — if internally leaking

Tools required

Wrench 1/4 inch

Wrench 14 mm

Parts required

#	Part number	Description
1	G1312-60008	Outlet ball valve
1	5063-6505	Sieve (pack of 10)

NOTE Before exchanging the outlet ball valve you can try to clean it in a sonic bath. Remove the gold seal and the sieve. Place the valve in upright position (onto the plastic cap) in a small beaker with alcohol. Place in a sonic bath for 5 to 10 minutes. Insert a new sieve and replace the gold seal.

1 Using a 1/4 inch wrench disconnect the valve capillary from the outlet ball valve.
2 Using the 14 mm wrench loosen the valve and remove it from the pump body.
3 Remove the plastic cap with the gold seal from the outlet ball valve.
4 Using a pair of tweezers remove the sieve.

NOTE Check the gold seal. It should be exchanged when strongly deformed. Place the valve in an upright position, insert the sieve into the recess and replace the gold seal with the cap. Make sure that the sieve cannot move and is away from the seal area of the gold seal.

5 Place a new sieve into the recess of the outlet ball valve and replace the cap with the gold seal.

6 Check that the new valve is assembled correctly and that the gold seal is present.

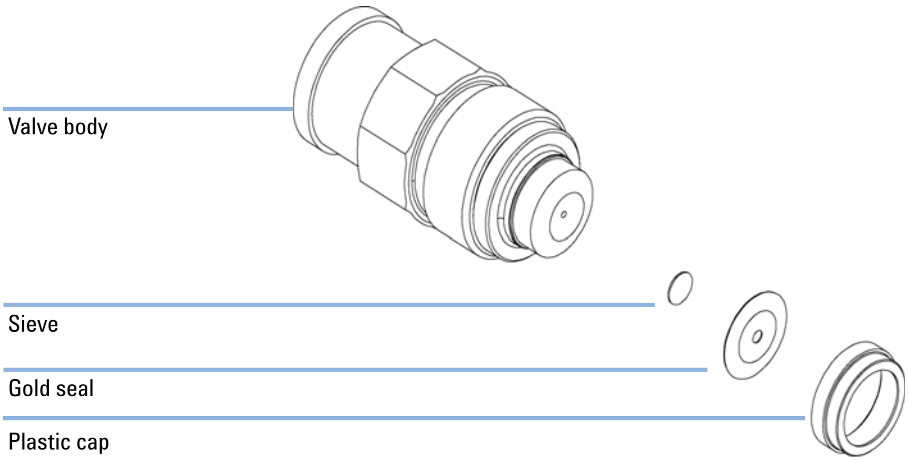


Figure 17 Outlet Ball Valve Parts

7 Reinstall the outlet ball valve and tighten the valve.

8 Reconnect the valve capillary.

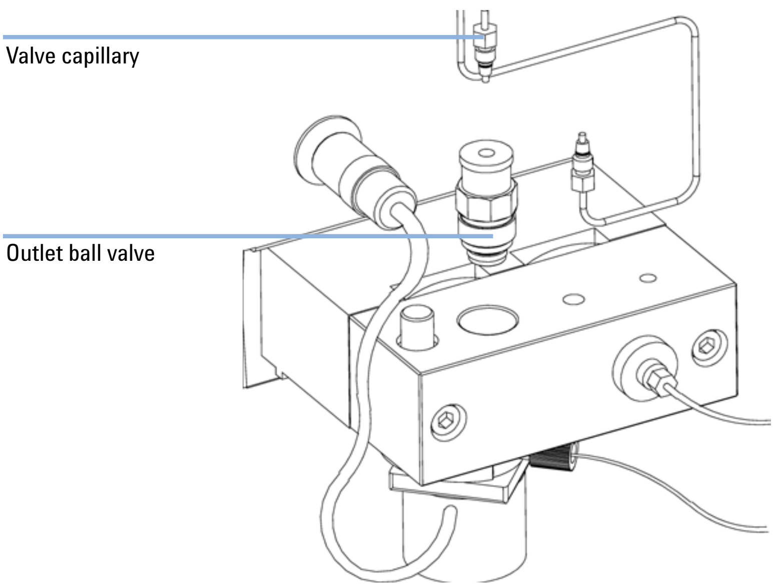


Figure 18 Exchanging the Outlet Ball Valve

Exchanging the Solvent Selection Valve

When If leaking internally (croossflow between the ports), or if one of the channels is blocked

Tools required Screwdriver Pozidriv #1

Parts required

#	Part number	Description
1	G1312-60000	Solvent selection valve (PN gives half of a complete solvent selection block)

1 Disconnect the solvent tubes and the active inlet valve connection tubes from the solvent selection valves. Place solvent tubes into the solvent cabinet to prevent leaks due to hydrostatic flow.

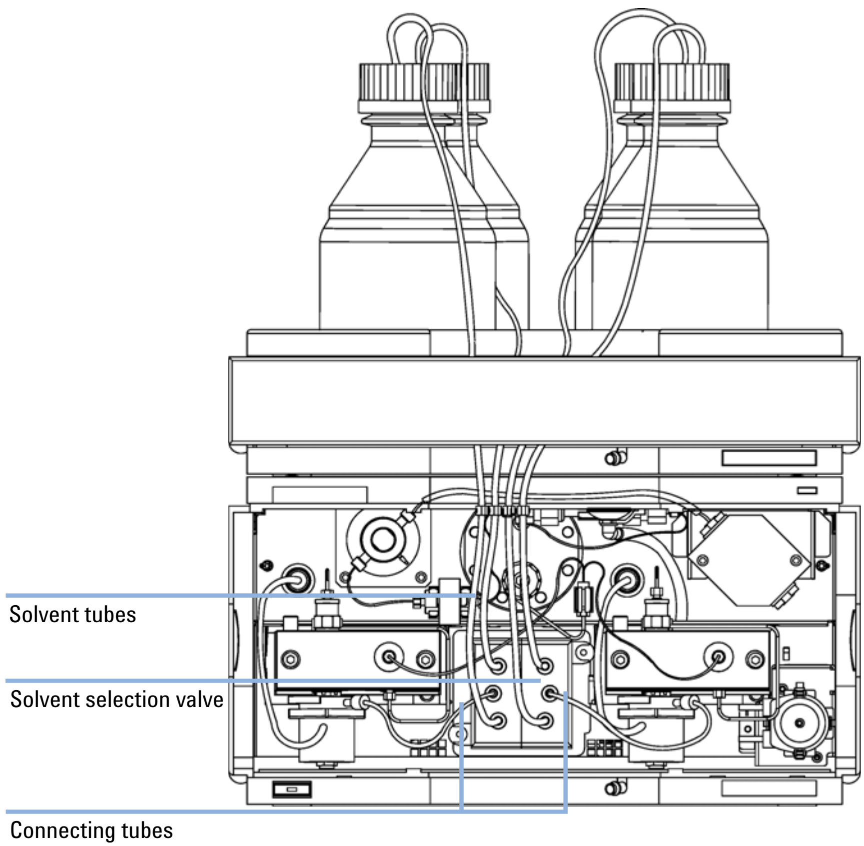


Figure 19 Exchanging the solvent selection valve

2. Using a Pozidriv screwdriver #1 loosen the holding screws of the valves.
3. Pull the valve module out of its connector.
4. Hold the two plastic bodies of the valves and pull the two solvent selection valves apart.
5. Exchange the defective solvent selection valve. Press the exchanged valve (new half) together with the properly working old half.
6. Connect the valve module to its electrical connectors and fix the assembly with the two holding screws.
7. Reinstall solvent tubes and the active inlet valve connection tubes

Removing and Disassembling the Pump Head Assembly

When

Exchanging pump seals

Exchanging plungers

Exchanging seals of the seal wash option

Tools required

Wrench 1/4 inch

3-mm hexagonal key

4-mm hexagonal key

Preparations

- Switch off capillary pump at power switch
- Remove the front cover to have access to the pump mechanics

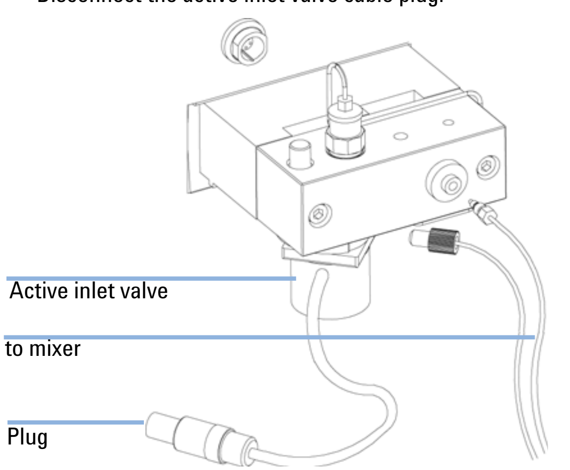
CAUTION

Damage of the pump drive

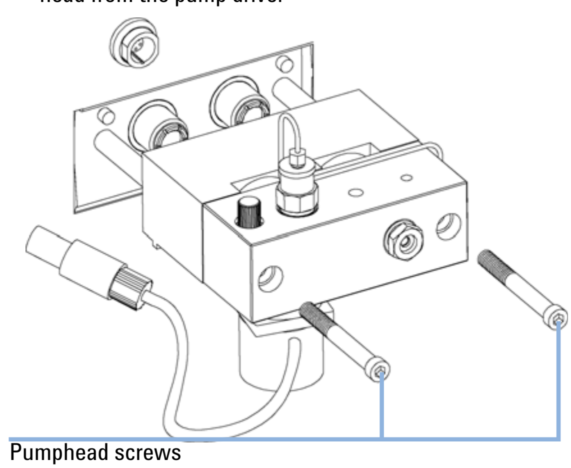
Starting the pump when the pump head is removed may damage the pump drive.

