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Vanquish

Pumps

VH-P10

Operating Manual

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ThermoFisher SCIENTIFIC

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The hardware descriptions in this manual revision refer to pumps VH-P10.

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Contents

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™ pump and provides instructions for installation, set up, start up, shut down, operation, maintenance and troubleshooting.

The layout of this manual is designed to provide quick reference to the sections of interest to the user. To obtain a full understanding of your pump, read this manual thoroughly.

This manual also contains safety messages, precautionary statements, and special notices that can prevent personal injury, damage to the pump, or loss of data when followed properly.

Note the following:

- The pump configuration may vary; therefore, not all descriptions necessarily apply to your particular pump.
- 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 pump or component. However, this does not influence the descriptions. No claims can be derived from the illustrations in this manual.

The descriptions in this manual assume that the pump 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 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 and Informational Notes

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 pump 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 pump.

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 **Start > All Programs > Thermo Chromeleon 7 > Services Manager > Start Instrument Controller**.

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 pump 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), for example, to sections and figures

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
  A printed version of the manual is shipped with the device.
- *Vanquish System Operating Manual*
  A printed version of the manual is shipped with the Vanquish system base and solvent rack.
- *Instrument Installation Qualification Operating Instructions*

TIP Electronic versions of these manuals are available as PDF (Portable Document Format) files. To open and read the PDF files, Adobe® Reader® or Adobe® Acrobat® is required.

Software Documentation

Additional software documentation includes the following:

- *Chromeleon™ 7 Help and documents*
  The *Chromeleon 7 Help* provides extensive information and comprehensive reference material for all aspects of the software. For basic information about device installation and configuration, refer to the *Installation Guide*; for specific information about a certain device, refer to the *Instrument Configuration Manager Help.* In Chromeleon 7, devices are called modules.

  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*.

  For a concise overview of the most important workflows, refer to the *Reference Card*.

- *Chromeleon™ 6.8 Help*
  The *Chromeleon 6.8 Help* provides extensive information for all aspects of the software, including device installation and configuration.

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 pump.

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 pump. 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 pump, read this manual carefully to be familiar with the pump and this manual. The manual contains important information with regard to user safety as well as use and care of the pump.
- Always keep the manual near the pump 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 Pump

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

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.
— O	Power supply is on Power supply is off
~	Indicates alternating current.

2.1.4 Rating Plate

The rating plate is present on the pump near the electrical connections. The rating plate indicates the serial number, part number, module name, line and fuse rating, and the manufacturer's address.

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

2.2 Intended Use

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

The intended use of the Vanquish system is to analyze a mixture of compounds in sample solutions. The pump is for use by qualified personnel and in laboratory environment only.

The pump and Vanquish system are intended for laboratory research use only. 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 pump.

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

- Operate the pump only within its technical specifications.
- Use only the replacement parts and additional components, options, and peripherals specifically authorized and qualified for the pump by Thermo Fisher Scientific.
- Perform only the procedures that are described in this operating manual and in supporting documents for the pump.
  Follow all instructions step by step and use the tools recommended for the procedure.
- Open the enclosure of the pump 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 pump. 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 pump.

Installation

Only skilled personnel are permitted to install the pump 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 pump is designed to be operated only by trained and qualified personnel in a laboratory environment.

All users must know the hazards presented by the pump 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 pump:

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.
- Do not operate the pump 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 pump in the presence of flammable gases or fumes.

CAUTION—Allergic Reaction

Some capillaries in the Vanquish 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 pump from the power line.

2.4 Solvent and Additive Information

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.
  For details about the materials that are used in the flow path of the pump, see the *Specifications* chapter. 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 module.

  Observe the general guidelines and recommendations on the use of solvents and additives in the chromatography system (see section 6.5, page 87).
- Allowed ranges and concentrations (standard system configuration):
  - pH range: 2-12
  - Chloride concentration: 1 mol/L or less
- Observe the following:
  - pH values higher than 9.5 with optical detectors
    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.
  - pH values of 2 or less or high chloride concentration
    With pH values of 2 or less or high chloride concentration, the application time should be as short as possible. Flush the system thoroughly after these applications.
  - Mobile phases containing ammonium hydroxide
    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.

NOTICE If the system flow path includes a Vanquish charged aerosol detector, observe the specific solvent and additive information for this detector. Refer to the *operating manual for the Vanquish charged aerosol detector*.

- Follow any specific recommendations presented in other sections of this manual. Refer also to the *operating manuals for all modules in the Vanquish system*. They may provide additional guidelines and information.

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. For details, see section 11.1, page 218.

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.

3 Pump Overview

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

3.1 Pump Features

The pump includes the following main features:

- Two-channel pump with each channel based on a dual-piston in-parallel design
- Independent drive for each piston for high accuracy and increased flexibility
- 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.
- Solvent selector "2 from 6" for increased flexibility
- Purge unit for easy and automatic purging
- Built-in vacuum degasser for enhanced flow stability and best detector sensitivity
- Easy access to the user-serviceable components and tool-free maintenance procedures for fast and reliable maintenance
- Easy maintenance because the pump remains in the Vanquish system stack

For specifications, see section 9.1 Performance Specifications, page 204.

3.2 Operating Principle

The pump can generate pressures up to 151 MPa with ultra-low pulsation. The pump is based on a two-channel, dual-piston design with electronic compressibility compensation.

The picture illustrates how the pump operates:

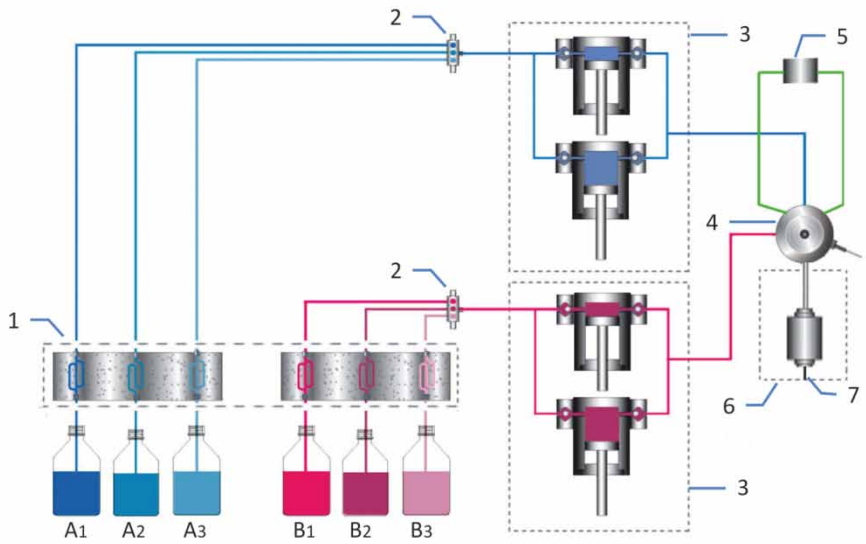


Figure 1: Operating Principle

No.	Description
1	Solvent degasser
2	Solvent selectors
3	Pump heads (two pistons, parallel)
4	Purge unit
5	Pressure transducer
6	Inline filter (static filter)
7	Pump outlet (outlet of the inline filter)

Each pump head comprises two cylinders that are connected in parallel. Thus, the solvent passes only one cylinder when the pump is delivering. To achieve continuous delivery, one cylinder is refilled while the other cylinder is delivering at the selected flow rate.

The pump uses independent piston drives and highly precise position and pressure sensors. This leads to high accuracy, increased reliability, and ultra-low pulsation when delivering compressible liquids. The flow rate at atmospheric pressure is always kept constant.

The vacuum degasser enhances the flow stability and allows best detector sensitivity by continuously removing air that may be trapped in the solvents.

Two 3-port solvent selectors allow forming binary gradients from three solvents per channel. The solvent to be used for each channel is selected in the user interface.

The solvent flow through the pump head is from the inlet assembly to the pump cylinders and on to a Tee piece, which combines the flows from the pump head cylinders before the solvent leaves the pump head.

From the pump heads, the solvent streams are directed to the purge unit, which combines the solvent streams from the two pump heads, and on to the inline filter.

3.3 Interior Components

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

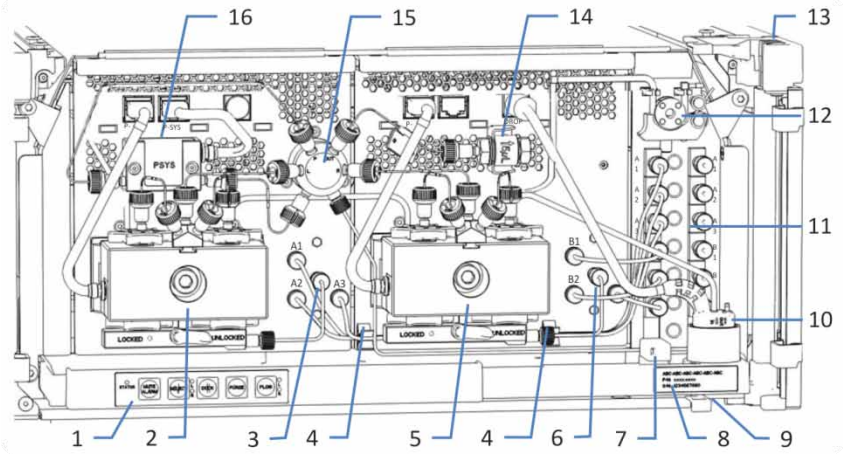


Figure 2: Interior view

No.	Description
1	Keypad with buttons for pump control
2+5	Pump heads
4	Tubing clips for routing solvent lines A1 to A3 to the solvent selector
3+6	Solvent selectors
7	Leak sensor
8	Type label, indicating the part number, module name, and serial number
9	Drain port
10	Seal wash detector (drop detector)
11	Vacuum degasser
12	Seal wash pump
13	Tubing chase with tubing guides
14	Inline filter (static filter)
15	Purge unit
16	System pressure sensor

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.

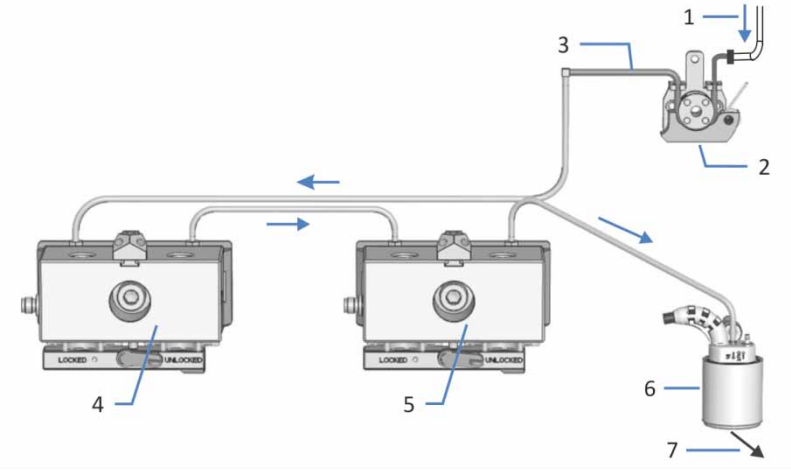


Figure 3: Flow path through the seal wash system

No.	Description
1	Supply line for seal wash liquid (from autosampler)
2	Seal wash pump (peristaltic pump)
3	Peristaltic tubing (PharMed® tubing)
4+5	Pump heads
6	Detector of the seal wash system (drop detector)
7	To waste

3.5 Purge Unit

The purge unit combines the solvent streams from the pump heads, connects the system pressure sensor to the flow system, and allows easy and automatic purging. The pump is shipped from the manufacturing site with the capillaries and tubing installed to the purge unit.

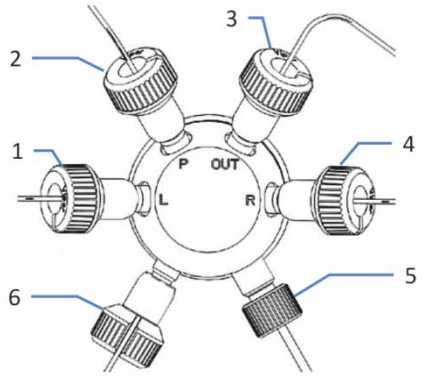


Figure 4: Connections on purge unit

No.	Description
1	Capillary from left pump head
2	Capillary to system pressure sensor (long capillary)
3	Capillary to inline filter
4	Capillary from right pump head
5	Waste tubing (from purge unit to drain port)
6	Capillary from system pressure sensor (short capillary)

3.6 Leak Detection

Leaks are a potential safety issue. The leak sensor inside the pump monitors the pump 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.

3.7 Operation

The pump 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 pump are available in the *Chromeleon Help*.

TIP The pump can be operated also with other data systems, such as 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 pump, allowing you to perform certain basic functions directly from the pump.

4 Unpacking and Transport

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

4.1 Unpacking and Moving

Damaged Packaging, Defective on Arrival

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

If you suspect that the pump 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 Pump

CAUTION—Heavy Load, Bulky Device

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

- Physical handling of the pump, including lifting or moving, requires a team effort of two persons.
- Use the carrying handles that were shipped with the pump to move or transport the pump. Never move or lift the pump by the front doors. This will damage the doors or the pump.

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 pump from the shipping container:
   Grasp the pump by the carrying handles.
   Slowly and carefully, lift the pump out of the shipping container.

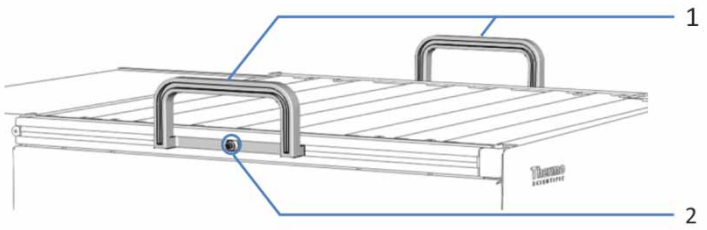


Figure 5: Carrying handles on the pump

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

4. Place the pump on a stable surface.
5. *If applicable*
   Remove any additional packing material. Leave any protective films attached to the surfaces of the pump until it is properly positioned in the system stack.
6. Transport the pump by the carrying handles to the installation site, if it is not already there, and place it in the system stack (see the *System Arrangement* section in this operating manual).
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 pump.

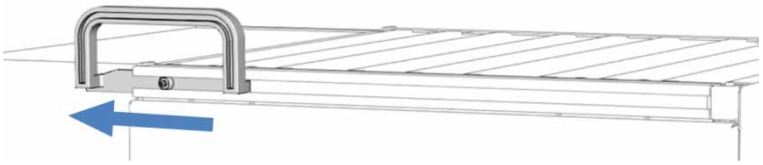


Figure 6: Sliding off the carrying handle from the left rail

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

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

Moving the Pump after Installation

If you have to move the pump after it has been set up and installed in the Vanquish system, prepare the pump for transport and move it to the new location. Follow the instructions in section 7.15 Transporting or Shipping the Pump, page 178.

4.2 Scope of Delivery

The following items are included in the delivery:

- Pump
- Ship Kit
  For details about the kit content, see section 10.2 Ship Kit, page 209.
- Operating manual
- Power cord

5 Installation

This chapter specifies the requirements for the installation site and describes how to set up, install, and configure the pump 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 section 2.3 Safety Precautions (see page 22).

CAUTION—Heavy Load, Bulky Device

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

- Physical handling of the pump, including lifting or moving, requires a team effort of two persons.
- Use the carrying handles that were shipped with the pump to move or transport the pump. Never move or lift the pump by the front doors. This will damage the doors or the pump.

5.2 Installing the Pump

The Vanquish system is installed and set up by a Thermo Fisher Scientific service engineer, 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 pump, follow the steps below.

NOTICE The pump 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.
   For the safety guidelines when installing the pump, see section 5.1, page 48. For the site requirements, see section 5.3, page 51.
2. Set up the pump hardware. See section 5.5, page 54.
3. Set up the flow connections. See section 5.6, page 58.
4. Turn on the pump. See section 5.7, page 77.

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 pump in the software. See section 5.8, page 78.
6. *Recommended:*
   Perform Instrument Installation Qualification.

   In Chromeleon, a wizard is available to guide you through the qualification process:

   - On the Chromeleon 7 Console: Click **Tools > Instrument Qualification > Installation Qualification**.

- In the Chromeleon 6.8 Browser: Click **Qualification > Instruments IQ**.

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

NOTICE If the pump 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.

5.3 Site Requirements

The operating environment is important to ensure optimal performance of the pump. This section provides important requirements for the installation site. Note the following:

- Operate the pump only under appropriate laboratory conditions.
- The pump 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 the *Specifications* section in this operating manual and the *Operating Manuals* for the other modules in the Vanquish system.

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. Therefore, connect the device to the specified line voltage only.
- Never connect the device to a power socket that is shared with other equipment (for example, multiple sockets).
- Do not use extensions cords.
- 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. Therefore, always unplug the power cord before starting repair work inside the device. If you were instructed to remove any covers or panels, do not connect the power cord to the device while the cover or panels are removed.

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 extensions 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.

Condensation

NOTICE Condensation in the device can damage the electronics. Therefore, 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 pump to the power line.

