Agilent 1260 Infinity Capillary Pump

User Manual

Agilent Technologies

Notices

Manual Part Number

G1376-90014

Edition

06/2010

Printed in Germany

Agilent Technologies
Hewlett-Packard-Strasse 8
76337 Waldbronn

This product may be used as a component of an in vitro diagnostic system if the system is registered with the appropriate authorities and complies with the relevant regulations. Otherwise, it is intended only for general laboratory use.

Warranty

The material contained in this document is provided "as is," and is subject to being changed, without notice, in future editions. Further, to the maximum extent permitted by applicable law, Agilent disclaims all warranties, either express or implied, with regard to this manual and any information contained herein, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Agilent shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Agilent and the user have a separate written agreement with warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement shall control.

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

Restricted Rights Legend

If software is for use in the performance of a U.S. Government prime contract or subcontract, Software is delivered and licensed as "Commercial computer software" as defined in DFAR 252.227-7014 (June 1995), or as a "commercial item" as defined in FAR 2.101(a) or as "Restricted computer software" as defined in FAR 52.227-19 (June 1987) or any equivalent agency regulation or contract clause. Use, duplication or disclosure of Software is subject to Agilent Technologies' standard commercial license terms, and non-DOD Departments and Agencies of the U.S. Government will receive no greater than Restricted Rights as defined in FAR 52.227-19(c)(1-2) (June 1987). U.S. Government users will receive no greater than Limited Rights as defined in FAR 52.227-14 (June 1987) or DFAR 252.227-7015 (b)(2) (November 1995), as applicable in any technical data.

Safety Notices

CAUTION

A **CAUTION** 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 damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

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.

Contents

1
Introduction to the 1260 Infinity Capillary Pump

This chapter provides an introduction to the operation principles of the capillary pump and the electrical interfaces.

Introduction to the Pump

The low flow pumps consist of two identical pumping units in a single housing. They generate gradients by high-pressure mixing. A solvent selection valve provides flexibility in the choice of solvents.

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

In order to deliver fast gradients over the whole composition range, the two pumpheads deliver a primary flow of 200 – 1100 µL/min from which a mass flow sensor controlled electromagnetic proportioning valve (EMPV) splits the set column flow. Excessive solvent is diverted to waste. This electronic flow control automatically compensates for changes in solvent properties and backpressure throughout a run.

Solvent degassing is not done directly in the pump. A 4-channel, low volume micro 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/nano LC applications.

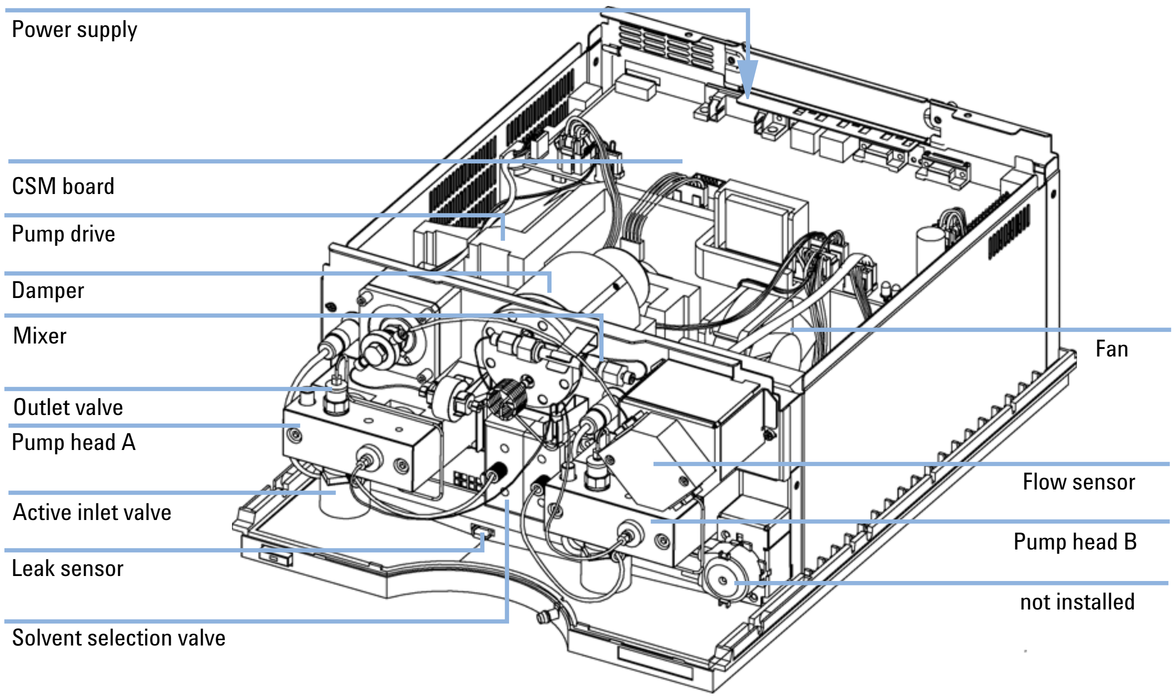


Figure 1 Overview of the Pump

Hydraulic Path Overview

The capillary pump is based on the 1200 Series Binary Pump (pressure limit 400 bar, active inlet valves), and performs all the functions necessary for a µ-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 metering drive assembly and pump head assembly. The pumphead assemblies both consist of two identical chambers, pistons and seals, plus an active inlet valve and an outlet 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.

In the capillary pump, 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. Due to the much smaller flow rates, the Nanoflow pump does not have a mixer.

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.

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 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 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 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 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 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.

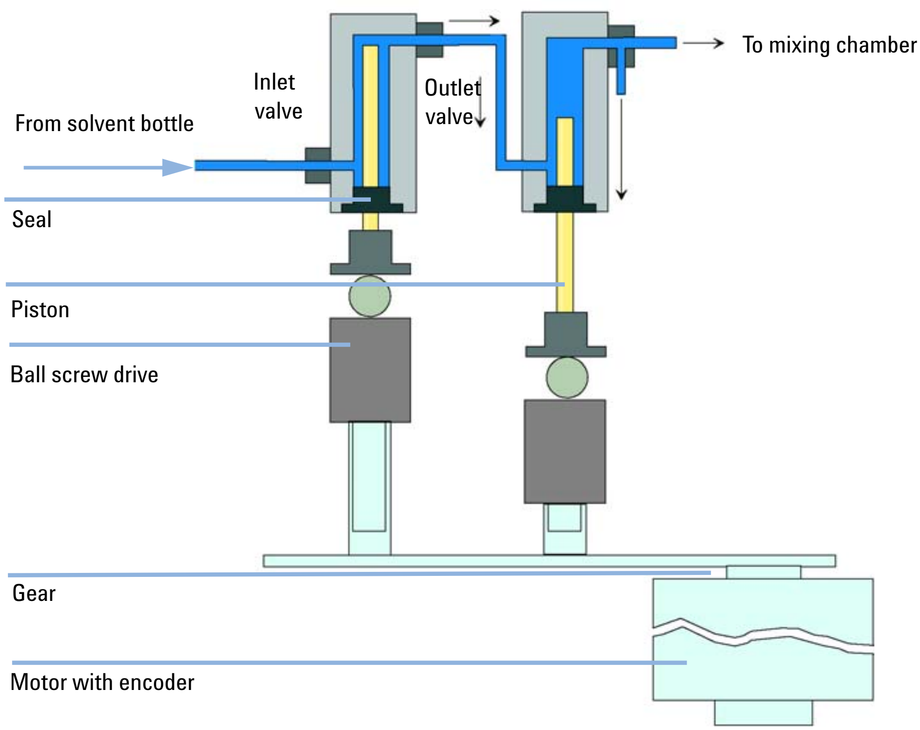


Figure 2 Operating Principle of the Pump Head

Table 1 Pump Details

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 “Performance Specifications” on page 38.

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 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 1 – 20 µL/min. An extended range flow sensor (optional) provides flow measurement and control in the range of 10 – 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 Feetback

Maintenance requires the exchange of components which are subject to wear or stress. Ideally, the frequency at which components are exchanged should be based on the intensity of usage of the module 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-selectable limits have been exceeded. The visual feedback in the user interface provides an indication that maintenance procedures should be scheduled.

EMF Counters

EMF counters increment with use and can be assigned a maximum limit which provides visual feedback in the user interface when the limit is exceeded. Some counters can be reset to zero after the required maintenance procedure.

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 useful maintenance cycle is dependent on the requirements for use. 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 the default **EMF** limits should be set. When instrument performance indicates maintenance is necessary, take note of the values displayed by the **EMF 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.

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 of 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.

Electrical Connections

- The CAN bus is a serial bus with high speed data transfer. The two connectors for the CAN bus are used for internal module data transfer and synchronization.
- One analog output provides signals for integrators or data handling systems.
- The interface board slot is used for external contacts and BCD bottle number output or LAN connections.
- The REMOTE connector may be used in combination with other analytical instruments from Agilent Technologies if you want to use features such as start, stop, common shut down, prepare, and so on.
- With the appropriate software, the RS-232C connector may be used to control the module from a computer through a RS-232C connection. This connector is activated and can be configured with the configuration switch.
- The power input socket accepts a line voltage of 100 – 240 VAC ± 10 % with a line frequency of 50 or 60 Hz. Maximum power consumption varies by module. There is no voltage selector on your module because the power supply has wide-ranging capability. There are no externally accessible fuses, because automatic electronic fuses are implemented in the power supply.

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

Serial Number Information (ALL)

The serial number information on the instrument labels provide the following information:

CCXZZ00000	Format
CC	Country of manufacturing (DE Germany)
X	Alphabetic character A-Z (used by manufacturing)
ZZ	Alpha-numeric code 0-9, A-Z, where each combination unambiguously denotes a module (there can be more than one code for the same module)
00000	Serial number

Rear View of the Module

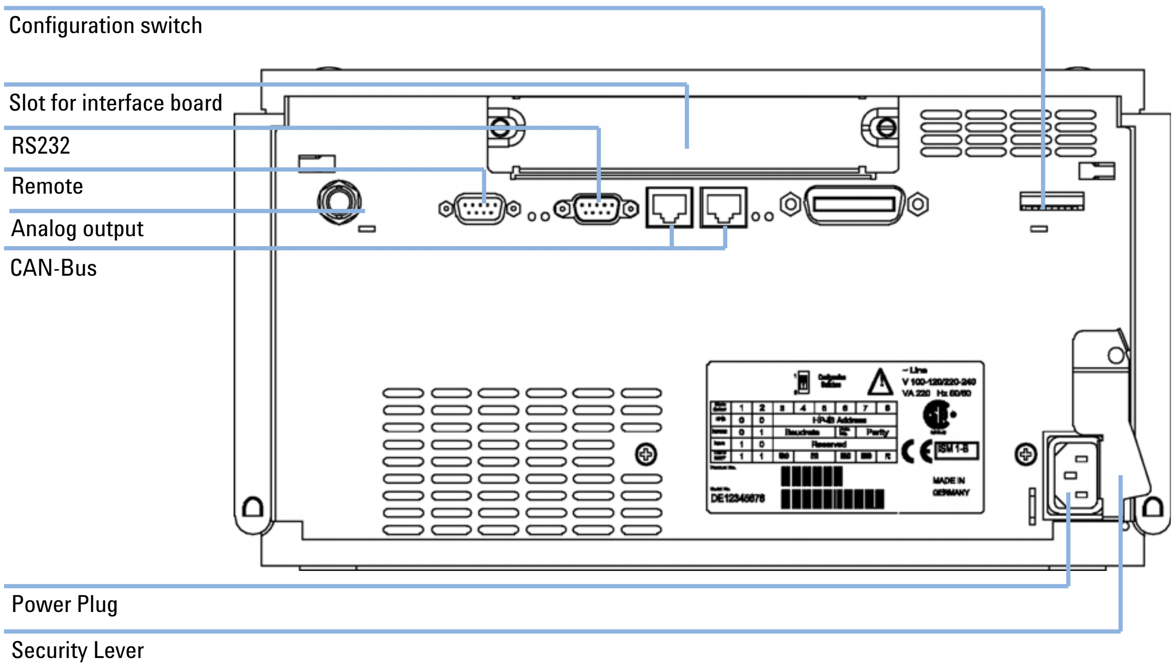


Figure 3 Rear View of the Module

NOTE The GPIB interface has been removed with the introduction of the 1260 Infinity modules.

Interfaces

The Agilent 1200 Infinity Series modules provide the following interfaces:

Table 2 Agilent 1200 Infinity Series Interfaces

Module	CAN	LAN/BCD (optional)	LAN (on-board)	RS-232	Analog	APG Remote	Special
Pumps							
G1310B Iso Pump G1311B Quat Pump G1311C Quat Pump VL G1312B Bin Pump G1312C Bin Pump VL 1376A Cap Pump G2226A Nano Pump	2	Yes	No	Yes	1	Yes	
G4220A/B Bin Pump	2	No	Yes	Yes	No	Yes	
G1361A Prep Pump	2	Yes	No	Yes	No	Yes	CAN-DC- OUT for CAN slaves
Samplers							
G1329B ALS G2260A Prep ALS	2	Yes	No	Yes	No	Yes	THERMOSTAT for G1330B
G1364B FC-PS G1364C FC-AS G1364D FC-µS G1367E HiP ALS G1377A HiP micro ALS G2258A DL ALS	2	Yes	No	Yes	No	Yes	THERMOSTAT for G1330B CAN-DC- OUT for CAN slaves
G4226A ALS	2	Yes	No	Yes	No	Yes	
Detectors							
G1314B VWD VL G1314C VWD VL+	2	Yes	No	Yes	1	Yes	
G1314E/F VWD	2	No	Yes	Yes	1	Yes	

Table 2 Agilent 1200 Infinity Series Interfaces

Module	CAN	LAN/BCD (optional)	LAN (on-board)	RS-232	Analog	APG Remote	Special
G4212A/B DAD	2	No	Yes	Yes	1	Yes	
G1315C DAD VL+ G1365C MWD G1315D DAD VL G1365D MWD VL	2	No	Yes	Yes	2	Yes	
G1321B FLD G1362A RID	2	Yes	No	Yes	1	Yes	
G4280A ELSD	No	No	No	Yes	Yes	Yes	EXT Contact AUTOZERO
Others							
G1316A/C TCC	2	No	No	Yes	No	Yes	
G1322A DEG	No	No	No	No	No	Yes	AUX
G1379B DEG	No	No	No	Yes	No	No	AUX
G4227A Flex Cube	2	No	No	No	No	No	
G4240A CHIP CUBE	2	Yes	No	Yes	No	Yes	CAN-DC- OUT for CAN slaves THERMOSTAT for G1330A/B (NOT USED)

NOTE The detector (DAD/MWD/FLD/VWD/RID) is the preferred access point for control via LAN. The inter-module communication is done via CAN.

- CAN connectors as interface to other modules
- LAN connector as interface to the control software
- RS-232C as interface to a computer
- REMOTE connector as interface to other Agilent products
- Analog output connector(s) for signal output

Overview Interfaces

CAN

The CAN is inter-module communication interface. It is a 2-wire serial bus system supporting high speed data communication and real-time requirement.

LAN

The modules have either an interface slot for an LAN card (e.g. Agilent G1369A/B LAN Interface) or they have an on-board LAN interface (e.g. detectors G1315C/D DAD and G1365C/D MWD). This interface allows the control of the module/system via a connected PC with the appropriate control software.

NOTE If an Agilent detector (DAD/MWD/FLD/VWD/RID) is in the system, the LAN should be connected to the DAD/MWD/FLD/VWD/RID (due to higher data load). If no Agilent detector is part of the system, the LAN interface should be installed in the pump or autosampler.

RS-232C (Serial)

The RS-232C connector is used to control the module from a computer through RS-232C connection, using the appropriate software. This connector can be configured with the configuration switch module at the rear of the module. Refer to *Communication Settings for RS-232C*.

NOTE There is no configuration possible on main boards with on-board LAN. These are pre-configured for

- 19200 baud,
- 8 data bit with no parity and
- one start bit and one stop bit are always used (not selectable).

The RS-232C is designed as DCE (data communication equipment) with a 9-pin male SUB-D type connector. The pins are defined as:

Table 3 RS-232C Connection Table

Pin	Direction	Function
1	In	DCD
2	In	RxD
3	Out	TxD
4	Out	DTR
5		Ground
6	In	DSR
7	Out	RTS
8	In	CTS
9	In	RI

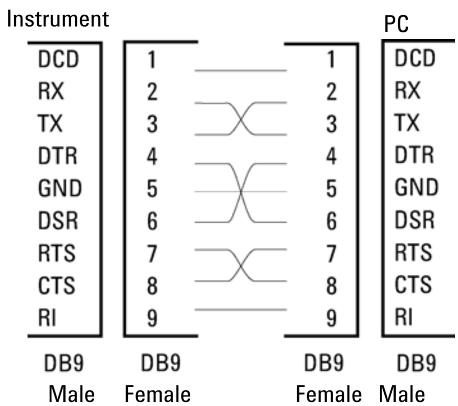


Figure 4 RS-232 Cable

Analog Signal Output

The analog signal output can be distributed to a recording device. For details refer to the description of the module's main board.

APG Remote

The APG Remote connector may be used in combination with other analytical instruments from Agilent Technologies if you want to use features as common shut down, prepare, and so on.

Remote control allows easy connection between single instruments or systems to ensure coordinated analysis with simple coupling requirements.

The subminiature D connector is used. The module provides one remote connector which is inputs/outputs (wired- or technique).

To provide maximum safety within a distributed analysis system, one line is dedicated to **SHUT DOWN** the system's critical parts in case any module detects a serious problem. To detect whether all participating modules are switched on or properly powered, one line is defined to summarize the **POWER ON** state of all connected modules. Control of analysis is maintained by signal readiness **READY** for next analysis, followed by **START** of run and optional **STOP** of run triggered on the respective lines. In addition **PREPARE** and **START REQUEST** may be issued. The signal levels are defined as:

- standard TTL levels (0 V is logic true, + 5.0 V is false),
- fan-out is 10,
- input load is 2.2 kOhm against + 5.0 V, and
- output are open collector type, inputs/outputs (wired- or technique).

NOTE All common TTL circuits operate with a 5 V power supply. A TTL signal is defined as "low" or L when between 0 V and 0.8 V and "high" or H when between 2.0 V and 5.0 V (with respect to the ground terminal).

Table 4 Remote Signal Distribution

Pin	Signal	Description
1	DGND	Digital ground
2	PREPARE	(L) Request to prepare for analysis (for example, calibration, detector lamp on). Receiver is any module performing pre-analysis activities.
3	START	(L) Request to start run / timetable. Receiver is any module performing run-time controlled activities.
4	SHUT DOWN	(L) System has serious problem (for example, leak: stops pump). Receiver is any module capable to reduce safety risk.