➔ Never start the pump when the pump head is removed.

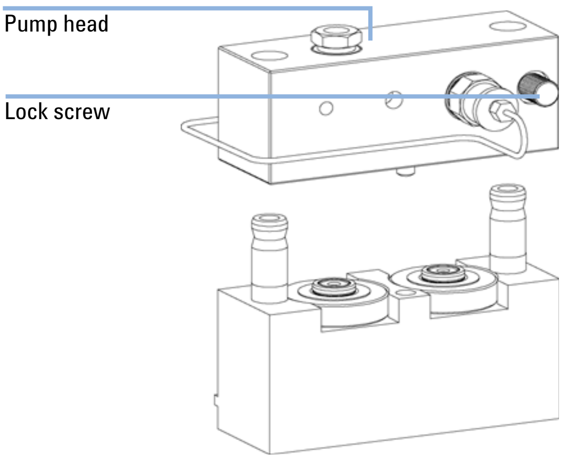
1 Disconnect the capillary at the pumphead adapter and the tube at the active inlet valve. Beware of leaking solvents. Disconnect the active inlet valve cable plug.



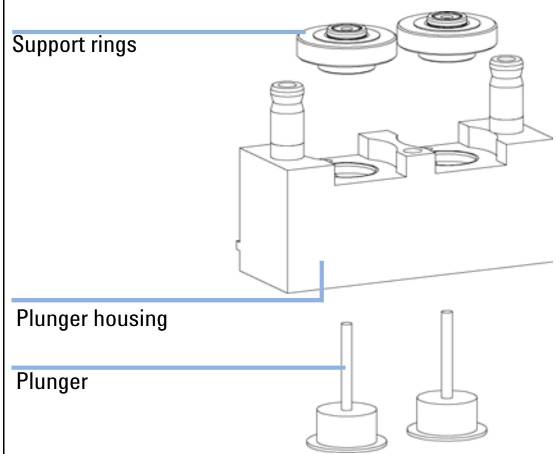
2 Using a 4-mm hexagonal key step wise loosen and remove the two pump head screws and remove the pump head from the pump drive.



3 Place the pump head on a flat surface. Loosen the lock screw (two revolutions). While holding the lower half of the assembly, carefully pull the pump head away from the plunger housing.



4 Remove the support rings from the plunger housing and lift the housing away from the plungers.



Exchanging the Pump Seals and Seal Wear-in Procedure

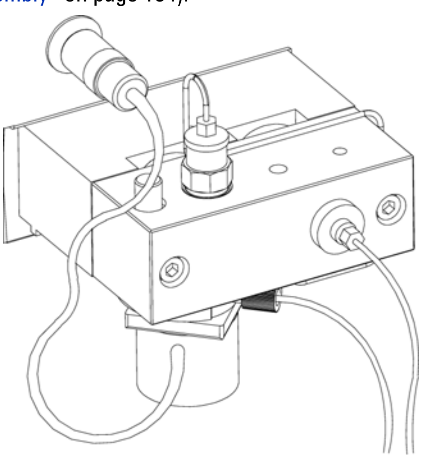
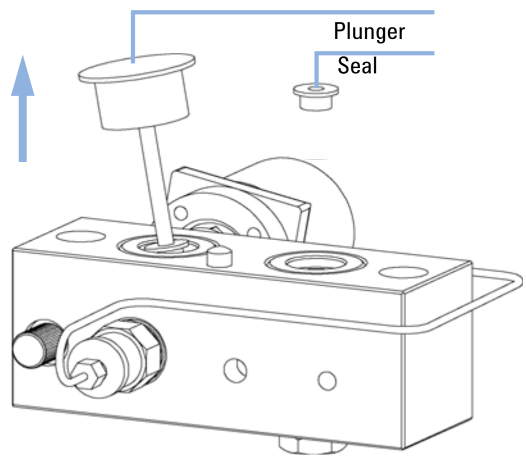
When Seals leaking, if indicated by the results of the pump test (check both pump heads individually!)

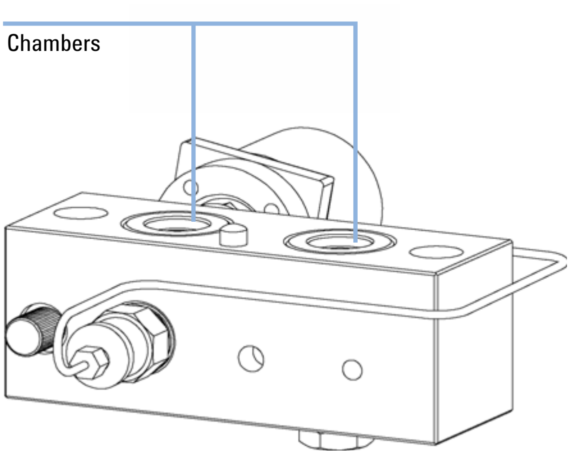
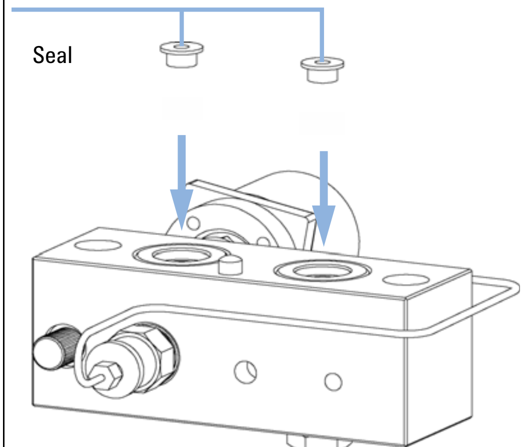
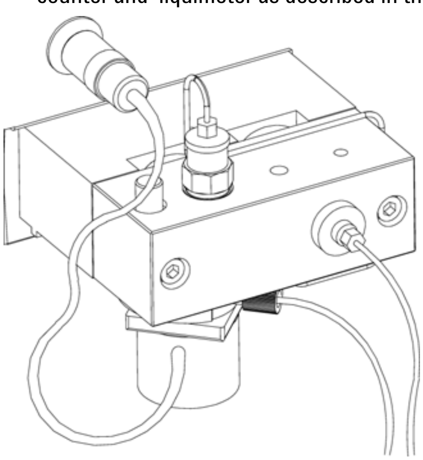
Tools required

3-mm hexagonal key
4-mm hexagonal key
1/4 inch wrench

Parts required

#	Part number	Description
2	5063-6589 (standard) or 0905-1420 (for normal phase application)	Seals (pack of 2)
1	5022-2159	*For the seal wear-in procedure:* Restriction capillary

1 Disassemble the pump head assembly of the leaky pump head (see “Removing and Disassembling the Pump Head Assembly” on page 134). 	**2** Using one of the plungers carefully remove the seal from the pump head (be careful, not to break the plunger). Remove wear retainers, if still present. 

3 Clean the pump chambers with lint free cloth. Ensure all particulate matter is removed. Best cleaning results will be achieved by removing all valves (see "Removing the Active Inlet Valve" on page 126 and "Exchanging the Outlet Ball Valve Sieve or the Complete Valve" on page 130) and the capillary. Inject solvent into each chamber. 	**4** Insert seals into the pump head and press firmly in position. 
5 Reassemble the pump head assembly (see "Reassembling the Pump Head Assembly" on page 142). Reset theseal wear counter and liquimeter as described in the User Interface documentation. 	

Seal Wear-in Procedure

NOTE This procedure is required for standard seals only (5063-6589), but it will definitely damage the normal phase application seals (0905-1420).

1. Place a bottle with 100 ml of Isopropanol in the solvent cabinet and place the tubing (including bottle head assembly) of the pump head that is supposed to be worn-in into the bottle.
2. Screw the adapter (0100-1847) to the AIV and connect the inlet tube from the bottle head directly to it.
3. Connect the restriction capillary (5022-2159) to the outlet of the EMPV. Insert its other end into a waste container.
4. Turn the system in *purge mode* and purge the system for 2 minutes with isopropanol at a flow rate of 2 ml/min.
5. Turn the system to *standard mode*, set the flow to a rate adequate to achieve a pressure of 350 bar. Pump 15 minutes at this pressure to wear in the seals. The pressure can be monitored at your analog output signal, with the handheld controller, Chemstation or any other controlling device connected to your pump.
6. Turn OFF the pump, slowly disconnect the restriction capillary from the EMPV to release the pressure from the system. Reconnect the capillary going to the flow sensor and the connecting tube from solvent selection valve to the AIV.
7. Rinse your system with the solvent used for your next application.