5.4 Accessing the Interior Components

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

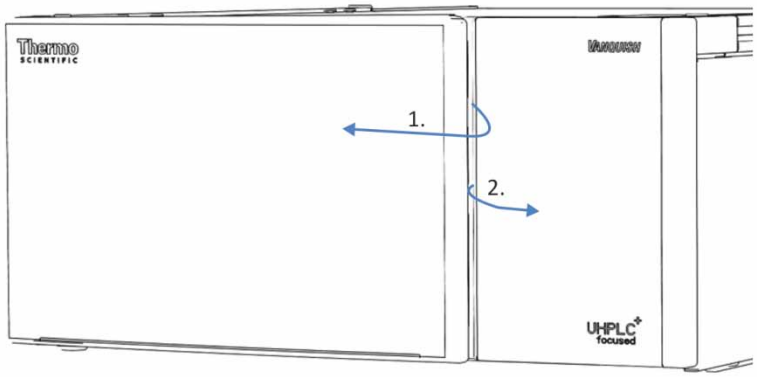


Figure 7: Opening the pump doors

5.5 Setting Up the Hardware

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

5.5.1 System Arrangement

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

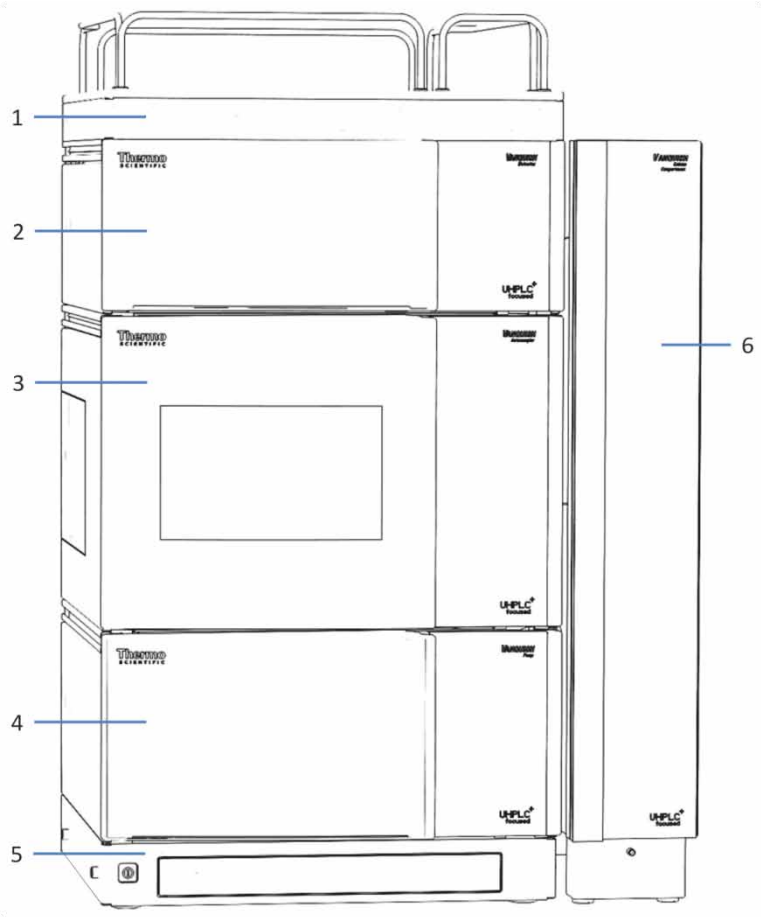


Figure 8: Vanquish system, standard configuration (example)

No.	Description
1	Solvent Rack
2	Detector

No.	Description
3	Autosampler
4	Pump
5	System Base
6	Column Compartment

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

5.5.2 Connecting the Pump

Pump Connectors

The following connectors are provided on the pump:

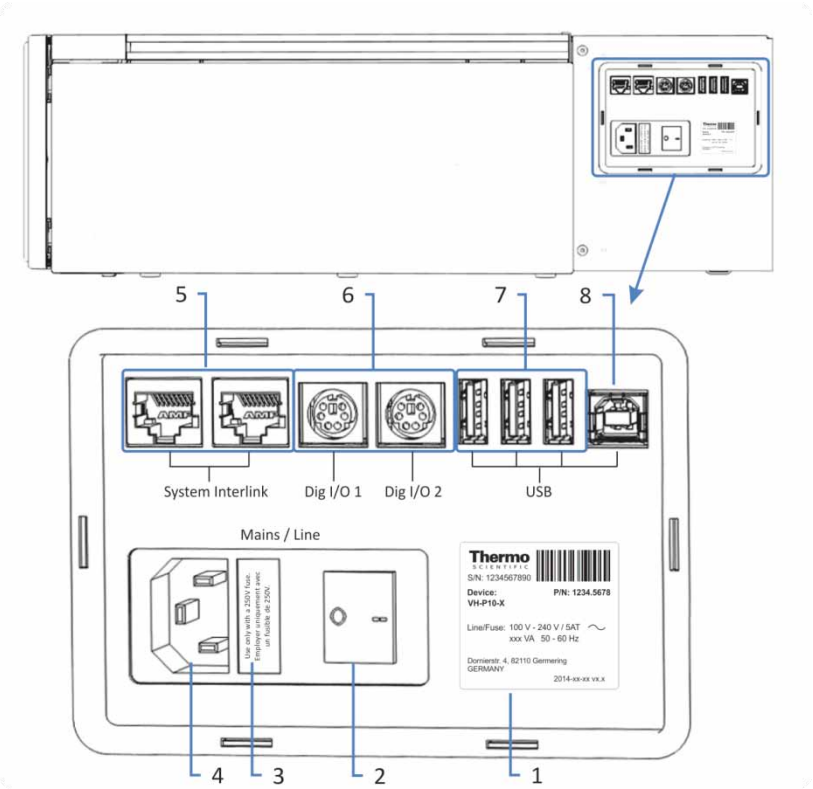


Figure 9: Electrical and device connectors on the pump

No.	Description
1	Rating plate, indicating the serial number, part number, module name, line and fuse rating, and the manufacturer's address
2 3 4	Main power switch (on/off control) Fuse holder Power-inlet connector
5	System Interlink port Allows power on/off control for the pump 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 section 11.2, page 220.

No.	Description
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.

Connecting the Pump

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 pump.

1. Place the pump 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 pump. For information about how to connect the pump to other modules in the Vanquish system or to the chromatography data system computer, refer to the *Vanquish System Operating Manual*.
3. Verify that the power switch on the pump is set to OFF.
4. Connect the power cord to the power-inlet connector on the pump.

NOTICE Before connecting the pump to the power line, be sure that no condensation is present in the device. Condensation in the device can damage the electronics. 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 completely gone before proceeding.

5. Connect the free end of the power cord to an appropriate power source.

5.6 Setting Up the Flow Connections

5.6.1 General Information and Guidelines

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

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

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 section 2.3 Safety Precautions (see page 22).

- 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 handling guidelines for capillaries, tubing, and fittings, see section 5.6.3 Connecting Fittings, Capillaries, and Tubing, page 61.

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

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 pump in the system, keep the plugs. You may need them to close the connections again, for example, for future transport.

1. Connect the pump to the drain system (see section 5.6.4, page 63).
2. Connect the solvent lines (see section 5.6.5, page64).
3. Set up the seal wash system (see section 5.6.6, page 69).
4. Connect the pump to the autosampler (see section 5.6.7, page 76).

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*.

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, Tubing Guide, Tubing Bracket

To guide certain tubes and lines (solvent tubing, wash liquid tubing, detector waste line) 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 (see picture).

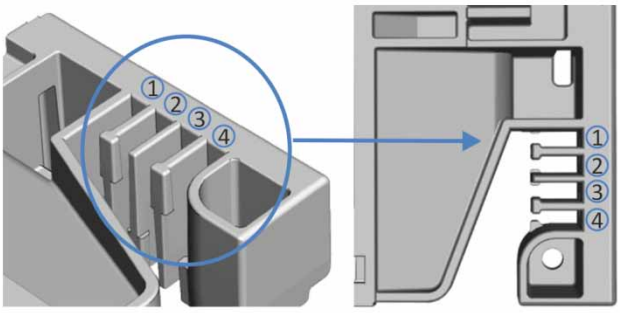


Figure 10: Tubing chase with tubing guides (left: view from inside, right: view from top)

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

Tubing brackets are available for holding the tubing in place. Slip the bracket side onto the drain pipe, and clamp the other side behind the front panel (see picture).

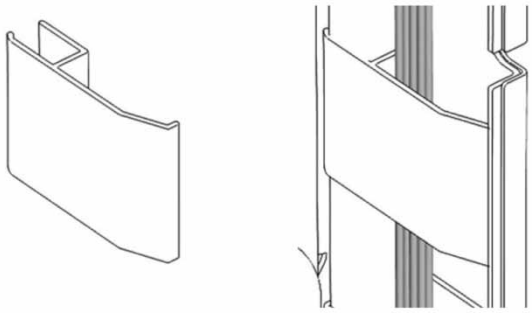


Figure 11: Tubing bracket (left), tubing bracket installed (right)

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:

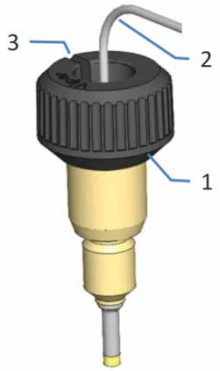
- Use only the capillaries and tubing (for example, solvent lines or waste tubing) that are shipped with the pump or additional or spare capillaries and tubing as recommended by Thermo Fisher Scientific.
- The connectors must be free from contaminants. Even minute particles may cause damage to the system or lead to invalid test results.
- Do not install capillaries or tubing that is stressed, nicked, kinked, or otherwise damaged.
- Install capillaries and fittings only at the positions for which they are intended.

5.6.3.2 Connecting Viper Capillaries

This section describes how to connect Viper™ capillaries. All Viper flow connections in the Vanquish system are designed to be finger-tight. To connect Viper capillaries with knurl, 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 connections *only* at atmospheric system pressure.



No.	Description
1	Knurl
2	Capillary
3	Slot

Figure 12: Viper fitting with knurl

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

TIP Note the slot in the knurl. For narrow connections, you can easily remove the knurls from neighboring capillaries through this slot and attach them again later.

3. If the connection leaks:
   a) Tighten the connection a little more.
   b) If leakage continues, remove the capillary.
   c) Clean the capillary ends carefully by using a lint-free tissue wetted with isopropanol.
   d) Reinstall the capillary.
   e) If the connection continues to leak, install a new Viper capillary.

5.6.4 Guiding Liquids to Waste

The following liquids leave the pump through the outlets at the bottom right of the leak tray:

- Leaking liquid from the leak tray
  Leaking liquid collects in the leak tray and flows off through the drain port outlet into the drain system of the Vanquish system.
- Waste liquid from the purge unit
  Waste liquid from the purge unit flows off through the waste outlet port into the drain system of the Vanquish system. To avoid false leak alarms, verify that the waste line sits properly in the waste outlet port. If it does not, liquid from the purge unit may accumulate in the drain port and activate the leak sensor.

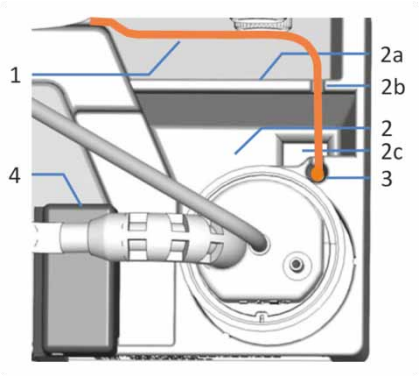


Figure 13: Outlets for guiding liquids to waste (view from top)

No.	Description
1	Waste line from purge unit: routing path to outlet
2	Drain port, with
2a	Drain port wall
2b	Groove in drain port wall for routing the waste line to the waste outlet port
2c	Drain port outlet (to Vanquish drain system)
3	Waste outlet port (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 degasser inlet ports and the solvent reservoirs.

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

  If you want to install shut off valves after initial setup or operation of the pump, follow the steps in section 6.9.3 Installing Solvent Shut Off Valves, page 106.

TIP To avoid the formation of gas bubbles in the solvent reservoirs, place the reservoirs in the system stack on the same level or higher than the pump. The setup description below assumes that the reservoirs are placed in the solvent rack.

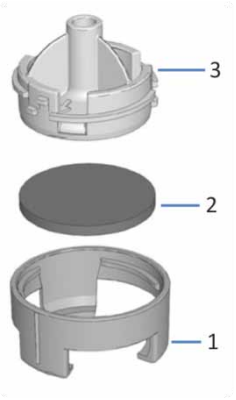
Preparation

- Assemble the solvent line filter, wearing appropriate clean gloves:

  a) Place the frit in the filter holder (bottom part).

  b) Make sure that the frit is in a level position.

c) Screw the filter top to the filter bottom.



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

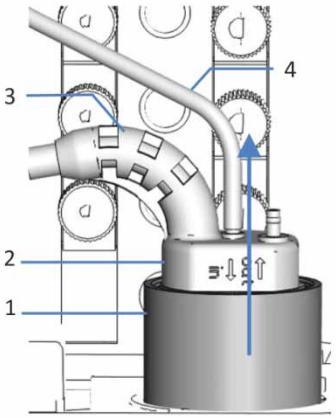
Figure 14: Assembling the solvent line filter

- Remove the plugs on the degasser inlets that protect the inlet during shipment, if applicable.

Follow these steps

1. Connect each solvent line to the degasser inlet for which it is intended (see the labeling on the solvent lines and on the degassing channels).

TIP For easy access to the lower degas chambers, 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.



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

Figure 15: Removing the seal wash detector assembly

2. Route the solvent lines from the degasser inlets 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 the *Guiding Capillaries and Tubing Through the System* section in this manual.
3. Feed the solvent lines through the guide hole in the solvent rack and fix them in the appropriate tubing guides in the solvent rack.

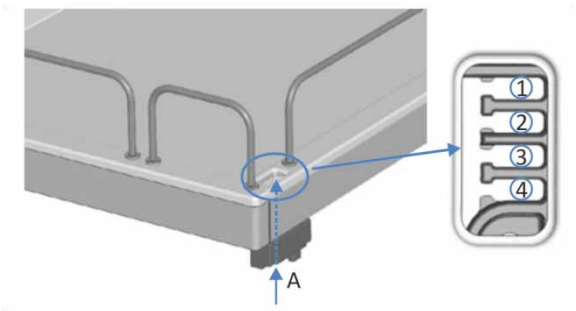
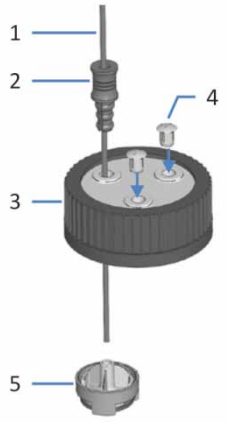


Figure 16: Guide hole and tubing guides in the solvent rack

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

4. Prepare the solvent lines:
   a) Feed each solvent line through a retaining guide.
   b) 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.
   c) Close any open holes in the reservoir caps with the cap plugs.



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

Figure 17: Preparing the solvent line and reservoir cap

5. Place the solvent reservoirs in the solvent rack. Position the solvent lines straight in the tubing guides.
6. Slide a filter holder onto each solvent line.
7. Fill the solvent reservoirs with solvent, observing the guidelines and recommendations in the *Use of Solvents and Additives* section in this manual.
   Before using a solvent reservoir for the first time, rinse the reservoirs thoroughly. Use a high-purity solvent for rinsing.
8. Tighten the reservoir caps hand-tight. Press the retaining guide into the hole in the reservoir cap to ensure that the tubing is kept in place in the cap.
9. *Optional – Required only if you want to install a shut off valve*

   a) Cut the solvent line near the reservoir cap with a tubing cutter. Make sure that the cut is at a right angle to the length of the line.

   b) 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).

   c) Tighten the solvent lines to the shut off valve.

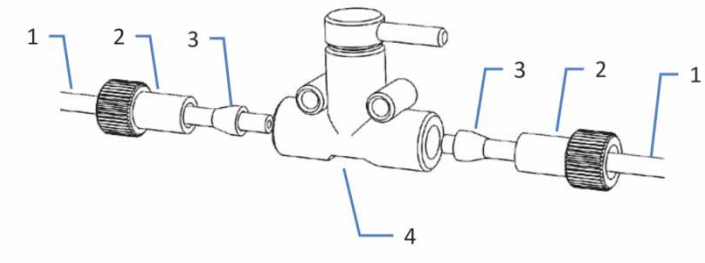
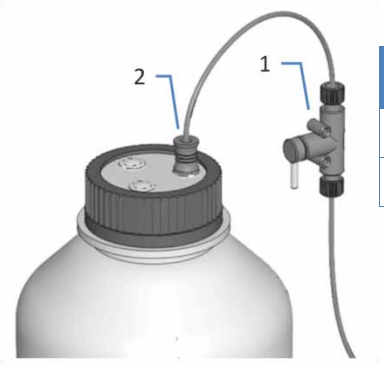


Figure 18: Installing a shut off valve in a solvent line

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



No.	Description
1	Shut off valve
2	Retaining guide

Figure 19: Solvent line with shut off valve installed

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.

5.6.6 Setting Up the 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. To complete the setup, follow the steps in section 5.6.6.2, page 69.

5.6.6.1 Choosing the Seal Wash Liquid

Use 75% isopropanol in water and 0.1% formic acid (HPLC-grade; preparation by volume, for example, *75 mL isopropanol + 25 mL water + 0.1 mL formic acid*).

5.6.6.2 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 gas bubbles in the seal wash reservoir, place the reservoir in the system stack on the same level or higher than the autosampler. The setup description below assumes that the reservoir is placed in the solvent rack.

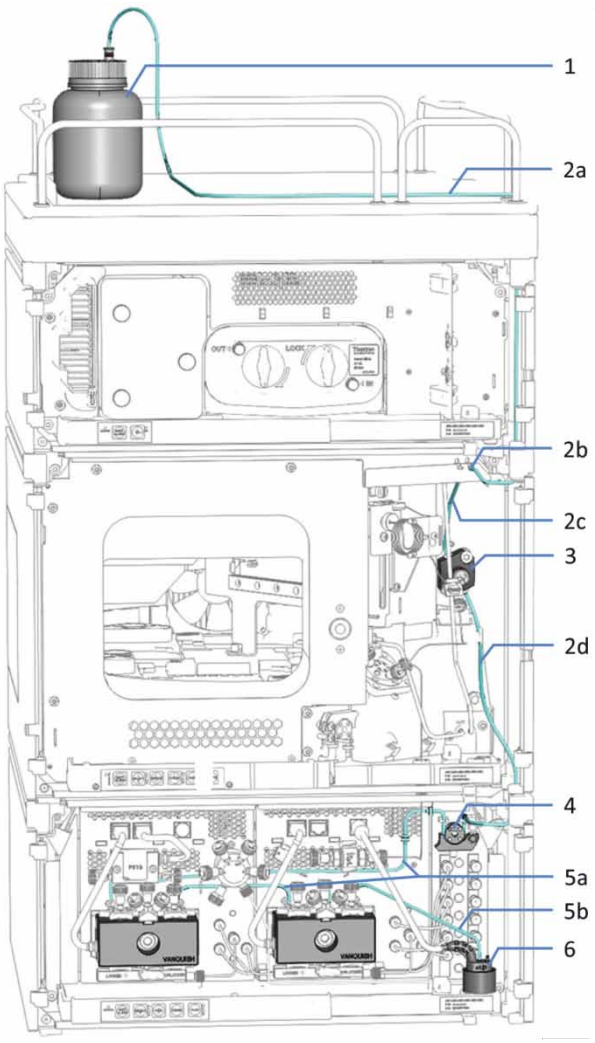


Figure 20: Seal wash system in the Vanquish system

No.	Description	No.	Description
1	Seal wash reservoir	3	Metering device head
2	Seal wash lines in the autosampler (thick tubing):	4	Seal wash pump (peristaltic pump)
2a	Wash line from reservoir to inlet port	5	Seal wash lines in the pump (thin tubing):

No.	Description	No.	Description
2b	Seal wash inlet port (right tubing connector)	5a	Wash lines from seal wash pump to pump head
2c	Wash line from inlet port to metering device head	5b	Wash line from pump head to seal wash detector
2d	Wash line to seal wash pump	6	Seal wash detector

Follow these steps

1. In the pump, engage the peristaltic tubing (PharMed® tubing) in the seal wash pump.

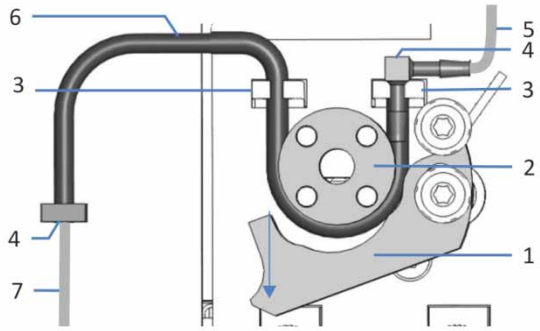


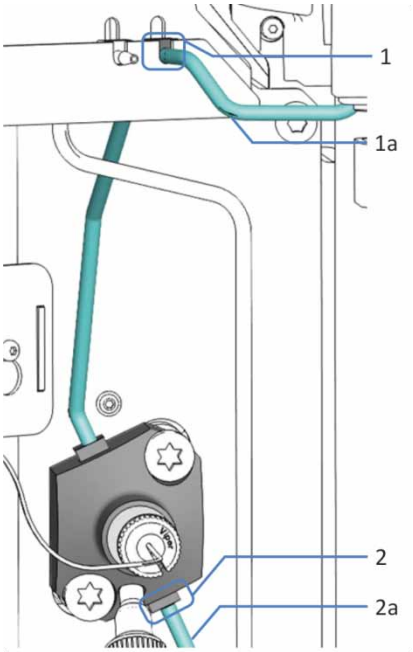
Figure 21: Seal wash pump

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

   a) Press down the lever on the seal wash pump and hold it in that position with one hand.
   b) With your other hand, insert the tubing between the lever and the rotor and wind it around the rotor.
   c) Release the lever.
   d) Check that the peristaltic tubing is properly inserted 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.

e) Check that the right tubing connector rests on the tubing holder. If it does not, push the tubing connector onto the holder.

2. In the autosampler, the seal wash line to the pump and the seal wash inlet port (right tubing connector) are interconnected. Disconnect the seal wash line (clear silicone tubing) from the seal wash inlet port (right tubing connector).