Table 4 Remote Signal Distribution

Pin	Signal	Description
5		Not used
6	POWER ON	(H) All modules connected to system are switched on. Receiver is any module relying on operation of others.
7	READY	(H) System is ready for next analysis. Receiver is any sequence controller.
8	STOP	(L) Request to reach system ready state as soon as possible (for example, stop run, abort or finish and stop injection). Receiver is any module performing run-time controlled activities.
9	START REQUEST	(L) Request to start injection cycle (for example, by start key on any module). Receiver is the autosampler.

Special Interfaces

Some modules have module specific interfaces/connectors. They are described in the module documentation.

Setting the 8-bit Configuration Switch (On-Board LAN)

The 8-bit configuration switch is located at the rear of the module. Switch settings provide configuration parameters for LAN, serial communication protocol and instrument specific initialization procedures.

All modules with on-board LAN, e.g. G1315/65C/D, G1314D/E/F, G4212A/B, G4220A:

- Default is ALL switches DOWN (best settings) - Bootp mode for LAN.
- For specific LAN modes switches 3-8 must be set as required.
- For boot/test modes switches 1+2 must be UP plus required mode.

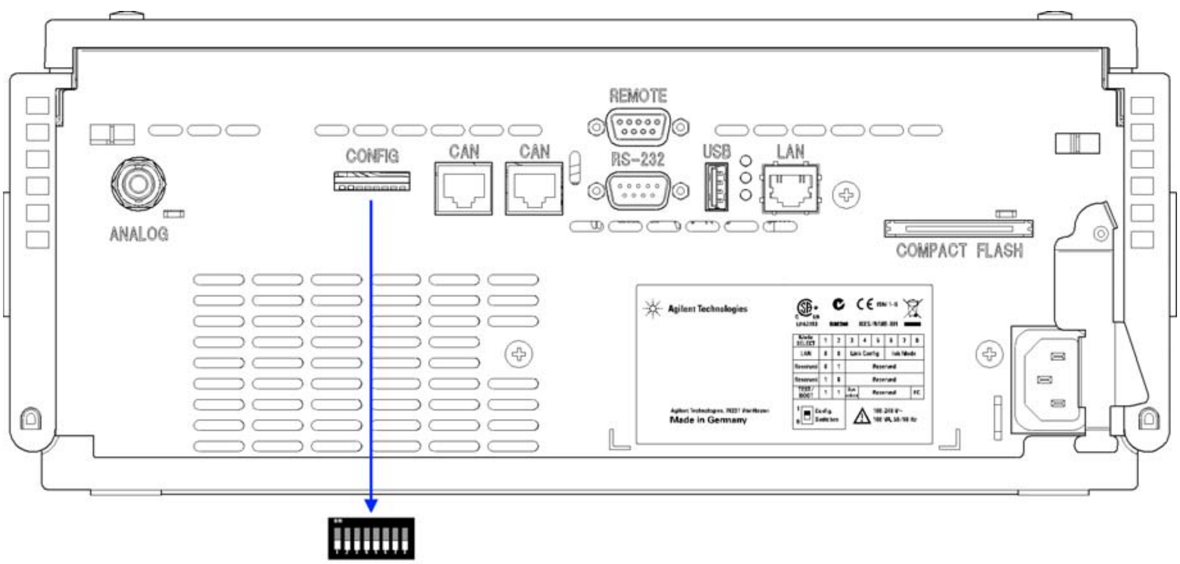


Figure 5 Location of Configuration Switch (example shows a G4212A DAD)

NOTE To perform any LAN configuration, SW1 and SW2 must be set to OFF. For details on the LAN settings/configuration refer to chapter LAN Configuration.

Table 5 8-bit Configuration Switch (with on-board LAN)

	Mode		Function					
	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
LAN	*0*	*0*	Link Configuration			Init Mode Selection		
Auto-negotiation			*0*	x	x	x	x	x
10 MBit, half-duplex			1	*0*	*0*	x	x	x
10 MBit, full-duplex			1	*0*	1	x	x	x
100 MBit, half-duplex			1	1	*0*	x	x	x
100 MBit, full-duplex			1	1	1	x	x	x
Bootp			x	x	x	*0*	*0*	*0*
Bootp & Store			x	x	x	*0*	*0*	1
Using Stored			x	x	x	*0*	1	*0*
Using Default			x	x	x	*0*	1	1
TEST	1	1	System					NVRAM
Boot Resident System			1					x
Revert to Default Data (Coldstart)			x	x	x			1

Legend:

0 (switch down), 1 (switch up), x (any position)

NOTE When selecting the mode TEST, the LAN settings are: Auto-Negotiation & Using Stored.

NOTE For explanation of "Boot Resident System" and "Revert to Default Data (Coldstart)" refer to “Special Settings” on page 30.

Setting the 8-bit Configuration Switch (without On-Board LAN)

The 8-bit configuration switch is located at the rear of the module.

Modules that do not have their own LAN interface (e.g. the TCC) can be controlled through the LAN interface of another module and a CAN connection to that module.

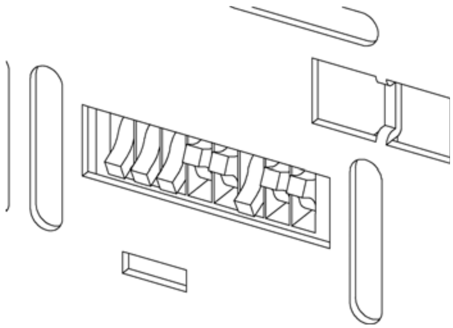


Figure 6 Configuration switch (settings depend on configured mode)

All modules without on-board LAN:

- default is ALL DIPS DOWN (best settings) - Bootp mode for LAN
- for boot/test modes DIPS 1+2 must be UP plus required mode

Switch settings provide configuration parameters for GPIB address, serial communication protocol and instrument specific initialization procedures.

NOTE With the introduction of the Agilent 1260 Infinity, all GPIB interfaces have been removed. The preferred communication is LAN.

NOTE The following tables represent the configuration switch settings for the modules without on-board LAN only.

Table 6 8-bit Configuration Switch (without on-board LAN)

<table>
<tr><td>Mode Select</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>RS-232C</td><td>0</td><td>1</td><td colspan="3">Baudrate</td><td>Data Bits</td><td colspan="2">Parity</td></tr>
<tr><td>Reserved</td><td>1</td><td>0</td><td colspan="6">Reserved</td></tr>
<tr><td>TEST/BOOT</td><td>1</td><td>1</td><td>RSVD</td><td colspan="2">SYS</td><td>RSVD</td><td>RSVD</td><td>FC</td></tr>
</table>

NOTE The LAN settings are done on the LAN Interface Card G1369A/B. Refer to the documentation provided with the card.

Communication Settings for RS-232C

The communication protocol used in the column compartment supports only hardware handshake (CTS/RTR).

Switches 1 in down and 2 in up position define that the RS-232C parameters will be changed. Once the change has been completed, the column instrument must be powered up again in order to store the values in the non-volatile memory.

Table 7 Communication Settings for RS-232C Communication (without on-board LAN)

Mode Select	1	2	3	4	5	6	7	8
RS-232C	0	1	Baudrate			Data Bits	Parity	

Use the following tables for selecting the setting which you want to use for RS-232C communication. The number 0 means that the switch is down and 1 means that the switch is up.

Table 8 Baudrate Settings (without on-board LAN)

Switches			Baud Rate	Switches			Baud Rate
3	4	5		3	4	5	
0	0	0	9600	1	0	0	9600
0	0	1	1200	1	0	1	14400
0	1	0	2400	1	1	0	19200
0	1	1	4800	1	1	1	38400

Table 9 Data Bit Settings (without on-board LAN)

Switch 6	Data Word Size
0	7 Bit Communication
1	8 Bit Communication

Table 10 Parity Settings (without on-board LAN)

Switches		Parity
7	8	
0	0	No Parity
1	0	Odd Parity
1	1	Even Parity

One start bit and one stop bit are always used (not selectable).

Per default, the module will turn into 19200 baud, 8 data bit with no parity.

Special Settings

The special settings are required for specific actions (normally in a service case).

NOTE The tables include both settings for modules – with on-board LAN and without on-board LAN. They are identified as LAN and no LAN.

Boot-Resident

Firmware update procedures may require this mode in case of firmware loading errors (main firmware part).

If you use the following switch settings and power the instrument up again, the instrument firmware stays in the resident mode. It is not operable as a module. It only uses basic functions of the operating system for example, for communication. In this mode the main firmware can be loaded (using update utilities).

Table 11 Boot Resident Settings (without on-board LAN)

	Mode Select	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
LAN	TEST/BOOT	1	1	1	0	0	0	0	0
No LAN	TEST/BOOT	1	1	0	0	1	0	0	0

Forced Cold Start

A forced cold start can be used to bring the module into a defined mode with default parameter settings.

CAUTION

Loss of data

Forced cold start erases all methods and data stored in the non-volatile memory. Exceptions are diagnosis and repair log books which will not be erased.

→ Save your methods and data before executing a forced cold start.

If you use the following switch settings and power the instrument up again, a forced cold start has been completed.

Table 12 Forced Cold Start Settings (without on-board LAN)

	Mode Select	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
LAN	TEST/BOOT	1	1	0	0	0	0	0	1
No LAN	TEST/BOOT	1	1	0	0	1	0	0	1

2
Site Requirements and Specifications

This chapter provides information about site requirements, physical specifications and performance specifications of the 1260 Infinity Capillary Pump.

Site Requirements

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

Power Considerations

The module power supply has wide ranging capability. It accepts any line voltage in the range described in Table 13 on page 37. Consequently there is no voltage selector in the rear of the module. There are also no externally accessible fuses, because automatic electronic fuses are implemented in the power supply.

WARNING

Hazard of electrical shock 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 only.

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. electrical shock, when the cover is opened and the module is connected to power.

→ Always unplug the power cable before opening the cover.

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

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.

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. The male end of each power cord is different and designed to match the wall socket of a particular country or region.

WARNING

Absence of ground connection or use of unspecified power cord

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

→ 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.

WARNING

Unintended use of supplied power cords

Using power cords for unintended purposes can lead to personal injury or damage of electronic equipment.

→ Never use the power cords that Agilent Technologies supplies with this instrument for any other equipment.

Bench Space

The module dimensions and weight (see Table 13 on page 37) allow you to place the module on almost any desk or 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 air circulation and electric connections.

If the bench should carry an Agilent system, make sure that the bench is designed to bear the weight of all modules.

The module should be operated in a horizontal position.

Condensation

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 13 Physical Specifications

Type	Specification	Comments
Weight	17 kg (38 lbs)	
Dimensions (height × width × depth)	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 (6562 ft)	
Non-operating altitude	Up to 4600 m (15091 ft)	For storing the module
Safety standards: IEC, CSA, UL	Installation Category II, Pollution Degree 2	For indoor use only.

Performance Specifications

Table 14 Performance Specification Agilent 1260 Infinity Capillary Pump (G1376A)

Type	Specification
Hydraulic system	Two independent pump channels, each with two pistons in series. One proprietary servo-controlled variable stroke drive per channel. Floating pistons, active inlet valves, solvent selection valves (two solvents per pump channel), 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 – 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), minimum primary flow/pump channel is 5 µL/min, primary flow 500 – 800 µL/min
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/min 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 – 480 µL (system pressure dependent) without mixer for flow rates up to 2.5 mL/min (Mixer delay volume 420 µL)
Pressure range	20 – 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 14 Performance Specification Agilent 1260 Infinity Capillary Pump (G1376A)

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), RS-232C, APG Remote: ready, start, stop and shut-down signals, LAN optional
Safety and maintenance	Extensive diagnostics, error detection and display (though Instant Pilot and Data System), 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 Module

This chapter provides information about the installation of the pump and the connection to other modules and to the control software.

Unpacking the Module

If the delivery packaging shows signs of external damage, please call your Agilent Technologies sales and service office immediately. Inform your service representative that the instrument may have been damaged during shipment.

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.

Delivery Checklist

Ensure all parts and materials have been delivered with the capillary pump. The delivery checklist is shown in Table 15 on page 42. To aid in parts identification, please see "Parts and Materials for Maintenance" on page 159. Please report missing or damaged parts to your local Agilent Technologies sales and service office.

Table 15 Capillary Pump Checklist

Description	Quantity
Agilent 1260 Infinity Capillary Pump (p/n G1376-64050)	1
Solvent cabinet, including all plastic parts (p/n 5065-9981)	1
Solvent bottle, amber (p/n 9301-1450)	1
Solvent bottle, transparent (p/n 9301-1420)	3
Analytical head assembly (p/n G1367-60003)	4
Capillary flow sensor to injection device (20 µL), 50 µm i.d., 55 cm length, PEEK /fused silica (p/n G1375-87310)	1
Power cord	1

Table 15 Capillary Pump Checklist

Description	Quantity
CAN cable, Agilent module to module, 1 m (p/n 5181-1519)	1
Remote cable	As ordered
Signal cable	As ordered
Service Manual	1
Accessory Kit (p/n G1376-68755)	1

Capillary Pump Accessory Kit

Accessory Kit (p/n G1376-68755)

p/n	Description
0515-0175	Mounting screw for manual purge valve holder, M4, 20 mm long
0890-1760 (2x)	Tubing Flexible 1 ea / 1 meter
2190-0586	Washer for purge valve holder screw
5022-2185	Replacement SS frit, 0.5 µm pore size
5181-1519	CAN cable, Agilent module to module, 1 m
01018-23702	Insert tool
01018-60025 (4x)	Solvent inlet filter, stainless steel
G1311-60009	Manual purge valve
G1312-23200	Holder for manual purge valve
G1315-45003	Torque adapter
G1375-87310	Fused silica/ PEEK capillary, 50 µm55 cm (20 µL flow sensor)
8710-1534	Wrench, 4 mm both ends, open end
8710-0806 (2x)	Wrench, open end 1/2 inch and 7/16 inch
G1376-90014	Agilent 1260 Infinity Capillary Pump User Manual

Optimizing the Stack Configuration

If your module is part of a complete Agilent 1260 Infinity Liquid Chromatograph, you can ensure optimum performance by installing the following configurations. These configurations optimize the system flow path, ensuring minimum delay volume.

One Stack Configuration

Ensure optimum performance by installing the modules of the Agilent 1260 Infinity LC System in the following configuration (See Figure 7 on page 45 and Figure 8 on page 46). This configuration optimizes the flow path for minimum delay volume and minimizes the bench space required.

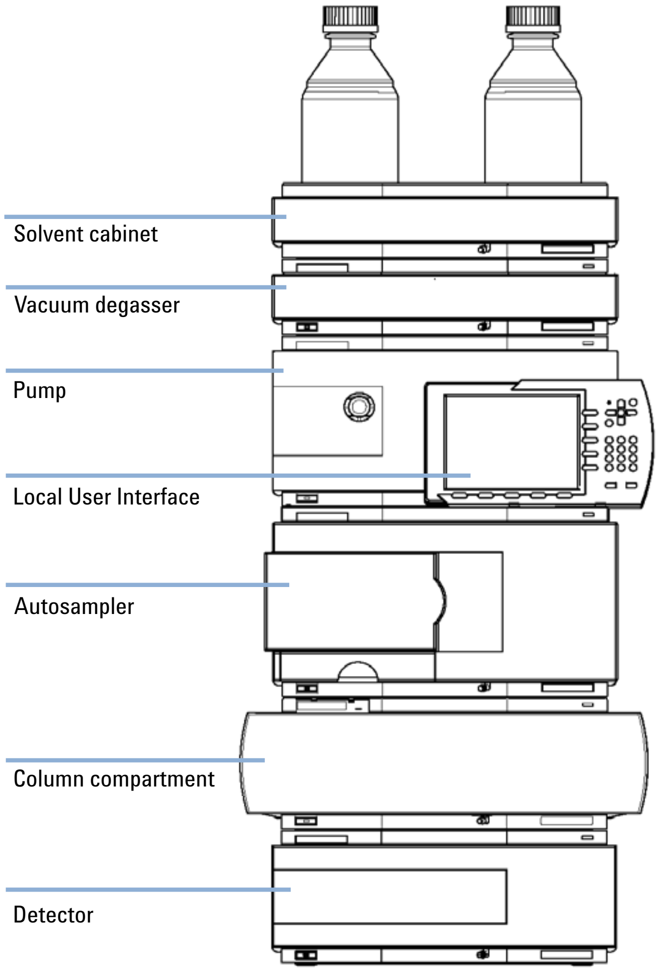


Figure 7 Recommended Stack Configuration for 1260 (Front View)

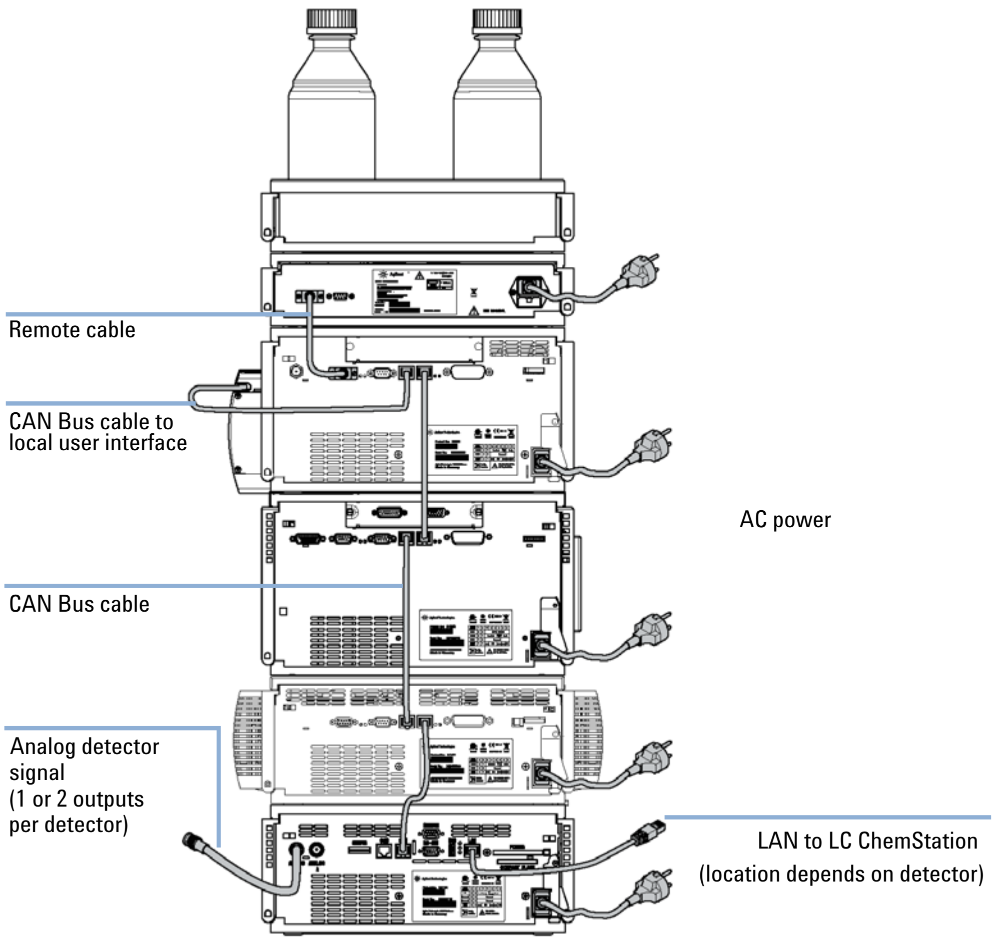


Figure 8 Recommended Stack Configuration for 1260 (Rear View)

Two Stack Configuration

To avoid excessive height of the stack when the autosampler thermostat is added to the system it is recommended to form two stacks. Some users prefer the lower height of this arrangement even without the autosampler thermostat. A slightly longer capillary is required between the pump and autosampler. (See Figure 9 on page 47 and Figure 10 on page 48).