Exchanging the Plungers

When When scratched

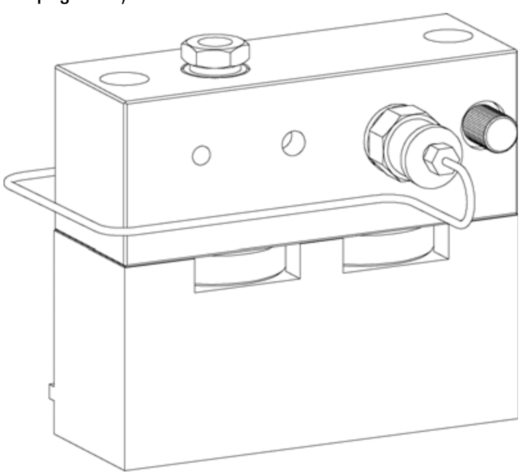
Tools required

- 3-mm hexagonal key
- 4-mm hexagonal key

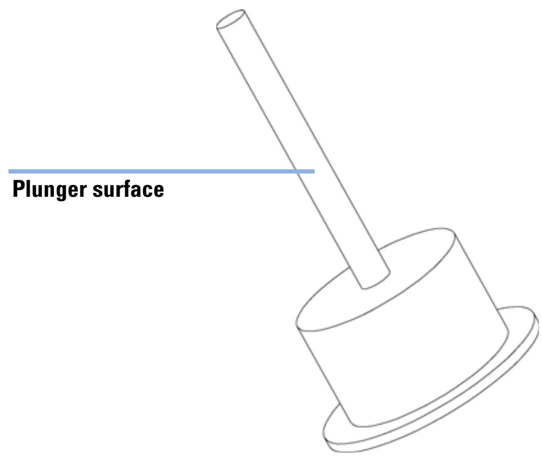
Parts required

#	Part number	Description
1	5063-6586	Plunger

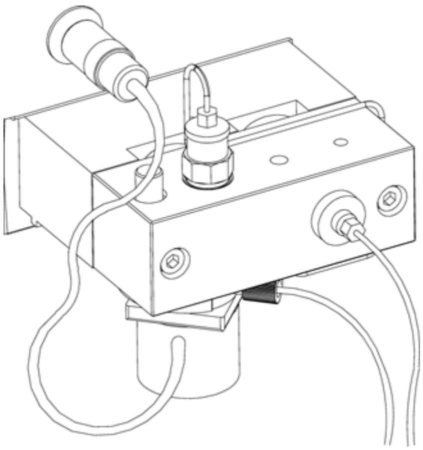
1 Disassemble the pump head assembly (see “Removing and Disassembling the Pump Head Assembly” on page 134)



2 Check the plunger surface and remove any deposits or layers. Cleaning can be done with alcohol or tooth paste. Replace plunger if scratched.



3 Reassemble the pump head assembly (see “Reassembling the Pump Head Assembly” on page 142).



Exchanging the Flow Sensor

When

Extended flow range (100 ul) needed.

Leak on the flow sensor.

Unstable column flow

Flow sensor blocked

Tools required

Screwdriver Pozidriv #1

Parts required

#	Part number	Description
1		Flow Sensor
	G1376-60001	20 ul
	G1376-60002	100 ul

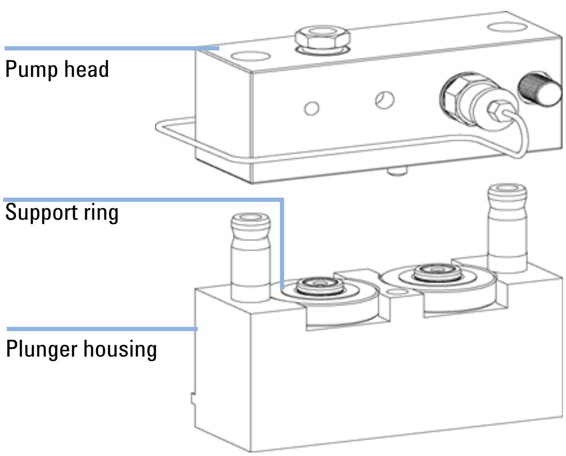
1 Turn off the pump.
2 Using a 1/4 inch wrench disconnect the capillaries:
   - coming from the EMPV.
   - going to the injection device (port 1).
3 Unscrew the flow sensor.
4 Re-install the new one.
5 Using a 1/4 inch wrench reconnect the capillaries:
   - coming from the EMPV.
   - going to the injection device (port 1).

Reassembling the Pump Head Assembly

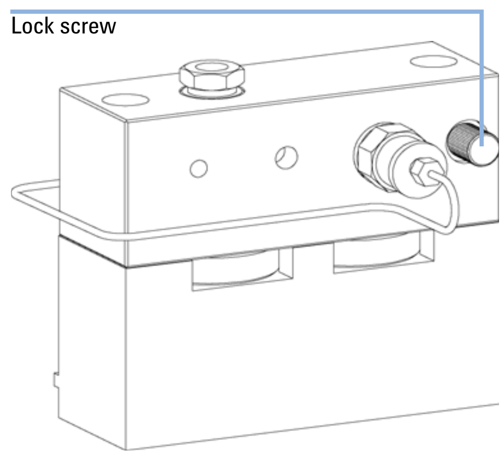
Tools required

- 3-mm hexagonal key
- 4-mm hexagonal key
- PTFE lubricant (79841-65501)

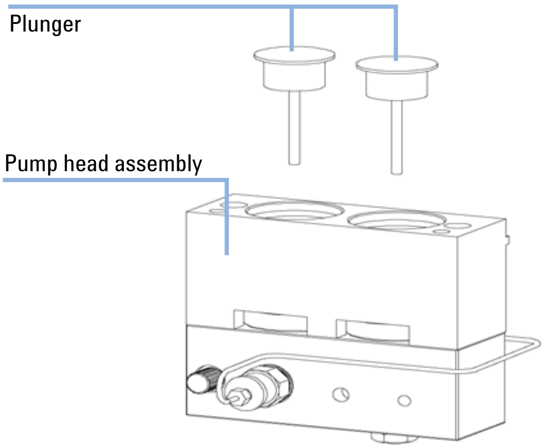
1 Place the support rings on the plunger housing (plungers not installed) and snap the pump head and plunger housing together.



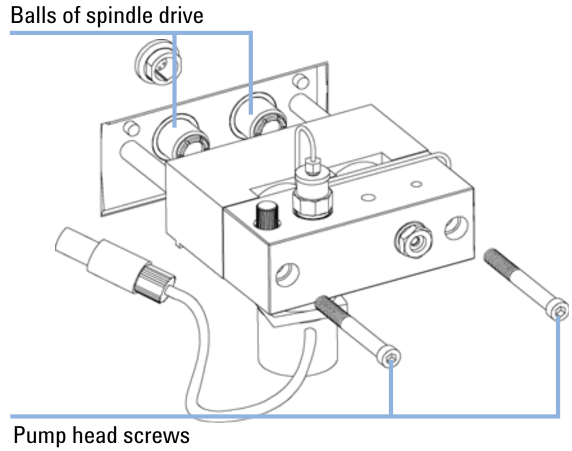
2 Tighten the lock screw.



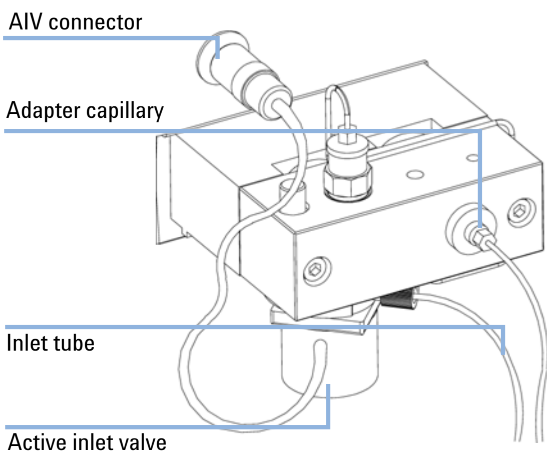
3 Carefully insert the plungers into the pump head assembly and press them completely into the seals



4 Slide the pump head assembly onto the pump drive. Apply a small amount of pump head grease to the pumphead screws and the balls of the spindle drive. Tighten screws stepwise with increasing torque.



5 Reconnect the capillaries, tubing and the active inlet valve cable to the connector.



Exchanging the Optional Interface Board

When Board defective

Parts required

#	Description
1	BCD (Interface) board, see service manual

CAUTION

Electrostatic discharge at electronic boards and components

Electronic boards and components are sensitive to electrostatic discharge (ESD).

