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Vanquish

Pumps C, Pumps F VC-Pxx, VF-Pxx

Operating Manual

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ThermoFisher
SCIENTIFIC

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Original Operating Manual

The hardware descriptions in this manual revision refer to devices: VC-P10-A-01, VC-P20-A-01, VC-P21-A-01, VC-P32-A-01, VC-P33-A-01, VC-P40-A-01, VF-P10-A-01, VF-P20-A, VF-P32-A-01.

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1 Using this Manual

This chapter provides information about this manual, the conventions used throughout the manual, and the reference documentation that is available in addition to this manual.

1.1 About this Manual

This manual describes the functional features and operating principle of your Vanquish™ device and provides instructions for installation, set up, start up, shut down, operation, maintenance and troubleshooting.

This manual also contains safety messages, precautionary statements, and special notices. Follow these properly to prevent personal injury, damage to the device, or loss of data.

Note the following:

- The device configuration may vary; therefore, not all descriptions necessarily apply to your particular device.
- If some detail applies to only one model or variant, the model or variant is identified by name.
- Illustrations in this manual are provided for basic understanding. They can vary from the actual model of the device or component. However, this does not influence the descriptions. No claims can be derived from the illustrations in this manual.
- The pump is also referred to as *device* in this manual. If some detail applies to only one pump type or model, the type or model is identified by name.

The descriptions in this manual assume that the device is installed in the Vanquish system stack. If this is not the case, additional hardware is required and must be ordered separately. The information in this manual applies correspondingly.

1.2 Conventions

This section describes the conventions that are used throughout this manual.

1.2.1 Conventions for Safety Messages

The safety messages and precautionary statements in this manual appear as follows:

- Safety messages or precautionary statements that apply to the entire manual and all procedures in this manual are grouped in the Safety chapter.
- Safety messages or precautionary statements that apply to an entire section or to multiple procedures in a section appear at the beginning of the section to which they apply.
- Safety messages that apply to only a particular section or procedure appear in the section or procedure to which they apply. They appear different from the main flow of text.

Safety messages are often preceded by an alert symbol and/or alert word. The alert word appears in uppercase letters and in bold type.

Make sure that you understand and follow all safety messages presented in this manual.

1.2.2 Special Notices

Special notices and informational notes in this manual appear different from the main flow of text. They appear in boxes and a note label identifies them. The label text appears in uppercase letters and in bold type.

NOTICE

Highlights information necessary to prevent damage to the device or invalid test results.

TIP Highlights information of general interest or helpful information that can make a task easier or optimize the performance of the device.

1.2.3 Typographical Conventions

These typographical conventions apply to the descriptions in this manual:

Data Input and Output

The following appears in **bold** type:

- Input that you enter by the keyboard or that you select with the mouse
- Buttons that you click on the screen
- Commands that you enter by the keyboard
- Names of, for example, dialog boxes, properties, and parameters

For brevity, long expressions and paths appear in the condensed form, for example: Click **File > Save as**.

References and Messages

- References to additional documentation appear *italicized*.
- Messages that appear on the screen are identified by quotation marks.

Viewpoint

If not otherwise stated, the expressions *left* and *right* in this manual always refer to the viewpoint of a person that is facing the device from the front.

Particularly Important Words

Particularly important words in the main flow of text appear *italicized*.

Electronic Manual Version (PDF)

The electronic version (PDF) of the manual contains numerous links that you can click to go to other locations within the manual. These include:

- Table of contents entries
- Index entries
- Cross-references (in blue text)

1.3 Reference Documentation

In addition to this operating manual, other documentation is available for reference.

Hardware Documentation

Additional hardware documentation includes the following:

- *Operating manuals* for the other modules of the Vanquish system
- *Vanquish System Operating Manual*
- *Instrument Installation Qualification Operating Instructions*

Thermo Fisher Scientific provides up-to-date operating manuals as PDF (Portable Document Format) files that you can access from our customer manuals web site. To open and read the PDF files, Adobe™ Reader™ or Adobe™ Acrobat™ is required.

Go to the following web site: www.thermofisher.com/HPLCmanuals

Software Documentation

Additional software documentation includes the following:

- *Chromeleon™ Help and documents*
The *Chromeleon Help* provides extensive information and comprehensive reference material for all aspects of the software.

In addition, the following documentation is available (availability depends on the software version):

- *Installation Guide*
For basic information about device installation and configuration, refer to the *Installation Guide*.
- *Instrument Configuration Manager Help*
For specific information about a certain device, refer to the *Instrument Configuration Manager Help*. In Chromeleon 7, devices are called modules.
- *Quick Start Guide*
For information about the main elements of the user interface and step-by-step guidance through the most important workflows, refer to the *Quick Start Guide*.
- *Reference Card*
For a concise overview of the most important workflows, refer to the *Reference Card*.

TIP The *Chromeleon Help* and documents are included in the software shipment.

Third-Party Documentation

Refer also to the user documentation provided by the manufacturers of third-party components and materials, for example, Safety Data Sheets (SDSs).

2 Safety

This chapter provides general and specific safety information and informs about the intended use of the device.

2.1 Safety Symbols and Signal Words

2.1.1 Safety Symbols and Signal Words in this Manual

This manual contains safety messages to prevent injury of the persons using the device.

The safety symbols and signal words in this manual include the following:



Always be aware of the safety information. Do not proceed until you have fully understood the information and consider the consequences of what you are doing.



CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.



WARNING

Indicates a hazardous situation that, if not avoided, could result in serious injury.

2.1.2 Observing this Manual

Observe the following:



- Before installing or operating the device, read this manual carefully to be familiar with the device and this manual. The manual contains important information with regard to user safety as well as use and care of the device.
- Always keep the manual near the device for quick reference.
- Save this manual and pass it on to any subsequent user.



Read, understand, and comply with all safety messages and precautionary statements presented in this manual.

2.1.3 Safety Symbols on the Device

The table lists the safety symbols that appear on the device or on labels affixed to the device. Follow the safety notices in this manual to prevent the risk of operator injury or damage to the device.

Symbol	Description
	Indicates a potential hazard. Refer to this manual to avoid the risk of personal injury and/or to prevent damage to the device.
—	Power supply is on
○	Power supply is off
	Indicates alternating current.

2.1.4 Rating Plate

The rating plate is present on the device near the electrical connections. The rating plate indicates the serial number, part number, module name, revision number (if any), and the line and fuse rating.

TIP An additional type label on the leak tray of the device indicates the module name, serial number, part number, and revision number (if any). To facilitate device identification, have the information from this label available when communicating with Thermo Fisher Scientific.

2.2 Intended Use

The device is intended to be part of the Vanquish system.

The intended use of the Vanquish system is to analyze mixtures of compounds in sample solutions.

The device is for use by qualified personnel and in laboratory environment only.

The device and Vanquish system are intended to be used as General Laboratory Equipment (GLE).

They are not intended for use in diagnostic procedures.

Laboratory Practice

Thermo Fisher Scientific recommends that the laboratory in which the Vanquish system is used follow best practices for LC analyses. This includes among others:

- Using appropriate standards
- Regularly running calibration
- Establishing shelf life limits and following them for all consumables used with the system
- Running the system according to the laboratory's verified and validated 'lab developed test' protocol

2.3 Safety Precautions

2.3.1 General Safety Information

All users must observe the general safety information presented in this section and all specific safety messages and precautionary statements elsewhere in this manual during all phases of installation, operation, troubleshooting, maintenance, shutdown, and transport of the device.



If the device is used in a manner not specified by Thermo Fisher Scientific, the protection provided by the device could be impaired. Observe the following:

- Operate the device only within its technical specifications.
- Use only the replacement parts and additional components, options, and peripherals specifically authorized and qualified for the device by Thermo Fisher Scientific.
- Perform only the procedures that are described in this operating manual and in supporting documents for the device. Follow all instructions step by step and use the tools recommended for the procedure.
- Open the enclosure of the device and other components only if specifically instructed to do so in this manual.
- Thermo Fisher Scientific cannot be held liable for any damage, material or otherwise, resulting from inappropriate or improper use of the device. If there is any question regarding appropriate usage, contact Thermo Fisher Scientific before proceeding.

Safety Standard

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

2.3.2 Qualification of the Personnel

Observe the information below on the proper qualification of the personnel installing and/or operating the device.



Installation

Only skilled personnel are permitted to install the device and to establish the electrical connections according to the appropriate regulations.

- Thermo Fisher Scientific recommends always having service personnel certified by Thermo Fisher Scientific perform the installation (for brevity, referred to as Thermo Fisher Scientific service engineer).
- If a person other than a Thermo Fisher Scientific service engineer installs and sets up the module, the installer is responsible for ensuring the safety of the module and system.



General Operation

The device is designed to be operated only by trained and qualified personnel in a laboratory environment.

All users must know the hazards presented by the device and the substances they are using. All users should observe the related Safety Data Sheets (SDSs).

2.3.3 Personal Protective Equipment

Wear personal protective equipment and follow good laboratory practice to protect you from hazardous substances. The appropriate equipment depends on the hazard. For advice on the hazards and the equipment required for the substances you are using, refer to the material handling and safety data sheet provided by the vendor.



An eyewash facility and a sink should be available nearby. If any substance contacts your skin or eyes, wash the affected area and seek medical attention.

Protective Clothing

To protect you from chemical splashes, harmful liquids, or other contamination, put on appropriate protective clothing, such as a lab coat.

Protective Eyewear

To prevent liquids from striking your eyes, put on appropriate protective eyewear, such as safety glasses with side shields. If there is a risk of splashing liquids, put on goggles.

Gloves

To protect you from harmful liquids and avoid personal injury during maintenance or service, put on appropriate protective gloves.

2.3.4 Electrical Safety Precautions



WARNING—Electric Shock or Damage to the Device

High voltages are present inside the device that could cause an electric shock or damage to the device.

- Do not make any changes to the electrical or grounding connections.
- If you suspect any kind of electrical damage, disconnect the power cord and contact Thermo Fisher Scientific Technical Support for assistance.
- Do not open the housing or remove protective panels unless specifically instructed to do so in this manual.
- Do not place liquid reservoirs directly upon the device. Liquid might leak into the device and get into contact with electronic components causing a short circuit. Instead, place liquid reservoirs in the solvent rack that is available for the Vanquish system.

2.3.5 General Residual Hazards

Pay attention to the following general residual hazards when working with the device:



WARNING—Hazardous Substances

Solvents, mobile phases, samples, and reagents might contain toxic, carcinogenic, mutagenic, infectious, or otherwise harmful substances. The handling of these substances can pose health and safety risks.

- Be sure that you know the properties of all substances that you are using. Avoid exposure to harmful substances. If you have any doubt about a substance, handle the substance as if it is potentially harmful.
- Wear personal protective equipment as required by the hazard and follow good laboratory practice.
- Reduce the volume of substances to the minimum volume required for sample analysis.
- Avoid handling of solvent reservoirs above head height.
- Do not operate the device in a potentially flammable environment.
- Avoid accumulation of harmful substances. Make sure that the installation site is well ventilated.
- Dispose of hazardous waste in an environmentally safe manner that is consistent with local regulations. Follow a regulated, approved waste disposal program.



WARNING—Biohazard

Biohazardous material, for example microorganisms, cell cultures, tissues, body fluids, and other biological agents can transmit infectious diseases. To avoid infections with these agents:

- Assume that all biological substances are at least potentially infectious.
- Wear personal protective equipment as required by the hazard and follow good laboratory practice.
- Dispose of biohazardous waste in an environmentally safe manner that is consistent with local regulations. Follow a regulated, approved waste disposal program.

**WARNING—Self-Ignition of Solvents**

Solvents with a self-ignition temperature below 150 °C might ignite when in contact with a hot surface (for example, due to leakage in the chromatography system).

Avoid the use of these solvents.

**WARNING—Hazardous Vapors**

Mobile phases and samples might contain volatile or flammable solvents. The handling of these substances can pose health and safety risks.

- Avoid accumulation of these substances. Make sure that the installation site is well ventilated.
- Avoid open flames and sparks.
- Do not operate the device in the presence of flammable gases or fumes.

**CAUTION—Allergic Reaction**

Some capillaries in the system are made of MP35N™, a nickel/cobalt-based alloy. Individuals with sensitivity to nickel/cobalt may show an allergic reaction from skin contact.

**CAUTION—Sparking due to Electrostatic Discharge**

Liquid flowing through capillaries can generate static electricity. This effect is particularly present with insulating capillaries and non-conductive solvents (for example, pure acetonitrile). Discharge of electrostatic energy might lead to sparking, which could constitute a fire hazard.

Prevent the generation of static electricity near the chromatography system.

2.3.6 In Case of Emergency

**WARNING—Safety Hazard**

In case of emergency, disconnect the device from the power line.

2.4 Solvent and Additive Information

2.4.1 General Compatibility

To protect optimal functionality of the Vanquish system, observe these recommendations on the use of solvents and additives:

- The system must be used with reversed-phase (RP) compatible solvents and additives only.
- Use only solvents and additives that are compatible with all parts in the flow path.
- Anhydrous methanol may lead to stress failures in titanium surfaces, especially when formic acid or TFA is added to the mixture. Thermo Fisher Scientific recommends adding 3% of water to prevent this.

TIP In a Vanquish Core system, normal-phase (NP) compatible solvents and additives may be used if the system modules have been modified for NP applications. Refer to the *Vanquish System Operating Manual*.

2.4.2 Piston Seal Compatibility

The table provides information about the piston seals used in the pumps and their solvent compatibility.

Pump	Piston Seals
VC-pumps except VC-P21 and VC-P33	<p>The pumps are shipped with UHMW-PE piston seals. Using tetrahydrofuran, ketones, or ammonium hydroxide as solvents can damage the seals.</p> <p>In rare cases, a shortened lifetime of reversed-phase (UHMW-PE) piston seals has been observed with high pH, ammonium hydroxide containing mobile phases and prolonged exposure.</p> <p>Under harsh conditions, consider replacing the UHMW-PE piston seals with carbon-fiber filled PTFE piston seals. Consider the following:</p> <ul style="list-style-type: none"> • With the piston seals, also replace the seal wash seals (part no. 6040.0306, containing 2 seals for use as both, piston seal and seal wash seal). • Install new pistons. Exchanging the piston seals but keeping the pistons that were used with the UHMW-PE piston seals may impair the seal life of the PTFE seals. • Note that slightly increased abrasion may be observed with these seals, depending on the application. Consider testing the permeability of the static mixer regularly at short intervals.

Pump	Piston Seals
VC-P21 and VC-P33 pumps	The pumps are shipped with carbon-fiber filled PTFE piston seals. Slightly increased abrasion may be observed with these seals, depending on the application. Consider testing the permeability of the static mixer regularly at short intervals.
VF-pumps	<p>The pumps are shipped with UHMW-PE piston seals. Using tetrahydrofuran, ketones, or ammonium hydroxide as solvents can damage the seals.</p> <p>In rare cases, a shortened lifetime of reversed-phase (UHMW-PE) piston seals has been observed with high pH, ammonium hydroxide containing mobile phases and prolonged exposure.</p> <p>Under harsh conditions, consider replacing the UHMW-PE piston seals with carbon-fiber filled PTFE piston seals. Consider the following:</p> <ul style="list-style-type: none"> • With the piston seals, also replace the seal wash seals (part no. 6040.0306, containing 2 seals for use as both, piston seal and seal wash seal). • Install new pistons. Exchanging the piston seals but keeping the pistons that were used with the UHMW-PE piston seals may impair the seal life of the PTFE seals. • In addition, note the following: <ul style="list-style-type: none"> ◆ Slightly increased abrasion may be observed with the PTFE seals, depending on the application. Consider testing the permeability of the static mixer regularly at short intervals. ◆ The pump should not be operated with pressures higher than 70 MPa. ◆ The pump is no longer biocompatible.

2.4.3 Allowed pH Ranges

Allowed pH ranges (standard system configuration):

System (Standard Configuration)	Allowed pH ranges	Remarks
Vanquish Core	1-13	<ul style="list-style-type: none"> • <i>pH value of 2 (Vanquish Horizon/Flex)</i>: Short-term use only. The application time should be as short as possible. Flush the system thoroughly after these applications. • <i>pH value of 1-2 (Vanquish Core)</i>: The application time should be as short as possible. Flush the system thoroughly after these applications. • <i>pH values higher than 9.5 with optical detectors</i>: Avoid using mobile phases with a pH value higher than 9.5 together with optical detectors. This can impair the functionality and optical performance of the detector flow cell.
Vanquish Horizon	2-12	
Vanquish Flex		

2.4.4 Allowed Concentrations

Allowed concentrations (standard system configuration):

System (Standard Configuration)	Chloride	Buffer	Remarks
Vanquish Core	0.1 mol/L or less	1 mol/L or less	<i>High chloride concentration:</i> The application time should be as short as possible. Flush the system thoroughly after these applications.
Vanquish Horizon Vanquish Flex	1 mol/L or less	-	

2.4.5 Further Information

- For details about the materials that are used in the analytical flow path of the device, see the *Specifications* chapter in this manual. For information about the materials that are used in the flow path of the other modules in the Vanquish system, refer to the *Specifications* chapter in the *Operating Manual* for the modules.
- Observe the general guidelines and recommendations on the use of solvents and additives in the chromatography system (see [Use of Solvents and Additives](#) (▶ page 90)).
- Refer also to the *Operating Manuals* for all modules in the Vanquish system. They may provide additional guidelines and information.

NOTICE

If the system configuration includes a non-standard detector, for example, a charged aerosol detector or refractive index detector, refer to the *Operating Manual* for the detector for specific recommendations regarding solvents and additives.

2.5 Compliance Information

Thermo Fisher Scientific performs complete testing and evaluation of its products to ensure full compliance with applicable domestic and international regulations. When the device is delivered to you, it meets all pertinent electromagnetic compatibility (EMC) and safety standards as described in this manual.

Changes that you make to the device may void compliance with one or more of these EMC and safety standards. Changes to the device include replacing a part or adding components, options, or peripherals not specifically authorized and qualified for the product by Thermo Fisher Scientific. To ensure continued compliance with EMC and safety standards, replacement parts and additional components, options, and peripherals must be ordered from Thermo Fisher Scientific or one of its authorized representatives.

The device has been shipped from the manufacturing site in a safe condition.

See also

 [Compliance Information \(▶ page 282\)](#)

3 Device Overview

This chapter introduces you to the device and the main components.

3.1 Pump Features

The pump comprises the following features:

Main Features

- Serial dual-piston pump with electronic compressibility compensation (SmartFlow™) for precise and virtually pulse-free flow
- Floating piston design for compensation of small mechanical tolerances within the specification and thus enhanced robustness of the pump
- Active piston seal wash system for high lifetime of pistons and piston seals
The piston seal wash system keeps the pistons wet and rinses the piston seals automatically. This prevents crystallization and particle deposits on the piston surfaces and seals, which may damage the components.
- Built-in vacuum degasser for enhanced flow stability and best detector sensitivity (all pumps except isocratic pump)
- Mixing system with capillary mixer and static mixer for smoother baselines
With the isocratic pump, the mixing system serves as inline filter.
- Easy access to the user-serviceable components
- Easy maintenance because the pump remains in the Vanquish system stack

For specifications, see [Performance Specifications](#) (▶ page 252).

Special Pump Features

- *Binary pump*
Solvent selector "2 from 6" for increased flexibility
- *Dual pump*
The dual pump combines two ternary pumps in a single enclosure.

3.2 Operating Principle

General Information

The pump is a serial dual-piston pump with electronic compressibility compensation for precise and virtually pulse-free flow.

The pump head comprises a working cylinder and an equilibration cylinder that are connected in series. Thus, the solvent passes both cylinders successively. To achieve continuous delivery, the working cylinder delivers while the equilibration cylinder is filled simultaneously. The equilibration cylinder serves as the reservoir and delivers while the working cylinder performs the intake stroke.

When delivering compressible liquids without controlled pre-compression, pulsation increases along with the increasing working pressure because part of the delivery stroke is required for compressing the liquid in the working cylinder. Pulsation during the pre-compression phase is reduced to a minimum by velocity modulation of the drive. Highly constant delivery is ensured by a patented secondary control system (automatic compressibility compensation). Independent of the operating pressure, the flow rate of the solvent (after expansion to atmospheric pressure) is always kept constant.

Pump-Specific Information

- Pumps with vacuum degasser
The vacuum degasser enhances the flow stability and allows best detector sensitivity by continuously removing dissolved gasses that may be trapped in the solvents.
- Pumps with mixing system
The mixing system ensures smoother baselines by combining and premixing the solvent streams in the capillary mixer and improving the mixing quality further in the static mixer.
- For pump-specific pictures that illustrate how the pump operates, see [Pump-Specific Information](#) (► page 215).

3.3 Interior Components

The user-accessible components of the pump are located directly behind the front doors.

For pump-specific pictures that provide an overview of the interior components, see [Pump-Specific Information](#) (► page 215).

3.4 Piston Seal Wash System

To keep the pistons wet and rinse the piston seals, the pump has an active piston seal wash system (seal wash system). Piston seal washing prolongs the lifetime of the pistons and seals by preventing crystallization and particle deposits on the piston surfaces and seals, which may otherwise damage the pistons and seals.

The picture shows the flow path through the seal wash system.

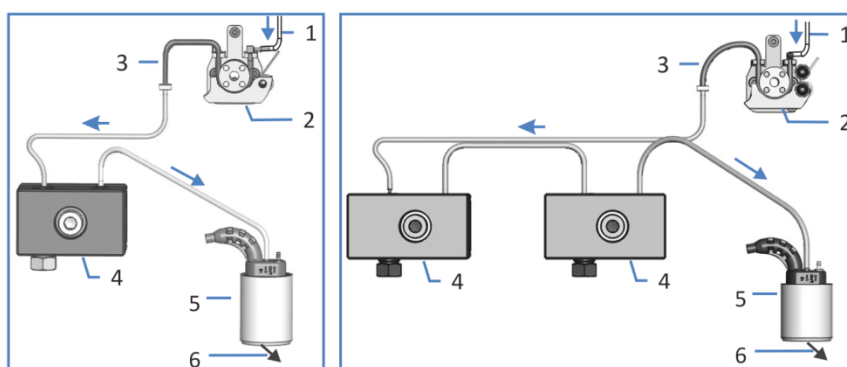


Figure 1: Flow path through the seal wash system (left: isocratic pump, quaternary pump; right: binary pump, dual pump)

No.	Description
1	Seal wash line from autosampler
2	Seal wash pump (peristaltic pump)
3	Peristaltic tubing (PharMed™ tubing)
4	Pump heads
5	Seal wash detector (drop detector)
6	To waste

3.5 Purge/Sensor Unit

The purge/sensor unit comprises the purge valve and the system pressure sensor.

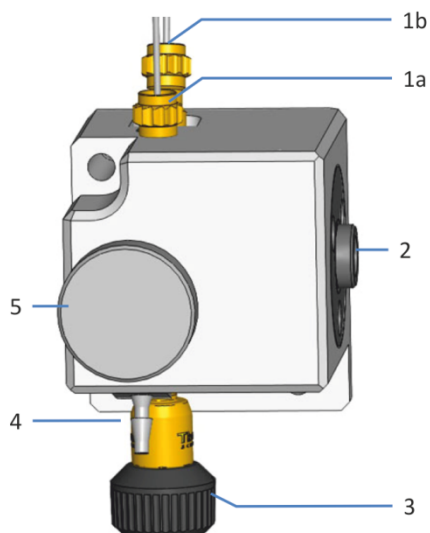


Figure 2: Purge/sensor unit (example, here in binary pump)

No.	Description
1a	<i>Isocratic pump, dual pump, quaternary pump:</i> Capillary from the pump head <i>Binary pump:</i> Capillary from the right pump head
1b	<i>Binary pump only:</i> Capillary from the left pump head
2	System pressure sensor
3	Capillary mixer
4	Purge outlet
5	Purge valve knob

Binary Pump

With the binary pump, the purge/sensor unit also combines the solvent streams from the pump heads.

3.6 Mixing System

The pump is shipped with a mixing system, comprising the following mixers:

- **Capillary mixer**
In the capillary mixer, the solvent streams delivered by the pump are combined and premixed.
- **Static mixer**
The static mixer improves the mixing quality.

Mixing with capillary mixer and static mixer results in smoother baselines.

The pump is shipped with the following mixing system:

Pump	Mixing System
Binary VC-pump Quaternary pump Dual pump	Mixing system, volume 400 µL, comprising: <ul style="list-style-type: none"> • Capillary mixer, volume: 50 µL • Static mixer, volume: 350 µL The dual pump has two mixing systems.
Binary VF-pump Isocratic pump	Mixing system, volume 200 µL, comprising: <ul style="list-style-type: none"> • Capillary mixer, volume: 50 µL • Static mixer, volume: 150 µL With the isocratic pump, the mixing system serves as inline filter.
For pump-specific pictures, see the <i>Interior Components</i> sections in Pump-Specific Information (► page 215).	

TIP Mixing systems with other volumes are available as an option (see [Gradient Delay Volume, Dwell Volume and Ripple](#) (► page 236)).

3.7 Leak Detection

Leaks are a potential safety issue.

The leak sensor inside the device monitors the device for liquid leaks from the flow connections. The liquid is collected in the leak tray and guided to the drain port. From the drain port, the liquid is discharged to waste through the drain system of the Vanquish system.

When the leak sensor detects leakage, the status indicators change to red and beeping starts to alert you. Follow the instructions in this manual to find and eliminate the source for the leakage.

If leakage is not resolved after 3 minutes, the pump stops the flow.

3.8 Operation

The device is designed to be operated from a computer configured with the Chromeleon Chromatography Data System (CDS). The Chromeleon software provides complete instrument control, data acquisition, and data management.

For a basic description of instrument control and automated sample analysis with the Chromeleon software, refer to the *Vanquish System Operating Manual*. Details on control and operation of the device are available in the *Chromeleon Help*.

TIP The device can be operated also with other data systems, such as Thermo Scientific™ Xcalibur™. In this case, installation of additional software is required in addition to the data system software. For details, contact the Thermo Fisher Scientific sales organization.

A keypad is available inside the device, allowing you to perform certain basic functions directly from the device.

4 Unpacking

This chapter provides information for unpacking the device and informs you about the scope of delivery.

4.1 Unpacking

Damaged Packaging, Defective on Arrival

Inspect the shipping container for signs of external damage and, after unpacking, inspect the device for any signs of mechanical damage that might have occurred during shipment.

If you suspect that the device may have been damaged during shipment, immediately notify the incoming carrier and Thermo Fisher Scientific about the damage. Shipping insurance will compensate for the damage only if reported immediately.

Unpacking the Device



CAUTION—Heavy Load, Bulky Device

The device is too heavy or bulky for one person alone to handle safely. To avoid personal injury or damage to the device, observe the following guidelines:

- Physical handling of the device, including lifting or moving, requires a team effort of two persons.
- A team effort is in particular required when lifting the device into the system stack or when removing it.
- Use the carrying handles that were shipped with the device to move or transport the device. Never move or lift the device by the front doors. This will damage the doors or the device.

Tools required

Screwdriver, Torx™ T20

Follow these steps

1. Place the shipping container on the floor and open it.
2. Remove the ship kit from the shipping container.
3. Remove the device from the shipping container: Grasp the device by the carrying handles. Slowly and carefully, lift the device out of the shipping container.

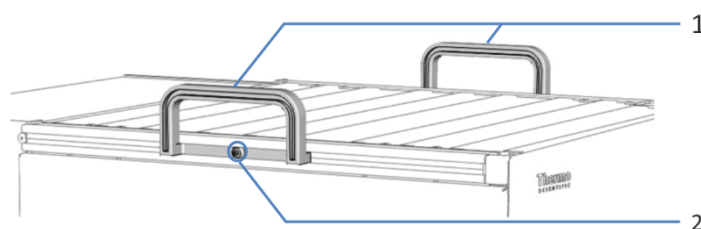


Figure 3: Carrying handles on the device

No.	Component
1	Carrying handles
2	Attachment screw (one on each carrying handle)

4. Place the device on a stable surface.
5. *If applicable:*
Remove any additional packing material. Leave any protective films attached to the surfaces of the device until it is properly positioned in the system stack.
6. Transport the device by the carrying handles to the installation site, if it is not already there, and place it in the system stack (see [System Arrangement](#) (► page 52)).
7. On each carrying handle, loosen the attachment screw until the carrying handle is moveable in the rail. Do not remove the screws from the carrying handles completely.
8. Slide off the carrying handles from the rails towards the rear of the device.

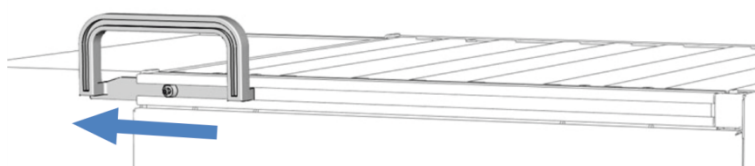


Figure 4: Sliding off the carrying handle from the left rail

TIP Keep the shipping container, the carrying handles with the attachment screws, and all packing material. These items will be needed if the device is transported to a new location or shipped.

9. Some surfaces including the doors of the device are covered by a protective film during shipment. Remove the protective film from all surfaces as applicable.

4.2 Scope of Delivery

The following items are included in the delivery:

- Pump
- Ship Kit
- Operating manual (downloadable from customer manual web site)
- Power cord

For information on contents of the ship kit or reordering parts, see [Accessories, Consumables and Replacement Parts](#) (▶ page 259).

5 Installation

This chapter specifies the requirements for the installation site and describes how to set up, install, and configure the device in the Vanquish system and in the chromatography software.

5.1 Safety Guidelines for Installation

Pay attention to the following safety guidelines:



Observe all warning messages and precautionary statements presented in [Safety Precautions](#) (► page 21).



CAUTION—Heavy Load, Bulky Device

The device is too heavy or bulky for one person alone to handle safely. To avoid personal injury or damage to the device, observe the following guidelines:

- Physical handling of the device, including lifting or moving, requires a team effort of two persons.
- A team effort is in particular required when lifting the device into the system stack or when removing it.
- Use the carrying handles that were shipped with the device to move or transport the device. Never move or lift the device by the front doors. This will damage the doors or the device.



CAUTION—Electric Shock or Damage to the Device

After the power to the device is turned off, the device is still energized as long as the power cord is connected. Repair work on the device while the device is connected to power could lead to personal injury.

- Always unplug the power cord before starting repair work inside the device.
- If you were instructed to remove any housing covers or panels, do not connect the power cord to the device while the cover or panels are removed.

5.2 Installing the Device

A Thermo Fisher Scientific service engineer installs and sets up the Vanquish system, including all modules and options or parts shipped with them. The service engineer checks that the installation is correct and that the Vanquish system and modules operate as specified. The engineer also demonstrates the basic operation and main features.

If personnel other than a Thermo Fisher Scientific service engineer installs the device, follow the steps below.

NOTICE

The device is part of the Vanquish system. Therefore, follow the order for installing the system modules as described in the *Vanquish System Operating Manual*.

1. Pay attention to the safety guidelines and observe all site requirements. See [Safety Guidelines for Installation](#) (▶ page 46) and [Site Requirements](#) (▶ page 49).
2. Set up the device hardware. See [Setting Up the Hardware](#) (▶ page 52).
3. Set up the flow connections. See [Setting Up the Flow Connections](#) (▶ page 55).
4. Turn on the device. See [Turning On the Device](#) (▶ page 79).

TIP

Before turning on the power to a Vanquish system module for the first time, verify that the chromatography software is installed on the data system computer. When the power is turned on, the required USB drivers are automatically found and the Windows™ operating system can detect the device.

5. Set up the device in the software. See [Setting Up the Device in the Software](#) (▶ page 80).

6. *Recommended:*

Perform Instrument Installation Qualification.

In the Chromeleon software, a wizard is available to guide you through the qualification process. On the **Chromeleon 7 Console**: Click **Tools > Instrument Qualification > Installation Qualification**.

Follow the instructions in the *Instruments Installation Qualification Operating Instructions*. The manual provides information about the required materials and detailed instructions.

NOTICE

If the device is operated with another data system, refer to the documentation for the software that you are using and/or perform the qualification manually. The *Instruments Installation Qualification Operating Instructions* provide information about the parameters to be adapted and the required settings.

7. *Recommended:* Perform Operational Qualification.
The qualification kit includes all materials required for the qualification and detailed instructions.

Moving the Device after Installation

If you have to move the device after it has been set up and installed in the Vanquish system, prepare the device for transport and move it to the new location. Follow the instructions in [Transporting or Shipping the Device](#) (▶ page 187).

5.3 Site Requirements

The operating environment is important to ensure optimal performance of the device.

This section provides important requirements for the installation site. Note the following:

- Operate the device only under appropriate laboratory conditions.
- The device is intended to be part of the Vanquish system. Observe the site requirements for the Vanquish system as stated in the *Vanquish System Operating Manual*.
- For specifications, see [Specifications](#) (▶ page 251) and the *Specifications* sections in the *Operating Manuals* for the other modules in the Vanquish system.
- For general residual hazards, see [General Residual Hazards](#) (▶ page 24).

5.3.1 Power Considerations

The power supply of the device has wide-ranging capability, accepting any line voltage in the range specified for the device.



CAUTION—Electric Shock or Damage to the Device

Connecting the device to a line voltage higher or lower than specified could result in personal injury or damage to the device.

Connect the device to the specified line voltage only.

5.3.2 Power Cord

The power cords are designed to match the wall socket requirements of the country in which they are used. The end of the power cords that plugs into the power socket on the device is identical for all power cords. The end of the power cords that plugs into the wall socket is different.

**WARNING—Electric Shock or Damage to the Device**

- Never use a power cord other than the power cords provided by Thermo Fisher Scientific for the device.
- Only use a power cord that is designed for the country in which you use the device.
- Do not use extension cords.
- Never plug the power cord to a power socket that is shared with other equipment (for example, multiple sockets).
- Operate the device only from a power outlet that has a protective ground connection.
- In case of emergency, it must be possible to reach the power cord easily at any time to disconnect the device from the power line.

**WARNING—Electric Shock or Damage to a Product**

Misuse of the power cords could cause personal injury or damage the instrument. Use the power cords provided by Thermo Fisher Scientific only for the purpose for which they are intended. Do not use them for any other purpose, for example, for connecting other instruments.

5.3.3 Condensation

NOTICE—Condensation in the device can damage the electronics.

- When using, shipping, or storing the device, avoid or minimize conditions that can lead to a build-up of condensation in the device. For example, avoid significant or fast changes in environmental conditions.
- If you suspect that condensation is present, allow the device to warm up to room temperature. This may take several hours. Wait until the condensation is gone completely before connecting the device to the power line.

5.4 Accessing the Interior Components

To access the interior components in the device, open the front doors. To allow easy access from the front, the user-accessible components and flow connections in the device are located directly behind the doors.

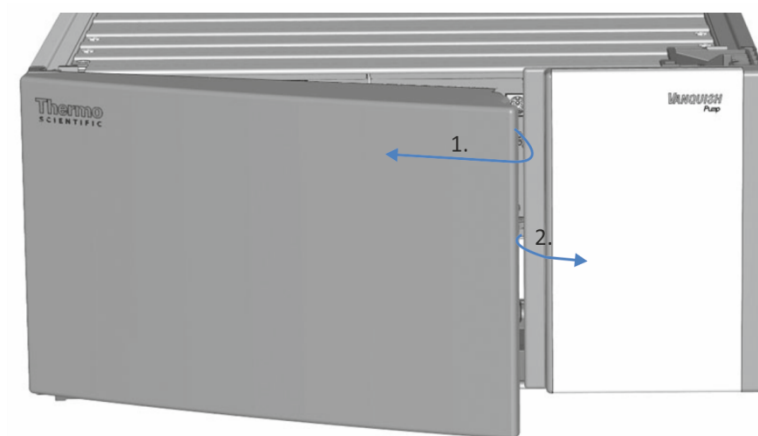


Figure 5: Opening the front doors

5.5 Setting Up the Hardware

This section describes how to set up the hardware and provides information about the device connectors and cables.

5.5.1 System Arrangement

The device is part of the Vanquish system. The system modules are typically arranged in a system stack, with the arrangement depending on the system configuration.

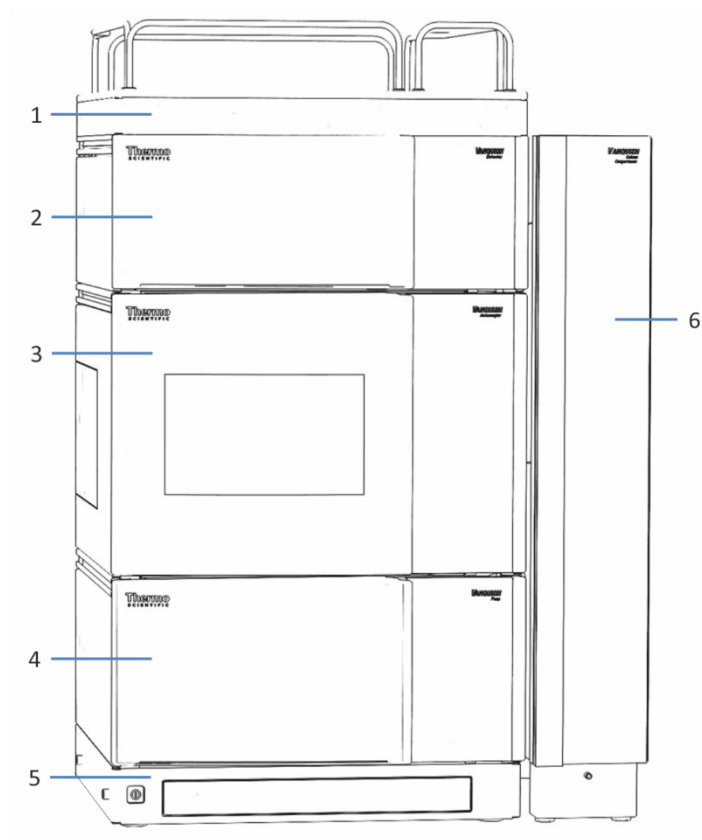


Figure 6: Vanquish system, standard configuration (example)

No.	Description
1	Solvent Rack
2	Detector
3	Autosampler
4	Pump
5	System Base
6	Column Compartment

For instructions on how to set up the system stack, refer to the *Vanquish System Operating Manual*.

5.5.2 Connecting the Device

Device Connectors

The following connectors are provided on the device:

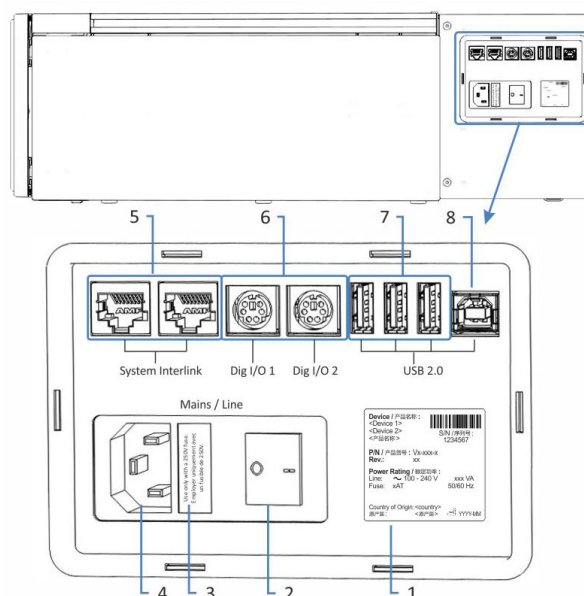


Figure 7: Electrical connectors and device connectors on the pump

No.	Description
1	Rating plate (example), indicating the serial number, part number, module name, revision number (if any), and the line and fuse rating
2	Main power switch (on/off control)
3	Fuse holder
4	Power-inlet connector
5	System Interlink port Allows power on/off control for the device from the Vanquish system base and device communication
6	Digital I/O ports (Dig I/O) Allow exchange of digital signals with external instruments Each digital I/O port provides one input, one relay output, and one bidirectional input/output. For connection and pin assignment information, see Digital I/O (► page 285).
7	USB hub ("A" type connector) Allows connection to other modules in the Vanquish system
8	USB (Universal Serial Bus) port ("B" type connector) Allows connection to other modules in the Vanquish system or the computer on which the data management system is installed, such as the Chromeleon software

TIP Thermo Fisher Scientific recommends using the USB ports only as described above. If the USB ports are used for any other purpose, Thermo Fisher Scientific cannot ensure proper functionality.

Follow these steps

NOTICE

- Never use defective communication cables. If you suspect that a cable is defective, replace the cable.
- To ensure trouble-free operation, use only the cables provided by Thermo Fisher Scientific for connecting the device.

1. Place the device in the system as required by the system configuration. For details, refer to the *Vanquish System Operating Manual*.
2. Connect the required interface cables to the device. For information about how to connect the device to other modules in the Vanquish system or to the chromatography data system computer, refer to the *Vanquish System Operating Manual*.
3. Connect the power cord (see [Connecting the Power Cord](#) (► page 54)).

5.5.3 Connecting the Power Cord

NOTICE

Condensation in a device can damage the electronics.

- Before connecting the devices to the power line, be sure that no condensation is present in the devices.
- If you suspect that condensation is present, allow the device to warm up to room temperature slowly. Wait until the condensation is completely gone before proceeding.

1. Verify that the power switch on the device is set to OFF.
2. Connect the power cord to the power inlet connector on the device.
3. Connect the free end of the power cord to an appropriate power source.

5.6 Setting Up the Flow Connections

This section describes how to set up the flow connections to and from the device and additional flow connections, if required.

5.6.1 General Information and Guidelines

The pump is shipped from the manufacturing site with the flow connections installed between the interior components.

When setting up flow connections, follow these rules and recommendations:



Flow connections can be filled with hazardous substances. Observe the warning messages and precautionary statements presented in [Safety Precautions](#) (▶ page 21).