No.	Description
1	Seal wash inlet port (right tubing connector)
1a	Seal wash line to reservoir
2	Seal wash outlet on the metering device head
2a	Seal wash line to pump

Figure 22: Seal wash connections in the autosampler

3. Route the seal wash line from the seal wash outlet of the metering device through the tubing guides to the peristaltic tubing in the pump.
4. In the pump, connect the seal wash line to the tubing connector on the free end of the peristaltic tubing.
5. Locate the seal wash line for connection from the autosampler to the seal wash reservoir.
6. Connect the seal wash line to the seal wash inlet port (right tubing connector) on the autosampler.
7. 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.

8. Route the seal wash line through the guide hole in the solvent rack.

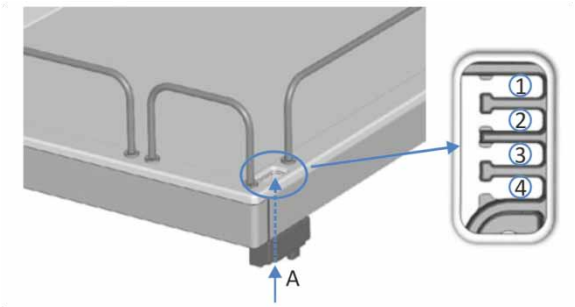


Figure 23: Guide hole and tubing guides in the solvent rack

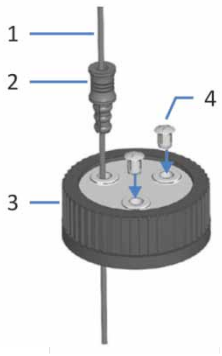
No.	Description
A	Guide hole
1+2	Not to be used for wash liquid line; reserved for other tubing
3	Tubing guide for wash liquid line
4	Not to be used for wash liquid line; reserved for other tubing

9. Prepare the seal wash line:

   a) Feed the seal wash line through the retaining guide.

   b) Feed the seal wash line through an open hole in the cap of the seal wash reservoir. The retaining guide keeps the tubing in place in the reservoir.

   c) Close any open holes in the reservoir cap with cap plugs.



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

Figure 24: Preparing the seal wash line

10. Fill the seal wash reservoir with seal wash liquid. Mind the requirements outlined in the previous section.
    Before using a seal wash reservoir for the first time, rinse the reservoir thoroughly. Use a high-purity solvent for rinsing.
11. Tighten the reservoir cap hand-tight. Press the retaining guide into the hole in the reservoir cap to ensure that the tubing is kept in place in the cap.
12. Place the seal wash reservoir in the solvent rack. Position the seal wash lines straight in the tubing guides.
13. Check the seal wash lines across the entire flow path. Make sure that the lines are not bent, pinched, or squeezed at any point in the flow path.
14. Flush the seal wash system (see the next section).

5.6.6.3 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 Chromeleon.
- 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 Chromeleon

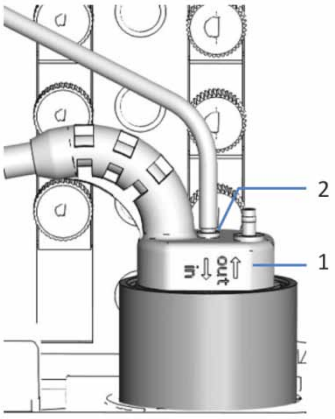
To flush the seal wash system from Chromeleon, start a seal wash cycle by setting the seal wash pump to **Active** mode (**SealWashPump** = **Active**).

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.



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

Figure 25: Seal wash detector

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**.

5.6.7 Connecting the Pump and Autosampler

Parts required

Capillary to connect the pump to the autosampler

Follow these steps

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

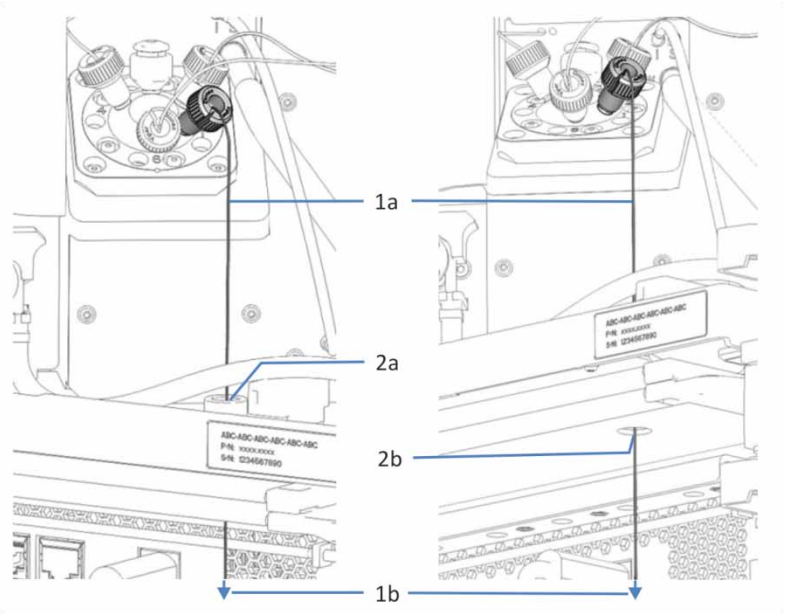


Figure 26: Guide holes in the autosampler and pump (left: view from autosampler; right: view from pump)

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)

2. In the pump, connect the capillary to the pump outlet.
3. In the autosampler, connect the capillary to the injection valve (port 1).

5.7 Turning On the Pump

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 pump, 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 pump with its main power switch.

Turn the pump off 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.

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 Chromeleon 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.

For power on/off control during pump operation, see section 6.4, page 86.

5.8 Setting Up the Pump 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 pump 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 pump has already been completed. If this is not the case, refer to the instructions in chapter 5 Installation before proceeding (see page 47).

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 pump are available in the *Chromeleon Help*.

6.2 Safety Guidelines for Operation

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

Observe all warning messages and precautionary statements presented in section 2.3 Safety Precautions (see page 22).

CAUTION—High Luminosity of LED

The high luminosity produced by the LED illuminating the inside of the pump 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:

- When operating the chromatography system, always set the lower pressure limit for the pump. This prevents damage resulting from leakage or from running the pump dry.
- If there is evidence of leakage in the pump, 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 pump is designed to be operated mainly from a computer running with the chromatography software. In addition, the following elements are available on the pump:

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

6.3.1 Keypad

The keypad inside the pump allows you to perform certain functions directly from the pump. When you press a button, a short beep confirms that the function is performed. When the pump is connected in the Chromeleon software, some functions may not be available from the keypad (see further down in this section).

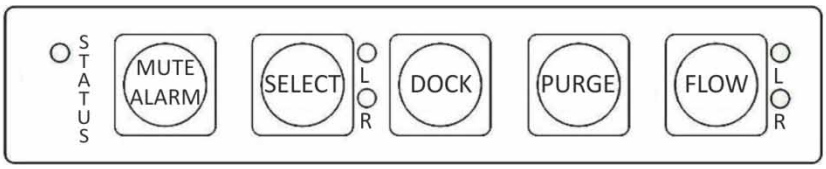


Figure 27: Keypad

STATUS

The **STATUS** LED provides a quick visual check of the operational status of the pump. When the doors are closed, the LED bar on the front side indicates the operational status. For status details, see section 6.3.2 Status Indicators, page 84.

MUTE ALARM

If beeping alerts you that the pump firmware detected a problem, for example leakage, beeping continues until you turn off the beep. Pressing this button turns off the beep for the current alarm. As a standard, beeping starts again after 10 minutes if the problem is still present or if the firmware detected another problem.

SELECT

Pressing the button selects a pump head. The LEDs next to the button indicate which pump head is selected, with **L** referring to the left pump head and **R** referring to the right pump head. The LED is green when the pump head is selected. Before performing a **Dock** or **Purge** function from the keypad, select the pump head for which you want to perform the action.

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.

To avoid damage to the pump, remove or install the pump heads only while the pistons are undocked (LED is flashing).

PURGE

Pressing the button starts a purge cycle. Pressing the button while a purge cycle is running stops the cycle.

For more information about purging, see section 6.8, Purging the Pump, page 96.

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	*In normal operation:* The pump head is delivering. *During maintenance:* The pistons are being moved into the appropriate position for maintenance and undocked.
Green, flashing	The pistons are undocked.

When the pump is connected in the Chromeleon software

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

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

  In addition, the **Select** function remains available from the keypad, allowing you to select a pump head.

6.3.2 Status Indicators

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

LED Bar

The LED bar provides the information when the pump is closed. When the pump is connected in the Chromeleon software, the LED bar may provide less information.

LED Bar	Description
Off (dark)	The power to the pump is turned off.
Dimmed	The doors of the pump are open.
Yellow, flashing slowly	The power to the pump is turned on, but the pump is not connected in the Chromeleon software.
Yellow	The pump is connected in the Chromeleon software, but is not equilibrated. The pump flow is off.
Green, flashing	A purge cycle is running.
Green	The pump is equilibrated, but no data acquisition is running. The pump flow is on.
Blue	A sample or sequence is running, including data acquisition.
Red	A problem or error has occurred. For the related message, check the Chromeleon Audit Trail. For remedial action, see the *Troubleshooting* section in this operating manual.

STATUS LED

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

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

For information about the LEDs that are present next to a button on the keypad, see section 6.3.1 Keypad, page 82.

6.4 Power On/Off Control

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

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.

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 Chromeleon 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 chromatography system and block the solvent line filters. Blocked capillaries or filters can cause increased or unstable system pressure.

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

- Be sure that the substances you are using are compatible with all parts in the flow path.
- 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.
- 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.
- When using water, use high-quality water for example, UHPLC-grade or LC/MS-grade (0.2 µm filtered). When you use water from water purification systems, keep in mind that polymeric contamination may occur if the purification system is not maintained properly.
- Before filling a solvent reservoir, always rinse the reservoir thoroughly with a high-purity solvent.
- Use fresh solvents at regular intervals. Avoid adding up (refreshing) solvents. With premixed solvents, be especially sure that they are properly prepared and fresh.
- Before changing from a buffer or salt solution to organic solution, flush the pump thoroughly with de-ionized water.
- When changing to a different type of solvent, 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.

- 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.
- The pump is shipped with UHMW-PE piston seals. Using tetrahydrofuran, ketones, or ammonium hydroxide as solvents can cause swelling and damage the seals.
- For best seal performance, do not recycle or recirculate solvents. Avoid using methanol from aluminum reservoirs.
- To reduce the growth of algae, consider using amber glassware or using appropriate additives, for example, formic acid.
- 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.
- Note the special properties of the solvents, such as viscosity, boiling point, or UV absorption.

6.6 Preparing the Pump for Operation

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

Before Operating the Pump for the First Time

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

NOTICE Flush the system flow path thoroughly before operating the pump 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 pump are filled with isopropanol when the pump is shipped from the manufacturing site. When operating the pump 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 pump 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.

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.
- Verify that the doors of the modules in the Vanquish system are closed.

- Make sure that the chromatography system is properly equilibrated. 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 thermostatting 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 pump. You can usually access them from the Chromeleon user interface. If a parameter listed below is not available in Chromeleon, consider updating the firmware and Chromeleon version. For more information, refer to *Chromeleon Help and documents*.

Parameter	Description
Compression	The compression values of the pump head can provide valuable information for troubleshooting. For details, see section 8.4 Checking the Compression Values, page 198.
Curve	You can specify linear or non-linear (curved) gradient profiles. • 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). 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.
Degasser	The degasser is enabled as a standard when the pump is shipped (**Degasser = On**). This setting is the preferred setting.
Flow	The allowed flow range is indicated in the dialog box for the pump in the Chromeleon 7 Instrument Configuration Manager (Chromeleon 6.8 Server Configuration). You can change the upper and lower limit for the flow rate within the allowed range.

Parameter	Description
Flow ramps	Set the flow acceleration and flow deceleration. *Recommendation*: 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 delivery 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.
Leak detection	Leak detection is enabled as a standard when the pump is shipped (**Leak Sensor Mode = Enabled**). This is the preferred setting.
Piston calibration value	The **Piston Calibration Value** property must match the 3-digit calibration value that is imprinted on the rear of the piston. You have to update the value in the Chromeleon software, for example, when you install new pistons (see page 138).
Piston seal washing/rear seal washing	The seal wash system is enabled and cannot be disabled. As a standard, the pump performs a seal wash in the following situations: • Once per hour • Each time the pump is turned on If required, you can start an additional seal wash cycle or stop a running cycle: • 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. You can disable the drop counter functionality by setting **Rear Seal Wash Monitoring** to **Off**. 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.

Parameter	Description
Pressure limits	The allowed pressure range is indicated in the dialog box for the pump in the Chromeleon 7 Instrument Configuration Manager (Chromeleon 6.8 Server Configuration). You can adapt the upper and lower pressure limits within the allowed range. • 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. When the pump pressure is outside the specified limits, the Chromeleon software stops the pump flow and aborts a running queue (or batch).
Pump pressure	In the dialog box for the pump in the Chromeleon 7 Instrument Configuration Manager (Chromeleon 6.8 Server Configuration), the **Pump_Pressure** check box is selected as a standard when the pump is set up in Chromeleon. The Chromeleon software uses this setting to generate the channel for recording the pump pressure (which corresponds to the column pressure). 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.
Purge	Purge the pump in the following situations: • To remove air bubbles that might be trapped in the system • When changing to a different type of solvent For details, see section 6.8 Purging the Pump, page 96.

Parameter	Description
Solvent composition	In the dialog box for the pump in the Chromeleon 7 Instrument Configuration Manager (Chromeleon 6.8 Server Configuration), set the number of the solvents to be used with the pump. You can change the standard solvent names (**%A1, %A2, %A3, %B1, %B2, %B3**) as required. The solvent names appear in the Chromeleon user interface. In the Chromeleon Client, you determine the solvent composition. For each of the two channels, you select the solvent and percentage of solvent that you want to deliver. • For channel A, select the solvent by setting **%A_Selector** to **%A1** or **%A2** or **%A3**. For channel B, set **%B_Selector** to **%B1** or **%B2** or **%B3**. • Determine the percentage of solvent that you want to deliver by setting the percentage for solvent B (**%B**). Solvent A automatically delivers the remaining volume. *Examples*: • To deliver 100% of solvent B2, select **%B2** and set **%B** to 100%. • To deliver 100% of solvent A3, select **%A3** and set **%B** to 0%. • To deliver 30% of solvent A1 and 70% of solvent B3, select **%A1** and **%B3** and set **%B** to 70%.
Solvent consumption	You can monitor the solvent consumption when you have entered the following information for the related solvent: • 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 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. • Warning limit when you want to be informed about the liquid level in the reservoir When the liquid in the reservoir reaches the lower limit, the Chromeleon software stops the pump as specified in the Emergency Method (or Program) if available or aborts the queue (or batch) and stops the pump flow.

Parameter	Description
Waste level	You can monitor the liquid level in the waste container when you have entered the following information: • 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

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. From the purge unit, the solvent is automatically dispensed to waste.

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.

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 Chromeleon 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 Chromeleon if required. The setting is considered also when purging the pump from the keypad.

Setting	Description
Channel to be purged and solvent to be used	Select the channel that you want to purge and the solvent to be used. For details, see further down in this section.

To Purge the Pump

Select one of the following alternatives:

- Purge the pump from Chromeleon.
- Purge the pump from the keypad.

Purging the Pump from Chromeleon

To purge the pump from Chromeleon, follow these steps:

1. For each channel, select the solvent that you want to use for purging. The solvent names below refer to the standard solvent names.
   For channel A, select the solvent by setting **%A_Selector** to **%A1** or **%A2** or **%A3**. For channel B, set **%B_Selector** to **%B1** or **%B2** or **%B3**.
2. Determine the percentage of solvent that you want to deliver by setting the percentage for solvent B (**%B**). Solvent A automatically delivers the remaining volume.

   Recommended: The channel to be purged should deliver 100% of the volume.

   Examples:

   - To purge channel B with solvent B1 delivering 100%, select **%B1** and set **%B** to 100%.
   - To purge channel A with solvent A3 delivering 100%, select **%A3** and set **%B** to 0%.

3. *Optional*
   Adapt the settings for the purge flow or purge time if required.
4. Start the purge cycle.
   The purge cycle ends automatically when the specified purge time ends. If you want to stop purging before the purge time ends, turn off the purge from Chromeleon.
5. Perform a purge cycle for all channels that you want to purge.

Purging the Pump from the Keypad

To purge the pump from the keypad, follow these steps:

1. Select the channels that you want to purge.
   On the keypad, check the LEDs next to the **Select** button. A green LED (**L** or **R** or both) indicates that the pump head (channel) is selected. Note the following:
   - The purge cycle will be performed for the selected pump head with the most recently used solvent.
   - When both pump heads are selected, each channel is purged with the most recently used solvent delivering 50 % of the volume.
   - When the pump is operated for the first time, the purge cycle will be performed for solvent 1 of the selected pump head (A1 or B1, respectively).

   Recommended: The channel to be purged should deliver 100% of the volume. Check and adapt the setting in Chromeleon if considered necessary.

2. *Optional (in Chromeleon)*
   Adapt the settings for the purge flow or purge time if required.
3. To start the purge cycle, press the **Purge** button.
   Note the following:
   - The purge cycle ends automatically when the specified purge time ends.
   - Pressing the button while a purge cycle is running stops the cycle.

6.9 Optimizing the Performance of the Pump

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

6.9.1 General Guidelines

To optimize the pump performance, consider the following general guidelines:

- Observe the information about the use of solvents and additives.
- In the following situations, consider replacing the inline filter (plus capillary mixer) with which the pump is shipped with a mixing system:
  - To reduce the mixing ripple when you use UV absorbing solvents or solvent additives
  - For TFA(trifluoroacetic acid) applications

  TIP Installing a mixing system affects the gradient delay volume, dwell volume, and ripple (see section 6.9.2, page 100).

- 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.
- Monitor the usage of specific pump components that are subject to wear and stress and schedule appropriate maintenance intervals (see section 7.4.4 Predictive Performance, page 124).

TIP Shut off valves for solvent lines are available as an option (see section 6.9.3, page 106). 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 Gradient Delay Volume, Dwell Volume, and Ripple

The gradient delay volume of an HPLC system is defined as the volume of the entire flow path between the point where the solvent streams from the pump heads are combined 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.

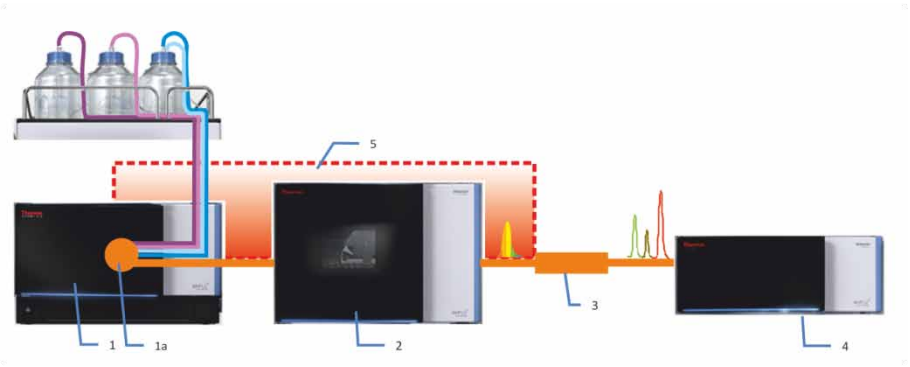


Figure 28: Gradient delay volume of an HPLC system

No.	Description
1	Pump with
1a	Point where the solvent streams from both pump heads are combined (purge unit)
2	Autosampler
3	Column
4	Detector
5	Gradient delay volume of the system

The pump contributes to the system gradient delay volume by the dwell volume, which is the calculated volume between the point where the solvent streams are combined and the pump outlet. For the dwell volume of the pump in the standard configuration, see section 9.1 Performance Specifications, page 204.