→ ? In order to prevent damage always use an ESD protection (for example, the ESD wrist strap from the accessory kit) when handling electronic boards and components.

1. Switch OFF the capillary pump at the main power switch. Unplug the pump from main power.
2. Disconnect cables from the interface board connectors.
3. Loosen the screws. Slide out the interface board from the capillary pump.
4. Install the new interface board. Secure screws.
5. Reconnect the cables to the board connector.

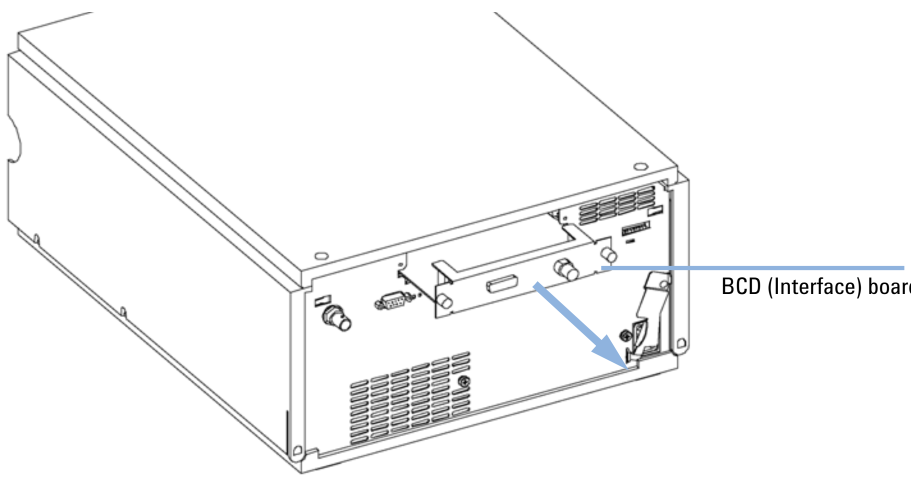


Figure 20 Exchanging the Interface Board

8
Parts and Materials for Maintenance

Pump Housing and Main Assemblies

Table 12 Repair Parts — Pump Housing and Main Assemblies (Front View)

Item	Description	Part Number
1	Pump head, see "Pump-Head Assembly" on page 152	**G1311-60004**
2	Pump drive assembly Exchange assembly — pump drive	**G1311-60001** **G1311-69001**
3	Cable assembly — AIV to main board	**G1311-61601**
4	Capillary system main board (CSM) Exchange assembly — CSM board	**G1376-66530** **G1376-69530**
5	Cable assembly — solvent selection valve	**G1312-61602**
6	Fan assembly	**3160-1017**
7	Damping unit	**79835-60005**
8	Solvent selection valve (half of a complete valve Screw, solvent selection valve	**G1312-60000** **5022-2112**
9	Leak pan - pump	**5042-8590**
10	EMPV	**G1361-60000**
11	Flow Sensor 20 µl Flow Sensor 100 µl	**G1376-60001** **G1376-60002**

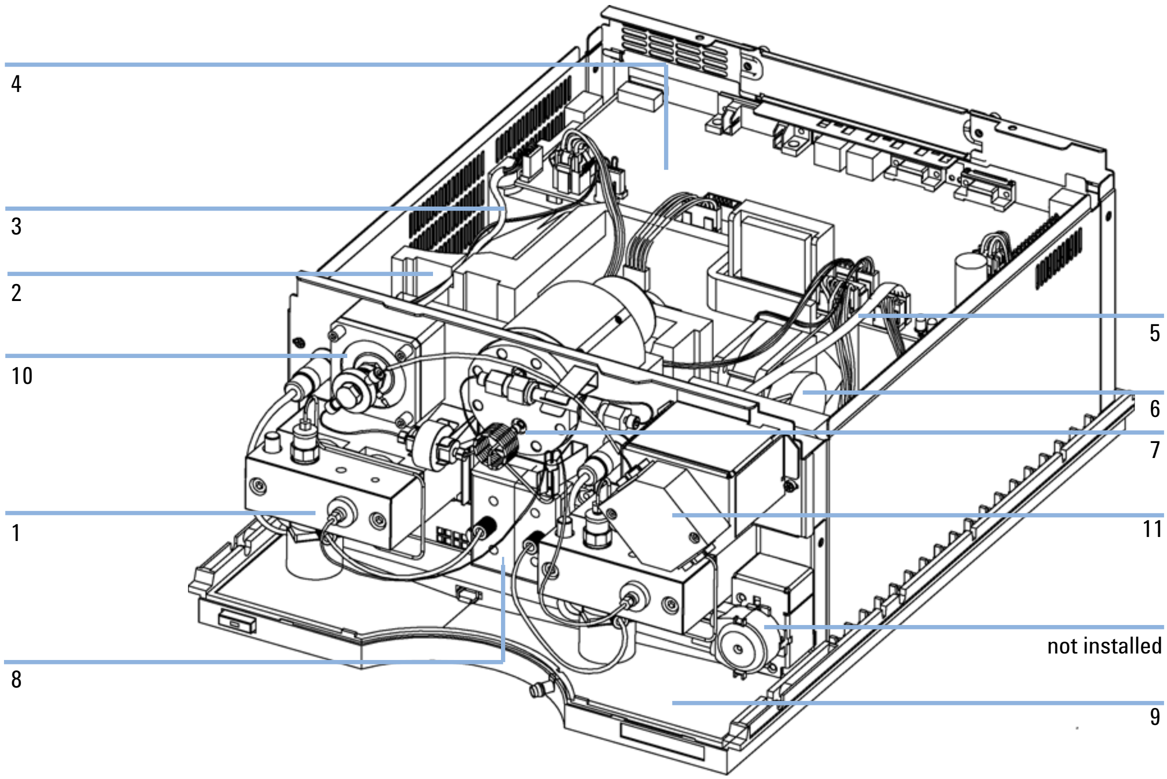


Figure 21 Overview of Main Assemblies (Front View)

Table 13 Repair Parts — Pump Housing and Main Assemblies (Rear View)

Item	Description	Part Number
1	Hexagonal nut for RS 232C connector	**1251-7788**
2	Nut M14 — analog output	**2940-0256**
3	Screw M14, 7 mm lg — power supply	**0515-0910**
4	Standoff — GPIB connector	**0380-0643**

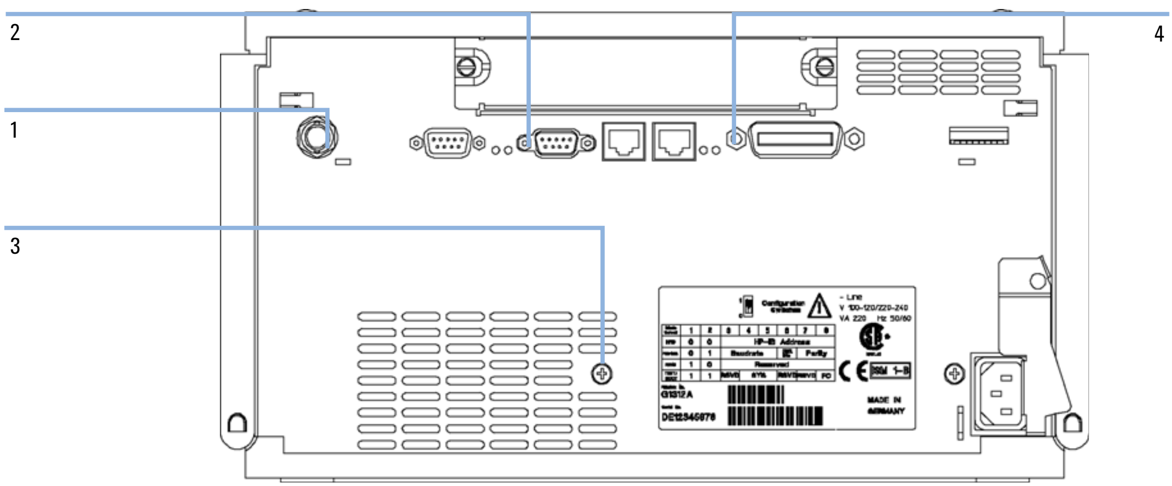


Figure 22 Overview of Main Assemblies (Rear View)

Solvent Cabinet and Bottle-Head Assembly

Table 14 Solvent Cabinet and Bottle-Head Assembly Parts

Item	Description	Part Number
1	Solvent cabinet, including all plastic parts	**5065-9981**
2	Name plate, Agilent 1200	**5042-8901**
3	Front panel, solvent cabinet	**5065-9954**
4	Leak pan, solvent cabinet	**5042-8567**
	Bottle-head assembly for Capillary pump includes items 8, 9, 10 and 11	**G1311-60003**
5/6	Solvent inlet filter (SST)	**01018-60025**
7	Solvent tubing, 5 m	**5062-2483**
	Ferrules with lock ring (pack of 10)	**5063-6598**
	Tube screw (pack of 10)	**5063-6599**
	Bottle transparent	**9301-1420**
	Bottle amber	**9301-1450**

