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Vanquish

Diode Array Detectors

VH-D10

Operating Manual

4820.8301-EN Revision 3.0 • January 2023

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ThermoFisher SCIENTIFIC

Original Operating Manual

The hardware descriptions in this manual revision refer to devices: VH-D10-A.

Trademarks

Disclaimer

Printed manual version only

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

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

Note the following:

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

The detector is referred to as module, device, detector or diode array detector in this manual. If other detector types are referenced, they are identified by name.

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

1.2 Conventions

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

1.2.1 Conventions for Safety Messages

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

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

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

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

1.2.2 Special Notices

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

NOTICE

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

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

1.2.3 Typographical Conventions

These typographical conventions apply to the descriptions in this manual:

Data Input and Output

The following appears in **bold** type:

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

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

References and Messages

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

Viewpoint

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

Particularly Important Words

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

Electronic Manual Version (PDF)

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

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

1.3 Reference Documentation

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

Hardware Documentation

Additional hardware documentation includes the following:

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

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

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

Software Documentation

Additional software documentation includes the following:

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

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

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

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

Third-Party Documentation

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

2 Safety

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

2.1 Safety Symbols and Signal Words

2.1.1 Safety Symbols and Signal Words in this Manual

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

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

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

CAUTION

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

WARNING

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

2.1.2 Observing this Manual

Observe the following:

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

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

2.1.3 Safety Symbols on the Device

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

Symbol	Description
	Indicates a potential hazard. Refer to this manual to avoid the risk of personal injury and/or to prevent damage to the device.
— O	Power supply is on Power supply is off
	Indicates alternating current.
	Indicates that the surface becomes hot during operation. Do not touch these surfaces while they are heated up.
	Indicates that the UV radiation produced by the deuterium lamp in the device may be harmful to eyes and skin. Do not look directly into the light produced by the deuterium lamp. Never operate the lamp outside the device.

2.1.4 Rating Plate

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

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

2.2 Intended Use

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

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

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

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

They are not intended for use in diagnostic procedures.

Laboratory Practice

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

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

2.3 Safety Precautions

2.3.1 General Safety Information

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

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

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

Safety Standard

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

2.3.2 Qualification of the Personnel

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

Installation

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

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

General Operation

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

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

2.3.3 Personal Protective Equipment

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

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

Protective Clothing

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

Protective Eyewear

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

Gloves

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

2.3.4 Electrical Safety Precautions

WARNING—Electric Shock or Damage to the Device

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

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

2.3.5 General Residual Hazards

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

WARNING—Hazardous Substances

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

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

WARNING—Biohazard

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

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

WARNING—Self-Ignition of Solvents

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

Avoid the use of these solvents.

WARNING—Hazardous Vapors

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

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

CAUTION—Escape of Hazardous Substances from PEEK Capillaries

Some capillaries in the system are made of PEEK. Swelling or attack by acids can cause PEEK capillaries to start leaking or to burst. Certain chemicals, for example, trichlormethane ($CHCl_3$), dimethyl sulfoxide (DMSO), or tetrahydrofuran (THF) can cause PEEK to swell. Concentrated acids, such as sulfuric acid and nitric acid, or a mixture of hexane, ethyl acetate, and methanol, can attack PEEK.

- Swelling or attack is not a problem with brief flushing procedures.
- For more information, refer to the technical literature on the chemical resistance of PEEK.

CAUTION—Allergic Reaction

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

CAUTION—Sparking due to Electrostatic Discharge

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

Prevent the generation of static electricity near the chromatography system.

2.3.6 In Case of Emergency

WARNING—Safety Hazard

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

2.4 Solvent and Additive Information

2.4.1 General Compatibility

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

- The system must be used with reversed-phase (RP) compatible solvents and additives only.
- Use only solvents and additives that are compatible with all parts in the flow path.

Piston Seal Compatibility

- 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.

2.4.2 Allowed pH Ranges

Allowed pH ranges (standard system configuration):

System (Standard Configuration)	Allowed pH ranges	Remarks
Vanquish Core	1-13	• *pH value of 2 (Vanquish Horizon/Flex)*: Short-term use only. The application time should be as short as possible. Flush the system thoroughly after these applications. • *pH value of 1-2 (Vanquish Core)*: The application time should be as short as possible. Flush the system thoroughly after these applications. • *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.
Vanquish Horizon Vanquish Flex	2-12	

2.4.3 Allowed Concentrations

Allowed concentrations (standard system configuration):

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

2.4.4 Further Information

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

NOTICE

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

2.5 Compliance Information

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

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

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

See also

Compliance Information (▶ page 184)

3 Device Overview

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

3.1 Detector Features

The device comprises the following main features:

- A deuterium lamp for ultraviolet (UV) and visible (VIS) wavelength detection as the light source of the device
  The deuterium lamp provides light for the complete wavelength detection range from 190 nm to 680 nm.
- Fused-silica LightPipe™ flow cells for minimum noise and peak broadening
- Internal validation of the wavelength accuracy with holmium oxide glass filter
- Variable slit width, settable to 1, 2, 4 or 8 nm, to optimize baseline noise and optical resolution
- For data collection, the device supports the following features:
  - Data collection rate up to 200 Hz
  - Acquiring 3D data fields (spectra) to record all wavelengths simultaneously

    Among other things, 3D spectra make peak purity analysis and spectral library search for peak identification possible.
  - Recording of up to 10 signal channels at individual wavelengths (2D data)
- Identification (ID) chip on the deuterium lamp and the flow cell
- Thermal control using heaters for the optics and a cooling fan for the lamp house
- Motorized filter paddle (shutter) to move into the light path before the flow cell
  The filter paddle can move into the following positions:
  - Open position for data acquisition
  - Closed (dark) position for protection of the flow cell
  - Holmium oxide filter position for validation of wavelength accuracy

3.2 Operating Principle

The device is designed for ultraviolet (UV) and visible (VIS) absorption spectroscopy in combination with HPLC or UHPLC separations. After sufficient separation from other sample compounds, the analysis of the target compound follows the Beer-Lambert law. This means that the response of the device is proportional to the concentration of the analyte.

The following picture shows the optics of the device, and illustrates how the device operates:

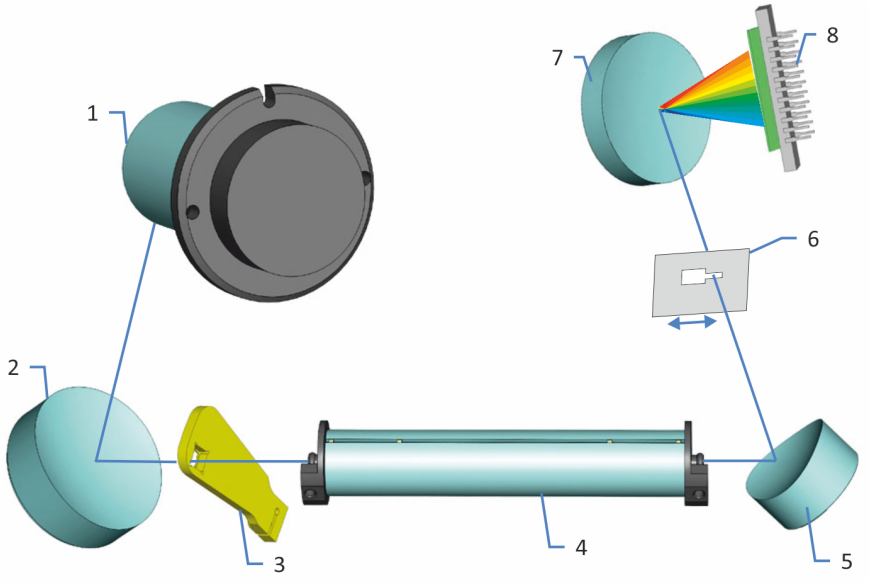

Figure 1: Operating principle of the optics

No.	Description
1	Deuterium lamp
2	Lamp mirror
3	Filter paddle (shutter)
4	Flow cell
5	Spectrograph mirror
6	Entrance slit
7	Grating
8	Diode array

A deuterium lamp (1) as light source emits light in the UV and VIS spectral range. The lamp mirror (2) focuses the light to the entrance of the flow cell (4). The shutter (motorized filter paddle, 3) can be opened in the light path before the flow cell.

The light passes through the sample flow path in the light pipe of the flow cell. After exiting the flow cell through the exit fiber, the light hits the spectrograph mirror.

The spectrograph mirror (5) focuses the light to the adjustable entrance slit (6) of the spectrograph. The light portion passing through the entrance slit hits the grating (7) and is forwarded to the photodiode array (8). The measured signals of all photodiodes are digitally processed, and a time-resolved absorption spectrum for the sample is calculated.

3.3 Interior Components

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

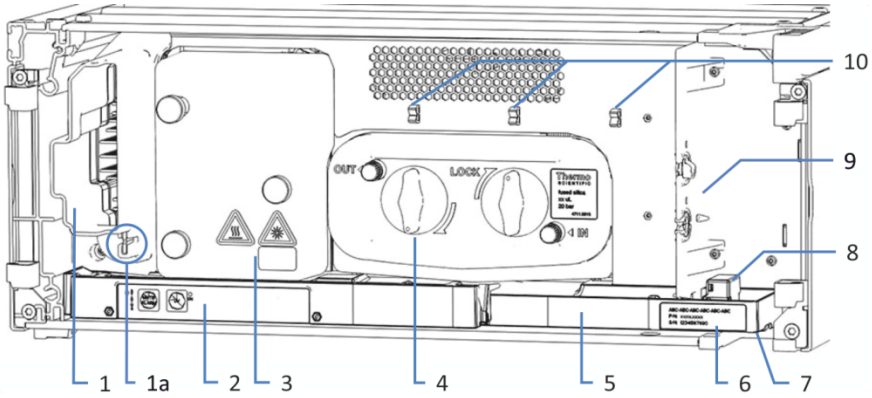

Figure 2: Interior view (here with flow cell installed)

No.	Description
1	Cooling air intake
1a	Capillary guide slit below the cooling air intake To hold the capillary if the column compartment is located to the left of the device.
2	Keypad with status indicators
3	Lamp house cover
4	Flow cell (after installation)
5	Leak tray with leak sensor
6	Type label, indicating the module name, serial number, part number, and revision number (if any)
7	Drain port
8	Leak sensor
9	Partition panel
10	Attachment clips for waste line

3.4 Flow Cell

The detector design allows easy access to the flow cell on the interior front.