- Dirty components can contaminate the chromatography system. Contamination leads to poor performance of the modules and entire system or can even cause damage to the modules and system. Therefore:
 - ◆ Always wear appropriate gloves.
 - ◆ Place the components only on a clean, lint-free surface.
 - ◆ Keep your tools clean.
 - ◆ Use only lint-free cloth for cleaning.
- For installation instructions and guidelines and for handling recommendations, see [Connecting Fittings, Capillaries, and Tubing](#) (▶ page 57).

NOTICE

When you install devices or components to the system, always flush them to waste before connecting them in the system flow path. To flush the Vanquish modules, follow the instructions in the *Vanquish System Operating Manual*.

TIP Components or connections in the flow path to other system modules may be closed with plugs to protect the component or connection during transport.

When you remove the plugs to connect the device in the system, keep the plugs. You may need them to close the connections again, for example, for future transport.

Follow these steps

To set up the additional flow connections and complete the installation, follow these steps:

1. Connect the pump to the drain system (see [Guiding Liquids to Waste](#) (▶ page 62)).
2. Connect the solvent lines (see [Connecting the Solvent Lines](#) (▶ page 63)).
3. Set up the seal wash system (see [Seal Wash System](#) (▶ page 69)).
4. Connect the pump to the autosampler (see [Connecting the Pump and Autosampler](#) (▶ page 78)).

5.6.2 Guiding Capillaries and Tubing Through the System

Flow connections between the modules of the Vanquish system are guided through either the tubing chase in the devices or the guide holes or capillary clips of the devices.

Tubing Chase with Tubing Guides

To guide certain tubes and lines from the top module to the bottom module in the Vanquish system stack, the stackable modules have a tubing chase on the inside right. The tubing chase provides four tubing guides.

Each guide can hold up to three tubes or lines. In each module, push the tube (or line) into the appropriate guide.

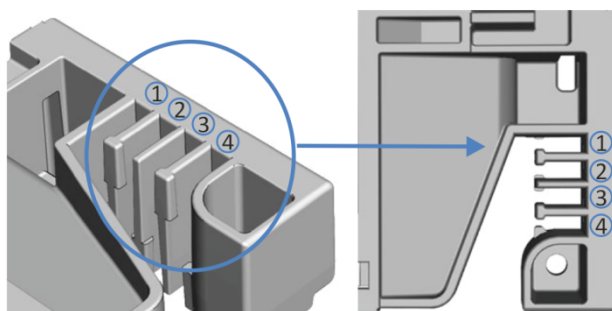


Figure 8: Tubing chase with tubing guides (left: view from inside, right: view from top)

No.	Use for
1	Solvent tubing (up to three solvent lines)
2	Solvent tubing (up to three solvent lines)
3	Wash liquid tubing (seal wash, autosampler needle wash)
4	Detector waste line

Tubing Brackets

Tubing brackets are available for holding the tubing in place. Slip the bracket side onto the drain pipe.

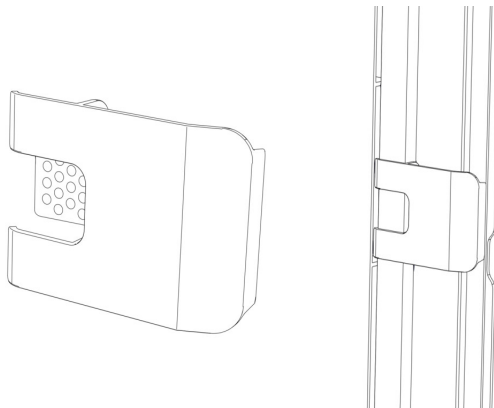


Figure 9: Tubing bracket (left), tubing bracket installed (right)

Dual System Arrangements

The number of tubes may exceed the capacity that the tubing guides can hold. In this case, it is recommended to place the solvent lines in the tubing guides and route any additional tubes freely in the tubing chase.

Guide Holes and Capillary Clips

Guide holes and capillary clips are provided at specific positions on the system modules. Route flow connections from one module to the next module in the Vanquish system through the appropriate guide hole or capillary clip when instructed to do so in the manual.

5.6.3 Connecting Fittings, Capillaries, and Tubing

This section provides information about how to connect and handle capillaries, fittings, and tubing.

5.6.3.1 General Guidelines

When connecting capillaries and tubing, follow these general recommendations:

- Use only the capillaries and tubing (for example, solvent lines or waste tubing) that are shipped with the product or additional or spare capillaries and tubing as recommended by Thermo Fisher Scientific.
- The connectors must be free from contaminants. Even minute particles may cause damage to the system or lead to invalid test results.

- Do not install capillaries or tubes that are stressed, nicked, kinked, or otherwise damaged.
- Install capillaries and fittings only at the positions for which they are intended.
- Follow the connecting instructions as required by the fitting connection:
 - ◆ For Viper connections, see [Connecting Viper Capillaries](#) (▶ page 58).
 - ◆ For capillaries with conventional fitting connections (non-Viper), see [Connecting Non-Viper Capillaries](#) (▶ page 61).

5.6.3.2 Connecting Viper Capillaries

This section describes how to connect Viper™ capillaries. The following Viper fittings are available:

- Viper fitting with torque tothing
- Viper fitting with knurl

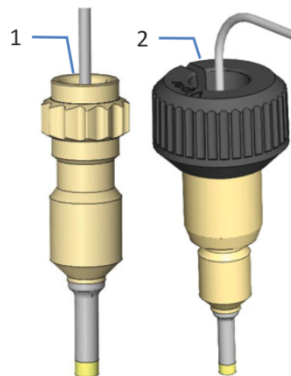


Figure 10: Viper fittings (examples)

No.	Description
1	Viper fitting, torque tothing
2	Viper fitting, knurl

When tightening or loosening a Viper capillary, observe the handling instructions for the respective fitting.

Connecting Viper Fittings with Torque Toothing

To connect Viper fittings with torque toothing, follow these steps:

NOTICE

- Tighten or loosen Viper capillaries *only* with your fingers and the special torque tool. Do not use tools others than those provided by Thermo Fisher Scientific for this purpose. Use the tool only for the connections for which it is intended.
- To avoid damage to the capillary or connection, tighten and loosen the Viper capillaries *only* when the system pressure is down to zero.
- Mind the correct orientation of the tool when tightening or loosening connections (see pictures).

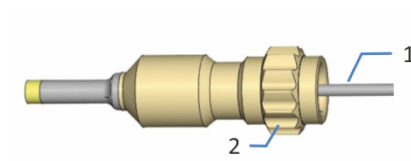


Figure 11: Viper fitting with torque toothing

No.	Description
1	Capillary
2	Torque toothing

1. Insert the Viper capillary into the connection port.
2. Tighten the connection with your fingers.
3. Use the installation tool to tighten the connection further.



Figure 12: Tool on torque toothing for tightening connections

4. Tighten the connection until the torque limitation has been reached, which is indicated by a clicking sound.
5. Check whether the connection leaks. If leakage exists, follow the steps further down.

Resolving Leakage with Viper Fittings with Torque Toothing

1. Remove the capillary.
2. Clean the capillary ends carefully by using a lint-free tissue wetted with isopropanol.
3. Reinstall the capillary.
4. If the connection continues to leak, install a new Viper capillary.

To loosen a connection, use this side of the installation tool.

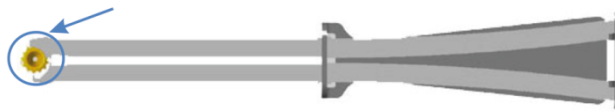


Figure 13: Tool on torque toothing for loosening connections

Connecting Viper Fittings with Knurls

To connect Viper capillaries with knurls, follow these steps:

NOTICE

- Tighten or loosen Viper capillaries *only* with your fingers. Do not use tools other than the knurl that comes with the capillary.
- To avoid damage to the capillary or connection, tighten and loosen the Viper capillaries *only* when the system pressure is down to zero.

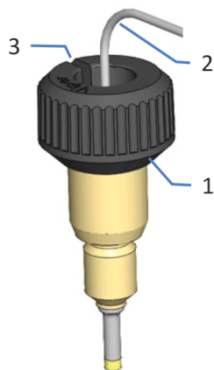


Figure 14: Viper fitting with knurl

No.	Description
1	Knurl
2	Capillary
3	Slot

1. Insert the Viper capillary into the connection port.
2. Tighten the connection by the knurl.

TIP Note the slot in the knurl. You can easily remove the knurl from the capillaries through this slot if space is limited.

3. Check whether the connection leaks. If leakage exists, follow the steps further down.

Resolving Leakage of Viper Fittings with Knurls

1. Tighten the connection a little more.
2. If leakage continues, remove the capillary.
3. Clean the capillary ends carefully by using a lint-free tissue wetted with isopropanol.
4. Reinstall the capillary.
5. If the connection continues to leak, install a new Viper capillary.

5.6.3.3 *Connecting Non-Viper Capillaries*

To connect capillaries with conventional fitting connections (using ferrules) (non-Viper), follow these steps:

1. Insert the capillary into the connection port.
2. Tighten the connection with a wrench (wrench size: 1/4").

NOTICE

Overtightening may damage the connection (both, the ferrule and the connection port). With a torque wrench, the torque should not exceed 3 Nm (for steel capillaries).

3. Check whether the connection leaks. If leakage exists, follow the steps further down.

Resolving Leakage with Conventional Fitting Connections

1. Remove the capillary.
2. Clean the connection port with a cleaning swab.
3. Reinstall the capillary.
4. If the connection continues to leak, install a new capillary.

NOTICE

To avoid increased dead volume, leakage, or damage to the system, reuse fittings and ferrules only for the same capillary connection.

5.6.4 Guiding Liquids to Waste

The following liquids collect in the leak tray and flow off through the drain port at the bottom right of the leak tray into the drain system of the Vanquish system:

- Leaking liquid from the leak tray
- Waste liquid from the purge unit: When purging the pump, attach silicone tubing to the purge outlet on the purge/sensor unit and guide the free end of the tubing to the drain port outlet.

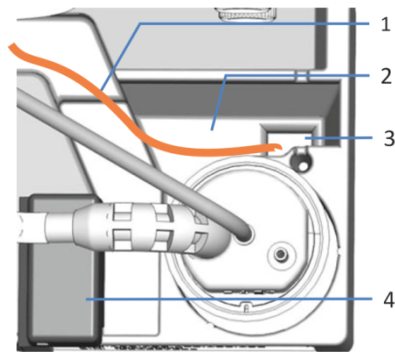


Figure 15: Drain port (view from top)

No.	Description
1	Waste line from purge unit: routing path to drain port outlet (example)
2	Drain port
3	Drain port outlet (to Vanquish drain system)
4	Leak sensor

For information about how the liquid is discharged to waste through the Vanquish drain system, refer to the *Vanquish System Operating Manual*.

5.6.5 Connecting the Solvent Lines

The pump is shipped from the manufacturing site with the solvent lines installed between the components in the pump. To complete the setup, install the solvent lines between the pump inlet ports and the solvent reservoirs.

The flow path determines the pump inlet (component at which the solvent enters the pump) and the solvent flow through the pump.

Pump Type	Pump Inlet
Binary pump	The pump inlets are the solvent selectors.
Isocratic pump	The pump inlet is the pump head.
Quaternary pump, dual pump	The pump inlet is the vacuum degasser.

For the pump-specific operating principles that illustrate the solvent flow through the pump, see [Pump-Specific Information](#) (▶ page 215).

Parts and tools required

- Solvent reservoir assemblies, including reservoir, reservoir cap, cap plugs, and retaining guide for the solvent line
- Solvent lines
- Solvent line filters

Optional to shut off the solvent flow through the system at the solvent reservoir

- Shut-off valve, kit containing one shut-off valve and fitting connections
- Tubing cutter

Preparations

1. Assemble the solvent line filter.
2. Rinse the solvent reservoirs thoroughly. Use a high-purity solvent for rinsing.
3. On the pump inlet, remove the plug that protects the inlet during shipment, if applicable.
4. For easier access to the lower degas chambers, remove the seal wash detector assembly (funnel and detector).

Assembling the Solvent Line Filter

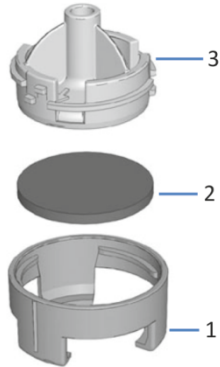


Figure 16: Solvent line filter

No.	Description
1	Solvent line filter, filter holder bottom part
2	Filter frit
3	Solvent line filter, filter holder top part

1. Assemble the solvent line filter, wearing appropriate clean gloves:
 - a) Place the frit in a level position in the filter holder (bottom part).
 - b) Screw the filter top to the filter bottom.

Removing the Seal Wash Detector Assembly

Grasp and pull the seal wash detector assembly (funnel and detector) upward by the funnel. The detector including the tubing and cable can remain connected to the funnel.

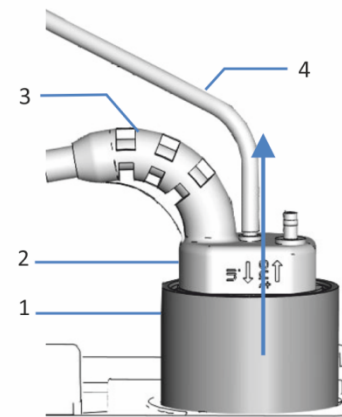


Figure 17: Removing the seal wash detector assembly

No.	Description
1	Funnel, seal wash detector
2	Seal wash detector
3	Detector cable
4	Seal wash line

Connecting the Solvent Lines

Connecting the solvent lines comprises the following steps:

1. Routing the solvent lines to the solvent rack
2. Connecting the solvent lines to the solvent reservoirs
3. *Optional:* Installing shut-off valves in the solvent lines

TIP To avoid the formation of air bubbles in liquid lines, always place reservoirs in the solvent rack on top of the system stack.

Routing the Solvent Lines to the Solvent Rack

1. Connect each solvent line to the pump inlet port for which it is intended (see the labeling on the solvent lines and in the pump).
2. Route the solvent lines from the pump to the solvent rack, through the tubing guides in the pump and all modules above the pump in the system stack. Observe the routing guidelines in [Guiding Capillaries and Tubing Through the System](#) (► page 56).
3. Route the solvent lines through the guide hole in the solvent rack and fix them in the appropriate tubing guides.

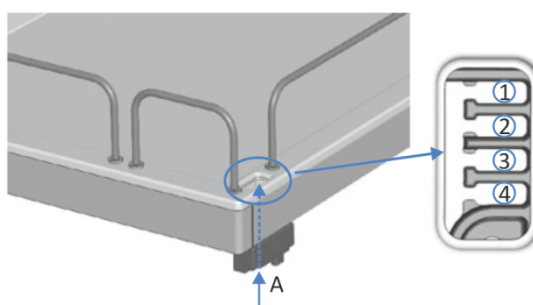


Figure 18: Guide hole and tubing guides in the solvent rack

No.	Description
A	Guide hole (solvent rack)
1	Solvent lines (up to three solvent lines)
2	Solvent lines (up to three solvent lines)
3+4	Not to be used for solvent lines; reserved for other tubing

Connecting the Solvent Line to the Solvent Reservoir

Observe the guidelines and recommendations in [Use of Solvents and Additives](#) (▶ page 90).

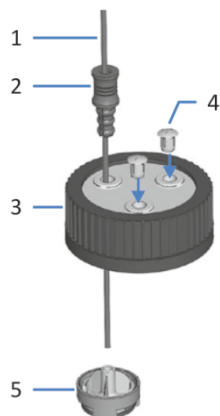


Figure 19: Preparing the solvent line and reservoir cap

No.	Description
1	Solvent line
2	Retaining guide
3	Reservoir cap
4	Cap plugs
5	Solvent line filter

1. Feed each solvent line through a retaining guide.
2. Feed the solvent line through an open hole in a cap for a solvent reservoir. The retaining guide keeps the solvent line in place in the reservoir.
3. Close any open holes in the reservoir caps with the cap plugs.
4. Slide a solvent line filter holder onto each solvent line.
5. Fill the solvent reservoirs with solvent.
6. Tighten the reservoir cap hand-tight. Press the retaining guide into the hole in the reservoir cap so that the tubing is kept in place in the cap.
7. Place the solvent reservoirs in the solvent rack.
8. Position the solvent lines straight in the tubing guides.
9. *Optional:* Install shut-off valves in the solvent lines (see [Installing Solvent Shut-Off Valves](#) (▶ page 67)).
10. Check the solvent lines across the entire flow path. Make sure that the lines are not bent, pinched, or squeezed at any point in the flow path.
11. Reinstall the seal wash detector assembly.

5.6.6 Installing Solvent Shut-Off Valves

These steps apply only when installing a shut-off valve *during* initial setup of the pump. To install a shut-off valve *after* initial operation of the pump, follow the steps in [Installing Solvent Shut-Off Valves](#) (▶ page 107).

When

To shut off the solvent flow through the system at the solvent reservoir, for example, to prevent solvent from flowing through the system when you open a flow connection on the low-pressure side

Parts and additional items required

- Shut-off valve, kit containing one shut-off valve and fitting connections
- Tubing cutter

Preparations

Prepare the pump and follow the steps in [Connecting the Solvent Lines](#) (▶ page 63).

Follow these steps

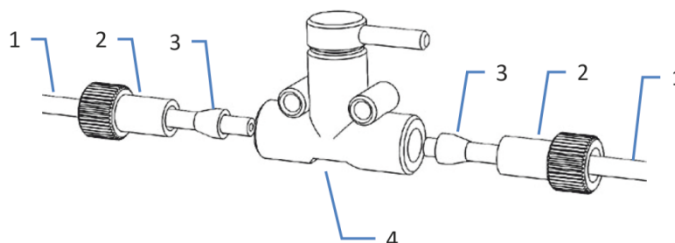


Figure 20: Installing a shut-off valve in the solvent line

No.	Description
1	Solvent line
2	Fitting
3	Ferrule
4	Shut-off valve

1. Cut the solvent line about 10 cm from the reservoir cap with a tubing cutter. Make sure that the cut is at a right angle to the length of the line.
2. Onto the free end of each solvent line, slide a fitting and a ferrule. Mind the correct orientation of the fitting and ferrule (see picture).

3. Tighten the solvent lines to the shut-off valve.

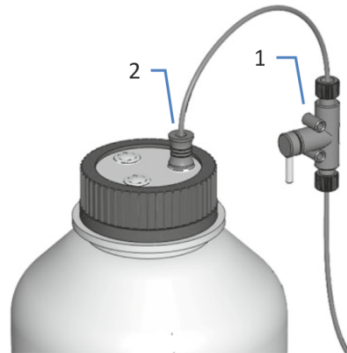


Figure 21: Solvent line with shut-off valve installed

No.	Description
1	Shut-off valve
2	Retaining guide

4. Check the solvent lines across the entire flow path. Make sure that the lines are not bent, pinched, or squeezed at any point in the flow path.

5.7 Seal Wash System

The flow path of the seal wash system passes through the metering device head in the autosampler and the pump heads in the pump. The seal wash system comprises the following parts:

- In the pump: Seal wash pump (peristaltic pump), seal wash lines, and seal wash detector (drop detector)
- In the autosampler: Seal wash lines
- Reservoir for the seal wash liquid

Both, the autosampler and pump are shipped with the seal wash components installed and the lines connected within each of the two modules.

To complete the setup, interconnect the seal wash paths of the modules, connect and fill the seal wash reservoir, and flush the seal wash system (see [Setting Up the Seal Wash System](#) (► page 70)).

5.7.1 Choosing the Seal Wash Liquid

Use seal wash liquid that fulfills the following requirements:

- The seal wash liquid is miscible with the solvent that is used in the pump.
- The seal wash liquid is compatible with the seal wash tubing.
- The seal wash liquid provides certain conductivity for reliable performance of the seal wash detector.
 - ◆ HPLC-grade water with 10% methanol is an appropriate choice.
 - ◆ With a Vanquish Core system that has been modified for NP applications, the appropriate liquid depends on the application:
 - NP application:*
Use ammonium formate in isopropanol (2 mmol/L).
 - RP application:*
Use HPLC-grade water with 10% methanol.

5.7.2 Setting Up the Seal Wash System

Parts and tools required

- Seal wash reservoir assembly, including reservoir, reservoir cap, cap plugs, and retaining guide for the seal wash line
- Seal wash line (silicone tubing) for connection to the seal wash pump; the line is pre-installed to the seal wash outlet of the metering device head
- Seal wash line (silicone tubing) for connection to the seal wash reservoir

TIP To avoid the formation of air bubbles in liquid lines, always place reservoirs in the solvent rack on top of the system stack.

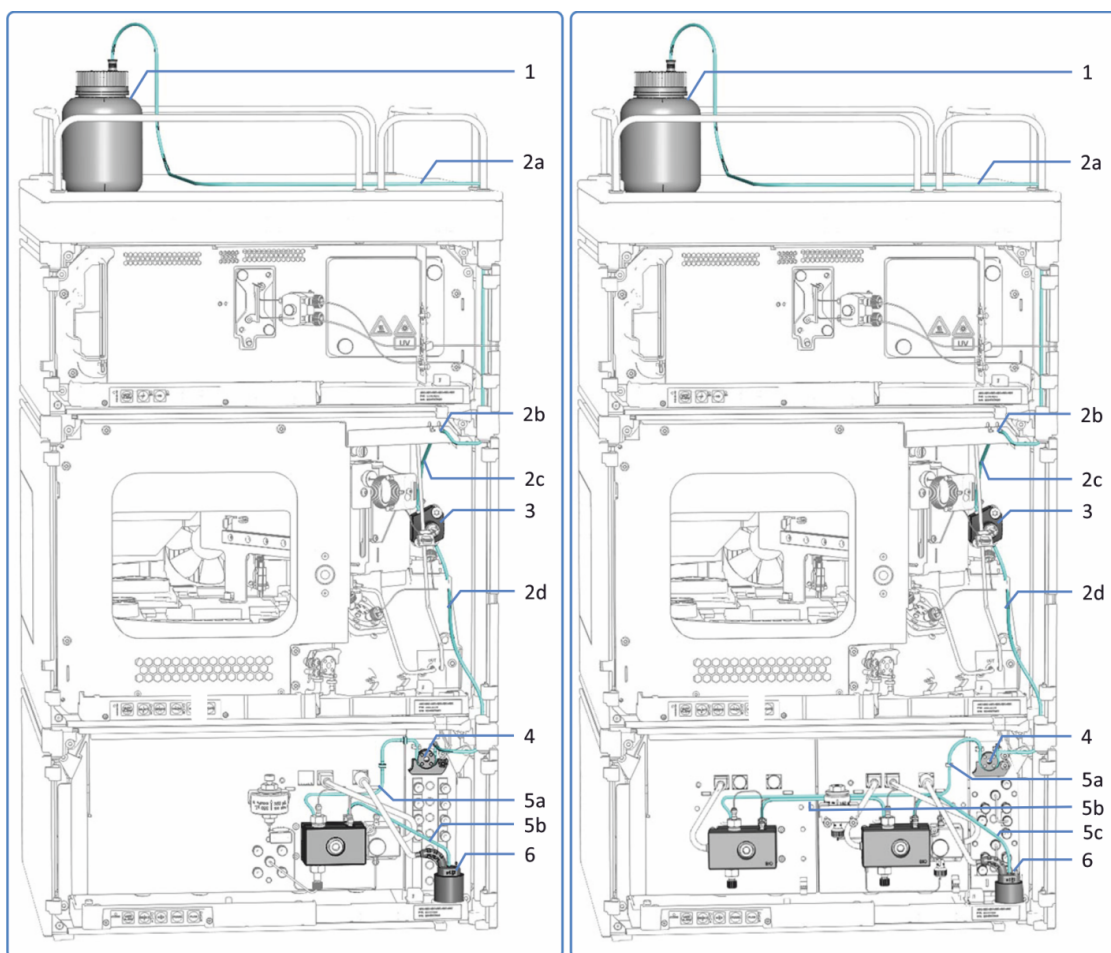


Figure 22: Seal wash system in the Vanquish system (examples with a single split sampler, left: with quaternary pump, right: with binary pump, as example for two-head pump)

No.	Description
1	Seal wash reservoir
2	Seal wash lines in the autosampler (thick tubing), with
2a	Wash line from reservoir to inlet port
2b	Seal wash inlet port (right tubing connector)
2c	Wash line from inlet port to metering device head
2d	Wash line to seal wash pump
3	Metering device head
4	Seal wash pump (peristaltic pump)
5	Seal wash lines in the pump (thin tubing), with:
5a	Wash lines from seal wash pump to pump head (<i>binary pump, dual pump</i> : to left pump head)
5b	<i>Isocratic pump, quaternary pump</i> : Wash line from pump head to seal wash detector <i>Binary pump, dual pump</i> : Wash line from left pump head to right pump head
5c	<i>Binary pump, dual pump</i> : Wash line from right pump head to seal wash detector
6	Seal wash detector (drop detector)

Preparations

Rinse the seal wash reservoir thoroughly. Use a high-purity solvent for rinsing.

Follow these steps

Setting up the seal wash system comprises the following steps:

1. Engaging the peristaltic tubing
2. Connecting the seal wash line between autosampler and pump
3. Routing the seal wash line to the solvent rack
4. Connecting the seal wash line to the seal wash reservoir
5. Flushing the seal wash system

Follow the steps in the respective sections.

Engaging the Peristaltic Tubing

In the pump, engage the peristaltic tubing (PharMed™ tubing) in the seal wash pump:

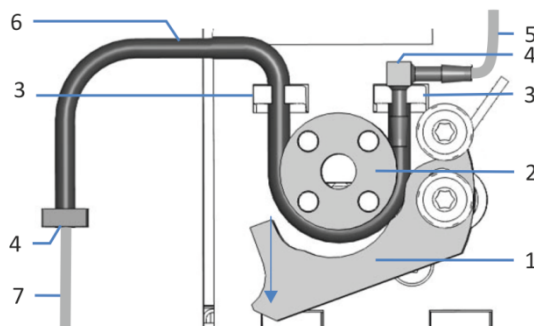


Figure 23: Seal wash pump

No.	Description
1	Pump lever
2	Pump rotor
3	Tubing holder (peristaltic tubing)
4	Tubing connector
5	Seal wash line from autosampler (silicone tubing)
6	Peristaltic tubing
7	Seal wash tubing to pump head (silicone tubing)

1. Press down the lever on the seal wash pump and hold it in that position with one hand.
2. With your other hand, insert the tubing between the lever and the rotor and wind it around the rotor.
3. Release the lever.
4. Check that the peristaltic tubing is inserted properly in the tubing holders. If it is not, push the tubing into the holders. Make sure that the tubing is not pinched or squeezed in the holders.
5. Check that the right tubing connector rests on the tubing holder. If it does not, push the tubing connector onto the holder.

Connecting the Seal Wash Line between Autosampler and Pump

1. In the autosampler, locate the seal wash line (clear silicone tubing) to the pump:
 - ◆ *Single split sampler:* The seal wash inlet port is located on the top enclosure frame (right tubing connector). The seal wash line to the pump is interconnected to the seal wash inlet port.
 - ◆ *Dual split sampler:* The seal wash inlet port is located on the right enclosure frame (top tubing connector). The seal wash line to the pump interconnects seal wash inlet and outlet port.
2. Disconnect the seal wash line from the seal wash inlet port.
3. Route the seal wash line from the seal wash outlet in the autosampler through the tubing guides to the peristaltic tubing in the pump.
 - ◆ *Single split sampler:* The seal wash outlet is located on the bottom end of the metering device.
 - ◆ *Dual split sampler:* The seal wash outlet is located on the right enclosure frame (bottom tubing connector).

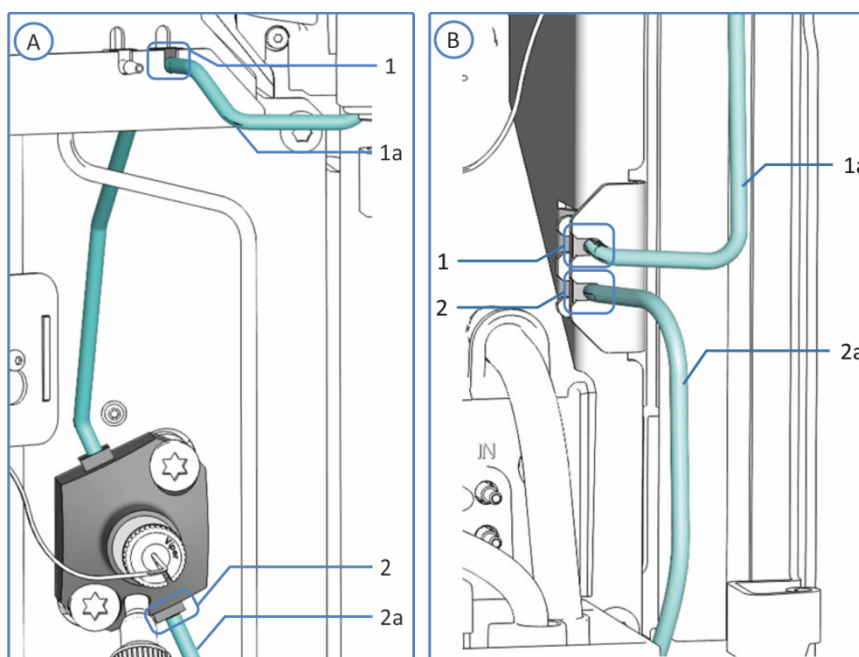


Figure 24: Seal wash connections

No.	Description
A	<i>Single split sampler:</i> Seal wash connections on the top enclosure frame
B	<i>Dual split sampler:</i> Seal wash connections on the right enclosure frame
1	Seal wash inlet port
1a	Seal wash line to reservoir

No.	Description
2	Seal wash outlet
2a	Seal wash line to pump

- In the pump, connect the seal wash line to the tubing connector on the free end of the peristaltic tubing.

Routing the Seal Wash Line to the Solvent Rack

- Locate the seal wash line for connection from the autosampler to the seal wash reservoir.
- Connect the seal wash line on the autosampler:
 - ◆ *Single split sampler:* Connect the line to the seal wash inlet port on the top enclosure frame (right tubing connector).
 - ◆ *Dual split sampler:* Connect the line to the seal wash inlet port on the right enclosure frame (top tubing connector).
- Route the seal wash line from the autosampler to the solvent rack through the tubing guides in the autosampler and all modules above the autosampler in the system stack.
- Route the seal wash line through the guide hole in the solvent rack and fix it in the appropriate tubing guide.

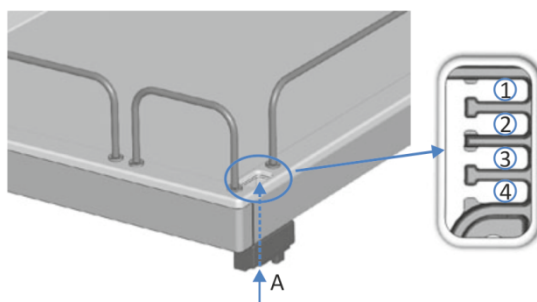


Figure 25: Guide hole and tubing guides in the solvent rack

No.	Description
A	Guide hole (solvent rack)
1+2	Not to be used for seal wash line; reserved for other tubing
3	Tubing guide for seal wash line
4	Not to be used for seal wash line; reserved for other tubing

Connecting the Seal Wash Line to the Seal Wash Reservoir

Mind the requirements outlined in [Choosing the Seal Wash Liquid](#) (▶ page 69).

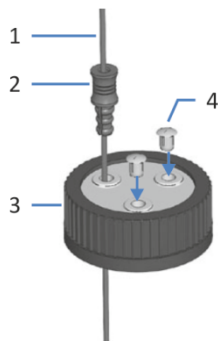


Figure 26: Wash line and reservoir cap

No.	Description
1	Wash line
2	Retaining guide
3	Reservoir cap
4	Cap plugs

1. Feed the wash line through the retaining guide.
2. Feed the wash line through an open hole in the cap of the wash reservoir. The retaining guide keeps the tubing in place in the reservoir.
3. Close any open holes in the reservoir cap with cap plugs.
4. Fill the wash reservoir with wash liquid.
5. Tighten the reservoir cap hand-tight. Press the retaining guide into the hole in the reservoir cap so that the tubing is kept in place in the cap.
6. Place the wash reservoir in the solvent rack.
7. Position the wash lines straight in the tubing guides.
8. Check the wash lines over the entire flow path:
 - a) Make sure that no bending (kink), pinching or squeezing of the wash lines is present at any point in the flow path.
 - b) If you have to cut tubing to length, use a tubing cutter. Make sure that the cut is at right angle to the length of the line.

Flushing the Seal Wash System

To flush the seal wash system, follow the procedure in [Flushing the Seal Wash System](#) (▶ page 76).

5.7.3 Flushing the Seal Wash System

To flush the seal wash system, select one of the following alternatives:

- Turn on the pump.
Whenever the pump is turned on, the pump starts operation with a seal wash cycle.
- Flush the seal wash system from the Chromeleon software.
- Flush the seal wash system from hand.
Select this alternative to flush the seal wash system when the pump is powered off.

Flushing the Seal Wash System from the Chromeleon software

To flush the seal wash system from the Chromeleon software, start a seal wash cycle by setting the seal wash pump to **Active** mode (**SealWashPump = Active**).

During the seal wash cycle, the seal wash system is automatically filled with the seal wash liquid. It will take 5 minutes for the liquid to travel through the entire flow path.

Flushing the Seal Wash System from Hand

To flush the seal wash system from hand, follow these steps:

1. Disconnect the tubing from the seal wash detector.

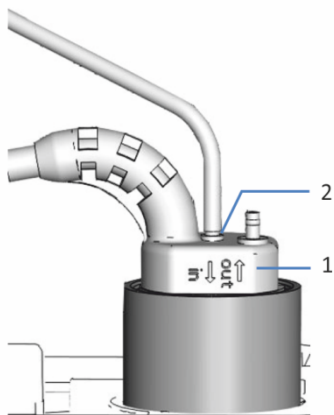


Figure 27: Seal wash detector

No.	Description
1	Seal wash detector
2	Tubing connection port (port labeled in)

2. Insert a syringe into the open end of the tubing.
3. To allow the liquid to travel easily through the seal wash system, press down the lever of the seal wash pump and hold it in that position with one hand.
4. Pull out the syringe plunger to draw seal wash liquid into the tubing.
5. Release the lever of the seal wash pump when the liquid reaches the syringe.
6. Remove the syringe and reconnect the tubing to the connection port on the seal wash detector.
Mind the port labeling. To ensure correct functioning of the seal wash detector, the tubing needs to be connected to the port labeled **in**.

5.8 Connecting the Pump and Autosampler

Parts required

Capillary to connect the pump to the autosampler, as required for the flow path

Follow these steps

1. On the connecting capillary, remove the knurls.
2. Guide the connecting capillary through the guide holes in the housings of both, the pump and autosampler.

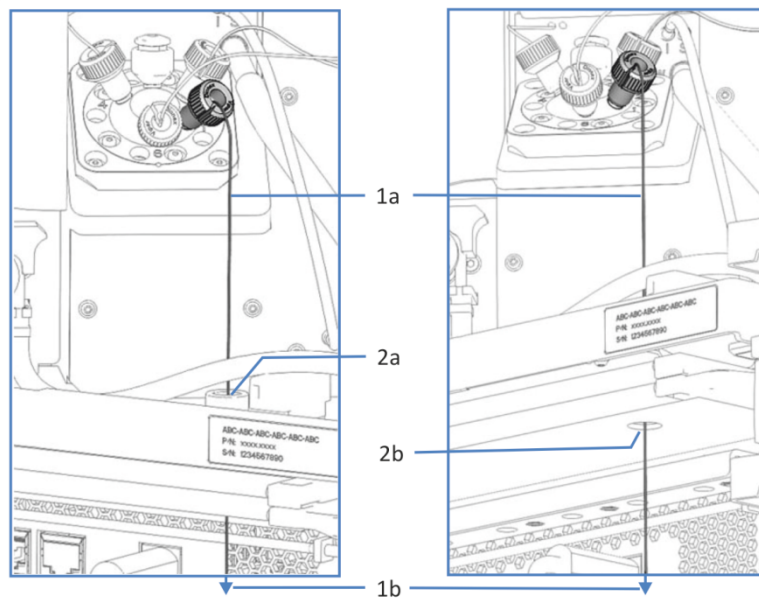


Figure 28: Guide holes in the autosampler and pump (left: view from VF-/VH-autosampler (example); right: view from pump)

No.	Description
1	Capillary connecting the pump and autosampler:
1a	Capillary end connected to the autosampler injection valve
1b	Capillary end to be connected to pump outlet
2	Guide holes in autosampler housing and pump housing:
2a	Guide hole in autosampler housing (view from above)
2b	Guide hole in pump housing (view from below)

3. Reattach the knurls to the connection capillary.
4. In the pump, connect the capillary to the pump outlet.
5. In the autosampler, connect the capillary to the injection valve.

5.9 Turning On the Device

TIP

Before turning on the power to a Vanquish system module for the first time, verify that the chromatography software is installed on the data system computer. When the power is turned on, the required USB drivers are automatically found and the Windows™ operating system can detect the device.

To turn on the power to the device, follow these steps:

1. Check that the power button on the front left of the Vanquish system base (system power button) is pressed in. If the power button stands out, press the power button to turn on the power on the system base.
2. Turn on the device with its main power switch.

Turn off the device with the main power switch, when instructed to do so, for example, during maintenance. Pressing the system power button will not be sufficient to turn off the power to the device completely.

When Powering Up the Pump

Whenever the power to the pump is turned on, the following sequence of events occurs:

- The pump performs a self-test.
If the self-test is not successful, the status indicators are red, and the pump is not ready for analysis. Check the Instrument Audit Trail for the related message and take appropriate remedial action.
- The pump starts operation with a seal wash cycle. Before turning on the pump, check the liquid level in the seal wash reservoir. Consider checking also the liquid level in the waste container.

See also

 [Power On/Off Control \(▶ page 89\)](#)

5.10 Setting Up the Device in the Software

This manual assumes that the chromatography software is already installed on the data system computer and a valid license is available.

For more information about setting up the Vanquish system in the software, refer to the *Vanquish System Operating Manual*.

The Help for the software that you are using provides detailed information about the settings on each property page.

6 Operation

This chapter describes the elements for device control, provides information for routine operation and for shutdown.

6.1 Introduction to this Chapter

The information in this chapter assumes that the initial setup of the device has already been completed. If this is not the case, see the instructions in [Installation](#) (▶ page 45).

For a basic description of instrument control and automated sample analysis with the Chromeleon software, refer to the *Vanquish System Operating Manual*. Details on control and operation of the device are available in the *Chromeleon Help*.

Software descriptions in this manual refer to Chromeleon 7. Terminology may be different to that of other software versions.

6.2 Safety Guidelines for Operation

When operating the device, pay attention to the following safety guidelines:



Observe all warning messages and precautionary statements presented in [Safety Precautions](#) (▶ page 21).



CAUTION—High Luminosity of LED

The high luminosity produced by the LED illuminating the inside of the device can be harmful to the eyes.

- Do not look directly into the light produced by the LED.
- Do not use light-focusing instruments for viewing the light beam.

NOTICE

Pay attention also to the following guidelines:

- To prevent damage resulting from leakage or from running the pump dry, always set the lower pressure limit for the pump.
- If there is evidence of leakage in the device, turn off the pump flow and remedy the situation immediately.
- If the pump flow is interrupted, act appropriately to protect the components in the detector. For details, refer to the *Operating Manual* for the detector.
- Always verify that the autosampler is turned on before the pump flow is on and pressure builds up. If the autosampler is turned off, for example, after a power failure, stop the pump flow and wait until the pressure is down to zero before turning on the autosampler or other modules again.

6.3 Control Elements

The device is designed to be operated mainly from a computer running with the chromatography software.

In addition, the following elements are available on the device:

- **Keypad**
The keypad buttons allow you to perform certain functions directly from the device.
- **Status indicators**
The LEDs (Light Emitting Diodes) on the status indicator LED bar on the front side of the device and the **STATUS** LED on the keypad provide a quick visual check of the operational status of the device.

Pump Block Status LED

The status indicator LED is located inside the pump above the pump head (pump block LED). The LED indicates the operational status of the pump block.

6.3.1 Keypad

The keypad inside the device allows you to perform certain functions directly from the device. When you press a button, a short beep confirms that the function is performed.

When the device is connected in the Chromeleon software, some functions may not be available from the keypad (see further down in this section).

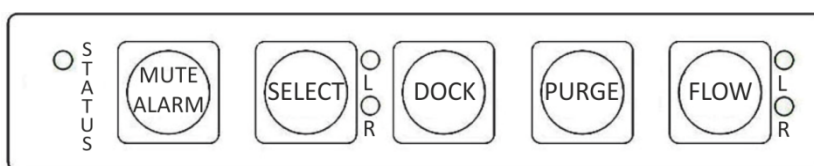


Figure 29: Keypad

STATUS

The **STATUS** LED provides a quick visual check of the operational status of the device.

When the doors are closed, the LED bar on the front side indicates the operational status.

For status details, see [Status Indicators](#) (► page 86).

MUTE ALARM

Beeping alerts you when the device detects a problem, for example, leakage. To turn off the beep for the current alarm, press this button. Eliminate the source for the alarm within 10 minutes. Otherwise, beeping starts again. If the device detects a different problem, beeping alerts you again immediately.

SELECT

Binary pump and dual pump

Pressing the button selects the pump head for you which you can perform a **DOCK** or **PURGE** function from the keypad. The LEDs next to the button indicate the selection:

LED	Description
LED L = green	Left pump head selected
LED R = green	Right pump head selected

Before performing a **DOCK** or **PURGE** function from the keypad, select the pump head for which you want to perform the action.

Isocratic pump and quaternary pump

The button is disabled.

DOCK

Pressing the button moves the pistons of the selected pump head to the appropriate position for maintenance procedures, such as pump head or piston replacement, and undocks the pistons.

When undocking is complete, the LED next to the **FLOW** button starts flashing green for the selected pump head. The LED continues flashing while no pistons are docked. Pressing the button again docks the pistons. Docking is complete when the LED stops flashing green.