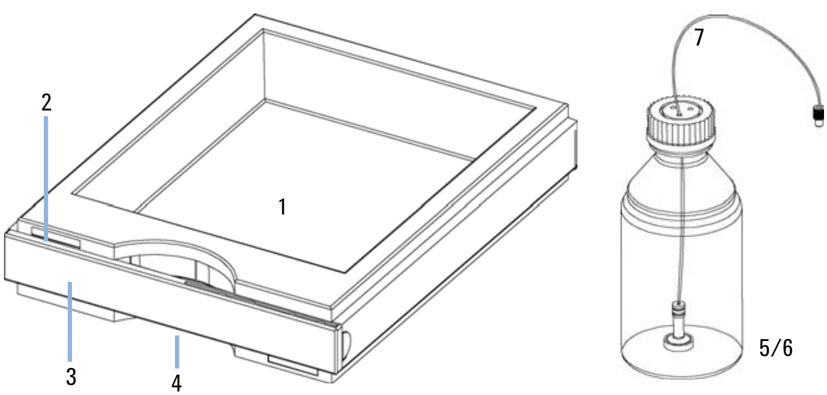


Figure 23 Solvent Cabinet Parts

Hydraulic Path

Table 15 Hydraulic Path

Item	Description	Part Number
1	Bottle-head assembly	**G1311-60003**
2	Connection tube	**G1311-67304**
3	Capillary, outlet ball valve to piston 2	**G1312-67300**
4	Restriction capillary	**G1312-67304**
5	Mixing capillary	**G1312-67302**
6	Capillary, damper to mixer	**01090-87308**
7	Mixer	**G1312-87330**
8	Capillary mixer to filter	**01090-87308**
9	Filter assembly (includes frit) Frit	**5064-8273** **5022-2185**
10	Capillary Filter to EMPV	**G1375-87400**
11	Capillary EMPV to flow sensor (20 µl) Capillary EMPV to flow sensor (100 µl)	**G1375-87301** **G1375-87305**
12	Capillary flow sensor to injection device (20 µl) Capillary flow sensor to injection device (100 µl)	**G1375-87310** **G1375-87306**
	Corrugated waste tube, 120 cm (re-order 5 m)	**5062-2463**

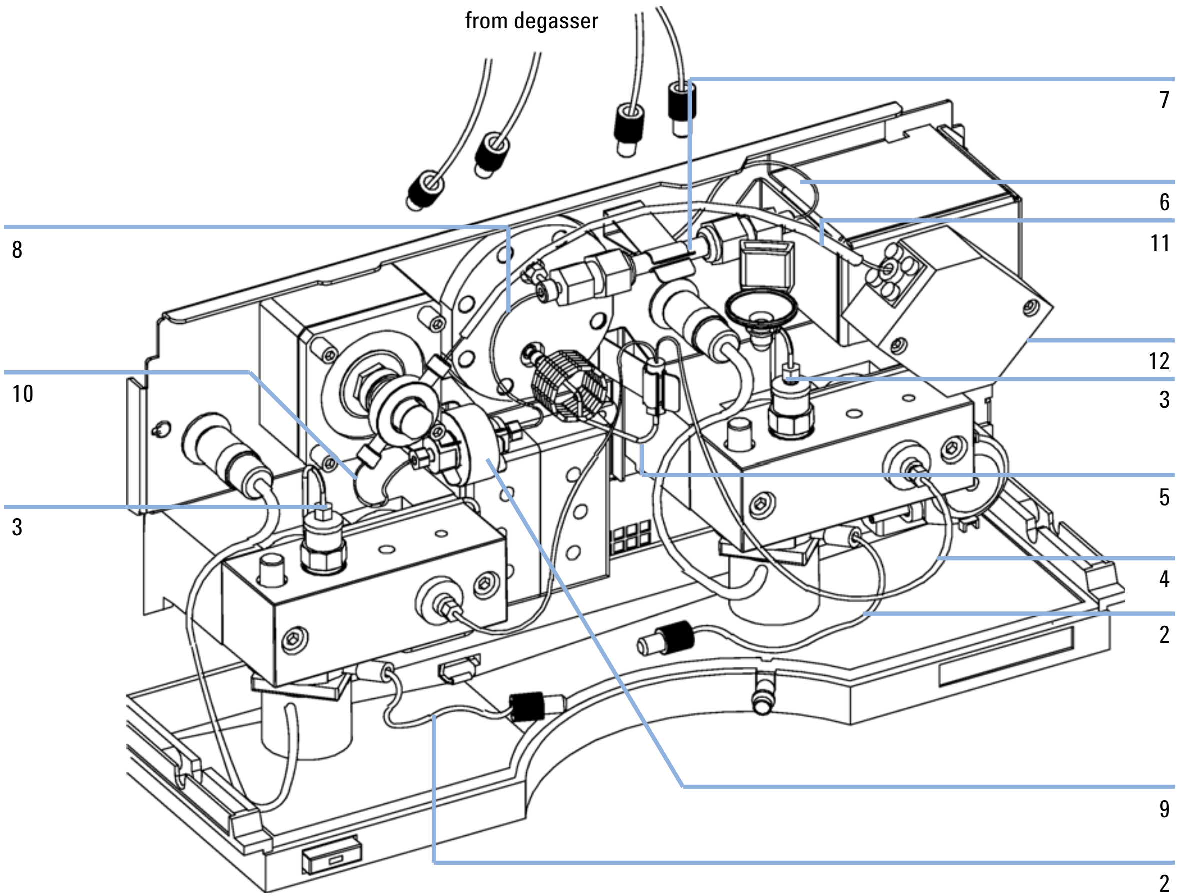


Figure 24 Hydraulic Path

Pump-Head Assembly

Table 16 Pump-Head Assembly

Item	Description	Part Number
	Complete assembly, included items marked with (*)	**G1311-60004**
1*	Sapphire plunger	**5063-6586**
2*	Plunger housing (including springs)	**G1311-60002**
3*	Support ring	**5001-3739**
4*	Seal (pack of 2) or Seal (pack of 2), for normal phase applications	**5063-6589** **0905-1420**
5	Capillary outlet valve to piston 2	**G1312-67300**
6*	Pump chamber housing	**G1311-25200**
7	Active inlet valve (without cartridge) Replacement cartridge for active inlet valve	**G1312-60025** **5062-8562**
8	Outlet ball valve	**G1312-60012**
9*	Screw lock	**5042-1303**
10	Apdater	**G1312-23201**
11*	Screw M5, 60 mm lg	**0515-2118**

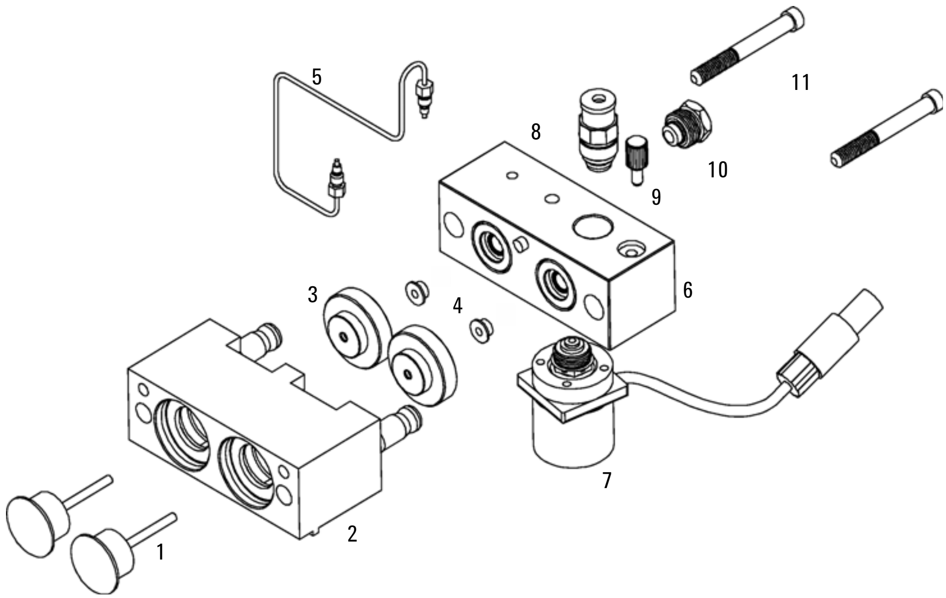


Figure 25 Pump-Head Assembly

Flow Sensor Assembly

Table 17 Flow Sensor Assembly

Item	Description	Part Number
1	Flow sensor assembly (20 µl)	**G1376-60001**
	Flow sensor assembly (100 µl)	**G1376-60002**
	Capillary EMPV to flow sensor (20 µl flow sensor) Capillary EMPV to flow sensor (100 µl flow sensor)	**G1375-87301** **G1375-87305**
	Capillary flow sensor to injection device (20 µl flow sensor) Capillary flow sensor to injection device (100 µl flow sensor)	**G1375-87310** **G1375-87306**