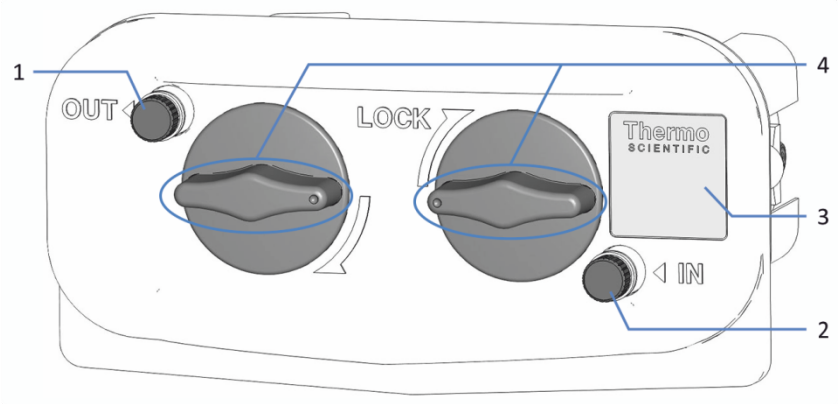

Figure 3: Flow cell (example)

No.	Description
1	Outlet (**OUT**) (closed with plug during storage and transport)
2	Inlet (**IN**) (closed with plug during storage and transport)
3	Flow cell label
4	Rotating locks (unlocked position)

Flow Cell Label

One or more flow cell labels are present on the flow cell, which contain information such as flow cell type, part number, and serial number.

Flow Cell Identification Chip

An identification (ID) chip on the flow cell stores information, including the flow cell type and the serial number of the flow cell. The ID chip also stores data during operation, such as the exposure time to the light.

When the flow cell is installed, the detector reads the data from the chip and transfers the flow cell data to the chromatography data system.

Light Pipe Technology

In flow cells that are based on light pipe technology, light is guided through the flow cell by total reflection along a fused-silica fiber. This provides lowest flow cell volume in combination with highest light throughput and long absorption path length. As a result, this design provides especially low noise, high response and minimum peak broadening.

The flow cells are optimized for highest possible light transmission and transmission stability for the complete wavelength range of the device from 190 nm to 680 nm.

The following flow cells are available for the device:

- LightPipe flow cell, standard, path length 10 mm
- LightPipe flow cell, high sensitivity, path length 60 mm
- LightPipe diagnostic cell

For the flow cell specifications, see Flow Cell Specifications (▶ page 174).

For details about the flow cells or about the availability of other flow cells, refer to the Thermo Fisher Scientific sales organization.

3.5 Lamp

As light source for ultraviolet (UV) and visible (VIS) wavelength detection, the deuterium lamp provides light for the complete wavelength detection range from 190 nm to 680 nm.

The lamp is equipped with an identification (ID) chip. The ID chip stores information about the lamp, including the number of lamp ignitions and the operating time of the lamp, thus, providing an overview of the lamp status.

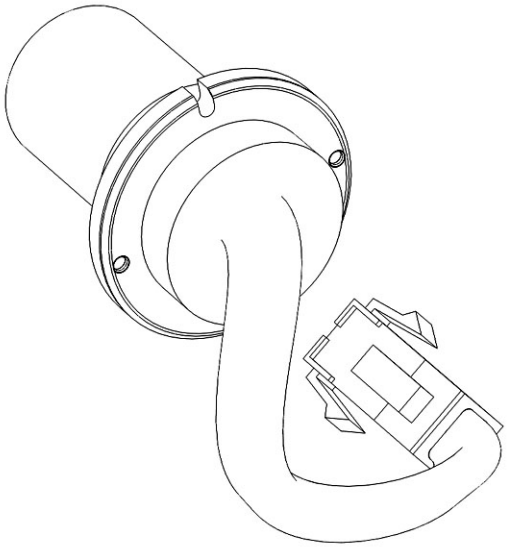

Figure 4: Lamp

3.6 Leak Detection

Leaks are a potential safety issue.

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

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

3.7 Operation

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

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

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

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

4 Unpacking

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

4.1 Unpacking

Damaged Packaging, Defective on Arrival

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

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

Unpacking the Device

CAUTION—Heavy Load, Bulky Device

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

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

Tools required

Screwdriver, Torx™ T20

Follow these steps

1. Place the shipping container on the floor and open it.
2. Remove the ship kit from the shipping container.

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

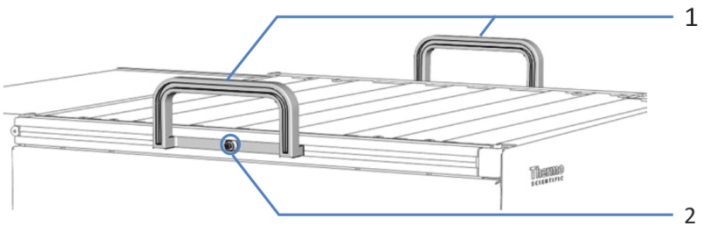

Figure 5: Carrying handles on the device

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

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

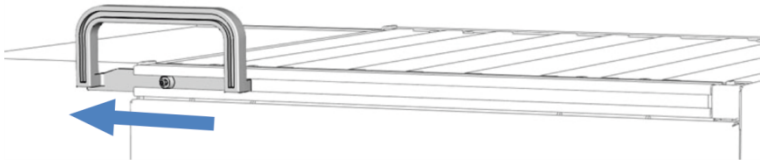

Figure 6: Sliding off the carrying handle from the left rail

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

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

4.2 Scope of Delivery

The following items are included in the delivery:

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

For information on contents of the ship kit or reordering parts, see Accessories, Consumables and Replacement Parts (page 177).

5 Installation

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

5.1 Safety Guidelines for Installation

Pay attention to the following safety guidelines:

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

CAUTION—Heavy Load, Bulky Device

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

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

CAUTION—Electric Shock or Damage to the Device

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

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

NOTICE—Highly sensitive flow cells

Improper use or handling can lead to increased noise, increased drift, increased refractive index sensitivity, clogging, leaks on the flow cell, or even destruction of the flow cell.

- Handle flow cells always with care and use them only and strictly within their specifications of up to 6 MPa and 50 °C.
- Observe all safety notes and guidelines for the flow cell.

5.2 Installing the Device

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

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

NOTICE

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

1. Pay attention to the safety guidelines and observe all site requirements. See Safety Guidelines for Installation (▸ page 46) and Site Requirements (▸ page 49).
2. Set up the device hardware. See Setting Up the Hardware (▸ page 52).
3. Set up the flow connections. See Setting Up the Flow Connections (▸ page 59).
4. Turn on the device. See Turning On the Device (▸ page 81).

TIP

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

5. Set up the device in the software. See Setting Up the Device in the Software (▸ page 82).

6. *Recommended*:
   Perform Instrument Installation Qualification.

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

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

NOTICE

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

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

Moving the Device after Installation

If you have to move the device after it has been set up and installed in the Vanquish system, prepare the device for transport and move it to the new location. Follow the instructions in Transporting or Shipping the Device (▸ page 153).

5.3 Site Requirements

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

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

- Operate the device only under appropriate laboratory conditions.
- The device is intended to be part of the Vanquish system. Observe the site requirements for the Vanquish system as stated in the *Vanquish System Operating Manual*.
- For specifications, see Specifications (▶ page 171) and the *Specifications* sections in the *Operating Manuals* for the other modules in the Vanquish system.
- For general residual hazards, see General Residual Hazards (▶ page 24).

5.3.1 Power Considerations

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

CAUTION—Electric Shock or Damage to the Device

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

Connect the device to the specified line voltage only.

5.3.2 Power Cord

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

WARNING—Electric Shock or Damage to the Device

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

WARNING—Electric Shock or Damage to a Product

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

5.3.3 Condensation

NOTICE—Condensation in the device can damage the electronics and optics.

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

5.4 Accessing the Interior Components

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

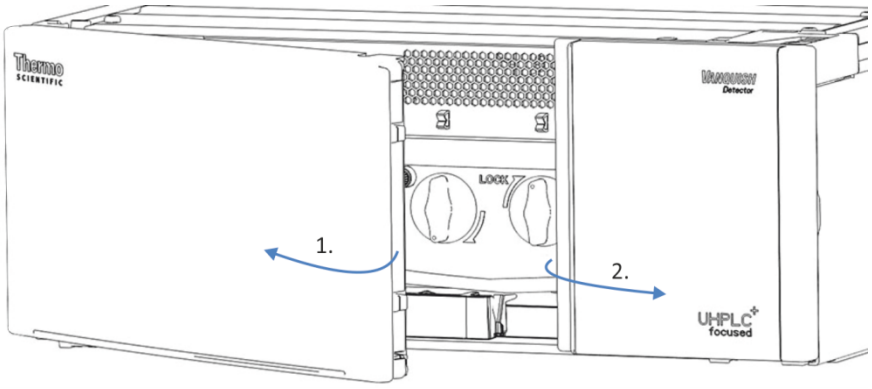

Figure 7: Opening the front doors

5.5 Setting Up the Hardware

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

5.5.1 System Arrangement

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

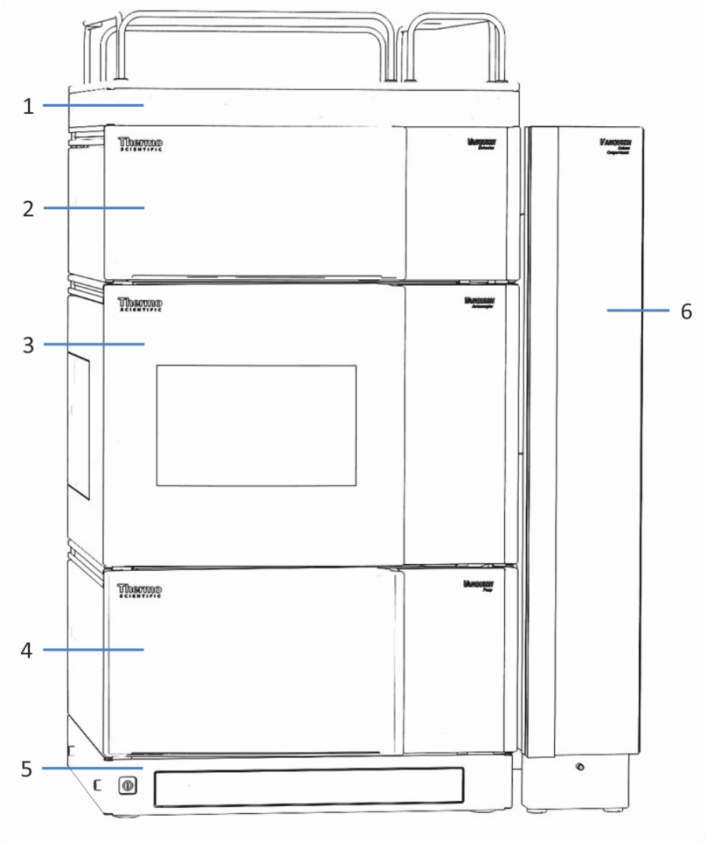

Figure 8: Vanquish system, standard configuration (example)