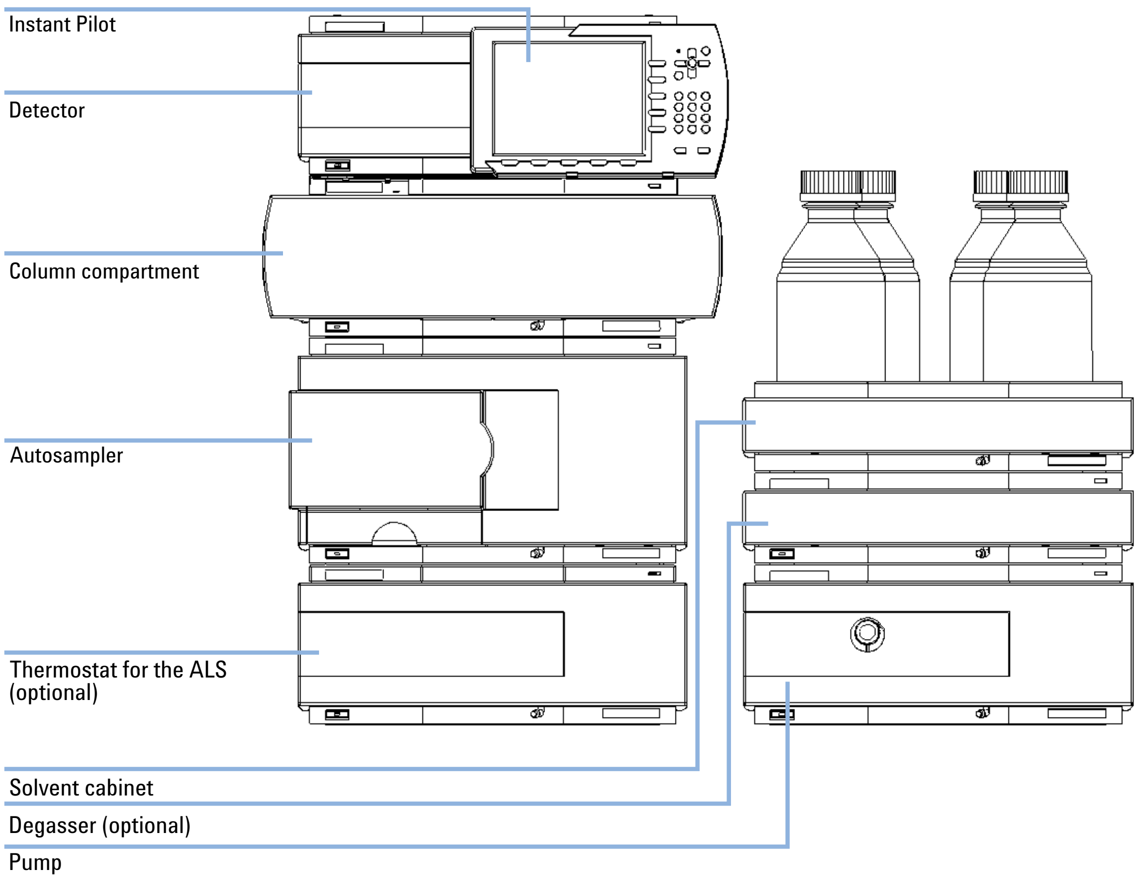


Figure 9 Recommended Two Stack Configuration for 1260 (Front View)

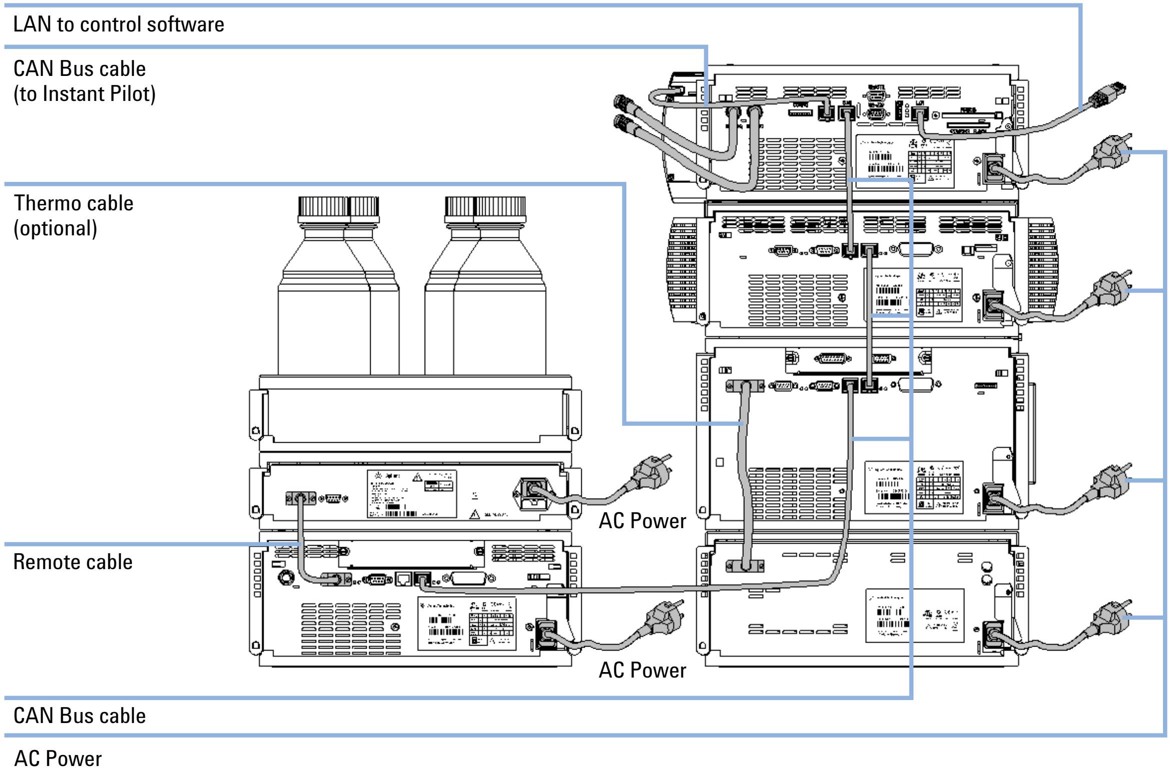


Figure 10 Recommended Two Stack Configuration for 1260 (Rear View)

Installing the Pump

Parts required

#	p/n	Description
1		Pump
1		Data System
1	G4208A	Instant Pilot
1		Power cord

For other cables see text below and “Cable Overview” on page 172.

Preparations

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

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 module on the bench in a horizontal position.

2 Ensure the power switch at the front of the module is OFF (switch stands out).

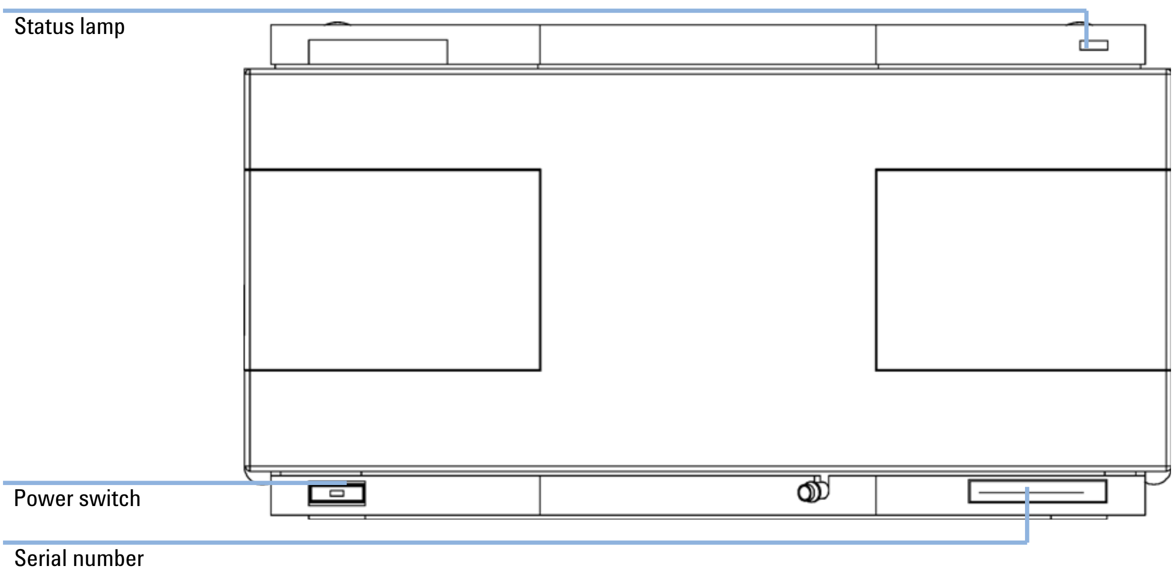


Figure 11 Front View of the Module

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 pump, see "Connecting Modules" on page 52.

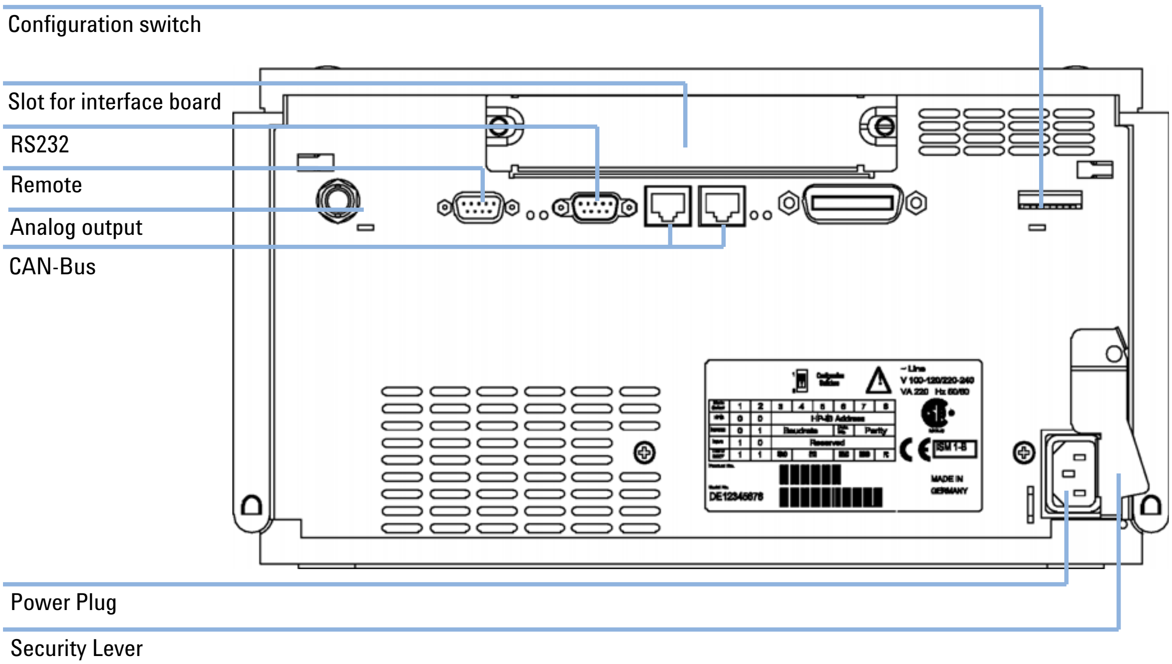


Figure 12 Rear View of the Module

6 Connect the capillary, solvent tubes and waste line (see "Flow Connections" on page 54).

7 Press the power switch to turn on the module.

NOTE The power switch stays pressed in and a green indicator lamp in the power switch is on when the module is turned on. When the line power switch stands out and the green light is off, the module is turned off.

8 Purge the pump (see "Priming Your System With the Pump" on page 59).

NOTE The pump shipps with default configuration settings. To change these settings, see "Setting the 8-bit Configuration Switch (without On-Board LAN)" on page 27.

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 Modules

1. Place the individual modules in a stack configuration as shown in Figure 7 on page 45.
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 8 on page 46.
5. Press in the power switches to turn on the modules.

Connecting a Vacuum Degasser

1. Place the vacuum degaser in the stack of modules as shown in Figure 7 on page 45.
2. Ensure the power switch at 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 degasser.
4. Connect the APG cable to the APG remote connector of the pump, see Figure 8 on page 46.
5. Press in the power switch to turn on the vacuum degasser.

NOTE

The AUX output is intended for troubleshooting. It provides a DC voltage in the range of 0 – 1 V which is proportional to the vacuum level in the degasser chambers.

Connecting Control Software and/or G4208 A Instant Pilot

NOTE With the introduction of the Agilent 1260 Infinity, all GPIB interfaces have been removed. The preferred communication is LAN.

NOTE Usually the detector is producing the most data in the stack, followed by the pump, and it is therefore highly recommended to use either of these modules for the LAN connection.

1 Ensure the power switches on the front of the modules in the stack are OFF (switches stand out).
2 If there are no other 1260 with LAN port in the HPLC stack, install a G1369B LAN board into the extension slot of the pump.
3 Connect the LAN enabled module with a LAN cable to the data system.
4 Plug the CAN connector of the Instant Pilot into any available CAN port of the 1260 system.
5 Plug a CAN cable into the CAN connector of the Instant Pilot.

NOTE The Micro Online Degasser must not be connected to LAN or CAN as its connector is for diagnostic use only.

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

NOTE For more information about connecting the control module or Agilent control software refer to the respective user manual. For connecting the Agilent 1260 Infinity equipment to non-Agilent equipment, see “Introduction to the Pump” on page 8.

Flow Connections

Parts required	#	p/n	Description
	1		Other modules
	1	G1376-68755	Accessory Kit
	1	G2226-68755	Accessory Kit (Nano Pump)
	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 bear 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.

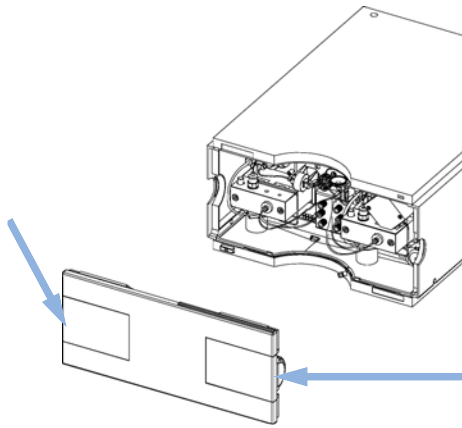


Figure 13 Removing the Front Cover

2 Place the solvent cabinet on top of the module.

3 Remove the sintered glas inlet filters and the filter adapters from the bottle head assemblies. Replace them by the stainless steel filters from the pump asseccories kit.

NOTE Use a piece of sand paper to get a good grip when pushing the stainless steel filters into the tubings.

4 Connect the bottle head solvent tubes to the lower ports of the online degasser. Connect the upper ports of the online degasser to the inlet ports A1, A2, B1 and B2 of the solvent selection valve of the pump. Fix the solvent tubes in the clips of pump, degasser and solvent cabinet. Label the solvent tubings with the provided stick-on labels.

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

6 If the pump is not part of an Agilent 1260 Infinity 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 System With the Pump” on page 59).

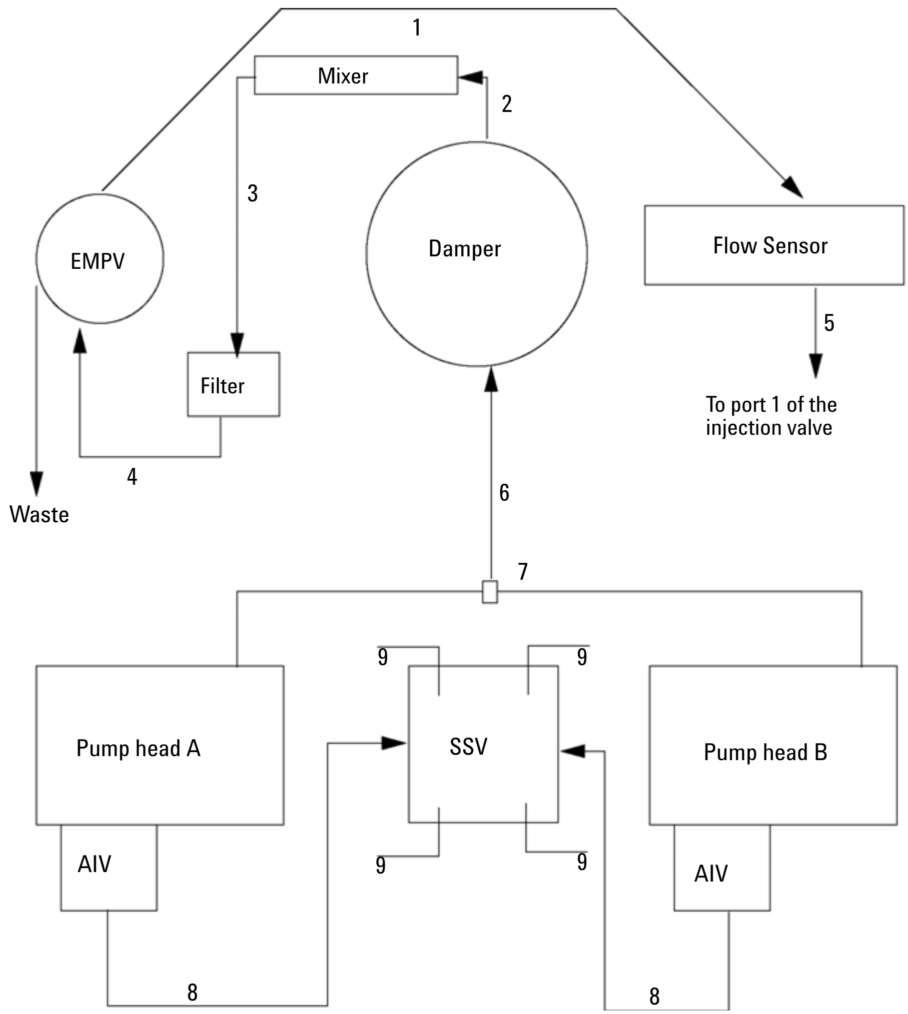


Figure 14 Flow connection of the capillary pump

1	Capillary EMPV to flow sensor (20 µL flow sensor) (p/n G1375-87301) Capillary EMPV to flow sensor (100 µL flow sensor) (p/n G1375-87305)
2, 3	Capillary, damper to mixer (capillary pump only) (p/n 01090-87308)
4	Capillary, filter to EMPV (p/n G1375-87400)
5	Capillary flow sensor to injection device (20 µL), 50 µm i.d., 55 cm length, PEEK /fused silica (p/n G1375-87310) Capillary flow sensor to injection device (100 µL flow sensor), 100 µm ID x 55 cm (p/n G1375-87306)
6	Restriction capillary (p/n G1312-67304)
7	Mixing capillary (p/n G1312-67302)
8	Connecting tube, SSV to AIV (p/n G1311-67304)
9	Bottle-head assembly (p/n 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.