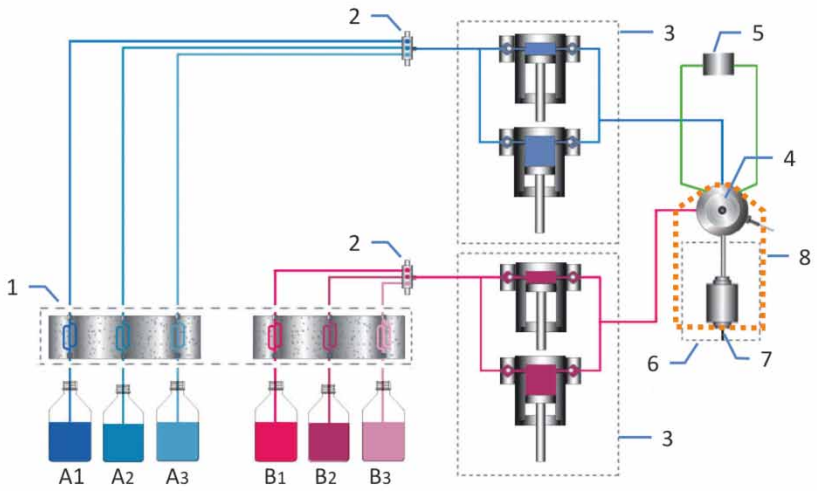


Figure 29: Dwell volume of the pump

No.	Description
1	Solvent degasser
2	Solvent selectors
3	Pump heads (two pistons, parallel)
4	Purge unit
5	Pressure transducer
6	Inline filter (static filter)
7	Pump outlet (outlet of the inline filter)
8	Dwell volume of the pump

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 inline filter and capillary mixer with which the pump is shipped with a mixing system.

Operating the pump with a 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 section 6.9.2.1 Available Mixing Systems on the next page.

6.9.2.1 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	
Mixing system, volume: 200 µL, comprising:	
	Static mixer, volume: 150 µL
	Capillary mixer, volume: 50 µL
Mixing system, volume: 400 µL, comprising:	
	Static mixer, volume: 350 µL
	Capillary mixer, volume: 50 µL

For ordering information, see section 10.3 Optional Accessories, page 210.

To install the mixing system, follow the steps in section 6.9.2.2 Installing the Mixing System on the next page.

6.9.2.2 Installing the Mixing System

When

- For highest sensitivity when mixing ripples interfere with the detection, for example, when you use UV absorbing solvents or solvent additives that amplify mixing ripples by interaction with the stationary phase
- For TFA applications

TIP Installing a mixing system affects the gradient delay volume, dwell volume, and ripple (see section 6.9.2, page 100).

Parts required

Optional mixer kit, comprising the mixing system and required installation material (mounting bracket and screws)

Tools and additional items required

- Screwdriver, Torx 10
- 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

1. Unplug the cable of the seal wash detector from the **DROP DET** port.
2. Unplug the cable of the right pump head from the **P-WORK** port if necessary.
3. Remove the capillary mixer (volume: 25 µL) that connects the purge unit and the inline filter when the pump is shipped from the manufacturing site.

4. On the filter outlet, disconnect the capillary that connects the inline filter to the autosampler injection valve.
5. Pull the inline filter out of the mounting bracket.
   You can remove the mounting bracket or leave it in the pump.
6. Using the screws shipped with the mixing system, attach the mounting bracket for the mixing system inside the pump (see picture).

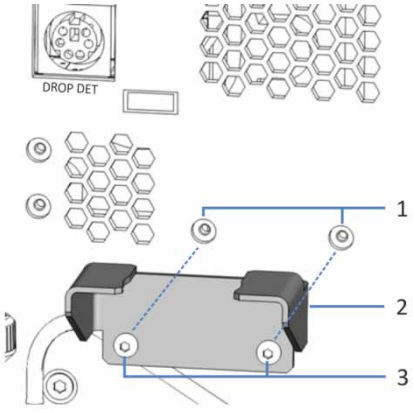
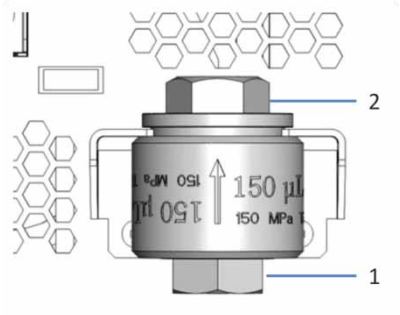


Figure 30: Mounting bracket for mixing system

No.	Description
1	Mounting holes for mounting bracket
2	Mounting bracket
3	Mounting screws (Torx)

7. Insert the static mixer into the mounting bracket. Mind the direction of flow through the mixer (indicated by the arrow on the static mixer).



No.	Description
1	Static mixer inlet
2	Static mixer outlet

Figure 31: Static mixer

8. Connect the capillary mixer from the mixer kit to the port labeled **OUT** on the purge unit and to the static mixer inlet.
9. On the static mixer outlet, reconnect the capillary to the autosampler injection valve.

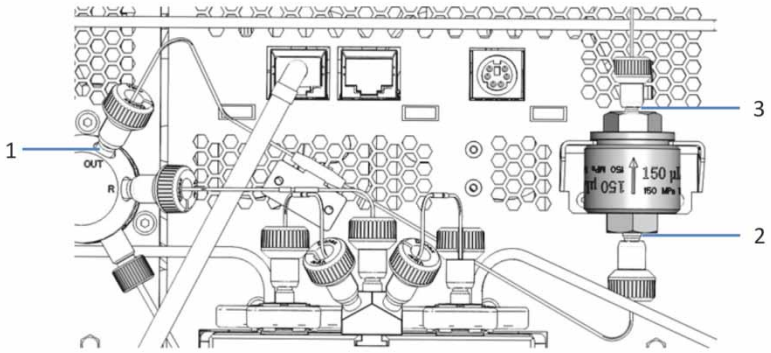


Figure 32: Mixing system installed and connected

No.	Description
1	Capillary mixer on purge unit (**OUT** port)
2	Capillary mixer on static mixer inlet
3	Capillary to autosampler injection valve

10. Reconnect the cable of seal wash detector to the **DROP DET** port.
11. Reconnect the pump head cable to **P-WORK** port if applicable.
12. Apply the flow rate of your application and have the pump deliver for a short time.
13. In Chromeleon:
    a) Set **StaticMixer** to the value indicated on the static mixer.
    b) Consider updating the Predictive Performance information (**InlineFilterChanged** command, see section 7.4.4, page 124).
14. Inspect the flow connections on the mixing system for indications of leakage before resuming operation.

6.9.3 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

- To install a shut off valve during initial setup of the flow connections, see the related steps in section 5.6.5 Connecting the Solvent Lines, page 64.
- To install a shut off valve after initial operation of the pump, follow the steps further down in this section.

Parts required

Solvent shut off valve, kit containing one shut off valve and fitting connections

Tools and additional items required

- Tubing cutter
- Solvent suitable for purging the pump

Preparations

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

Follow these steps

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

1. Unscrew the cap of the solvent reservoir and remove the solvent line together with the cap from the reservoir.
2. Stop purging as soon as the solvent line is empty.
3. Retighten the reservoir cap hand-tight. Verify that the retaining guide remains in the hole in the reservoir cap. If it does not, press the retaining guide into the hole to ensure that the tubing is kept in place in the cap.

4. Install the shut off valve:

   a) Cut the solvent line near the reservoir cap with a tubing cutter. Make sure that the cut is at a right angle to the length of the line.

   b) 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).

   c) Tighten the solvent lines to the shut off valve.

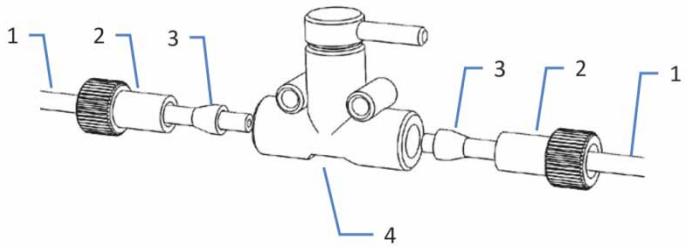
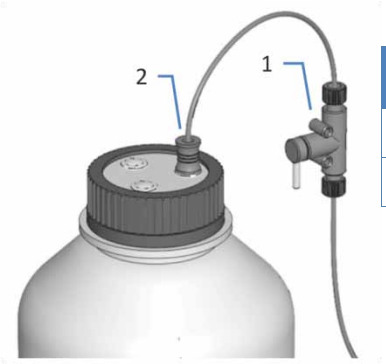


Figure 33: Installing a shut off valve in a solvent line

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



No.	Description
1	Shut off valve
2	Retaining guide

Figure 34: Solvent line with shut off valve installed

5. 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.

6. To remove any air bubbles from the solvent lines, purge the pump.

6.10 Shutting Down the Pump

If the pump will not be operated for some time, follow the instructions in this section.

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 pump 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:
  - *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 detector:*
    The lamp(s) in the detector can remain turned on. 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

Shutting Down the Pump

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

TIP Shutting down the pump affects the operation of the system. When shutting down the pump, 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. Flush the system with an appropriate, pure solvent (minimum HPLC-grade).
   Observe the following:
   - *Pump remains in the laboratory after shutdown*
     - If no additive is used, flush the system, for example with methanol. 100% acetonitrile should not be used.
     - If an additive is used, flush the system with several volumes (for example, 1.0 mL/min for 10 minutes with the standard system) of methanol and water (50:50) to prevent salt buildup in the fluidics. If the solvents in the pump are not miscible with water, use an appropriate intermediate solvent.
   - *Pump shall be transported or shipped after shutdown*
     - If no additive is used, flush the system with isopropanol.
     - If an additive is used, flush the system first with several volumes (for example, 1.0 mL/min for 10 minutes with the standard system) of methanol and water (50:50) to prevent salt buildup in the fluidics. If the solvents in the pump are not miscible with water, use an appropriate intermediate solvent. Afterward, flush the system with isopropanol.

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

3. Disconnect the solvent lines:

   a) Unscrew the caps of the solvent reservoirs and remove the solvent lines together with the caps from the reservoirs. Protect the solvent lines filter from contamination with a plastic bag.

   b) Purge the pump until the solvent lines are empty.

   c) Disconnect the solvent lines on the degasser inlets.

   d) Close the degasser inlets with appropriate plugs.

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.

4. Empty the seal wash system:

   a) Unscrew the cap of the seal wash reservoir and remove the seal wash line together with the cap from the seal wash reservoir.

   b) Remove the peristaltic tubing from the seal wash pump. When the tubing is removed, any liquid that is present in the seal wash line flows off to waste.

5. The step depends as follows:

   - *Pump 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.
   - *Pump shall be transported or shipped after shutdown*
     If one of the modules shall be removed from the system stack, turn off *all* 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 section 7.15 Transporting or Shipping the Pump, page 178.

Restarting the Pump

To restart the pump, 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.
   Retighten the reservoir caps hand-tight. Verify that the retaining guide remains in the hole in the reservoir cap. If it does not, press the retaining guide into the hole to ensure that the tubing is kept in place in the cap.
3. Turn on the pump.
4. 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.
5. Purge the pump and then have the pump deliver for a short time.
6. Let the system equilibrate and be sure that it is ready for operation (see section 6.6 Preparing the Pump for Operation, page 89).

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 pump is designed for easy maintenance and service. The user-serviceable parts of the pump can be accessed from the front. If not stated otherwise, the maintenance procedures do not require that you remove the pump 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 section 7.14 Replacing the Doors, page 176.

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 that are presented in section 2.3 Safety Precautions, page 22.

WARNING—High Voltage

High voltages are present inside the pump 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—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.

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.

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 solvents lines. Follow the instructions in section 7.10.1, page 165. Then, retighten the reservoir caps.

7.3 General Rules for Maintenance and Service

For successful maintenance and service procedures, follow these rules and recommendations:

- Before starting maintenance or service procedures, shut down the pump when instructed to do so.
- Use only the replacement parts specifically authorized and qualified for the pump by Thermo Fisher Scientific. For ordering information, see section 10.4 Consumables and Replacement Parts, page 211.
- Follow all instructions step by step and use the tools recommended for the procedure.
- 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.
- If you need to return the pump for depot repair, follow the instructions in section 7.15 Transporting or Shipping the Pump, page 178.

7.4 Routine and Preventive Maintenance

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

7.4.1 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 pump.

Frequency	What you should do…
Daily	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 on a daily basis.
	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 pump thoroughly after use with an appropriate solvent that does not contain buffers or salts.
Regularly	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 section 7.5.1, page 125).
	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 inline filter or static mixer, depending on which component is installed.
	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 pump and clearly legible. If they are not, contact Thermo Fisher Scientific for replacement.

Frequency	What you should do…
Annually	Clean the check valves in an ultrasonic bath.
	Replace the seal wash seals (see section 7.6.7, page 146).
	Inspect the pistons for particle deposits or indications of damage, for example, scratches or scores (see section 7.6.4, page 139).
	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 section 10.4 Consumables and Replacement Parts, page 211).

TIP The Chromeleon software supports functions for estimating the lifetime of consumables (see section 7.4.4 Predictive Performance, page 120).

7.4.2 Flushing the Pump

When

- To avoid contamination of the pump, see section 7.4.2.1.
- With persistent contamination, see section 7.4.2.2, page 120.

7.4.2.1 Avoiding Contamination

When

To avoid contamination of the degassing channels

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 degassing channels with fresh solvent is usually sufficient.

- If you use water and acetonitrile or methanol for your chromatography, flushing the channels 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. They may require a much shorter flushing interval.
- 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 the next section in this manual.

7.4.2.2 With Persistent Contamination Only

When

TIP With conventional use of the Vanquish system as recommended in this manual, regularly flushing the degassing channels is usually sufficient (see the previous section in this manual).

With persistent contamination, 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)
- Nitric acid (20%) (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.
5. For 1 hour, apply the flow rate of your application and flush the pump with 20% nitric acid.
6. Flush the pump with fresh HPLC-grade water until the pH value is neutral or equal to the fresh HPLC-grade water, respectively.
7. Remove the waste container with the nitric acid and re-install the waste container that was previously installed.
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.

7.4.3 Cleaning or Decontaminating the Pump

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 pump. Use a suitable cleaning detergent or disinfectant to ensure that the treatment renders the pump 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 pump 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 pump. Liquids can cause a short circuit when getting in contact with the electronic components.

Preparations

Turn off the power to the pump 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.

7.4.4 Predictive Performance

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, which are called Predictive Performance, 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*.

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

- CheckValvesServiceDone
  For each pump head, a common counter is available for all check valves (inlet check valves and outlet check valves).
- InlineFilterChanged
  If you have installed the static mixer instead of the inline filter, consider resetting this counter after mixer installation or mixer replacement.
- PistonsChanged
  For each pump head, a common counter is available for both pistons.
- SealsChanged
  For each pump head, a common counter is available for all piston seals in the pump head.
- QualificationDone
- ServiceDone

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, see the next section further down.
- To replace the seal wash lines, see section 7.5.2, page 126.
- To replace the seal wash detector (drop detector), see section 7.5.3, page 129.

TIP To replace the seal wash seal, which are part of the pump head, see section 7.6.7, page 146.

7.5.1 Testing the Seal Wash System for Leakage

When

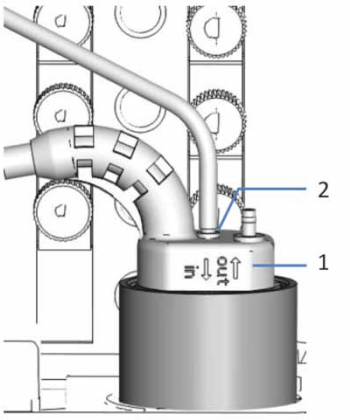
- At regular intervals
- If you performed maintenance on components in the pump head, for example, after replacing the piston seals

Items required

Syringe (12 mL)

Follow these steps

1. Disconnect the tubing from the seal wash detector.



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

Figure 35: Seal wash detector

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.
   - If leakage is present, tighten or replace leaky connections as necessary and repeat the inspection.
   - If 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

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 section 5.6.6.2 Setting Up the Seal Wash System, page 69.

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

1. When you have to remove a seal wash line from the tubing guides, be careful not to pull on other tubing in the guides.
2. Follow the sequence of steps for the seal wash line that you want to replace:
   - 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.*
   - Peristaltic tubing:

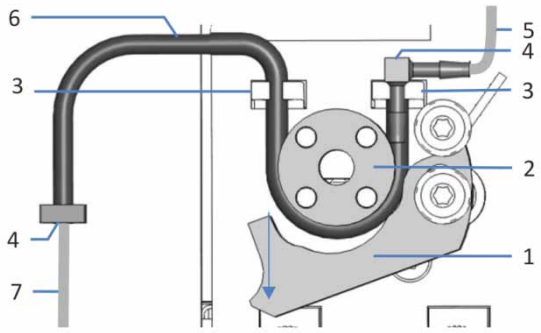


Figure 36: Seal wash pump

No.	Description
1	Pump lever
2	Pump rotor
3	Tubing holder (peristaltic tubing)
4	Tubing connectors

No.	Description
5	Seal wash line from autosampler
6	Peristaltic tubing
7	Seal wash tubing to pump head

a) Disconnect the peristaltic tubing from the silicone tubing.

b) Press down the lever on the seal wash pump and remove the peristaltic tubing from the pump and from the tubing holders.

c) Connect the new peristaltic tubing to the silicone tubing.

d) 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.

e) Press down the lever on the seal wash pump and hold it in that position with one hand.

f) With your other hand, insert the peristaltic tubing between the lever and the rotor and wind it around the rotor.

g) Release the lever.

h) Insert the peristaltic tubing into the left tubing holder.

i) Check that the peristaltic tubing is properly inserted 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.

j) Continue with the next step.

- Seal wash lines from peristaltic tubing to the pump heads and on to the seal wash detector:

a) Disconnect the seal wash tubing from the tubing connectors. Do not remove the tubing connectors.

b) Connect the new seal wash lines.

c) Continue with the next step.

3. Retighten the cap to the seal wash reservoir hand-tight. Verify that the retaining guide remains in the hole in the reservoir cap. If it does not, press the retaining guide into the hole to ensure that the tubing is kept in place in the cap.

4. Check the seal wash lines over the entire flow path:

   a) Make sure that no bending, pinching or squeezing of the seal 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 (see section 5.6.6.3, page 74). Use fresh seal wash liquid.

7.5.3 Replacing the Seal Wash Detector

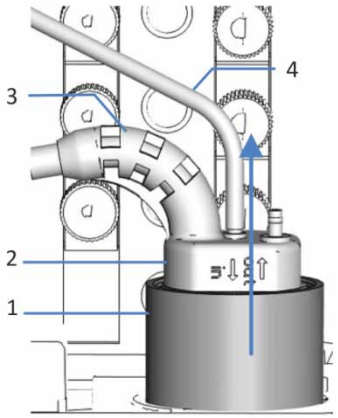
When

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

Parts required

Seal wash detector assembly, consisting of the detector and funnel

Follow these steps



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

Figure 37: Removing the seal wash detector assembly

1. Disconnect the tubing 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. Install the new seal wash detector assembly in the pump:

   a) The seal wash detector and funnel come as an assembled unit. If you have to assemble both parts for any reason, push the detector into the funnel. Mind the orientation of the funnel.

   b) Push the assembly into the pump.