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

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

5.5.2 Connecting the Device

Device Connectors

The following connectors are provided on the device:

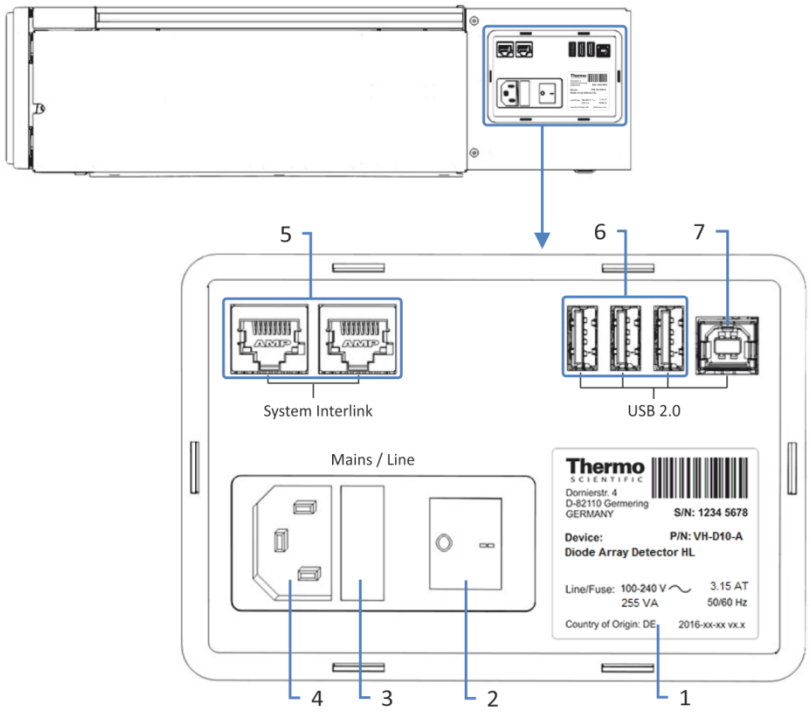

Figure 9: Electrical connectors on the right side of the device

No.	Description
1	Rating plate, indicating the serial number, part number, module name, revision number (if any), and the line and fuse rating.
2	Main power switch (on/off control)
3	Fuse holder
4	Power-inlet connector
5	System Interlink port Allows power on/off control for the device from the Vanquish system base and device communication and synchronization between the device and other modules in the Vanquish system. For example, the interconnection between autosampler and device automatically enables direct synchronization of sample inject and data acquisition start in the device. As a result, the synchronization improves the retention time reproducibility.
6	USB hub ("A" type connector) Allows connection to other modules in the Vanquish system
7	USB (Universal Serial Bus) port ("B" type connector) Allows connection to other modules in the Vanquish system or the computer on which the data management system is installed, such as the Chromeleon software

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

Follow these steps

NOTICE

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

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

5.5.3 Connecting the Power Cord

NOTICE

Condensation in a device can damage the electronics.

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

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

5.6 Installing the Flow Cell

This section describes the installation of the flow cell upon initial installation of the device.

For instructions on exchanging a flow cell or installing a flow cell after storage, see Flow Cell (▷ page 126).

NOTICE—Sensitive Flow Cells

Flow cells are highly sensitive to damage. Observe the following guidelines for use of the flow cell:

- Handle flow cells with care.
- Mechanical shocks, mechanical vibrations or intruding objects can lead to leaks on the flow cell or even destroy it. Avoid exposure of the flow cell to mechanical shocks or vibrations. Do not let it hit hard surfaces. Do not intrude the flow cell enclosure with any objects. Do not open the flow cell enclosure and do not disassemble the flow cell.
- The optical ports of the flow cell are sensitive to contamination and scratches. Do not touch the optical ports of the flow cell or immerse them. To avoid damage to the optical ports of the flow cell, be careful when inserting the flow cell into the flow cell opening of the detector.
- On the rear side of the flow cell, the contact pads for the identification chip are located. Never touch the contact pads. Avoid damage to the electronics of the ID chip.

Parts required

Flow cell

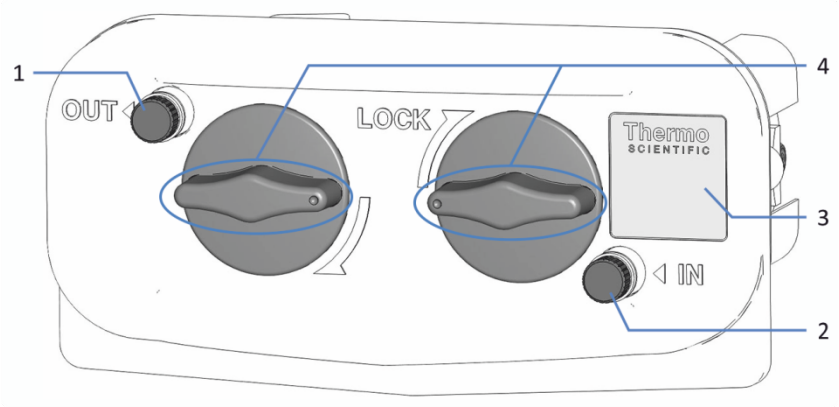

Figure 10: Front side of the flow cell

No.	Description
1	Outlet (**OUT**) (closed with plug during storage and transport)
2	Inlet (**IN**) (closed with plug during storage and transport)
3	Flow cell label
4	Rotating locks (unlocked position)

Preparations

1. On the interior front of the device, turn the rotating locks on the cover of the flow cell opening counterclockwise until they are in a horizontal position.
2. Remove the cover from the flow cell opening. Keep the cover to close the flow cell opening when no flow cell is installed in the device.

NOTICE—Flow Cell Opening

The optical ports and the contact pad for the identification chip in the flow cell opening are sensitive to electrostatic discharge, contamination and scratches.

Do not touch any surfaces or optical ports in the flow cell opening.

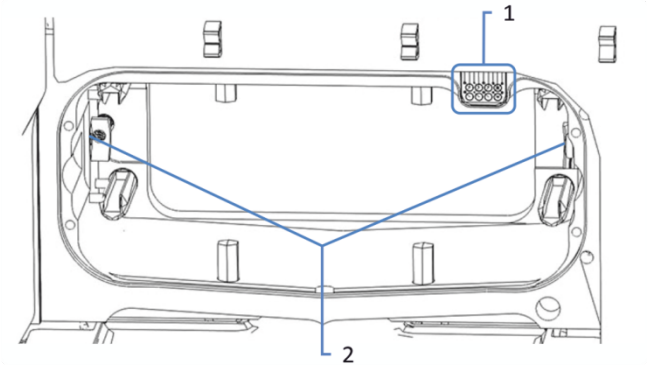

Figure 11: Flow cell opening on the device

No.	Description
1	Contact pad for flow cell identification chip
2	Optical ports in the device

3. Unpack the cell.

Follow these steps

1. Remove the shipping locks carefully on the left and right rear side of the flow cell.

TIP Store the shipping locks in the cell packaging to have them easily available when storing or shipping the cell.

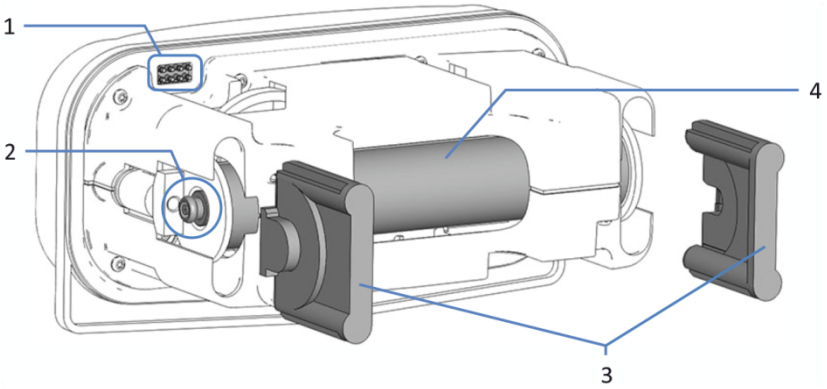

Figure 12: Rear side of the flow cell

No.	Description
1	Identification chip
2	Optical ports on the flow cell (on both sides of the flow cell) The ports are very sensitive and must not be touched.
3	Shipping locks To protect the flow cell during storage and transport.
4	Light pipe

2. Check the position of the rotating locks on the front of the flow cell. If the rotating locks are not in a horizontal position, turn them counterclockwise to a horizontal position. To insert the flow cell, the rotating locks must always be in a horizontal position and thus opened.

3. Carefully insert the flow cell into the flow cell opening in the device. The flow cell must sit completely in the opening.

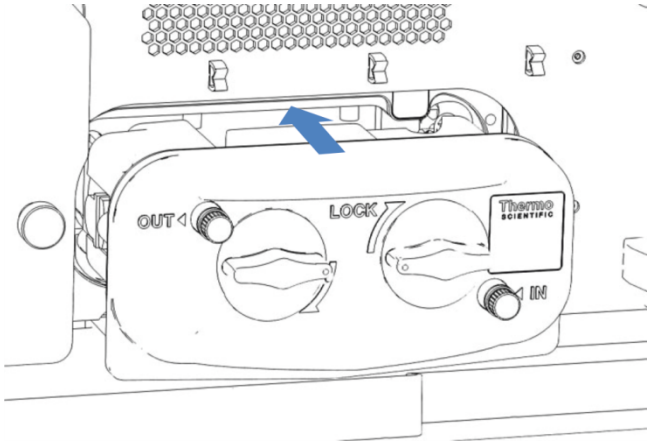

Figure 13: Inserting the flow cell with opened rotating locks

4. Turn the rotating locks simultaneously clockwise until they are in a vertical position. The flow cell is locked in place, when the rotating locks arrest.