Manually Priming the Solvent Channels

WARNING **Liquid may drip from the disconnected solvent tube.**

→ Make sure to follow appropriate safety precautions.

NOTE This procedure should be carried out before the modules are turned on.

1. The degasser accessory kit contains a 20 mL plastic syringe and a solvent tube adapter for the syringe. Push the adapter onto the syringe.
2. Fill required analytical solvents into the solvent bottles, and install the bottles on the described solvent channels. Use isopropanol for channels which will not be used right away.
3. Put a paper towel over the leak sensor in the pump leak tray.
4. Disconnect the channel A solvent tube from the A1 port of the pump solvent selection valve.
5. Connect the end of the solvent tube to the syringe adapter. Slowly draw one syringe volume (20 mL) from the solvent tube.
6. Disconnect the solvent tube from the syringe adapter, and reconnect the tube to the A1 port of the solvent selection valve. Eject the syringe contents into an appropriate waste container.

7 Repeat steps 4 to 6 for the three remaining solvent channels.
8 When all 4 channels are manually primed, remove the paper towel from the pump leak tray. Make sure that the pump leak sensor is dry before turning on the pump.

Priming Your 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 bear 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 59 through step 2 on page 59 for the other channel(s) of the 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 Pump

This chapter provides advice for the successful operation of the 1260 Series Capillary Pump and the checkout procedure for Agilent capillary HPLC-systems.

Hints For Successfully Using the Pump

Pump Issues

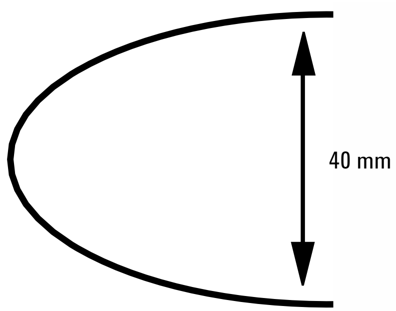
- Flush the pump extensively. First with in the **Purge Mode**, second with a pressure applied to remove all the gas bubbles. It is recommended to do this first with 100 % A and than 100 % B.
- The system pressure must be higher than 20 bar at the pump outlet.
- In **Micro Mode**, unexpected high column flow variation is an indication for dirt within the system, blocked frits or leaking pump valves.
- Always place the solvent cabinet with the solvent bottles on top (or at a higher level) of the pump.
- Make sure the pump is only used with the provided stainless steel solvent filters (Solvent inlet filter, stainless steel (p/n 01018-60025)). Glas inlet filters may release particles that impact the operation of the EMPV (electromagnetic proportioning valve). For the same reason, never use the pump without filters.
- Use the provided brown solvent bottle for aqueous solvents as the lower light transmission will help to prevent the growth of algae. Clean the bottle regularly (e.g. every second day) and discard any unused solvent.
- When using buffer solutions, flush the system with water before switching it off.
- Check the pump pistons for scratches when changing the piston seals. Scratched pistons will lead to micro leaks and will decrease the lifetime of the seal.
- After changing the piston seals apply the seal wear-in procedure.
- Place the aqueous solvent in channel A and the organic solvent in 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 in **Micro Mode**, check the correct instrument setup (flow sensor type, used mixer and filter).

Fused Silica Capillary Issues

- When connecting a capillary (especially at the column) press it smoothly into the fitting to avoid void volumes. Incorrect setting will result in dispersion, causing tailing or footing peaks.

NOTE The quartz core of PEEK/fused silica capillaries will crack and debris will clog the flow path if the fittings are overtightened. Fittings shouldn't be tightened harder than finger tight plus 1/4 turn with a wrench.

- Be careful when bending fused silica capillaries. 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 the fitting under flow. Set the column flow to zero, re-insert the capillary, tighten and set the new column flow.
- Avoid the use of alkaline solutions (pH > 8.5) as they attack the fused silica of the capillaries.
- Be careful not to crush capillaries when closing module doors.
- A broken capillary can release silica particles into the system (e.g. cell) causing problems in the system downstream of the crack.
- Often, a clogged capillary can be recovered by backflushing with acetone.

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 attack the fused silica in PEEK coated fused silica capillaries.

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 1260 Infinity HPLC

The presence of algae in the Agilent 1260 Infinity can cause the following to occur:

- Increased system pressure caused by clogging of the inline filter. Algae deposits are barely visible on the stainless steel filter frit. Replace the frit if the backpressure of the pump in purge mode (water, 2.5 mL/min) exceeds 20 bar.
- 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 (Solvent bottle, amber (p/n 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 16 Conditions

Flow:	15.0 µL/min
Stoptime:	~ 7.00 min
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 1260 Infinity Capillary LC Instrument	• 1260 Micro Degasser • 1260 Capillary Pump - 20 µL/min sensor installed • 1260 Micro High Performance Autosampler • 1260 Thermostatted Column Compartment - optional • Detector - 1260 Multiple Wavelength Detector VL or SL, or 1260 Diode Array Detector VL or SL - with 500 nL flow cell installed • Data system
Column:	Column ZORBAX SB C18, 5 µm, 150 x 0.5 mm (p/n 5064-8256)
Standard:	Agilent isocratic checkout sample (p/n 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 15 on page 68.

Typical Chromatogram

A typical chromatogram for this analysis is shown in Figure 15 on page 68. 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.

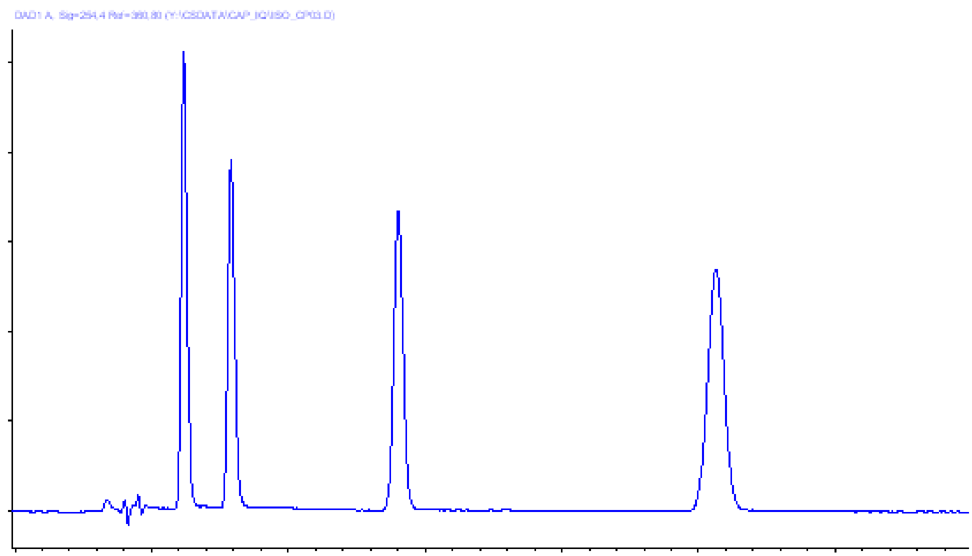


Figure 15 Chromatogram

Checkout procedure for a G2229A Nano LC System

Use this procedure to confirm that

- the system has been installed correctly
- the Nanoflow LC System performs within specification
- a technical problem is caused by the Nanoflow LC System

Parts required

#	Description
G1379B	1260 Micro Degasser
G2226A	1260 Nanoflow Pump
G1377A	1260 Micro High Performance Autosampler
G2226-67300	Nanoflow restriction capillary

Preparations

- Channel A1: Water
- Channel B1: Acetonitrile
- Channel A2: Isopropanol

1 Purge channel A1 with 100 % water at 2.5 mL/min for 2 min
2 Purge channel B1 with 100 % aetonitrile at 2.5 mL/min for 2 min.

NOTE You can speed up the preparation by skipping steps 3 and 4 and running step 7 in pressure control mode at 140 bar (pressure control mode can be enabled in the module service center of Lab Advisor software).

3 Pump 10 µL/min, normal mode, 100 % (water) for at least 5 min.
4 Pump 10 µL/min, normal mode, 100 % B (acetonitrile) for at least 5 min.
5 Check the pressure tightness of the system by executing a micro pressure test with port 6 of the autosampler valve blanked off.
6 Install the restriction capillary to port 6 of the autosampler injection valve.
7 Pump 1.5 µL/min, micro mode, 70 % A (water) / 30 % B (acetonitrile). Pump as long as it takes for the pressure to get stable. Continue pumping for at least 5 min more before continuing.

8 Pump 0.6 µL/min, micro mode, 70 % A (water) / 30 % B (acetonitrile). Pump as long as it takes for the pressure to become stable. Pump at least 5 min more before continuing.

NOTE Make absolutely sure that all parts of the flow path have been thoroughly flushed before starting the checkout procedure. Any trace of other solvents, air bubbles or leaks in the flow path will negatively affect the results.

Method Parameters

Method Parameters Nanoflow Pump

Table 17 Method Parameters for Nanoflow Pump

Parameter	Value
Column flow	0.6 µL/min
Stoptime	15 min
Solvent A	70 %
Solvent B	30 %
Calibrated as	H_2O/ACN
Primary flow	200 – 500 µL/min
Compressibility A	$50 \cdot 10^{-6}$ /bar
Compressibility B	$115 \cdot 10^{-6}$ /bar
Min stroke A and B	Auto
Fast composition change	ON

Table 18 Timetable

Time (min)	0.00	3.00	3.01	6.00	6.01	9.00	9.01	12.00	12.01	15.00
Flow (µL/min)	0.6	0.6	0.3	0.3	0.6	0.6	0.3	0.3	0.6	0.6

Method Parameters Micro High Performance Autosampler

- Injection volume: 0.000 µL
- Injection mode: Edit inj. prog. (→Inject + →Bypass)

NOTE Verify that the injection valve is set to **Mainpass** in the **Set Injection Valve** box of the **Autosampler Configuration** dialog.

Test Results and Evaluation

Typical pressure in bypass mode at 600 nL/min is 100 bar and at 300 nL/min50 bar (with the Fused Silica/PEEK capillary 25 µm, 35 cm (p/n G1375-87322) installed between the flow sensor and port 1 of the injection valve plus the restriction capillary installed on port 6 of the injection valve).

NOTE Due to capillary ID tolerances the nominal pressure at 600 nL/min and 300 nL/min might be different from system to system. These differences can be up to ± 40 %.

The evaluation is done by a visual inspection of the test results: The average pressure between the different plateaus at the same flow rate must be in a range of ±2 bar and typically ±1 %. The pressure at 300 nL/min should be half of the pressure at 600 nL/min.

NOTE If no UV detector is connected to the system you will not be able to open your test data file to review the pressure and the flow profile acquired during the run. In this case, locate and copy the signal file DAD1A.CH from the directory HPCHEM/1/DATA/DEMO/ISOCRA.D to the directory for your checkout test data file before opening the file for review.

If the test results are not in the expected range verify that the flow path has been thoroughly flushed and is filled with homogenous solvent composition. The flow rate for a nano pump is very low compared to the volume of the flow path. Depending on the configuration, it may take several hours to obtain stable conditions.

5
Optimizing Performance

This chapter provides additional information about further application specific hardware and parameter optimization.

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 1260 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,
- the pump was turned OFF for a length of time (for example over night) and volatile solvent mixtures are used.

For more information see Agilent 1260 Infinity (G1379B) Micro Degasser User Manual (p/n G1379-90013).

Choosing the Right Pump 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 using polyethylene pump seals (PE seals (pack of 2) (p/n 0905-1420)) and Wash Seal PE (p/n 0905-1718). These seals have less abrasion compared to the standard seals.

NOTE

Polyethylene seals have a limited pressure range of 0 – 200 bar. When used above 200 bar their lifetime is reduced significantly. *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 set 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) or isocratic operation. This mode is not suitable for fast changes in solvent composition due to the longer gradient delay. During step gradients at the end of the run the flow control may start to oscillate for a short time.

- 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 internal volume of the flow path of the pump which is defined by the type of inline filter, the presence or absence of the static mixer, and the flow sensor configuration.

Table 19 on page 76 gives approximate primary flow values in function of the system pressure, and the set primary flow range.

Table 19 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

Static Mixer and Filter

The 1260 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 1260 Capillary 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 use of the Universal solvent filter kit, 20 µL (p/n 01090-68703) is recommended. Be aware that the filter efficiency and capacity is significantly reduced compared to the standard one.

NOTE Never run the 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 which is 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 20 on page 79. 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 1260 Capillary Pump in the *Normal Mode* at least 100 µL/min.

1 Start channel A of the 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 data system or Instant Pilot with which the pressure and %-ripple can be monitored, otherwhise 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 78 through step 5 on page 79 for the B channel of your pump.

Table 20 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

This chapter provides information about the module's status indicators, error messages, and the available test functions in Instant Pilot and Lab Advisor.

Overview of the Module's Indicators and Test Functions

Status Indicators

The module is provided with two status indicators which indicate the operational state (prerun, run, and error states) of the module. The status indicators provide a quick visual check of the operation of the module.

Error Messages

In the event of an electronic, mechanical or hydraulic failure, the module generates an error message in the user interface. For each message, a short description of the failure, a list of probable causes of the problem, and a list of suggested actions to fix the problem are provided (see chapter Error Information).

Test Functions

A series of test functions are available for troubleshooting and operational verification after exchanging internal components (see Tests and Calibrations).

System Pressure Test

The **System 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.

Leak Rate Test

The **Leak Rate Test** is a diagnostic test designed to determine the pressure tightness of the pump. When a problem with the pump is suspected, use this test to help troubleshoot the pump and its pumping performance.

EMPV Test

The EMPV test is designed to verify the performance of the EMPV. Perform this test after replacing the EMPV or when observing flow stability problems in micro mode.

EMPV Cleaning

The pump is equipped with a 0.5 µm pore width inline filter. Although it retains most particles, particular matter will over time collect in the EMPV (electromagnetic proportioning valve), causing unstable micro flow and -pressure. The EMPV cleaning procedure quickly and reliably removes these particles to restore pump performance in micro mode.

Status Indicators

Two status indicators are located on the front of the module. The lower left indicates the power supply status, the upper right indicates the module status.

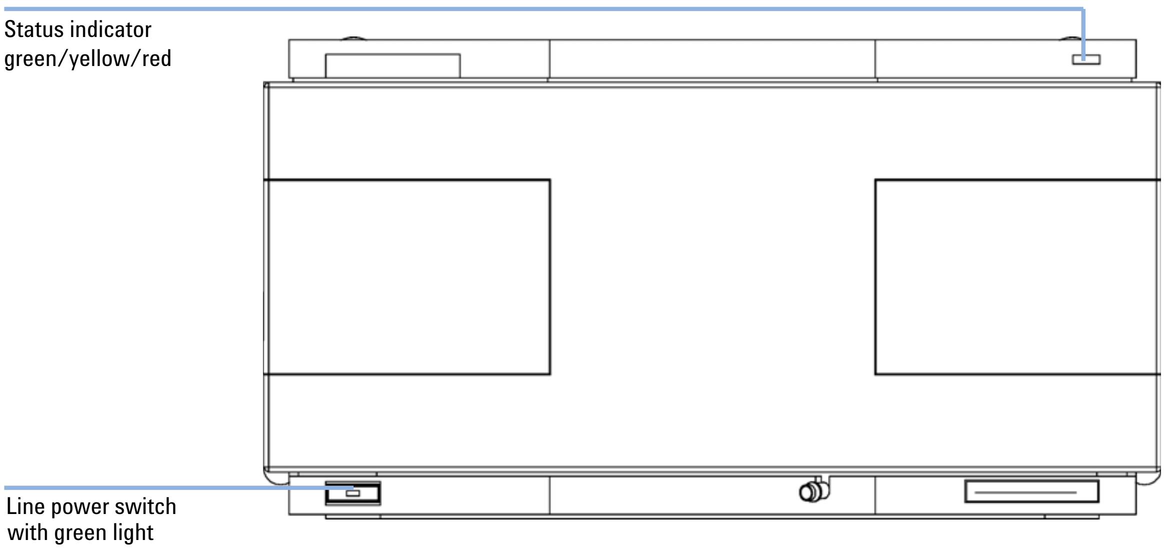


Figure 16 Location of Status Indicators

Power Supply Indicator

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

Module Status Indicator

The module status indicator indicates one of six possible module conditions:

- When the status indicator is *OFF* (and power switch light is on), the module is in a *prerun* condition, and is ready to begin an analysis.
- A *green* status indicator, indicates the module is performing an analysis (*run* mode).
- A *yellow* indicator indicates a *not-ready* condition. The module 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 set point), or while a self-test procedure is running.
- An *error* condition is indicated when the status indicator is *red*. An error condition indicates the module has detected an internal problem which affects correct operation of the module. Usually, an error condition requires attention (e.g. leak, defective internal components). An error condition always interrupts the analysis.
- A *red-blinking* (modules with on-board LAN) or *yellow-blinking* (modules without on-board LAN) indicator indicates that the module is in resident mode (e.g. during update of main firmware).
- A *fast red-blinking* (modules with on-board LAN) or *fast yellow-blinking* (modules without on-board LAN) indicator indicates that the module is in boot loader mode (e.g. during update of main firmware). In such a case try to re-boot the module or try a cold-start.