Note the following:

- To avoid damage to the pump, remove or install the pump heads only while the pistons are undocked (LED is flashing).
- *Before* you press the button to undock the pistons, open the purge valve by turning the valve knob counterclockwise.
- When docking is complete, close the purge valve.

PURGE

Pressing the button starts a purge cycle. Pressing the button while a purge cycle is running stops the cycle. See [Purging the Pump](#) (▶ page 100).

FLOW

Pressing the button starts or stops the flow, considering the selected flow rate, solvent composition, and flow acceleration/deceleration.

The LEDs next to the button indicate the following:

LED	Description
Off (dark)	The pump flow is off or zero.
Green	The pump head is delivering.
Green, flashing	The pistons are undocked.

When the Device is Connected in the Chromeleon Software

The button functionality is as follows when the device is connected in the Chromeleon software:

- No injection or sequence is running:
All functions are available from the keypad.
- An injection or sequence is running:
The **MUTE ALARM** function remains available from the keypad, allowing you to turn off the beep for the current alarm.

6.3.2 Status Indicators

This section provides information about the status LED bar on the front side of the device, the **STATUS** LED on the inside keypad, and the pump block status LED.

The status LED bar on the front side of the device and the **STATUS** LED on the inside keypad provide information about the device status.

LED Bar

The LED bar colors provide the following information:

TIP—Dual pump only: With a dual pump, the LED bar is a two-part bar, with the lights on the left referring to the left pump and the lights on the right referring to the right pump.

LED Bar	Description
Off (dark)	The power to the device is turned off.
Dimmed	The doors of the device are open.
Yellow, flashing slowly	The power to the device is turned on, but the device is not connected in the chromatography data system.

LED Bar	Description
Yellow	The device is connected in the Chromeleon software, but the device is not equilibrated. The pump flow is off.
Green, flashing	A purge cycle is running.
Green	The device is equilibrated, but no data acquisition is running. The pump flow is on.
Blue	An injection or sequence is running, including data acquisition.
Red	A problem or error has occurred. For the related message, check the Instrument Audit Trail. For remedial action, see Troubleshooting (▶ page 197).

STATUS LED

The **STATUS** LED on the keypad inside the device provides the following information:

STATUS LED	Description
Off (dark)	The power to the device is turned off.
Green	The device is functioning properly.
Red	A problem or error has occurred. For the related message, check the Instrument Audit Trail. For remedial action, see Troubleshooting (▶ page 197).

For information about the LEDs that are present next to a button on the keypad, see [Keypad](#) (▶ page 84).

Pump Block Status LED

The status indicator LED is located inside the pump above the pump head (pump block LED). The LED indicates the operational status of the pump block.

LED	Operational Status
Off (dark)	No flow
Green	The pump head is delivering.
Green, flashing – during normal operation	In addition, the message " Compression limit reached " (code 4156) appears in the Instrument Audit Trail. The compression value was 100% during each of the past three strokes. If the compression value is lower than 100% for several strokes afterward, the message " Compression back to normal " (code 4157) will appear in the Instrument Audit Trail. For more information about the compression values, see Checking the Compression Values (▶ page 211).
Green, flashing – during pump maintenance	The pistons are in the appropriate position for piston (seal) replacement.

LED	Operational Status
Red, flashing	<p>The pistons are not in the appropriate position for normal operation (for example, after piston (seal) replacement) or an error occurred during internal maintenance (see Internal Maintenance (▶ page 120)).</p> <p>In both cases, an accompanying message appears in the Instrument Audit Trail when you try to start the flow, for example, "The pump drive is still in undock position; Please execute a dock command" (code 4127). Follow the remedial actions for the accompanying message in Messages (▶ page 200).</p>

6.4 Power On/Off Control

The power switch on the device is the main switch for power on/off control. The main power switch is turned on during initial installation of the device.

For easier handling, you can use the power button on the front left of the Vanquish system base (system power button) for power on/off.

Observe the following:

- All modules in the Vanquish system that are connected to the system base via system interlink cables are turned on or off simultaneously when the system power button is pressed.
- When the power is on, the system power button is pressed in. When the power is off, the system power button stands out.
- If the main power switch on a device is off, you cannot turn on the device with the system power button.
- To turn off a device completely, you *have to* turn it off with the main power switch on the device. Pressing the system power button will not be sufficient to turn off the power to the device completely.

When Powering Up the Pump

Whenever the power to the pump is turned on, the following sequence of events occurs:

- The pump performs a self-test.
If the self-test is not successful, the status indicators are red, and the pump is not ready for analysis. Check the Instrument Audit Trail for the related message and take appropriate remedial action.
- The pump starts operation with a seal wash cycle. Before turning on the pump, check the liquid level in the seal wash reservoir. Consider checking also the liquid level in the waste container.

6.5 Use of Solvents and Additives

Particles entering the chromatography system can block capillaries and valves, increase wear, and damage the column or system. Especially with aqueous solvents, algae and other microorganisms can grow and deposit in the system and block the solvent line filters. Blocked capillaries or filters can cause increased or unstable system pressure.

TIP In a Vanquish Core system, normal-phase (NP) compatible solvents and additives may be used if the system modules have been modified for NP applications. Refer to the *Vanquish System Operating Manual*.

For optimum performance of the chromatography system, observe the following guidelines:

Solvent Quality and Filtration

- Use high-quality high-purity solvents (filtered) and additives as required by the application, for example, UHPLC-grade or LC/MS-grade. If a fluorescence detector is used in the system, consider using fluorescence-grade solvents. Filtered high-purity solvents are usually labeled accordingly by the vendor.
- Use high-quality water for example, UHPLC-grade or LC/MS-grade (0.2 µm filtered).
- When you use water from water purification systems, polymeric contamination may occur if the purification system is not maintained properly.
- When preparing salt solutions or buffers and preparation is complete, use membrane filtration (0.2 µm) to remove any particulate matter and to reduce microbial growth.
- Use fresh solvents at regular intervals. Avoid adding up (refreshing) solvents. With premixed solvents, be especially sure that they are properly prepared and fresh.
- Always use the appropriate solvent line filters as recommended by Thermo Fisher Scientific. Check the filter frits for permeability at regular intervals and replace them as necessary.
- For best seal performance, do not recycle or recirculate solvents.
- Note the special properties of the solvents, such as viscosity, boiling point, or UV absorption.

Solvent Reservoirs

- Before filling a solvent reservoir, rinse the reservoir thoroughly with a high-purity solvent.
- To reduce the growth of algae, consider using amber glassware or using appropriate additives, for example, formic acid.
- Avoid using methanol from aluminum reservoirs.

Flushing after Operation

- Flush out buffers and solutions that form peroxides.
- Never leave buffers, salt solutions, or aggressive solvents in the system for a longer period without flow.
- Before you change from a buffer or salt solution to organic solution, flush the system thoroughly with de-ionized water.
- Before you change solvents, make sure that the new solvent is miscible with the previous solvent. If the solvents are not miscible, flocculation may occur.
Mix immiscible solvents with an intermediate solvent to replace them step by step. For example, use isopropanol.

6.6 Preparing the Device for Operation

This section gives information on any additional steps that are required to prepare the device for operation and sample analysis.

Before Operating the Device for the First Time

Prepare the device for the first-time operation, observing the following:

NOTICE

Flush the system flow path thoroughly before operating the device for the first time:

- When you install devices or components to the system, always flush them to waste before connecting them in the system flow path. To flush the Vanquish modules, follow the instructions in the *Vanquish System Operating Manual*.
 - Some components of the device are filled with isopropanol when the device is shipped from the manufacturing site. When operating the device for the first time, use solvents that are miscible with isopropanol. If they are not, use an appropriate intermediate solvent.
-
- To remove the isopropanol from the device components:
 - ◆ Verify that the flow cell and the column are not connected in the flow path.
 - ◆ Purge the pump and then have the pump deliver flow for a short time.
 - Verify that any air bubbles are completely flushed out of the system flow path.
 - *Quaternary pump and dual pump:* Synchronize the injection time of the Vanquish autosampler with the strokes of the pump. See [Synchronizing the Injection Time with the Pump Strokes](#) (► page 224).

Before Starting Sample Analysis

Before starting an analysis:

- Check the liquid level in the solvent reservoirs. Verify that the amount of solvent is sufficient for the analysis.

- Close the doors of all modules in the Vanquish system, if not already done.

NOTICE

During pumping cycle keep the pump doors closed. Otherwise, functionality may be adversely impacted.

- Make sure that the chromatography system is properly equilibrated (see further down).

System Equilibration

System equilibration should include the following operations:

- Purging the pump (*all* channels, including those not used for the application)
- Flushing the entire chromatography system with the starting solvent to rinse out any solvent from a previous analysis run
- Warming up (or cooling down) all temperature-controlled devices in the system to the starting temperature. Temperature-controlled devices can be, for example
 - ◆ Column compartment and post-column cooler
 - ◆ Sample compartment thermostating in the autosampler
 - ◆ Flow cell in a fluorescence detector
 - ◆ Evaporation tube in a charged aerosol detector
- Turning on the lamp (or lamps) in the UV/VIS detector
- Monitoring the pump pressure and pressure ripple and checking that the pressure is stable and the ripple within reasonable limits for the application
- Monitoring the detector signal and checking whether the detector signal is stable so that the drift and signal noise are within reasonable limits for the application
- Performing an autozero of the detector baseline

TIP The Chromeleon software supports procedures for automatically starting a chromatography system in the software (**Smart Startup**). The startup procedure includes the operations for system equilibration. For details, refer to the *Chromeleon Help*.

6.7 Important Operating Parameters

The parameters described in this section should be considered for routine operation of the device. You can usually access these parameters from the Chromeleon user interface.

If a parameter listed below is not available in the Chromeleon software, consider updating the firmware and Chromeleon version.

For more information, refer to *Chromeleon Help and documents*.

Flow Parameters

Parameter	Description
Flow	The allowed flow range is indicated in the dialog box for the pump in the Instrument Configuration Manager. You can change the upper and lower limit for the flow rate within the allowed range.
Flow ramps	Set the flow acceleration and flow deceleration. <i>Recommendation:</i> Set the parameters to a value between 1/3 and factor 3 of the (column) flow rate.
Flow acceleration	The flow acceleration (Maximum Flow Ramp Up) determines how fast the pump starts delivering with the selected flow rate. If the value is too low, it will take correspondingly long for the pump to build up the necessary pressure and start delivering the required flow. If the value is too high, this may impair the column lifetime.
Flow deceleration	The flow deceleration (Maximum Flow Ramp Down) determines how fast the pump reduces the flow. If the value is too low, it will take correspondingly long for the pump to reduce the flow and thus the pressure. If the value is too high, this may impair the column lifetime.

Pressure Parameters

Parameter	Description
Pressure limits	<p>The allowed pressure range is indicated in the dialog box for the pump in the Instrument Configuration Manager. You can adapt the upper and lower pressure limits within the allowed range.</p> <ul style="list-style-type: none"> • The lower pressure limit helps to prevent the pump (and column) from running dry. A typical setting is 1 MPa. • The upper pressure limit helps to protect the column from too high pressure. The column and the application determine the appropriate setting. <p>When the pump pressure is outside the specified limits, the Chromeleon software stops the pump flow and aborts a running Queue.</p>
Pump pressure	<p>In the dialog box for the pump in the Instrument Configuration Manager, the Pump_Pressure check box is selected as a standard when the pump is set up in the Chromeleon software. The Chromeleon software uses this setting to generate the channel for recording the pump pressure (which corresponds to the column pressure). With the dual pump, the check boxes are labeled PumpLeft_Pressure for the left pump and PumpRight_Pressure for the right pump.</p> <p>Always record the pump pressure. If a problem occurs, the information from the pump pressure channel can provide helpful information to identify and eliminate the source for the problem.</p>

Solvent and Waste Liquid Parameters

Parameter	Description
Solvent composition	<p>In the dialog box for the pump in the Instrument Configuration Manager, set the number of the solvents to be used with the pump. You can change the standard solvent names as required. The solvent names appear in the Chromeleon user interface.</p> <p>In the Chromeleon Client, set the solvent composition. For more information, see the related section in Pump-Specific Information (▶ page 215).</p>
Solvent consumption	<p>You can monitor the liquid level in the solvent reservoir (solvent consumption) when you have entered the required information for the related solvent. Based on this information, the Chromeleon software <i>calculates</i> the liquid level. To monitor the liquid level in real time, based on real <i>physical</i> measurement, install the Vanquish Solvent Monitor. The solvent monitor is available as an option (see Optional Accessories (▶ page 267)).</p> <p>For monitoring from the Chromeleon software, enter the following information:</p> <ul style="list-style-type: none"> • Volume of solvent in the reservoir (at the beginning of a sequence) • Lower limit for the solvent in the reservoir, which is the minimum volume of liquid that must be available in the reservoir <p>The Remain Time property for the solvent reports the time left until the liquid level is expected to reach the lower limit. The Chromeleon software calculates the time from the current flow rate and volume entered.</p> <ul style="list-style-type: none"> • Warning limit when you want to be informed about the liquid level in the reservoir <p>When the liquid in the reservoir reaches the lower limit, the Chromeleon software stops the pump as specified in the Emergency Instrument Method if available or aborts the Queue and stops the pump flow.</p> <p><i>Relevant for dual pump only</i></p> <p>You can monitor the solvent consumption of the dual pump as a whole if the two pumps share the same set of solvent reservoirs. If the pumps are connected to different sets of solvent reservoirs, you can monitor the solvent consumption separately each pump (see Monitoring the Solvent Consumption (▶ page 226)).</p>

Parameter	Description
Waste level	<p>You can monitor the liquid level in the waste container when you have entered the required information. Based on this information, the Chromeleon software <i>calculates</i> the liquid level. To monitor the liquid level in real time, based on real <i>physical</i> measurement, install the Vanquish Solvent Monitor. The solvent monitor is available as an option (see Optional Accessories (▶ page 267)).</p> <p>For monitoring from the Chromeleon software, enter the following information:</p> <ul style="list-style-type: none"> • Volume of liquid in the waste container at the beginning of a sequence • Upper limit for the liquid level in the waste container The Remain Time property for the waste reports the time left until the liquid level is expected to reach the upper limit. The Chromeleon software calculates the time from the current flow rate and calculated current liquid level. • Warning limit when you want to be informed about the liquid level in the waste container <p><i>Relevant for dual pump only</i></p> <p>You can monitor the liquid level in the waste container for the dual pump as a whole if the two pumps share the same container. If the waste liquid is guided to different waste containers, you can monitor the liquid level for each pump. For details, see Monitoring the Liquid Level in the Waste Container (▶ page 227).</p>

Other Parameters

Parameter	Description
Compression	The compression values of the pump head can provide valuable information for troubleshooting. For details, see Checking the Compression Values (▶ page 211).
Curve	<p>You can specify linear or non-linear (curved) gradient profiles.</p> <ul style="list-style-type: none"> • Curve 5 (default setting) is linear. Changes in the composition of the delivered solvent over time are constant. • Curves 1 through 4 are convex upward. Convex curves cause rapid changes in solvent composition at the beginning of the gradient and slower changes at the end. Slope changes over time become extreme as curves go from 4 (least convex) to 1 (most convex). • Curves 6 through 9 are concave upward. Concave curves cause slower changes in solvent composition at the beginning of the gradient and rapid changes at the end. Slope changes over time become extreme as curves go from 6 (least concave) to 9 (most concave). <p>In addition, you can define step gradients directly in the gradient table (for example, step A and step B). Thus, more than 11 different options are available to change the gradient.</p>
Degasser	The degasser is enabled as a standard when the pump is shipped (Degasser = On). This setting is the preferred setting.
Leak detection	Leak detection is enabled as a standard when the device is shipped (Leak Sensor Mode = Enabled). This is the preferred setting.
Purge	<p>Purge the pump in the following situations:</p> <ul style="list-style-type: none"> • To remove air bubbles that might be trapped in the system • When changing to a different type of solvent <p>See Purging the Pump (▶ page 100).</p>

Parameter	Description
Seal washing	<p>The seal wash system is enabled and cannot be disabled. As a standard, the pump performs a seal wash in the following situations:</p> <ul style="list-style-type: none"> • Once per hour • Each time the pump is turned on <p>If required, you can start an additional seal wash cycle or stop a running cycle:</p> <ul style="list-style-type: none"> • If the seal wash pump is in Idle mode, select Active to start a wash cycle. • If the seal wash pump is in Active mode, select Idle to stop a running wash cycle. <p>You can disable the drop counter functionality by setting Rear Seal Wash Monitoring to Disabled. Note that disabling drop detection will not disable the seal wash system. However, messages relating to the seal wash system (for example, when the system has run out of wash liquid) or piston seal leakage will no longer alert you in the user interface.</p>
Synchronization of the injection time with the pump strokes	<p><i>Relevant for quaternary pump and dual pump only</i></p> <p>Synchronizing the injection time with the pump strokes enhances the retention time precision. For details, see Synchronizing the Injection Time with the Pump Strokes (▶ page 224).</p>

6.8 Purging the Pump

Purging the pump means rinsing the pump for a short time at a higher flow rate, using the selected solvents.

Settings

The following settings are considered for the purge cycle:

Setting	Description
Purge flow	The standard setting is 5 mL/min. You can adapt the setting in the Chromeleon software if required. The setting is considered also when purging the pump from the keypad.
Purge time	The standard purge time is 5 minutes. You can adapt the setting in the Chromeleon software if required. The setting is considered also when purging the pump from the keypad.
Channel to be purged and solvent to be used	The purge cycle is performed with the most recently selected channel and eluent composition. You can adapt the settings in the Chromeleon software if required. The settings are considered also when purging the pump from the keypad.

To Purge the Pump

The following alternatives are available:

Procedure	Description
Automatic purging	Automatic purging runs without further user interaction. Automatic purging is possible only when certain prerequisites are fulfilled. When the prerequisites are fulfilled, automatic purging is performed by default when you press the PURGE button on the keypad. See Automatic Purging (▶ page 101).
Manual purging	With manual purging, user interaction is required at the beginning and at the end of the purge cycle. See Manual Purging (▶ page 102).

TIP With a dual pump, purge each pump separately.

6.8.1 Automatic Purging

Automatic purging means that the solvent is automatically directed to waste, through the wash port of the Vanquish autosampler, without further user interaction.

Prerequisites

Automatic purging is possible only when the pump is fluidically connected to the Vanquish autosampler and when both modules have an appropriate firmware installed.

When these prerequisites are fulfilled, automatic purging runs by default when you press the PURGE button on the keypad.

Dual pump: If the second pump is not connected fluidically to a Vanquish autosampler, purge the pump manually (see [Manual Purging](#) (► page 102)).

When

- The pump is operated for the first time
To flush out the isopropanol that is present in some components of the pump when the pump is shipped from the manufacturing site
- One or more solvent lines have been empty
- To remove air bubbles that might be trapped in the system (pump head, solvent lines) because air bubbles in the system may lead to the following problems:
 - ◆ Pressure pulsation
 - ◆ High noise level or pulsation during pump operation
 - ◆ Non-reproducible analysis
- When changing to a different type of solvent, for example, when changing to a different analytical method

Items required

Solvents suitable for purging

To flush out the isopropanol when operating the pump for the first time, use solvents that are miscible with isopropanol. If they are not, use an appropriate intermediate solvent.

Follow these steps

1. In the Chromeleon software, set the channel that you want to purge to 100%.
2. *Optional:* In the Chromeleon software, adapt the settings for the purge flow or purge time if required.
3. Start the purge cycle. You can start the purge cycle from the Chromeleon software or by pressing the PURGE button on the keypad.
The purge cycle ends automatically when the specified purge time ends. If you want to stop purging before the purge time ends, turn the purge off from the Chromeleon software or by pressing the PURGE button on the keypad.
4. Repeat the above steps for *all channels*, including those that are not used for the application.

6.8.2 Manual Purging

Manual purging requires user interaction. The user must open and close the purge valve by hand to direct the solvent to waste, through the purge outlet on the purge/sensor unit.

The procedure depends on the reason for purging:

- When the pump is operated for the first time or when solvent lines are empty, follow the steps in [Purging with First Time Operation or Empty Solvent Lines](#) (▶ page 102).
- To remove air bubbles, or to change to a different type of solvent, or when using a fresh reservoir of solvent after a longer period without flow, follow the steps in [Purging for Removing Air Bubbles or Changing to Different Solvent Type](#) (▶ page 105).

6.8.2.1 Purging with First Time Operation or Empty Solvent Lines

When

- The pump is operated for the first time
To flush out the isopropanol that is present in some components of the pump when the pump is shipped from the manufacturing site
- One or more solvent lines have been empty

TIP To remove air bubbles or to change to a different type of solvent, follow the steps in [Purging for Removing Air Bubbles or Changing to Different Solvent Type](#) (▶ page 105).

Items required

- Solvents suitable for purging
To flush out the isopropanol when operating the pump for the first time, use solvents that are miscible with isopropanol. If they are not, use an appropriate intermediate solvent.
- Silicone tubing
- Tissue
- Syringe

TIP For first time-operation: Silicone tubing and a syringe are available in the ship kit.

Preparations

1. To be able to generate negative pressure, connect an autosampler or another type of flow restriction to the pump outlet. If necessary, close the pump outlet with a fitting plug.
2. On the purge/sensor unit, attach silicone tubing to the purge outlet (if it is not yet connected).
3. Insert the syringe tip into the open end of the tubing.
4. Open the purge valve by turning the valve knob counterclockwise.

Follow these steps

1. In the Chromeleon software, set the channel that you want to purge to 100%.
2. *Optional:* In the Chromeleon software, adapt the settings for the purge flow or purge time if required.
3. *Binary pump and dual pump:* For purging from the keypad, verify that you have selected the pump head (pump) for which you want to perform the procedure.
4. Start the purge cycle. You can start the purge cycle from the Chromeleon software or by pressing the PURGE button on the keypad.
5. Use the syringe to draw enough solvent for filling the solvent line to the purge outlet.
6. When the liquid enters the silicone tubing, examine the solvent line. If the solvent line is completely filled with liquid and no air bubbles are visible, stop the purge cycle (from the Chromeleon software or by pressing the PURGE button).

7. Remove the syringe from the silicone tubing, absorbing any liquid that leaves the tubing with a tissue.
8. Route the free end of the tubing to the drain port outlet (see [Guiding Liquids to Waste](#) (▶ page 62)).
9. Perform the above steps for *all* channels, including those that are not used for the application.
If necessary, empty the syringe before starting the procedure for the next channel.
10. When purging is complete, close the purge valve by turning the valve knob clockwise.

NOTICE

Turn the valve knob only with your fingers. If the knob leaks, tighten a little more. Be careful; overtightening may damage the purge valve seals.

11. Empty the silicone tubing.
12. *Dual pump only:* If applicable, perform the purge procedure also for the other pump.

*Emptying the Silicone Tubing***NOTICE**

Always empty the silicone tubing when purging is complete. When the purge valve is closed, purge liquid remains in the tubing connected to the purge outlet. Leaving the liquid in the tubing for a longer period limits the tubing lifetime.

1. To absorb any liquid that might be leaving the purge outlet when the tubing is removed, place the tissue under the outlet.
2. On the purge/sensor unit, remove the silicone tubing from the purge outlet. The other end of the tubing remains in the purge drain port outlet.
3. Hold the tubing so that any liquid that is present in the tubing flows off through the drain port outlet.
4. On the purge/sensor unit, consider reconnecting the silicone tubing.

6.8.2.2 Purging for Removing Air Bubbles or Changing to Different Solvent Type

- To remove air bubbles that might be trapped in the system (pump head, solvent lines) because air bubbles in the system may lead to the following problems:
 - ◆ Pressure pulsation
 - ◆ High noise level or pulsation during pump operation
 - ◆ Non-reproducible analysis
- When changing to a different type of solvent, for example, when changing to a different analytical method

TIP When the pump is operated for the first time or when solvent lines are empty, follow the steps in [Purging with First Time Operation or Empty Solvent Lines](#) (▶ page 102).

Items required

- Solvents suitable for purging
- Silicone tubing
- Tissue

Preparations

1. To be able to generate negative pressure, connect an autosampler or another type of flow restriction to the pump outlet. If necessary, close the pump outlet with a fitting plug.
2. On the purge/sensor unit, attach silicone tubing to the purge outlet (if it is not yet connected).
3. Route the free end of the tubing to the drain port outlet (see [Guiding Liquids to Waste](#) (▶ page 62)).
4. Open the purge valve by turning the valve knob counterclockwise.

Follow these steps

1. In the Chromeleon software, set the channel that you want to purge to 100%.
2. *Optional:* In the Chromeleon software, adapt the settings for the purge flow or purge time if required.
3. *Binary pump and dual pump:* For purging from the keypad, verify that you have selected the pump head (pump) for which you want to perform the procedure.

4. Start the purge cycle. You can start the purge cycle from the Chromeleon software or by pressing the PURGE button on the keypad.
5. Perform the above steps for *all* channels, including those that are not used for the application.
6. When purging is complete, close the purge valve by turning the valve knob clockwise.

NOTICE

Turn the valve knob only with your fingers. If the knob leaks, tighten a little more. Be careful; overtightening may damage the purge valve seals.

7. Empty the silicone tubing.
8. *Dual pump only:* If applicable, perform the purge procedure also for the other pump.

Emptying the Silicone Tubing

NOTICE

Always empty the silicone tubing when purging is complete. When the purge valve is closed, purge liquid remains in the tubing connected to the purge outlet. Leaving the liquid in the tubing for a longer period limits the tubing lifetime.

1. To absorb any liquid that might be leaving the purge outlet when the tubing is removed, place the tissue under the outlet.
2. On the purge/sensor unit, remove the silicone tubing from the purge outlet. The other end of the tubing remains in the purge drain port outlet.
3. Hold the tubing so that any liquid that is present in the tubing flows off through the drain port outlet.
4. On the purge/sensor unit, consider reconnecting the silicone tubing.

Troubleshooting with Persistent Air Bubbles

If you are unable to remove air bubbles with purging, purge the pump against backpressure. Follow the procedure for running in new piston seals in [Recommendations for New Piston Seals](#) (► page 149).

6.9 Optimizing the Performance of the Device

This section provides information for best performance of the device and gives hints on what you can do to optimize the performance further.

6.9.1 General Guidelines

To optimize the performance of the device, consider the following general guidelines:

- Monitor the usage of specific device components that are subject to wear and stress and schedule appropriate maintenance intervals (see [Predictive Performance](#) (▶ page 125)).
- Observe the general guidelines and recommendations on the use of solvents and additives in the chromatography system (see [Use of Solvents and Additives](#) (▶ page 90)).
- *Pumps with built-in vacuum degasser:* Always use the built-in vacuum degasser.
- Purge the pump when changing to a different type of solvent or when restarting the pump after periods of inactivity.

TIP Shut-off valves for solvent lines are available as an option (see [Installing Solvent Shut-Off Valves](#) (▶ page 107)). These valves allow you to shut off the solvent flow through the system at the solvent reservoir, for example, to prevent solvent from flowing through the system when the pump flow is zero for a longer period.

6.9.2 Installing Solvent Shut-Off Valves

When

To shut off the solvent flow through the system at the solvent reservoir, for example, to prevent solvent from flowing through the system when you open a flow connection on the low-pressure side

The steps in this section apply only when installing a shut-off valve *after* initial operation of the pump. To install a shut-off valve *during* initial setup of the flow connections, follow the steps in [Connecting the Solvent Lines](#) (▶ page 63).

Parts and additional items required

- Shut-off valve, kit containing one shut-off valve and fitting connections
- Tubing cutter
- Solvent suitable for purging the pump

Preparations

1. Turn off the pump flow and wait until the system pressure is down to zero.
2. Prepare the pump for purging (see [Purging the Pump](#) (▶ page 100)).

Follow these steps

Follow the steps for each solvent line in which you want to install a shut-off valve.

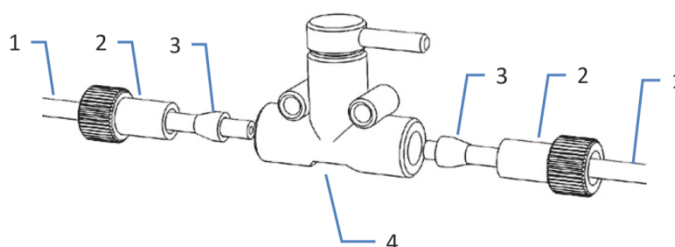


Figure 30: Installing a shut-off valve in the solvent line

No.	Description
1	Solvent line
2	Fitting
3	Ferrule
4	Shut-off valve

1. Unscrew the cap of the solvent reservoir and remove the cap together with the solvent line from the reservoir.
2. Start a purge cycle as appropriate.
3. Stop purging as soon as the solvent line is empty.
4. Retighten the reservoir cap hand-tight. The retaining guide must remain in the hole in the reservoir cap. If it does not, press the retaining guide into the hole so that the tubing is kept in place in the cap.

5. Cut the solvent line about 10 cm from the reservoir cap with a tubing cutter. Make sure that the cut is at a right angle to the length of the line.
6. Onto the free end of each solvent line, slide a fitting and a ferrule. Mind the correct orientation of the fitting and ferrule (see picture).
7. Tighten the solvent lines to the shut-off valve.
8. Check the solvent lines across the entire flow path. Make sure that the lines are not bent, pinched, or squeezed at any point in the flow path.
9. To remove any air from the solvent lines, purge the pump using the solvent of your application.

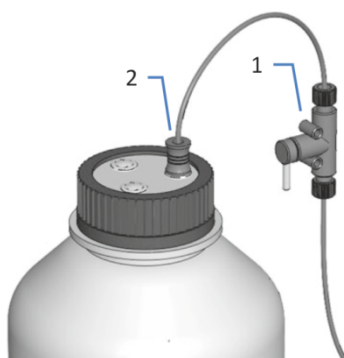


Figure 31: Solvent line with shut-off valve installed

No.	Description
1	Shut-off valve
2	Retaining guide

6.10 Shutting Down the Device

If the device will not be operated for some time, follow the instructions in this section to shut down the device.

TIP The Chromeleon software provides procedures for automatically preparing the chromatography system for shutdown. The procedures include, for example, operations for reducing the flow rate, reducing the temperature in temperature-controlled devices, and turning off the detector lamps. For information about **Smart Shutdown** and **Smart Standby**, refer to the *Chromeleon Help*.

6.10.1 Short-Term Shutdown (Interruption of Operation)

To interrupt operation of the device for a short period (short-term shutdown), for example, overnight, observe these guidelines for the Vanquish system modules, as required by your system arrangement:

- For your Vanquish detector, note the following:

Detector Type	Description
Charged aerosol detector	Check that sufficient gas is available to continue gas flowing through the detector. This is to prevent any build-up of residue from solvents or analytes. Gas must be flowing when pump flow is delivered to the detector.
UV/VIS detectors	The lamp(s) in the detector can remain turned on. <i>Variable wavelength detector and VH-D10 diode array detector only:</i> The shutter can be moved to a closed position for protection of the flow cell.
Fluorescence detector	Turn off temperature control for the flow cell.

- Apply a flow of 0.05 mL/min and have the pump deliver an appropriate solvent.
Check the lower pressure limit for the pump and adapt the value if necessary. If the pressure falls below the lower limit, the pump stops the flow.
- Set the injection valve in the autosampler to the Inject position.
- Make sure that the temperature of the column does not exceed 40 °C.
- When resuming operation, let the flow equilibrate and verify that the operating parameters for the other system modules are set as required before proceeding.

6.10.2 Long-Term Shutdown

To interrupt operation for a longer period, follow the instructions in this section.

TIP Shutting down the device affects the operation of the system. When shutting down the device, also observe the shutting down instructions for the other Vanquish system modules and take appropriate action (refer to the *Operating Manuals* for the modules).

1. Remove the column.
2. Flush the system with an appropriate solvent (minimum HPLC-grade). Observe the following:

TIP With a Vanquish Core system that has been modified for using normal-phase compatible solvents and additives, refer to the information about the flushing liquid in the *Considerations with Normal-Phase Compatible Solvents and Additives* section in the *Vanquish System Operating Manual*.

Situation after Shutdown	If no additive is used	If an additive is used
Device remains in the laboratory after shutdown	Flush the system, for example with methanol. 100% acetonitrile should not be used.	Flush the system with several volumes of methanol and water (50:50) (for example, 1.0 mL/min for 10 minutes with the standard system) to prevent salt buildup in the fluidics. If the solvents in the device are not miscible with water, use an appropriate intermediate solvent.
Device shall be transported or shipped after shutdown	Flush the system with isopropanol.	Flush the system first with several volumes of methanol and water (50:50) (for example, 1.0 mL/min for 10 minutes with the standard system) to prevent salt buildup in the fluidics. If the solvents in the device are not miscible with water, use an appropriate intermediate solvent. Afterward, flush the system with isopropanol.

3. Turn off the pump flow and wait until the system pressure is down to zero.
4. Disconnect the solvent lines. See [Disconnecting the Solvent Lines](#) (▶ page 112).

TIP Removing the solvent lines from the tubing guides is usually not required (not even for replacing the slide-in module). However, when you remove the solvent lines from the tubing guides in the pump and all modules above the pump in the system stack, be careful not to pull on other tubing in the guides.

5. Empty the seal wash system. See [Emptying the Seal Wash System](#) (▶ page 113).
6. The step depends as follows:

Situation	Steps
Device and all other system modules remain in the system stack and are to be turned off	Turn off the system with the system power button on the system base.
Device shall be transported or shipped after shutdown	If one of the modules shall be removed from the system stack, turn off <i>all</i> system modules with their main power switch. Pressing the system power button will not be sufficient to turn off the power to the devices completely. Follow the instructions in Transporting or Shipping the Device (▶ page 187).

Disconnecting the Solvent Lines

1. Unscrew the caps of the solvent reservoirs.
2. Together with the caps, remove the solvent lines from the reservoirs.
3. Protect the solvent line filters from contamination as appropriate.
4. Empty the solvent lines. See [Emptying the Solvent Lines](#) (▶ page 169).
5. Disconnect the solvent lines on the pump inlets.
6. Close the pump inlets with appropriate plugs.

Emptying the Seal Wash System

1. Unscrew the cap of the seal wash reservoir.
2. Together with the cap, remove the seal wash line from the seal wash reservoir.
3. Remove the peristaltic tubing from the seal wash pump. When the tubing is removed, any liquid that may be present in the seal wash line, flows off to waste.

6.10.3 Restart after Long-Term Shutdown

To restart the device after a long-term shutdown, follow these steps:

1. Engage the peristaltic tubing in the seal wash pump.
2. Reconnect the seal wash line and the solvent lines to the appropriate reservoirs.
3. Retighten the reservoir cap hand-tight. The retaining guide must remain in the hole in the reservoir cap. If it does not, press the retaining guide into the hole so that the tubing is kept in place in the cap.
4. Turn on the device. Observe the following:

Situation	Action
If the device remained in the system stack and all system modules were turned off.	Turn on the system with the system power button on the system base.
If the device is restarted after transport.	Turn on the device with the main power switch.

5. Prepare and restart the other modules in the Vanquish system, following the instructions in the *Operating Manuals* for the modules. Pay special attention to the *Preparing the Module for Operation* section.
6. Purge the pump and then have the pump deliver for a short time.
7. Before starting an analysis, let the device equilibrate and be sure that it is ready for operation. See [Preparing the Device for Operation](#) (▶ page 92).

7 Maintenance and Service

This chapter describes the routine maintenance and the service procedures that the user may perform.

7.1 Introduction to Maintenance and Service

This chapter describes the routine maintenance and service and repair procedures that the user may perform.



Additional maintenance or service procedures must be performed only by service personnel certified by Thermo Fisher Scientific (for brevity, referred to as Thermo Fisher Scientific service personnel).

The device is designed for easy maintenance and service. The user-serviceable parts of the device can be accessed from the front. If not stated otherwise, the maintenance procedures do not require that you remove the device from the system.

The maintenance procedures do not require that you remove the doors. However, it is possible to remove a door if this should ever be required for a specific reason or procedure. If you need to remove a door, follow the related steps in [Replacing the Doors](#) (▶ page 185).

7.2 Safety Guidelines for Maintenance and Service

When performing maintenance or service procedures, pay attention to the following safety guidelines:



Observe all warning messages and precautionary statements presented in [Safety Precautions](#) (▶ page 21).



WARNING—High Voltage

High voltages are present inside the device that could cause an electric shock.

Do not open the housing or remove protective panels unless specifically instructed to do so in this manual.



WARNING—Escape of Hazardous Substances from Flow Connections

Flow and capillary connections can be filled with substances that can pose health risks. Solvent can spray when capillaries burst, slip out of their fittings, or are not properly tightened or when capillary connections are otherwise open.

- Wear appropriate protective equipment and follow good laboratory practice.
- Before starting maintenance or repair procedures, flush out harmful substances with an appropriate solvent.



WARNING—Tilting Liquid Reservoirs

Liquids in the reservoirs on the solvent rack might contain harmful substances. Spilling of these substances can pose health and safety risks.

To prevent the reservoirs from tilting, be careful not to pull on the liquid lines when performing maintenance.



CAUTION—Spraying Solvent

Solvents can spray when under high pressure.

- Stop the pump flow prior to opening the flow path.
- Wait until the system pressure is down to zero.
- When opening the flow path, wear appropriate protective equipment.



CAUTION—Hydrostatic Pressure

Solvent may spill when you open the flow path. This is due to hydrostatic pressure in the system when the solvent reservoirs are located above the pump outlet. Before you loosen a connection in the flow path:

- Turn off the pump flow and wait until the system pressure is down to zero.
- Unscrew the caps of the solvent reservoirs and remove the solvent lines together with the caps from the reservoirs.
- Empty the solvent lines. See [Emptying the Solvent Lines](#) (► page 169).
- Retighten the reservoir caps.



CAUTION—Electric Shock or Damage to the Device

After the power to the device is turned off, the device is still energized as long as the power cord is connected. Repair work on the device while the device is connected to power could lead to personal injury.

- Always unplug the power cord before starting repair work inside the device.
- If you were instructed to remove any housing covers or panels, do not connect the power cord to the device while the cover or panels are removed.

7.3 General Rules for Maintenance and Service

For successful maintenance and service procedures, follow the rules and recommendations below.

General Rules

- Before starting maintenance or service procedures, shut down the device when instructed to do so.
- Use only the replacement parts specifically authorized and qualified for the device by Thermo Fisher Scientific.
- Follow all instructions step by step and use the tools recommended for the procedure.

Opening Flow Path Connections

- Before opening the flow path to replace capillaries in the system, turn off the pump flow and wait until the system pressure is down to zero.
- Dirty components can contaminate the chromatography system. Contamination leads to poor performance of the modules and entire system or can even cause damage to the modules and system. Therefore:
 - ◆ Always wear appropriate gloves.
 - ◆ Place the components only on a clean, lint-free surface.
 - ◆ Keep your tools clean.
 - ◆ Use only lint-free cloth for cleaning.
- After you have performed maintenance or service on the flow connections in the pump, test the pump for leakage before you resume operation.

Depot Repair

- If you need to return the device for depot repair, follow the instructions in [Transporting or Shipping the Device](#) (► page 187).

7.4 Routine and Preventive Maintenance

Optimum device performance, maximum uptime of the device, and accurate results can be obtained only if the device is in good condition and properly maintained.

7.4.1 Internal Maintenance

Every six weeks, the pump automatically performs an internal maintenance procedure when you initiate a purge cycle. The purge cycle starts automatically when internal maintenance is complete. This may take some seconds. While internal maintenance is running, the purge valve must remain open.

If no purge cycle is initiated after another 6 weeks, a message appears in the Instrument Audit Trail, reminding you to start a purge cycle.

7.4.2 Maintenance Plan

Perform the maintenance procedures in the table on a regular basis. The frequency given in the table is a suggestion. The optimum frequency for maintenance depends on several factors, such as the types and amounts of samples and solvents used with the device.

Frequency	What you should do...
Daily	<ul style="list-style-type: none"> • Inspect the flow connections for signs of leakage or blockage. • Inspect the flow connections for indications of salt deposits. • Inspect the flow connections for indications of air bubbles. Degas the solvents and purge the pump if necessary. • If the solvent is pure water or an aqueous buffer, replace the solvent in the reservoir daily. • Check the liquid level in the seal wash reservoir. Fill the seal wash reservoir with fresh seal wash liquid if required. • When you use buffers or salt solutions, flush the device thoroughly after use with an appropriate solvent that does not contain buffers or salts.

Frequency	What you should do...
Regularly	<ul style="list-style-type: none"> • Check the liquid level in the solvent reservoirs to prevent the pump from running dry. Especially with phosphate buffer applications: The solvent reservoirs must not run empty while the pump is running. If they do, problems with check valves and/or proportioning valves might occur. When the system is not operated for more than 1 day, flush the system and solvent lines, including those that are not used for the application, with buffer-free solvent. • Replace the wash liquid in the seal wash reservoir with fresh liquid. Rinse the reservoir thoroughly before filling it. Use a high-purity solvent for rinsing. • Test the seal wash system for leakage (see Testing the Seal Wash System for Leakage (▶ page 128)). • Replace the peristaltic tubing in the seal wash pump every 6 months (see Replacing the Seal Wash Lines (▶ page 129)). • Inspect the flow connections for damage, such as cracks, nicks, cuts, or blockage. • When you use additives, inspect the pump for leakage once a month. • Test the permeability of the static mixer (see Testing the Static Mixer for Permeability (▶ page 166)). • To avoid contamination of the degasser, prepare fresh solvents, clean the solvent lines, and flush the degasser. • Check that all warning labels are still present on the device and clearly legible. If they are not, contact Thermo Fisher Scientific for replacement.
Annually	<ul style="list-style-type: none"> • Clean the check valves in an ultrasonic bath (see Cleaning the Check Valves (▶ page 164)). • Replace the seal wash seals (see Replacing the Seal Wash Seals (▶ page 151)). • Replace the seal wash lines (see Replacing the Seal Wash Lines (▶ page 129)). • Inspect the pistons for particle deposits or indications of damage, for example, scratches or scores (see Cleaning the Piston (▶ page 144)). • Have Thermo Fisher Scientific service personnel perform preventive maintenance once a year.