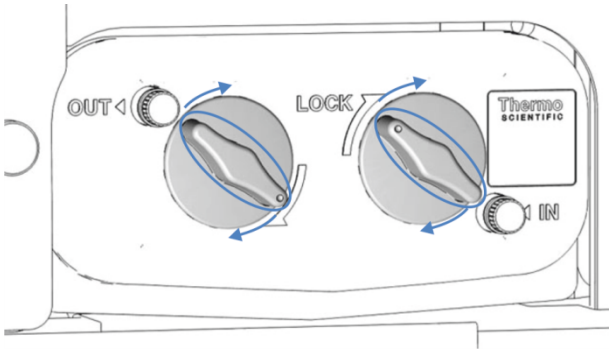

Figure 14: Closing the rotating locks

5. Check that the flow cell sits correctly in the flow cell opening. The front of the flow cell should lie flush with the device front panel.

5.7 Setting Up the Flow Connections

5.7.1 General Information and Guidelines

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

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

NOTICE

Particulate matter from other system modules and components can deposit in the flow cell and clog it.

- Before you connect the flow cell to the flow path, make sure that you thoroughly flush the modules in the system flow path upstream of the device to waste.
- 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*.

NOTICE

Flow cells are highly sensitive to contamination, clogging and high backpressures. Even if the pressure exceeds the upper limit for a very short time only, the flow cell may be permanently damaged. Observe the following notes when connecting the flow cell to the system flow path:

- When connecting a component in the flow path after the flow cell, observe the specified backpressure for the flow cell.
- Use only clean Viper capillaries which were provided for the flow cell and which have been properly protected by their cap before.
- Use only the waste line which was provided for the flow cell.
- Avoid clogging of the flow cell or waste line.
- Improperly set up flow connections can lead to leaks on the flow cell or even destroy the flow cell.

- If using multi-detector configurations, configurations that include a diverter valve, and hyphenated techniques like LC-MS or fractionation after a LightPipe flow cell, install an overpressure relief valve. The valve is intended to limit pressure in an error case. It is not intended to limit overpressure events as a consequence of the system configuration and/or instrument method not observing the flow cell pressure limit. Repetitive triggers due to such instrument methods limit the ability of the valve to function correctly and reduce the lifetime of the flow cell.
  To protect the flow cell against overpressure and pressure shocks, observe the following:
  - Set up instrument methods that ensure that the pressure inside the flow cell stays well within its pressure specification (for information on how to determine the pressure inside the flow cell of a configuration, see the Determining the Pressure inside the Flow Cell section in this manual).
  - Observe the pressure limit at all times.
  - If the valve has opened, find, and resolve the root cause for opening and ensure that the valve is tight before restarting measurements.
  - If using mass spectrometers with diverter valves that offer a Make-Before-Break connection, use this capability.

Follow these steps

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

1. Set up the flow connections to the flow cell (see Flow Connections to the Flow Cell (▸ page 66)).
2. Connect the device to the drain system (refer to the *Vanquish System Operating Manual*).

For installation instructions, guidelines, and handling recommendations, see Connecting Fittings, Capillaries, and Tubing (▸ page 64).

5.7.2 Guiding Capillaries and Tubing Through the System

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

Tubing Chase with Tubing Guides

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

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

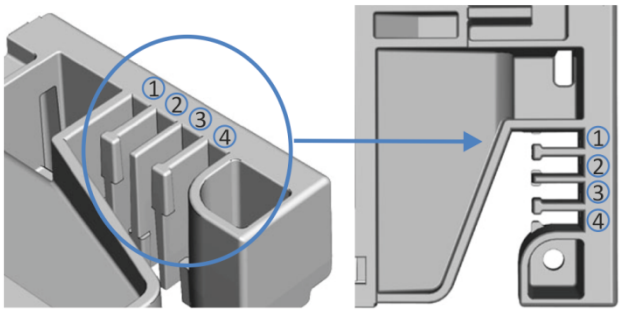

Figure 15: Tubing chase with tubing guides (left: view from inside, right: view from top)

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

Tubing Brackets

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

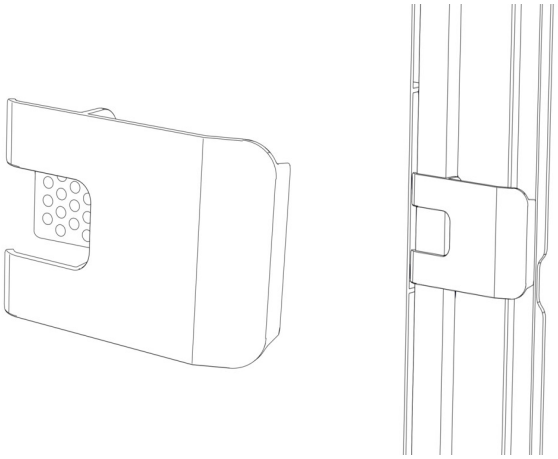

Figure 16: Tubing bracket (left), tubing bracket installed (right)

Dual System Arrangements

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

Guide Holes and Capillary Clips

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

5.7.3 Installing the Partition Panel Plugs

There are two types of partition panel plugs available in the detector ship kit.

Figure 17: Plugs available for the partition panel

No.	Description
1	Plug with slit, for guiding capillaries with small outer diameter, such as uninsulated capillaries.
2	Rotating plug, for guiding capillaries that do not fit in the plug with slit, including insulated capillaries.

Installing the plug with slit

1. On the detector partition panel, push the plug with slit in the required recess of the partition panel (if not present yet).
2. To secure the plug with slit, insert the nose into the opening of the partition panel.

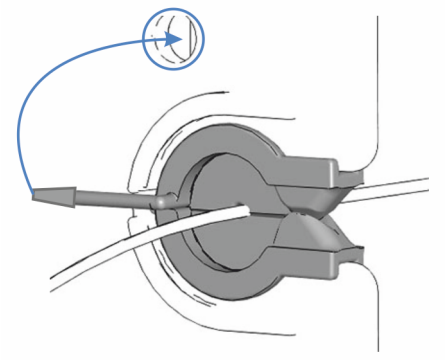

Figure 18: Securing the partition panel plug with slit

3. To secure the capillary, push the capillary into the slit of the plug.

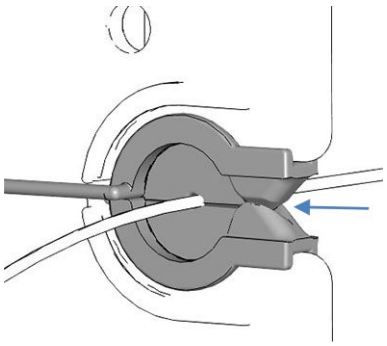

Figure 19: Capillary installed in the plug with slit

Installing the rotating plug

1. On the detector partition panel, push the rotating plug in the required recess of the partition panel (if not present yet).
2. To open the plug in order to route the capillary through the plug, turn the rotating plug toward the front.
3. To secure the capillary, turn the rotating plug toward the partition panel to close the opening of the rotating plug.

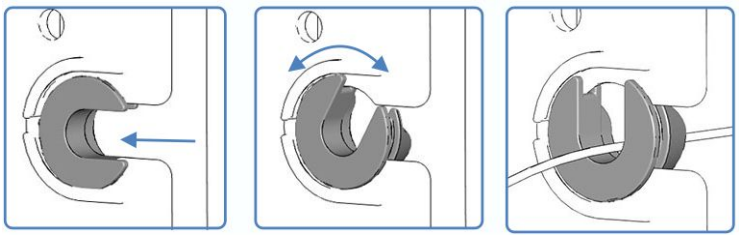

Figure 20: Using the rotating plug

5.7.4 Connecting Fittings, Capillaries, and Tubing

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

5.7.4.1 General Guidelines

When connecting capillaries and tubing, follow these general recommendations:

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

5.7.4.2 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 knurls, follow these steps:

NOTICE

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

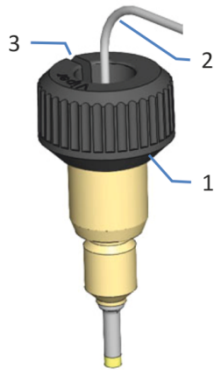

Figure 21: Viper fitting with knurl

No.	Description
1	Knurl
2	Capillary
3	Slot

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

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

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

Resolving Leakage of Viper Fittings with Knurls

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

5.7.5 Flow Connections to the Flow Cell

Connect the inlet capillary and waste line to the flow cell when the flow cell is installed to the device.

NOTICE

Flow cells are highly sensitive to contamination, clogging and high backpressures. Even if the pressure exceeds the upper limit for a very short time only, the flow cell may be permanently damaged. Observe the following notes when connecting the flow cell to the system flow path:

- Backpressures that exceed the specified maximum pressure limit of the flow cell can destroy the flow cell. Never expose the flow cell to excessive backpressure. When connecting a component in the flow path after the flow cell, observe the specified backpressure for the flow cell.
- Avoid clogging of the flow cell or waste line.
- Improperly set up flow connections can lead to leaks on the flow cell or even destroy the flow cell.
- Use only clean Viper capillaries which were provided for the flow cell and which have been properly protected by their cap before.
- Use only the waste line which was provided for the flow cell.
- Use the flow cell only with a column or a filter frit connected in the flow path before the flow cell.
- Do not invert the flow cell inlet and outlet for normal flow cell operation. Inverting the flow connections is only allowed for the back-flushing procedure that is described in the manual.
- Use only the waste line connection that is provided for your detector.
- Connect the waste line to the flow cell only as described in the manual.
- Do not discharge waste from the flow cell through the open leakage drain system of the Vanquish system.

In addition, observe the guidelines for proper connection of the flow cell in General Information and Guidelines (▶ page 59).