User Interfaces

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

Table 21 Test Functions available vs. User Interface

Test	Instant Pilot G4208A	Agilent Lab Advisor software
Micro Mode Pressure Test	Yes	Yes
Normal Mode Pressure Test	Yes	Yes
Leak Test	Yes	Yes
EMPV Test	No	Yes
EMPV Cleaning	Yes	Yes

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 software 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 software provides diagnostic capabilities for all Agilent 1200 Infinity Series modules. This includes diagnostic capabilities, calibration procedures and maintenance routines for all the maintenance routines.

The Agilent Lab Advisor software 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 software help files.

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

7
Error Information

This chapter describes the meaning of error messages, and provides information on probable causes and suggested actions how to recover from error conditions.

What Are 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, or exchange of consumables is necessary). 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 module logbook.

General Error Messages

General error messages are generic to all Agilent series HPLC modules and may show up on other modules as well.

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 degasser or the 1260 pump that has the degasser built-in.

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 (for example, 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 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 another module.	Switch off the system. Restart the system, and determine which module or modules are not recognized by the system.

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 flow sensor.	Please contact your Agilent service representative.
2 Leak sensor incorrectly routed, being pinched by a metal component.	Please contact your Agilent service representative.

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.	Please contact your Agilent service representative.
2 Defective leak sensor.	Please contact your Agilent service representative.
3 Leak sensor incorrectly routed, being pinched by a metal component.	Please contact your Agilent service representative.

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.	Please contact your Agilent service representative.

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.	Please contact your Agilent service representative.

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 a certain limit for a certain length of time, the error message is generated.

This limit is given by 2 revolutions/second for longer than 5 seconds.

Probable cause	Suggested actions
1 Fan cable disconnected.	Please contact your Agilent service representative.
2 Defective fan.	Please contact your Agilent service representative.
3 Defective main board.	Please contact your Agilent service representative.
4 Improperly positioned cables or wires obstructing fan blades.	Ensure the fan is not mechanically blocked.

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.

Module Error Messages

Zero Solvent Counter

The error message is triggered if the remaining volume in a solvent bottle falls below the set limit.

Probable cause	Suggested actions
1 Volume in bottle below specified volume.	Refill bottles and reset solvent counters.
2 Incorrect setting.	Make sure the set solvent volume matches the actual bottle filling and set the shutoff limit to a reasonable value (e.g. 100 mL for 1 L bottles)

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: inline filter frit, needle (autosampler), seat capillary (autosampler), sample loop (autosampler), column frits and capillaries with small internal diameters (e.g. 50 µm ID).
3 Defective damper.	Please contact your Agilent service representative.
4 Defective main board.	Please contact your Agilent service representative.

Pressure Below Lower Limit

The system pressure has fallen below the lower pressure limit.

Probable cause	Suggested actions
1 Solvent bottle empty.	Replenish solvent.
2 Lower pressure limit set too high.	Ensure the lower pressure limit is set to a value suitable for the analysis.
3 Air bubbles in the mobile phase.	• Ensure solvents are degassed. Purge the module. • Ensure solvent inlet filters are not blocked.
4 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.
5 Defective damper.	Please contact your Agilent service representative.
6 Defective main board.	Please contact your Agilent service representative.
7 Defective active inlet valve (AIV)	Replace AIV cartridge.
8 Defective outlet ball valve (OBV)	Replace OBV.

Pressure Signal Missing

The pressure signal of the damper is missing.

The pressure signal of 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.	Please contact your Agilent service representative.
2 Defective damper.	Please contact your Agilent service representative.

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 signal of 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 disconnected.	Please contact your Agilent service representative.
2 Defective damper.	Please contact your Agilent service representative.
3 Defective main board.	Please contact your Agilent service representative.

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).	Please contact your Agilent service representative.
3 Defective main board.	Please contact your Agilent service representative.
4 1200 Series solvent selection valve installed.	Replace by 1260 solvent selection valve.

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).	Please contact your Agilent service representative.
3 Defective main board.	Please contact your Agilent service representative.

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.	Please contact your Agilent service representative.

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.	Please contact your Agilent service representative.
4 Defective main board.	Please contact your Agilent service representative.

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 valve.	Exchange the outlet 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.	Please contact your Agilent service representative.
5 Defective main board.	Please contact your Agilent service representative.
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.	Please contact your Agilent service representative.
2 Defective pump drive assembly.	Please contact your Agilent service representative.

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.	Please contact your Agilent service representative.
2 Disconnected or defective connection cable (front panel to main board).	Please contact your Agilent service representative.
3 Defective active inlet valve.	Exchange the active inlet valve.

Electro-Magnetic-Proportional-Valve (EMPV) Missing

EMPV Missing

The EMPV in the capillary pump or nanoflow pump is missing or defective.

Probable cause	Suggested actions
1 Disconnected or defective cable.	Please contact your Agilent service representative.
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.	Please contact your Agilent service representative.

Leak Sensor Missing

Probable cause	Suggested actions
1 Disconnected or defective cable.	Please contact your Agilent service representative.
2 Defective flow sensor.	Please contact your Agilent service representative.

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 cable.	Please contact your Agilent service representative.
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.	Please contact your Agilent service representative.
4 Defective main board.	Please contact your Agilent service representative.

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 piston.	Exchange the piston.

Index Limit

Index Limit: Pump channel A

B: Index Limit: Pump channel B

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

During initialization, the first piston is moved to the mechanical stop. After reaching the mechanical stop, the piston 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, pistons, and internal components for signs of wear, contamination or damage. Exchange components as required.
2 Defective pump drive assembly.	Please contact your Agilent service representative.

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 piston is moved to the mechanical stop. After reaching the mechanical stop, the piston 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, pistons, and internal components for signs of wear, contamination or damage. Exchange components as required.
2 Defective pump drive assembly.	Please contact your Agilent service representative.

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 piston is moved to the mechanical stop. After reaching the mechanical stop, the piston 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.	Please contact your Agilent service representative.
2 Defective pump drive assembly.	Please contact your Agilent service representative.

Stroke Length

Stroke Length: Pump channel A

B: Stroke Length: Pump channel B

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

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

Probable cause	Suggested actions
1 Defective pump drive assembly.	Please contact your Agilent service representative.

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 passive inlet valve.	Exchange the inlet valve.
2 Defective pump drive assembly.	Please contact your Agilent service representative.
3 Defective main board.	Please contact your Agilent service representative.

Wait Timeout

When running certain tests in the diagnostics mode or other special applications, the pump must wait for the pistons 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 valve or piston 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 valve, piston seal).
3 Flow changed after starting test.	Ensure correct operating condition for the special application in use.
4 Defective pump drive assembly.	Please contact your Agilent service representative.

Electronic fuse of SSV

The electronic fuse protecting the solvent selection valve electronics has blown.

Probable cause	Suggested actions
1 Recoverable error of the SSV electronic.	Restart module, the electronic fuse can recover. If not, contact Agilent service.
2 Short cut of SSV/cable	Replace cable between board and SSV

8
Test Functions and Calibration

This chapter describes the tests for the module.

Micro Mode Pressure Test

Description

This is a fast test to verify the tightness of a micro system, where the pump is operating in **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 with 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 Advisor Software

CAUTION

Stainless steel blank nuts can damage the flow sensor.

→ In step 10 of following procedure, use the PEEK blank nut from the accessories kit to block the flow sensor outlet.

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 Advisor software.

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 Micro Mode Pressure Test Failure

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

Table 22 Potential Cause (Pump)

Potential Cause (Pump)	Corrective Action
Loose or leaky fitting.	Tighten the fitting or exchange the capillary.
High flow sensor offset.	Run the flow sensor accuracy calibration and correct the flow sensor offset.

Table 23 Potential Cause (Autosampler)

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

Normal Mode Pressure Test

Description

The **System Pressure Test** is a quick, built-in test designed to demonstrate the pressure-tightness of the system. The test is required, if problems with small leaks are suspected, or after maintenance of flow-path components (e.g., pump seals, injection seal) to prove pressure tightness up to 400 bar.

For running the test, please refer to the online help of the diagnostic software.

Preparation

The EMPV is not designed for pressure tightness towards the waste port. Install the manual purge valve from the accessories kit to pump head A. Move the inline filter outlet capillary from the EMPV to the manual purge valve.

Step 1

The test begins with the initialization of both pumpheads. After initialization, pistons 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 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 “Leak Test Description” on page 120.

Step 2

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

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

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

Tools required Wrench 1/4 inch

Parts required

#	p/n	Description
1	01080-83202	Blank nut
1		500 ml Isopropanol

Preparations

- Place a bottle of LC-grade isopropanol in the solvent cabinet and connect it to channel A2.
- Install the manual purge valve from the accessories kit to pump head A.
- Move the inline filter outlet capillary from the EMPV to to manual purge valve.

NOTE Make absolutely sure that all parts of the flow path that are part of the test are very thoroughly flushed with isopropanol 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 Advisor

1. Select the **Pressure 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.

"Evaluating the Results" on page 119 describes the evaluation and interpretation of the **Pressure Test** results.

For detailed instructions refer to the Agilent Lab Advisor Software.

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

Leak Test Description

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

Ramp 1

The test begins with the initialization of both pumps. After initialization, pistons A1 and B1 are both at the top of their stroke. Next, the 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, pistons A1 and B1 are at the top of their stroke.

Ramp 2

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

Ramp 3

Just before the start of the first plateau, piston A2 delivers with a flow rate of 50 µL/min for approximately 8 s.

Plateau 1

At plateau 1, piston A2 delivers with a flow rate of 3 µL/min for 30 s.

Ramp 4

Piston B2 delivers 50 µL/min for approximately 8 s.

Plateau 2

Piston B2 delivers with a flow rate of 3 µL/min for 30 s.

Ramp 5

Piston A1 delivers 50 µL/min for approximately 8 s.

Plateau 3

Piston A1 delivers with a flow rate of 3 µL/min for 30 s.

Ramp 6

Piston B1 delivers 50 µL/min for approximately 7 s.

Plateau 4

Piston B1 delivers with a flow rate of 3 µL/min for approximately 30 s. At the end of the fourth plateau, the test is finished and the pump switches off.

Running the Leak Test

When If problems with the pump are suspected

Tools required Wrench 1/4 inch

Parts required

#	p/n	Description
1	G1313-87305	Restriction Capillary
1	01080-83202	Blank nut
1		500 ml Isopropanol

Preparations

- Place two bottles of LC-grade isopropyl alcohol in channels A2 and B2.
- The EMPV is not designed for pressure tightness towards the waste port. Install the manual purge valve from the accessories kit to pump head A.
- Move the inline filter outlet capillary from the EMPV to to manual purge valve.

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 Advisor 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.

HINT "Evaluating the Results" on page 123 describes the evaluation and interpretation of the leak test results.

HINT For detailed instructions refer to the Agilent Lab Advisor 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 were not within the specified limits.

NOTE Often it is only the 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 or outlet valve.	Ensure the leaky components are installed tightly. Exchange the component if required.

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 Loose pump head screws in channel A or B.	Ensure the pump head screws in channels A and B are tight.
4 Leaking seal or scratched piston in channel A2 or B2.	Exchange the pump seals in both channels. Check the pistons for scratches. Exchange if scratched.
5 Leaking outlet valve in channel A or B.	Exchange the outlet valve.
6 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 piston in channel A2.	Exchange the pump seals in channel A. Check the piston 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 piston in channel B2.	Exchange the pump seals in channel B. Check the piston 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 (14 mm 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 piston in channel A1.	Exchange the pump seals in channel A. Check the pistons 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 piston in channel B1.	Exchange the pump seals in channel B. Check the pistons for scratches. Exchange if scratched.
6 Defective active inlet valve in channel B.	Exchange the active inlet valve in channel B.

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

1260 Capillary Pump EMPV Cleaning Description

Depending on the application, particles can sometimes collect 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!

9 Maintenance

This chapter describes the maintenance of the module.

Introduction to Maintenance

The pump is designed for easy repair. The most frequent repairs such as piston seal exchange and filter frit replacement can be done with the pump in place in the system stack. These repairs are described in Table 24 on page 132.

Warnings and Cautions

WARNING

Toxic, flammable and hazardous solvents, samples and reagents

The handling of solvents, samples and reagents can hold health and safety risks.

→ When working with these substances observe appropriate safety procedures (for example by wearing goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the vendor and follow good laboratory practice.

→ The amount of substances should be reduced to the minimal volume required for the analysis.

→ Do not operate the instrument in an explosive atmosphere.

WARNING

Electrical shock

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

→ Do not remove the metal top cover of the module. No serviceable parts inside.

→ Only certified persons are authorized to carry out repairs inside the module.

WARNING

Personal injury or damage to the product

Agilent is not responsible for any damages caused, in whole or in part, by improper use of the products, unauthorized alterations, adjustments or modifications to the products, failure to comply with procedures in Agilent product user guides, or use of the products in violation of applicable laws, rules or regulations.

→ Use your Agilent products only in the manner described in the Agilent product user guides.

CAUTION

Safety standards for external equipment

→ If you connect external equipment to the instrument, make sure that you only use accessory units tested and approved according to the safety standards appropriate for the type of external equipment.

Overview of Maintenance

Table 24 Simple Repair Procedures

Procedure	Symptom	Notes
"Removing the Active Inlet Valve" on page 139	If internally leaking	Pressure ripple unstable, run leak test for verification
"Exchanging the Outlet Valve Sieve" on page 142	If internally leaking	Pressure ripple unstable, run leak test for verification
"Exchanging the Solvent Selection Valve" on page 144	Unstable column flow or system pressure	
"Exchanging the Solvent Selection Valve" on page 144	Column flow and system pressure drops from time to time.	A pressure drop of > 10 bar across the frit (2.5 mL/min H_2O with purge open) indicates blockage
"Exchanging the Pump Seals and Seal Wear-in Procedure" on page 148	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 Pistons" on page 151	If scratched	Seal life time shorter than normally expected — check pistons while changing the seals
"Exchanging the Flow Sensor" on page 153	Extended flow range (100 ul) needed. Leak on the flow sensor. Unstable column flow Flow sensor blocked	

Figure 17 on page 133 shows the main assemblies of the 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.

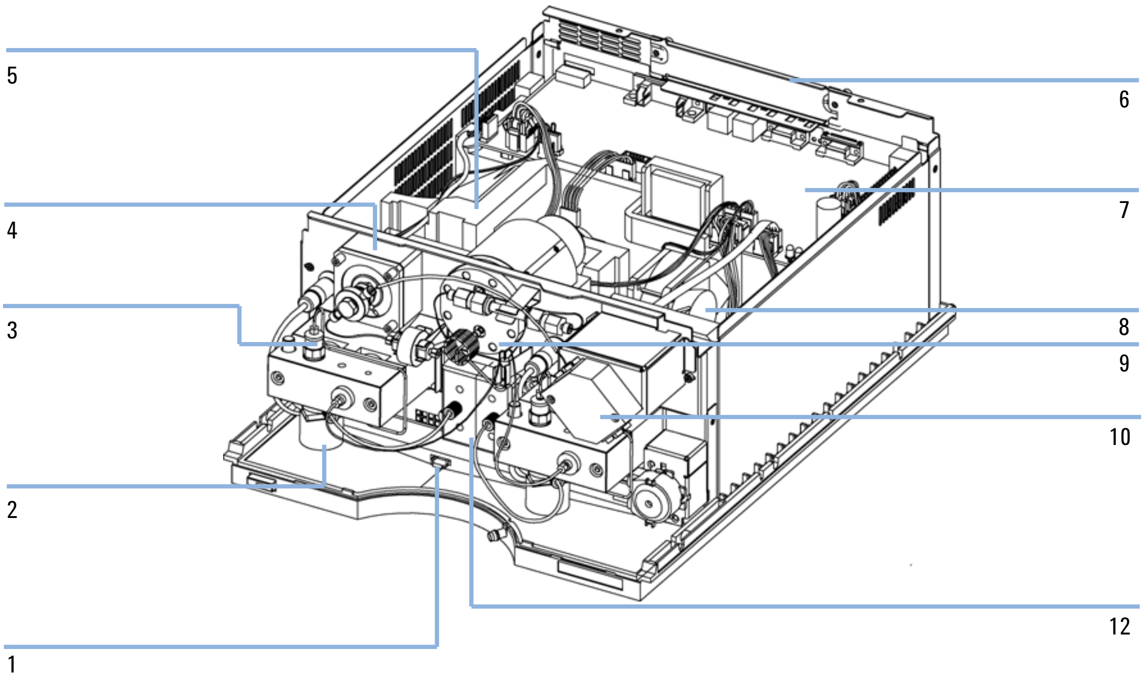


Figure 17 Overview of Repair Procedures

12	Active inlet valve, see “Removing the Active Inlet Valve” on page 139
23	Outlet ball valve, see “Exchanging the Outlet Valve Sieve” on page 142
312	Solvent selection valve, see “Exchanging the Solvent Selection Valve” on page 144

Cleaning the Module

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 mild detergent. Do not use an excessively damp cloth as liquid may drip into 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 excessively damp cloth during cleaning.

→ Drain all solvent lines before opening any fittings.

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.

Checking and Cleaning the Solvent Inlet Filters

When	If solvent filter is blocked
Parts required	**Description**
	Concentrated nitric acid (65 %)
	Bidistilled water
	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 bear 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 pump. A blocked filter therefore does not affect the pressure readings of the 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 LC grade water (remove all nitric acid, some columns can be damaged by concentrated nitric acid).

3 Reinstall the filter.

Exchanging the Active Inlet Valve Cartridge or the Active Inlet Valve

Removing the Active Inlet Valve

When If defective, see next two procedures for repair details.

Tools required Wrench 14 mm

Parts required

#	p/n	Description
1	G1312-60025	Active inlet valve body (optional), without cartridge
1	5062-8562	Active Inlet Valve Cartridge (400 bar)
1	G1311-67304	Connecting tube, MCGV to AIV

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.

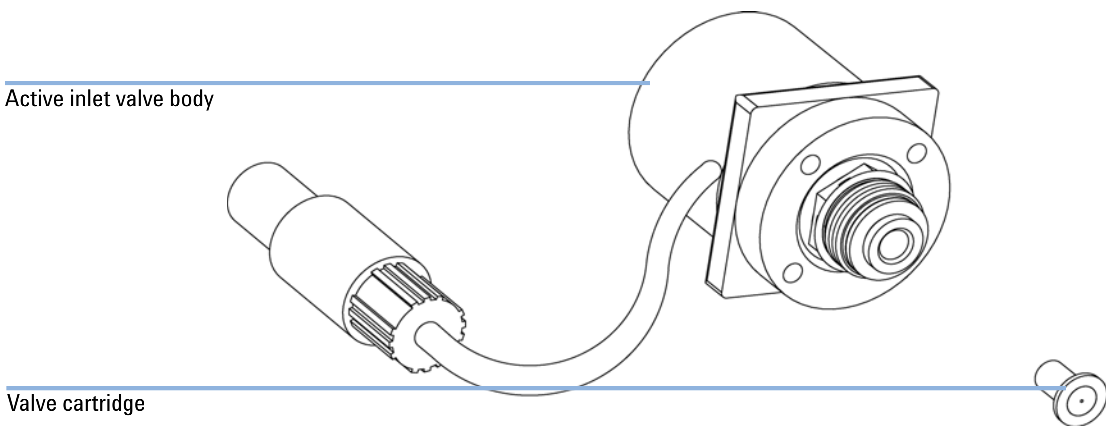


Figure 18 Active Inlet Valve Parts

Exchanging the Valve Cartridge

When If internally leaking (backflow)

Tools required Wrench 14 mm

Parts required

#	p/n	Description
1	5062-8562	Active Inlet 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 cartridge into the actuator assembly (make sure the valve cartridge is completely inserted into the actuator assembly).