A maintenance kit is available for the pump, which includes all parts that are required for routine maintenance (see [Consumables and Replacement Parts](#) (▶ page 270)).

TIP The Chromeleon software supports functions for estimating the lifetime of consumables (see [Predictive Performance](#) (▶ page 125)).

7.4.3 Flushing the Pump to Avoid Contamination

Items required

Fresh solvent

Observe the following guidelines

The following guidelines refer to conventional use of the Vanquish system as recommended in this manual, such as using fresh high-quality solvents (minimum UHPLC-grade or LC/MS-grade) that are replaced frequently:

- Regularly flushing the pump with fresh solvent is usually sufficient.
- If you use water, acetonitrile, or methanol for your chromatography, flushing the pump once a week is an appropriate interval.
- Mobile phases containing salts, buffering agents and/or other additives are inherently prone to organic contamination and/or biodegradation. When using non-volatile buffers, observe the following:
 - ◆ Mobile phases must be filtered before use.
 - ◆ For continuous trouble-free operation, the system must be flushed with, for example, > 60 % isopropanol or ethanol as a weekly procedure.
- Adapt the interval to the solvents in use.

TIP With persistent contamination, for example, if ghost peaks appear reproducibly in your blank chromatogram without injecting a sample, see [Flushing the Pump with Persistent Contamination Only](#) (▶ [page 123](#)).

7.4.4 Flushing the Pump with Persistent Contamination Only

When

TIP With conventional use of the Vanquish system as recommended in this manual, regularly flushing the pump is usually sufficient (see [Flushing the Pump to Avoid Contamination](#) (► page 122)).

For example, if ghost peaks appear reproducibly in your blank chromatogram without injecting a sample, consider a harsher cleaning procedure. Follow the instructions below.

Parts and additional items required

- Backpressure capillary (from Diagnostics tool kit)
- 6 molar (6 M) nitric acid (HPLC-grade)
- Waste container (for collecting the nitric acid)
- Fresh water (HPLC-grade)
- Fresh acetonitrile (HPLC-grade)
- New solvent reservoirs with fresh solvent
- New frits for solvent line filters

Follow these steps

1. Turn off the pump flow and wait until the system pressure is down to zero.
2. Install the backpressure capillary on the pump outlet. Guide the free end of the capillary to the waste container.
3. Replace the frits in the solvent line filters with new frits.
4. Replace the installed waste container with the new waste container to prevent any chemical reaction between the nitric acid and the solvent in the waste container.
5. For 1 hour, apply the flow rate of your application and flush the pump with 6 M nitric acid.
6. Flush the pump with fresh HPLC-grade water until the pH value is neutral.
7. Remove the waste container with the nitric acid and re-install the waste container that was installed previously.
8. For 2 hours, apply the flow rate of your application and flush the pump with fresh acetonitrile.

9. Connect the new solvent reservoirs, which contain fresh solvent.
10. Turn off the pump flow and wait until the system pressure is down to zero.
11. Uninstall the backpressure capillary and reconnect the system as required by your application.
12. Purge the pump.
13. Equilibrate the system.

7.4.5 Cleaning or Decontaminating the Device

Cleaning and decontamination must be performed by qualified personnel wearing suitable personal protective equipment. Always observe national and local regulations.

NOTICE

Wipe up all liquids spilled onto the system immediately. If surfaces are exposed for longer periods, these liquids can cause damage.

Decontamination

Decontamination is required, for example, when leakage or spillage has occurred, or before service or transport of the device. Use a suitable cleaning detergent or disinfectant to ensure that the treatment renders the device safe to handle.

Parts required

- Suitable cleaning detergent (or disinfectant)
- Purified water
- Lint-free cloths or wipes



CAUTION—Explosive Gas Mixtures from Alcoholic Cleaning Detergents

Alcohol-containing cleaning detergents may form flammable and explosive gas mixtures when exposed to air.

- Use such cleaning detergents only when required and only in adequately ventilated rooms.
- Avoid open flames or exposure to excessive heat during the cleaning process.
- Wipe the cleaned components thoroughly dry after cleaning. Do not operate the device before it is completely dry.

NOTICE

Observe the following:

- Only use cleaning detergents that will not damage the surfaces of the system.
- Never use sharp tools or brushes for cleaning any surfaces.
- Do not use sprays for cleaning.
- Prevent cleaning detergent from entering the flow path.
- Do not use excessively wetted cloth or wipes for cleaning. Prevent any liquids from entering the functional components of the device. Liquids can cause a short circuit when getting in contact with the electronic components.

Preparations

1. Turn off the power to the device and disconnect the power cord from the power source.

Follow these steps

1. Wipe the surfaces clean with a clean, dry, soft, lint-free cloth or wipe. If necessary, slightly dampen the cloth or wipe with a solution of lukewarm water and a suitable cleaning detergent.
2. Allow the cleaning detergent to react as recommended by the manufacturer.
3. Wipe the cleaned surfaces with purified water to ensure that all cleaning detergent residues have been removed.
4. Wipe the surfaces dry using a soft, lint-free cloth or wipe.

7.4.6 Predictive Performance

General Overview

The Chromeleon software supports functions for estimating the lifetime of consumables and for monitoring and recording service and qualification information about the device. These functions are called Predictive Performance. They allow you to schedule maintenance procedures based on the actual operating and usage conditions of the device.

On special wellness, service, and qualification panels, you can define intervals for replacing components that are subject to wear or stress and for service procedures or qualification procedures. In addition, you can set limits to alert you before and when the replacement, service, or qualification is due.

Color-coded bars on special panels provide visual feedback, allowing you to easily check and monitor the status. If a warning limit was set, a message in the Chromeleon Audit Trail alerts you when the action is due.

Some counters can be reset to zero after the required action was performed. To keep the Predictive Performance information up-to-date, consider resetting the counter when a maintenance, service, or qualification procedure has been performed.

For more information, refer to the *Chromeleon Help*.

Available Parameters for the Pump

The list shows the most important Predictive Performance counters for the pump. Consider resetting these parameters after performing the related maintenance procedure:

Predictive Performance Command	To perform...
CheckValvesServiceDone	After replacement of the check valves. For each pump head, a common counter is available for all check valves (inlet check valves and outlet check valves).
PistonsChanged	After replacement of the pistons or pump head. For each pump head, a common counter is available for both pistons.
SealsChanged	After replacement of the piston seals or pump head. For each pump head, a common counter is available for all piston seals in the pump head.
MixerChanged	After replacement of the static mixer.
QualificationDone	After qualification procedures, for example, Instrument Qualification or Performance Qualification.
ServiceDone	After annual maintenance by service personnel.

7.5 Seal Wash System

Follow the sequence of steps for the maintenance procedure that you want to perform:

- To test the seal wash system for leakage, follow the steps in [Testing the Seal Wash System for Leakage](#) (▶ page 128).
- To replace the seal wash lines, follow the steps in [Replacing the Seal Wash Lines](#) (▶ page 129).
- To replace the seal wash detector (drop detector), follow the steps in [Replacing the Seal Wash Detector](#) (▶ page 132).

TIP To replace the seal wash seals, which are part of the pump head, see [Replacing the Seal Wash Seals](#) (▶ page 151).

7.5.1 Testing the Seal Wash System for Leakage

When

- At regular intervals
- When you installed the pump head during maintenance procedures

Items required

- Syringe (12 mL)
- Seal wash liquid

Follow these steps

1. Disconnect the tubing from the seal wash detector.

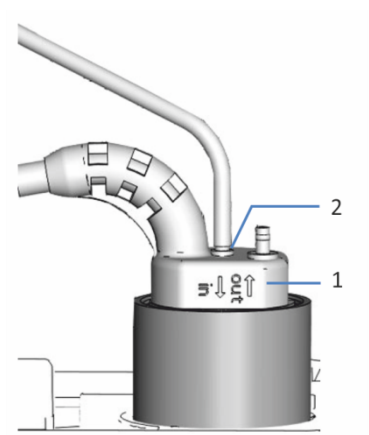


Figure 32: Seal wash detector

No.	Description
1	Seal wash detector
2	Tubing connection port (port labeled in)

2. Insert a syringe into the open end of the tubing.
3. To allow the liquid to travel easily through the seal wash system, press down the lever of the seal wash pump and hold it in that position with one hand.
4. Pull out the syringe plunger to draw seal wash liquid into the tubing.
5. When about 10 mL of liquid are present in the syringe, release the lever of the seal wash pump.
6. Press the lever firmly onto the tubing and press the liquid from the syringe into the seal wash system.

7. Check whether liquid escapes from the connections of the seal wash system or under the pump heads.

Observation	Remedial Action
Leakage is present	Tighten or replace leaky connections. Repeat the inspection.
No leakage is present	Remove the syringe and reconnect the tubing to the seal wash detector (port labeled in).

7.5.2 Replacing the Seal Wash Lines

When

- Damage or blockage of the seal wash lines
- Peristaltic tubing: Every 6 months as preventive maintenance for the seal wash pump
- Other seal wash lines: Once a year

Parts and additional items required

- Seal wash lines as required:
 - ◆ Seal wash lines that connect the seal wash reservoir to the peristaltic tubing in the pump
For more information, refer to the *Operating Manual* for the Vanquish autosampler.
 - ◆ Seal wash lines that connect the components in the pump
 - ◆ Peristaltic tubing (PharMed tubing)
- Fresh seal wash liquid

For an overview of the seal wash system, see the picture in [Setting Up the Seal Wash System](#) (▶ page 70).

Tools required

Tubing cutter (optional)

Preparations

1. Unscrew the cap of the seal wash reservoir and remove the seal wash line together with the cap from the reservoir.
2. To empty the seal wash line, press down the lever of the seal wash pump. Release the lever when the line is empty.

Follow these steps

NOTICE

When you must remove a seal wash line from the tubing guides, be careful not to pull on other tubing in the guides.

Follow the sequence of steps for the seal wash line that you want to replace:

- For the seal wash lines that connect the seal wash reservoir to the peristaltic tubing in the pump, follow the steps in the *Operating Manual* for the Vanquish autosampler.
- For the peristaltic tubing, see [Replacing the Peristaltic Tubing](#) (▶ page 130).
- For the seal wash lines from peristaltic tubing to the pump heads and on to the seal wash detector, see [Replacing the Seal Wash Lines between the Peristaltic Tubing and the Seal Wash Detector](#) (▶ page 131).

Replacing the Peristaltic Tubing

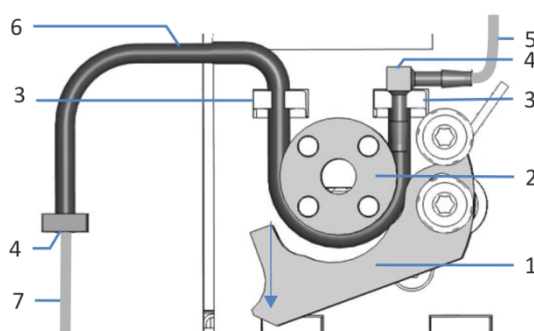


Figure 33: Seal wash pump

No.	Description
1	Pump lever
2	Pump rotor
3	Tubing holder (peristaltic tubing)
4	Tubing connector
5	Seal wash line from autosampler (silicone tubing)
6	Peristaltic tubing
7	Seal wash tubing to pump head (silicone tubing)

1. Disconnect the peristaltic tubing from the tubing connectors that connect it to the silicone tubing.
2. Press down the lever on the seal wash pump and remove the peristaltic tubing from the pump and from the tubing holders.
3. Connect the new peristaltic tubing to the silicone tubing using the tubing connectors. Cut tubing to required length, if applicable.
4. Insert the peristaltic tubing into the right tubing holder. Make sure that the tubing connector rests on the tubing holder. Push the tubing connector vertically down onto the holder if required.
5. Press down the lever on the seal wash pump and hold it in that position with one hand.
6. With your other hand, insert the tubing between the lever and the rotor and wind it around the rotor.
7. Release the lever.
8. Insert the peristaltic tubing into the left tubing holder.
9. Check that the peristaltic tubing is inserted properly in the tubing holders. If it is not, push the tubing into the holders. Make sure that the tubing is not pinched or squeezed in the holders.

Restarting the Seal Wash System

1. Retighten the reservoir cap hand-tight. The retaining guide must remain in the hole in the reservoir cap. If it does not, press the retaining guide into the hole so that the tubing is kept in place in the cap.
2. Check the wash lines over the entire flow path:
 - a) Make sure that no bending (kink), pinching or squeezing of the wash lines is present at any point in the flow path.
 - b) If you have to cut tubing to length, use a tubing cutter. Make sure that the cut is at right angle to the length of the line.
3. Flush the seal wash system, using fresh seal wash liquid (see [Flushing the Seal Wash System](#) (▶ page 76)).

Replacing the Seal Wash Lines between the Peristaltic Tubing and the Seal Wash Detector

1. Disconnect the seal wash tubing from the tubing connectors. Do not remove the tubing connectors.
2. Connect the new seal wash lines.

3. Retighten the reservoir cap hand-tight. The retaining guide must remain in the hole in the reservoir cap. If it does not, press the retaining guide into the hole so that the tubing is kept in place in the cap.
4. Check the wash lines over the entire flow path:
 - a) Make sure that no bending (kink), pinching or squeezing of the wash lines is present at any point in the flow path.
 - b) If you have to cut tubing to length, use a tubing cutter. Make sure that the cut is at right angle to the length of the line.
5. Flush the seal wash system, using fresh seal wash liquid (see [Flushing the Seal Wash System](#) ► page 76)).

7.5.3 Replacing the Seal Wash Detector

When

- Contamination of detector electrodes
- Impaired functionality of the seal wash system

Parts required

Seal wash detector assembly, consisting of the detector and funnel

Preparations

To prepare the new seal wash detector assembly push the seal wash detector into the funnel. Mind the orientation of the funnel.

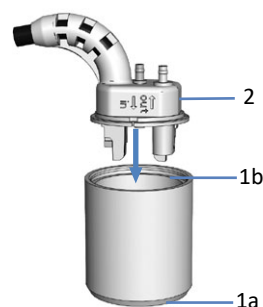


Figure 34: Assembling the seal wash detector parts

No.	Description
1a	Funnel (bottom side)
1b	Funnel (top side)
2	Seal wash detector

Follow these steps

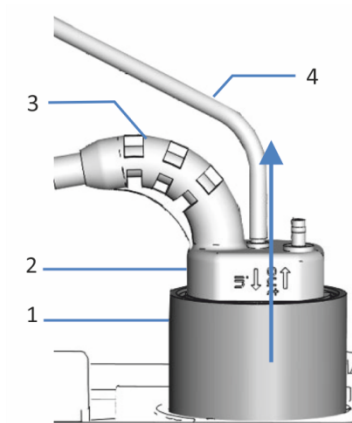


Figure 35: Removing the seal wash detector assembly

No.	Description
1	Funnel, seal wash detector
2	Seal wash detector
3	Detector cable
4	Seal wash line

1. Disconnect the seal wash line from the seal wash detector (port labeled **in**).
2. Unplug the detector cable from the **DROP DET** port.
3. Grasp and pull the seal wash detector assembly upward by the funnel.
4. Push the new seal wash detector assembly into the pump.

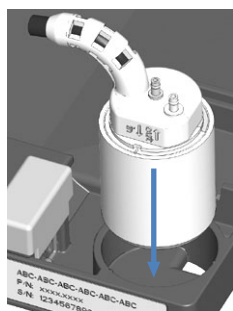


Figure 36: Installing the seal wash detector assembly

5. Reconnect the seal wash line to the seal wash detector (port labeled **in**).
6. Connect the detector cable to the **DROP DET** port.
7. Flush the seal wash system, using fresh seal wash liquid (see [Flushing the Seal Wash System](#) (▶ page 76)).

7.6 Pump Head

Follow the sequence of steps for the maintenance procedure that you want to perform:

NOTICE

All pumps except VC-P21 and VC-P33: Whenever you remove the pump head, you must replace the seal wash seals.

- To replace a pump head, see [Replacing the Pump Head](#) (▶ page 136).
- To replace a piston, see [Replacing the Pistons](#) (▶ page 142).
- To clean a piston, see [Cleaning the Piston](#) (▶ page 144).
- To replace the piston seals or support ring, see [Replacing the Piston Seals or Support Ring](#) (▶ page 145).
- To replace the seal wash seals, see [Replacing the Seal Wash Seals](#) (▶ page 151).
- To replace the pump head seals, see [Replacing the Pump Head Seals](#) (▶ page 154).
- To test the pump for piston seal leakage, see [Testing the Piston Seals for Leakage](#) (▶ page 156).

For an overview of the pump head parts, see [Overview of Pump Head Parts](#) (▶ page 135).

7.6.1 Overview of Pump Head Parts

The picture shows the main pump head parts.

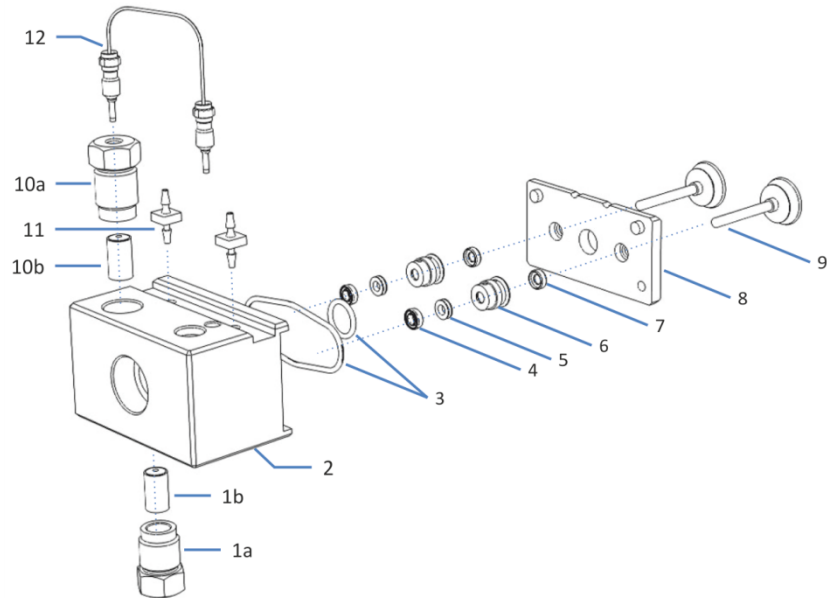


Figure 37: Overview of pump head parts

No.	Description
1	Inlet check valve, including:
1a	Valve nut
1b	Valve cartridge
2	Pump head
3	Pump head seals (2 PTFE O-ring seals)
4	Piston seals
5	Support rings
6	Seal wash bodies (pump head bushing)
7	Seal wash seals
8	Seal wash plate
9	Pistons
10	Outlet check valve, including:
10a	Valve nut
10b	Valve cartridge
11	Connectors for seal wash tubing (pluggable)
12	U-tube (capillary from working cylinder to equilibration cylinder)

7.6.2 Replacing the Pump Head

When

Damage of pump head

Parts required

- Pump head
- Spacing tool (pump head tool)

Tools and additional items required

- Hexagon wrench, size 6
- Depending on the capillary that connects the pump head to the purge/sensor unit:
 - ◆ Viper capillary: Installation tool for Viper capillaries with torque tothing
 - ◆ Conventional capillary (non-Viper): Open-end wrench, size 1/4"
- Solvent suitable for purging to flush out harmful substances
- Seal wash liquid
- Solvent suitable for your application

Preparations

1. To flush out harmful substances, purge the pump with an appropriate solvent.
2. Turn off the pump flow and wait until the system pressure is down to zero.

Follow these steps

1. Remove the pump head. See [Removing the Pump Head](#) (▶ page 137).
2. Install the pump head. See [Installing the Pump Head](#) (▶ page 138).

7.6.2.1 Removing the Pump Head

Preparations

Prepare the pump for removing the pump head. See [Replacing the Pump Head](#) (▶ page 136).

Follow these steps

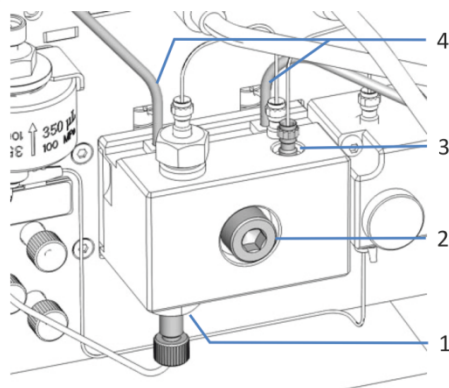


Figure 38: Pump head

No.	Description
1	Pump head inlet
2	Pump head screw
3	Pump head outlet
4	Seal wash tubing

1. Open the purge valve by turning the valve knob counterclockwise.
2. *As required by the pump type:*

Pump Type	Action
Binary pump	Select the pump head for which you want to perform the procedure.
Dual pump	Select the pump for which you want to perform the procedure.
Isocratic pump, quaternary pump	Continue with the next step.

3. Undock the pistons either from the keypad or from the Chromeleon software. Wait until undocking is complete before proceeding with the next step.
4. Remove the capillary that connects the pump head to the purge/sensor unit. Disconnect the capillary on both the pump head outlet and the purge/sensor unit.

5. On the pump head, disconnect the following tubing and capillaries:
 - ◆ On the pump head inlet, disconnect the tubing.
 - ◆ Remove the seal wash lines from the tubing connectors on the pump head. Do not remove the tubing connectors.
6. *Binary pump*: Unplug the cable of the pressure sensor from the **P-WORK** connector.
7. Loosen the pump head screw with the hexagon wrench.
8. Hold the pump head with one hand, remove the pump head screw, and then remove the pump head by pulling it toward you.
9. It may happen that the seal wash plate remains in the pump when you remove the pump head. Follow these steps:
 - a) Insert the spacing tool between the pump head and pump block.
 - b) Carefully pull the seal wash plate away from the pump block.

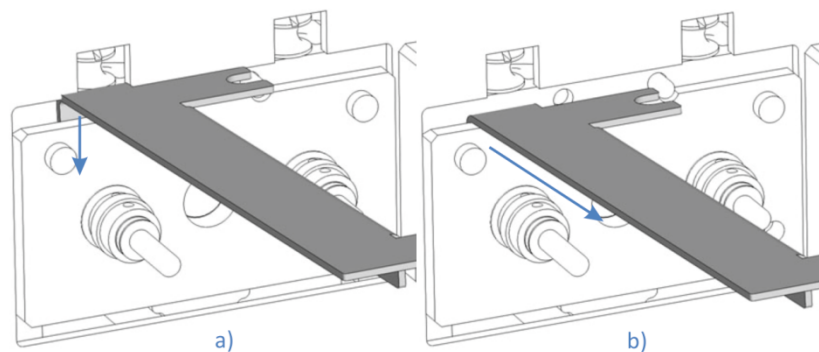


Figure 39: Removing the seal wash plate

7.6.2.2 Installing the Pump Head

Preparations

1. Remove the pump head. See [Removing the Pump Head](#) (▶ page 137).
2. Before you begin, note the information for reinstalling pump heads and installing new pump heads (replacement pump heads).

Reinstallation of pump heads (binary pump or dual pump only): Be sure not to interchange the pump heads.

- *Binary pump*: To identify the correct installation position, note the labeling on the pressure sensor cable (**A** for the left pump head or **B** for the right pump head).

- **Dual pump:** To identify the correct installation position, note the labeling on the U-tube (capillary from working cylinder to equilibration cylinder) (**A** for the pump head of the left pump or **B** for the pump head of the right pump).

Installation of new pump heads (replacement pump heads)

- **With binary pump and dual pump:** New pump heads can be installed in either position when installed for the first time. They have no label on the pressure sensor cable or U-tube. For easier identification during future maintenance, consider labeling them according to the installation position (**A** for the left pump head or **B** for the right pump head).
- To protect the pistons during shipment, the spacing tool is installed between the seal wash plate and the pistons. Remove the spacing tool. Be careful not to pull out the pistons any further.

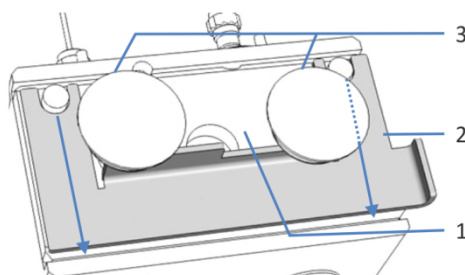


Figure 40: Removing the spacing tool

No.	Description
1	Seal wash plate
2	Spacing tool
3	Pistons

Follow these steps

1. Insert the pump head into the pump and tighten the pump head screw (recommended torque: 10 Nm).
2. On the pump head, reconnect the following tubing and capillaries:
 - ◆ On the pump head inlet, reconnect the tubing. Avoid cross-threading.
 - ◆ Connect the seal wash lines to the tubing connectors on the pump head.
3. Reconnect the capillary that connects the pump head to the purge/sensor unit. Observe the following:
Install the capillary in the direction of solvent flow (indicated by the arrow on the capillary).

4. *Binary pump*: Connect the cable of the pressure sensor to the **P-WORK** connector.
5. Dock the pistons either from the keypad or from the Chromeleon software. Wait until docking is complete before proceeding with the next step.
6. Flush the seal wash system with seal wash liquid (see [Flushing the Seal Wash System](#) (▶ page 141)).
7. Purge the pump using the solvent of your application.
8. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections when the system pressure is down to zero.
9. In the Chromeleon software, consider updating the Predictive Performance information for the pump head components.
10. Test the seal wash system and pump for leakage (see [Testing the Seal Wash System for Leakage](#) (▶ page 128) and [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177)).
11. *Recommended*: From the Chromeleon software, perform performance qualification for the pump:
 - ◆ Run the pump-specific **Performance Qualification** tests (PQ tests) (= Flow Precision Test and Gradient Accuracy Test). For details, refer to the *Operational and Performance Qualifications manual*.
 - ◆ When the tests are completed, execute the **QualificationDone** command.

7.6.2.3 Flushing the Seal Wash System

When

To flush the seal wash system during pump head installation, follow the steps in this section.

To flush the seal wash system for any other reason, see [Flushing the Seal Wash System](#) (▶ page 76).

Follow these steps

1. Disconnect the tubing from the seal wash detector.

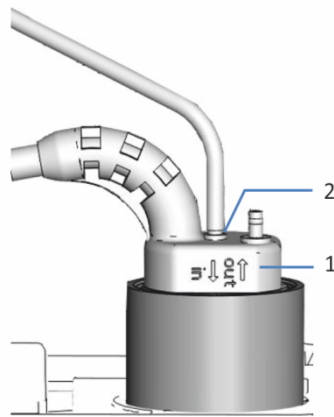


Figure 41: Seal wash detector

No.	Description
1	Seal wash detector
2	Tubing connection port (port labeled in)

2. Insert a syringe into the open end of the tubing.
3. To allow the liquid to travel easily through the seal wash system, press down the lever of the seal wash pump and hold it in that position with one hand.
4. Pull out the syringe plunger to draw seal wash liquid into the tubing.
5. When about 10 mL of liquid are present in the syringe, release the lever of the seal wash pump.

7.6.3 Replacing the Pistons

When

Damage of piston

Parts and additional items required

- Pistons
- Syringe filled with isopropanol
- Seal wash seals (and seal-handling tool)
- Seal wash liquid
- Solvent suitable for your application

NOTICE

All pumps except VC-P21 and VC-P33: Whenever you remove the pump head, you must replace the seal wash seals.

Preparations

Remove the pump head (see [Replacing the Pump Head](#) (▶ page 136)).

Follow these steps

1. Remove the pistons:
 - ◆ *If the seal wash plate was removed together with the pump head:* Hold down the seal wash plate onto the pump head and pull out the pistons.
 - ◆ *If the seal wash plate was removed separately:* Pull out the pistons from the seal wash plate.
2. *When reinstalling a piston that you removed*
Clean the piston. Follow the steps in [Cleaning the Piston](#) (▶ page 144).
3. Replace the seal wash seals (see [Replacing the Seal Wash Seals](#) (▶ page 151)).
4. To facilitate piston installation, inject a few drops of isopropanol into the piston cavity in which you want to install the piston.

5. Place the spacing tool onto the pump head.

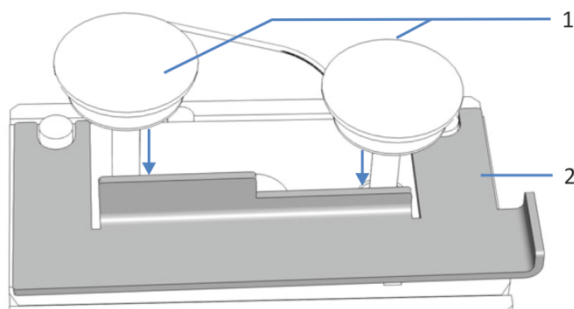


Figure 42: Installing the spacing tool and pistons

No.	Description
1	Pistons (in the picture, the piston bases are marked)
2	Spacing tool

6. Grasping the pistons by the piston base, push in the pistons until they contact the tool.
7. Remove the spacing tool. Be careful not to pull out the pistons any further.
8. Install the pump head (see [Installing the Pump Head](#) (▶ page 138)).
9. Flush the seal wash system with seal wash liquid (see [Flushing the Seal Wash System](#) (▶ page 141)).
10. Purge the pump using the solvent of your application.
11. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections when the system pressure is down to zero.
12. In the Chromeleon software, consider updating the Predictive Performance information for the pistons.
13. Test the seal wash system and pump for leakage (see [Testing the Seal Wash System for Leakage](#) (▶ page 128) and [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177)).
14. *Recommended:* From the Chromeleon software, perform performance qualification for the pump:
- ◆ Run the pump-specific **Performance Qualification** tests (PQ tests) (= Flow Precision Test and Gradient Accuracy Test). For details, refer to the *Operational and Performance Qualifications manual*.
 - ◆ When the tests are completed, execute the **QualificationDone** command.

7.6.4 Cleaning the Piston

When

Before reinstalling a piston that you removed

Items required

- Dry, lint-free tissue
- Light source
- Isopropanol

Follow these steps

1. Inspect the piston for signs of damage.

TIP Hold the rear side of the piston into the light. The refraction of the light makes dirt particles appear larger.

2. Even if the piston seems to be clean: Hold the piston and carefully move your fingernail over the piston surface. You should not feel inconsistent or rough areas.

3. Depends on the situation:

Situation	Action
No damage visible, no inconsistent or rough areas	<ol style="list-style-type: none"> 1. Carefully rinse the piston, using isopropanol. 2. With a dry, lint-free tissue, rub the piston several times. 3. Reinstall the piston.
Piston is scratched or scored	Install a new piston.

7.6.5 Replacing the Piston Seals or Support Ring

When

- Damage to piston seals, leaky seals
- Unstable flow rates or baseline noise

Parts required

- Piston seals
- Support ring
Note that the support ring is *not* a wear part. You need *not* replace the support ring when you replace a piston seal. Replace the support ring only when applicable.
- Seal wash seals (and seal-handling tool)

NOTICE

All pumps except VC-P21 and VC-P33: Whenever you remove the pump head, you must replace the seal wash seals.

Tools and additional items required

- Syringe filled with isopropanol
- Cleaning swab
- Lint-free tissue
- Seal-handling tool

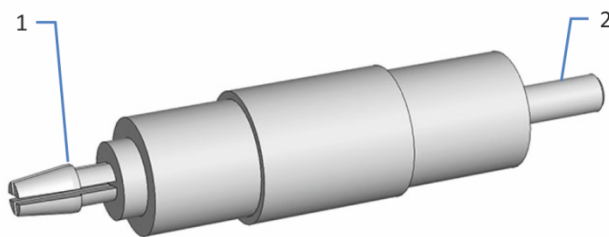


Figure 43: Seal-handling tool

No.	Description
1	Seal removal pin
2	Seal insertion pin

Preparations

1. Remove the pump head (see [Replacing the Pump Head](#) (▶ page 136)).
2. Remove the pistons (see [Replacing the Pistons](#) (▶ page 142)).

Follow these steps

1. Remove the seal wash plate from the pump head if applicable.

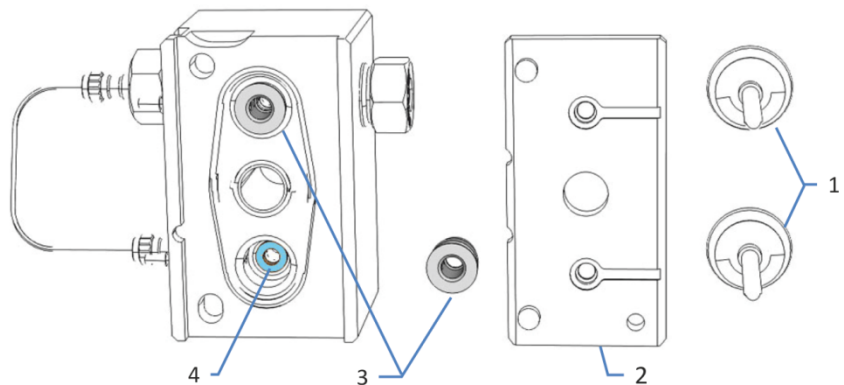


Figure 44: Pump head, seal wash plate removed

No.	Description
1	Pistons
2	Seal wash plate
3	Seal wash bodies
4	Support ring

2. Remove the seal wash bodies from the pump head.
3. Remove the support ring.
Gently tap the pump head on a clean work surface to make the support ring drop out.

If the support ring does not drop out, use the seal-handling tool. With the *insertion* pin, push the seal-handling tool at a slight angle into the pump head and remove the tool. The support ring is removed together with the tool.

NOTICE

Do *not* use the *seal removal pin* to remove the support ring. The support ring can be removed from the tool only with difficulties.

4. Remove the piston seal.
With the *removal* pin, push the seal-handling tool into the pump head as far as it goes in and remove the tool. The piston seal is removed together with the tool. Once the seal has been removed, it cannot be reused.
5. *Required if you reinstall the support ring*
Clean the support ring from the inside and outside, using isopropanol, a cleaning swab, and a lint-free tissue.
6. Pipette a few drops of isopropanol into cavity in the pump head, on the edge on which the piston seal will rest.

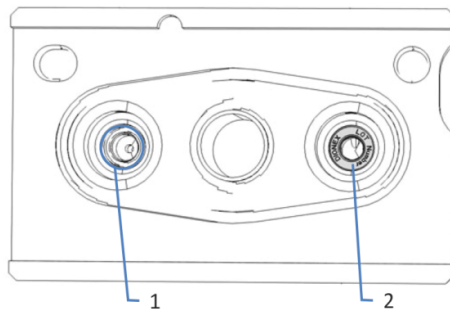


Figure 45: Pump head (left: no piston seal installed, right: piston seal installed)

No.	Description
1	Edge on which the piston seal will rest
2	Piston seal installed

7. Slide the support ring onto the insertion pin of the seal-handling tool.
8. Slide the piston seal onto the insertion pin, with the open side of the seal facing away from the tool.

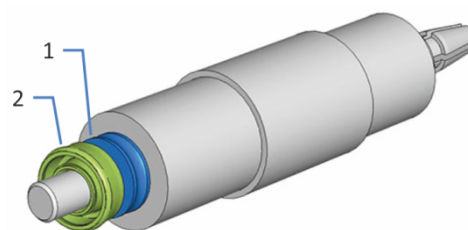


Figure 46: Support ring and piston seal on insertion pin

No.	Description
1	Support ring
2	Piston seal (open side facing away from the tool)

9. With the insertion pin, push the seal-handling tool into the pump head as far as it goes in.
10. Remove the tool from the pump head. The piston seal and support ring remain in the pump head.

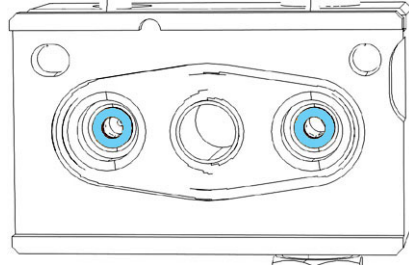


Figure 47: Pump head, piston seals, and support rings installed

11. Insert the seal wash bodies into the pump head. Mind the correct orientation. The even side faces the pump head.

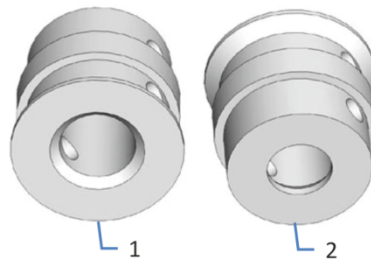


Figure 48: Orientation of the seal wash body

No.	Description
1	Side facing the seal wash plate
2	Side facing the pump head (even side)

12. Replace the seal wash seals. Follow the appropriate steps in [Replacing the Seal Wash Seals](#) (▶ page 151).
13. Install the pistons. Follow the related steps in [Replacing the Pistons](#) (▶ page 142).
14. Install the pump head. See [Installing the Pump Head](#) (▶ page 138).
15. Observe the recommendations for new piston seals (see [Recommendations for New Piston Seals](#) (▶ page 149)).
16. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections when the system pressure is down to zero.
17. In the Chromeleon software, consider updating the Predictive Performance information for the piston seals.

18. Test the seal wash system and pump for leakage (see [Testing the Seal Wash System for Leakage](#) (▶ page 128) and [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177)).
19. *Recommended:* From the Chromeleon software, perform performance qualification for the pump:
 - ◆ Run the pump-specific **Performance Qualification** tests (PQ tests) (= Flow Precision Test and Gradient Accuracy Test). For details, refer to the *Operational and Performance Qualifications manual*.
 - ◆ When the tests are completed, execute the **QualificationDone** command.

7.6.6 Recommendations for New Piston Seals

When

When new piston seals have been installed

TIP The actions recommended in this section directly influence pump performance and the piston seal life cycle.

Items required

- Backpressure capillary (length: 15 m) and Viper union (from the Diagnostics tool kit)
- nanoViper™ capillary (length: 750 mm, inner diameter: 75 µm)
- Silicone tubing
- Isopropanol
- Solvent suitable for your application

Recommendations

- Allow new piston seals to run in.
- Never run the pump dry.
Running the pump dry can damage the pistons or piston seals.

Allowing New Piston Seals to Run In

1. On the purge/sensor unit, attach silicone tubing to the purge outlet (if it is not yet connected).
2. Route the free end of the tubing to the drain port outlet (see [Guiding Liquids to Waste](#) (▶ page 62)).
3. Open the purge valve by turning the valve knob counterclockwise.
4. Install the backpressure capillary on the pump outlet.

5. With the Viper union, connect the nanoViper capillary to the backpressure capillary. Guide the free end of the capillary to the waste container.
6. Operate the pump. For 15 minutes, apply a flow of 1.3 mL/min using isopropanol.
7. Close the purge valve by turning the valve knob clockwise.
8. Generate the necessary backpressure. For 30 minutes, apply the flow indicated in the table using isopropanol.

Pump Type	Flow	Backpressure
VC-pumps	1 mL/min (approximately)	45 MPa (approximately)
VF-pumps	2 mL/min (approximately)	80 MPa (approximately)

9. Turn off the pump flow and wait until the system pressure is down to zero.
10. Remove the capillary from the pump outlet and reconnect the pump to the system.
11. Purge the pump using the solvent for your application.
12. When purging is complete, empty the silicon tubing.
13. If an increased leakage rate is observed with new piston seals after several hours of operation, operate the pump for at least 2 hours at 35 MPa.

TIP If the piston seals are not sufficiently tight yet, have the pump build up high pressure and hold the pressure for some minutes.

Emptying the Silicone Tubing

NOTICE

Always empty the silicone tubing when purging is complete. When the purge valve is closed, purge liquid remains in the tubing connected to the purge outlet. Leaving the liquid in the tubing for a longer period limits the tubing lifetime.

1. To absorb any liquid that might be leaving the purge outlet when the tubing is removed, place the tissue under the outlet.
2. On the purge/sensor unit, remove the silicone tubing from the purge outlet. The other end of the tubing remains in the purge drain port outlet.
3. Hold the tubing so that any liquid that is present in the tubing flows off through the drain port outlet.
4. On the purge/sensor unit, consider reconnecting the silicone tubing.

7.6.7 Replacing the Seal Wash Seals

When

- Damage to the seal wash seal, leaky seal
- Whenever you removed the pump head
- Once a year

Parts required

Seal wash seals

Tools and additional items required

- Syringe filled with isopropanol
- Seal-handling tool

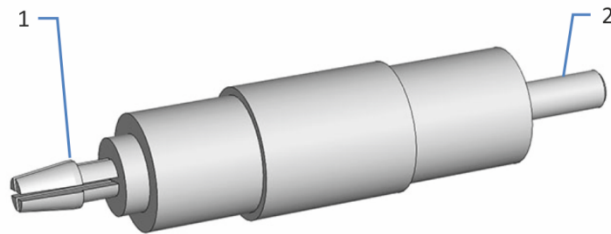


Figure 49: Seal-handling tool

No.	Description
1	Seal removal pin
2	Seal insertion pin

Preparations

1. Remove the pump head (see [Replacing the Pump Head](#) (▶ page 136)).
2. Remove the pistons (see [Replacing the Pistons](#) (▶ page 142)).

Follow these steps

1. Remove the seal wash plate from the pump head if applicable.

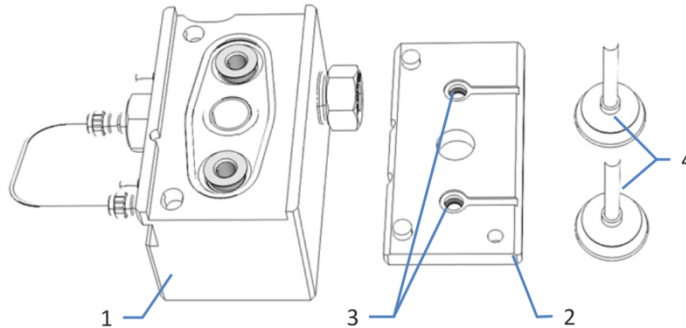


Figure 50: Pump head, seal wash plate, and pistons removed

No.	Description
1	Pump head
2	Seal wash plate, channel side
3	Seal wash seals
4	Pistons

2. Remove the seal wash seal.
On the seal wash plate (channel side), set the *insertion* pin of the seal-handling tool at a slight angle to the seal. Push the seal out of the plate and remove the tool.