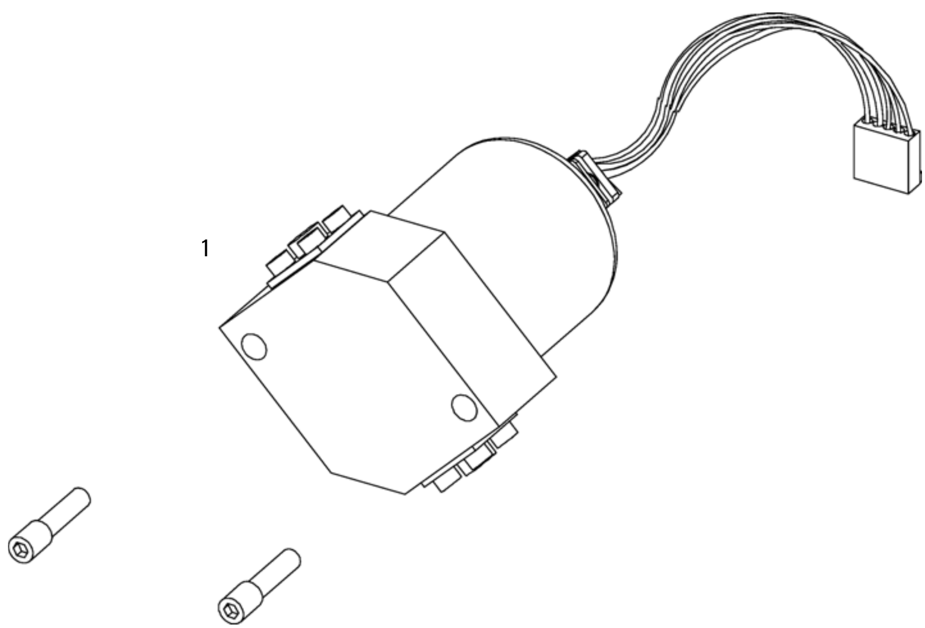


Figure 26 Flow Sensor Assembly

Capillary Pump Accessory Kit

Table 18 Accessory Kit G1376-68705

Description	Part Number
Tubing flexible, 2 m	**0890-1760**
SST Frit 2 µm, Qty = 1	**5022-2185**
Wrench open end 7/16 - 1/2 inch, Qty = 2	**8710-0806**
Wrench open end 1/4 - 5/16 inch, Qty = 1	**8710-0510**
Wrench open end 14 mm, Qty = 1	**8710-1924**
Wrench open end 4 mm, Qty = 1	**8710-1534**
Hex key 2.5 mm, Qty = 1	**8710-2412**
Hex key 3.0 mm, Qty = 1	**8710-2411**
Torque Adapter	**G1315-45003**
Insertion Tool, Qty = 1	**01018-23702**
ESD Wrist Strap, Qty = 1	**9300-1408**
Can cable, 1 m long	**5181-1519**
Hex key 4 mm 15 cm long T-handle	**8710-2392**
Solvent inlet filter (x4)	**01018-60025**
Purge valve assembly	**G1311-60009**
Purge valve holder	**G1312-23200**
Capillary 550 mm 50 µm	**G1375-87310**

9
Identifying Cables

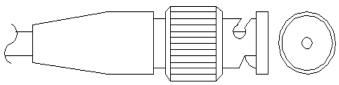
Cable Overview

NOTE Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.

Type	Description	Part Number
Analog cables	3390/2/3 integrators	**01040-60101**
	3394/6 integrators	**35900-60750**
	Agilent **35900A** A/D converter	**35900-60750**
	General purpose (spade lugs)	**01046-60105**
Remote cables	3390 integrator	**01046-60203**
	3392/3 integrators	**01046-60206**
	3394 integrator	**01046-60210**
	3396A (Series I) integrator	**03394-60600**
	3396 Series II / 3395A integrator, see details in section "Remote Cables" on page 163	
	3396 Series III / 3395B integrator	**03396-61010**
	HP 1050 modules / HP 1046A FLD	**5061-3378**
	HP 1046A FLD	**5061-3378**
	Agilent **35900A** A/D converter	**5061-3378**
	HP 1040 diode-array detector	**01046-60202**
	HP 1090 liquid chromatographs	**01046-60202**
	Signal distribution module	**01046-60202**
BCD cables	3396 integrator	**03396-60560**
	General purpose (spade Lugs)	**G1351-81600**
Auxiliary	Agilent 1100 Series vacuum degasser	**G1322-61600**

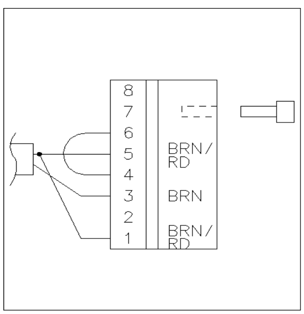
Type	Description	Part Number
CAN cables	Agilent 1100/1200 module to module,0.5m lg Agilent 1100/1200 module to module, 1m lg	**5181-1516** **5181-1519**
External contacts	Agilent 1100/1200 Series interface board to general purpose	**G1103-61611**
GPIB cable	Agilent 1100/1200 module to ChemStation, 1 m Agilent 1100/1200 module to ChemStation, 2 m	**10833A** **10833B**
RS-232 cable	Agilent 1100/1200 module to a computer This kit contains a 9-pin female to 9-pin female Null Modem (printer) cable and one adapter.	**34398A**
LAN cable	Twisted pair cross over LAN cable, (shielded 3m long) (for point to point connection)	**5023-0203**
	Twisted pair cross over LAN cable, (shielded 7m long) (for point to point connection)	**5023-0202**

Analog Cables

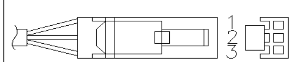


One end of these cables provides a BNC connector to be connected to Agilent 1100/1200 Series modules. The other end depends on the instrument to which connection is being made.

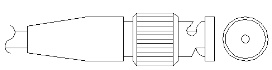
Agilent 1100/1200 to 3390/2/3 Integrators

Connector 01040-60101	Pin 3390/2/3	Pin Agilent 1100/1200	Signal Name
	1	Shield	Ground
	2		Not connected
	3	Center	Signal +
	4		Connected to pin 6
	5	Shield	Analog -
	6		Connected to pin 4
	7		Key
	8		Not connected

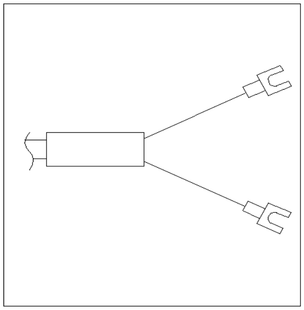
Agilent 1100/1200 to 3394/6 Integrators

Connector35900-60750	Pin 3394/6	Pin Agilent 1100/1200	Signal Name
	1		Not connected
	2	Shield	Analog -
	3	Center	Analog +

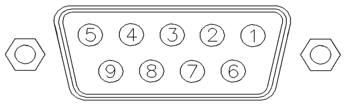
Agilent 1100/1200 to BNC Connector

Connector8120-1840	Pin BNC	Pin Agilent 1100/1200	Signal Name
	Shield	Shield	Analog -
	Center	Center	Analog +

Agilent 1100/1200 to General Purpose

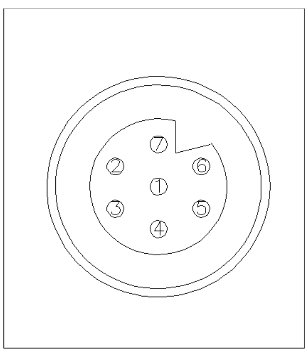
Connector01046-60105	Pin 3394/6	Pin Agilent 1100/1200	Signal Name
	1		Not connected
	2	Black	Analog -
	3	Red	Analog +

Remote Cables

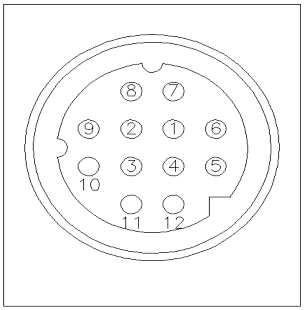


One end of these cables provides a Agilent Technologies APG (Analytical Products Group) remote connector to be connected to Agilent 1100/1200 Series modules. The other end depends on the instrument to be connected to.