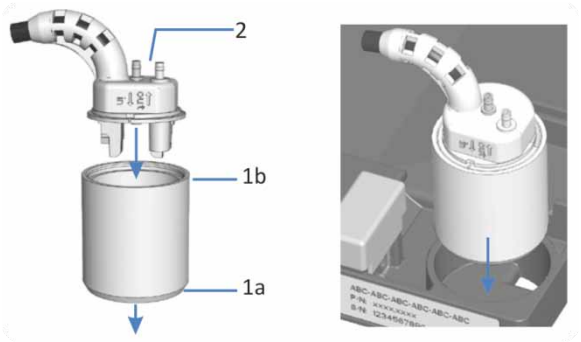


Figure 38: Installing the seal wash detector assembly

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

5. Reconnect the tubing to the seal wash detector (port labeled **in**).
6. Connect the detector cable to the **Drop Det** port.
7. Flush the seal wash system (see section 5.6.6.3, page 74).

7.6 Pump Head

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

- To replace a pump head, see section 7.6.2, page 133.
- To replace a piston, see section 7.6.3, page 136.
- To clean a piston, see section 7.6.4, page 139.
- To replace the piston seals or support ring, see section 7.6.5, page 140.
- To replace a seal wash seal, see section 7.6.7, page 146.
- To replace the pump head seals, see section 7.6.8, page 150.
- To test the pump for piston seal leakage, see section 7.6.9, page 153.

For an overview of the pump head parts, see the next section.

7.6.1 Overview of Pump Head Parts

The picture shows the main pump head parts.

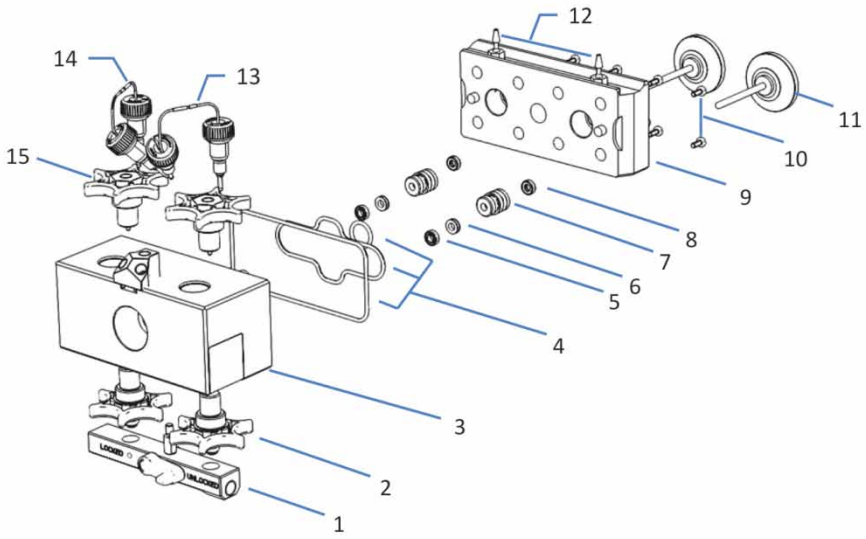


Figure 39: Overview of pump head parts

No.	Description
1	Inlet assembly
2	Inlet check valves
3	Pump head
4	Pump head seals (3 PTFE O-ring seals)
5	Piston seals
6	Support rings
7	Seal wash bodies (pump head bushing)
8	Seal wash seals
9	Seal wash plate
10	Screws, seal wash plate (8 screws)
11	Pistons
12	Connectors for seal wash tubing (screwable)
13 + 14	U-tubes (right and left)
15	Outlet check valves

7.6.2 Replacing the Pump Head

When

- Damage of pump head
- Problems with pump performance

Parts required

Pump head

Tools and additional items required

- Hexagon wrench, size 6
- Solvent suitable for purging to flush out harmful substances
- 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 to remove the pump head

1. Select the pump head for which you want to perform the procedure.
2. Undock the pistons either from the keypad or from Chromeleon. Wait until undocking is complete before proceeding with the next step.
3. On the inlet assembly of the pump head, disconnect the tubing from the solvent selector.
4. Unplug the cable of the pressure sensor from the **P-Work** connector.
5. Remove the capillary that connects the pump head to the purge unit.
6. Remove the seal wash lines from the tubing connectors on the pump head. Do not remove the tubing connectors.
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. The pistons are usually removed from the pump together with the pump head.

TIP If a piston remained in the pump, write down the installation position in the pump head (right or left) and pull the piston out. If both pistons remained in the pump, be careful not to interchange them.

Follow these steps to install the pump head

1. Observe the following:
   - Reinstallation of pump heads
     - Be sure not to interchange the pump heads. Note the labeling (**L** for the left pump head or **R** for the right pump head) on the pressure sensor cable to identify the correct installation position.
     - If the pistons remained in the pump head, consider verifying that the distance between the pistons and seal wash plate is correct (see the related steps in section 7.6.3, page 136).
     - If you have to reinstall the pistons, follow the steps in section 7.6.3, page 136.
   - Installation of new pump heads (replacement pump heads)
     - 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.

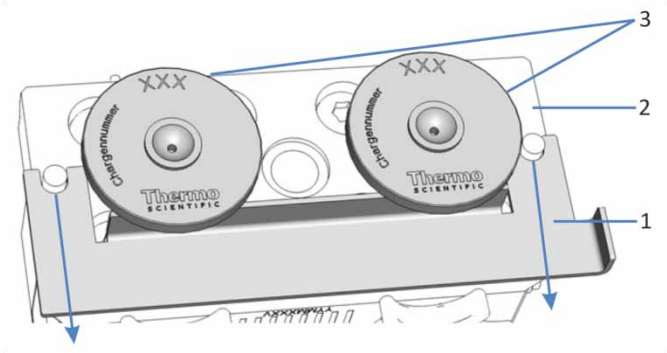


Figure 40: Removing the spacing tool

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

- New pump heads can be installed in either position when installed for the first time. They have no label on the pressure sensor cable. For easier identification during future maintenance, consider labeling them according to the installation position (**L** for the left pump head or **R** for the right pump head).

2. Insert the pump head into the pump and tighten the pump head screw.
3. Connect the seal wash lines to the tubing connectors on the pump head.
4. Install the capillary that connects the pump head to the purge unit.
5. Connect the cable of the pressure sensor to the **P-Work** connector.
6. On the inlet assembly of the pump head, connect the tubing from the solvent selector.
7. If the pump is connected in Chromeleon, disconnect the pump.
8. Turn off the pump with its main power switch and on again.
9. Dock the pistons either from the keypad or from Chromeleon. Wait until docking is complete before proceeding with the next step.
10. Purge the pump using the solvent for your application.
11. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections.
12. In Chromeleon, consider updating the Predictive Performance information for the pump head components.
13. *Optional*
    Test the seal wash system and the pump for leakage.
14. *Recommended*
    Perform performance qualification for the pump:
    a) From Chromeleon, run the pump-specific **Performance Qualification** (PQ) tests (= Flow Precision Test and Gradient Accuracy Test). For details, refer to the *Operational and Performance Qualifications manual*.
    b) In Chromeleon, execute the **QualificationDone** command.

7.6.3 Replacing the Pistons

When

Damage of piston

Parts and additional items required

- Pistons
- Isopropanol

Preparations

Remove the pump head (see section 7.6.2, page 133).

Follow these steps

1. Remove the pistons from the pump head (or pump if necessary).
2. Observe the following:
   - Write down the 3-digit piston calibration value (which is imprinted on the rear of the piston, see picture) and the installation position in the pump head (left or right). You might need this assignment in a later step.

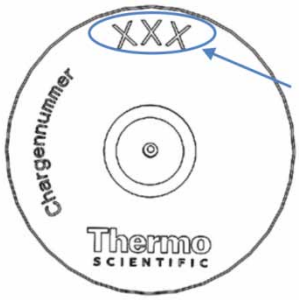


Figure 41: Piston calibration value

   - Reinstallation of pistons
     Be sure not to interchange the pistons.
   - Installation of new pistons (replacement pistons)
     New pistons can be installed in either position.
3. *When reinstalling a piston you removed*
   Clean the piston. Follow the steps in section 7.6.4, page 139.
4. To facilitate piston installation, inject a few drops of isopropanol into the piston cavity in which you want to install the piston.

5. Insert the pistons into the cavities.

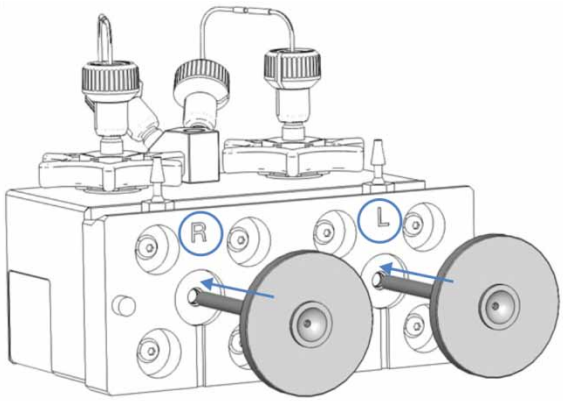


Figure 42: Installing the pistons

6. Place the spacing tool onto the pump head.

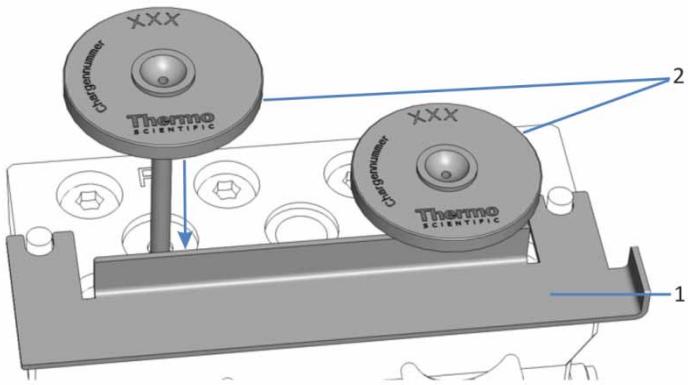


Figure 43: Installing the spacing tool and pistons

No.	Description
1	Spacing tool
2	Pistons

7. Push in the pistons until they contact the tool.
8. Remove the spacing tool. Be careful not to pull out the pistons any further.
9. Install the pump head. Follow the related steps in section 7.6.2, page 133.

10. *In Chromeleon, as applicable*

    - When installing a new piston

      a) Update the related **Piston Calibration Value** property with the value from the new piston:

Pump Head	Property to be updated
For the left pump head	Under **Pump_Wellness_LeftBlock**
Left piston	**PistonCalibrationValue_Drv1**
Right piston	**PistonCalibrationValue_Drv2**
For the right pump head	Under **Pump_Wellness_RightBlock**:
Left piston	**PistonCalibrationValue_Drv1**
Right piston	**PistonCalibrationValue_Drv2**
The property names in the table refer to the names in the **Command** window.	

      b) Run a self-test.

      Non-matching values may result in periodic baseline fluctuation or pulsation.

    - When reinstalling a piston
      Consider verifying that the **Piston Calibration Value** property for the related piston matches the value on the piston.

    Non-matching values may result in periodic baseline fluctuation or pulsation.

11. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections.

12. In Chromeleon, consider updating the Predictive Performance information for the pistons.

13. *Optional*
    Test the seal wash system and the pump for leakage.

14. *Recommended*
    Perform performance qualification for the pump:

    a) From Chromeleon, run the pump-specific **Performance Qualification** (PQ) tests (= Flow Precision Test and Gradient Accuracy Test). For details, refer to the *Operational and Performance Qualifications manual*.

    b) In Chromeleon, execute the **QualificationDone** command.

7.6.4 Cleaning the Piston

When

When reinstalling the piston you removed

Items required

- Dry, lint-free tissue
- Isopropanol

Follow these steps

1. Inspect the piston for signs of damage.

TIP When the entire piston is still black and the fingernail test does not reveal rough areas on the piston surface, the piston is in good condition.

2. Carefully rinse the piston, preferably using isopropanol.
3. With a dry, lint-free tissue, rub the piston several times.
4. *Recommended*
   Even if the piston seems to be clean, perform the fingernail test:
   a) Hold the piston and carefully move your fingernail over the piston surface.
      The piston is clean when the fingernail test does not reveal inconsistent or rough areas.
   b) Repeat steps 2 and 3.
5. When no damage is visible and the piston is clean, reinstall the piston. If the 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.
- *Optional:* Seal wash seals (and seal-handling tool)
  Replacing the seal wash seal is recommended.

Tools and additional items required

- Screwdriver, Torx TX25
- Seal-handling tool

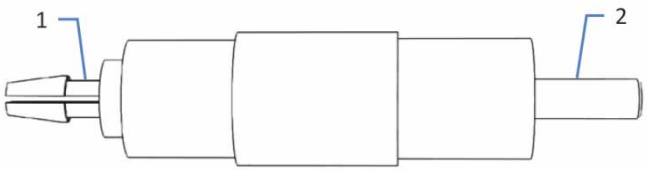


Figure 44: Seal-handling tool

No.	Description
1	Seal removal pin
2	Seal insertion pin

- Syringe filled with isopropanol
- Cleaning swab
- Lint-free tissue

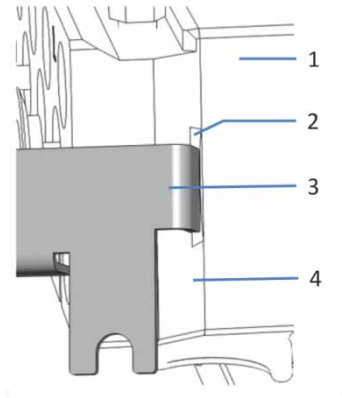
Preparations

1. Remove the pump head (see section 7.6.2, page 133).
2. Remove the pistons (see section 7.6.3, page 136).

Follow these steps

1. Remove the screws on the rear of the pump head (on the seal wash plate).
2. Remove the seal wash plate from the pump head.

TIP Removing the seal wash plate may be easier with the spacing tool. Insert the spacing tool into the opening on one side of the seal wash plate and lever the plate away from the pump head. Repeat on the other side.



No.	Description
1	Pump head
2	Opening on seal wash plate
3	Spacing tool
4	Seal wash plate

Figure 45: Removing the seal wash plate with the spacing tool

3. Remove the seal wash bodies from the pump head if applicable.
4. 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.

5. 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.
6. *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.
7. Pipette a few drops of isopropanol into cavity in the pump head, on the edge on which the piston seal will rest.

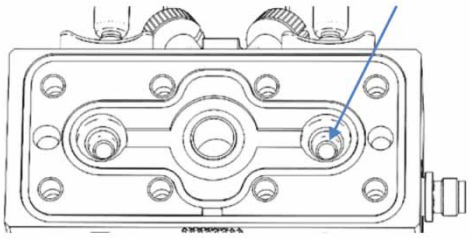


Figure 46: Edge on which the piston seal will rest

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

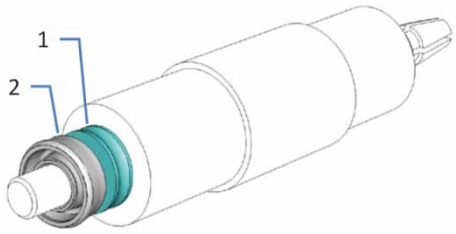


Figure 47: Support ring and piston seal on seal insertion pin

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.

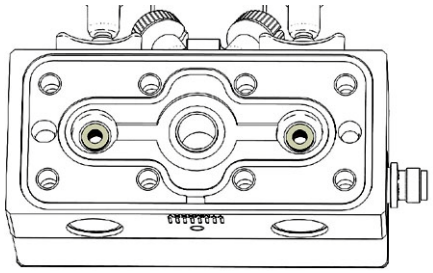
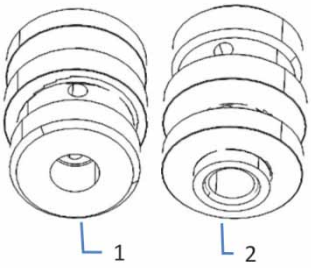


Figure 48: Pump head, piston seals, and support rings installed

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



No.	Description
1	Side facing the pump head
2	Side facing the seal wash plate

Figure 49: Orientation of the seal wash body

12. *Recommended:*
    Replace also the seal wash seals. Follow the appropriate steps in section 7.6.7, page 146).

13. Place the seal wash plate onto the pump head and insert the screws.

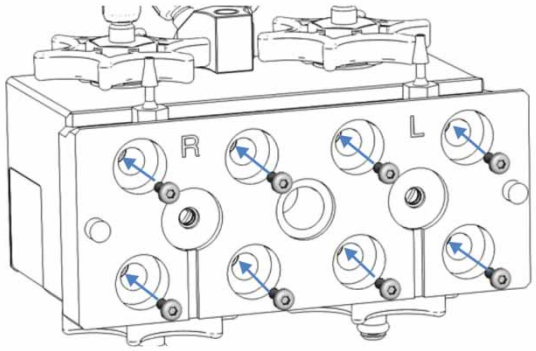


Figure 50: Pump head with seal wash plate and plate screws

14. With the screwdriver, hand-tighten the screws step by step in the order shown in the picture.

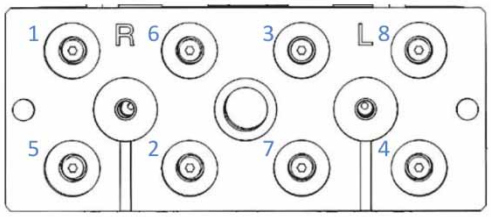


Figure 51: Tightening order for seal wash screws

15. Tighten the screws step by step in the given order once again.
16. Install the pistons. Follow the related steps in section 7.6.3, page 136.
17. Install the pump head. Follow the related steps in section 7.6.2, page 133.
18. Observe the recommendations for new piston seals (see section 7.6.6, page 145).
19. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections.
20. In Chromeleon, consider updating the Predictive Performance information for the piston seals.
21. *Optional*
    Test the seal wash system and the pump for leakage.
22. *Recommended*
    Perform performance qualification for the pump:
    a) From Chromeleon, run the pump-specific **Performance Qualification** (PQ) tests (= Flow Precision Test and Gradient Accuracy Test). For details, refer to the *Operational and Performance Qualifications manual*.
    b) In Chromeleon, 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 (from Diagnostics tool kit)
- Isopropanol
- Solvent suitable for your application

Recommendations

Allow new piston seals to run in.

To run in new piston seals, follow these steps:

1. Purge the pump. For 15 minutes, apply a purge flow of approximately 1.3 mL/min using isopropanol.
2. Install the backpressure capillary on the pump outlet.
3. For 30 minutes, apply a flow of approximately 1.3 mL/min using isopropanol to generate a backpressure of approximately 30 MPa.
4. Turn off the pump flow and wait until the system pressure is down to zero.
5. Remove the backpressure capillary from the pump outlet and reconnect the pump to the system.
6. Purge the pump using the solvent for your application.
7. 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 and hold high pressure for some minutes.

Never run the pump dry.

Running the pump dry can damage the pistons or piston seals.

7.6.7 Replacing the Seal Wash Seals

When

- Damage to the seal wash seal, leaky seal
- Once a year

Parts required

Seal wash seals

Tools and additional items required

- Screwdriver, Torx TX25
- Seal-handling tool (see Figure 44, page 140)
- Syringe filled with isopropanol

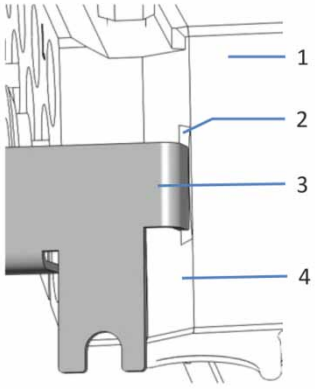
Preparations

1. Remove the pump head (see section 7.6.2, page 133).
2. Remove the pistons (see section 7.6.3, page 136).

Follow these steps

1. Remove the screws on the rear of the pump head (on the seal wash plate).
2. Remove the seal wash plate from the pump head.

TIP Removing the seal wash plate may be easier with the spacing tool. Insert the spacing tool into the opening on one side of the seal wash plate and lever the plate away from the pump head. Repeat on the other side.