Replacing the Active Inlet Valve Body

When

- If leaking from the bottom of the active inlet valve body
- If the soleniod is defective

Tools required Wrench 14 mm

Parts required

#	Description
G1312-60025	Active inlet valve without cartridge
5062-8562	Active Inlet Valve Cartridge (400 bar), optional

1. Move the AIV cartridge from the old valve body to the new one. Optionally, you may use a new AIV cartridge.
2. Insert the new valve into the pump head. Using the 14 mm wrench turn the nut until it is hand tight.
3. Position the valve so that the solvent inlet tube connection points towards the front.

4 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.

5 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*.

6 After an exchange of the valve cartridge it may be required to prime the respective pump channel with several milliliters of solvent before it is completely purged and the pressure ripple has returned to its normal value.

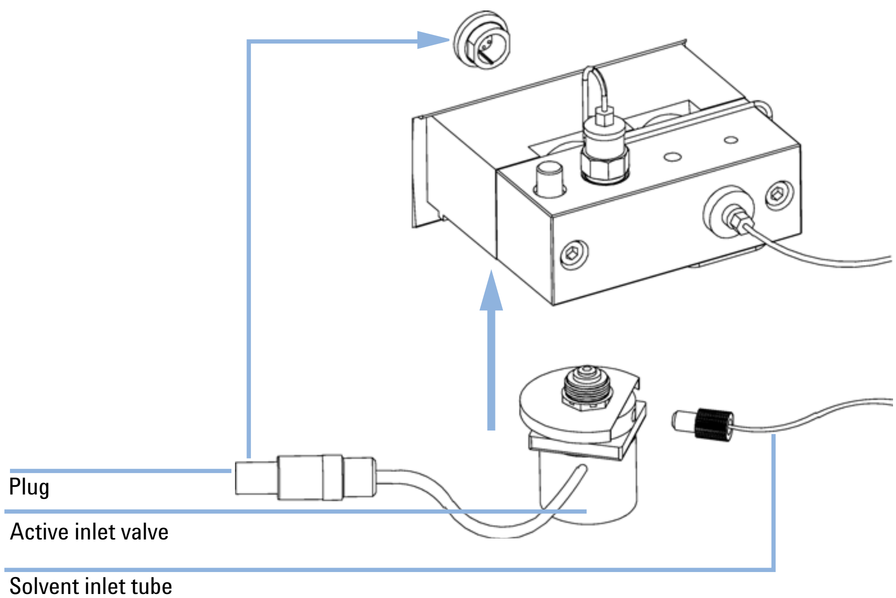


Figure 19 Exchanging the Active Inlet Valve

Exchanging the Outlet Valve Sieve

When	Sieve — whenever the pump seals will be exchanged Valve — if internally leaking
Tools required	Wrench 1/4 inch Wrench 14 mm

Parts required

#	p/n	Description
1	G1312-60067	Outlet valve, complete
1	5063-6505	Sieve (pack of 10)

NOTE Before exchanging the outlet 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 – 10 min. Insert a new sieve and replace the gold seal.

1 Using a 1/4 inch wrench disconnect the valve capillary from the outlet 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 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 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 (if the gold seal is deformed, it should be replaced).

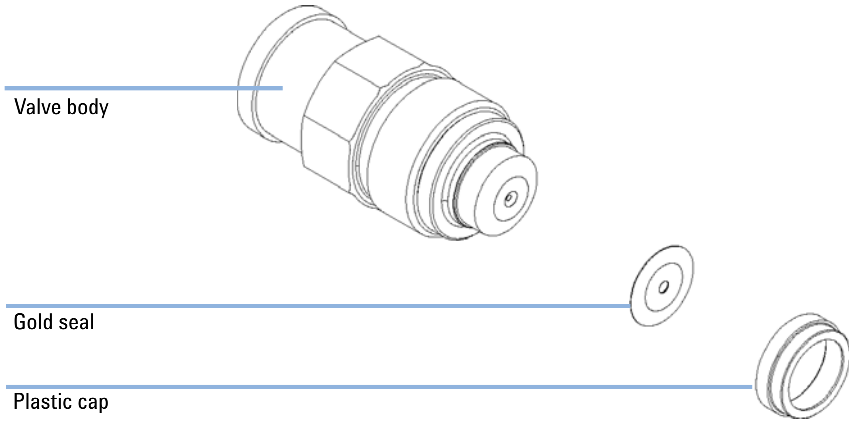


Figure 20 Outlet Ball Valve Parts

7 Reinstall the outlet valve and tighten the valve.

8 Reconnect the valve capillary.

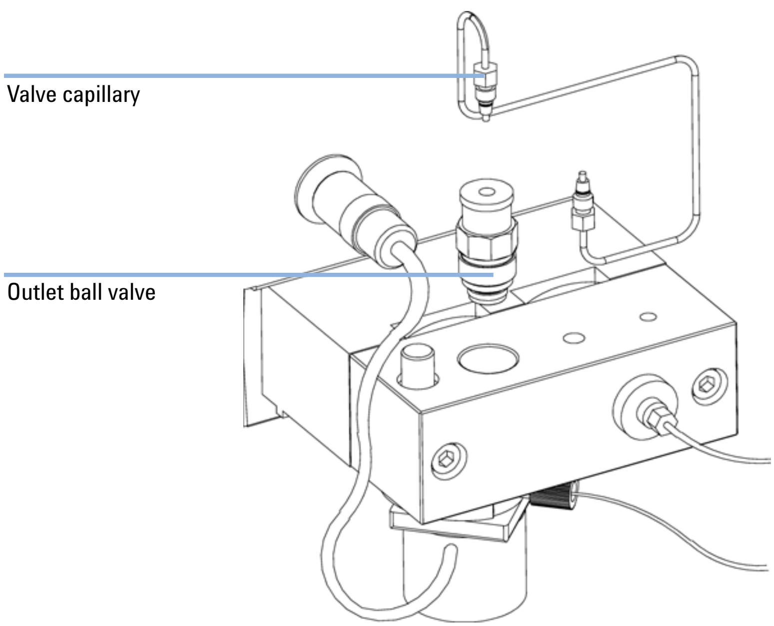


Figure 21 Exchanging the Outlet Valve

Exchanging the Solvent Selection Valve

When	If leaking internally, if blocked or if one of the solenoids is defective	
Tools required	Screwdriver Pozidriv #1	
Parts required	**#**	**Description**
	G1312-60068	Solvent selection valve

CAUTION

Solvent spillage

➔ Position the solvent bottles at a level below the pump to avoid solvent spillage due to hydrostatic pressure.

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.

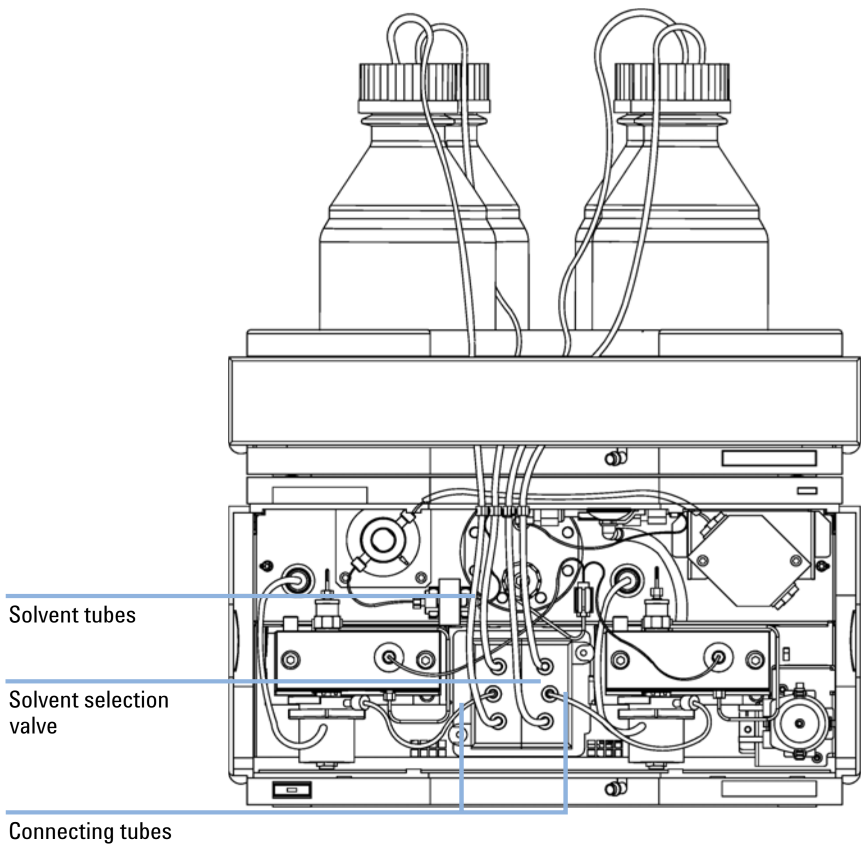


Figure 22 Exchanging the solvent selection valve

2 Using a Pozidriv screwdriver #1 loosen the holding screws of the valves.

3 Pull the valve module out and detach the connector.

4 Push the connector of the new solvent selection valve into the receptacle.

5 Fix the new valve with the two holding screws and reconnect the solvent lines.

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

When	• Exchanging pump seals • Exchanging pistons • Exchanging seals of the seal wash option
Tools required	Wrench 1/4 inch 3-mm hexagonal key 4-mm hexagonal key
Preparations	• Switch off pump at power switch • Remove the front cover to have access to the pump mechanics

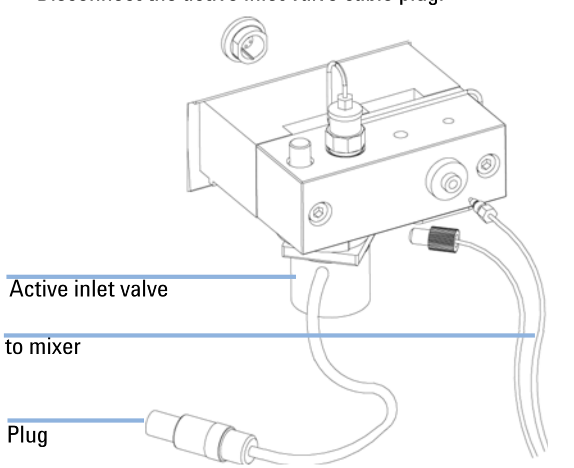
CAUTION

Damage of the pump drive

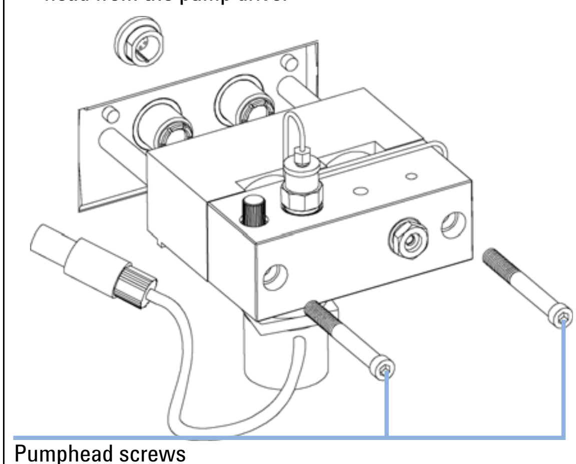
Starting the pump when the pump head is removed may damage the pump drive.

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

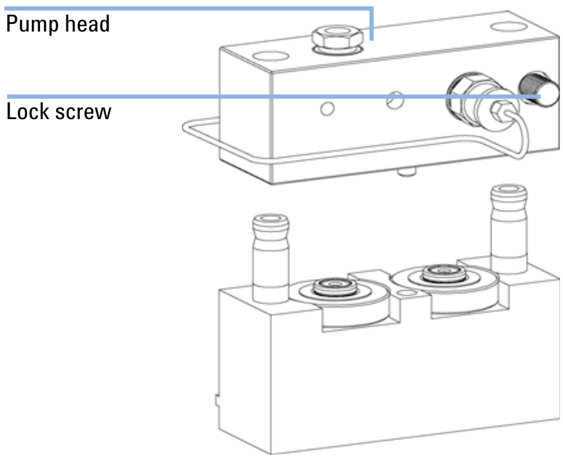
1 Disconnect the capillary at the pumphead adapter and the tube at the active inlet valve. Beware of leaking solvents. Disconnect the active inlet valve cable plug.



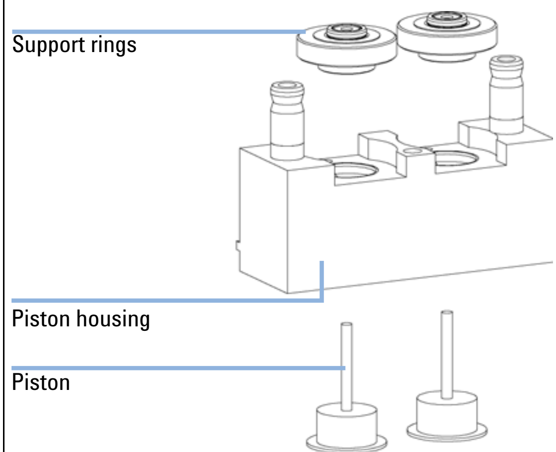
2 Using a 4-mm hexagonal key step wise loosen and remove the two pump head screws and remove the pump head from the pump drive.



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 piston housing.

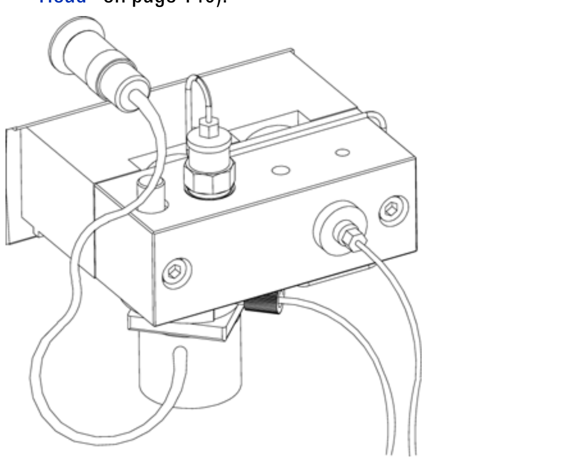
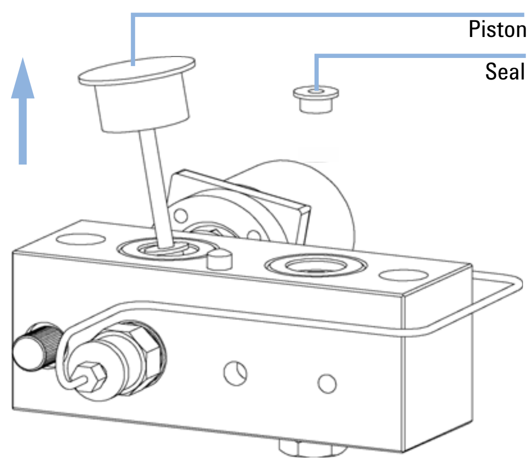


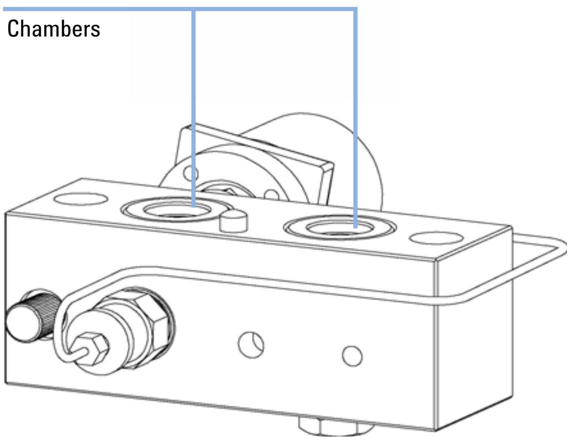
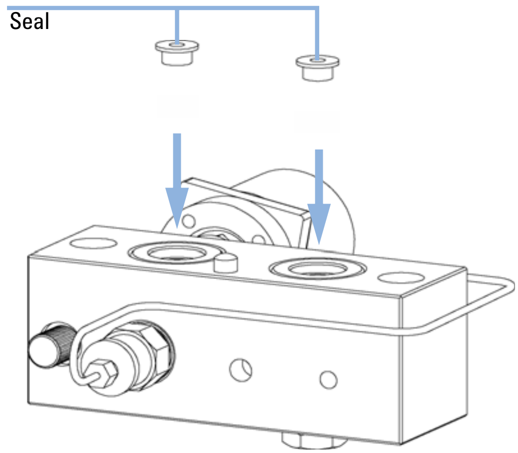
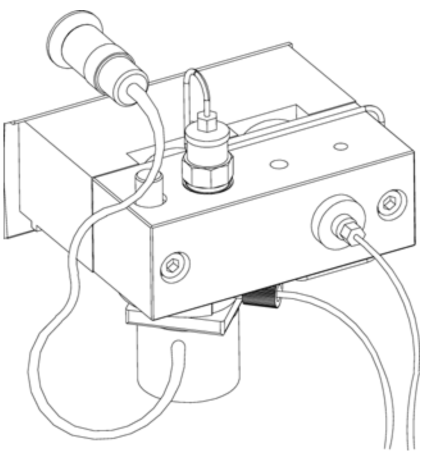
4 Remove the support rings from the piston housing and lift the housing away from the pistons.