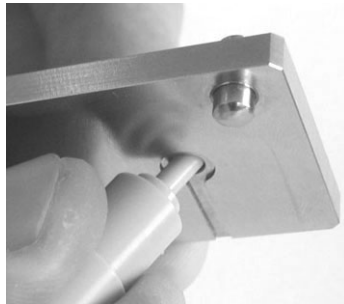


Figure 51: Removing the seal wash seal

3. Slide the new seal onto the insertion pin of the seal-handling tool.
4. To facilitate seal installation, inject a few drops of isopropanol into the seal cavities on the seal wash plate (no-channel side).
5. On the seal wash plate (no-channel side), set the insertion pin of the seal-handling tool at a 90° angle to the plate and push the insertion pin vertically into the plate as far as it goes in.

6. Remove the tool from the seal wash plate. The seal remains in the plate.

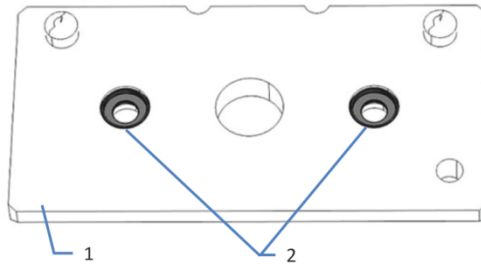


Figure 52: Seal wash plate (no-channel side)

No.	Description
1	Seal wash plate (no-channel side)
2	Seal wash seals

7. Place the seal wash plate onto the pump head, with the seals facing the pump head.

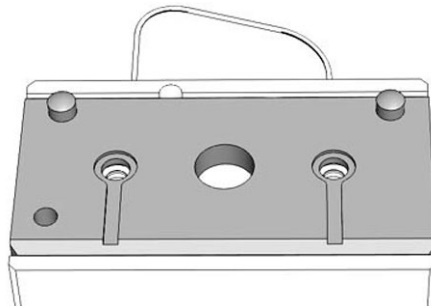


Figure 53: Pump head with seal wash plate installed

8. Install the pistons. Follow the related steps in [Replacing the Pistons](#) (▶ page 142).
9. Install the pump head. See [Installing the Pump Head](#) (▶ page 138).
10. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections when the system pressure is down to zero.
11. Test the seal wash system and pump for leakage (see [Testing the Seal Wash System for Leakage](#) (▶ page 128) and [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177)).
12. If you also replaced the piston seals, proceed with the specific steps further down.

Specific Steps After Piston Seal Replacement

If you replaced the piston seals together with the seal wash seals, proceed with these steps:

1. Observe the recommendations for new piston seals (see [Recommendations for New Piston Seals](#) (► page 149)).
2. In the Chromeleon software, consider updating the Predictive Performance information for the piston seals.
3. *Recommended:* From the Chromeleon software, perform performance qualification for the pump:
 - ◆ Run the pump-specific **Performance Qualification** tests (PQ tests) (= Flow Precision Test and Gradient Accuracy Test). For details, refer to the *Operational and Performance Qualifications manual*.
 - ◆ When the tests are completed, execute the **QualificationDone** command.

7.6.8 Replacing the Pump Head Seals*When*

Damage to pump head seals, leaky seals

Parts and tools required

- Pump head seals
- Seal wash seals (and seal-handling tool)

NOTICE

All pumps except VC-P21 and VC-P33: Whenever you remove the pump head, you must replace the seal wash seals.

Preparations

1. Remove the pump head (see [Replacing the Pump Head](#) (► page 136)).
2. Remove the pistons (see [Replacing the Pistons](#) (► page 142)).

Follow these steps

1. Remove the seal wash plate from the pump head if applicable.
2. Remove the seal wash bodies from the pump head if applicable.

- Remove the pump head seals.

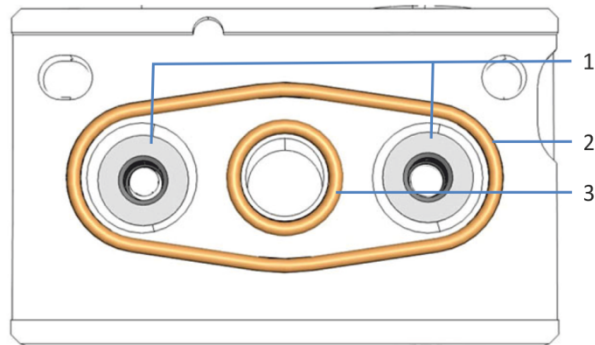


Figure 54: Pump head seals

No.	Description
1	Seal wash bodies
2	Pump head seal, O-ring 32x1.5
3	Pump head seal, O-ring 9x1.5

- Install the new seals.
Place the seal onto the receiving groove. With your finger on the seal, follow the groove shape until the seal rests exactly in the groove.
- Insert the seal wash bodies into the pump head. Mind the correct orientation. The even side faces the pump head.

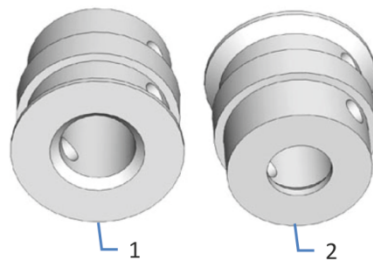


Figure 55: Orientation of the seal wash body

No.	Description
1	Side facing the seal wash plate
2	Side facing the pump head (even side)

- Replace the seal wash seals (see [Replacing the Seal Wash Seals](#) (▶ page 151)).
- Install the pistons. Follow the related steps in [Replacing the Pistons](#) (▶ page 142).

8. Install the pump head. See [Installing the Pump Head](#) (▶ page 138).
9. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections when the system pressure is down to zero.
10. Test the seal wash system and pump for leakage (see [Testing the Seal Wash System for Leakage](#) (▶ page 128) and [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177)).

7.6.9 Testing the Piston Seals for Leakage

When

- Pressure pulsation, shift in retention times, and/or poor reproducibility can indicate possible piston seal leakage.
- If messages regarding piston seal leakage appear in the chromatography software, for example, "**The piston seal leakage has exceeded the recommended limit (code 4121)**".

Parts and additional items required

- Backpressure capillary (from Diagnostics tool kit) (optional)
- Isopropanol

Follow these steps

1. From the Chromeleon software, start a seal wash cycle.
2. When the seal wash cycle is complete, disconnect the tubing from the seal wash detector (port labeled **in**).

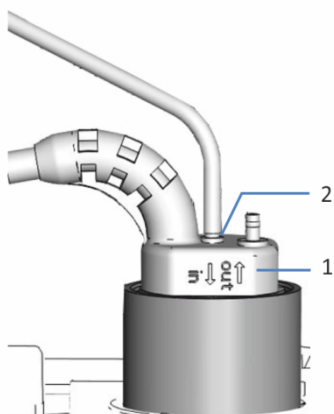


Figure 56: Seal wash detector

No.	Description
1	Seal wash detector
2	Tubing connection port (port labeled in)

3. Remove some liquid from the tubing, for example, by shaking the tubing.
4. Set up the system in such a way that the backpressure indicated in the table is produced.
For example, install an appropriate backpressure capillary on the pump outlet (outlet of the static mixer).

Pump Type	Backpressure
VC-pumps	60 MPa (approximately)
VF-pumps	80 MPa (approximately)

5. Apply a flow rate of 2 mL/min using isopropanol.
6. To evaluate possible leakage, observe the liquid level in the tubing. Finish the observation before a new seal wash cycle starts (after one hour).
7. Depends on your observation:

Observation	Remedial Action
Liquid level in the tubing remains unchanged	The piston seals seal tightly. Reconnect the seal wash tubing to the seal wash detector (port labeled in). This completes the test.
Liquid level in the tubing is decreasing	The seal wash seals are leaky: 1. Replace the seal wash seals. 2. Reconnect the seal wash tubing to the seal wash detector (port labeled in). 3. Repeat the test starting with step 1.
Liquid level in the tubing is increasing	One or more piston seals are leaky. <i>Isocratic pump and quaternary pump:</i> 1. Replace the piston seals in the pump head. 2. Reconnect the seal wash tubing to the seal wash detector (port labeled in). 3. Repeat the test starting with step 1. <i>Binary pump and dual pump:</i> Continue with the next steps.

8. On the right pump head, remove the seal wash tubing that connects the left pump head to the right pump head.
9. Depends on the pump type:

Pump Type	Action
Binary pump	Apply a flow rate of 2 mL/min for 100% solvent A using isopropanol.
Dual pump	Apply a flow rate of 2 mL/min for the left pump using isopropanol.

10. For about 5 minutes, observe the liquid level in the tubing. Finish the observation before a new seal wash cycle starts.

11. Depends on your observation:

Observation	Remedial Action
Liquid level in the tubing is increasing again	<ol style="list-style-type: none"> 1. Replace the piston seals in the <i>left</i> pump head. 2. Reconnect the seal wash tubing to the right pump head. 3. Reconnect the seal wash tubing to the seal wash detector (port labeled in). 4. Repeat the test starting with step 1.
Liquid level in the tubing does not increase again	<ol style="list-style-type: none"> 1. Replace the piston seals in the <i>right</i> pump head. 2. Reconnect the seal wash tubing to the right pump head. 3. Reconnect the seal wash tubing to the seal wash detector (port labeled in). 4. Repeat the test starting with step 1.

TIP If you observe leakage from a pump head, verify that the seal wash tubing is properly connected to the pump head. If the tubing is not properly connected or if the tubing is crimped or kinked, seal wash liquid may leak into the pump.

7.7 Check Valves

Follow the sequence of steps for the maintenance procedure that you want to perform:

- To replace the inlet check valves, see the next section.
- To replace the outlet check valves, see [Replacing the Outlet Check Valves](#) (▶ page 161).
- To clean the check valves, see [Cleaning the Check Valves](#) (▶ page 164).

7.7.1 Replacing the Inlet Check Valves

The picture shows the parts that must be removed.

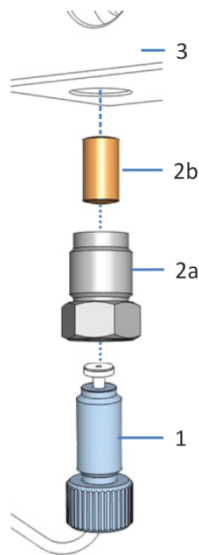


Figure 57: Replacing the inlet check valve

No.	Description
1	Tubing on inlet check valve
2	Inlet check valve, including:
2a	Valve nut
2b	Valve cartridge
3	Pump head

When

- Issue with the check valve that could not be solved by cleaning (for example, persistent leakage)
- Damage of inlet check valve

Parts required

- Valve cartridge
- Valve nut, required only when leakage is present at the fitting connection to the valve

Tools and additional items required

- Solvent suitable for purging to flush out harmful substances
- Solvent suitable for your application
- Open-end wrench, size 13 mm
- Tweezers, flat tips or curved tips

Preparations

1. To flush out harmful substances, purge the pump with an appropriate solvent.
2. Turn off the pump flow and wait until the system pressure is down to zero.

Follow these steps

1. On the valve nut, disconnect the tubing.
2. Use the open-end wrench to loosen and remove the valve nut from the pump head.
3. Remove the valve cartridge:

Valve Cartridge	Action
Valve cartridge removed together with valve nut	Hold the nut over your hand and turn it upside down to allow the cartridge to drop into your hand.
Valve cartridge remained in pump	Pull out the cartridge using the tweezers.

4. Insert the new cartridge into the valve nut. Insert the cartridge in the direction of flow (indicated by the arrow on the cartridge).

5. Screw the valve nut into the pump head and tighten with the open-end wrench.

NOTICE

Overtightening may damage the valve cartridge. The torque should not exceed 10 Nm.

6. On the valve nut, reconnect the tubing.
7. Rinse the pump thoroughly:
 - ◆ Use the solvent for your application.
 - ◆ Open the purge valve to prevent the rinsing liquid from entering the Vanquish system.
8. Inspect the inlet check valve and fitting connection for indications of leakage. Tighten leaky connections when the system pressure is down to zero.
9. *Optional:* Test the pump for leakage (see [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177)).

7.7.2 Replacing the Outlet Check Valves

The picture shows the parts that must be removed.

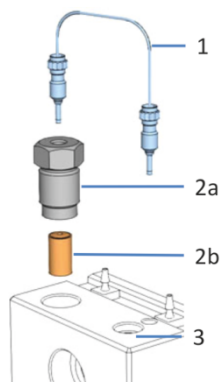


Figure 58: Replacing an outlet check valve (example, here VF-pump)

No.	Description
1	U-tube
2	Outlet check valve, including
2a	Valve nut
2b	Valve cartridge
3	Pump head

When

- Issue with the check valve that could not be solved by cleaning (for example, persistent leakage)
- Damage of outlet check valve

Parts required

- Valve cartridge
- Valve nut, required only when leakage is present at the fitting connection to the valve

Tools and additional items required

- Solvent suitable for purging to flush out harmful substances
- Solvent suitable for your application
- Open-end wrench, size 13 mm
- Tweezers, flat tips or curved tips
- Depending on the capillary connections:
 - ◆ Viper capillary: Installation tool for Viper capillaries with torque tothing
 - ◆ Conventional capillary (non-Viper): Open-end wrench, size 1/4"

Preparations

1. To flush out harmful substances, purge the pump with an appropriate solvent.
2. Turn off the pump flow and wait until the system pressure is down to zero.

Follow these steps

1. Remove the capillary that connects the pump head to the purge/sensor unit. Disconnect the capillary on both the pump head outlet and purge/sensor unit.
2. Remove the U-tube.
3. Use the open-end wrench to loosen and remove the valve nut from the pump head.

4. Remove the valve cartridge:

Valve Cartridge	Action
Valve cartridge removed together with valve nut	Hold the nut over your hand and turn it upside down to allow the cartridge to drop into your hand.
Valve cartridge remained in pump	Pull out the cartridge using the tweezers.

5. Insert the new cartridge into the valve nut. Insert the cartridge in the direction of flow (indicated by the arrow on the cartridge).
6. Screw the valve nut into the pump head and tighten with the open-end wrench.

NOTICE

Overtightening may damage the valve cartridge. The torque should not exceed 10 Nm.

7. Reinstall the U-tube.
8. Reconnect the capillary that connects the pump head to the purge/sensor unit. Observe the following:
Install the capillary in the direction of solvent flow. Note that one end of the capillary is longer than the other end. Connect the longer end to the pump head.
9. Rinse the pump thoroughly:
 - ◆ Use the solvent for your application.
 - ◆ Open the purge valve to prevent the rinsing liquid from entering the Vanquish system.
10. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections when the system pressure is down to zero.
11. *Optional:* Test the pump for leakage (see [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177)).

7.7.3 Cleaning the Check Valves

The cleaning procedure includes the following:

- Ultrasonic cleaning with pure isopropanol
- Running-in the check valves in the pump at high backpressure

When

- Dirty or malfunctioning check valves
- Once a year

Parts and additional items required

- Syringe (12 mL), filled with isopropanol
- Small beaker filled with isopropanol
- Ultrasonic bath
- Solvents suitable for your application (for purging)
- Solvents suitable for the run-in procedure
In most cases, you can use the solvents of your application. To avoid electrostatic discharge in the backpressure capillary, at least 20% water should be present in the 50/50 mixture of solvents A and B. If you are using water-free solvents like normal-phase solvents, use 80% isopropanol in water on both, channel A and channel B.
- Backpressure capillary
You can use any Viper capillary that can generate the backpressure indicated in the table with a flow rate between 1 mL/min and 4 mL/min. For example, you can connect the two Viper capillaries (length: 15 m each) from the Diagnostics tool kit with the connection union to obtain a 30 m capillary with 180 µm inner diameter.

Pump	Requested Backpressure	Approximate Flow Rate*
VC-pump	Approximately 62 MPa	Approximately 1.2 mL/min
VF-pump	Approximately 92 MPa	Approximately 1.8 mL/min

* Approximate flow rate with 80% isopropanol in water and 30 m capillary with 180 µm inner diameter

Preparations

Remove the check valves that you want to clean.

Recommended: Clean the inlet check valves and outlet check valves of all pump heads at the same time. To remove the check valves, follow the steps in [Replacing the Inlet Check Valves](#) (▶ page 159) and [Replacing the Outlet Check Valves](#) (▶ page 161).

Follow these steps

1. In the direction of flow, fill the check valves with isopropanol, using the syringe.
2. Place the check valves in the beaker. Clean them in the ultrasonic bath for 10 minutes.
3. In the direction of flow, flush the check valves with isopropanol, using the syringe.
4. Reinstall the check valves. Follow the steps in [Replacing the Inlet Check Valves](#) (▶ page 159) and [Replacing the Outlet Check Valves](#) (▶ page 161).
5. Install the backpressure capillary on the pump outlet. Guide the free end of the capillary to the waste container.
6. Have the pump deliver the solvents suitable for the run-in procedure: Start with 50% B and a flow rate of 1 mL/min. Increase the flow rate until the system pressure is well above 60 MPa (VC-pump) or 90 MPa (VF-pump) and run the pump for 20 minutes.
7. Inspect the pump heads and check valves for indications for leakage. Tighten leaky connections only when the system pressure is down to zero.
8. Uninstall the backpressure capillary and reconnect the pump as required by your application.
9. Purge the pump, using the solvents of your application.
10. Test the pump for leakage (see [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177)).
11. In the Chromeleon software, consider updating the Predictive Performance information for the check valves.

7.8 Mixing System

TIP The information and references to the static mixer in this section apply equally to the inline filter if installed.

Follow the sequence of steps for the maintenance procedure that you want to perform:

- To test the static mixer for permeability, see [Testing the Static Mixer for Permeability](#) (▶ page 166).
- To replace the static mixer or capillary mixer, see [Replacing the Static Mixer or Capillary Mixer](#) (▶ page 167).

7.8.1 Testing the Static Mixer for Permeability

TIP With the dual pump, test each static mixer separately.

When

If you observe pressure pulsation, inconstant pressure, or high backpressure at the column and pump

Additional items required

- Water as solvent
- Tissue

Follow these steps

NOTICE

Turning the static mixer in the mounting bracket when loosening or tightening capillaries can damage the mounting bracket.

To prevent the mixer from turning in the bracket, hold the mixer with an open-end wrench when you loosen or tighten capillaries on the mixer.

1. Disconnect the capillary on the outlet of the static mixer.
2. To absorb liquid leaving the static mixer, place the tissue on the mixer outlet.
3. Apply a flow of 2 mL/min using water.
4. Observe the pump pressure.

5. Depends on the pressure reading:

Pressure Reading	Action
Pressure is less than 0.8 MPa	Continue with the next step.
Pressure is 0.8 MPa or higher	Replace the static mixer.

6. Reconnect the capillary to the outlet of the static mixer.

7. Test the pump for leakage. See [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177).

7.8.2 Replacing the Static Mixer or Capillary Mixer

When

- Impaired permeability of the static mixer
- Damage of static mixer
- Leaky capillary mixer

Parts, tools and additional items required

- As applicable
 - ◆ Static mixer
 - ◆ Capillary mixer
- Depending on the capillary connection:
 - ◆ Viper capillary: Viper knurl (usually present on the capillary)
 - ◆ Conventional capillary (non-Viper): Open-end wrench, size 1/4"
- Solvent suitable for purging

Preparations

1. To flush out harmful substances, purge the pump with an appropriate solvent.
2. To remove harmful substances from the components in the flow path after the purge unit, have the pump deliver for a short time with the solvent that was used for purging.
3. Turn off the pump flow and wait until the system pressure is down to zero.

Follow these steps

NOTICE

Turning the static mixer in the mounting bracket when loosening or tightening capillaries can damage the mounting bracket.

To prevent the mixer from turning in the bracket, hold the mixer with an open-end wrench when you loosen or tighten capillaries on the mixer.

1. On the static mixer outlet, disconnect the capillary that connects the static mixer to the autosampler injection valve.
2. Disconnect the capillary mixer on the purge/sensor unit.
3. Pull the static mixer out of the mounting bracket.
4. Remove the assembly of static mixer and capillary mixer from the pump.
5. Disconnect the capillary mixer from the static mixer.
6. Connect the capillary mixer to the static mixer.
Mind the direction of flow through the static mixer and capillary mixer (indicated by the arrow on the mixer).
7. Insert the assembly of static mixer and capillary mixer into the pump.
8. Insert the static mixer into the mounting bracket.
9. Connect the capillary mixer on the purge/sensor unit.
10. On the static mixer outlet, connect the capillary to the autosampler injection valve.
11. Apply the flow rate of your application and have the pump deliver for a short time.
12. Inspect the flow connections on the mixer for indications of leakage before resuming operation.
13. *When the static mixer has been replaced:* In the Chromeleon software, consider updating the Predictive Performance information for the static mixer (**MixerChanged** command).

7.9 Solvent Lines and Solvent Line Filters

Follow the sequence of steps for the maintenance procedure that you want to perform:

- To empty the solvent lines, see [Emptying the Solvent Lines](#) (▶ page 169).
- To replace solvent lines, see [Replacing Solvent Lines](#) (▶ page 170).
- To replace the solvent line filter, see [Replacing the Solvent Line Filter](#) (▶ page 173).

7.9.1 Emptying the Solvent Lines

When

To empty the solvent lines, for example, for maintenance or service procedures

Parts required

- Silicone tubing
- Syringe

Preparations

1. Turn off the pump flow and wait until the system pressure is down to zero.
2. Prepare the pump for purging (see [Purging the Pump](#) (▶ page 100)).

Follow these steps

1. Unscrew the cap of the solvent reservoir and remove the cap together with the solvent line from the reservoir.
2. Start a purge cycle as appropriate.
3. Stop purging as soon as the solvent line is empty.

7.9.2 Replacing Solvent Lines

To replace solvent lines, follow the sequence of steps for the solvent line that you want to replace.

The flow path determines the pump inlet (component at which the solvent enters the pump) and the solvent flow through the pump.

Pump Type	Pump Inlet
Binary pump	The pump inlets are the solvent selectors.
Isocratic pump	The pump inlet is the pump head.
Quaternary pump, dual pump	The pump inlet is the vacuum degasser.

For the pump-specific operating principles that illustrate the solvent flow through the pump, see [Pump-Specific Information](#) (► page 215).

- Solvent line from the solvent reservoir to the pump inlet: Follow the steps in [Solvent Lines From Reservoir To Pump Inlet](#) (► page 171).
- *Depending on the pump type*
Solvent line from the pump inlet to the proportioning valve or degasser: Follow the steps in [Solvent Lines From Pump Inlet to Proportioning Valve or Degasser](#) (► page 171).
- *Depending on the pump type*
Solvent line from the proportioning valve or degasser to the pump head: Follow the steps in [Solvent Line From Proportioning Valve or Degasser To Pump Head](#) (► page 172).

7.9.2.1 Solvent Lines From Reservoir To Pump Inlet

When

Damage or blockage of the solvent line

Parts and additional items required

- Solvent line between solvent reservoir and pump inlet
- Solvent suitable for purging

Preparations

1. To flush out harmful substances, purge the pump with an appropriate solvent.
2. Empty the solvent lines (see [Emptying the Solvent Lines](#) (▶ page 169)).

Follow these steps

1. Remove the solvent line from the reservoir cap:
 - a) Remove the filter from the solvent line.
 - b) Remove the retaining guide.
 - c) Pull the solvent line out of the reservoir cap.
2. Disconnect the solvent line on the pump inlet.
3. Remove the solvent line from the pump and all modules above the pump in the system stack. When removing the solvent line from the tubing guides, do not pull on other tubing in the guides.
4. To install the new solvent line, follow the related steps in [Connecting the Solvent Lines](#) (▶ page 63).
5. To remove any air from the solvent lines, purge the pump using the solvent of your application.

7.9.2.2 Solvent Lines From Pump Inlet to Proportioning Valve or Degasser

This section applies to all pumps except the isocratic pump.

When

Damage or blockage of the solvent line

Parts and additional items required

- Solvent line between pump inlet and proportioning valve or degasser inlet, as applicable for the pump
- Solvent suitable for purging

Preparations

- Empty the solvent lines (see [Emptying the Solvent Lines](#) (▶ page 169)).

Follow these steps

1. Retighten the reservoir cap hand-tight. The retaining guide must remain in the hole in the reservoir cap. If it does not, press the retaining guide into the hole so that the tubing is kept in place in the cap.
2. Remove the solvent line on the pump inlet and on the degasser.
3. Install the new solvent line.
4. To remove any air from the solvent lines, purge the pump using the solvent of your application.

7.9.2.3 Solvent Line From Proportioning Valve or Degasser To Pump Head

This section applies to all pumps except the isocratic pump.

When

Damage or blockage of the solvent line

Parts and additional items required

- Solvent line between proportioning valve or degasser and pump head inlet, as applicable for the pump
- Solvent suitable for purging

Preparations

- To flush out harmful substances, purge the pump with an appropriate solvent.

Follow these steps

1. Remove the solvent line on the proportioning valve or degasser and on the pump head inlet.
2. Install the new solvent line.
3. To remove any air from the solvent lines, purge the pump using the solvent of your application.

7.9.3 Replacing the Solvent Line Filter

When

- Damage of solvent line filter
- Impaired permeability of filter frit

Parts and additional items required

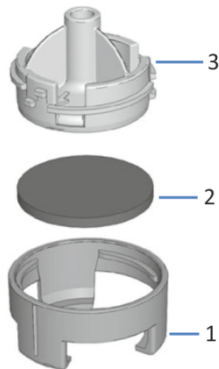


Figure 59: Solvent line filter

No.	Description
1	Solvent line filter, filter holder bottom part
2	Filter frit
3	Solvent line filter, filter holder top part

- As applicable:
 - ◆ Filter holder
 - ◆ Filter frit
- Solvent suitable for purging

Preparations

1. Turn off the pump flow and wait until the system pressure is down to zero.

Follow these steps

1. Unscrew the cap of the solvent reservoir and remove the cap together with the solvent line from the reservoir.
2. Remove the filter holder from the solvent line.
3. *As applicable:* Open the filter holder and remove the filter frit.

4. Assemble the solvent line filter, wearing appropriate clean gloves:
 - a) Place the frit in a level position in the filter holder (bottom part).
 - b) Screw the filter top to the filter bottom.
5. Slide the filter holder onto the solvent line.
6. Retighten the reservoir cap hand-tight. The retaining guide must remain in the hole in the reservoir cap. If it does not, press the retaining guide into the hole so that the tubing is kept in place in the cap.
7. To remove any air from the solvent lines, purge the pump using the solvent of your application.

7.10 Replacing the Purge Valve Knob

When

- Leakage is observed around the valve knob when the valve is open.
- Leakage is observed on the purge outlet when the valve is closed.

Parts required

Purge valve knob (with integrated seals)

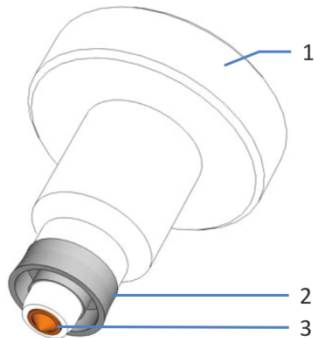


Figure 60: Purge valve knob with integrated seals

No.	Description
1	Purge valve knob
2	Ring seal
3	Cap seal

NOTICE

Avoid holding the new valve knob by the seal end. Scratches on the seals will prevent a proper seal and cause leakage.

Additional items required

- Solvent suitable for purging to flush out harmful substances
- Cleaning swab
- Solvent suitable for your application

Preparations

1. To flush out harmful substances, purge the pump with an appropriate solvent.
2. Turn off the pump flow and wait until the system pressure is down to zero.

Follow these steps

1. To remove the purge valve knob from the purge/sensor unit, turn the valve knob counterclockwise all the way and pull it straight off the purge/sensor unit.
2. Before installing the new purge valve knob, clean the opening in the purge/sensor unit with a cleaning swab.
3. Insert the new purge valve knob into the purge/sensor unit.
4. To tighten, turn the valve knob clockwise with your fingers until it is finger-tight.

NOTICE

Turn the valve knob only with your fingers. Overtightening may damage the purge valve seals.

5. Resume operation.
6. Inspect the purge outlet. If liquid leaves the outlet, the valve knob may not be tightened enough. Tighten a little more.

7.11 Testing the Pump for Leakage (General Test)

When

Following maintenance on the fluidic system of the pump, such as the flow connections, pump heads, or check valves

To Test the Pump

The following tests are available:

Test	Description
Automatic testing	See Automatic Testing (▶ page 177). <i>Prerequisite:</i> The chromatography data system supports tightness testing for the Vanquish system configuration.
Manual testing	See Manual Testing (▶ page 178).

7.11.1 Automatic Testing

Automatic testing means that the test runs automatically without further user interaction. The test checks the tightness of the pump and autosampler.

Prerequisite

A compatible chromatography data system that supports basic tightness testing for the configuration of your Vanquish system

Follow these steps

1. In the chromatography data system, run the **Basic Tightness Test** from the **Diagnostic Tests** menu.
2. If the test fails, check the Instrument Audit Trail for a message.
3. Take remedial action as suggested for the message in the *Troubleshooting* section of *Operating Manual* for the module for which the test failed.

7.11.2 Manual Testing

If the **Basic Tightness Test** is not available in the chromatography data system for your Vanquish system configuration, test the pump manually. Manual testing requires user interaction.

TIP With the dual pump, test each pump separately.

Parts and additional items required

- Fitting plug, Viper
- Solvent suitable for your application

Follow these steps

1. Disconnect the capillary on the pump outlet.
2. Close the pump outlet with the fitting plug.
3. In the chromatography data system, set the upper pressure limit to the appropriate value:

Pump	Upper Pressure Limit
VC-pump	60 MPa
VF-pump	80 MPa

4. Apply a flow of 50 $\mu\text{L}/\text{min}$ and use the solvent for the application.
5. Observe the pressure. When the pressure reading is as indicated in the table, change the flow rate to a lower value.

Pump	Pressure
VC-pump	Between 30 MPa and 40 MPa
VF-pump	Between 60 MPa and 70 MPa

6. Have the pump deliver until the following pressure has built up:

Pump	Pressure
VC-pump	55 MPa
VF-pump	75 MPa

7. When the pressure has built up, apply the following flow:

Pump	Flow
Standard pump	
VC-P10, VC-P20, VC-P32, VC-P40	1 µL/min
VC-P21, VC-P33	4 µL/min
VF-pump	1 µL/min
Pump modified for NP applications	
VC-P20, VC-P21, VC-P32, VC-P32, VC-P40	4 µL/min
VC-P10	6 µL/min

8. Observe the pressure.
The pressure should increase or remain constant for a minimum of 1 minute. A drop in pressure indicates possible leakage.
9. Find and eliminate the cause for the leak.
Take remedial action only when the system pressure is down to zero.

Possible Source	Remedial Action
Capillary connections	Inspect the capillary connections for signs of leakage. Tighten or replace leaky connections when the system pressure is down to zero.
Piston seals	<ul style="list-style-type: none"> • Test the piston seals for leakage. Replace leaky piston seals. • If leakage is observed with new piston seals, run in the seals. Using the solvent of your application or water, operate the pump for 2 hours or longer at 35 MPa.
Check valves	<ul style="list-style-type: none"> • If leakage is observed on the connection port, turn off the pump flow. When the system pressure is down to zero, tighten the check valve a little more. • Remove the valve cartridge. Clean the cartridge in an ultrasonic bath. If cleaning is not sufficient, replace the cartridge.
Purge valve knob	Inspect the purge valve knob and purge outlet for indications of leakage.

10. After taking a remedial action, test the pump.

Testing the Pump

1. Pressure up the pump.
This is the best way to identify whether a connection is leaky.
2. Allow 5 minutes for the pressure to stabilize.
This is important. The pressure drops faster during the first 5 minutes until the seals and other components have adjusted to the pressure.

3. After the stabilization time, monitor the pressure drop.
4. Tighten the connection that you want to test a little more. The pressure will suddenly increase a little.
5. Monitor if the pressure drops at the same rate as before. If the pressure drops significantly slower, the connection was leaky.
6. When testing the pump for leakage is complete, reset the upper pressure limit to the value used before the leakage test.

7.12 Replacing the Main Power Fuses

When

Blown fuses

Parts required

Fuses (2 fuses, 3.15 AT, 250 V AC, slow-blow, 5 x 20 mm) from Fuses Kit

Tools required

Slotted screwdriver, any size between 3.3 mm and 5.5 mm is appropriate

Preparations



WARNING—Electric Shock

High voltages are present inside the device that could cause an electric shock or damage to the device.

- Turn off the device with its main power switch. Disconnect the power cord from both the power source and the device.
- Use only the fuses of the type and current rating specified for the device by Thermo Fisher Scientific.
- Do not use repaired fuses and do not short-circuit the fuse holders.

Follow these steps

The fuse holder is located next to the main power switch.

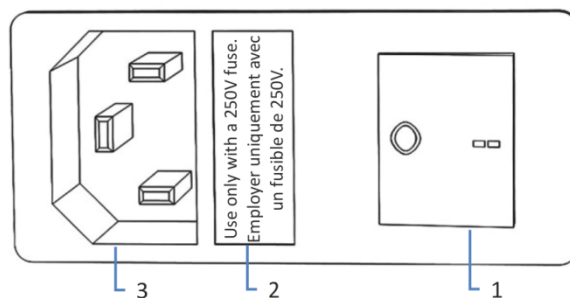


Figure 61: Fuse holder

No.	Description
1	Main power switch (on/off control)
2	Fuse holder
3	Power-inlet connector

1. Use the screwdriver to remove the fuse holder.
2. Replace the two fuses with new fuses of the specified type and current rating. Always replace *both* fuses.
3. Reinstall the fuse holder.
4. Reconnect the power cord to the power source and to the device.
5. Turn on the device with the main power switch.

7.13 Updating the Device Firmware

The description in this section refers to the Chromeleon 7 Chromatography Data System.

When

Updating the device firmware might be required, for example, when a new firmware version is released that adds functionality or solves problems of a previous version.

Items required

Firmware version/Chromeleon version as appropriate

TIP When a new firmware version is released, the new version will be included in the next available Chromeleon version. The new firmware will *not* be transferred automatically to the device when you install the Chromeleon version.

Preparations

1. Read the release notes provided with the firmware and/or Chromeleon version.
2. Connect the device in the Chromeleon software.
3. Stop all operations on the Instrument that includes the device.
4. Wait until the Instrument is idle.
5. Turn off the pump flow and wait until the system pressure is down to zero.

Follow these steps

1. Start the Instrument Configuration Manager program.
2. Perform a firmware update from the **General** tab page in the configuration dialog box for the device. For details, refer to the *Chromeleon Help*.
The firmware update may take several minutes.

NOTICE

A firmware downgrade or incomplete firmware update may result in loss of functionality or malfunctioning of the device.

- Do not interrupt communication between the Chromeleon software and the device at any time during the procedure.
- At the beginning of the update process, a message appears showing the firmware version currently installed in the device and the version that will be transferred from the Chromeleon software. If the firmware installed in the device is a later version than the version in the Chromeleon software, cancel the download.

3. Monitor the Audit Trail of the Instrument Configuration Manager program to see whether the firmware update was successful or failed.
4. Depends on the situation:

Situation	Action
Firmware update successful	Requalification of the device may be required. Refer to the release notes.
Firmware update failed	Turn the device off and on again. Repeat the firmware update.
Firmware update fails repeatedly	Contact Thermo Fisher Scientific Technical Support.

7.14 Replacing the Doors

When

Damage of door

TIP The maintenance procedures do not require that you remove the doors. If this should ever be required for a specific reason or procedure, follow the steps in this section.

Parts required

Replacement door

Preparations

If the door to be replaced is located directly below the solvent rack, remove all reservoirs from the solvent rack.

If the display is installed next to the door to be replaced, consider loosening the fastening block of the display to push the display toward the system rear.

Follow these steps

NOTICE

To avoid damage to the door hinges, be careful when performing the following sequence of steps and do not apply force.

1. If the door is located directly below the solvent rack, lift the solvent rack slightly on the front edge.
2. To remove a door, push the door upward while opening. Open the door to a position in which the two hinges on the housing are aligned in the grooves on the door. You can remove the door only when the hinges are in the grooves.

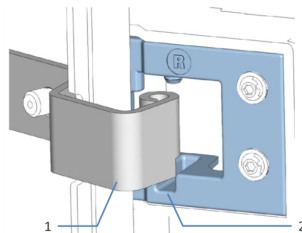


Figure 62: Unhinging a door

No.	Description
1	Hinge on the housing
2	Reception groove on the door

3. Slightly tilt the door to the outside, away from the housing, and remove the door.
4. To install the door, align the door with the hinges on the housing. Do not clamp tubing or capillaries between the door and the enclosure.
5. Insert the hinges in the groove, by pushing up and slightly turning the door.
6. Push the door downward to lock it in place.
You can close the door only when it is properly installed.

7.15 Transporting or Shipping the Device

If you want to transport the device to a new location or if you need to ship the device, first prepare the device for transport, and then move or ship the device as required. Follow the instructions in this section.

Observe the following safety guidelines:



CAUTION—Heavy Load, Bulky Device

The device is too heavy or bulky for one person alone to handle safely. To avoid personal injury or damage to the device, observe the following guidelines:

- Physical handling of the device, including lifting or moving, requires a team effort of two persons.
- A team effort is in particular required when lifting the device into the system stack or when removing it.
- Use the carrying handles that were shipped with the device to move or transport the device. Never move or lift the device by the front doors. This will damage the doors or the device.

Follow these steps

1. Prepare the device for transport. See [Preparing the Device for Transport](#) (▶ page 187).
2. The step depends as follows:
 - ◆ To transport the device to a new location, follow the instructions in [Transporting the Device to a New Location](#) (▶ page 188).
 - ◆ To ship the device, follow the instructions in [Shipping the Device](#) (▶ page 189).

7.15.1 Preparing the Device for Transport

To prepare the device for transport, follow these steps:

1. Perform a long-term shut down of the device (see [Long-Term Shutdown](#) (▶ page 111)).
2. Turn off the device with its main power switch and disconnect the power cord.
3. Remove all cables and flow connections to other devices.
4. Close open flow connections with appropriate plugs, for example, the plugs you removed when setting up the pump.

5. Check the leak tray and drain port. If liquid is present, absorb the liquid with a tissue.
6. Remove the device or slide-in module from the system stack as required:
Install the carrying handles and remove the device from the Vanquish system. Follow the instructions on dismantling the system stack in the *Transporting or Shipping the System* section of the *Vanquish System Operating Manual*.

-or-

Remove the slide-in module from the device enclosure in the system stack (see [Removing the Slide-In Module](#) (▶ page 190)).

7.15.2 Transporting the Device to a New Location

Preparations

Prepare the device for transport. See [Preparing the Device for Transport](#) (▶ page 187).

Follow these steps

1. Observe the notes for handling and lifting the device safely.
2. Transport the device to the new location.
3. Install and set up the device in the system stack. Follow the instructions on mounting the system stack in the *Vanquish System Operating Manual*.
4. Set up the device:
 - a) Connect the device and set up flow connections (see [Installation](#) (▶ page 45)).
 - b) Prepare the device for operation (see [Preparing the Device for Operation](#) (▶ page 92)).
5. Before starting an analysis, let the device equilibrate and be sure that it is ready for operation.

7.15.3 Shipping the Device

Preparations

Prepare the device for transport. See [Preparing the Device for Transport](#) (▶ page 187).



CAUTION—Possible Contamination

Hazardous substances may have contaminated the device during operation and may cause personal injury to service personnel.

- Decontaminate all parts of the device that you want to return for repair.
- Fill in and sign the Health and Safety Form. Thermo Fisher Scientific refuses to accept devices for repair if the Health and Safety Form is missing, incompletely filled in, or unsigned.

Follow these steps

1. Follow the unpacking instructions in this manual in the reverse order.
Use only the original packing material and shipping container. If the original shipping container is not available, appropriate containers and packing material can be ordered from the Thermo Fisher Scientific sales organization.
2. If you need to return the device to Thermo Fisher Scientific for depot repair, contact your local Thermo Fisher Scientific support organization for the appropriate procedure.

Restarting the Device after Shipping

To install the device after shipping, follow the instructions on mounting the system stack in the *Vanquish System Operating Manual*.

7.16 Replacing the Slide-In Module

You can remove the slide-in module from the enclosure of a module for transporting or shipping purposes. The enclosure remains in the system stack. To return a defective module to the factory, install the slide-in module in the enclosure of the replacement module.

7.16.1 Removing the Slide-In Module



CAUTION—Heavy Load, Bulky Device

The device is too heavy or bulky for one person alone to handle safely. To avoid personal injury or damage to the device, observe the following guidelines:

- Physical handling of the device, including lifting or moving, requires a team effort of two persons.
- A team effort is in particular required when lifting the device into the system stack or when removing it.

Tools required

Screwdriver, Torx T20

Preparations

1. Prepare the device for transport. See [Transporting or Shipping the Device](#) (▶ page 187).

Follow these steps

1. Loosen the four captive screws on the front left and front right of the device.

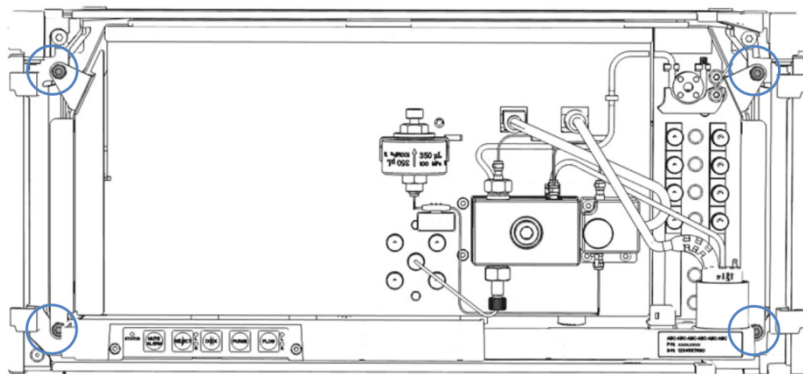


Figure 63: Captive screws on the slide-in module

2. Push all tubing and capillaries, which are present in the tubing chase of the Vanquish system modules, into the tubing chase. Otherwise, you will not be able to remove the slide-in module properly from the enclosure in the next step.
3. Grasp the slide-in module by the leak tray and pull the module out of the enclosure by approximately 10 cm.