No.	Description
1	Pump head
2	Opening on seal wash plate
3	Spacing tool
4	Seal wash plate

Figure 52: Removing the seal wash plate with the spacing tool

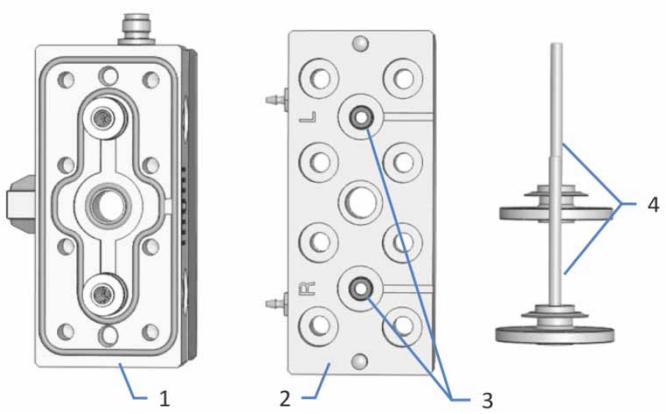


Figure 53: Removing the seal wash plate with the spacing tool

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

3. If the seal wash bodies are present in the seal wash plate, remove them from the plate.

4. 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 54: Removing the seal wash seal

5. Slide the new seal onto the insertion pin of the seal-handling tool.

6. To facilitate seal installation, inject a few drops of isopropanol into the seal cavities on the seal wash plate (no-channel side).
7. 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.
8. Remove the tool from the seal wash plate. The seal remains in the plate.

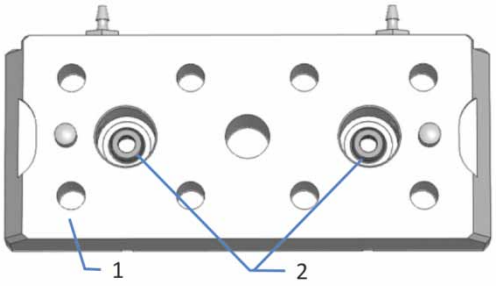
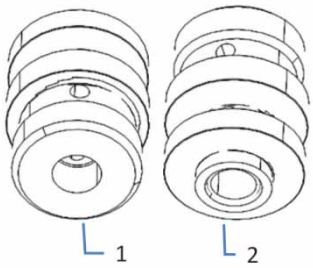


Figure 55: Seal wash plate (no-channel side)

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

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



No.	Description
1	Side facing the pump head
2	Side facing the seal wash plate

Figure 56: Orientation of the seal wash body

10. Place the seal wash plate onto the pump head and insert the screws.

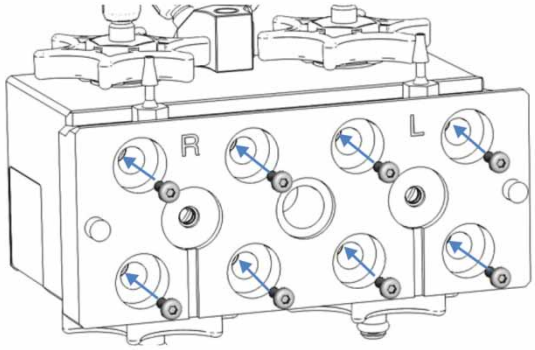


Figure 57: Pump head with seal wash plate and plate screws

11. With the screwdriver, hand-tighten the screws step by step in the order shown in the picture.

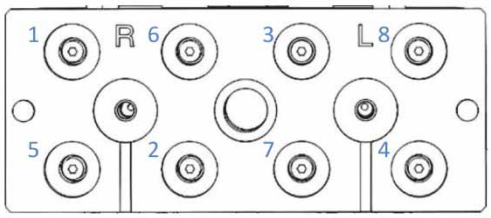


Figure 58: Tightening order for seal wash screws

12. Tighten the screws step by step in the given order once again.
13. Install the pistons. Follow the related steps in section 7.6.3, page 136.
14. Install the pump head. Follow the related steps in section 7.6.2, page 133.
15. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections.
16. Test the seal wash system and the pump for leakage.
17. If you replaced the seal wash seals together with the piston seals, proceed with the specific steps required after piston seal replacement (see section 7.6.5, page 140).

7.6.8 Replacing the Pump Head Seals

When

Damage to pump head seals, leaky seals

Parts and tools required

- Pump head seals
- Tweezers

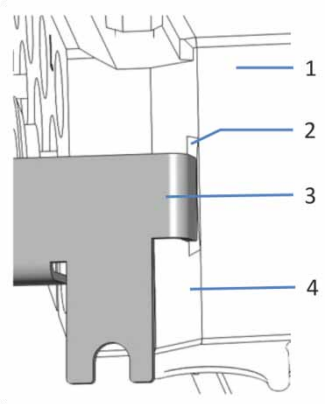
Preparations

1. Remove the pump head (see section 7.6.2, page 133).
2. Remove the pistons (see section 7.6.3, page 136).

Follow these steps

1. Remove the screws on the rear of the pump head (on the seal wash plate).
2. Remove the seal wash plate from the pump head.

TIP Removing the seal wash plate may be easier with the spacing tool. Insert the spacing tool into the opening on one side of the seal wash plate and lever the plate away from the pump head. Repeat on the other side.



No.	Description
1	Pump head
2	Opening on seal wash plate
3	Spacing tool
4	Seal wash plate

Figure 59: Removing the seal wash plate with the spacing tool

3. Remove the seal wash bodies from the pump head if applicable.
4. Remove the pump head seals. Using tweezers facilitates the procedure for the seals labeled 1 and 3 in the picture.

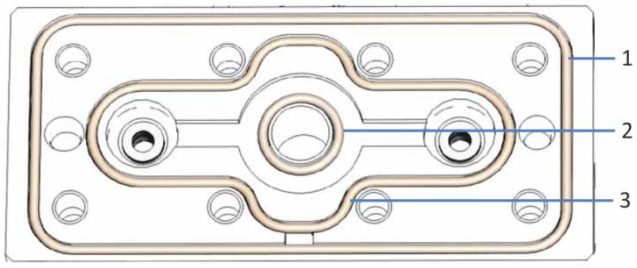
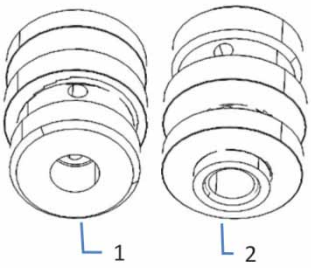


Figure 60: Pump head seals

No.	Description
1	Pump head seal, O-ring 65x1.5
2	Pump head seal, O-ring 9x1.5
3	Pump head seal, O-ring 45x1.5

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



No.	Description
1	Side facing the pump head
2	Side facing the seal wash plate

Figure 61: Orientation of the seal wash body

7. Place the seal wash plate onto the pump head and insert the screws.

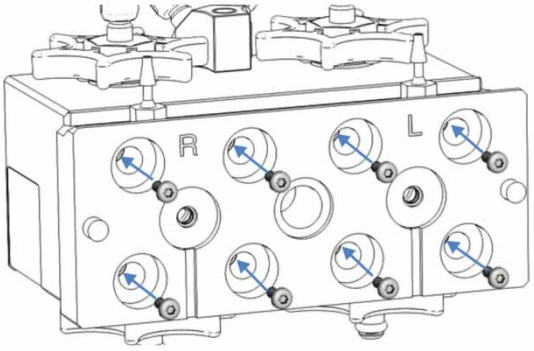


Figure 62: Pump head with seal wash plate and plate screws

8. With the screwdriver, hand-tighten the screws step by step in the order shown in the picture.

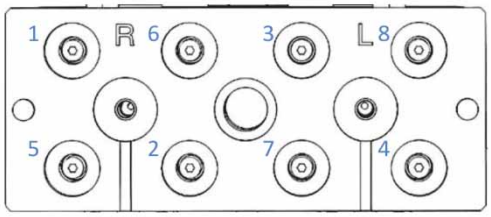


Figure 63: Tightening order for seal wash screws

9. Tighten the screws step by step in the given order once again.
10. Install the pistons. Follow the related steps in section 7.6.3, page 136.
11. Install the pump head. Follow the related steps in section 7.6.2, page 133.
12. Inspect all flow connections on the pump head for indications of leakage. Tighten leaky connections.
13. *Optional*
    Test the seal wash system and the pump for leakage.

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.

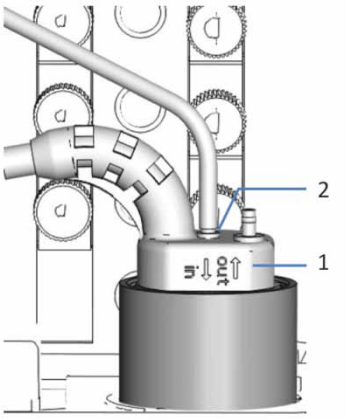
If messages regarding piston seal leakage appear in the chromatography software, for example, "The piston seal leakage has exceeded the recommended limit (code 4121)".

Parts required

Backpressure capillary (from Diagnostics tool kit) (optional)

Follow these steps

1. From Chromeleon, start a seal wash cycle.
2. Disconnect the tubing from the seal wash detector (port labeled **in**).



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

Figure 64: Seal wash detector

3. Remove some liquid from the tubing, for example, by shaking the tubing.
4. Set up the system in such a way that approximately 80 MPa of backpressure is produced.
   For example, install an appropriate backpressure capillary on the pump outlet (outlet of the inline filter or static mixer).
5. Apply an appropriate flow rate.
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:
   - *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. Continue with the next steps:

     a) Replace the seal wash seals.

     b) Reconnect the seal wash tubing to the seal wash detector (port labeled **in**).

     c) Repeat the test starting with step 1.
   - *Liquid level in the tubing is increasing*
     One or more piston seals are leaky. 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. Repeat the observation (step 6 and following steps).
10. Depends on your observation:
    - *Liquid level in the tubing increases again*
      a) Replace the piston seals in the *left* pump head.

      b) Reconnect the seal wash tubing to the right pump head.

      c) Reconnect the seal wash tubing to the seal wash detector (port labeled **in**).

      d) Repeat the test starting with step 1.
    - *Liquid level in the tubing does not increase again*
      a) Replace the piston seals in the *right* pump head.

      b) Reconnect the seal wash tubing to the right pump head.

      c) Reconnect the seal wash tubing to the seal wash detector (port labeled **in**).

      d) Repeat the test starting with step 1.

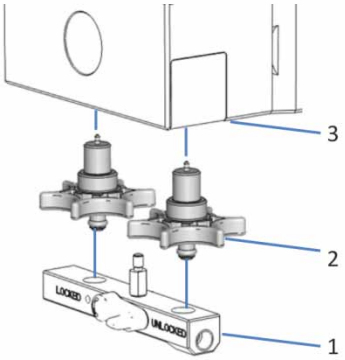
7.7 Check Valves

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 section 7.7.2, page 157.
- To clean the check valves, see section 7.7.3, page 158.

7.7.1 Replacing the Inlet Check Valves

The picture shows the parts that must be removed.



No.	Description
1	Pump head inlet assembly
2	Inlet check valves
3	Pump head

Figure 65: Replacing the inlet check valves

When

Damage of check valve or leaky check valve

Parts required

Inlet check valve

Additional items required

- Solvent suitable for purging to flush out harmful substances
- 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

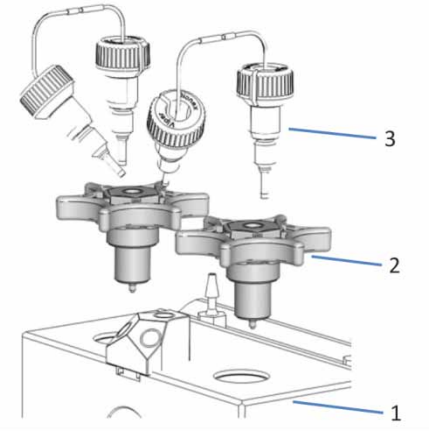
1. On the inlet assembly of the pump head, disconnect the tubing from the solvent selector.
2. Remove the inlet assembly.
   Set the lever on the assembly into the **Unlock** position and pull the assembly downward.

   TIP Pushing down the assembly on the left side facilitates removing the assembly.

3. Loosen and remove the inlet check valve.
4. Tighten the new inlet check valve finger-tight.
5. Install the inlet assembly.
   Push the assembly onto the inlet check valves and set the lever on the assembly into the **Lock** position.
6. On the inlet assembly, reconnect the tubing from the solvent selector.
7. Purge the pump using the solvent for your application.
8. Inspect the check valves and inlet assembly connections for indications of leakage. Tighten leaky connections.
9. *Optional*
   Test the pump for leakage (see section 7.11, page 170).

7.7.2 Replacing the Outlet Check Valves

The picture shows the parts that must be removed.



No.	Description
1	Pump head
2	Outlet check valves
3	U-tubes

Figure 66: Replacing an outlet check valve

When

Damage of check valve or leaky check valve

Parts required

Outlet check valve

Additional items required

- Solvent suitable for purging to flush out harmful substances
- 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 U-tube on the outlet check valve that you want to remove.
2. Loosen and remove the outlet check valve.
3. Tighten the new outlet check valve finger-tight.

4. Install the U-tube.
5. Purge the pump using the solvent for your application.
6. Inspect the check valves and connections for indications of leakage. Tighten leaky connections.
7. *Optional*
   Test the pump for leakage (see section 7.11, page 170).

7.7.3 Cleaning the Check Valves

When

- Dirty check valves
- Once a year

Parts and additional items required

- Syringe (12 mL), filled with isopropanol
- Ultrasonic bath

Preparations

Remove the check valves that you want to clean. It is recommended to clean all check valves of the pump head at the same time. To remove the check valves, follow the appropriate steps in section 7.7.1, page 155 or section 7.7.2, page 157.

Follow these steps

1. In the direction of flow, fill the check valves with isopropanol, using the syringe.
2. For 10 minutes, place the check valves in the ultrasonic bath.
3. In the direction of flow, rinse the check valves with isopropanol, using the syringe.
4. Reinstall the check valves, following the appropriate steps section 7.7.1, page 155 or section 7.7.2, page 157.
5. In Chromeleon, consider updating the Predictive Performance information for the check valves.

7.8 Inline Filter

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

- To test the inline filter for permeability, see the next section.
- To replace the inline filter or the capillary mixer (volume: 25 µL) connecting the purge unit to the filter inlet, see section 7.8.2, page 160.

7.8.1 Testing the Inline Filter for Permeability

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

1. Disconnect the capillary on the outlet of the inline filter.
2. To absorb the liquid leaving the filter, place the tissue under the filter outlet.
3. Apply a flow of 2 mL/min using water.
4. Observe the pump pressure.
5. Depends on the pressure reading:
   - ♦ Pressure is less than 0.8 MPa
     Continue with the next step.
   - ♦ Pressure is 0.8 MPa or higher
     Replace the inline filter.
6. Reconnect the capillary to the outlet of the inline filter.
7. Test the pump for leakage (see section 7.11, page 170).

7.8.2 Replacing the Inline Filter or Capillary Mixer

When

- Impaired filter permeability
- Damage of inline filter or capillary mixer, which connects the purge unit to the inline filter

Parts and additional items required

- As applicable
  - Inline filter (static filter)
  - Capillary mixer (volume: 25 µL), connecting the purge unit to filter inlet
- 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

1. Unplug the cable of the seal wash detector from the **DROP DET** port.
2. Unplug the cable of the right pump head from the **P-WORK** port if applicable.
3. As applicable, disconnect the capillary mixer on the filter inlet or remove the capillary mixer on the filter inlet and on the purge unit.
4. On the filter outlet, disconnect the capillary that connects the inline filter to the autosampler injection valve.
5. Pull the inline filter out of the mounting bracket.
6. Insert the new inline filter into the mounting bracket. Mind the direction of flow through the filter (indicated by the arrow on the filter).

7. As applicable, reconnect the capillary mixer to the filter inlet or install a new capillary mixer.
   When installing a new capillary mixer, mind the direction of flow through the mixer (indicated by the arrow on the capillary mixer).
8. On the filter outlet, reconnect the capillary to the autosampler injection valve.
9. Reconnect the cable of seal wash detector to the **DROP DET** port.
10. Reconnect the pump head cable to **P-WORK** port if applicable.
11. Apply the flow rate of your application and have the pump deliver for a short time.
12. Inspect the flow connections on the inline filter for indications of leakage before resuming operation.
13. In Chromeleon, consider updating the Predictive Performance information for the inline filter.
14. *Optional*
    Test the pump for leakage (see section 7.11, page 170).

7.9 Mixing System

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

- To test the static mixer for permeability, see the next section.
- To replace the static mixer or capillary mixer, see section 7.9.2, page 163.

7.9.1 Testing the Static Mixer for Permeability

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

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 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 section 7.11, page 170).

7.9.2 Replacing the Static Mixer or Capillary Mixer

When

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

Parts and additional items required

- As applicable
  - Static mixer
  - Capillary mixer
- 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

1. Unplug the cable of the seal wash detector from the **DROP DET** port.
2. Unplug the cable of the right pump head from the **P-WORK** port if applicable.
3. As applicable, disconnect the capillary mixer on the static mixer inlet or remove the capillary mixer on the static mixer inlet and purge unit.
4. On the static mixer outlet, disconnect the capillary that connects the static mixer to the autosampler injection valve.
5. Pull the static mixer out of the mounting bracket.
6. Insert the new static mixer into the mounting bracket. Mind the direction of flow through the static mixer (indicated by the arrow on the static mixer).

7. As applicable, reconnect the capillary mixer to the static mixer inlet or install a new capillary mixer.
   When installing a new capillary mixer, mind the direction of flow through the capillary mixer (indicated by the arrow on the capillary mixer).
8. On the static mixer outlet, reconnect the capillary to the autosampler injection valve.
9. Reconnect the cable of seal wash detector to the **DROP DET** port.
10. Reconnect the pump head cable to **P-WORK** port if applicable.
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. In Chromeleon, consider updating the Predictive Performance information for the static mixer (**InlineFilterChanged** command).
14. *Optional*
    Test the pump for leakage.

7.10 Solvent Lines and Solvent Line Filters

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

- To replace solvent lines, see section 7.10.2.
- To replace the solvent line filter, see section 7.10.3, page 168.

7.10.1 Emptying the Solvent Lines

When

To empty the solvent lines, for example, for maintenance or service procedures or for long-term shutdown

Preparations

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

Follow these steps

Follow these steps for each solvent line that you want to empty:

1. Unscrew the cap of the solvent reservoir and remove the solvent line together with the cap from the reservoir.
2. Stop purging as soon as the solvent line is empty.

7.10.2 Replacing Solvent Lines

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

- Solvent line from the solvent reservoir to the degasser
  Follow the steps in the next section.
- Solvent line from the degasser to the solvent selector
  Follow the steps in section 7.10.2.2, page 167.
- Solvent line from the solvent selector to the pump head
  Follow the steps in section 7.10.2.3, page 167.

7.10.2.1 Solvent Lines From Reservoir To Degasser

When

Damage or blockage of the solvent line

Parts required

Solvent line between solvent reservoir and degasser inlet port

Additional items required

Solvent suitable for purging

Preparations

Empty the solvent lines (see section 7.10.1, page 165).

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 degasser 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, be careful not to pull on other tubing in the guides.
4. To install the new solvent line, follow steps 1 through 10 in section 5.6.5 Connecting the Solvent Lines, page 64.
5. To remove any air bubbles from the solvent lines, purge the pump.

7.10.2.2 Solvent Lines From Degasser to Selector

When

Damage or blockage of the solvent line

Parts and additional items required

- Solvent line between degasser outlet port and solvent selector
- Solvent suitable for purging

Preparations

Empty the solvent lines (see section 7.10.1, page 165).