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	**#**	**p/n**	**Description**
	2	5063-6589 (standard) or 0905-1420 (for normal phase application)	Seals (pack of 2)
	1	5022-2159	Restriction capillary

1 Disassemble the pump head assembly of the leaky pump head (see “Removing and Disassembling the Pump Head” on page 146). 	**2** Using one of the pistons carefully remove the seal from the pump head (be careful, not to break the piston). 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 139 and "Exchanging the Outlet Valve Sieve" on page 142) 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 154). 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. If an AIV is installed, screw the Adapter AIV to solvent inlet tubes (p/n 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 min at this pressure to wear in the seals. The pressure can be monitored at your analog output signal, with the Instant Pilot, data system 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 Pistons

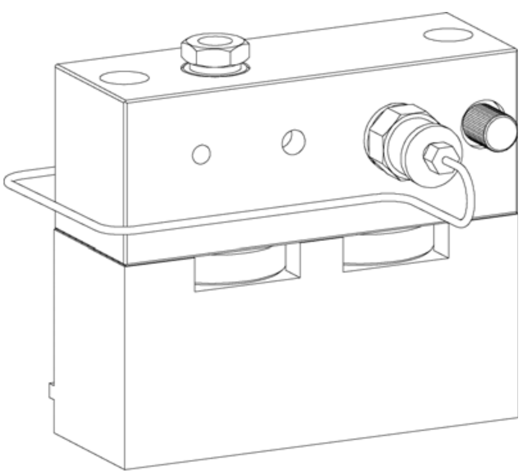
When When scratched

Tools required
- 3-mm hexagonal key
- 4-mm hexagonal key

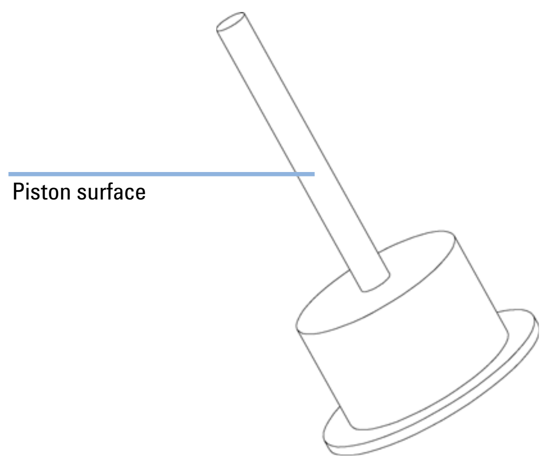
Parts required

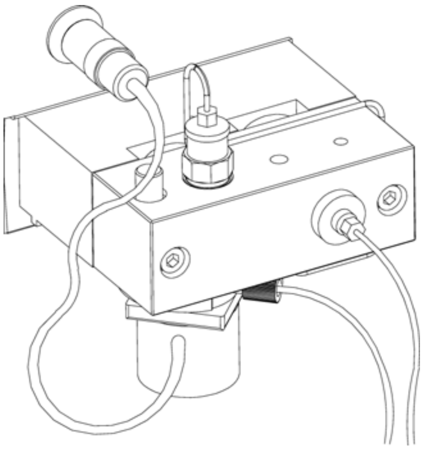
#	p/n	Description
1	5063-6586	Piston

1 Disassemble the pump head assembly (see "Removing and Disassembling the Pump Head" on page 146)



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



<table>
<tr>
<td>3 Reassemble the pump head assembly (see “Reassembling the Pump Head Assembly” on page 154).
</td>
<td></td>
</tr>
</table>

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

#	p/n	Description
1	G1376-60001	Flow sensor 20 µL (1260 Capillary Pump)
1	G1376-60002	100 ul

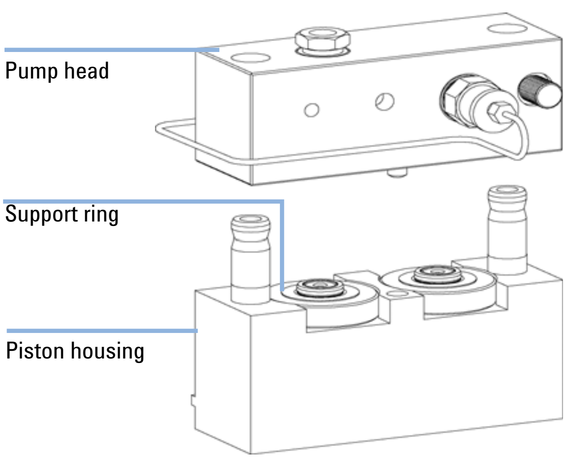
1. Turn off the pump.
2. Using a 1/4 inch wrench disconnect the capillaries:
   - coming from the EMPV.
   - going to the injection device (port 1).
3. Unscrew the flow sensor.
4. Re-install the new one.
5. Using a 1/4 inch wrench reconnect the capillaries:
   - coming from the EMPV.
   - going to the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

Reassembling the Pump Head Assembly

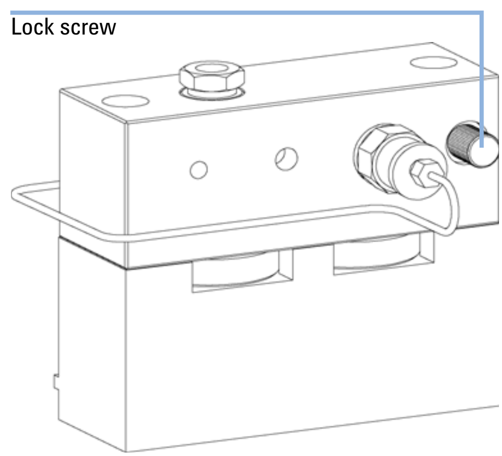
Tools required

- 3-mm hexagonal key
- 4-mm hexagonal key
- PTFE lubricant (79846-65501)

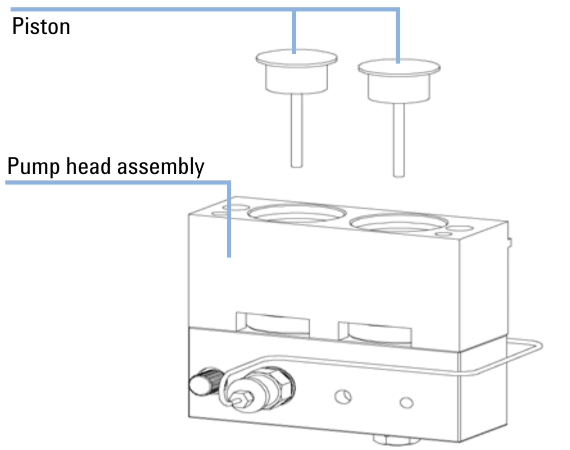
1 Place the support rings on the piston housing (pistons not installed) and snap the pump head and piston housing together.



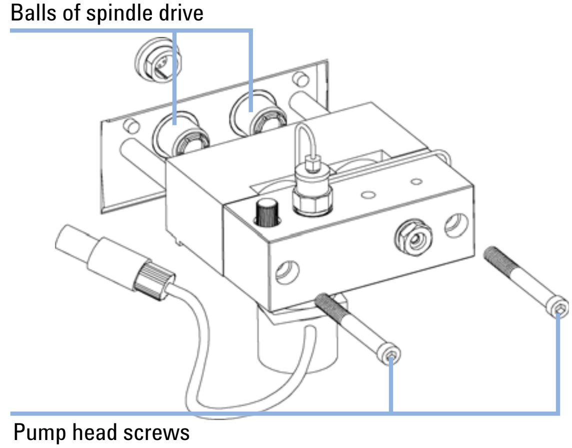
2 Tighten the lock screw.



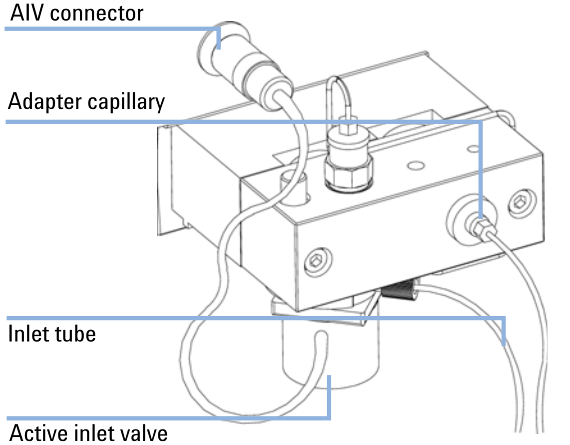
3 Carefully insert the pistons into the pump head assembly and press them completely into the seals.



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

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.

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

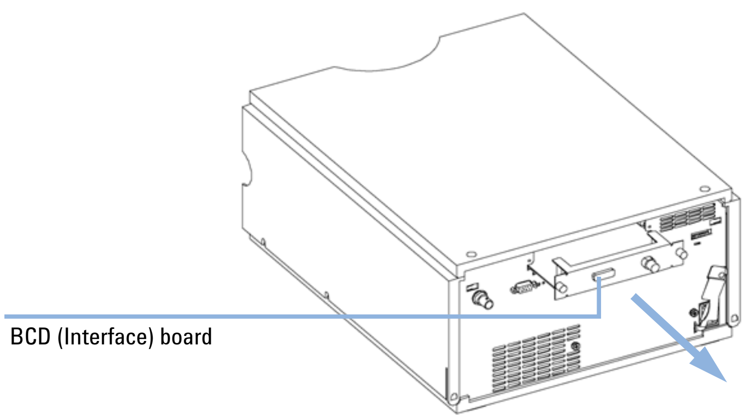


Figure 23 Exchanging the Interface Board

Replacing Module Firmware

When

The installation of newer firmware might be necessary

- if a newer version solves problems of older versions or
- to keep all systems on the same (validated) revision.

The installation of older firmware might be necessary

- to keep all systems on the same (validated) revision or
- if a new module with newer firmware is added to a system or
- if third part control software requires a special version.

Tools required

- LAN/RS-232 Firmware Update Tool or
- Agilent Diagnostic Software
- Instant Pilot G4208A (only if supported by module)

Parts required

#	Description
1	Firmware, tools and documentation from Agilent web site

Preparations

Read update documentation provided with the Firmware Update Tool.

To upgrade/downgrade the module's firmware carry out the following steps:

1 Download the required module firmware, the latest LAN/RS-232 FW Update Tool and the documentation from the Agilent web.

   - http://www.chem.agilent.com/scripts/cag_firmware.asp.

2 To load the firmware into the module follow the instructions in the documentation.

Module Specific Information

There is no specific information for this module.

10
Parts and Materials for Maintenance

This chapter provides information on parts for maintenance.

Pump Housing and Main Assemblies

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

Item	p/n	Description
1	G1312-60064	Pump Head without Seal Wash
2	G1311-60001	Pump drive assembly
	G1311-69001	Exchange assembly for pump drive
3	G1311-61601	Cable assembly — AIV to main board
4	G1376-65030	Capillary system main board (CSM)
	G1376-69030	Exchange assembly—CSM board
5	G4280-81618	Cable assembly—solvent selection valve
	G1312-05208	SSV holder
	G1312-05207	Holder for SSV connector
6	3160-1017	Fan assembly
7	79835-60005	Damper
8	G4280-60028	Solvent selection valve
	5022-2112	Screw, for cover and Z-panel
9	5042-8590	Leak plane
10	G1361-60000	EMPV assembly
11	G1376-60001	Flow sensor 20 µL (1260 Capillary Pump)
11	G1376-60002	Flow sensor 100 µL (1260 Capillary Pump)

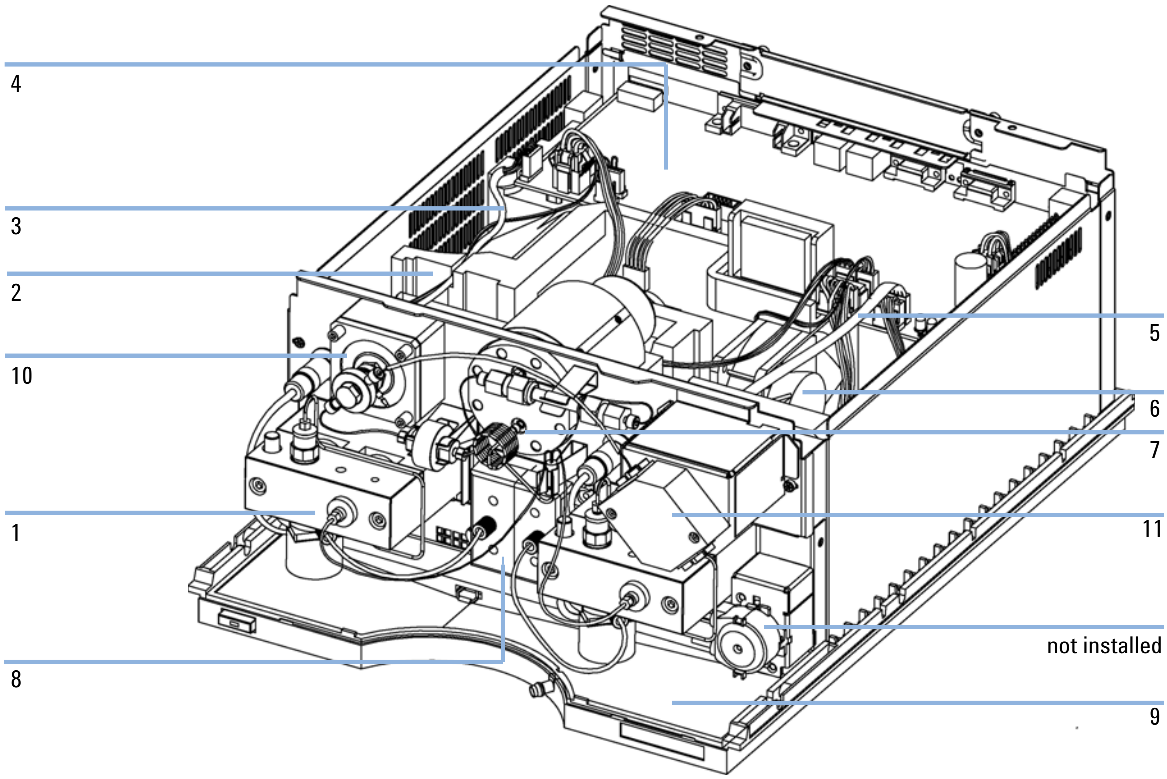


Figure 24 Overview of Main Assemblies (Front View)

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

Item	p/n	Description
1	1251-7788	Hexagonal Nut for remote/RS-232 connector
2	2940-0256	Nut M14 — analog output
3	0515-0910	Screw M4 x 0.7, 8 mm lg, to fix power supply at rear panel
4	0515-0924	Screw M3x0.5, 6 mm long, for Housing Front (2x)

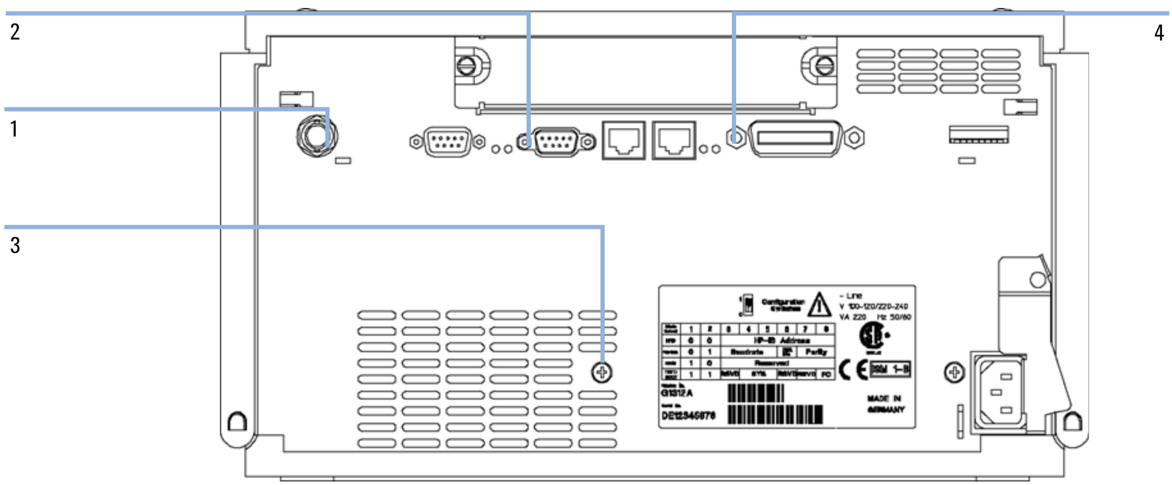


Figure 25 Overview of Main Assemblies (Rear View)

Solvent Cabinet and Bottle-Head Assembly

Item	p/n	Description
1	5065-9981	Solvent cabinet, including all plastic parts
2	5042-8901	Name plate
	5043-0207	Name plate 1260
3	5065-9954	Front panel, solvent cabinet
4	5042-8567	Leak pan
	G1311-60003	Bottle-head assembly
5/6	01018-60025	Solvent inlet filter, stainless steel
7	5062-2483	Solvent tubing, 5 m
	5063-6598	Ferrules with lock ring (10x)
	5063-6599	Tube screw (10x)
	9301-1420	Solvent bottle, transparent
	9301-1450	Solvent bottle, amber

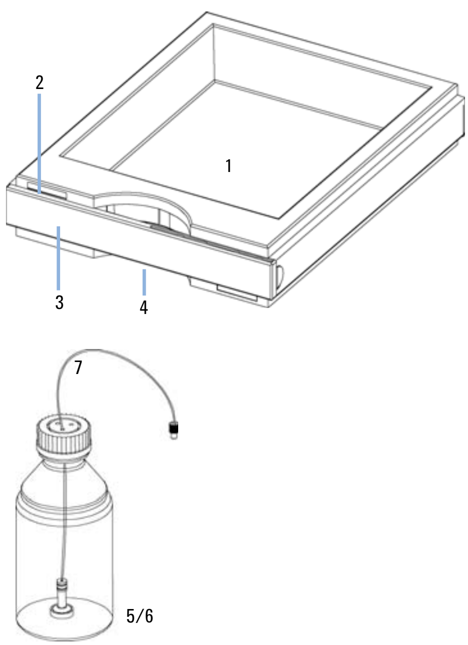


Figure 26 Solvent Cabinet Parts

Hydraulic Path

Item	p/n	Description
1	G1311-60003	Bottle-head assembly
2	G1311-67304	Connecting tube, SSV to AIV
3	G1312-67300	Capillary, outlet valve to piston 2
4	G1312-67304	Restriction capillary
5	G1312-67302	Mixing capillary
6	01090-87308	Capillary, damper to mixer (capillary pump only)
7	G1312-87330	Mixer (capillary pump only)
	01090-87308	Capillary, mixer to filter (capillary pump only)
9	5064-8273	Filter assembly (includes frit)
	5022-2185	Replacement SS frit, 0.5 µm pore size
10	G1375-87400	Capillary, filter to EMPV
11	G1375-87301	Capillary EMPV to flow sensor (20 µL flow sensor)
	G1375-87305	Capillary EMPV to flow sensor (100 µL flow sensor)
12	G1375-87310	Capillary flow sensor to injection device (20 µL), 50 µm i.d., 55 cm length, PEEK /fused silica
	G1375-87306	Capillary flow sensor to injection device (100 µL flow sensor), 100 µm ID x 55 cm
	5062-2463	Corrugated waste tubing, 5 m (reorder pack)