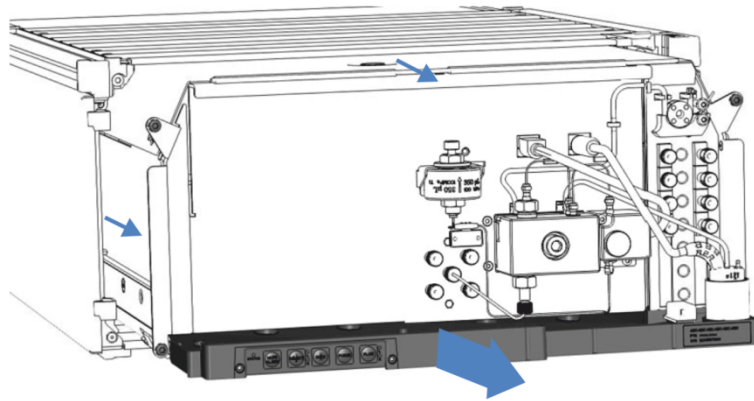


Figure 64: Pulling out the slide-in module

NOTICE

The slide-in module can fall down when pulling it out of the enclosure too far.

Pull out the slide-in module just far enough so that you can grasp it on both sides from below.

4. Remove the slide-in module from the enclosure. The following steps require a team effort:
 - a) Take the slide-in module on both sides from below.
 - b) Pull the slide-in module from the rails towards the front.
 - c) Place the slide-in module on a clean and stable surface.

7.16.2 Returning the Slide-In Module



CAUTION—Possible Contamination

Hazardous substances may have contaminated the device during operation and may cause personal injury to service personnel.

- Decontaminate all parts of the device that you want to return for repair.
- Fill in and sign the Health and Safety Form. Thermo Fisher Scientific refuses to accept devices for repair if the Health and Safety Form is missing, incompletely filled in, or unsigned.

Preparations

Remove the slide-in module from the enclosure. See [Removing the Slide-In Module](#) (▶ page 190).

Follow these steps

1. Install the slide-in module to the enclosure of the replacement device. Follow the steps for inserting the slide-in module in the enclosure and tightening the captive screws in [Installing the Slide-In Module](#) (▶ page 192).
2. Follow the instructions in [Shipping the Device](#) (▶ page 189).

NOTICE

Shipping the slide-in module improperly leads to damage to the device. Always ship the slide-in module as described in this operating manual.

7.16.3 Installing the Slide-In Module



CAUTION—Heavy Load, Bulky Device

The device is too heavy or bulky for one person alone to handle safely. To avoid personal injury or damage to the device, observe the following guidelines:

- Physical handling of the device, including lifting or moving, requires a team effort of two persons.
- A team effort is in particular required when lifting the device into the system stack or when removing it.

Tools required

Screwdriver, Torx T20

Preparations

1. Unpack the replacement device. Remove the slide-in module from its enclosure as described in [Removing the Slide-In Module](#) (▶ page 190).
2. Verify that the device enclosure into which the slide-in module shall be installed is clean. If required, clean the inner and outer surfaces of the enclosure. See [Cleaning or Decontaminating the Device](#) (▶ page 124).
3. When installing the slide-in module to an enclosure in the system stack, check that the enclosure is placed correctly in the stack.

Follow these steps

1. Push all tubing and capillaries, which are present in the tubing chase of the Vanquish system modules, into the tubing chase. Otherwise, you will not be able to insert the slide-in module properly into the enclosure in the next step.
2. On the slide-in module, check that you can move the captive screws back and forth with your fingers. If you cannot, screw them in until you can.
3. Insert the slide-in module in the enclosure. The following steps require a team effort:
 - a) Take the slide-in module on both sides from below.
 - b) Lift the slide-in module to the height of the enclosure.
 - c) Place the slide-in module in the enclosure so that the module sits in the enclosure by approximately 25 cm.
 - d) Push the slide-in module onto the rails and into the enclosure until the slide-in module sits completely in the enclosure.

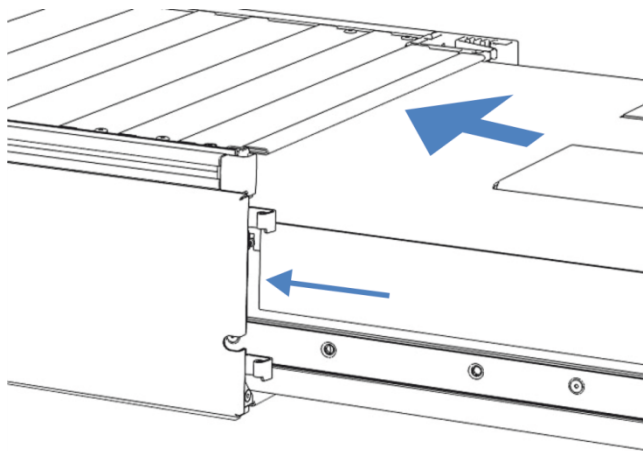


Figure 65: Inserting the slide-in module

4. To facilitate tightening the slide-in module in the enclosure, pull out the module a few millimeters (approximately 2 to 5 mm).
5. With the screwdriver, move each captive screw back and forth while pressing inward until the screw slips into the thread.
6. Push the slide-in module back into the enclosure as far as it goes in.
7. Gradually and evenly, tighten the four captive screws on the slide-in module hand-tight.

NOTICE

- Verify that the screws are tightened. Pull the slide-in module by the leak tray towards the front and check whether the screws move. If they do not move, the slide-in module is installed properly.
- If the screws move, tighten the screws further. With a torque wrench, the recommended torque is 1.2 Nm.

8. Set up and restart the module.

7.16.4 Setting Up the Slide-In Module

After you have installed the slide-in module in the enclosure, set up and restart the device.

Follow these steps

1. Set up the slide-in module:
 - a) Connect the slide-in module and set up flow connections (see [Installation](#) (► page 45)).
 - b) Prepare the slide-in module for first-time operation (see [Preparing the Device for Operation](#) (► page 92)).
 - c) If you installed a replacement slide-in module, update the instrument configuration in the chromatography data system accordingly.
2. Prepare *all other* modules of the Vanquish system for operation and restart them. Refer to the *Operating Manuals* for the modules.
3. Before starting an analysis, let the chromatography system equilibrate and be sure that it is ready for operation.

4. From the Chromeleon software, perform performance qualification for the pump:
 - ◆ Run the pump-specific **Performance Qualification** tests (PQ tests) (= Flow Precision Test and Gradient Accuracy Test). For details, refer to the *Operational and Performance Qualifications manual*.
 - ◆ When the tests are completed, execute the **QualificationDone** command.

8 Troubleshooting

This chapter is a guide to troubleshooting issues that may arise during operation of the device.

8.1 General Information about Troubleshooting

The following features help you to identify and eliminate the source for problems that may arise during operation of the device.

NOTICE

When the Vanquish system includes a Vanquish charged aerosol detector, the detector may affect the operation and/or performance of the pump. For example, errors in the detector may affect the pump by automatically stopping the pump flow. For more information, refer to the *Operating Manual* for the detector.

TIP For information about operating issues that might occur during the operation of a Vanquish system, refer to the *Vanquish System Operating Manual*.

If you are unable to resolve a problem following the instructions given here or if you experience problems that are not covered in this section, contact Thermo Fisher Scientific Technical Support for assistance. See the contact information at the beginning of this manual.

To facilitate device identification, have the serial number and technical name available when communicating with Thermo Fisher Scientific.

Status Indicators

The status indicator LED bar on the front side of the device and the **STATUS** LED on the keypad inside provide quick visual feedback on the operational status of the device. If the device firmware detects a problem, the status indicators are red.

Pump Block Status LED

The status indicator LED is located inside the pump above the pump head (pump block LED). The LED indicates the operational status of the pump block.

Alarms

Leaks are a potential safety issue. Therefore, if a leak sensor detects leakage, beeping starts to alert you in addition to the message in the Instrument Audit Trail and the status indicators changing to red. Follow the instructions in this manual to find and eliminate the source for the leakage.

Instrument Audit Trail Messages

If the device firmware detects a problem, the problem is reported to the chromatography data system.

The data system logs information about all events related to instrument operation for the current day in an Instrument Audit Trail. The Instrument Audit Trail is named with the current date, using the format `yyyymmdd`. For example, the Instrument Audit Trail for May 15, 2019, is named `20190515`.

The Instrument Audit Trails can be found on the ePanel Set (Audit ePanel). In addition, Audit Trails for each instrument are available in the Chromeleon 7 Console Data view, in the folder of the Instrument.

Messages in the Instrument Audit Trail are preceded by an icon. The icon identifies the seriousness of the problem. For possible causes and remedial actions, see [Messages](#) (▶ [page 200](#)).

Firmware Failure

If a firmware failure occurred during operation of the module, an exception log has been created about the processes during the firmware failure. The firmware sends the exception log to the Instrument Audit Trail when the module is connected in the chromatography data system.

In this case, observe the following:

- Send the Instrument Audit Trail as **.cmbx** file to the Technical Support before you clear the log.
- To clear the exception log and continue operation of the module, perform the command **ExceptionLogClear**.

For more information, refer to the *Chromeleon Help*.

8.2 Messages

This section provides information about the messages that may appear in the Instrument Audit Trail during operation of the pump. For easier identification of the source for a problem, note the **Device** information that may appear in front of the message:

Device Information	Description
[Main Device Name]	With messages relating to the entire pump, for example, to the leak detection, main board or with a communication error
[Pump Device Name]	With messages relating to the entire flow unit, for example, to the system pressure
[Pump Device Name]_Wellness_RightBlock	With messages relating to the right pump block or components in the right pump head, for example, the pistons or check valves.
[Pump Device Name]_Wellness_LeftBlock	With messages relating to the left pump block or components in the left pump head, for example, the pistons or check valves.

The **Device Names** are specified in the dialog box for the pump in the Instrument Configuration Manager. The default names are:

Pump	Device Name	Default Name
Binary pump, Isocratic pump, Quaternary pump	[Main Device Name]	PumpModule
	[Pump Device Name]	Pump
Dual Pump	Main [Device Name]	PumpModule
	Left [Pump Device Name]	PumpLeft
	Right [Pump Device Name]	PumpRight

The table lists the most frequently observed messages for the device and provides troubleshooting assistance.

Each message consists of a code number and a text. The code number is the unique identifier for the problem while the wording may change. Note the following:

- To facilitate finding a message, the table lists the messages sorted by code.
- If you cannot find the code you are looking for, check the message text. The two messages "Unexpected module behavior" and "Module malfunction detected" can be assigned to different codes. See the beginning of the table for more information.

TIP If you are unable to resolve the problem following the instructions in this manual, or if you encounter a message not listed in the table, write down the code and wording of the message and contact us. For details, see the *Contacting Us* section at the beginning of this manual.

Message and Code	Description and Remedial Action
Unexpected module behavior. Code xx	<p>xx = Two-digit to four-digit code number.</p> <p>When the message appears, write down the message code and turn off the module. Wait for 5 seconds and turn on the module again.</p> <p>TIP If the message appears with <i>codes 74 or 103</i>, the firmware may be defective or incomplete. Update the firmware, see Updating the Device Firmware (▶ page 183). If the message appears again, contact Technical Support.</p>
Module malfunction detected. Code xx	<p>xx = two-digit to four-digit code number</p> <p>When the message appears, write down the message code. Turn off the module and contact Technical Support.</p>
Code 33 Leak detected – eliminate within approx. 180 seconds.	Find and eliminate the source for the leakage (see Resolving Liquid Leaks (▶ page 210)). The pump flow stops if leakage is not resolved within 3 minutes.
Code 34 Leak detected.	The pump stopped because of leakage. The message appears because the leakage reported earlier with code 33 was not resolved within 3 minutes. Find and eliminate the source for the leakage (see Resolving Liquid Leaks (▶ page 210)).
Code 36 Download failed.	The firmware download has not been successful. Repeat the download.
Code 37 Download firmware mismatch.	You tried to download a firmware file that is invalid for the pump. Repeat the download with a firmware file that is valid for the pump.
Code 52 Module software incomplete. Download firmware (again).	The firmware is incomplete, for example, because the communication between the chromatography data system and the module was interrupted during the firmware download. Repeat the download.
Code 89 Liquid leak sensor missing or defective.	Contact Thermo Fisher Scientific Technical Support for assistance. To operate the device nevertheless, you can disable the leak sensor functionality in the chromatography data system by setting Leak Sensor Mode to Disabled .
Code 90 Download firmware mismatch – invalid version.	You tried to download an incompatible firmware with an earlier version number than the firmware that is currently installed in the module. Downgrading the firmware may result in loss of functionality or malfunctioning of the module. If required, repeat the download with a firmware version later than the version currently installed in the module.
Code 91 Data changed during read.	<ul style="list-style-type: none"> • This may be a temporary error. Turn off the module. Wait for 5 seconds and turn on the module again. • The firmware may be defective. Update the firmware.

Message and Code	Description and Remedial Action
Code 92 Data verification failed.	<ul style="list-style-type: none"> This may be a temporary error. Turn off the module. Wait for 5 seconds and turn on the module again. The firmware may be defective. Update the firmware.
Code 118 USB Buffer Overflow.	<p>This is a software problem. The module produces data faster than the computer on which the chromatography data system is running reads the data.</p> <ol style="list-style-type: none"> In the chromatography data system, disconnect and reconnect the module. If this does not solve the problem, update the firmware or the chromatography data system version. If the problem persists: Also, third-party software on the computer, for example, virus scanners or poor computer performance can cause the problem. Contact the onsite IT department.
Code 120 System interlink request timed out.	<p>Communication with the module failed. The module did not respond in time.</p> <p>For the module for which the message appears:</p> <ol style="list-style-type: none"> Turn on the module if it is not yet turned on. Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. If the message persists, replace the system interlink cables.
Code 126 Device lost system interlink connection.	<p>A system interlink cable may be disconnected from the module or defective.</p> <ol style="list-style-type: none"> Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. If the message persists, replace the system interlink cables.
Code 128 System interlink data errors.	<p>A system interlink cable may be disconnected from the module or defective.</p> <ol style="list-style-type: none"> Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. If the message persists, replace the system interlink cables.
Code 129 Device X not found on system interlink.	<p>X = serial number</p> <p>The module with the given serial number may be disconnected, turned off or a firmware update is running.</p> <ol style="list-style-type: none"> Check the system interlink connections to the module. If the message persists, check the module operational status.
Code 131 System interlink bus not operable.	<p>A system interlink cable may be disconnected from the module or defective.</p> <ol style="list-style-type: none"> Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. If the message persists, replace the system interlink cables.
Code 136 Lock request rejected – already locked by X.	<p>X = lock holder ID, with USB address referring to the chromatography data system or system interlink address referring to the system controller or a module</p> <p>The module is already locked by another software (system controller or chromatography data system).</p> <p>Wait until the module is released from the locked state.</p>

Message and Code	Description and Remedial Action
Code 137 Lock by X expired.	X = lock holder ID, with USB address referring to the chromatography data system or system interlink address referring to the system controller or a module Inform Thermo Fisher Scientific about the occurrence. No further action required.
Code 145 Lock holder X lost.	X = lock holder ID, with USB address referring to the chromatography data system or system interlink address referring to the system controller or a module The lock was released automatically since its holder disappeared from system interlink. Check the system interlink connections to the module.
Code 152 Assignment or command rejected – device locked.	Module is not ready to accept command or property assignment since locked by another software (system controller or chromatography data system). Wait until module is released by the current software (system controller or chromatography data system).
Code 4098 Upper pressure limit exceeded	Check the flow path for blockage. <i>If the flow path is blocked:</i> <ul style="list-style-type: none"> The column may be contaminated. Rinse or replace the column. If the problem occurs due to column ageing, it may be sufficient to increase the setting for the upper pressure limit. The autosampler may be blocked. Check the autosampler components and eliminate the source for the blockage. <i>If the flow path is not blocked:</i> Test the static mixer for permeability (see Testing the Static Mixer for Permeability (▶ page 166)).
Code 4099 Pressure fallen below lower limit.	Check the following causes: <ul style="list-style-type: none"> One or more solvent reservoirs are empty. Fill the reservoirs and purge the pump. If you are monitoring the solvent consumption from the Chromeleon software, the message "Code 4158 Out of eluent X" alerts you when a reservoir is empty. Air bubbles may be trapped in the solvent lines. Check the solvent line filters. Purge the pump. Leakage may be present in the system. Resolve the leakage. For the pump, see Resolving Liquid Leaks (▶ page 210). For the other system modules, refer to the <i>Operating Manuals</i> for the modules. A check valve may be contaminated or defective. Clean or replace the check valves as appropriate (see Check Valves (▶ page 159)). With the applied flow, the pump cannot build up enough pressure to reach the lower pressure limit. Adapt the lower pressure limit or increase the flow.

Message and Code	Description and Remedial Action
Code 4100 Purge pressure limit exceeded	<p>A pressure of more than 5 MPa built up after a purge cycle has started.</p> <p>Perform the following sequence of steps:</p> <ol style="list-style-type: none"> 1. Open the purge valve if it is not yet open. 2. Check the flow path for indications of blockage. See also Code 4098 Upper pressure limit exceeded. 3. Take appropriate remedial action as necessary. 4. Mute the alarm by pressing the MUTE ALARM button on the pump keypad. 5. Start a new purge cycle.
Code 4101 Not ready. Please run self-test.	<p>The pump is not ready because the self-test was not successful. Perform the following sequence of steps:</p> <ol style="list-style-type: none"> 1. Open the purge valve. 2. Repeat the self-test. 3. Close the purge valve.
Code 4112 Self-test failed because of fluctuating pressure.	<p>Changes in pressure have occurred during the self-test. Perform the following sequence of steps:</p> <ol style="list-style-type: none"> 1. Open the purge valve. 2. Repeat the self-test. 3. Close the purge valve.
Code 4113 Self-test failed because pressure is out of range.	<p>The pressure has not been down to zero during the self-test. Verify that the pressure sensor cables are properly connected.</p> <ol style="list-style-type: none"> 1. Open the purge valve. 2. Repeat the self-test. 3. Close the purge valve. <p>If the message appears again, the system pressure sensor may be defective. Contact Technical Support.</p>
Code 4114 The device is busy. Please retry after 1 minute.	<p>The pump is not ready because, for example, a self-test is running. Retry after 1 minute. If the message appears again, perform the following sequence of steps:</p> <ol style="list-style-type: none"> 1. Open the purge valve. 2. Repeat the self-test. 3. Close the purge valve.
Code 4115 Working piston pressure zero out of range.	<p>The message may appear for the pressure sensor in a pump head or for the system pressure sensor:</p> <ul style="list-style-type: none"> • If the message appears for only the right pump block or the left pump block, the cable for the pressure sensor in the pump head may not seat properly in the P-WORK connector. • If the message appears for both pump blocks at the system time, the cable for the system pressure sensor may not seat properly in the P-SYS connector. <p>Verify that the pressure sensor cable is properly plugged into the connection port and retry. If the problem persists, contact Technical Support.</p>

Message and Code	Description and Remedial Action
Code 4116 The pressure signals are not consistent. There may be air in the working cylinder.	<p>The pressure calibration factor for the working piston is out of range. Perform these steps:</p> <ol style="list-style-type: none"> 1. Verify that the degasser is working. 2. Purge the pump.
Code 4119 Can't start pump while alarm is on.	<p>An alarm is present, for example, because leakage has been detected. You can restart the pump flow only when the alarm is no longer present. Mute the alarm by pressing the MUTE ALARM button on the pump keypad. Find and eliminate the source for the alarm as suggested for the accompanying message.</p>
Code 4120 The rear seal wash system has run out of wash solution.	<p>This message alerts you only when the drop counter functionality of the seal wash detector is enabled (standard setting).</p> <ul style="list-style-type: none"> • Verify that wash liquid is present in the seal wash reservoir. • Inspect the seal wash lines across the entire flow path for indications of blockage or leakage. Verify that all seal wash lines are properly connected and routed. Replace the seal wash lines as necessary (see Replacing the Seal Wash Lines (▶ page 129)). • Inspect the peristaltic tubing for indications of blockage or damage. Replace the tubing as necessary (see Replacing the Seal Wash Lines (▶ page 129)). • Verify that the peristaltic tubing is properly inserted in the seal wash pump and that the lever of the pump is not blocked. • Inspect the electrodes of the seal wash detector for contamination or damage. Replace the seal wash detector as necessary (see Replacing the Seal Wash Detector (▶ page 132)). • Make sure that the seal wash liquid is sufficiently conductive (see Choosing the Seal Wash Liquid (▶ page 69)). • Start an additional seal wash cycle from the Chromeleon software. While the wash cycle is running, inspect the pump heads. If droplets leave the pump head at the rear, the seal wash seal is defective. Replace the seal wash seals (see Replacing the Seal Wash Seals (▶ page 151)).
Code 4121 Piston seal leakage has exceeded the recommended limit.	<p>This message alerts you only when the drop counter functionality of the seal wash detector is enabled (standard setting).</p> <p>Test the pump for piston seal leakage and take the recommended action (see Testing the Piston Seals for Leakage (▶ page 156)).</p>
Code 4122 The rear seal leak sensor detects drops constantly.	<p>This message alerts you only when the drop counter functionality of the seal wash detector is enabled (standard setting).</p> <p>Inspect the electrodes of the seal wash detector for contamination or damage. Replace the seal wash detector as necessary (see Replacing the Seal Wash Detector (▶ page 132)).</p> <p>The message appears also when the percentage of water in the seal wash liquid is too high. Observe the information about the composition of the seal wash liquid in Choosing the Seal Wash Liquid (▶ page 69).</p>

Message and Code	Description and Remedial Action
Code 4125 Degasser malfunction	<p>The vacuum level monitoring function detected insufficient degasser vacuum.</p> <p>Turn the pump off and on again. In the chromatography data system, check the degasser vacuum. After about 1 minute, the setting should change from NotOk to Ok. If the degasser vacuum is still insufficient, the degasser may be leaky. Locate the DegasserPressure property in the Command window, write down the pressure reading, which can provide helpful information to identify the source for the problem, and contact Technical Support.</p>
Code 4127 The pump drive is still in undock position. Please execute a dock command.	<p><i>The message alerts you during pump maintenance:</i></p> <p>This message alerts you during pump maintenance (for example, when replacing the piston seals or pistons) when you try to start the pump while the pistons are not yet in the correct position for normal operation. To return the pistons into the correct position, perform the following sequence of steps:</p> <ol style="list-style-type: none"> 1. Open the purge valve. 2. Dock the pistons. 3. Close the purge valve. <p><i>The message alerts you during internal pump maintenance:</i></p> <p>If the message appears during the internal maintenance procedure, perform an additional purge cycle.</p>
Code 4130 Pressure buildup during maintenance operation.	<p>A pressure of more than 0.5 MPa built up during piston maintenance or piston seal maintenance. To reduce the pressure, perform the following sequence of steps:</p> <ol style="list-style-type: none"> 1. Open the purge valve. 2. Dock or undock the pistons, depending on when the message appeared. 3. Close the purge valve. <p>If the message appears during the internal maintenance procedure, perform an additional purge cycle.</p>
Code 4148 Can't perform this command while the flow is on.	<p>You tried to run a self-test while the flow rate was not yet down to zero. Turn off the flow and repeat the command.</p>
Code 4152 Pressure sensor malfunction. Check the cable connection and retry.	<p>Verify that the cable for the pressure sensor is properly plugged into the connection port and retry. If the message appears again, follow these steps:</p> <ol style="list-style-type: none"> 1. Open the purge valve. 2. Perform a self-test. 3. Close the purge valve. 4. Restart the flow. 5. If this message appears again or if another message relating to the pressure or a pressure sensor appears, contact Technical Support.

Message and Code	Description and Remedial Action
Code 4156 Compression limit reached.	The compression value was 100% during the last stroke. If the compression value is lower than 100% for several strokes afterward, the message " Compression back to normal " (code 4157) appears. If this message does not appear, inspect the flow connections for indications of air bubbles. Purge the pump if necessary. If the message " Compression limit reached " persists, see Checking the Compression Values (▶ page 211).
Code 4158 Out of eluent X	This message alerts you only if you are monitoring the solvent consumption from the Chromeleon software. The message indicates for which solvent the reservoir is empty.
Code 4159 The waste bottle is full.	This message alerts you only if you are monitoring the liquid level in the waste container. Empty the waste container when needed.
Code 4161 Pressure recalibration deviates by xx bar.	The pump pressure was not down to zero during the self-test. Verify that the pressure sensor cable is properly connected to the P-SYS connector. Wait until the pressure is down and repeat the test. To speed up the pressure drop, open the purge valve and then, start the self-test.
Code 4176 The pump pressure exceeded the absolute limit. Check pressure sensor cables for proper connection and flow path for clogging. Then, perform a self-test.	Follow these steps: 1. Verify that the pressure sensor cables are properly connected. Reconnect the cables if necessary. 2. Check the flow path for clogging and remedy the situation if necessary. 3. Perform a self-test. If the self-test is not successful, contact Technical Support.
Code 4234 The flow was stopped due to a request from another module.	The pump flow was stopped because of a problem with another module. Check the messages from other modules.
Code 4237 Out of solvent.	The solvent reservoir is empty. Refill the solvent reservoir and purge the pump.
Code 4238 Mainboard initialization failed.	Main board initialization has not been successful. 1. This may be a temporary error. Turn off the module. Wait for 5 seconds and turn on the module again. 2. If the message appears again, update the firmware. 3. If the message persists, the main board may be defective. Contact Technical Support.
Code 4239 Could not build up enough pressure.	<ul style="list-style-type: none"> • Air bubbles may be trapped in the system. Purge the pump. • Leakage may be present. As leakage usually occurs at a connection, visually inspect all components and connections in the flow path. For tests that can help you to identify the source for the leakage, see Testing the Pump for Leakage (▶ page 209).
Code 4240 Column temperature is too high.	The procedure that you want to perform will stop the pump flow. This may damage the column if the column temperature is too high. Reduce the column oven temperature. Repeat the procedure.

Message and Code	Description and Remedial Action
Code 4241 An autosampler is required.	To perform the procedure, an autosampler is required that is unambiguously defined. In the Chromeleon software, select the correct configuration for your system and connect all devices.
Code 4242 The autosampler is offline.	The autosampler is not accessible via a System Interlink connection. Check that the autosampler is properly connected via System Interlink and that the autosampler is powered on.
Code 4243 Unsupported autosampler.	The autosampler in the system configuration does not support this procedure.
Code 4244 The column compartment is offline.	The column compartment in the system configuration is not accessible via the System Interlink connection. Check that the column compartment is properly connected via System Interlink and that the column compartment is powered on.

8.3 Testing the Pump for Leakage

When

If you suspect leakage in the pump

When the leak sensor reports leakage, see [Resolving Liquid Leaks](#) (▶ page 210).

Tests

The following tests assist you in finding out whether leakage is present in the pump and they help you to locate the source of a leak:

- Pump leak test (general test)
See [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177)
- Piston seal leak test
See [Testing the Piston Seals for Leakage](#) (▶ page 156)
- Seal wash system leak test
See [Testing the Seal Wash System for Leakage](#) (▶ page 128)

8.4 Resolving Liquid Leaks

TIP If leakage is observed around the purge valve knob (when the purge valve is open) or on the purge outlet (when the purge valve is closed), the purge valve knob may be defective (see [Replacing the Purge Valve Knob](#) (▶ page 175)).

When

The leak sensor is wet. The leak sensor reports leakage.

If leakage is not resolved after 3 minutes, the pump stops the flow.

Parts and additional items required

- Replacement part as required
- Cloth or tissue

Preparations

When resolving leakage, observe the safety guidelines and general rules for maintenance and service as presented in [Maintenance and Service](#) (▶ page 115).

Follow these steps

1. Locate the source of the leak.
As leakage usually occurs at a connection, visually inspect all components and connections in the flow path.
The following tests can help you to identify the source:
 - ◆ Leakage test for the seal wash system
See [Testing the Seal Wash System for Leakage](#) (▶ page 128).
 - ◆ Leakage test for the piston seals
See [Testing the Piston Seals for Leakage](#) (▶ page 156).
 - ◆ Leakage test for the entire pump
See [Testing the Pump for Leakage \(General Test\)](#) (▶ page 177).After taking remedial action as required, proceed with the next steps.
2. With a cloth or tissue, thoroughly absorb all liquid that has collected in the leak tray and under the leak sensor. Be careful not to bend the sensor.
3. Allow the sensor to adjust to the ambient temperature for a few minutes.
4. If leakage is no longer reported, you can resume operation.

8.5 Pressure Issues or Shifts in Retention Time

When you observe pressure issues or shifts in retention time, the following sections help you to identify and eliminate the source for the problem:

- The pressure is *not* down to zero when the purge valve is open
See [Pressure Not Zero with Open Purge Valve](#) (▶ page 211).
- Pressure pulsation
See [Checking the Compression Values](#) (▶ page 211) and [Testing the Static Mixer for Permeability](#) (▶ page 166).
- Shift in retention time
See [Checking the Compression Values](#) (▶ page 211).
- Inconstant pressure or high backpressure at the column and pump
See [Testing the Static Mixer for Permeability](#) (▶ page 166).

8.5.1 Pressure Not Zero with Open Purge Valve

When

The pressure is *not* down to zero when the purge valve is open.

Follow these steps

1. For the pressure sensor for which the pressure is not down to zero, check the pressure sensor cable and connector for proper contact.
 - a) Unplug the pressure sensor cable.
 - b) Reconnect the cable. To ensure proper contact push the cable firmly into the connector.
2. Perform a self-test.
3. If the self-test produces a message, follow the remedial actions recommended for the message.

8.5.2 Checking the Compression Values

The compression values of the pump heads can provide valuable information for troubleshooting.

When

You observe pressure pulsation or shifts in retention time.

Follow these steps

1. In the Chromeleon software, check the **Compression** value for the pump heads (= **CompressionDrv1**).

The values indicate the compression of the last stroke in percent.

The compression value should be less than 100%.

- ◆ With isocratic conditions, the compression value should remain stable.
- ◆ When running a gradient, the compression value changes roughly proportional to the pressure curve.

If the value is close to 100%, the required precompression may not be reached and pulsation may occur.

The table shows guide values for some solvents (pure solvent, degassed, delivered at 40 MPa) with the pump being purged and the pressure being stable for some time. In a range between 30 MPa and 60 MPa the values can be considered as linear to the pressure.

Solvent	Compression in %
Water	25 % ± 10 %
Methanol	50 % ± 10 %
Acetonitrile	45 % ± 10 %

2. Take remedial action if required.

Compression	Remedial Action
Lower than indicated in the table	The outlet check valve may be defective. Replace the valve cartridge. See Replacing the Outlet Check Valves (▶ page 161).
Higher than indicated in the table	<ul style="list-style-type: none"> • The piston seal may be defective. Replace the piston seal. See Replacing the Piston Seals or Support Ring (▶ page 145). • The inlet check valve may be defective. Replace the valve cartridge. See Replacing the Inlet Check Valves (▶ page 159).
Very high (message " Compression limit reached " and low pressure)	<ul style="list-style-type: none"> • Air bubbles may be present in the pump. Make sure that no air bubbles are present in the solvent lines and purge the pump. • <i>If solvent shut-off valves are installed:</i> Verify that the valves are open. • Excessive leakage may be present on the inlet check valve. Remove the solvent line from the solvent reservoir and the solvent line filter from the solvent line. While the pump is running, observe the liquid in the solvent line. If the liquid moves also against the direction of flow during the stroke, the inlet check valve may be defective. Replace the valve cartridge. See Replacing the Inlet Check Valves (▶ page 159).

8.5.3 Testing the Static Mixer for Permeability

TIP The information and references to the static mixer in this section apply equally to the inline filter if installed.

When

If you observe pressure pulsation, inconstant pressure, or high backpressure at the column and pump

Additional items required

- Water as solvent
- Tissue

Follow these steps

Test the static mixer by following the steps in [Testing the Static Mixer for Permeability](#) (▶ [page 166](#)).

8.6 Removing Persistent Air Bubbles

If you are unable to remove air bubbles with purging, purge the pump against backpressure. Follow the procedure for running in new piston seals in [Recommendations for New Piston Seals](#) (▶ page 149).

9 Pump-Specific Information

This chapter provides specific information about the pump, for example, the interior components and operating principle.

9.1 Introduction to this Chapter

This chapter provides information that is specific to the pumps, for example the interior components and the operating principle:

- [Quaternary Pump and Dual Pump \(▶ page 217\)](#)
- [Binary Pump \(▶ page 228\)](#)
- [Isocratic Pump \(▶ page 233\)](#)

9.2 Quaternary Pump and Dual Pump

This section provides specific information on the quaternary pump and the dual pump.

TIP The dual pump combines two ternary pumps in a single enclosure. The two pumps are referred to as left pump and right pump. If not otherwise stated, the information in this section applies equally to the quaternary pump and the two pumps of the dual pump.

Quaternary Pump and Dual Pump – See

- [Interior Components \(Quaternary Pump\) \(▶ page 218\)](#)
- [Interior Components \(Dual Pump\) \(▶ page 219\)](#)
- [Operating Principle \(▶ page 221\)](#)
- [Dwell Volume of the Pump \(▶ page 222\)](#)
- [Setting the Solvent Composition \(▶ page 223\)](#)
- [Synchronizing the Injection Time with the Pump Strokes \(▶ page 224\)](#)

Dual Pump Only - See

- [Dual Pump Specifics \(▶ page 225\)](#)
- [Sharing the Dual Pump \(▶ page 225\)](#)
- [Monitoring the Solvent Consumption \(▶ page 226\)](#)
- [Monitoring the Liquid Level in the Waste Container \(▶ page 227\)](#)

9.2.1 Interior Components (Quaternary Pump)

The user-accessible components of the pump are located directly behind the front doors:

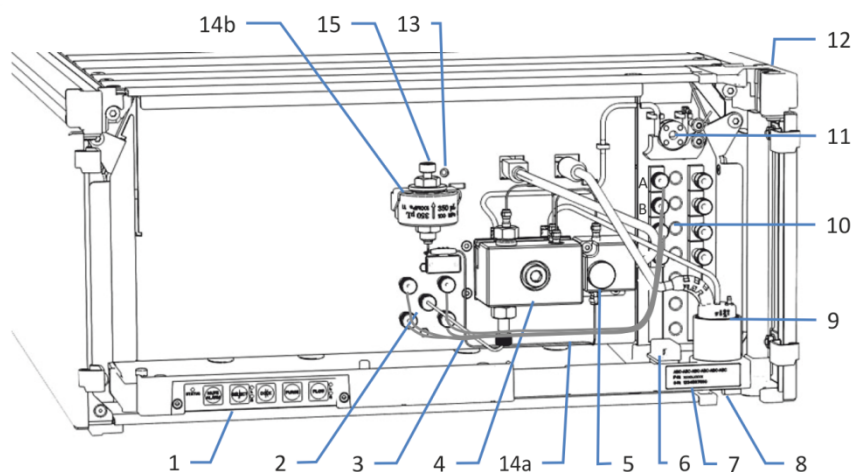


Figure 66: Interior view

No.	Description
1	Keypad with buttons for pump control
2	Proportioning valve (4 channels)
3	Tubing clips for routing solvent lines to the proportioning valve
4	Pump head
5	Purge/sensor unit including purge valve and system pressure sensor
6	Leak sensor
7	Type label, indicating the module name, serial number, part number, and revision number (if any)
8	Drain port for guiding leaking liquid to waste
9	Seal wash detector (drop detector)
10	Vacuum degasser
11	Seal wash pump
12	Tubing chase with tubing guides
13	Pump block LED
14a	Capillary mixer (as part of mixing system)
14b	Static mixer (as part of mixing system)
15	Pump outlet (outlet of the static mixer)

9.2.2 Interior Components (Dual Pump)

The user-accessible components of the pump are located directly behind the front doors:

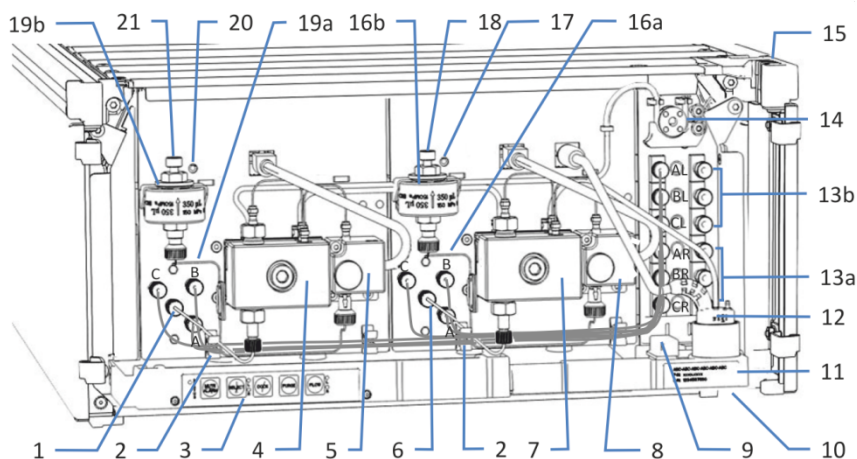


Figure 67: Interior view

No.	Description
1	Proportioning valve (3 channels) (left pump)
2	Tubing clips for routing solvent lines to the proportioning valve
3	Keypad with buttons for pump control
4	Pump head (left pump)
5	Purge/sensor unit including purge valve and system pressure sensor (left pump)
6	Proportioning valve (3 channels) (right pump)
7	Pump head (right pump)
8	Purge/sensor unit including purge valve and system pressure sensor (right pump)
9	Leak sensor
10	Drain port for guiding leaking liquid to waste
11	Type label, indicating the module name, serial number, part number, and revision number (if any)
12	Seal wash detector (drop detector)
13a	Vacuum degasser: Degas chambers for left pump, upper chambers (solvents AL BL CL)
13b	Vacuum degasser: Degas chambers for right pump, bottom chambers (solvents AR BR CR)
14	Seal wash pump
15	Tubing chase with tubing guides
16a	Capillary mixer (as part of mixing system, right pump)

No.	Description
16b	Static mixer (as part of mixing system, right pump)
17	Pump block LED (right pump)
18	Pump outlet (outlet of the static mixer) (right pump)
19a	Capillary mixer (as part of mixing system, left pump)
19b	Static mixer (as part of mixing system, left pump)
20	Pump block LED (left pump)
21	Pump outlet (outlet of the static mixer) (left pump)

9.2.3 Operating Principle

The picture illustrates how the pump operates:

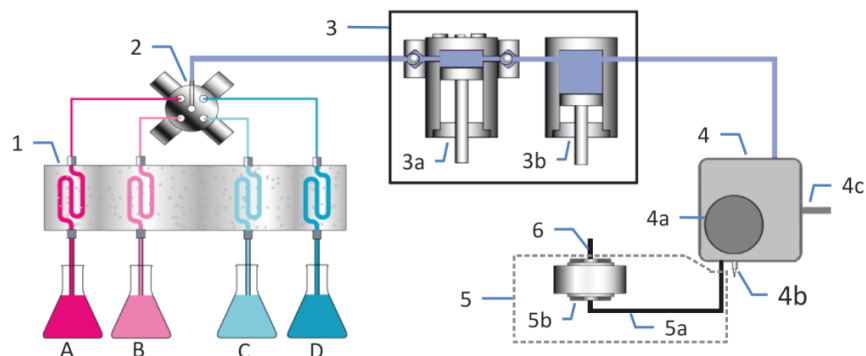


Figure 68: Operating principle

No.	Description
A-D	Solvent options: <ul style="list-style-type: none"> • 4 solvents available with the quaternary pump (solvents A-D) • 3 solvents available with the dual pump (solvents A-C), with each of the two pumps
1	Solvent degasser (vacuum degasser) (pump inlet)
2	Proportioning valve
3	Pump head, with
3a	Working cylinder (pump head)
3b	Equilibration cylinder (pump head)
4	Purge/sensor unit, with
4a	Purge valve knob
4b	Purge outlet
4c	System pressure sensor
5	Mixing system, with
5a	Capillary mixer
5b	Static mixer
6	Pump outlet (outlet of the static mixer)

For additional information, see [Operating Principle](#) (▶ page 33).

9.2.4 Dwell Volume of the Pump

The gradient delay volume of an HPLC system is defined as the volume of the entire flow path between the point where the gradient is formed and the point where the mobile phase enters the column (see [Gradient Delay Volume, Dwell Volume and Ripple](#) (► page 236)).

The pump contributes to the system gradient delay volume by the dwell volume, which is the calculated volume between the point where the gradient is formed and the pump outlet.

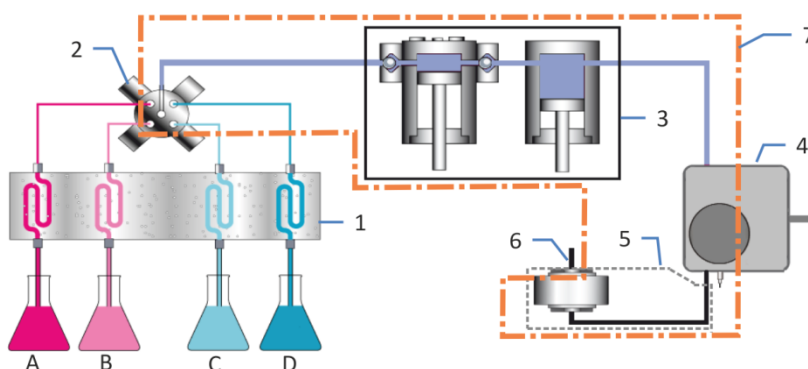


Figure 69: Dwell volume of the pump

No.	Description
A-D	Solvent options: <ul style="list-style-type: none"> • 4 solvents available with the quaternary pump (solvents A-D) • 3 solvents available with the dual pump (solvents A-C), with each of the two pumps
1	Solvent degasser (vacuum degasser)
2	Proportioning valve
3	Pump head
4	Purge/sensor unit
5	Mixing system with capillary mixer and static mixer
6	Pump outlet
7	Dwell volume of the pump

For the dwell volume of the pump, see [Performance Specifications](#) (► page 252).