Follow these steps

1. Retighten the reservoir cap hand-tight. Verify that the retaining guide remains in the hole in the reservoir cap. If it does not, press the retaining guide into the hole to ensure that the tubing is kept in place in the cap.
2. Remove the solvent line on the degasser outlet port and on the solvent selector.
3. Install the new solvent line.
4. To remove any air bubbles from the solvent lines, purge the pump.

7.10.2.3 Solvent Line From Solvent Selector To Pump Head

When

Damage or blockage of the solvent line

Parts and additional items required

- Solvent line between solvent selector and pump head inlet
- 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 solvent selector and on the inlet assembly of the pump head.
2. Install the new solvent line.
3. To remove any air bubbles from the solvent lines, purge the pump.

7.10.3 Replacing the Solvent Line Filter

When

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

Parts required

As applicable:

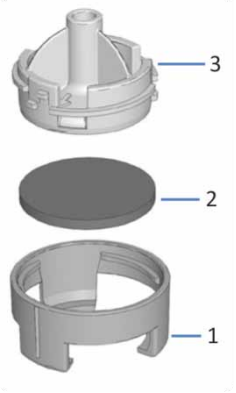
- Filter holder
- Filter frit

Preparations

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 the filter holder (bottom part).
   b) Make sure that the frit is in a level position.
   c) Screw the filter top to the filter bottom.



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

Figure 67: Assembling the solvent line filter

5. Slide the filter holder onto the solvent line.
6. Retighten the reservoir cap hand-tight. Verify that the retaining guide remains in the hole in the reservoir cap. If it does not, press the retaining guide into the hole to ensure that the tubing is kept in place in the cap.

7.11 Testing the Pump for Leakage

When

After maintenance on the fluidic system of the pump, for example on the flow connections, pump head, or check valves

Parts and additional items required

- Fitting plug, Viper
- Solvent suitable for your application

Follow these steps

1. Disconnect the capillary on the outlet of the inline filter (or static mixer if installed).
2. Close the outlet with the fitting plug.
3. Set the upper pressure limit to 145 MPa.
4. Apply a flow of 50 µL/min and use the solvent for the application.
5. Observe the pressure. When the pressure reading is between 60 MPa and 100 MPa, change the flow rate to a lower value.
6. Have the pump deliver until a pressure of 140 MPa has built up.
7. When the pressure is 140 MPa, apply a flow of 1 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:

   a) Check the sources listed further down in this section.

   b) Before taking remedial action, you *must* purge the pump to depressurize the system. Purge the pump for a minimum of 10 seconds.

   Possible sources for leakage:

   - Capillary connections
     Inspect the capillary connections for signs of leakage. Tighten or replace leaky connections.

- Piston seals
  - 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
  - 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 check valve. Clean the check valve in an ultrasonic bath. If cleaning is not sufficient, replace the check valve.
- Purge Unit
  Pull the waste line out of the waste outlet port (see Figure 13, page 63) and repeat the test. If liquid leaves the waste line, the purge unit is leaky. Contact Technical Support.

  After the test, push the waste line back into the waste outlet port. To avoid false leak alarms, verify that the waste line sits properly in the waste outlet port. If it does not, liquid from the purge unit may accumulate in the drain port and activate the leak sensor.

7.12 Replacing the Main Power Fuses

When

Blown fuses

Parts required

Fuses (2 fuses, 5AT, 230V 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 pump that could cause an electric shock or damage to the device.

Turn off the pump 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 pump 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.

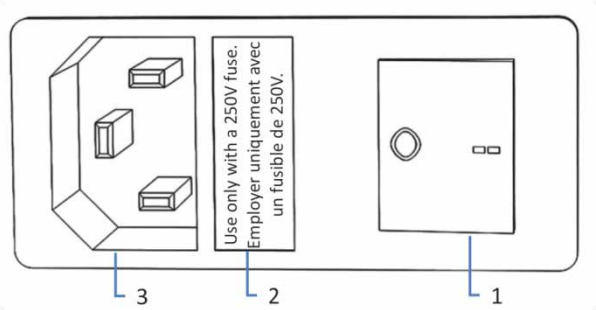


Figure 68: Fuse holder

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 pump.
5. Turn on the pump with the main power switch.

7.13 Updating the Pump Firmware

When

Updating the pump 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 Service Release as appropriate

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

Preparations

- Read the release notes provided with the firmware and/or Chromeleon Service release.
- Verify the following:
  - The pump is connected in Chromeleon.
  - All operations on the instrument (Chromeleon 7) or timebase (Chromeleon 6.8) that includes the pump have been stopped. The instrument or timebase is idle.
  - The pump flow is turned off and the system pressure is down to zero.

Follow these steps

1. Start the Chromeleon 7 Instrument Configuration Manager or the Chromeleon 6.8 Server Configuration program.
2. Perform a firmware update from the **General** tab page in the configuration dialog box for the pump. For details, refer to the *Chromeleon Help*.

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

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

The firmware update may take several minutes.

- Monitor the Audit Trail of the Chromeleon Instrument Configuration Manager (or Server Configuration program) to see whether the firmware update was successful or failed.
- If the firmware update failed, turn the device off and on again and repeat the firmware update.
- If the firmware update fails repeatedly, contact Thermo Fisher Scientific Technical Support for assistance.

3. After a successful firmware update, requalification of the pump may be required. See the release notes for a recommendation.

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 related steps in this section.

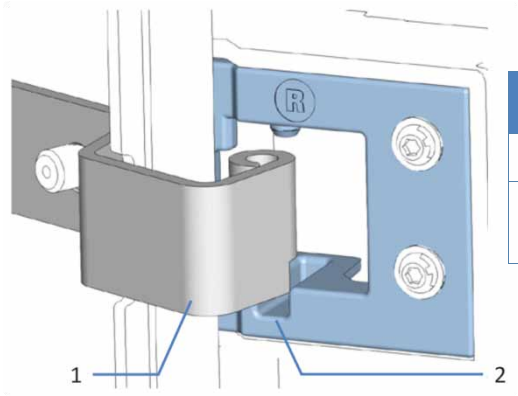
Parts required

Replacement door

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. 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.



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

Figure 69: Unhinging a door

2. Slightly tilt the door to the outside, away from the housing, and remove the door.
3. To install the door, align the door with the hinges on the housing. Be careful not to clamp tubing or capillaries between the door and the enclosure.
4. Insert the hinges in the groove, by pushing up and slightly turning the door.
5. 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 Pump

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

Observe the following safety guidelines:

CAUTION—Heavy Load, Bulky Device

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

- Physical handling of the pump, including lifting or moving, requires a team effort of two persons.
- Use the carrying handles that were shipped with the pump to move or transport the pump. Never move or lift the pump by the front doors. This will damage the doors or the pump.

Preparing the Pump for Transport

To prepare the pump for transport, follow these steps:

1. Perform a long-term shut down of the pump. See section 6.10.2 Long-Term Shutdown, page 110.
2. Turn off the pump 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. Pull the waste line out of the waste outlet port (see Figure 13, page 63).
6. Check the leak tray and drain port. If liquid is present, absorb the liquid with a tissue.

7. Install the carrying handles and remove the pump from the Vanquish system. Follow the instructions on dismounting the system stack in the *Transporting or Shipping the System* section of the *Vanquish System Operating Manual*.

TIP To remove the slide-in module from the pump, follow the related steps in section 7.16 Replacing the Slide-In Module, page 181.

Transporting the Pump to a New Location

To transport the pump to a new location, follow these steps:

1. Observe the notes for handling and lifting the pump safely.
2. Transport the pump to the new location.
3. Install and set up the pump in the system stack. Follow the instructions on mounting the system stack in the *Vanquish System Operating Manual*.
4. Set up the pump:
   a) To connect the pump and to set up flow connections, follow the instructions in the *Installation chapter* in this operating manual.
   b) To prepare the pump for first-time operation, follow the instructions in the *Preparing the Pump for Operation section* in this operating manual.
5. Before starting an analysis, let the pump equilibrate and be sure that it is ready for operation.

Shipping the Pump

To ship the pump, 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 pump to Thermo Fisher Scientific for depot repair, contact your local Thermo Fisher Scientific support organization for the appropriate procedure.

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 Decontamination Certificate, which is part of the Service Return Form. Sign the certificate to confirm that the device has been properly decontaminated and that it is free of hazardous substances.
- Thermo Fisher Scientific refuses to accept devices for repair if the Decontamination Certificate is missing.

Restarting the Pump after Shipping

To restart the pump after shipping, follow these steps:

1. Follow the unpacking instruction in this operating manual.
2. Install and set up the pump in the system stack. Follow the instructions on mounting the system stack in the *Vanquish System Operating Manual*.
3. Set up the pump:
   a) To connect the pump and to set up flow connections, follow the instructions in the *Installation chapter* in this operating manual.
   b) To prepare the pump for first-time operation, follow the instructions in the *Preparing the Pump for Operation section* in this operating manual.
4. Before starting an analysis, let the pump equilibrate and be sure that it is ready for operation.

7.16 Replacing the Slide-In Module

CAUTION—Heavy Load, Bulky Device

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

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

7.16.1 Removing the Slide-In Module

Tools required

Screwdriver, Torx T20

Preparations

Prepare the pump for transport. See the *Transporting or Shipping the Pump section* in this operating manual.

Follow these steps

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

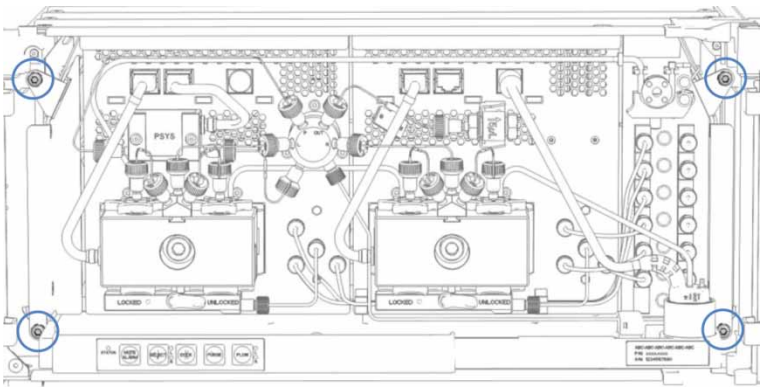


Figure 70: Captive screws on the slide-in module

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.

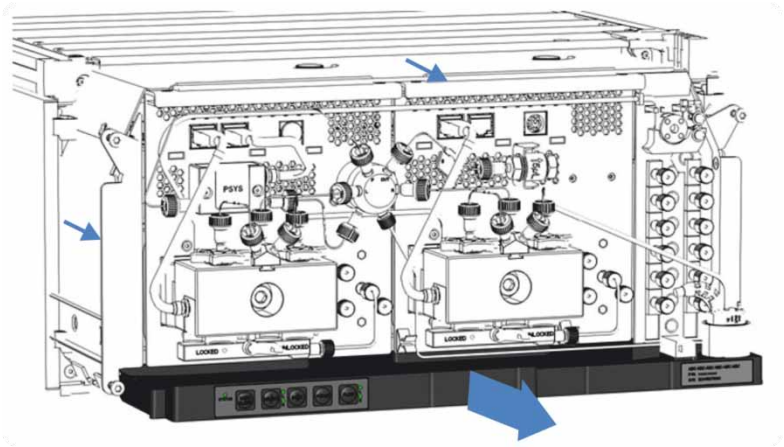


Figure 71: Pulling out the slide-in module

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.

5. Return the slide-in module:
   a) To request a dedicated packaging for the slide-in module and for the appropriate procedure for returning the module, contact your local Thermo Fisher Scientific support organization.
   b) Pack the slide-in module in the dedicated packaging.

NOTICE The packaging for the slide-in module differs from the packaging for the complete module. Shipping the slide-in module or the pump incorrectly leads to damage on the device. Always pack and ship the slide-in module and the pump in the respective, dedicated packaging.

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 Decontamination Certificate, which is part of the Service Return Form. Sign the certificate to confirm that the device has been properly decontaminated and that it is free of hazardous substances.
- Thermo Fisher Scientific refuses to accept devices for repair if the Decontamination Certificate is missing.

7.16.2 Installing the Slide-In Module

Parts required

Replacement slide-in module

Tools required

Screwdriver, Torx T20

Preparations

1. Verify that the pump enclosure into which the slide-in module is installed is clean. If required, clean the inner and outer surfaces of the enclosure. See the *Cleaning the Pump section* in this operating manual.
2. 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. Unpack the slide-in module. Remove any foam spacers from the 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 insert the slide-in module properly into the enclosure in the next step.
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.

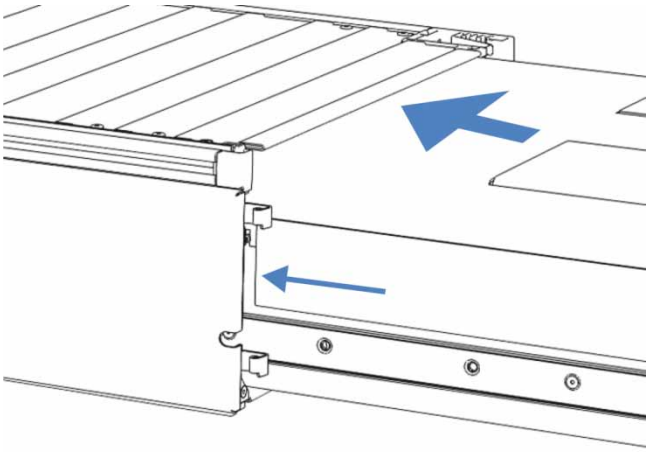


Figure 72: Inserting the slide-in module

4. 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.

5. Set up the slide-in module:

   a) To connect the slide-in module and to set up flow connections, follow the instructions in the *Installation chapter* in this operating manual.

   b) To prepare the slide-in module for first-time operation, follow the instructions in the *Preparing the Pump for Operation section* in this operating manual.

6. Prepare *all other* modules of the Vanquish system for operation and restart them. Refer to the *Operating Manuals* for the modules.

7. Before starting an analysis, let the chromatography system equilibrate and be sure that it is ready for operation.

8. Perform performance qualification for the pump:

   a) From Chromeleon, run the pump-specific **Performance Qualification** (PQ) tests (= Flow Precision Test and Gradient Accuracy Test). For details, refer to the *Operational and Performance Qualifications manual*.

   b) In Chromeleon, execute the **QualificationDone** command.

8 Troubleshooting

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

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 pump.

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 pump and the **STATUS** LED on the keypad inside provide quick visual feedback on the operational status of the device. If the pump firmware detects a problem, the status indicators are red. The problem is reported to the Chromeleon software and a message appears in the Audit Trail. For possible causes and recommended remedial actions, see section 8.2 Messages, page 190.

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 Chromeleon Audit Trail and the status indicators changing to red. Follow the instructions in this manual to find and eliminate the source for the leakage.

Chromeleon Audit Trail Messages

If the device firmware detects a problem, the problem is reported to the Chromeleon software.

The Chromeleon software logs information about all events related to instrument operation for the current day in an Audit Trail. The Audit Trail is named with the current date, using the format yyyymmdd. For example, the Audit Trail for May 15, 2013, is named 20130515.

- *Chromeleon 7*: 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.
- *Chromeleon 6.8*: The Daily Audit Trails can be found on the panel tabset (Sequence Control panel). In addition, Daily Audit Trails are available in the Browser, in the folder of the timebase.

Messages in the Chromeleon Audit Trail are preceded by an icon. The icon identifies the seriousness of the problem. The table shows the icons and explains the severity level.

Icon	Severity	Description
	Warning	• The queue (Chromeleon 7) or batch (Chromeleon 6.8) can be started. • The current run is not interrupted. Nevertheless, Thermo Fisher Scientific recommends taking appropriate remedial action to resolve the problem.
	Error	The software attempts to correct the problem. An error does not interrupt the current analysis. However, if the error occurs during the Ready Check, the analysis will not be started.
 or 	Abort	• The queue (Chromeleon 7) or batch (Chromeleon 6.8) cannot be started. • A running queue or batch is stopped immediately.

For possible causes and recommended remedial actions, see section 8.2 Messages, page 190.

8.2 Messages

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

Name	Description
PumpModule	With messages relating to the entire pump, for example, to the leak detection, main board or with a communication error
Pump	With messages relating to the entire flow unit, for example, to the system pressure
Pump_Wellness_LeftBlock **Pump_Wellness_RightBlock**	With messages relating to the *left* or *right* pump block or components in the *left* or *right* pump head, respectively, for example, the pistons or check valves Whenever possible, the source of the problem is narrowed down further by the following text:
Drive1	Indicates that components on the *left* side in the pump block/head cause the problem
Drive2	Indicates that components on the *right* side in the pump block/head cause the problem
Example	*Pump_Wellness_LeftBlock (Drive 2)* in front of a message indicates that the message refers to the components on the *right* side in the *left* pump block/head.

The table lists the most frequently observed messages for the pump 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. Two messages ("Unexpected module behavior" and "Module malfunction detected") can have different codes and therefore, appear at the beginning of the table.

If you are unable to resolve the problem following the instructions, contact Thermo Fisher Scientific Technical Support for assistance.

TIP If a message appears in the Audit Trail that is not listed in the table, write down the code and wording of the message. If you are unable to resolve the problem, contact Thermo Fisher Scientific Technical Support for assistance.

Message and Code	Possible Cause and Remedial Action
Unexpected module behavior. Code XX	XX can be a two-digit or four-digit code number. When the message appears, write down the message code and turn off the module. Wait for 5 seconds and turn on the module again. If the message appears again, contact Technical Support. **TIP** If the message appears with *codes 74* or *91*, the firmware may be defective. Update the firmware, see section 7.13, page 174. If the message appears again, contact Technical Support.
Module malfunction detected. Code XX	XX can be a two-digit or four-digit code number. When the message appears, write down the message code. Turn off the module and contact Technical Support.
Code 33 Leak detected – eliminate within approx. 180 seconds.	Find and eliminate the source for the leakage (see section 8.3, page 197). 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 section 8.3, page 197).
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 89 Liquid leak sensor missing or defective	Contact Thermo Fisher Scientific Technical Support for assistance. To operate the pump nevertheless, you can disable the leak sensor functionality in Chromeleon by setting **Leak Sensor Mode** to **Disabled**.
Code 90 Download firmware mismatch – invalid version	You tried to download a firmware with an earlier version number than the firmware that is currently installed in the pump. Downgrading the firmware may result in loss of functionality or malfunctioning of the pump. If required, repeat the download with a firmware version later than the version currently installed in the pump.

Message and Code	Possible Cause and Remedial Action
Code 4098 Upper pressure limit exceeded.	Check the flow path for blockage. *If the flow path is blocked:* • 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. *If the flow path is not blocked:* Depending on the pump configuration, test the inline filter or static mixer for permeability (depending on which component is installed, see section 7.8.1, page 159 or section 7.9.1, page 162).
Code 4099 Pressure fallen below lower limit.	Check the following causes: • One or more solvent reservoirs are empty. Fill the reservoirs and purge the pump (see section 6.8, page 96). If you are monitoring the solvent consumption from Chromeleon, 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 (see section 6.8, page 96). • Leakage may be present in the system. Resolve the leakage. For the pump, see section 8.3, page 197. For the other system modules, refer to the *Operating Manuals* for the modules. • A check valve may be contaminated or defective. Clean or replace the check valves as appropriate (see section 7.7, page 155). • 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.
Code 4100 Purge pressure limit exceeded.	A pressure of more than 5 MPa built up after a purge cycle has started. Perform the following sequence of steps: 1. On the purge unit, remove the capillary from the system pressure sensor. 2. To absorb liquid leaving the capillary, place a tissue under the purge unit and capillary. 3. Mute the alarm by pressing the **Mute Alarm** button on the pump keypad. 4. Start a purge cycle. *If the message does not appear again:* The purge unit is defective. Contact Technical Support. *If the message appears again:* 1. The capillaries that connect the system pressure sensor to the purge unit are blocked. Replace the capillaries. 2. If the message appears again afterward, run a self-test. 3. If the message persists, contact Technical Support.
Code 4101 Not ready. Please run self-test.	The pump is not ready because the self-test was not successful. Repeat the self-test.