Agilent 1100/1200 to 3390 Integrators

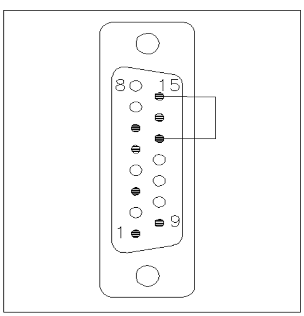
Connector 01046-60203	Pin 3390	Pin Agilent 1100/1200	Signal Name	Active (TTL)
	2	1 - White	Digital ground	
	NC	2 - Brown	Prepare run	Low
	7	3 - Gray	Start	Low
	NC	4 - Blue	Shut down	Low
	NC	5 - Pink	Not connected	
	NC	6 - Yellow	Power on	High
	NC	7 - Red	Ready	High
	NC	8 - Green	Stop	Low
	NC	9 - Black	Start request	Low

Agilent 1100/1200 to 3392/3 Integrators



Connector01046-60206	Pin 3392/3	Pin Agilent 1100/1200	Signal Name	Active (TTL)
	3	1 - White	Digital ground	
	NC	2 - Brown	Prepare run	Low
	11	3 - Gray	Start	Low
	NC	4 - Blue	Shut down	Low
	NC	5 - Pink	Not connected	
	NC	6 - Yellow	Power on	High
	9	7 - Red	Ready	High
	1	8 - Green	Stop	Low
	NC	9 - Black	Start request	Low

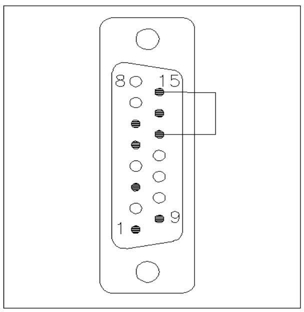
Agilent 1100/1200 to 3394 Integrators



Connector01046-60210	Pin 3394	Pin Agilent 1100/1200	Signal Name	Active (TTL)
	9	1 - White	Digital ground	
	NC	2 - Brown	Prepare run	Low
	3	3 - Gray	Start	Low
	NC	4 - Blue	Shut down	Low
	NC	5 - Pink	Not connected	
	NC	6 - Yellow	Power on	High
	5,14	7 - Red	Ready	High
	6	8 - Green	Stop	Low
	1	9 - Black	Start request	Low
	13, 15		Not connected	

NOTE START and STOP are connected via diodes to pin 3 of the 3394 connector.

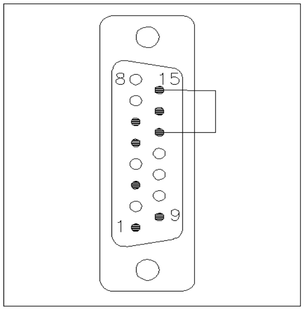
Agilent 1100/1200 to 3396A Integrators

Connector03394-60600	Pin 3394	Pin Agilent 1100/1200	Signal Name	Active (TTL)
	9	1 - White	Digital ground	
	NC	2 - Brown	Prepare run	Low
	3	3 - Gray	Start	Low
	NC	4 - Blue	Shut down	Low
	NC	5 - Pink	Not connected	
	NC	6 - Yellow	Power on	High
	5,14	7 - Red	Ready	High
	1	8 - Green	Stop	Low
	NC	9 - Black	Start request	Low
	13, 15		Not connected	

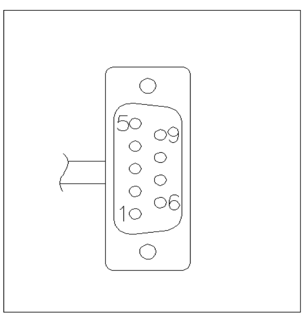
Agilent 1100/1200 to 3396 Series II / 3395A Integrators

Use the cable **part number: 03394-60600** and cut pin #5 on the integrator side. Otherwise the integrator prints START; not ready.

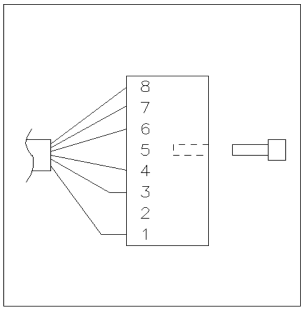
Agilent 1100/1200 to 3396 Series III / 3395B Integrators

Connector03396-61010	Pin 33XX	Pin Agilent 1100/1200	Signal Name	Active (TTL)
	9	1 - White	Digital ground	
	NC	2 - Brown	Prepare run	Low
	3	3 - Gray	Start	Low
	NC	4 - Blue	Shut down	Low
	NC	5 - Pink	Not connected	
	NC	6 - Yellow	Power on	High
	14	7 - Red	Ready	High
	4	8 - Green	Stop	Low
	NC	9 - Black	Start request	Low
	13, 15		Not connected	

Agilent 1100/1200 to HP 1050, HP 1046A or Agilent 35900 A/D Converters

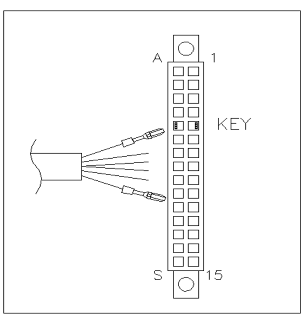
Connector5061-3378	Pin HP 1050/….	Pin Agilent 1100/1200	Signal Name	Active (TTL)
	1 - White	1 - White	Digital ground	
	2 - Brown	2 - Brown	Prepare run	Low
	3 - Gray	3 - Gray	Start	Low
	4 - Blue	4 - Blue	Shut down	Low
	5 - Pink	5 - Pink	Not connected	
	6 - Yellow	6 - Yellow	Power on	High
	7 - Red	7 - Red	Ready	High
	8 - Green	8 - Green	Stop	Low
	9 - Black	9 - Black	Start request	Low

Agilent 1100/1200 to HP 1090 LC or Signal Distribution Module



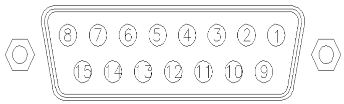
Connector01046-60202	Pin HP 1090	Pin Agilent 1100/1200	Signal Name	Active (TTL)
	1	1 - White	Digital ground	
	NC	2 - Brown	Prepare run	Low
	4	3 - Gray	Start	Low
	7	4 - Blue	Shut down	Low
	8	5 - Pink	Not connected	
	NC	6 - Yellow	Power on	High
	3	7 - Red	Ready	High
	6	8 - Green	Stop	Low
	NC	9 - Black	Start request	Low

Agilent 1100/1200 to General Purpose



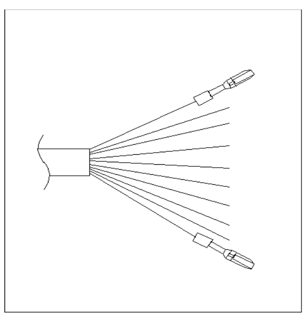
Connector01046-60201	Pin Universal	Pin Agilent 1100/1200	Signal Name	Active (TTL)
		1 - White	Digital ground	
		2 - Brown	Prepare run	Low
		3 - Gray	Start	Low
		4 - Blue	Shut down	Low
		5 - Pink	Not connected	
		6 - Yellow	Power on	High
		7 - Red	Ready	High
		8 - Green	Stop	Low
		9 - Black	Start request	Low

BCD Cables

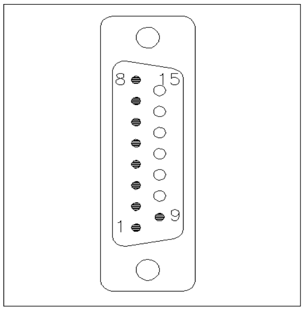


One end of these cables provides a 15-pin BCD connector to be connected to the Agilent 1200 Series modules. The other end depends on the instrument to be connected to

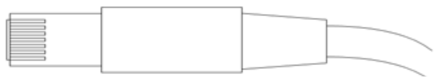
Agilent 1200 to General Purpose

Connector G1351-81600	Wire Color	Pin Agilent 1200	Signal Name	BCD Digit
	Green	1	BCD 5	20
	Violet	2	BCD 7	80
	Blue	3	BCD 6	40
	Yellow	4	BCD 4	10
	Black	5	BCD 0	1
	Orange	6	BCD 3	8
	Red	7	BCD 2	4
	Brown	8	BCD 1	2
	Gray	9	Digital ground	Gray
	Gray/pink	10	BCD 11	800
	Red/blue	11	BCD 10	400
	White/green	12	BCD 9	200
	Brown/green	13	BCD 8	100
	not connected	14		
	not connected	15	+ 5 V	Low

Agilent 1200 to 3396 Integrators

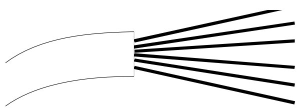
Connector03396-60560	Pin 3392/3	Pin Agilent 1200	Signal Name	BCD Digit
	1	1	BCD 5	20
	2	2	BCD 7	80
	3	3	BCD 6	40
	4	4	BCD 4	10
	5	5	BCD0	1
	6	6	BCD 3	8
	7	7	BCD 2	4
	8	8	BCD 1	2
	9	9	Digital ground	
	NC	15	+ 5 V	Low

Auxiliary Cable

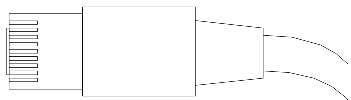


One end of this cable provides a modular plug to be connected to the Agilent 1100 Series vacuum degasser. The other end is for general purpose.

Agilent 1100 Series Degasser to general purposes

Connector G1322-81600	Color	Pin Agilent 1100	Signal Name
	White	1	Ground
	Brown	2	Pressure signal
	Green	3	
	Yellow	4	
	Grey	5	DC + 5 V IN
	Pink	6	Vent

CAN/LAN Cables



Both ends of this cable provide a modular plug to be connected to Agilent 1200 Series module's CAN or LAN connectors.