Parts required

- Inlet capillary
- Detector waste line
  For instructions on connecting the waste line, follow the steps in Connecting the Detector Waste Line (▸ page 69).
- Plugs for the partition panel from the detector ship kit (if not pre-installed), depending on the capillary to be installed:
  - For capillaries with small outer diameter, such as uninsulated capillaries, use the plug with slit (no. 1 in the image below).
  - For capillaries that do not fit in the plug with slit, including insulated capillaries, use the rotating plug (no. 2 in the image below).

Figure 22: Plugs available for the partition panel

Tools required

For the detector waste line: Tubing cutter (optional)

Preparations

1. Flush the system modules and capillaries upstream of the device to waste before you connect the flow cell to the system flow path. Refer to the *Vanquish System Operating Manual*.
2. Remove the plugs from the flow cell inlet and outlet.

TIP Store the plugs of the flow cell, for example in the flow cell packaging, to have them easily available when storing or shipping the flow cell.

3. Install the partition panel plugs (if not present yet). See Installing the Partition Panel Plugs (▸ page 62).

Follow these steps

1. Connect the inlet of the flow cell:
   Connect the capillary from the column to the flow cell. See Connecting the Inlet Capillary (▸ page 68).
2. Connect the outlet of the flow cell:
   - If the detector is the last module in the system flow path, connect the detector waste line to the flow cell. See Connecting the Detector Waste Line (▸ page 69).
   - If you attach other detectors or a mass spectrometer in the flow path after the flow cell, determine the backpressure first to ensure that the pressure within the flow cell does not exceed 6 MPa. See Determining the Pressure inside the Flow Cell (▸ page 71).

5.7.5.1 Connecting the Inlet Capillary

Preparations

See Flow Connections to the Flow Cell (▸ page 66).

Follow these steps

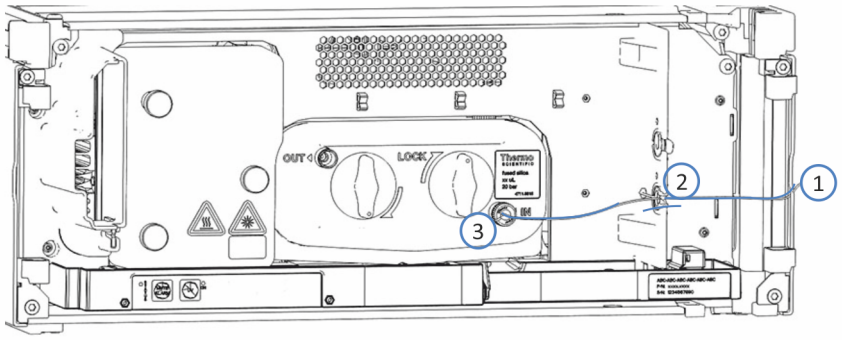

Figure 23: Connecting the inlet capillary from the column compartment (example)

1. Route the inlet capillary from the column compartment through the guide hole in the device enclosure. Use the guide hole that is next to the column compartment.

TIP Always keep the capillary connection between the column compartment and the flow cell as short as possible to minimize peak broadening (i.e. peak broadening effects due to extra dispersion volume).

2. *If the column compartment is located to the right of the detector*
   Route the capillary through the bottom recess in the partition panel. Make sure that you use the suitable partition panel plug for the capillary.

TIP For capillaries with small outer diameter, the plug with slit secures the capillary properly. For capillaries that do not fit in the plug with slit, such as an insulated inlet capillary, use the rotating plug.

3. Connect the inlet capillary to the flow cell inlet port (**IN**).

5.7.5.2 *Connecting the Detector Waste Line*

Preparations

1. See Flow Connections to the Flow Cell (▶ page 66).

Follow these steps

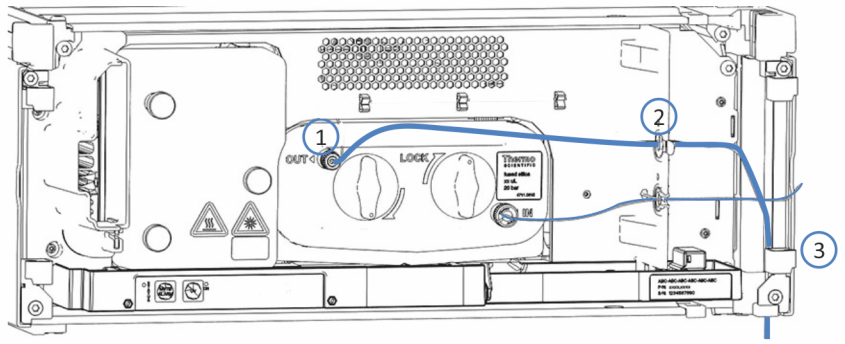

Figure 24: Connecting the detector waste line

1. Connect the waste line to the flow cell outlet (OUT) (1).
2. Route the waste line through the top recess (2) in the partition panel.
3. Route the waste line through the tubing guides of the system modules below the detector to the Vanquish system base (3).
4. On the system base, route the detector waste line through the dedicated detector waste outlet to waste and connect the detector waste line to the waste container as described in the *Vanquish System Operating Manual*.

TIP The waste line should go straight to the system base and to waste. Make sure that the line is positioned straight in the tubing guides.

5. 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 and that the cut is not crimped.

6. Check the waste line over the entire flow path: Make sure that no bending (kink), pinching or squeezing of the waste line is present at any point in the flow path.

5.7.6 Guiding Liquid Leaks to Waste

Leaking liquids of the device are collected in the leak tray, where they flow off through the chase on the right side of the leak tray to the drain system.

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

5.8 Determining the Pressure inside the Flow Cell

All modules, capillaries and waste lines downstream of the flow cell contribute to the pressure inside the flow cell. If you attach additional modules such as detectors, fraction collectors or a mass spectrometer in the flow path after the flow cell, make sure that the pressure within the flow cell does not exceed its pressure specification.

NOTICE—Flow cell damage due to pressure spikes

The tests described in this section are designed to determine the static pressure inside the flow cell. They cannot detect pressure spikes that can occur when switching a valve.

- If you intend to use a switching valve downstream of the flow cell, ensure enough safety margin for pressure spikes.
- Install an overpressure relief valve, if available.

When

- If you install additional devices, such as other detectors, valves and capillaries in the flow path after the flow cell:
  - Before installing the mentioned additional modules
  - After having installed the mentioned additional modules
- Before you use a new method
- After you have replaced capillaries in the flow path after the flow cell
- Depending on the application, for example, if you use high salt concentrations, this procedure may help you troubleshooting.

Parts required

- Union connector (for example, Viper union from the system ship kit)
- Capillaries and waste line from the detector ship kit
- Overpressure relief valve, if available
- One of the following solvent mixtures of high viscosity:

Gradient usage	Solvent Mixture
If using gradients	Solvent to be used in your application. Use the mixing ratio with the highest viscosity.
If not using gradients	• 60% water and 40% methanol –or– • 70% water and 30% acetonitrile

General Outline of the Procedure

1. Measure the backpressure of the waste line (see Measuring the Backpressure of the Waste Line (▷ page 73)).
   Flow path: Pump – waste line
2. Measure the backpressure of the Vanquish system including the column, detector inlet capillary and waste line (without installed flow cell and additional module) (see Measuring the Vanquish System Backpressure (Without Flow Cell and Additional Module) (▷ page 74)).
   Flow path: Pump – autosampler – column – waste line
3. Determine the backpressure at the flow cell outlet caused by the connected additional module (see Determine the Backpressure at the Flow Cell Outlet Caused by the Connected Additional Module (Without Flow Cell) (▷ page 76)).
   Flow path: Pump – autosampler – column – additional module (- waste line)
4. Determine the backpressure of the flow cell (see Determining the Backpressure of the Flow Cell (▷ page 78)).
   Flow path: Pump – autosampler – column – flow cell – waste line
5. Calculate the pressure at the inlet port of the flow cell (see Calculating the Pressure at the Inlet Port of the Flow Cell (▷ page 79)).
   Flow path: Pump – autosampler – column – flow cell – additional module (- waste line)

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.

See also

Flow Cell Specifications (▷ page 174)

5.8.1 Measuring the Backpressure of the Waste Line

This procedure describes how to measure the backpressure of the waste line (p0).

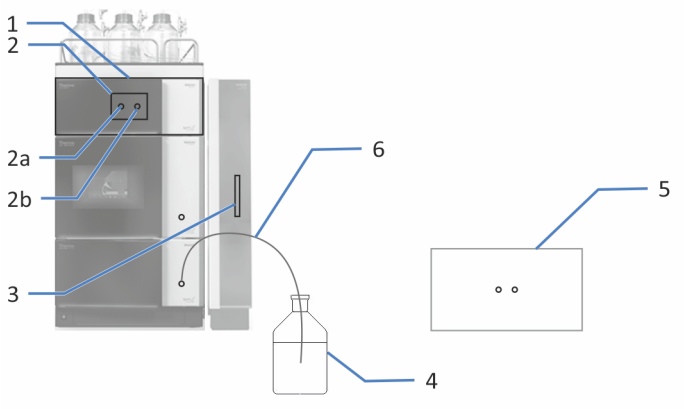

Figure 25: Measuring the backpressure of the waste line

No.	Description	No.	Description
1	Detector	3	Column
2	Flow cell	4	Waste container
2a	Outlet port of the flow cell	5	Second detector
2b	Inlet port of the flow cell	6	Waste line

The description below assumes that the Vanquish system is set up as described in the *System Operating Manual*.

1. Turn on the system (refer to the *Vanquish System Operating Manual*).
2. If applicable, disconnect the autosampler inlet capillary from the pump/static mixer outlet port.
3. Connect the waste line to the pump/static mixer outlet port.
4. Insert the other end of the waste line into the waste container.
5. Start the pump flow at the maximum flow rate of your application.
6. Check all flow connections for leakages:
   - *If a leakage has occurred*: See Resolving Liquid Leaks (▶ page 170).
   - *If no leakage was found and the pressure value has stabilized*: Proceed with the next step.

7. When the system pressure has stabilized, read the system pressure and write down the value for p0.
   p0: Backpressure caused by the waste line
8. Remove the waste line from the pump/static mixer outlet port.
9. Connect the autosampler inlet capillary to the pump/static mixer outlet port.