9.2.5 Setting the Solvent Composition

This section describes how you set the solvent composition for the quaternary pump (solvents A to D). The steps and examples apply equally to the ternary pumps of the dual pump (solvents AR to CR and AL to CL).

Follow these steps

1. In the Instrument Configuration Manager, in the dialog box for the pump, check and the change the following if required:
 - ◆ Number of the solvents to be used with the pump
 - ◆ Standard solvent names
These solvent names appear in the Chromeleon user interface.
2. In the Chromeleon Client, determine the percentage of solvent that you want to deliver.
Set the percentage for solvents B, C, and D (**%B, %C, %D**). Solvent A (**%A**) automatically delivers the remaining volume.

Examples

- To deliver 100% of solvent **%A**:
Set **%B, %C, and %D** to 0%.
- To deliver 100% of solvent **%B** (or **%C** or **%D**):
Set **%B** (or **%C** or **%D**) to 100%. The remaining solvents are automatically set to 0%.
- To deliver 20% of solvent **%A**, 40% of solvent **%B**, 30% of solvent **%C**, and 10% of solvent **%D**:
Set **%B** to 40%, set **%C** to 30%, and set **%D** to 10%. **%A** is automatically set to 20%.

9.2.6 Synchronizing the Injection Time with the Pump Strokes

To enhance the retention time precision with gradient applications, you can synchronize the injection time of the Vanquish autosampler with the strokes of the Vanquish pump. The synchronization ensures that all injections are performed at the same phase of the pump cycle.

Synchronization is possible only when configured in the Chromeleon software (refer to the *Chromeleon Help*).

Then, the following properties are available in the Chromeleon software:

- **SyncWithPump**
To enable synchronization, set the property to **On**. To disable synchronization, for example, for a specific application, set **SyncWithPump** to **Off**.
- **Pump**
Shows the name of the pump to which the autosampler is linked.

9.2.7 Dual Pump Specifics

Note the following:

- The dual pump combines two ternary pumps in a single enclosure.
- The two pumps are referred to as left pump and right pump.
 - ◆ On the keypad, **L** refers to the left pump and **R** refers to the right pump.
 - ◆ In the Chromeleon user interface, **Left** refers to the left pump and **Right** refers to the right pump, for example, as in **PumpLeft_Pressure** and **PumpRight_Pressure**.
- The dual pump can be shared by two different instruments (see [Sharing the Dual Pump](#) (▶ page 225)).
- You can monitor the solvent consumption of the dual pump as a whole or separately for each pump (see [Monitoring the Solvent Consumption](#) (▶ page 226)).
- You can monitor the liquid level in the waste container of the dual pump as a whole or separately for each pump (see [Monitoring the Liquid Level in the Waste Container](#) (▶ page 227)).

9.2.7.1 Sharing the Dual Pump

In the Chromeleon software, you can share the dual pump between two instruments.

The default assignment for the two pumps is the instrument in which the dual pump is installed.

To share the dual pump, follow these steps:

1. In the Instrument Configuration Manager, open the dialog box for the dual pump.
2. On the **Devices** tab page, assign each pump to the instrument on which you want to use the pump. Select the instrument from the list of available instruments.

TIP Notice that the pumps now appear in the instruments to which they have been assigned.

9.2.7.2 Monitoring the Solvent Consumption

TIP When monitoring the liquid level in the solvent reservoirs (solvent consumption) as described in this section, the Chromeleon software *calculates* the liquid level. To monitor the liquid level in real time, based on real *physical* measurement, install the Vanquish Solvent Monitor. The solvent monitor is available as an option (see [Optional Accessories](#) (► page 267)).

For monitoring the solvent consumption, note the following:

- The two pumps can share the same set of solvent reservoirs or they can be connected to different sets of reservoirs.
- Depending on the setup, you can monitor the solvent consumption for the dual pump as a whole or separately for each pump.

Monitoring the Solvent Consumption for the Dual Pump as a Whole

TIP It is possible to share solvent reservoirs even if the two pumps are assigned to different instruments.

1. In the Instrument Configuration Manager, open the dialog box for the dual pump.
2. On the **Bottles** tab page, select the **Share Eluent Bottles** check box.
3. In the Chromeleon user interface, enter the information that is required for monitoring (see [Important Operating Parameters](#) (► page 94)). Enter the information for both pumps.

Notice that the monitoring properties show the same values for both pumps, for example, the **RemainTime** property.

Monitoring the Solvent Consumption for Each Pump Separately

1. In the Instrument Configuration Manager, open the dialog box for the dual pump.
2. On the **Bottles** tab page, clear the **Share Eluent Bottles** check box.
3. In the Chromeleon user interface, enter the information that is required for monitoring (see [Important Operating Parameters](#) (► page 94)). Enter the information for both pumps.

9.2.7.3 Monitoring the Liquid Level in the Waste Container

TIP When monitoring the liquid level in the waste container as described in this section, the Chromeleon software *calculates* the liquid level. To monitor the liquid level in real time, based on real *physical* measurement, install the Vanquish Solvent Monitor. The solvent monitor is available as an option (see [Optional Accessories](#) (▶ page 267)).

For monitoring the liquid level in the waste container, note the following:

- The waste liquids from the two pumps can be guided into the same waste container or into different waste containers.
- Depending on the setup, you can monitor the liquid level in the waste container for the dual pump as a whole or separately for each pump.

Monitoring the Liquid Level for the Pump as a Whole

TIP It is possible to share the waste container even if the two pumps are assigned to different instruments.

1. In the Instrument Configuration Manager, open the dialog box for the dual pump.
2. On the **Bottles** tab page, select the **Share Waste Bottles** check box.
3. In the Chromeleon user interface, enter the information that is required for monitoring (see [Important Operating Parameters](#) (▶ page 94)). Enter the information for both pumps.

Notice that the monitoring properties show the same values for both pumps, for example, the **RemainTime** property.

Monitoring the Liquid Level for Each Pump Separately

1. In the Instrument Configuration Manager, open the dialog box for the dual pump.
2. On the **Bottles** tab page, clear the **Share Waste Bottles** check box.
3. In the Chromeleon user interface, enter the information that is required for monitoring (see [Important Operating Parameters](#) (▶ page 94)). Enter the information for both pumps.

9.3 Binary Pump

This section provides specific information on the binary pump. See

- [Interior Components \(overview\)](#) (▶ page 228)
- [Operating Principle](#) (▶ page 230)
- [Dwell Volume of the Pump](#) (▶ page 231)
- [Setting the Solvent Composition](#) (▶ page 232)

9.3.1 Interior Components

The user-accessible components of the pump are located directly behind the front doors:

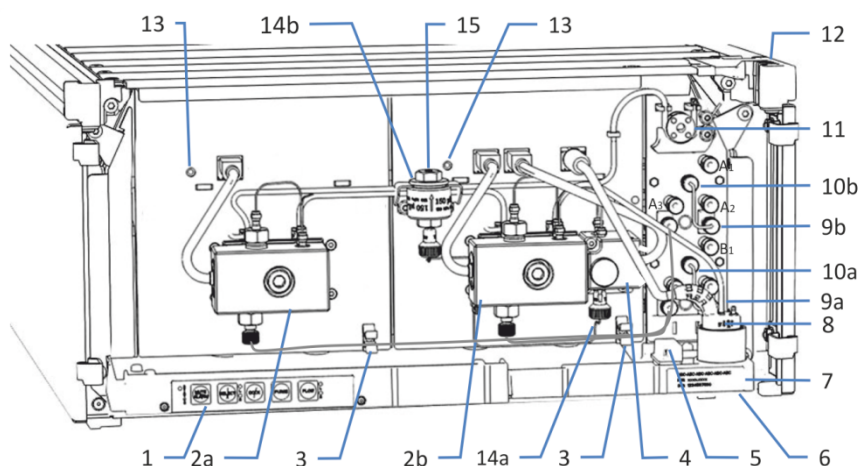


Figure 70: Interior view

No.	Description
1	Keypad with buttons for pump control
2a	Pump head (left)
2b	Pump head (right)
3	Tubing clips for routing the solvent lines from the degasser outlets to the pump heads
4	Purge/sensor unit including purge valve and system pressure sensor
5	Leak sensor
6	Drain port
7	Type label, indicating the module name, serial number, part number, and revision number (if any)
8	Seal wash detector (drop detector)
9a	Vacuum degasser (solvent B)

No.	Description
9b	Vacuum degasser (solvent A)
10a	Solvent selector (solvent B)
10b	Solvent selector (solvent A)
11	Seal wash pump
12	Tubing chase with tubing guides
13	Pump block LEDs
14a	Capillary mixer (as part of mixing system)
14b	Static mixer (as part of mixing system)
15	Pump outlet (outlet of the static mixer)

9.3.2 Operating Principle

The picture illustrates how the pump operates:

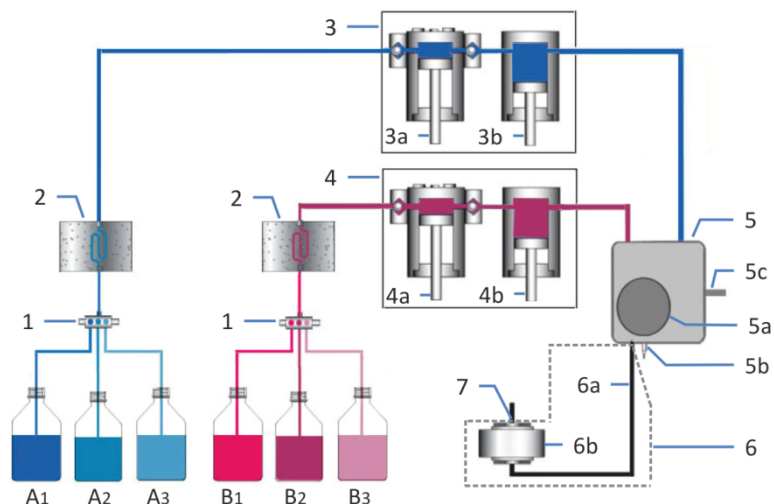


Figure 71: Operating principle

No.	Description
1	Solvent selector (pump inlet)
2	Solvent degasser (vacuum degasser)
3	Pump head, left, with
3a	Working cylinder (left pump head)
3b	Equilibration cylinder (left pump head)
4	Pump head right, with
4a	Working cylinder (right pump head)
4b	Equilibration cylinder (right pump head)
5	Purge/sensor unit, with
5a	Purge valve knob
5b	Purge outlet
5c	System pressure sensor
6	Mixing system, with
6a	Capillary mixer
6b	Static mixer
7	Pump outlet (outlet of the static mixer)

For additional information, see [Operating Principle](#) (▶ page 33).

9.3.3 Dwell Volume of the Pump

The gradient delay volume of an HPLC system is defined as the volume of the entire flow path between the point where the gradient is formed and the point where the mobile phase enters the column (see [Gradient Delay Volume, Dwell Volume and Ripple](#) (► page 236)).

The pump contributes to the system gradient delay volume by the dwell volume, which is the calculated volume between the point where the gradient is formed and the pump outlet.

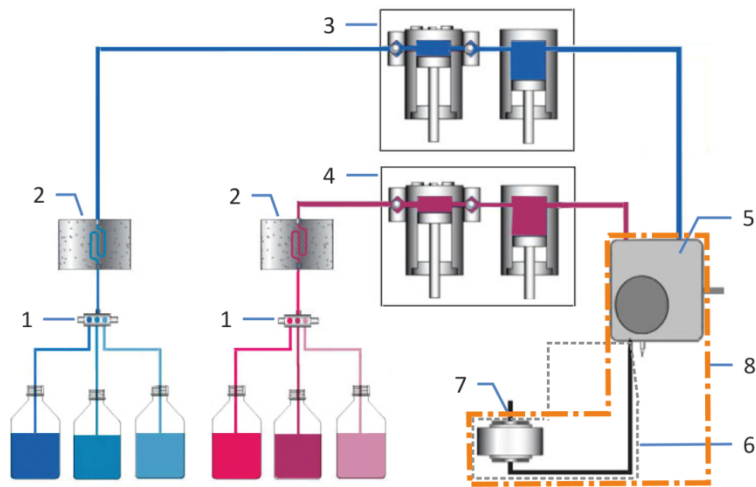


Figure 72: Dwell volume of the pump

No.	Description
1	Solvent selectors
2	Solvent degasser
3+4	Pump heads
5	Purge/sensor unit
6	Mixing system with capillary mixer and static mixer
7	Pump outlet
8	Dwell volume of the pump

For the dwell volume of the pump, see [Performance Specifications](#) (► page 252).

9.3.4 Setting the Solvent Composition

For increased flexibility, the pump is shipped with two 3-port solvent selectors. They allow forming binary gradients from three solvents per channel. The solvent to be used for each channel is selected in the user interface.

Follow these steps

1. In the Instrument Configuration Manager, in the dialog box for the pump, check and change the following if required:
 - ◆ Number of the solvents to be used with the pump
 - ◆ Standard solvent names
These solvent names appear in the Chromeleon user interface.
2. In the Chromeleon Client, set the solvent composition. For each of the two channels, select the solvent and set the percentage of solvent that you want to deliver.

Selecting the Solvent

1. For channel A, set **%A_Selector** to **%A1** or **%A2** or **%A3**.
2. For channel B, set **%B_Selector** to **%B1** or **%B2** or **%B3**.

Determining the Percentage of Solvent to Deliver

Set the percentage for solvent B (**%B**). Solvent A automatically delivers the remaining volume.

Examples

- To deliver 100% of solvent B2:
Set **%B_Selector** to **%B2** and set **%B** to 100%.
- To deliver 100% of solvent A3:
Set **%A_Selector** to **%A3** and set **%B** to 0%.
- To deliver 30% of solvent A1 and 70% of solvent B3:
Set **%A_Selector** to **%A1**, set **%B_Selector** to **%B3**, and set **%B** to 70%.

9.4 Isocratic Pump

This section provides specific information on the isocratic pump. See

- [Interior Components \(overview\)](#) (▶ page 233)
- [Operating Principle](#) (▶ page 234)

9.4.1 Interior Components

The user-accessible components of the pump are located directly behind the front doors:

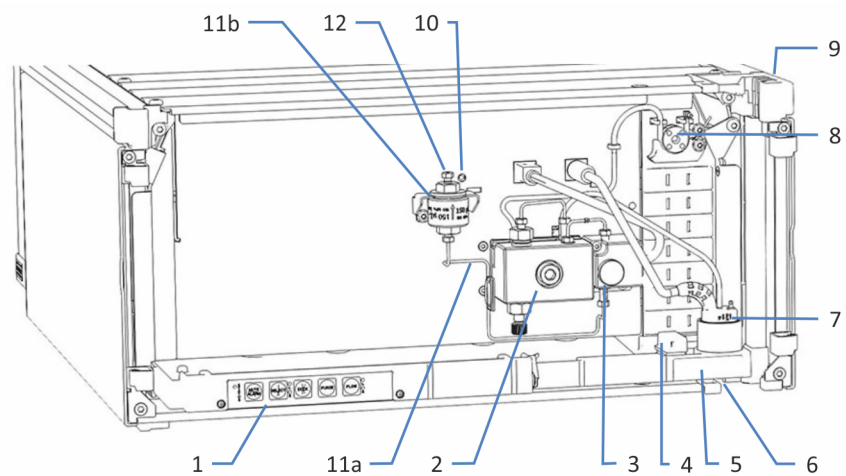


Figure 73: Interior view

No.	Description
1	Keypad with buttons for pump control
2	Pump head
3	Purge/sensor unit including purge valve and system pressure sensor
4	Leak sensor
5	Type label, indicating the module name, serial number, part number, and revision number (if any)
6	Drain port for guiding leaking liquid to waste
7	Seal wash detector (drop detector)
8	Seal wash pump
9	Tubing chase with tubing guides
10	Pump block LED
11a	Capillary mixer (as part of mixing system, which serves as inline filter)
11b	Static mixer (as part of mixing system, which serves as inline filter)
12	Pump outlet (outlet of the static mixer)

9.4.2 Operating Principle

The picture illustrates how the pump operates:

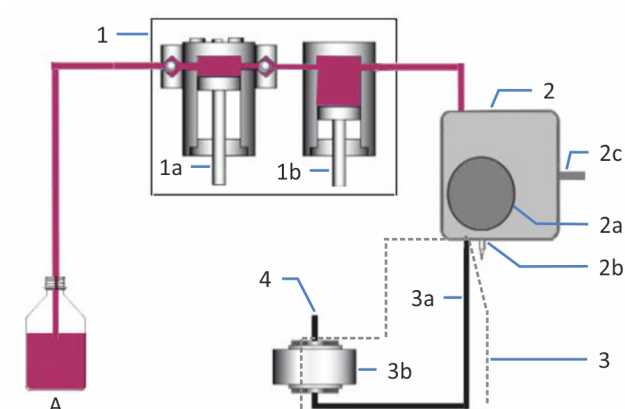


Figure 74: Operating principle

No.	Description
A	Solvent
1	Pump head, with
1a	Working cylinder
1b	Equilibration cylinder
2	Purge/sensor unit, with
2a	Purge valve knob
2b	Purge outlet
2c	System pressure sensor
3	Mixing system, serving as inline filter, with
3a	Capillary mixer
3b	Static mixer
4	Pump outlet (outlet of the static mixer)

For additional information, see [Operating Principle](#) (▶ page 33).

10 Modifying the Pump for Specific Applications

This chapter provides information about how you can modify the pump for specific applications.

10.1 Gradient Delay Volume, Dwell Volume and Ripple

This section applies to binary pumps, quaternary pumps, and dual pumps.

The gradient delay volume of an HPLC system is defined as the volume of the entire flow path between the point where the gradient is formed and the point where the mobile phase enters the column. Thus, the gradient delay volume of an HPLC system is the volume that the pump must deliver until a change in solvent composition reaches the column inlet.

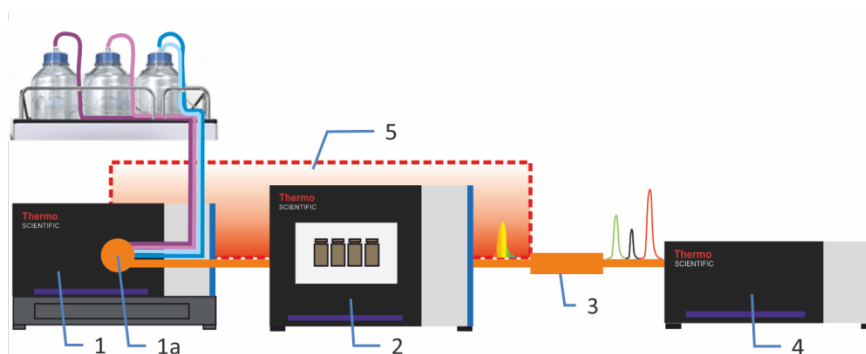


Figure 75: Gradient delay volume of an HPLC system

No.	Description
1	Pump with
1a	Point where the gradient is formed: <i>Quaternary pump:</i> The gradient is formed after the proportioning valve. <i>Dual pump:</i> The gradient is formed after the proportioning valve (with each of the two pumps). <i>Binary pump:</i> The gradient is formed in the purge/sensor unit.
2	Autosampler
3	Column
4	Detector
5	Gradient delay volume of the system

Reducing the gradient delay volume allows changes in the solvent composition to become effective on the column much earlier and thus, having a faster effect on the elution of analytes.

The pump contributes to the system gradient delay volume by the dwell volume (see [Pump-Specific Information](#) (▶ page 215)). For the dwell volume of the pump, see [Performance Specifications](#) (▶ page 252).

In the standard configuration, the pump has been optimized for the dwell volume and ripple. You can adapt the dwell volume or ripple to your requirements by replacing the mixing system with which the pump is shipped with a mixing system with a different volume:

- **Mixing system with lower volume**
Operating the pump with a lower volume mixing system reduces the dwell volume of the pump and thus, the gradient delay volume of the system but increases the ripple.

Consider installing a mixing system with lower volume for gradient separations at low flow rates (for example, less than 100 μL) or for very steep gradients.
- **Mixing system with higher volume**
Operating the pump with a higher volume mixing system reduces the ripple but increases the dwell volume of the pump and thus, the gradient delay volume of the system.

For information about the available mixing systems, see [Available Mixing Systems](#) (► page 237).

10.1.1 Available Mixing Systems

Each mixing system comprises a static mixer and a capillary mixer. The volumes of both mixers determine the entire volume of the mixing system.

The table lists the available mixing systems:

Description	Remarks
Set inline filter, volume: 35 μL , comprising: <ul style="list-style-type: none"> • Inline filter (static filter), volume: 10 μL • Capillary mixer, volume: 25 μL 	Requires also a different capillary to connect the pump to the autosampler.
Mixing system, volume: 100 μL , comprising: <ul style="list-style-type: none"> • Static mixer, volume: 75 μL • Capillary mixer, volume: 25 μL 	Requires also a different capillary to connect the pump to the autosampler.
Mixing system, volume: 200 μL , comprising: <ul style="list-style-type: none"> • Static mixer, volume: 150 μL • Capillary mixer, volume: 50 μL 	<i>Binary VF-pump, isocratic pump:</i> Mixing system with which the pump is shipped. With the isocratic pump, the mixing system serves as inline filter. <i>Other pumps:</i> See TIP at the end of this table.

Description	Remarks
Mixing system, volume: 400 μL , comprising: <ul style="list-style-type: none"> • Static mixer, volume: 350 μL • Capillary mixer, volume: 50 μL 	<i>Binary VC-pump, quaternary pump, dual pump:</i> Mixing system with which the pump is shipped. The dual pump has two mixing systems. <i>Other pumps:</i> See TIP at the end of this table.
Mixing system, volume: 800 μL , comprising: <ul style="list-style-type: none"> • Static mixer, volume: 750 μL • Capillary mixer, volume: 50 μL 	See TIP at the end of this table.
Mixing system, volume: 1550 μL , comprising: <ul style="list-style-type: none"> • Static mixer, volume: 1500 μL • Capillary mixer, volume: 50 μL 	See TIP at the end of this table.
TIP With this mixing system, only the static mixer is different from the static mixer with which the pump is shipped. The capillary mixer remains the same. Thus, if you want to change to this mixing system, you need to order only the static mixer.	

For ordering information, see [Optional Accessories](#) (► page 267).

To change to a different mixing system, see [Exchanging the Mixing System](#) (► page 239).

10.1.2 Exchanging the Mixing System

When

Changing to a mixing system with different volume

Follow these steps

1. Remove the mixing system with which the pump is shipped (see the next section).
2. Install the new mixing system. Follow the sequence of steps for the mixing system that you want to install. See:
 - ◆ [Installing a Mixing System with a Volume higher than 100 \$\mu\$ L](#) (▶ page 240)
 - ◆ [Installing the 100 \$\mu\$ L Mixing System](#) (▶ page 243)
 - ◆ [Installing the 35 \$\mu\$ L Inline Filter Set](#) (▶ page 245)

10.1.2.1 Removing the Mixing System

Preparations

1. To flush out harmful substances, purge the pump with an appropriate solvent.
2. To remove harmful substances from the components in the flow path after the purge unit, have the pump deliver for a short time with the solvent that was used for purging.
3. Turn off the pump flow and wait until the system pressure is down to zero.

Follow these steps

NOTICE

Turning the static mixer in the mounting bracket when loosening or tightening capillaries can damage the mounting bracket.

To prevent the mixer from turning in the bracket, hold the mixer with an open-end wrench when you loosen or tighten capillaries on the mixer.

1. On the static mixer outlet, disconnect the capillary that connects the static mixer to the autosampler injection valve.
2. *If you want to install the 100 μ L mixing system or 35 μ L inline filter set:* Disconnect the other end of the capillary on the autosampler injection valve and remove the capillary.
3. Disconnect the capillary mixer on the purge/sensor unit.

4. Pull the static mixer out of the mounting bracket.
5. Remove the assembly of static mixer and capillary mixer from the pump.
6. Disconnect the capillary mixer from the static mixer.

10.1.2.2 Installing a Mixing System with a Volume higher than 100 μL

Parts required

Static mixer as required for the mixing system (see [Available Mixing Systems](#) (► page 237)).

Tools and additional items required

- Depending on the fitting connection on the capillaries
 - ◆ Viper capillary: Viper knurl (usually present on the capillary)
 - ◆ Conventional capillary (non-Viper): Open-end wrench, size 1/4"
- Solvent suitable for purging
- Screwdriver, Torx T10 (required only for static mixers with a volume of 750 μL or 1500 μL)

Preparations

1. *If not yet done:* Remove the mixing system with which the pump is shipped (see [Removing the Mixing System](#) (► page 239)).
2. *Only required if you want to install a static mixer with a volume of 750 μL or 1500 μL*
These mixers require a different mounting bracket. Install the new mounting bracket. The mounting bracket is included in the mixer shipment.

Installing the New Mounting Bracket

Required only for static mixers with a volume of 750 μL or 1500 μL

1. Remove the mounting bracket that is installed in the pump. Mind the orientation of the bracket. The orientation is important for the new bracket.
Binary pump: Keep the spacer sleeves. You will need them when installing the new mounting bracket.

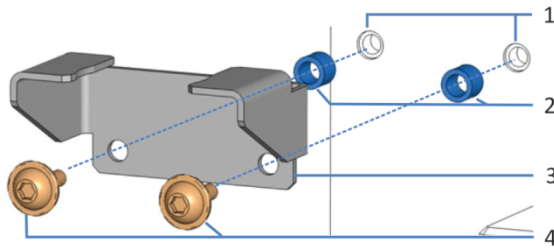


Figure 76: Removing the mounting bracket

No.	Description
1	Mounting holes for mounting bracket
2	With binary pump only: spacer sleeves
3	Mounting bracket
4	Mounting screws (Torx)

- Using the screws shipped with the mounting bracket, attach the new bracket inside the pump (same position and orientation as the one you removed).

Binary pump: Reinsert the spacer sleeves.

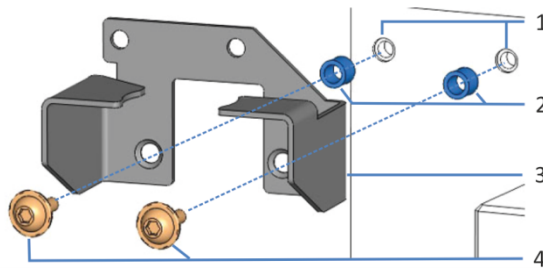


Figure 77: Installing the mounting bracket

No.	Description
1	Mounting holes for mounting bracket
2	With binary pump only: spacer sleeves
3	Mounting bracket
4	Mounting screws (Torx)

Follow these steps

NOTICE

Turning the static mixer in the mounting bracket when loosening or tightening capillaries can damage the mounting bracket.

To prevent the mixer from turning in the bracket, hold the mixer with an open-end wrench when you loosen or tighten capillaries on the mixer.

1. Connect the capillary mixer to the static mixer.
Mind the direction of flow through the static mixer and capillary mixer (indicated by the arrow on the mixer).
2. Insert the assembly of static mixer and capillary mixer into the pump.
3. Insert the static mixer into the mounting bracket.
4. Connect the capillary mixer on the purge/sensor unit.
5. On the static mixer outlet, connect the capillary to the autosampler injection valve.
6. In the Chromeleon software, set the **StaticMixer** property to the value indicated on the static mixer. If the property is not set to the correct value, the leak tests may not provide reliable results.
7. Apply the flow rate of your application and have the pump deliver for a short time.
8. Inspect the flow connections on the mixer for indications of leakage before resuming operation.
9. In the Chromeleon software, consider updating the Predictive Performance information for the static mixer (**MixerChanged** command).

When operating the pump, observe the following

- Operating the pump with a mixing system with a volume lower than the volume installed in the pump upon shipment reduces the gradient delay volume but increases the ripple.
- Operating the pump with a mixing system with a volume higher than the volume installed in the pump upon shipment reduces the ripple but increases the gradient delay volume.
- The maintenance procedures are the same as for the mixing system with which the pump was shipped (see [Mixing System](#) (► page 166)).

10.1.2.3 Installing the 100 μ L Mixing System

Parts required

- Mixing system, volume: 100 μ L, comprising a static mixer (volume: 75 μ L) and a capillary mixer (volume: 25 μ L)
- Capillary to connect the pump to the autosampler

Tools and additional items required

- Depending on the fitting connection on the capillaries
 - ◆ Viper capillary: Viper knurl (usually present on the capillary)
 - ◆ Conventional capillary (non-Viper): Open-end wrench, size 1/4"
- Solvent suitable for purging

Preparations

1. *If not yet done:* Remove the mixing system with which the pump is shipped (see [Removing the Mixing System](#) (► page 239)).
2. For easier installation, remove the seal wash detector assembly (funnel and detector). Grasp and pull the assembly upward by the funnel. The detector including the tubing and cable can remain connected to the funnel.

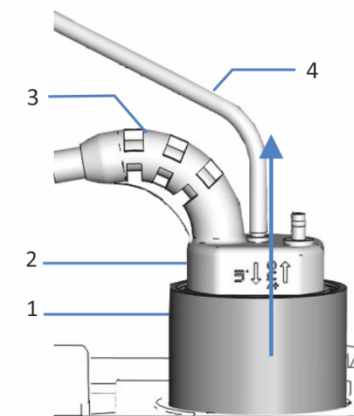


Figure 78: Removing the seal wash detector assembly

No.	Description
1	Funnel, seal wash detector
2	Seal wash detector
3	Detector cable
4	Seal wash line

Follow these steps

1. Connect the capillary mixer on the purge/sensor unit. Mind the direction of flow through the capillary mixer (indicated by the arrow on the mixer).

TIP To facilitate installation of the static mixer, loosely tighten the capillary mixer on the purge/sensor unit so that you can easily access the free end of the capillary.

2. Connect the static mixer to the capillary mixer. Mind the direction of flow through the static mixer (indicated by the arrow on the mixer).
3. Turn and insert the assembly of static mixer and capillary mixer into the pump so that the knurl of the capillary mixer rests on the edge of the purge/sensor unit.

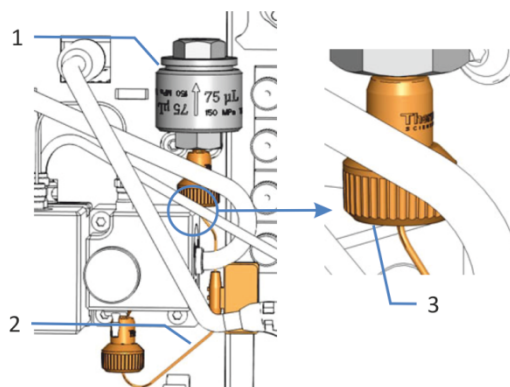


Figure 79: 100 µL mixing system installed

No.	Description
1	Static mixer
2	Capillary mixer
3	Knurl resting on the purge/sensor unit

4. Tighten the capillary mixer on the purge/sensor unit.
5. Reinstall the seal wash detector assembly in the pump (see [Replacing the Seal Wash Detector](#) (▶ page 132)).
6. Connect the static mixer outlet to the autosampler injection valve (see [Connecting the Pump and Autosampler](#) (▶ page 78)).
7. In the Chromeleon software, set the **StaticMixer** property to the value indicated on the static mixer. If the property is not set to the correct value, the leak tests may not provide reliable results.

8. *With Chromeleon 7.2.8 and later:* In the Chromeleon software, set the **CapillaryMixer** property to the value indicated on the capillary mixer.
9. Apply the flow rate of your application and have the pump deliver for a short time.
10. Inspect the flow connections on the mixer for indications of leakage before resuming operation.
11. In the Chromeleon software, consider updating the Predictive Performance information for the static mixer (**MixerChanged** command).

When operating the pump, observe the following

- Operating the pump with a mixing system with a volume lower than the volume installed in the pump upon shipment reduces the gradient delay volume but increases the ripple.
- The maintenance procedures are the same as for the mixing system with which the pump was shipped (see [Mixing System](#) (▶ page 166)).

10.1.2.4 Installing the 35 µL Inline Filter Set

Parts required

- Set inline filter, volume: 35 µL, comprising an inline filter (static filter, volume: 10 µL) and a capillary mixer (volume: 25 µL)
- Capillary to connect the pump to the autosampler

Tools and additional items required

- Depending on the fitting connection on the capillaries
 - ◆ Viper capillary: Viper knurl (usually present on the capillary)
 - ◆ Conventional capillary (non-Viper): Open-end wrench, size 1/4"
- Solvent suitable for purging
- Screwdriver, Torx T10

Preparations

1. *If not yet done:* Remove the mixing system with which the pump is shipped (see [Removing the Mixing System](#) (▶ page 239)).
2. The inline filter requires a different mounting bracket. Install the new mounting bracket. The mounting bracket is included in the inline filter ship kit.

Installing the New Mounting Bracket

1. Unplug the system pressure sensor cable from the **P-SYS** connector.
2. Remove the seal wash detector assembly (funnel and detector). Grasp and pull the assembly upward by the funnel. The detector including the tubing and cable can remain connected to the funnel.

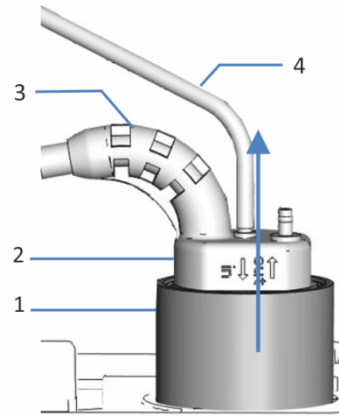


Figure 80: Removing the seal wash detector assembly

No.	Description
1	Funnel, seal wash detector
2	Seal wash detector
3	Detector cable
4	Seal wash line

3. To attach the new mounting bracket inside the pump (above the purge/sensor unit):
 - a) Remove the push rivets that cover the mounting holes while no mounting bracket is installed.
 - b) Using the screws shipped with the mounting bracket, attach the new bracket inside the pump.

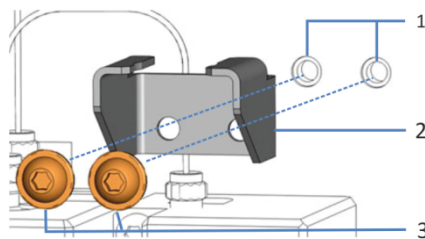


Figure 81: Installing the mounting bracket

No.	Description
1	Mounting holes for mounting bracket (covered by push rivets while no mounting bracket is installed in this position)
2	Mounting bracket
3	Mounting screws (Torx)

Follow these steps

1. Connect the capillary mixer on the purge/sensor unit. Mind the direction of flow through the capillary mixer (indicated by the arrow on the mixer).

TIP To facilitate installation of the inline filter, loosely tighten the capillary mixer on the purge/sensor unit so that you can easily access the free end of the capillary.

2. Connect the inline filter to the capillary mixer. Mind the direction of flow through the inline filter (indicated by the arrow on the filter).
3. Turn and insert the assembly of inline filter and capillary mixer into the mounting bracket.

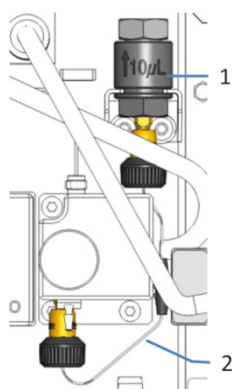


Figure 82: Inline filter with capillary mixer installed

No.	Description
1	Inline filter
2	Capillary mixer

4. Tighten the capillary mixer on the purge/sensor unit.
5. Reinstall the seal wash detector assembly in the pump (see [Replacing the Seal Wash Detector](#) (► page 132)).
6. Reconnect the system pressure sensor cable.
7. Connect the inline filter outlet to the autosampler injection valve (see [Connecting the Pump and Autosampler](#) (► page 78)).
8. In the Chromeleon software, set the **StaticMixer** property to the value indicated on the inline filter. If the property is not set to the correct value, the leak tests may not provide reliable results.

9. *With Chromeleon 7.2.8 and later:* In the Chromeleon software, set the **CapillaryMixer** property to the value indicated on the capillary mixer.
10. Apply the flow rate of your application and have the pump deliver for a short time.
11. Inspect the flow connections on the mixer for indications of leakage before resuming operation.
12. In the Chromeleon software, consider updating the Predictive Performance information for the static mixer (**MixerChanged** command).

When operating the pump, observe the following

- Operating the pump with the inline filter reduces the gradient delay volume but increases the ripple.
- The maintenance procedures for the static mixer apply equally to the inline filter (see [Mixing System](#) (▶ page 166)).

10.2 Normal-Phase Compatible Solvents and Additives

This section applies to Vanquish Core system modules.

In a Vanquish Core system, normal-phase (NP) compatible solvents and additives may be used if the system modules have been modified for NP applications. Refer to the *Vanquish System Operating Manual*.

11 Specifications

This chapter provides the physical and performance specifications, including information about the materials used in the flow path of the device.

11.1 Performance Specifications

For details on the performance specifications for the pumps, see the next sections.