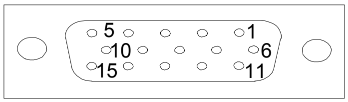
CAN Cables

Agilent 1200 module to module, 0.5 m	**5181-1516**
Agilent 1200 module to module, 1 m	**5181-1519**
Agilent 1200 module to control module	**G1323-81600**

LAN Cables

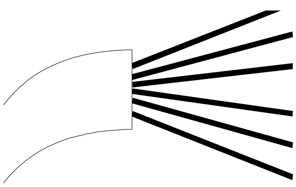
Description	Part number
Cross-over network cable (shielded, 3 m long), (for point to point connection)	**5023-0203**
Twisted pair network cable (shielded, 7 m long) (for hub connections)	**5023-0202**

External Contact Cable



One end of this cable provides a 15-pin plug to be connected to Agilent 1200 Series module's interface board. The other end is for general purpose.

Agilent 1200 Series Interface Board to general purposes

Connector G1103-61611	Color	Pin Agilent 1200	Signal Name
	White	1	EXT 1
	Brown	2	EXT 1
	Green	3	EXT 2
	Yellow	4	EXT 2
	Grey	5	EXT 3
	Pink	6	EXT 3
	Blue	7	EXT 4
	Red	8	EXT 4
	Black	9	Not connected
	Violet	10	Not connected
	Grey/pink	11	Not connected
	Red/blue	12	Not connected
	White/green	13	Not connected
	Brown/green	14	Not connected
	White/yellow	15	Not connected

RS-232 Cable Kit

This kit contains a 9-pin female to 9-pin female Null Modem (printer) cable and one adapter. Use the cable and adapter to connect Aligent Technologies instruments with 9-pin male RS-232 connectors to most PCs or printers.

Description	Part number
RS-232 cable, instrument to PC, 9-to-9 pin (female) This cable has special pin-out, and is not compatible with connecting printers and plotters.	**24542U** **G1530-60600**
RS-232 cable kit, 9-to-9 pin (female) and one adapter 9-pin (male) 25-pin female. Suited for instrument to PC.	**34398A**
Cable Printer Serial & Parallel, is a SUB-D 9 pin female vs. Centronics connector on the other end (NOT FOR FW UPDATE).	**5181-1529**
This kit contains a 9-pin female to 9-pin female Null Modem (printer) cable and one adapter. Use the cable and adapter to connect Agilent Technologies instruments with 9-pin male RS-232 connectors to most PCs or printers.	**34398A**

10 Appendix

General Safety Information

General Safety Information

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

WARNING

Ensure the proper usage of the equipment.

The protection provided by the equipment may be impaired.

→ The operator of this instrument is advised to use the equipment in a manner as specified in this manual.

Safety Standards

This is a Safety Class I instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

Operation

Before applying power, comply with the installation section. Additionally the following must be observed.

Do not remove instrument covers when operating. Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers, and devices connected to it must be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any intended operation.

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, and so on) are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be avoided.

Some adjustments described in the manual, are made with power supplied to the instrument, and protective covers removed. Energy available at many points may, if contacted, result in personal injury.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided whenever possible. When inevitable, this has to be carried out by a skilled person who is aware of the hazard involved. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present. Do not replace components with power cable connected.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

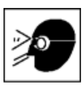
Do not install substitute parts or make any unauthorized modification to the instrument.

Capacitors inside the instrument may still be charged, even though the instrument has been disconnected from its source of supply. Dangerous voltages, capable of causing serious personal injury, are present in this instrument. Use extreme caution when handling, testing and adjusting.

When working with solvents please observe appropriate safety procedures (e.g. goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet by the solvent vendor, especially when toxic or hazardous solvents are used.

Safety Symbols

Table 19 Safety Symbols

Symbol	Description
	The apparatus is marked with this symbol when the user should refer to the instruction manual in order to protect risk of harm to the operator and to protect the apparatus against damage.
	Indicates dangerous voltages.
	Indicates a protected ground terminal.
	Indicates eye damage may result from directly viewing the light produced by the deuterium lamp used in this product.
	The apparatus is marked with this symbol when hot surfaces are available and the user should not touch it when heated up.

WARNING

A WARNING

alerts you to situations that could cause physical injury or death.

→ Do not proceed beyond a warning until you have fully understood and met the indicated conditions.

CAUTION

A CAUTION

alerts you to situations that could cause loss of data, or damage of equipment.

→ Do not proceed beyond a caution until you have fully understood and met the indicated conditions.

The Waste Electrical and Electronic Equipment Directive

Abstract

The Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC), adopted by EU Commission on 13 February 2003, is introducing producer responsibility on all electric and electronic appliances starting with 13 August 2005.

NOTE

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category:

With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a “Monitoring and Control Instrumentation” product.

NOTE

Do not dispose off in domestic household waste

To return unwanted products, contact your local Agilent office, or see www.agilent.com for more information.

Lithium Batteries Information

WARNING

Lithium batteries may not be disposed-off into the domestic waste. Transportation of discharged Lithium batteries through carriers regulated by IATA/ICAO, ADR, RID, IMDG is not allowed.

Danger of explosion if battery is incorrectly replaced.

→ Discharged Lithium batteries shall be disposed off locally according to national waste disposal regulations for batteries.

→ Replace only with the same or equivalent type recommended by the equipment manufacturer.

WARNING

Lithiumbatteri - Eksplosionsfare ved fejlagtig håndtering.

Udskiftning må kun ske med batteri af samme fabrikat og type.

→ Lever det brugte batteri tilbage til leverandøren.

WARNING

Lithiumbatteri - Eksplosionsfare.

Ved udskiftning benyttes kun batteri som anbefalt av apparatfabrikanten.

→ Brukt batteri returneres appararleverandoren.

NOTE

Bij dit apparaat zijn batterijen geleverd. Wanneer deze leeg zijn, moet u ze niet weggooien maar inleveren als KCA.

Radio Interference

Cables supplied by Agilent Technoligies are screened to provide opitimized protection against radio interference. All cables are in compliance with safety or EMC regulations.

Test and Measurement

If test and measurement equipment is operated with unscreened cables, or used for measurements on open set-ups, the user has to assure that under operating conditions the radio interference limits are still met within the premises.

Sound Emission

Manufacturer's Declaration

This statement is provided to comply with the requirements of the German Sound Emission Directive of 18 January 1991.

This product has a sound pressure emission (at the operator position) < 70 dB.

- Sound Pressure Lp < 70 dB (A)
- At Operator Position
- Normal Operation
- According to ISO 7779:1988/EN 27779/1991 (Type Test)

Solvent Information

Flow Cell

To protect optimal functionality of your flow-cell:

- Avoid the use of alkaline solutions (pH > 9.5) which can attack quartz and thus impair the optical properties of the flow cell.
- If the flow cell is transported while temperatures are below 5 degree C, it must be assured that the cell is filled with alcohol.
- Aqueous solvents in the flow cell can built up algae. Therefore do not leave aqueous solvents sitting in the flow cell. Add a small % of organic solvents (e.g. acetonitrile or methanol ~5%).

Use of Solvents

Observe the following recommendations on the use of solvents.

- Brown glass ware can avoid growth of algae.
- Small particles can permanently block capillaries and valves. Therefore always filter solvents through 0.4 µm filters.
- Avoid the use of the following steel-corrosive solvents:
  - Solutions of alkali halides and their respective acids (for example, lithium iodide, potassium chloride, and so on),
  - High concentrations of inorganic acids like sulfuric acid and nitric acid, especially at higher temperatures (if your chromatography method allows, replace by phosphoric acid or phosphate buffer which are less corrosive against stainless steel),
  - Halogenated solvents or mixtures which form radicals and/or acids, for example:

    $2CHCl_3 + O_2 \rightarrow 2COCl_2 + 2HCl$

    This reaction, in which stainless steel probably acts as a catalyst, occurs quickly with dried chloroform if the drying process removes the stabilizing alcohol,

- Chromatographic grade ethers, which can contain peroxides (for example, THF, dioxane, di-isopropylether) such ethers should be filtered through dry aluminium oxide which adsorbs the peroxides,
- Solvents containing strong complexing agents (e.g. EDTA),
- Mixtures of carbon tetrachloride with 2-propanol or THF.

Agilent Technologies on Internet

For the latest information on products and services visit our worldwide web site on the Internet at:

http://www.agilent.com

Select Products/Chemical Analysis

It will provide also the latest firmware of the Agilent 1200 Series modules for download.

Index

www.agilent.com

In This Book

This manual contains technical reference information about the Agilent 1200 Series capillary pump. The manual describes the following:

- introduction to the pump,
- requirements and specifications,
- installation,
- using the pump,
- optimizing performance,
- troubleshooting and diagnostics,
- maintenance,
- parts and materials,
- overview of cables,
- legal, safety and warranty information.

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