5.8.2 Measuring the Vanquish System Backpressure (Without Flow Cell and Additional Module)

This procedure describes how to measure the Vanquish system backpressure including, for example, the autosampler inlet capillary, the column inlet capillary, the column, detector inlet capillary or detector inlet capillary with overpressure relief valve, and the waste line (p1).

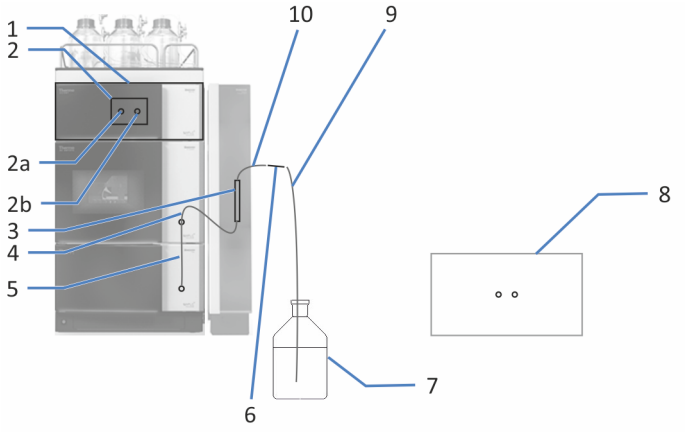

Figure 26: Measuring the Vanquish system backpressure (without flow cell and additional module)

No.	Description	No.	Description
1	Detector	5	Autosampler inlet capillary
2	Flow cell	6	Union connector
2a	Outlet port of the flow cell	7	Waste container
2b	Inlet port of the flow cell	8	Second detector
3	Column	9	Waste line
4	Column inlet capillary	10	Detector inlet capillary or overpressure relief valve with detector inlet capillary

1. If applicable, disconnect the detector inlet capillary from the flow cell IN port.
2. If applicable, disconnect the waste line from the flow cell OUT port.
3. Connect the free end of the detector inlet capillary to the union connector.
4. Connect the free end of the waste line to the other side of the union connector.
5. Start the pump flow at the maximum flow rate of your application.
6. Check all flow connections for leakages:
   - *If a leakage has occurred*: See Resolving Liquid Leaks (▷ page 170).
   - *If no leakage was found and the pressure value has stabilized*: Proceed with the next step.
7. When the system pressure has stabilized, read the system pressure and write down the value for p1.
   p1: Vanquish system backpressure (without flow cell and additional module)
8. Stop the pump flow.

5.8.3 Determine the Backpressure at the Flow Cell Outlet Caused by the Connected Additional Module (Without Flow Cell)

This procedure first describes how to measure the system backpressure with the additional module (p2), but with the flow cell replaced by the union connector. Afterward, the backpressure the connected additional module will produce at the flow cell outlet (p3) is calculated by subtracting the backpressure generated by all other components (p1-p0).

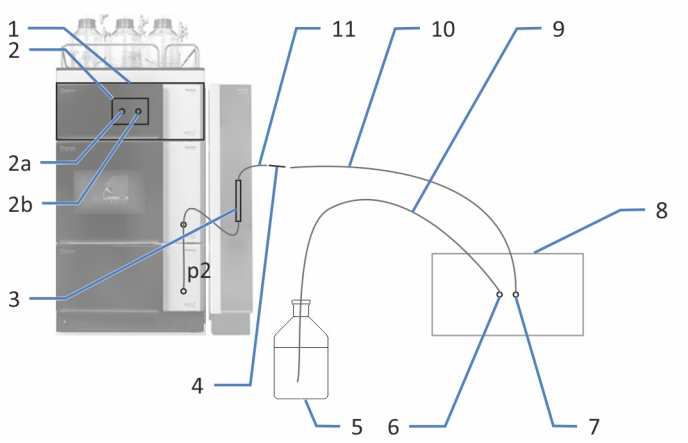

Figure 27: Determining the backpressure of a second detector (example)

No.	Description	No.	Description
1	Detector	6	Outlet port of the second detector
2	Flow cell	7	Inlet port of the second detector
2a	Outlet port of the flow cell	8	Second detector
2b	Inlet port of the flow cell	9	Waste line
3	Column	10	Transfer capillary
4	Union connector	11	Detector inlet capillary or overpressure relief valve with detector inlet capillary
5	Waste container		

1. Turn on the additional module(s) in the flow path after the flow cell. Refer to the *Operating Manuals* for these modules.
2. Disconnect the waste line from the union connector.
3. *Only if the second detector has an outlet port*: Connect the waste line to the outlet port of the second detector.

4. Connect the inlet port of the additional module to the free end of the union connector with the transfer capillary which will be used to connect the additional module in the application setup.
5. Start the pump flow at the maximum flow rate of your application.
6. Check all flow connections for leakages:
   - *If a leakage has occurred*: See Resolving Liquid Leaks (▷ page 170).
   - *If no leakage was found and the pressure value has stabilized*: Proceed with the next step.
7. When the system pressure has stabilized, read the system pressure and write down the value for p2.
   p2: System backpressure with the additional module, but with the flow cell replaced by the union connector
8. Stop the pump flow.
9. Calculate the backpressure the connected additional module produces at the flow cell outlet: p3 = p2 – (p1-p0).
   p3: Backpressure the connected additional module produces at the flow cell outlet

   p2: System backpressure with the additional module, but with the flow cell replaced by the union connector

   p1: Vanquish system backpressure (without flow cell and additional module)

   p0: Backpressure caused by the waste line
10. Compare p3 with the pressure limit of the flow cell.

Situation	Steps
If p3 is well below the pressure limit of your flow cell	Proceed with Determining the Backpressure of the Flow Cell (▷ page 78).
If p3 is close to the pressure limit of your flow cell or exceeds it	Reduce the flow rate gradually and restart the procedure until p3 is well below the pressure limit of your flow cell. –or– Change the system configuration (for example, the transfer capillary) and restart the procedure to check if p3 is well below the pressure limit of your flow cell.

See also

Flow Cell Specifications (▷ page 174)

5.8.4 Determining the Backpressure of the Flow Cell

This procedure first describes how to measure the system backpressure with flow cell but without additional module (p4). The backpressure of the flow cell (p5) is then calculated by subtracting the Vanquish system backpressure without flow cell and additional module (p1).

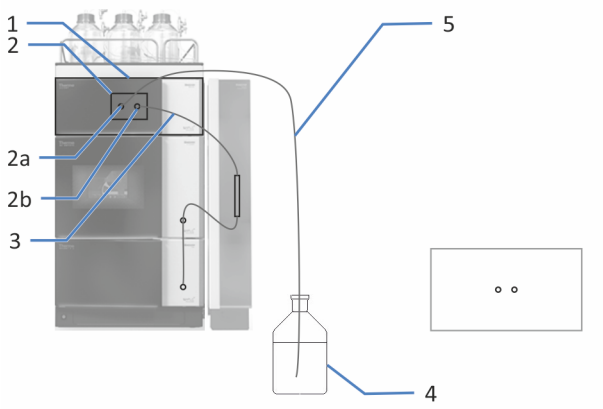

Figure 28: Measuring the backpressure of the flow cell, column, detector inlet capillary and waste line

No.	Description	No.	Description
1	Detector	3	Detector inlet capillary or overpressure relief valve with detector inlet capillary
2	Flow cell	4	Waste container
2a	Outlet port of the flow cell	5	Waste line
2b	Inlet port of the flow cell		

1. Set up the flow connections as described in Flow Connections to the Flow Cell (▶ page 66).
2. Start the pump flow at the flow rate of your application.
3. Check all flow connections for leakages:
   - *If a leakage has occurred*: See Resolving Liquid Leaks (▶ page 170).
   - *If no leakage was found and the pressure value has stabilized*: Proceed with the next step.
4. When the system pressure has stabilized, read the system pressure and write down the value for p4.
   p4: System backpressure with flow cell but without additional module
5. Stop the pump flow.

6. Calculate the difference between the two measured pressure values: p5 = p4 – p1.
   p5: Backpressure caused by the flow cell

   p4: System backpressure with flow cell but without additional module

   p1: Vanquish system backpressure (without flow cell and additional module)

5.8.5 Calculating the Pressure at the Inlet Port of the Flow Cell

This procedure describes how to determine the pressure at the flow cell inlet port (p6) for the intended configuration.

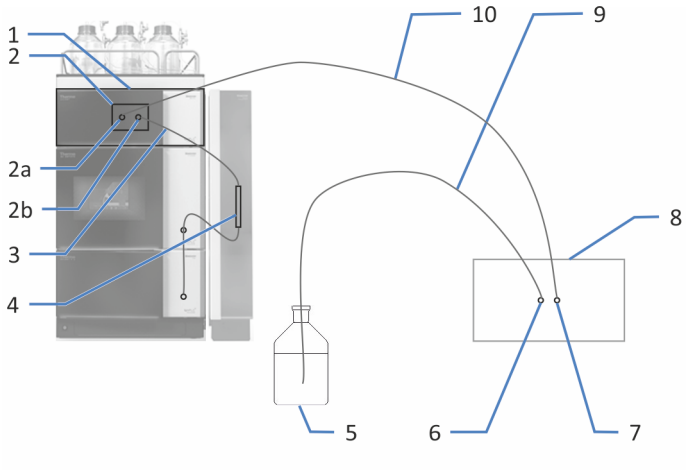

Figure 29: Calculating the pressure at the inlet port of the flow cell in your used system configuration

No.	Description	No.	Description
1	Detector	5	Waste container
2	Flow cell	6	Outlet port of the second detector
2a	Outlet port of the flow cell	7	Inlet port of the second detector
2b	Inlet port of the flow cell	8	Second detector
3	Detector inlet capillary or overpressure relief valve with detector inlet capillary	9	Waste line
4	Column	10	Transfer capillary

1. Calculate p6 = p5 + p3.
   p6: Pressure at the inlet port of the flow cell

   p5: Backpressure caused by the flow cell

   p3: Backpressure the connected additional module produces at the flow cell outlet

2. Compare p6 with the pressure limit of the flow cell.

Situation	Steps
p6 is at least 5 bar below the pressure limit of the flow cell	The configuration can be used.
p6 is less than 5 bar below the pressure limit of the flow cell or above the limit	Operate the system configuration at a reduced flow rate. –or– Change the system configuration (for example, the transfer capillary) to meet the specification of the flow cell.