Message and Code	Possible Cause and Remedial Action
Code 4112 Self-test failed because of fluctuating pressure.	Changes in pressure have occurred during the self-test. Wait until the system pressure is down or depressurize the system and repeat the self-test.
Code 4113 Self-test failed because pressure is out of range.	The pressure has not been down to zero during the self-test. Verify that the pressure sensor cables are properly connected. Wait until the system pressure is down or depressurize the system and repeat the self-test. If the message appears again, the system pressure sensor may be defective. Contact Technical Support.
Code 4114 The device is busy. Please retry after 1 minute.	The pump is not ready because, for example, a self-test or recalibration procedure is running. Retry after 1 minute. If the message appears again, wait until the system pressure is down or depressurize the system and turn the pump off and on again.
Code 4119 Can't start pump while alarm is on.	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.
Code 4120 The rear seal wash system has run out of wash solution.	This message alerts you only when the drop counter functionality of the seal wash detector is enabled (standard setting). • 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 section 7.5.2, page 126). • Inspect the peristaltic tubing for indications of blockage or damage. Replace the tubing as necessary (see section 7.5.2, page 126). • 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 section 7.5.3, page 129). • Start an additional seal wash cycle in Chromeleon (see section 6.7, page 91). 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 seal (see section 7.6.7, page 146).
Code 4121 Piston seal leakage has exceeded the recommended limit.	This message alerts you only when the drop counter functionality of the seal wash detector is enabled (standard setting). Test the pump for piston seal leakage and take the recommend action (see section 7.6.9, page 153).
Code 4122 The rear seal leak sensor detects drops constantly.	This message alerts you only when the drop counter functionality of the seal wash detector is enabled (standard setting). Inspect the electrodes of the seal wash detector for contamination or damage. Replace the seal wash detector as necessary (see section 7.5.3, page 129).

Message and Code	Possible Cause and Remedial Action
Code 4125 Degasser malfunction	The vacuum level monitoring function detected insufficient degasser vacuum. Turn the pump off and on again. Check the degasser vacuum in Chromeleon. 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.
Code 4127 The pump drive is still in undock position. Please execute a dock command.	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 a **Dock** command.
Code 4148 Can't perform this command while the flow is on.	You tried to run a self-test while the flow rate was not yet down to zero. Apply a flow of 0 and repeat the command.
Code 4152 Pressure sensor malfunction. Check cable connection and retry.	Verify that the cable of the pressure sensor for which the message appears is properly plugged into the connection port. Restart the flow. If the message appears again, the pressure sensor may be defective: • If the message appears for the pressure sensor of a pump head, replace the pump head. • If the message appears for the system pressure sensor, contact Technical Support.
Code 4156 Compression limit reached.	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" appears. For more information about the compression values, see section 8.4, page 198.
Code 4158 Out of eluent X.	This message alerts you only if you are monitoring the solvent consumption from Chromeleon (see section 6.8, page 96). 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 (see section 6.8, page 96). Empty the waste container when needed.
Code 4161 Pressure recalibration deviates by xx bar	The pump pressure has not been 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.

Message and Code	Possible Cause and Remedial Action
Code 4176 The 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 message appears again, follow these steps: 1. Purge the pump. 2. Perform pressure recalibration (see section 8.5, page 200). 3. Start the pump flow. If the message persists, the system pressure sensor may be defective. Contact Technical Support.
Code 4182 Unexpected piston docking or linear encoder error	The message appears if the pistons are not correctly docked for pump operation. Follow these steps: 1. With the SELECT button on the keypad, select both pump heads. 2. Undock the pistons by pressing the DOCK button. 3. Wait until undocking is complete (LEDs next to the FLOW button are flashing green). 4. Dock the pistons by pressing the DOCK button again. 5. If the message appears again, contact Technical Support.
Code 4208 System pressure too high. Please relief pressure and retry.	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 message persists, the system pressure sensor may be defective. Contact Technical Support.
Code 4209 Could not build up enough pressure. Please check the fitting plug.	The pump could not build up enough pressure during pressure sensor calibration. This may be caused by the following: • Insufficient purging: Purge the pump. • Leakage at the pump outlet: Check that the plug at the pump outlet is properly seated. • Pump leakage: Test the pump for leakage (see section 7.11, page 170).
Code 4211 Invalid calibration. Please perform pressure recalibration.	This message may appear while pressure recalibration is running, indicating that the recalibration procedure cannot be performed correctly. Check the pressure reading. If the pressure does not reach 140 MPa, follow these steps: 1. Purge the pump. 2. Perform pressure recalibration (see section 8.5, page 200). If the message appears again, inspect the pump for indications of leakage and replace leaky components as necessary.

Message and Code	Possible Cause and Remedial Action
Code 4212 Nonlinear pressure sensor. Please perform pressure recalibration.	Start the pressure recalibration procedure (see section 8.5, page 200).
Code 4213 Head pressure does not match system pressure signal. Execute self-test or perform pressure recalibration.	First, run the self-test. If the message appears again, perform pressure recalibration (see section 8.5, page 200).
Code 4220 Pump head not recognized. Please plug in the sensor cable.	If the pump head cable is not yet connected to the **P-Work** connector, connect the cable. If the cable is connected, verify that it is properly seated. If the problem persists, the pump head may be defective. Replace the pump head (see section 7.6.2, page 133).
Code 4230 Wrong value entered. Please verify your input with the piston calibration data.	The piston calibration value you entered is incorrect. Be sure that your input corresponds to the 3-digit calibration value that is imprinted on the rear of the piston. Check your input for typing errors.
Code 4231 Pressure sensor not recognized. Please plug in the sensor cable.	Verify that the cable of the pressure sensor for which the message appears is properly plugged into the connection port. Restart the flow. If the message appears again, the pressure sensor may be defective: • If the message appears for the pressure sensor of a pump head, replace the pump head (see section 7.6.2, page 133). • If the message appears for the system pressure sensor, the system pressure sensor may be defective. Contact Technical Service.
Code 4232 The XX pump head has been exchanged.	XX is the left pump head or right pump head The message appears when a pump head has been replaced or when the left and right pump heads have been interchanged, for example, accidentally during maintenance/service. The message is for informational purposes only. No action is required.
Code 4233 The data of the XX is invalid. Did you plug it into the correct socket?	XX is the left pump head or right pump head or the system pressure sensor You may have connected the cable of the device indicated in the message to the wrong socket, for example, the cable of the system pressure sensor has been connected to the socket for the pump head cable. Verify that the cable is connected to the correct socket and that the cable is properly seated.
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 Audit Trail for messages from other modules and eliminate the source for the problem as appropriate.

8.3 Resolving Leakage

When

The leak sensor is wet. The leak sensor reports leakage.

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

Preparations

When resolving leakage, observe the safety guidelines and general rules for maintenance and service as presented in chapter 7 Maintenance and Service, page 113.

As leakage usually occurs at a connection, inspect all components and connections in the flow path.

Parts required

Replacement part as required

Additional items required

Cloth or tissue

Follow these steps

1. Locate the source of the leak.
   The following tests can help you to identify the source:
   - Test the seal wash system for leakage (see section 7.5.1, page 125).
   - Test the pump for piston seal leakage (see section 7.6.9, page 153).
   - Test the entire pump for leakage (see section 7.11, page 170).
2. Tighten or replace the connection or component as required.
3. 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.
4. Allow the sensor to adjust to the ambient temperature for a few minutes.
5. If leakage is no longer reported, you can resume operation.

8.4 Checking the Compression Values

The compression values of the pump head can provide valuable information for troubleshooting.

When

You observe pressure pulsation or shifts in retention time.

Follow these steps

1. In Chromeleon, check the **Compression** values for the pump head (compression on the left side in the pump head = **CompressionDrv1**, on the right side = **CompressionDrv2**).
   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) with the pump being purged and the pressure being stable for some time. The values are linear to the pressure.

	Compression in % with		
Pressure (MPa)	**Water**	**Methanol**	**Acetonitrile**
250	11% ± 7%	22% ± 7%	22%± 7%
500	21%± 7%	41%± 7%	38%± 7%
750	30%± 7%	57%± 7%	53%± 7%
1000	39%± 7%	71%± 7%	66%± 7%
1250	47%± 7%	82%± 7%	76%± 7%
1500	55%± 7%	90%± 7%	85%± 7%

2. Take remedial action if required.

   - *Compression value lower than indicated in the table*
     Replace the outlet check valve.
   - *Compression value higher than indicated in the table*

- The piston seal may be defective. Replace the piston seal.
- The inlet check valve may be defective. Replace the inlet check valve.

- *Very high compression (message "Compression limit reached" and low pressure)*
  - Air bubbles may be present in the pump. Make sure that no air bubbles are present in the solvent lines and then, purge the pump.
  - 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 inlet check valve.

8.5 Performing Pressure Recalibration

When

Messages regarding the pump head pressure or nonlinear pressure sensor appear in chromatography software, for example:

- Code 4212 Nonlinear pressure sensor. Please perform pressure recalibration.
- Code 4213 Head pressure does not match system pressure signal. Execute self-test or perform pressure recalibration.

Follow these steps

1. *Before* you perform pressure recalibration, check the message in the *Messages* section in this manual.
   Before pressure recalibration should be performed, message-specific remedial actions might be required. Perform these actions as applicable and proceed with the next step.
2. On the purge unit, remove the capillary from the **OUT** port.
3. Close the port and the open end of the capillary with an appropriate plug or cap.
4. In Chromeleon, on the **Service** sub-panel for the pump, click **Calibrate** to start the pressure recalibration procedure.

8.6 Testing the Inline Filter/Static Mixer for Permeability

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

- *The pump has an inline filter installed*
  Test the inline filter by following the steps in section 7.8.1, page 159.
- *The pump has the mixing system installed*
  Test the static mixer by following the steps in section 7.9.1, page 162.

9 Specifications

This chapter provides the physical and performance specifications, including information about the materials used in the flow path of the pump.

9.1 Performance Specifications

The pump performance is specified as follows:

Type		Specification*
Operating principle		Parallel dual-piston pump with independent piston drives and variable stroke volume
Compressibility compensation		Fully automated, independent of the composition of the mobile phase
Flow range (settable)		0.001 – 5 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		5 – 151 MPa (50 – 1517 bar, 700 – 22002 psi)
Pulsation		< 0.4% or < 0.2 MPa, whichever is greater
Gradient formation		High-pressure gradient proportioning
Proportioning		
	Accuracy	± 0.2% (of full-scale), for 0.2 to 4.0 mL/min from 1% to 99%
	Precision	< 0.15%SD, for 0.2 to 4.0 mL/min from 1% to 99%
Number of solvents		2 from 6
Maximum stroke volume		120 µL
Mixer volume		Default configuration: 25 µL capillary mixer (proprietary)
Dwell volume		35 µL
Solvent degassing		Internal 6-channel degasser
Biocompatible		Yes
Communication		
	USB	1 USB port (USB 2.0, "B" type connector) 1 USB hub with 3 ports (USB 2.0, "A" type connectors)
	I/O Interface	2 digital I/O ports (mini-DIN), each providing one input, one relay output, and one bidirectional input/output
	System Interlink	2 system interlink ports (RJ45-8 connectors)
Control		Chromeleon 7, Chromeleon 6.8 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

Type	Specification*
Materials in the flow path	MP35N, DLC (diamond like carbon), titanium, zirconium oxide, sapphire, aluminum oxide, PEEK, PTFE, ECTFE, FEP, UHMW polyethylene, perfluoro-elastomer, amorphous fluoropolymer (AF) **NOTICE** For information about the chemical resistance of materials, refer to the technical literature.
Solvent and additive information	See section 2.4, page 28
Safety features	Leak detection and safe leak handling, excess pressure monitoring
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: 1 mL/min at 60 MPa	

9.2 Physical Specifications

The physical conditions of the pump are specified as follows:

Type	Specification
Range of use	Indoor use only
Ambient temperature	5 °C – 35 °C
Ambient humidity	20% - 80% relative humidity (non-condensing)
Pollution degree	2
Power requirements	100 – 240 VAC; 50 /60 Hz, max. 525 W / 550 VA
Overvoltage category	II
Emission sound pressure level	<70 dB(A), typically <48 dB(A)
Dimensions (height x width x depth)	19.2 cm x 42 cm x 62 cm
Weight	32 kg

10 Accessories, Consumables and Replacement Parts

This chapter describes the standard accessories that are shipped with the pump and the accessories that are available as an option. This chapter also provides information for reordering consumables and replacement parts.

10.1 General Information

The pump 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.

10.2 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. See the content list included in the kit for the most recent information about the kit content at the time when the pump is shipped.

Ship kit

Item	Quantity in shipment
Silicone tubing	3 m
Tubing connector, straight, for tubing IDs 1.0 – 2.0 mm (pack of 5)	1
Tubing connector, ID 1/16"	5
Solvent line filter, filter holder (no filter frit included)	7
Solvent line filter, filter frit, biocompatible, 10 µm	12
Plugs and retaining guides for reservoir caps, kit including • 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 • Screwdriver, Torx TX25 • Hexagon wrench, size 6 • Seal-handling tool • Spacing tool, pump heads 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
USB cable, type A to type B, high-speed, USB 2.0, cable length: 5 m	1

For reordering information, see section 10.4 Consumables and Replacement Parts, page 211.

10.3 Optional Accessories

Item	Remarks	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
Mixing systems	• For highest sensitivity when mixing ripples interfere with the detection • For TFA applications **NOTE**: The mixer kit includes the mixing system and required installation material. Each mixing system comprises a static mixer and a capillary mixer. The volumes of both mixers determine the entire volume of the mixing system.	
Mixer kit, 200 µL	The kit includes the mixing system, volume: 200 µL, comprising: • Static mixer, volume: 150 µL • Capillary mixer, volume: 50 µL	6268.5120
Mixer kit, 400 µL	The kit includes the mixing system, volume: 400 µL, comprising: • Static mixer, volume: 350 µL • Capillary mixer, volume: 50 µL	6268.5310

10.4 Consumables and Replacement Parts

Pump head and components

Description	Part No.
Pump head (complete assembly), including spacing tool	6044.1200
Piston seal (RP) and seal wash seal (pack of 2 each)	6266.0309
Support ring	6040.0012
Piston, sapphire	6267.0050
Inlet assembly	6044.2330
Inlet check valve	6044.2300
Outlet check valve	6044.2310
Pump head seals (3 PTFE seals, different sized)	6044.1210
Screws for seal wash plate (pack of 8)	6000.0036
Capillary kit, pump head, including: • U-tubes, for right and left pump head • Capillary from pump head to purge unit—bend the capillary as required by the installation position (left or right pump head)	6044.1931
Seal-handling tool	6040.7158

Inline filter

Description	Part No.
Inline filter set, including: • Inline filter (static filter, volume: 10 µL) • Capillary mixer (volume: 25 µL) to connect the purge unit to the static inline filter • 2 fitting plugs	6044.5018

Solvent lines, solvent line filters, waste tubing

Description	Part No.
Solvent lines to connect the degasser inlet ports to the solvent reservoirs	6036.1701
Tubing kit, including: • Solvent lines from degasser to solvent selector • Solvent line from solvent selector to pump head • Waste tubing from purge unit to drain port	6044.2050
Solvent line filter, filter holder (pack of 6) (no filter frits included)	6268.0115
Solvent line filter, filter frit, biocompatible, 10 µm (pack of 10)	6268.0111

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
Plugs and retaining guides for reservoir caps, kit including • 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
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

Seal wash system

Description	Part No.
Seal wash detector (drop detector) and funnel	6044.1898
Peristaltic and wash tubing kit The kit includes peristaltic tubing (PharMed), silicone tubing, and tubing connectors for use in • Seal wash system in the pump and the autosampler • Needle wash system in the autosampler • Drain pump in the autosampler **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.	6044.1150
Piston seal (RP) and seal wash seal (pack of 2 each)	6266.0309

Maintenance kit

Description	Part No.
Maintenance kit, including: • Pump head seal (3 PTFE seals, different sized) • Silicone tubing (clear tubing) • Peristaltic tubing (white tubing) • Tubing connector (straight) • Tubing connector (90°-angled) • Tubing connector (ID 1/16") (pack of 4) • Seal wash seal (pack of 4) • Piston seal (pack of 4) • Solvent line filter (5 filter holders and 6 frits, biocompatible, 10 µm) • Cleaning swab (pack of 25) • Seal wash plate, screws (pack of 8) • Tubing clip (self-adhesive) (pack of 2)	6044.1956

Miscellaneous cables, capillaries and tubing

Description	Part No.
Cable, mini-DIN, 6-pin, cable length: 5 m	6000.1004
USB cables, type A to type B, high-speed, USB 2.0 • Cable length: 1 m • Cable length: 5 m	 6035.9035 6911.0002
Capillary kit, system pressure sensor (P-Sys) The kit includes the capillaries from system pressure sensor to purge unit (short capillary) and from purge unit to system pressure sensor (long capillary).	6044.1933
System interlink cable	6036.0004
For system capillaries and tubing, see the *Vanquish System Operating Manual.*	

Miscellaneous

Description	Part No.
Fuses kit, Vanquish system The kit includes the appropriate fuses for the Vanquish system modules. For the pump, use only the 5AT, 230V AC, slow-blow fuses.	6036.0002
Front door kit, including right door and left door	6044.1920
Slide-in pump module	6044.1430
Fitting plug, Viper, biocompatible	6040.2303
Diagnostics tool kit The kit includes a fitting plug (Viper, biocompatible) and backpressure capillary.	6044.0100
Cleaning swabs (pack of 10)	6040.0006

Power cords

Description	Part No.
Power cord, Australia, China	6000.1060
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

Description	Part No.
Power cord, UK	6000.1020
Power cord, USA	6000.1001
Power cord, Switzerland	6000.1030

11 Appendix

This chapter provides additional information about compliance and the use of the digital I/O ports.

11.1 Compliance Information

11.1.1 Declarations of Conformity

CE Declaration of Conformity

The device has satisfied the requirements for the CE mark and is compliant with the applicable requirements.

cTUVus Compliance

The cTUVus label on the device indicates that the device has satisfied the requirements for the cTUVus mark. Compliance with the applicable standards has been evaluated by TÜV Rheinland of North America Inc.

11.1.2 WEEE Compliance

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

Figure 73: 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.

11.1.3 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.

11.2 Digital I/O

The digital I/O ports (Dig I/O) on the pump can be used to exchange digital signals with external devices. Each port provides one digital input, one relay output, and one bidirectional input/output.

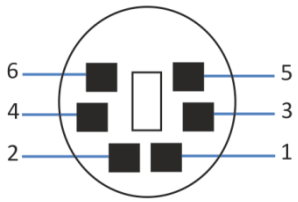


Figure 74: Digital I/O port

Pin	Description
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 pump 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)

To use the digital I/O functionality, the following prerequisites must be fulfilled:

- The digital I/O port must be connected to the external device with the appropriate mini-DIN cable (part no. 6036.0006).

  1. Plug the 6-pin connector of the cable into the digital I/O port that you want to use.
     The 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: • 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
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: • 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

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.

- The inputs and outputs that you want to use must be selected in dialog box for the pump in the Chromeleon 7 Instrument Configuration Manager (Chromeleon 6.8 Server Configuration program).
  In the dialog box, on the **Inputs** and **Outputs** pages, select the inputs (**Pump_Input_X**) and outputs (**Pump_Relay_X**) that you want to use. Note the following:
  - The numbering in the dialog box corresponds to the port numbers on the pump.
  - 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.

12 Index

A

B

C

D

E

F

G

I

K

L

M

O

P

Q

R

S

T

U

V

W

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