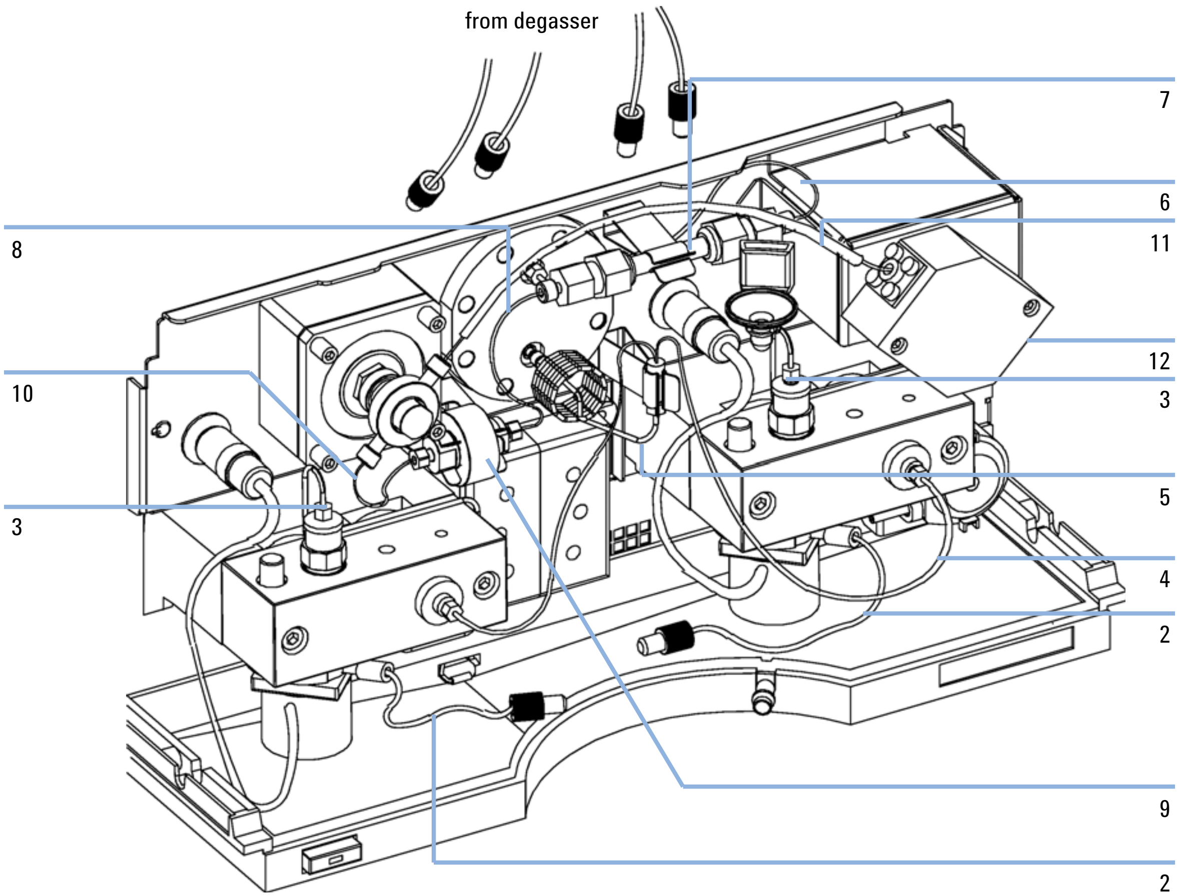


Figure 27 Hydraulic Path

Pump-Head Assembly

Item	p/n	Description
	G1312-60064	Pump Head without Seal Wash
1	5067-4695	Sapphire piston (default)
2	G1312-60062	Adapter, integrated, 1260
3	G4220-63015	Support Ring without Seal Wash
	G4220-24013	Backup Ring for Seal Holder
4	5063-6589	Seal, general purpose, black, pack of 2
	0905-1420	Seal, general purpose, black, pack of 2
5	G1312-67300	Capillary, outlet valve to piston 2
6	G1312-25260	Pump head body, 1260
7	G1312-60025	Active inlet valve without cartridge
	5062-8562	Active Inlet Valve Cartridge (400 bar)
8	G1312-60067	Outlet valve, complete
9	5042-1303	Screw lock
10	G1312-23201	Adapter
11	0515-2118	Screw M5, 60 mm long

The complete pump head assembly includes items 1 - 4, 6, 9 and 11.

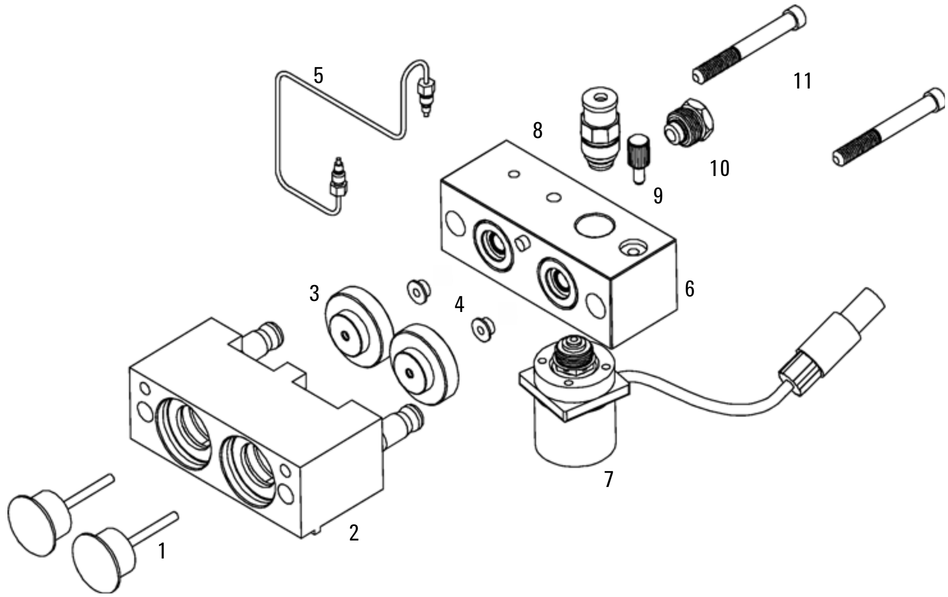


Figure 28 Pump-Head Assembly

Flow Sensor Assembly

Item	p/n	Description
1	G1376-60001	Flow sensor 20 µL (1260 Capillary Pump)
	G1376-60002	Flow sensor 100 µL (1260 Capillary Pump)
	G1375-87301	Capillary EMPV to flow sensor (20 µL flow sensor)
	G1375-87305	Capillary EMPV to flow sensor (100 µL flow sensor)
	G1375-87310	Fused silica/ PEEK capillary, 50 µm55 cm (20 µL flow sensor)
	G1375-87306	Fused silica/ PEEK capillary, 100 µm55 cm (100 µL flow sensor)

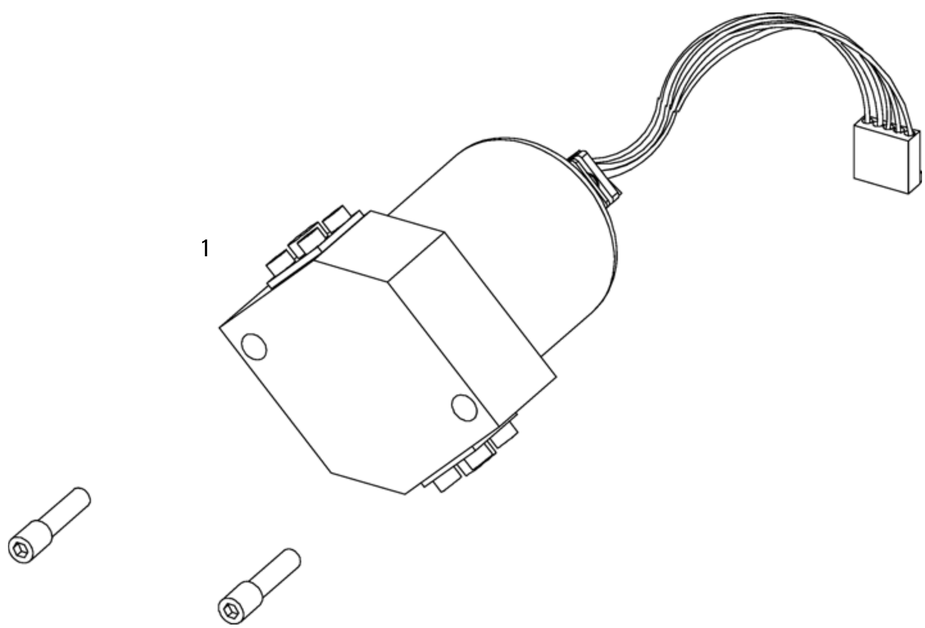


Figure 29 Flow Sensor Assembly

Capillary Pump Accessory Kit

Accessory Kit (p/n G1376-68755)

p/n	Description
0515-0175	Mounting screw for manual purge valve holder, M4, 20 mm long
0890-1760 (2x)	Tubing Flexible 1 ea / 1 meter
2190-0586	Washer for purge valve holder screw
5022-2185	Replacement SS frit, 0.5 µm pore size
5181-1519	CAN cable, Agilent module to module, 1 m
01018-23702	Insert tool
01018-60025 (4x)	Solvent inlet filter, stainless steel
G1311-60009	Manual purge valve
G1312-23200	Holder for manual purge valve
G1315-45003	Torque adapter
G1375-87310	Fused silica/ PEEK capillary, 50 µm55 cm (20 µL flow sensor)
8710-1534	Wrench, 4 mm both ends, open end
8710-0806 (2x)	Wrench, open end 1/2 inch and 7/16 inch
G1376-90014	Agilent 1260 Infinity Capillary Pump User Manual

11
Identifying Cables

This chapter provides information on cables used with the Agilent 1200 Infinity Series modules.

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.

Analog cables

p/n	Description
35900-60750	Agilent module to 3394/6 integrators
35900-60750	Agilent 35900A A/D converter
01046-60105	Analog cable (BNC to general purpose, spade lugs)

Remote cables

p/n	Description
03394-60600	Agilent module to 3396A Series I integrators
	3396 Series II / 3395A integrator, see details in section “Remote Cables” on page 176
03396-61010	Agilent module to 3396 Series III / 3395B integrators
5061-3378	Agilent module to Agilent 35900 A/D converters (or HP 1050/1046A/1049A)
01046-60201	Agilent module to general purpose

BCD cables

p/n	Description
03396-60560	Agilent module to 3396 integrators
G1351-81600	Agilent module to general purpose

CAN cables

p/n	Description
5181-1516	CAN cable, Agilent module to module, 0.5 m
5181-1519	CAN cable, Agilent module to module, 1 m

LAN cables

p/n	Description
5023-0203	Cross-over network cable, shielded, 3 m (for point to point connection)
5023-0202	Twisted pair network cable, shielded, 7 m (for point to point connection)

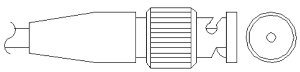
External Contact Cable

p/n	Description
G1103-61611	External contact cable - Agilent module interface board to general purposes

RS-232 cables

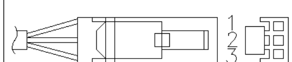
p/n	Description
G1530-60600	RS-232 cable, 2 m
RS232-61600	RS-232 cable, 2.5 m Instrument to PC, 9-to-9 pin (female). This cable has special pin-out, and is not compatible with connecting printers and plotters. It's also called "Null Modem Cable" with full handshaking where the wiring is made between pins 1-1, 2-3, 3-2, 4-6, 5-5, 6-4, 7-8, 8-7, 9-9.
5181-1561	RS-232 cable, 8 m

Analog Cables

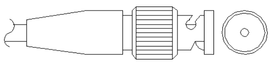


One end of these cables provides a BNC connector to be connected to Agilent modules. The other end depends on the instrument to which connection is being made.

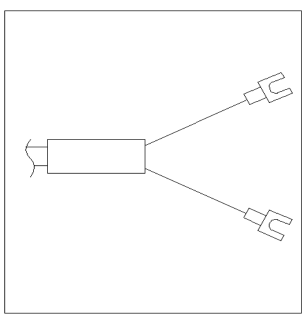
Agilent Module to 3394/6 Integrators

p/n 35900-60750	Pin 3394/6	Pin Agilent module	Signal Name
	1		Not connected
	2	Shield	Analog -
	3	Center	Analog +

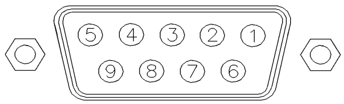
Agilent Module to BNC Connector

p/n 8120-1840	Pin BNC	Pin Agilent module	Signal Name
	Shield	Shield	Analog -
	Center	Center	Analog +

Agilent Module to General Purpose

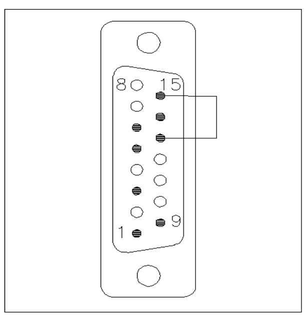
p/n 01046-60105	Pin 3394/6	Pin Agilent module	Signal Name
	1		Not connected
	2	Black	Analog -
	3	Red	Analog +

Remote Cables



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

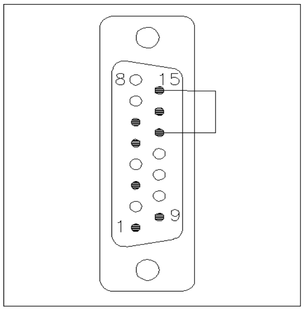
Agilent Module to 3396A Integrators

p/n 03394-60600	Pin 3394	Pin Agilent module	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	

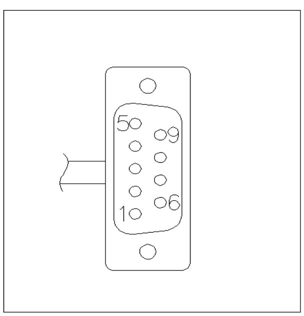
Agilent Module to 3396 Series II / 3395A Integrators

Use the cable Agilent module to 3396A Series I integrators (p/n 03394-60600) and cut pin #5 on the integrator side. Otherwise the integrator prints START; not ready.

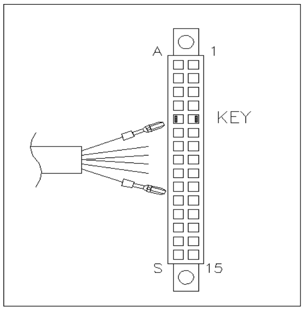
Agilent Module to 3396 Series III / 3395B Integrators

p/n 03396-61010	Pin 33XX	Pin Agilent module	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	

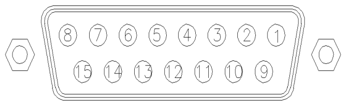
Agilent Module to Agilent 35900 A/D Converters

p/n 5061-3378	Pin 35900 A/D	Pin Agilent module	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 Module to General Purpose

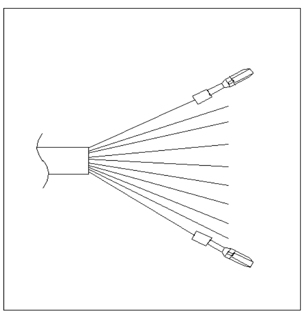
p/n 01046-60201	Pin Universal	Pin Agilent module	Signal Name	Active (TTL)
		1 - White	Digital ground	
		2 - Brown	Prepare run	Low
		3 - Gray	Start	Low
		4 - Blue	Shut down	Low
		5 - Pink	Not connected	
		6 - Yellow	Power on	High
		7 - Red	Ready	High
		8 - Green	Stop	Low
		9 - Black	Start request	Low

BCD Cables

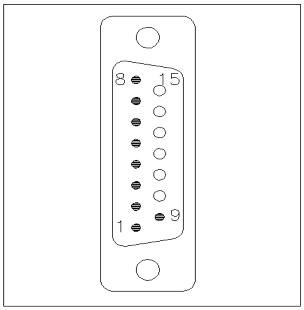


One end of these cables provides a 15-pin BCD connector to be connected to the Agilent modules. The other end depends on the instrument to be connected to

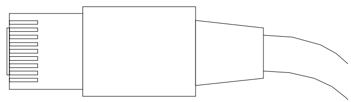
Agilent Module to General Purpose

p/n G1351-81600	Wire Color	Pin Agilent module	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 Module to 3396 Integrators

p/n 03396-60560	Pin 3396	Pin Agilent module	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

CAN/LAN Cables



Both ends of this cable provide a modular plug to be connected to Agilent modules CAN or LAN connectors.

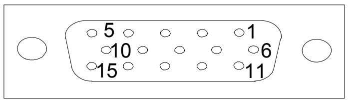
CAN Cables

p/n	Description
5181-1516	CAN cable, Agilent module to module, 0.5 m
5181-1519	CAN cable, Agilent module to module, 1 m

LAN Cables

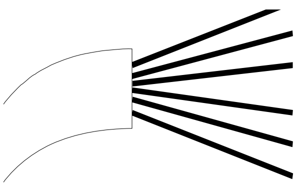
p/n	Description
5023-0203	Cross-over network cable, shielded, 3 m (for point to point connection)
5023-0202	Twisted pair network cable, shielded, 7 m (for point to point connection)

External Contact Cable



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

Agilent Module Interface Board to general purposes

p/n G1103-61611	Color	Pin Agilent module	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

Agilent Module to PC

p/n	Description
G1530-60600	RS-232 cable, 2 m
RS232-61600	RS-232 cable, 2.5 m Instrument to PC, 9-to-9 pin (female). This cable has special pin-out, and is not compatible with connecting printers and plotters. It's also called "Null Modem Cable" with full handshaking where the wiring is made between pins 1-1, 2-3, 3-2, 4-6, 5-5, 6-4, 7-8, 8-7, 9-9.
5181-1561	RS-232 cable, 8 m

Agilent 1200 Module to Printer

p/n	Description
5181-1529	Cable Printer Serial & Parallel, is a SUB-D 9 pin female vs. Centronics connector on the other end (NOT FOR FW UPDATE). For use with G1323 Control Module.

12
Appendix

This chapter provides addition information on safety, legal and web.

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.

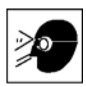
Do not install substitute parts or make any unauthorized modification to the instrument.

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 25 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.

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 Technologies are screened to provide optimized 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

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 modules for download.

Index

www.agilent.com

In This Book

This manual contains technical reference information about the Agilent 1260 Infinity Capillary Pump (G1376A). 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.

Printed in Germany
06/2010

G1376-90014

Agilent Technologies