TIP The tests described in this section are designed to determine the static pressure inside the flow cell. They cannot detect pressure spikes that can occur when switching a valve.

If you intend to use a switching valve downstream of the flow cell, ensure enough safety margin for pressure spikes.

See also

Flow Cell Specifications (▷ page 174)

5.9 Turning On the Device

TIP

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

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

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

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

See also

Power On/Off Control (▶ page 89)

5.10 Setting Up the Device in the Software

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

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

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

6 Operation

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

6.1 Introduction to this Chapter

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

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

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

6.2 Safety Guidelines for Operation

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

Observe all warning messages and precautionary statements presented in Safety Precautions (▸ page 21).

CAUTION—Hot Surfaces

Surfaces inside the device may become hot during operation. Touching hot parts might cause burns.

Allow hot surfaces to cool down before you touch them.

NOTICE

Pay attention also to the following guidelines:

- To prevent damage resulting from leakage or from running the pump dry, always set the lower pressure limit for the pump.
- If there is evidence of leakage in the device, turn off the pump flow and remedy the situation immediately.
- If the pump flow is interrupted, take appropriate measures to protect the flow cell. Observe the guidelines for use of flow cells in Guidelines for Use of Flow Cells (▸ page 93).

NOTICE—Highly sensitive flow cells

Improper use or handling can lead to increased noise, increased drift, increased refractive index sensitivity, clogging, leaks on the flow cell, or even destruction of the flow cell.

- Handle flow cells always with care and use them only and strictly within their specifications of up to 6 MPa and 50 °C.
- Observe all safety notes and guidelines for the flow cell.

6.3 Control Elements

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

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

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

6.3.1 Keypad

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

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

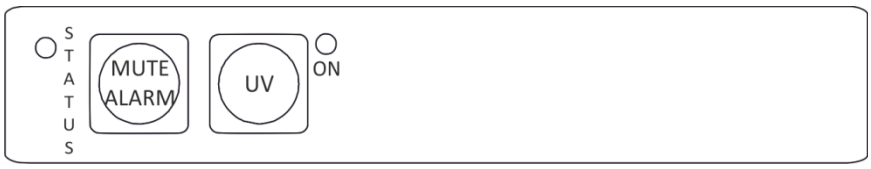

Figure 30: Keypad

STATUS

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

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

For status details, see Status Indicators (▶ page 87).

MUTE ALARM

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

UV

The **UV** button allows you to turn the UV lamp on and off directly from the detector. To turn on the UV lamp, press the **UV** button.

The LED next to the button indicates the lamp status:

LED	Description
Off (dark)	The UV lamp is turned off.
Green, flashing	The UV lamp ignites.
Green	The UV lamp is turned on.

When the Device is Connected in the Chromatography Data System

The button functionality is as follows when the device is connected in the chromatography data system:

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

6.3.2 Status Indicators

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

LED Bar

The LED bar colors provide the following information:

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

LED Bar	Description
Yellow	The device is connected in the Chromeleon software, but the device is not equilibrated. The UV lamp is turned off, or no flow cell (or diagnostic cell) is installed.
Green, flashing	The device is equilibrating. The UV lamp is igniting.
Green	The device is connected and equilibrated, but no data acquisition is running. The UV lamp is turned on. **TIP** Measurements that started right after the LED bar is permanently green may show increased drift. For perfect measurement results, wait until a Ready Check does not return any warning messages.
Blue, running	A data acquisition is running.
Blue	An injection or sequence is running.
Red	A problem or error has occurred. For the related message, check the Instrument Audit Trail. For remedial action, see Troubleshooting (▸ page 161).

STATUS LED

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

STATUS LED	Description
Off (dark)	The power to the device is turned off.
Green	The device is functioning properly.
Red	A problem or error has occurred. For the related message, check the Instrument Audit Trail. For remedial action, see Troubleshooting (▸ page 161).

For information about the LED that is present next to the **UV** button on the keypad, see Keypad (▸ page 86).

6.4 Power On/Off Control

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

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

Observe the following:

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

6.5 Preparing the Device for Operation

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

Before Operating the Device for the First Time

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

NOTICE

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

- When you install devices or components to the system, always flush them to waste before connecting them in the system flow path. To flush the Vanquish modules, follow the instructions in the *Vanquish System Operating Manual*.
- New flow cells are dry when shipped. When operating the detector with a flow cell that was stored, it is filled with isopropanol. Use solvents that are miscible with isopropanol. If they are not, use an appropriate intermediate solvent.

- To remove the isopropanol from the flow cell:
  - Verify that a column or a filter frit is connected in the flow path.
  - Have the pump deliver flow for a short time.
- Verify that any air bubbles are completely flushed out of the system flow path.
- Perform a wavelength validation. If the validation fails, perform a wavelength calibration.

Before Starting Sample Analysis

Before starting an analysis:

- Check the liquid level in the solvent reservoirs. Verify that the amount of solvent is sufficient for the analysis.
- Close the doors of all modules in the Vanquish system, if not already done.
- Observe the guidelines for use of flow cells in Guidelines for Use of Flow Cells (▶ page 93).

NOTICE—The flow cells are highly sensitive

Make sure that you have read and follow all safety notes and guidelines for the flow cells.

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

System Equilibration

System equilibration should include the following operations:

- Purging the pump (*all* channels, including those not used for the application)
- Flushing the entire chromatography system with the starting solvent to rinse out any solvent from a previous analysis run
- Warming up (or cooling down) all temperature-controlled devices in the system to the starting temperature. Temperature-controlled devices can be, for example
  - Column compartment and post-column cooler
  - Sample compartment 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*.

TIP When you start the data acquisition or perform an autozero, the shutter in the light path before the flow cell is opened automatically. After the data acquisition, close the shutter, if required.

6.6 Turning On the UV Lamp

Prerequisites

The lamp house cover must be installed.

TIP If you remove the lamp house cover while the lamp is turned on, the lamp is turned off automatically.

Follow these steps

1. Press the **UV** button on the keypad of the detector.
   - or –

   In the chromatography data system, turn on the lamp on the ePanel for the detector.
2. Allow the lamp and optics to warm up and stabilize for at least one hour until the working temperature is reached before you start analysis.

NOTICE

Turning on and off the lamp too often can reduce the lifetime of the lamp.

- If you intend to use the detector again within 24 hours (for example, the next day), do not turn off the lamp. Leave the lamp turned on and close the shutter.
- If the detector is not used for a longer time (over 24 hours, for example, over the weekend), turn off the lamp to save lamp life time and energy.

TIP When the UV lamp was turned off, a cooling-off period of 5 minutes is required before the lamp can ignite again.

Turning on the Lamp Automatically

To turn on the UV lamp automatically after power on, in the chromatography data system, set **AutoactivateUV_Lamp** to **On**.

6.7 Guidelines for Use of Flow Cells

NOTICE—Highly sensitive flow cells

Flow cells are highly sensitive to damage.

- Handle flow cells with care.
- Observe the following guidelines for use of the flow cell.

Operating conditions

- Observe the specified maximum temperature limit and pressure limit for the flow cell. See the specifications for flow cells in Flow Cell Specifications (▷ page 174). If your application requires column temperatures above the specified maximum limit, install and use a post-column cooler in the flow path before the flow cell.
- Allow the flow cell to warm up.
- The flow cell is sensitive to thermal changes in the environment. If the doors are opened during analysis, the thermal changes may lead to a baseline drift. To avoid a baseline drift, keep the detector doors closed.

Use of solvents and eluates

- Solvents with a low boiling point can evaporate in the warm flow cell, thus degrading the performance of the flow cell. Consider that the combination of temperature and pressure of the eluate in the flow cell can prevent boiling of the eluate.
- Particulate matter from the eluate, system modules and components can deposit in the flow cell and clog it. This can lead to an instable baseline behavior, such as increased noise, or a blockage and a destruction of the flow cell. To avoid this, observe the following:
  - Use the flow cell only with a column or a filter frit connected in the flow path before the flow cell.
  - Use highly pure solvents, such as of LC/MS-grade, only.
  - If capillaries are removed from the flow cell inlet and outlet, install the plugs supplied with the flow cell to close the ports.
- When system operating parameters, such as temperature or pressure, change in the flow cell, salt from eluates with high salt contents, such as buffers, may crystallize in the flow cell and cause precipitations.
  - Never leave eluates with high salt content in the flow cell without flow. Flush the flow cell regularly when using concentrated salt solutions. Monitor the backpressure via the pump pressure.
  - Make sure that buffer salts remain soluble also with the highest applied content of organic solvent.

Devices in the Flow Path After the Flow Cell

NOTICE

If using multi-detector configurations, configurations that include a diverter valve, and hyphenated techniques like LC-MS or fractionation after a LightPipe flow cell, install an overpressure relief valve. The valve is intended to limit pressure in an error case. It is not intended to limit overpressure events as a consequence of the system configuration and/or instrument method not observing the flow cell pressure limit. Repetitive triggers due to such instrument methods limit the ability of the valve to function correctly and reduce the lifetime of the flow cell. To protect the flow cell against overpressure and pressure shocks, observe the following:
- Set up instrument methods that ensure that the pressure inside the flow cell stays well within its pressure specification (for information on how to determine the pressure inside the flow cell of a configuration, see the Determining the Pressure inside the Flow Cell section in this manual).
- Observe the pressure limit at all times.
- If the valve has opened, find, and resolve the root cause for opening and ensure that the valve is tight before restarting measurements.
- If using mass spectrometers with diverter valves that offer a Make-Before-Break connection, use this capability.

Interrupted operation

- *During short analysis breaks, take appropriate measures to protect the flow cell*:
  - Never leave any substances in the flow cell without flow. Avoid leaving particularly any aggressive solvents in the flow cell for a longer time.
  - Without flow, air bubbles in the flow cell can accelerate the deposition of substances. Never leave air bubbles in the flow cell without flow.
  - If the lamp is turned on, close the shutter in the light path before the flow cell to protect the flow cell from the UV light.
  - Additionally, follow the guidelines in Short-Term Shutdown (Interruption of Operation) (▷ page 106).

- *During long analysis breaks, take appropriate measures to protect the flow cell*:
  - Turn off the lamps to protect the flow cell from the light. Otherwise, the radiation from the lamps may damage the flow cell.
  - If the pump flow is stopped for a longer time, fill the flow cell with a high-purity solvent, for example, isopropanol.
  - Additionally, follow the guidelines in Long-Term Shutdown (▷ page 107).