11.1.1 Quaternary Pump and Dual Pump

The pump performance is specified as follows:

Type	Specification*	
Operating principle	Serial dual-piston pump	
Compressibility compensation	Fully automated, independent of the composition of the mobile phase	
Flow range (settable)	<i>VC-pumps:</i> 0.001 – 10 mL/min in 1 µL/min increments	<i>VF-pumps:</i> 0.001 – 8 mL/min in 1 µL/min increments
Flow accuracy	± 0.1%	
Flow precision	< 0.05% RSD or < 0.01 min SD, whichever is greater	
Pressure range	<i>VC-pumps:</i> 2-70 MPa (20-700 bar, 290 – 10100 psi) With a flow rate of > 5 mL/min, the maximum pressure decreases linearly down to 30 MPa (300 bar, 4350 psi).	<i>VF-pumps:</i> 2 – 103 MPa (20 – 1034 bar, 290 – 15000 psi) With a flow rate of > 5 mL/min, the pressure range decreases linearly down to 80 MPa (800 bar, 11600 psi).
Pulsation	< 1.0% or < 0.2 MPa, whichever is greater	
Gradient formation	Low-pressure gradient proportioning	
Proportioning accuracy	± 0.5% (of full-scale)	
Proportioning precision	< 0.15% SD	
Number of solvents	<i>VC-pumps:</i> VC-P20, VC-P21: 4 VC-P32, VC-P33: 2 x 3	<i>VF-pumps:</i> VF-P20: 4 VF-P32: 2 x 3
Maximum stroke volume	80 µL	
Mixer volume	Standard configuration: 400 µL mixing system, consisting of a capillary mixer (volume: 50 µL) and a static mixer (volume: 350 µL) Other mixing systems are available as an option.	
Dwell volume (contribution of the pump to the system gradient delay volume)	679 µL (in standard pump configuration) (314 µL to 1829 µL with optionally available mixing systems)	
Solvent degassing	<i>VC-pumps:</i> VC-P20, VC-P21: Built-in, 4 channels VC-P32, VC-P33: Built-in, 6 channels	<i>VF-pumps:</i> VF-P20: Built-in, 4 channels VF-P32: Built-in, 6 channels

Type	Specification*	
Biocompatible	VC-pumps: no	VF-pumps: yes
Communication	<p>USB:</p> <p>1 USB port (USB 2.0, "B" type connector)</p> <p>1 USB hub with 3 ports (USB 2.0, "A" type connectors)</p> <p>I/O Interface:</p> <p>2 Dig I/O ports (mini-DIN), each providing one input, one relay output, and one bidirectional input/output</p> <p>System Interlink:</p> <p>2 system interlink ports (RJ45-8 connectors)</p>	
Control	<p>Chromeleon 7</p> <p>The pump can be operated also with other data systems. For details, contact the Thermo Fisher Scientific sales organization.</p> <p>Keypad with 5 buttons for performing certain functions directly from the pump</p>	
Materials in the analytical flow path	<p>VC-pumps:</p> <p>Stainless steel, titanium, ceramics, sapphire, PEEK, UHMW PE, fluoropolymers</p>	<p>VF-pumps:</p> <p>MP35N, titanium, ceramics, sapphire, PEEK, UHMW PE, fluoropolymers</p>
	For information about the chemical resistance of materials refer to the technical literature.	
Solvent and additive information	See Solvent and Additive Information (▶ page 26).	
Safety features	Leak detection and safe leak handling, excess pressure monitoring	
Good Laboratory Practice (GLP) features	<p>Predictive Performance functions for scheduling maintenance procedures based on the actual operating and usage conditions of the pump.</p> <p>All system parameters logged in the Chromeleon Audit Trail.</p>	
<p>* Typical operating conditions for measurable specifications:</p> <p>Flow accuracy, flow precision, pulsation: 1 mL/min at 20 MPa or 2 mL/min at 40 MPa, water</p> <p>Proportioning accuracy, proportioning precision: 1 mL/min at 20 MPa or 2 mL/min at 40 MPa, 0-100%, water/spiked water</p>		

11.1.2 Binary Pump

The pump performance is specified as follows:

Type	Specification*	
Operating principle	Serial dual-piston pump	
Compressibility compensation	Fully automated, independent of the composition of the mobile phase	
Flow range (settable)	<i>VC-pump:</i> 0.001 – 10 mL/min in 1 µL/min increments	<i>VF-pump:</i> 0.001 – 8 mL/min in 1 µL/min increments
Flow accuracy	± 0.1%	
Flow precision	< 0.05% RSD or < 0.01 min SD, whichever is greater	
Pressure range	<i>VC-pump:</i> 2-70 MPa (20-700 bar, 290 – 10100 psi) With a flow rate of > 5 mL/min, the maximum pressure decreases linearly down to 30 MPa (300 bar, 4350 psi).	<i>VF-pump:</i> 2 – 103 MPa (20 – 1034 bar, 290 – 15000 psi) With a flow rate of > 5 mL/min, the pressure range decreases linearly down to 80 MPa (800 bar, 11600 psi).
Pulsation	< 1.0% or < 0.2 MPa, whichever is greater	
Gradient formation	High-pressure gradient proportioning	
Proportioning accuracy	± 0.2% (of full-scale)	
Proportioning precision	< 0.15% SD	
Number of solvents	2 out of 6	
Maximum stroke volume	80 µL	
Mixer volume	<i>VC-pump:</i> Standard configuration: 400 µL mixing system, consisting of a capillary mixer (volume: 50 µL) and a static mixer (volume: 350 µL) Other mixing systems are available as an option.	<i>VF-pump:</i> Standard configuration: 200 µL mixing system, consisting of a capillary mixer (volume: 50 µL) and a static mixer (volume: 150 µL) Other mixing systems are available as an option.
Dwell volume (contribution of the pump to the system gradient delay volume)	400 µL (in standard pump configuration) (35 µL to 1550 µL with optionally available mixing systems)	200 µL (in standard pump configuration) (35 µL to 1550 µL with optionally available mixing systems)
Solvent degassing	Built-in, number of channels: 2 out of 6	
Biocompatible	<i>VC-pumps:</i> no	<i>VF-pumps:</i> yes

Type	Specification*	
Communication	<p><i>USB:</i></p> <p>1 USB port (USB 2.0, "B" type connector)</p> <p>1 USB hub with 3 ports (USB 2.0, "A" type connectors)</p> <p><i>I/O Interface:</i></p> <p>2 Dig I/O ports (mini-DIN), each providing one input, one relay output, and one bidirectional input/output</p> <p><i>System Interlink:</i></p> <p>2 system interlink ports (RJ45-8 connectors)</p>	
Control	<p>Chromeleon 7</p> <p>The pump can be operated also with other data systems. For details, contact the Thermo Fisher Scientific sales organization.</p> <p>Keypad with 5 buttons for performing certain functions directly from the pump</p>	
Materials in the analytical flow path	<p><i>VC-pumps:</i></p> <p>Stainless steel, titanium, ceramics, sapphire, PEEK, UHMW PE, fluoropolymers</p>	<p><i>VF-pumps:</i></p> <p>MP35N, titanium, ceramics, sapphire, PEEK, UHMW PE, fluoropolymers</p>
	For information about the chemical resistance of materials refer to the technical literature.	
Solvent and additive information	See Solvent and Additive Information (▶ page 26).	
Safety features	Leak detection and safe leak handling, excess pressure monitoring	
Good Laboratory Practice (GLP) features	<p>Predictive Performance functions for scheduling maintenance procedures based on the actual operating and usage conditions of the pump.</p> <p>All system parameters logged in the Chromeleon Audit Trail.</p>	
<p>* Typical operating conditions for measurable specifications:</p> <p>Flow accuracy, flow precision, pulsation: 1 mL/min at 20 MPa or 2 mL/min at 40 MPa, water</p> <p>Proportioning accuracy, proportioning precision: 1 mL/min at 20 MPa or 2 mL/min at 40 MPa, 0-100%, water/spiked water</p>		

11.1.3 Isocratic Pump

The pump performance is specified as follows:

Type	Specification*
Operating principle	Serial dual-piston pump
Compressibility compensation	Fully automated, independent of the composition of the mobile phase
Flow range (settable)	0.001 – 10 mL/min in 1 µL/min increments
Flow accuracy	± 0.1%
Flow precision	< 0.05% RSD or < 0.01 min SD, whichever is greater
Pressure range	2-70 MPa (20-700 bar, 290 – 10100 psi) With a flow rate of > 5 mL/min, the maximum pressure decreases linearly down to 30 MPa (300 bar, 4350 psi).
Pulsation	< 1.0% or < 0.2 MPa, whichever is greater
Number of solvents	1
Maximum stroke volume	80 µL
Mixer volume	With the isocratic pump, the mixing system serves as inline filter. Standard configuration: 200 µL mixing system, consisting of a capillary mixer (volume: 50 µL) and a static mixer (volume: 150 µL) Other mixing systems (inline filters) are available as an option.
Solvent degassing	No (available as optional accessory)
Biocompatible	No
Communication	<i>USB:</i> 1 USB port (USB 2.0, "B" type connector) 1 USB hub with 3 ports (USB 2.0, "A" type connectors) <i>I/O Interface:</i> 2 Dig I/O ports (mini-DIN), each providing one input, one relay output, and one bidirectional input/output <i>System Interlink:</i> 2 system interlink ports (RJ45-8 connectors)
Control	Chromeleon 7 The pump can be operated also with other data systems. For details, contact the Thermo Fisher Scientific sales organization. Keypad with 5 buttons for performing certain functions directly from the pump
Materials in the analytical flow path	Stainless steel, titanium, ceramics, sapphire, PEEK, UHMW PE, fluoropolymers For information about the chemical resistance of materials refer to the technical literature.
Solvent and additive information	See Solvent and Additive Information (► page 26).
Safety features	Leak detection and safe leak handling, excess pressure monitoring

Type	Specification*
Good Laboratory Practice (GLP) features	Predictive Performance functions for scheduling maintenance procedures based on the actual operating and usage conditions of the pump. All system parameters logged in the Chromeleon Audit Trail.
* Typical operating conditions for measurable specifications: Flow accuracy, flow precision, pulsation: 1 mL/min at 20 MPa or 2 mL/min at 40 MPa, water	

11.2 Physical Specifications

The physical conditions of the device are specified as follows:

Type	Specification
Range of use	Indoor use only
Ambient operating temperature	5 °C - 35 °C
Ambient storage temperature	-20 °C - 45 °C
Ambient operating humidity	20% - 80% relative humidity (non-condensing)
Ambient storage humidity	Maximum 60% relative humidity (non-condensing)
Operating altitude	Maximum 2000 m above sea level
Pollution degree	2
Power requirements	100 – 240 VAC, ± 10 %; 50/60 Hz, max. 245 W / 255 VA
Overvoltage category	II
Emission sound pressure level	< 70 dB(A), typically < 40 dB(A)
Dimensions (height x width x depth)	19.2 x 42 x 62 cm
Weight	Binary pump/dual pump: 20 kg, isocratic pump/quaternary pump: 17 kg

12 Accessories, Consumables and Replacement Parts

This chapter describes the standard accessories that are shipped with the device and the accessories that are available as an option. This chapter also provides information for reordering consumables and replacement parts.

12.1 General Information

The device must be operated only with the replacement parts and additional components, options, and peripherals specifically authorized and qualified by Thermo Fisher Scientific.

Accessories, consumables, and replacement parts are always maintained at the latest technical standard. Therefore, part numbers are subject to change. If not otherwise stated, updated parts will be compatible with the parts they replace.

12.2 Ship Kit

The ship kit includes the items listed in the table. The kit content is subject to change and may vary from the information in this manual. Refer to the content list included in the kit for the most recent information about the kit content at the time when the device is shipped.

12.2.1 Binary Pump

For reordering information of the ship kit components, see [Consumables and Replacement Parts](#) (▶ page 270).

VC-P10 ship kit

Item	Quantity in shipment
Silicone tubing, 3 m	1
Syringe, plastic, 12 mL	1
Tubing connector (90°-angled)	2
Solvent line filter, filter holder (no filter frit included)	6
Solvent line filter, filter frit, 10 µm (pack of 10)	1
Plugs and retaining guides for reservoir caps, kit including <ul style="list-style-type: none"> • Cap plug to close open holes in the reservoir cap (pack of 5) • Retaining guide to keep the liquid line in place in the reservoir cap (pack of 2) 	7
Fitting plug, Viper	1
Tool kit, including <ul style="list-style-type: none"> • Open-end wrench, size 11 x 13 mm • Double-ended ring wrench, size 11 x 13 mm • Open-end wrench, size 1/4" x 5/16" • Hexagon wrench, size 6 • Seal-handling tool • Spacing tool, pump head and pistons 	1
Reservoir, 0.25 L, with reservoir cap	1
Tubing bracket	1
Solvent lines (pack of 6), from solvent reservoirs to solvent selectors	1
System interlink cable (RJ45), 0.5 m	1
USB cable, type A to type B, high-speed, USB 2.0, cable length: 5 m	1

VF-P10 ship kit

Item	Quantity in shipment
Silicone tubing, 3 m	1
Syringe, plastic, 12 mL	1
Tubing connector (90°-angled)	2
Solvent line filter, filter holder (no filter frit included)	6
Solvent line filter, filter frit, biocompatible, 10 µm	6
Plugs and retaining guides for reservoir caps, kit including <ul style="list-style-type: none"> • Cap plug to close open holes in the reservoir cap (pack of 5) • Retaining guide to keep the liquid line in place in the reservoir cap (pack of 2) 	7
Fitting plug, Viper	1
Tool kit, including <ul style="list-style-type: none"> • Open-end wrench, size 11 x 13 mm • Double-ended ring wrench, size 11 x 13 mm • Open-end wrench, size 1/4" x 5/16" • Hexagon wrench, size 6 • Seal-handling tool • Spacing tool, pump head and pistons 	1
Installation tool for Viper capillaries with torque tothing	1
Reservoir, 0.25 L, with reservoir cap	1
Tubing bracket	1
Solvent lines (pack of 6), from solvent reservoirs to solvent selectors	1
System interlink cable (RJ45), 0.5 m	1
USB cable, type A to type B, high-speed, USB 2.0, cable length: 5 m	1

12.2.2 Dual Pump

For reordering information of the ship kit components, see [Consumables and Replacement Parts](#) (▶ page 270).

VC-P32, VC-P33 ship kit

Item	Quantity in shipment
Silicone tubing, 3 m	1
Syringe, plastic, 12 mL	1
Tubing connector (90°-angled)	2
Solvent line filter, filter holder (no filter frit included)	6
Solvent line filter, filter frit, 10 µm (pack of 10)	1
Plugs and retaining guides for reservoir caps, kit including <ul style="list-style-type: none"> • Cap plug to close open holes in the reservoir cap (pack of 5) • Retaining guide to keep the liquid line in place in the reservoir cap (pack of 2) 	7
Fitting plug, Viper	1
Tool kit, including <ul style="list-style-type: none"> • Open-end wrench, size 11 x 13 mm • Double-ended ring wrench, size 11 x 13 mm • Open-end wrench, size 1/4" x 5/16" • Hexagon wrench, size 6 • Seal-handling tool • Spacing tool, pump head and pistons 	1
Reservoir, 0.25 L, with reservoir cap	1
Tubing bracket	1
Solvent lines (pack of 6) from solvent reservoirs to pump degasser	1
System interlink cable (RJ45), 0.5 m	1
USB cable, type A to type B, high-speed, USB 2.0, cable length: 5 m	1

VF-P32 ship kit

Item	Quantity in shipment
Silicone tubing, 3 m	1
Syringe, plastic, 12 mL	1
Tubing connector (90°-angled)	2
Solvent line filter, filter holder (no filter frit included)	6
Solvent line filter, filter frit, biocompatible, 10 µm	6

Item	Quantity in shipment
Plugs and retaining guides for reservoir caps, kit including <ul style="list-style-type: none"> • Cap plug to close open holes in the reservoir cap (pack of 5) • Retaining guide to keep the liquid line in place in the reservoir cap (pack of 2) 	7
Fitting plug, Viper	1
Tool kit, including <ul style="list-style-type: none"> • Open-end wrench, size 11 x 13 mm • Double-ended ring wrench, size 11 x 13 mm • Open-end wrench, size 1/4" x 5/16" • Hexagon wrench, size 6 • Seal-handling tool • Spacing tool, pump head and pistons 	1
Installation tool for Viper capillaries with torque toothing	1
Reservoir, 0.25 L, with reservoir cap	1
Tubing bracket	1
Solvent lines (pack of 6) from solvent reservoirs to pump degasser	1
System interlink cable (RJ45), 0.5 m	1
USB cable, type A to type B, high-speed, USB 2.0, cable length: 5 m	1

12.2.3 Isocratic Pump

For reordering information of the ship kit components, see [Consumables and Replacement Parts](#) (► page 270).

VC-P40 ship kit

Item	Quantity in shipment
Silicone tubing, 3 m	1
Syringe, plastic, 12 mL	1
Tubing connector (90°-angled)	2
Solvent line filter, filter holder (no filter frit included)	2
Solvent line filter, filter frit, 10 µm (pack of 10)	1
Plugs and retaining guides for reservoir caps, kit including <ul style="list-style-type: none"> • Cap plug to close open holes in the reservoir cap (pack of 5) • Retaining guide to keep the liquid line in place in the reservoir cap (pack of 2) 	5
Fitting plug, Viper	1

Item	Quantity in shipment
Tool kit, including <ul style="list-style-type: none"> • Open-end wrench, size 11 x 13 mm • Double-ended ring wrench, size 11 x 13 mm • Open-end wrench, size 1/4" x 5/16" • Hexagon wrench, size 6 • Seal-handling tool • Spacing tool, pump head and pistons 	1
Reservoir, 0.25 L, with reservoir cap	1
Tubing bracket	1
Solvent lines (pack of 2), from solvent reservoirs to pump head	1
System interlink cable (RJ45), 0.5 m	1
USB cable, type A to type B, high-speed, USB 2.0, cable length: 5 m	1

12.2.4 Quaternary Pump

For reordering information of the ship kit components, see [Consumables and Replacement Parts](#) (► page 270).

VC-P20, VC-P21 ship kit

Item	Quantity in shipment
Silicone tubing, 3 m	1
Syringe, plastic, 12 mL	1
Tubing connector (90°-angled)	2
Solvent line filter, filter holder (no filter frit included)	4
Solvent line filter, filter frit, 10 µm (pack of 10)	1
Plugs and retaining guides for reservoir caps, kit including <ul style="list-style-type: none"> • Cap plug to close open holes in the reservoir cap (pack of 5) • Retaining guide to keep the liquid line in place in the reservoir cap (pack of 2) 	5
Fitting plug, Viper	1
Tool kit, including <ul style="list-style-type: none"> • Open-end wrench, size 11 x 13 mm • Double-ended ring wrench, size 11 x 13 mm • Open-end wrench, size 1/4" x 5/16" • Hexagon wrench, size 6 • Seal-handling tool • Spacing tool, pump head and pistons 	1
Reservoir, 0.25 L, with reservoir cap	1

Item	Quantity in shipment
Tubing bracket	1
Solvent lines (pack of 4), from solvent reservoirs to pump degasser	1
System interlink cable (RJ45), 0.5 m	1
USB cable, type A to type B, high-speed, USB 2.0, cable length: 5 m	1

VF-P20 ship kit

Item	Quantity in shipment
Silicone tubing, 3 m	1
Syringe, plastic, 12 mL	1
Tubing connector (90°-angled)	2
Solvent line filter, filter holder (no filter frit included)	4
Solvent line filter, filter frit, biocompatible, 10 µm	4
Plugs and retaining guides for reservoir caps, kit including <ul style="list-style-type: none"> • Cap plug to close open holes in the reservoir cap (pack of 5) • Retaining guide to keep the liquid line in place in the reservoir cap (pack of 2) 	5
Fitting plug, Viper	1
Tool kit, including <ul style="list-style-type: none"> • Open-end wrench, size 11 x 13 mm • Double-ended ring wrench, size 11 x 13 mm • Open-end wrench, size 1/4" x 5/16" • Hexagon wrench, size 6 • Seal-handling tool • Spacing tool, pump head and pistons 	1
Installation tool for Viper capillaries with torque toothing	1
Reservoir, 0.25 L, with reservoir cap	1
Tubing bracket	1
Solvent lines (pack of 4), from solvent reservoirs to pump degasser	1
System interlink cable (RJ45), 0.5 m	1
USB cable, type A to type B, high-speed, USB 2.0, cable length: 5 m	1

12.3 Optional Accessories

For accessories that are available as an option, see

- [Optional Accessories \(Miscellaneous\)](#) (▶ page 267)
- [Optional Mixing Systems and Inline Filters](#) (▶ page 268)

12.3.1 Optional Accessories (Miscellaneous)

Solvent shut-off valve

Description	Part No.
Solvent shut-off valve To prevent the solvent from flowing through the system, for example, when opening a flow connection on the low-pressure side.	6036.0010

Solvent monitor

Description	Part No.
Vanquish Solvent Monitor To actively monitor the liquid level in solvent reservoirs and waste containers in real time. Monitoring is based on real physical measurement.	
Solvent monitor, 4-channel version	6230.1320
Solvent monitor, 8-channel version	6230.1310

Buffer Performance kit

Description	Part No.
Buffer Performance kit for quaternary or dual pumps To avoid pressure pulsation issues with buffer applications in quaternary pumps or dual pumps. Depending on the application, two kits may be required with the dual pump. Due to bad solubility of salts in organic fluids, mixing of a buffer solution with organic fluids in a quaternary or dual pump can lead to precipitation of salt at the mixing point. The precipitated salt can deposit in the check valves and prevent them from closing. This leads to pressure pulsation in buffer applications. Modifying the sequence of the fluidics with the kit components enhances the mixing performance.	6040.5320

Degasser kit (VC-P40)

Description	Part No.
Degasser kit VC-P40 To retrofit the isocratic pump with a vacuum degasser. Thermo Fisher Scientific service personnel must retrofit the pump with the degasser.	6045.3731

Mixing systems, inline filters

Description	Part No.
Mixing systems, set inline filter See Optional Mixing Systems and Inline Filters (▶ page 268).	

12.3.2 Optional Mixing Systems and Inline Filters

Each mixing system comprises a static mixer and a capillary mixer. The volumes of both mixers determine the entire volume of the mixing system.

TIP With mixing systems (volumes: 200 μL , 400 μL , 800 μL or 1550 μL), only the static mixer is different from the static mixer with which the pump is shipped. The capillary mixer remains the same. Thus, if you want to change to this mixing system, you need to order only the static mixer. If you want to replace the capillary mixer nevertheless, order the appropriate part number as indicated in the table.

Static mixers

Description	Part No.
Static mixers for use with 50 μL capillary mixer:	
Static mixer, volume: 150 μL (for total volume of mixing system: 200 μL) <i>Binary VF-pump, isocratic pump:</i> The pump is shipped with the mixing system with a volume of 200 μL . With the isocratic pump, the mixing system serves as inline filter.	6044.5110
Static mixer, volume: 350 μL (for total volume of mixing system: 400 μL) <i>Binary VC-pump, quaternary pump:</i> The pump is shipped with the mixing system with a volume of 400 μL . <i>Dual pump:</i> The pump is shipped with two mixing systems, each with a volume of 400 μL .	6044.5310
Static mixer, volume: 750 μL (for total volume of mixing system: 800 μL)	6044.5750A
Static mixer, volume: 1500 μL (for total volume of mixing system: 1550 μL)	6044.5450A

Capillary mixers

Description	Part No.
Capillary mixer (volume: 50 µL) for use with static mixers (volumes: 150 µL, 350 µL, 750 µL, and 1500 µL) for:	
VC-pumps	6044.3015
VF-pumps	6044.5026

Mixing systems, set inline filter

VC-pumps

Description	Part No.
Mixing system, volume: 100 µL, including: <ul style="list-style-type: none"> • Static mixer, volume: 75 µL • Capillary mixer, volume: 25 µL 	6045.5100
Set inline filter, volume: 35 µL, including: <ul style="list-style-type: none"> • Inline filter (static filter) volume: 10 µL • Capillary mixer, volume: 25 µL In addition, order the capillary to connect the pump to the autosampler.	6045.3020
Capillary to connect the pump to the autosampler, for use with 100 µL mixing system and 35 µL inline filter set For use with binary pump, isocratic pump, and quaternary pump <i>Dual pump</i> : The capillaries to use depend on the application workflow and are provided in the respective Workflow Solution Kits. For details refer to the documentation that comes with the kit.	6040.2325

VF-pumps

Description	Part No.
Mixing system, volume: 100 µL, including: <ul style="list-style-type: none"> • Static mixer, volume: 75 µL • Capillary mixer, volume: 25 µL 	6044.5100
Set inline filter, volume: 35 µL, including: <ul style="list-style-type: none"> • Inline filter (static filter) volume: 10 µL • Capillary mixer, volume: 25 µL In addition, order the capillary to connect the pump to the autosampler.	6044.3870
Capillary to connect the pump to the autosampler, for use with the 100 µL mixing system and 35 µL inline filter set For use with binary pump, isocratic pump, and quaternary pump <i>Dual pump</i> : The capillaries to use depend on the application workflow and are provided in the respective Workflow Solution Kits. For details refer to the documentation that comes with the kit.	6042.2330

12.4 Consumables and Replacement Parts

The following consumables and replacement parts are available for the pump.

12.4.1 Maintenance Kits

The maintenance kits that are available for the pumps include all parts that are required for routine maintenance.

- See [Maintenance Kits \(VC-Pumps\)](#) (► page 270).
- See [Maintenance Kits \(VF-Pumps\)](#) (► page 272).

12.4.1.1 Maintenance Kits (VC-Pumps)

TIP Maintenance kits can include parts that are not required for your specific pump. These parts are marked accordingly in the contents lists for the kits.

VC-P10

Description	Part No.
Maintenance kit for VC-P10, including: <ul style="list-style-type: none"> • Pump head seal (2 PTFE seals (2 each), different sized) • Silicone tubing (clear tubing) • Peristaltic tubing (light yellow tubing) • Tubing connector (straight) (pack of 5) • Tubing connector (90°-angled) • Seal wash seal (pack of 4) • Piston seal (pack of 4) • Valve cartridge, ceramics (pack of 2) • Solvent line filter (4 filter holders and filter frits) • Cleaning swab (pack of 5) • Tubing clip (self-adhesive) (pack of 3) <i>Not required with VC-P10:</i> Support ring	6040.1953A

VC-P20

Description	Part No.
Maintenance kit for VC-P20, including: <ul style="list-style-type: none"> • Pump head seal (2 PTFE seals, different sized) • Silicone tubing (clear tubing) • Peristaltic tubing (light yellow tubing) • Tubing connector (straight) (pack of 4) • Tubing connector (90°-angled) • Seal wash seal (pack of 2) • Piston seal (pack of 2) • Valve cartridge, ceramics • Solvent line filter (4 filter holders and filter frits) • Cleaning swab (pack of 5) • Tubing clip (self-adhesive) (pack of 2) <i>Not required with VC-P20: Support ring</i>	6040.1951A

VC-P32

Description	Part No.
Maintenance kit for VC-P32, including: <ul style="list-style-type: none"> • Pump head seal (2 PTFE seals (2 each), different sized) • Silicone tubing (clear tubing) • Peristaltic tubing (light yellow tubing) • Tubing connector (straight) (pack of 5) • Tubing connector (90°-angled) • Seal wash seal (pack of 4) • Piston seal (pack of 4) • Valve cartridge, ceramics (pack of 2) • Solvent line filter (6 filter holders and filter frits) • Cleaning swab (pack of 5) • Tubing clip (self-adhesive) (pack of 3) <i>Not required with VC-P32: Support ring</i>	6040.1952A

VC-P40

Description	Part No.
Maintenance kit for VC-P40, including: <ul style="list-style-type: none"> • Pump head seal (2 PTFE seals, different sized) • Silicone tubing (clear tubing) • Peristaltic tubing (light yellow tubing) • Tubing connector (straight) (pack of 3) • Tubing connector (90°-angled) • Seal wash seal (pack of 2) • Piston seal (pack of 2) • Valve cartridge, ceramics • Solvent line filter (1 filter holder and filter frits) • Cleaning swab (pack of 5) • Tubing clip (self-adhesive) (pack of 2) Not required with VC-P40: Support ring	6040.1950A

12.4.1.2 Maintenance Kits (VF-Pumps)

VF-P10

Description	Part No.
Maintenance kit for VF-P10, including: <ul style="list-style-type: none"> • Pump head seal (2 PTFE seals (2 each), different sized) • Silicone tubing (clear tubing) • Peristaltic tubing (light yellow tubing) • Tubing connector (straight) (pack of 5) • Tubing connector (90°-angled) • Seal wash seal (pack of 4) • Piston seal (pack of 4) • Valve cartridge, ceramics (pack of 2) • Solvent line filter (4 filter holders and filter frits) • Cleaning swab (pack of 5) • Tubing clip (self-adhesive) (pack of 3) 	6040.1956B

VF-P20

Description	Part No.
Maintenance kit for VF-P20, including: <ul style="list-style-type: none"> • Pump head seal (2 PTFE seals, different sized) • Silicone tubing (clear tubing) • Peristaltic tubing (light yellow tubing) • Tubing connector (straight) (pack of 4) • Tubing connector (90°-angled) • Seal wash seal (pack of 2) • Piston seal (pack of 2) • Valve cartridge, ceramics • Solvent line filter (4 filter holders and filter frits) • Cleaning swab (pack of 5) • Tubing clip (self-adhesive) (pack of 2) 	6040.1954A

VF-P32

Description	Part No.
Maintenance kit for VF-P32, including: <ul style="list-style-type: none"> • Pump head seal (2 PTFE seals (2 each), different sized) • Silicone tubing (clear tubing) • Peristaltic tubing (light yellow tubing) • Tubing connector (straight) (pack of 5) • Tubing connector (90°-angled) • Seal wash seal (pack of 4) • Piston seal (pack of 4) • Valve cartridge, ceramics (pack of 2) • Solvent line filter (6 filter holders and filter frits) • Cleaning swab (pack of 5) • Tubing clip (self-adhesive) (pack of 3) 	6040.1955B

12.4.2 Pump Heads and Components

- See [Pump Heads and Components \(VC-Pumps\)](#) (▶ page 274).
- See [Pump Heads and Components \(VF-Pumps\)](#) (▶ page 275).

12.4.2.1 Pump Heads and Components (VC-Pumps)

VC-P10

Description	Part No.
Pump head (complete assembly), including spacing tool	6045.3205
Piston seal (RP) (pack of 2)*	6040.0304
Seal wash seal (pack of 2)*	6040.0033
Support ring (pack of 2)	6040.0012
Piston, sapphire (pack of 2)	6040.0042
Check valve, valve nut kit, including: <ul style="list-style-type: none"> • Nut for inlet check valve • Nut for outlet check valve 	6035.1965
Check valve, cartridge, ceramics Identical for inlet check valve and outlet check valve	6041.2301
Pump head seals (PTFE O-rings, sizes: 32x1.5 and 9x1.5; 5 each)	6040.2208
Capillary kit, pump head, including: <ul style="list-style-type: none"> • U-tube (pack of 2) • Capillary from right pump head to purge/sensor unit • Capillary from left pump head to purge/sensor unit 	6045.3000
Seal-handling tool	6040.7158
* <i>With pump modified for NP applications:</i> Seals (pack of 2) for use as both piston seals and seal wash seals	6040.0306

VC-P20, VC-P32, and VC-P40

Description	Part No.
Pump head (complete assembly), including spacing tool	6044.3204
Piston seal (RP) (pack of 2)*	6040.0304
Seal wash seal (pack of 2)*	6040.0033
Support ring (pack of 2)	6040.0012
Piston, sapphire (pack of 2)	6040.0042
Check valve, valve nut kit, including: <ul style="list-style-type: none"> • Nut for inlet check valve • Nut for outlet check valve 	6035.1965
Check valve, cartridge, ceramics Identical for inlet check valve and outlet check valve	6041.2301

Description	Part No.
Pump head seals (PTFE O-rings, sizes: 32x1.5 and 9x1.5; 5 each)	6040.2208
Capillary kit, pump head, including: <ul style="list-style-type: none"> • U-tube (pack of 2) • Capillary from pump head to purge/sensor unit (pack of 2) 	6040.3001
Seal-handling tool	6040.7158
* With pump modified for NP applications: Seals (pack of 2) for use as both piston seals and seal wash seals	6040.0306

VC-P21 and VC-P33

Description	Part No.
Pump head (complete assembly), including spacing tool	6044.3202
Seals (pack of 2) for use as both seal wash seals and piston seals	6040.0306
Support ring (pack of 2)	6040.0012
Piston, sapphire (pack of 2)	6040.0042
Check valve, valve nut kit, including: <ul style="list-style-type: none"> • Nut for inlet check valve • Nut for outlet check valve 	6035.1965
Check valve, cartridge, ceramics Identical for inlet check valve and outlet check valve	6041.2301
Pump head seals (PTFE O-rings, sizes: 32x1.5 and 9x1.5; 5 each)	6040.2208
Capillary kit, pump head, including: <ul style="list-style-type: none"> • U-tube (pack of 2) • Capillary from pump head to purge/sensor unit (pack of 2) 	6040.3001
Seal-handling tool	6040.7158

12.4.2.2 Pump Heads and Components (VF-Pumps)

VF-P10

Description	Part No.
Pump head (complete assembly), including spacing tool	6044.5201
Piston seal (RP) and seal wash seal (pack of 2 each)	6044.0295
Support ring (pack of 2)	6040.0012
Piston, sapphire (pack of 2)	6040.0042
Check valve, valve nut kit, including: <ul style="list-style-type: none"> • Nut for inlet check valve • Nut for outlet check valve 	6037.1964
Check valve, cartridge, ceramics Identical for inlet check valve and outlet check valve	6041.2301

Description	Part No.
Pump head seals (PTFE O-rings, sizes: 32x1.5 and 9x1.5; 5 each)	6040.2208
Capillary kit, pump head, including: <ul style="list-style-type: none"> • U-tube (pack of 2) • Capillary from right pump head to purge/sensor unit • Capillary from left pump head to purge/sensor unit 	6044.5016
Seal-handling tool	6040.7158
Installation tool for Viper capillaries with torque toothing	6040.2314

VF-P20 and VF-P32

Description	Part No.
Pump head (complete assembly), including spacing tool	6044.5204
Piston seal (RP) and seal wash seal (pack of 2 each)	6044.0295
Support ring (pack of 2)	6040.0012
Piston, sapphire (pack of 2)	6040.0042
Check valve, valve nut kit, including: <ul style="list-style-type: none"> • Nut for inlet check valve • Nut for outlet check valve 	6037.1964
Check valve, cartridge, ceramics Identical for inlet check valve and outlet check valve	6041.2301
Pump head seals (PTFE O-rings, sizes: 32x1.5 and 9x1.5; 5 each)	6040.2208
Capillary kit, pump head, including: <ul style="list-style-type: none"> • U-tube (pack of 2) • Capillary from pump head to purge/sensor unit (pack of 2) 	6040.3003
Seal-handling tool	6040.7158
Installation tool for Viper capillaries with torque toothing	6040.2314

12.4.3 Solvents and Wash Systems

Reservoirs for solvents and wash liquids

Description	Part No.
Reservoir, 1 L, including cap	2270.0012
Reservoir, 0.25 L, including cap	2270.0026
Cap for reservoirs, screw-cap (pack of 4)	6270.0013
Cap plug to close open holes in the reservoir cap (pack of 20)	6000.0047
Retaining guide to keep the liquid line in place in the reservoir cap (pack of 5)	6000.0042
Plugs and retaining guides for reservoir caps, kit including <ul style="list-style-type: none"> • Cap plug to close open holes in the reservoir cap (pack of 10) • Retaining guide to keep the liquid line in place in the reservoir cap (pack of 5) 	6030.9101

Seal wash system

Description	Part No.
Peristaltic and wash tubing kit The kit includes peristaltic tubing (PharMed), silicone tubing, and tubing connectors for use in <ul style="list-style-type: none"> • Seal wash system in the pump and in the autosampler • Needle wash system in the autosampler • Drain pump in the autosampler <p>NOTICE: Use the thick silicone tubing (and related tubing connectors) in the autosampler. Use the thin silicone tubing (and related tubing connectors) in the pump. Use the screwable connectors for the pump head. The screwable tubing connectors are not used with the VC-pumps and VF-pumps.</p> <p>NOTE: For a Vanquish Core system that has been modified for NP applications, order the Normal-Phase (NP) tubing kit. For ordering details and kit content, refer to the <i>Vanquish System Operating Manual</i>.</p>	6044.1150
Seal wash detector (drop detector) with funnel	6044.1898
Seal wash detector (drop detector) with funnel, NP	6044.1902
Seal wash seals	
VF-pumps: Seal wash seal (pack of 2 seal wash seals and 2 piston seals (RP))	6044.0295
VC-pumps – all VC-pumps except VC-P21 and VC-P33: Seal wash seal (pack of 2 seal wash seals)	6040.0033
VC-P21, VC-P33, and VC-pumps modified for NP applications: Seals (NP) (pack of 2) for use as both seal wash seals and piston seals	6040.0306

Solvent line filters, solvent lines and tubing

Description	Part No.
Solvent line filter, filter holder (pack of 6) (no filter frits included)	6268.0115
Solvent line filter, filter frits, 10 µm (pack of 10) for	
<i>VF-pumps</i> (biocompatible frits)	6268.0111
<i>VC-pumps</i> (stainless steel frits)	6268.0110
Solvent lines to connect the solvent reservoirs to the pump inlet	
<i>Quaternary pump</i> : Solvent lines to connect the solvent reservoirs to the degasser inlet ports	6036.1703
<i>Dual pump</i> : Solvent lines to connect the solvent reservoirs to the degasser inlet ports	6036.1704
<i>Binary pump</i> : Solvent lines to connect the solvent reservoirs to the solvent selectors	6036.1701
<i>Isocratic pump</i> : Solvent line to connect the solvent reservoir to the pump head	6036.1705
Solvent lines to connect the pump inlet to the pump heads	
<i>Quaternary pump</i> : Tubing kit, including: <ul style="list-style-type: none"> • Solvent lines from degasser to proportioning valve • Solvent line from proportioning valve to pump head 	6044.8017
<i>Dual pump</i> : Tubing kit, including: <ul style="list-style-type: none"> • Solvent lines from degasser to proportioning valve • Solvent line from proportioning valve to pump head 	6044.8005
<i>Binary pump</i> : Tubing kit, including: <ul style="list-style-type: none"> • Solvent lines from solvent selectors to degasser • Solvent lines from degasser to pump heads 	6044.8006

12.4.4 Mixing Systems

Each mixing system comprises a static mixer and a capillary mixer. The volumes of both mixers determine the entire volume of the mixing system.

The tables list the reordering part numbers for the components with which the pump is shipped from the factory. Mixing systems with other volumes are available as an option. For ordering information, see [Optional Accessories](#) (► page 267).

Static mixers

Description	Part No.
Static mixer, volume: 350 µL (standard in binary VC-pump, quaternary pumps and dual pumps)	6044.5310
Static mixer, volume: 150 µL (standard in binary VF- pump and isocratic pumps)	6044.5110

Capillary mixers

Description	Part No.
Capillary mixer (volume: 50 µL) for use with static mixers (volumes: 150 µL, 350 µL, 750 µL, and 1500 µL) for:	
VC-pumps	6044.3015
VF-pumps	6044.5026

12.4.5 Miscellaneous Parts

Description	Part No.
Capillary, nanoViper (length: 750 mm, inner diameter: 75 µm) To be used, for example, when running in new piston seals.	6041.5780
Cleaning swabs (pack of 25)	6040.0007
Diagnostics tool kit The kit includes a fitting plug (Viper, biocompatible) and backpressure capillaries (2 capillaries with 15 m length each).	6040.3099
Fitting plug, Viper, biocompatible	6040.2303
Front door kit, including right door and left door	6044.1920
Fuses kit, Vanquish system The kit includes the appropriate fuses for the Vanquish system modules. For the pump, use only the 3.15 AT 250 V AC, slow-blow fuses.	6036.0002
Packaging material for pump	6084.7001
Purge valve knob (with integrated seals)	6040.2035

Description	Part No.
Syringe and tubing kit, including <ul style="list-style-type: none"> • 12 mL plastic syringe (pack of 5) • Silicone tubing (O.D. x I.D. 2.8 x 1.3), 3 m 	6000.0010
Tool kit, including <ul style="list-style-type: none"> • Open-end wrench, size 11 x 13 mm • Double-ended ring wrench, size 11 x 13 mm • Open-end wrench, size 1/4" x 5/16" • Hexagon wrench, size 6 • Seal-handling tool • Spacing tools, pump head and pistons 	6007.9304
For system capillaries and tubing, refer to the <i>Vanquish System Operating Manual</i> . For system capillaries and tubing for special applications, refer to the related application documentation.	

12.4.6 Interface Cables and Power Cords

Interface cables

Description	Part No.
Digital I/O signaling cable, 6-pin, cable length: 5 m	6036.0006
System interlink cable (RJ45), 0.5 m	6036.0004
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 1 m	6035.9035A
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 5 m	6911.0002A

Power cords

Description	Part No.
Power cord, Australia	6000.1060
Power cord, China	6000.1080
Power cord, Denmark	6000.1070
Power cord, EU	6000.1000
Power cord, India, SA	6000.1090
Power cord, Italy	6000.1040
Power cord, Japan	6000.1050
Power cord, UK	6000.1020
Power cord, USA	6000.1001
Power cord, Switzerland	6000.1030

13 Appendix

This chapter provides additional information about compliance and the use of the digital I/O ports.

13.1 Compliance Information

13.1.1 Declarations of Conformity

CE Declaration of Conformity

The device has satisfied the requirements for the CE mark and is compliant with the applicable requirements.

EAC Declaration of Conformity

The device has satisfied the requirements for the EAC mark and is compliant with the applicable requirements.



RoHS Compliance

This product complies with the RoHS (Restrictions of Hazardous Substances) directives:

- *European RoHS Directive*
Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment

The CE mark on the device indicates that the product is compliant with the directive.
- *China RoHS regulations*
Measures for Administration of the Pollution Control of Electronic Information Products

One of the following logos may be present on the device if applicable:

Logo	Description
	The green logo marks items that do not contain the hazardous substances identified by the regulations.
	The orange logo including a one-digit or two-digit number marks items that contain hazardous substances identified by the regulations. The number indicates the environment-friendly use period (EFUP) of the item. During this period, the item (when used as intended) will not cause serious damage to human health or environment. For more information, go to http://www.thermofisher.com/us/en/home/technical-resources/rohs-certificates.html

UKCA Declaration of Conformity

The device has satisfied the requirements for the UKCA mark and is compliant with the applicable requirements.

UL/CSA 61010-1 Compliance

The label of the NRTL Lab on the device (for example, cTUVus or CSA mark) indicates that the device has satisfied the requirements of the applicable standards.

13.1.2 WEEE Compliance

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive. It is marked with the following symbol:



Figure 83: WEEE symbol

Thermo Fisher Scientific has contracted with one or more recycling or disposal companies in each European Union (EU) Member State, and these companies should dispose of or recycle this product. For further information, contact Thermo Fisher Scientific.

13.1.3 FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the U.S. FCC Rules.

These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his expense.

13.1.4 Manual Release History

Revision	Covering
4.0 and 5.0	VC-P10-A, VC-P20-A, VC-P21-A, VC-P32-A, VC-P33-A, VC-P40-A, VF-P10-A, VF-P20-A, VF-P32-A
3.0	VF-P10-A, VF-P20-A, VF-P32-A
2.0 and 2.0a	VF-P10-A, VF-P20-A
1.1 and 1.2	VF-P20-A

The instructions were prepared in English (original instructions). Other language versions are translations based on the English original instructions.

13.2 Digital I/O

The digital I/O ports (Dig I/O) can be used to exchange digital signals with external devices. Each port provides:

- one digital input
- one relay output
- one bidirectional input/output

Pin Assignment

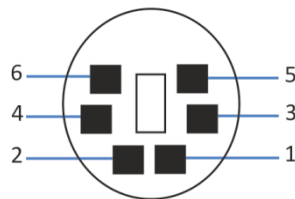


Figure 84: Digital I/O port

Pin	Description — Signal Name
1	Bidirectional input/output
2	Relay output — Relay_NC (Normally Closed contact)
3	Ground — GND
4	Digital input — Input
5	Relay output — Relay_COM COM is the common contact for NO and NC. If the relay is not activated or if the device is turned off, the connection is between COM and NC. If the relay is activated, the connection is between COM and NO.
6	Relay output — Relay_NO (Normally Open contact)

The next table lists the functions assigned to the connector pins and the color of the cable wire connected to each pin.

Pin	Wire Color	Signal Name	Signal Level	Remarks
1	Pink	Input/output	Input (low active): On: 0-0.4 V Off: 2.2-5 V Open Collector Output: 0-5 V, 0-2 mA Pull-up resistor: 47 kΩ to 5 V	Configure as either input or output. Reference potential is ground. Note the following: <ul style="list-style-type: none"> • The maximum input voltage at the input must not exceed +5 V with reference to ground. • The minimum input voltage must not be lower than the ground potential.
2	Gray	Relay output — Relay_NC	Potential free 0-24 V, 0-100 mA	Opening contact

Pin	Wire Color	Signal Name	Signal Level	Remarks
3	Green	Ground — GND	Ground	Reference potential
4	Yellow	Digital input — Input	Input (low active): On: 0-0.4 V Off: 2.2-5 V Pull-up resistor: 47 kΩ to 5 V	Digital input; reference potential is ground. Note the following: <ul style="list-style-type: none"> • The maximum input voltage at the input must not exceed +5 V with reference to ground. • The minimum input voltage must not be lower than the ground potential.
5	White	Relay output — Relay_COM	Potential free	Common contact for NO and NC
6	Brown	Relay output — Relay_NO	Potential free 0-24 V, 0-100 mA	Closing contact

Prerequisites

To use the digital I/O functionality, the following must be fulfilled:

- The digital I/O port is connected to the external device with the digital I/O signaling cable.
- The inputs and outputs that you want to use are selected in the Instrument Configuration Manager.

Connecting a Digital I/O Port

1. Plug the 6-pin connector of the cable into the digital I/O port that you want to use.
2. For each relay output or digital input to be used, connect the appropriate signal wire and ground wire to the corresponding connectors on the external device. For details, refer to the documentation provided with the external device.

Selecting the inputs and outputs in the chromatography data system

1. In the dialog box for the pump, on the **Inputs** and **Outputs** pages, select the inputs (**Pump_Input_X**) and outputs (**Pump_Relay_X**) that you want to use. The numbering in the dialog box corresponds to the port numbers on the pump.
2. To configure the bidirectional input/output (**Pump_IO_X**), select the related check box on either the **Inputs** or **Outputs** page, depending on the preferred usage.

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