6.8 Important Operating Parameters

The commands and parameters described in the table should be considered for simple routine operation of the device. You can usually access these parameters from the Chromeleon user interface.

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

TIP The Instrument Method Wizard provides different parameter view modes. Depending on the parameters to be set, you can select the desired view mode (for example, **Easy** or **Advanced**).

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

General Parameters

Parameters	Description
UV lamp	Turn on the lamp before starting an analysis (**UV_Lamp=On**). This setting allows turning on and off the lamp of the detector.
Shutter	Move the shutter (filter paddle) into the required position: • Open position for data acquisition Check that flow is established through the flow cell before you open the shutter while the lamp is turned on. • Closed position for protection of the flow cell when no flow is established through the flow cell and the lamp is turned on.
UV_VIS	The **UV_VIS** signal channels (**UV_VIS_x**) that are available for data acquisition are listed in the dialog box for the device in the Instrument Configuration Manager. Select the required signal channels. The device can record up to 10 signal channels simultaneously, thus at 10 different wavelengths. Most measurement parameters, such as the wavelength, are settable for each signal channel separately.
Acquisition On Acquisition Off	Turn on or off the data acquisition. **TIP** When you start the data acquisition or perform an autozero, the shutter in the light path before the flow cell is opened automatically. After the data acquisition, close the shutter, if required.

Parameters	Description
Wavelength	Set a wavelength for each **UV_VIS_x** signal channel individually, in the range of 190 nm to 680 nm for up to 10 signal channels. The wavelength defines the value at which the device measures the absorbance of the analyte(s) in the sample. Observe the following: • Set the **Wavelength** to the wavelength with the absorbance maxima for the analytes of interest. • For best selectivity, select a specific wavelength for every substance to be analyzed with a low optical bandwidth, for example, by using a separate signal channel for each analyte. • To obtain optimum linearity, set the **Wavelength** to a peak or a valley in the absorption spectrum. A valley can provide best linearity for high concentrations.
Data collection rate	The data collection rate is the number of data points per second (Hz) that Chromeleon collects from the device and stores as raw data. Select a data collection rate up to 200 Hz. Set the data collection rate, at which data is to be collected from the device. The data collection rate applies for all signal channels and the 3D field. As a standard, when setting the **Data Collection Rate** parameter, the response time and peak width are defined. For guidelines on selecting the data collection rate, see Selecting the Data Collection Rate (▸ page 101).
Bandwidth	The bandwidth specifies the optical bandwidth (i.e. the ability of the device to distinguish between single wavelengths), at which the signal channel (**UV_VIS**) is recorded. In general, this corresponds to the optical resolution of a device. The standard **Bandwidth** is set to 4 nm. If required, you can set a different value for the bandwidth. For details on the bandwidth and setting it to a different value, see Optimizing the Bandwidth and Slit Width Settings (▸ page 102).
Slit width	The slit width determines how much light passes through the adjustable entrance slit and is available for measurement. As more light is available for the measurement, the baseline noise is minimized. However, the optical resolution diminishes. The setting of the slit width affects all signal channels and the 3D field. The standard **Slit Width** is set to 4 nm. If required, you can set a different value for the slit width. For details on the slit width and selecting it individually, see Optimizing the Bandwidth and Slit Width Settings (▸ page 102).
Response time	The response time determines how quickly the device responds to a change in signal. As a standard, the **Response Time** setting is defined when the data collection rate is set. If required, you can set a specific value for the response time. For details on the response time and selecting it individually, see Selecting the Response Time and Peak Width (▸ page 102).

Parameters	Description
Peak width	The peak width is a supporting parameter for the data collection rate setting and the response time. As a standard, the **Peak Width** setting is defined when the data collection rate is set. If required, you can set a specific value for the peak width. For details on the peak width, see Selecting the Response Time and Peak Width (▷ page 102).
Reference wavelength	A reference wavelength can be selected and set optionally to correct the signal measured from the sample if interfering substances absorb in addition to the absorption of the analyte. As a standard, no reference wavelength is set. To use the **Reference Wavelength** setting, select it separately for each signal channel. For further information about the reference wavelength, see Selecting the Reference Wavelength and Bandwidth (▷ page 104).
Reference bandwidth	If a reference wavelength is used, the reference bandwidth is used to average several photodiode signals. The reference bandwidth is set it separately for each signal channel. As a standard, the **Reference Bandwidth** is set to 4 nm. If required, you can set a different reference bandwidth. For further information about the reference bandwidth, see Selecting the Reference Wavelength and Bandwidth (▷ page 104).
3D field	The device can record a 3D field that comprises a wavelength range. To use the 3D data collection, select the **3D Field** signal channel. Set the 3D wavelength range that is to be recorded. You can restrict the recorded range in Chromeleon to the wavelengths that are relevant for your analysis. Thus, you can reduce the amount of data that Chromeleon records. • Enter the **Minimum Wavelength** to define the start wavelength for the 3D wavelength range. • Enter the **Maximum Wavelength** to define the end wavelength for the 3D wavelength range.
Bunch width	If the **3D Field** signal is selected, set the bunch width. The bunch width setting determines the distance of the wavelengths between recorded data points in a 3D field. For each recorded data point, the absorption of a diode range is averaged (bunched) with the width of the bunch width. The function of the bunch width in the 3D field is analogous to the function of the bandwidth in the signal channel. The standard **Bunch Width** is set to 4 nm. If required, you can set a different bunch width. Note that selecting a higher bunch width will reduce the required data storage, the noise, the spectral resolution and may reduce the signal height.

Parameters	Description
Autozero	Perform an automatic null balancing. The current device signal is interpreted as 0. Therefore, no absorbing sample should be in the flow cell when **Autozero** is performed. **TIP** When you start the data acquisition or perform an autozero, the shutter in the light path before the flow cell is opened automatically. After the data acquisition, close the shutter, if required.
Leak detection	Leak detection is enabled as a standard when the device is shipped (**Leak Sensor Mode = Enabled**). This is the preferred setting.
Wavelength validation	Perform the wavelength validation as required. A holmium-oxide glass filter is moved into the light path of the lamp and is used to validate the wavelength accuracy. For further information, see Performing a Wavelength Validation and Wavelength Calibration (▸ page 120).
Wavelength calibration	If the wavelength validation failed, perform a calibration of wavelengths. During the calibration, the device determines the measured wavelength of the D-alpha line of the UV lamp. If the device determines that the D-alpha line differs from the expected value, the device will adjust its wavelength calibration. For further information, see Performing a Wavelength Validation and Wavelength Calibration (▸ page 120).
Lamphouse temperature *-and-* Spectrograph temperature	Two temperature signal channels are available in the **Properties** dialog box of the device: **Lamphouse Temperature** and **Spectrograph Temperature**. The lamp and the spectrograph of the device are very sensitive (regarding drift) to changes in temperature. The temperature signal channels can be used for troubleshooting purposes: In case of a long-term baseline drift, a varying lamp house temperature signal indicates strong temperature variations. In case of a long-term baseline drift and a constant lamp house temperature, a changing spectrograph temperature indicates a device defect (defective optics insulation or defective spectrograph temperature control). Select one or both signal channels to record the temperatures. Chromeleon generates the appropriate channels for recording the temperatures of the device lamp house and spectrograph.

6.9 Optimizing the Performance of the Device

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

6.9.1 Guidelines for Optimum Performance

Consider the following guidelines for optimization of the device performance:

- The recording of up to 10 signal channels at individual wavelengths enables a selective detection with narrow bandwidths. In a selective detection, the UV spectrum for a particular species is recorded. Determine an appropriate absorbance maximum.
  Avoid the wavelength range where the solvents absorb strongly (for example, below 220 nm for methanol and below 210 nm for acetonitrile).
- Ignite the UV lamp only if required. Igniting the UV lamp frequently reduces the lifetime of the lamp. In addition, some time is required for the detector to stabilize after a (re-)ignition of the lamp.
- Monitor the lamp age and schedule appropriate maintenance intervals.
- Ensure that the operating conditions are suitable. This includes:
  - Stable environmental conditions, such as a stable temperature
  - No air drafts
  - No vibrations or mechanical shocks caused by external sources
  - No EMC-related sources of strong interference. Operate only certified laboratory equipment in close proximity to the detector.
  - Stable backpressure and correct waste line setup
- Monitor the usage of device-specific components that are subject to wear and stress and schedule appropriate maintenance intervals (see Predictive Performance (page 119)).
- Observe the general guidelines and recommendations on the use of solvents and additives in the chromatography system. Refer to *Use of Solvents and Additives* in the *Vanquish System Operating Manual*.
- Degas the solvent.
- Consider the influences of the parameters on the detection.
- Keep the device doors closed during operation to avoid exposure of the flow cell to thermal changes in the environment that may lead to a baseline drift.

6.9.2 Overview of Optimization Parameters

The following table serves as an overview of parameters that influence the spectral averaging, and, in case of the data collection rate and the response time, the time averaging during data acquisition.

Parameter	Affects
Wavelength	Sensitivity, linearity
Data collection rate	Peak resolution, disk space
Bandwidth	Baseline noise, spectral resolution, peak match, selectivity
Slit width	Baseline noise, spectral resolution, peak match, selectivity, linearity
Response time/peak width	Baseline noise, peak width, sensitivity
Bunch width (3D field)	Spectral resolution, peak match, disk space
Reference wavelength	Baseline drift, baseline noise, linearity, negative ghost peaks
Reference bandwidth	Baseline noise, baseline drift

For further information about the parameters, refer to the *Chromeleon Help*.

6.9.3 Selecting the Data Collection Rate

The data collection rate is the number of data points per second (Hz) that the Chromeleon software collects from the detector and stores as raw data.

When you select a data collection rate, observe the following guidelines:

- In general, each peak should be defined by at least 20 data points. For chromatograms with co-eluting peaks or low signal-to-noise ratios, 40 data points per peak are recommended.
- If the data collection rate is too low, the start points, maxima, and end points of peaks will not be determined accurately.
- If the data collection rate is too high, data files may need more disk space and post-run analyses may require more processing time.
- If all peaks are relatively wide, select a lower data collection rate (for example, 1.0 Hz). This saves disk space and allows for a faster display of data in the Chromeleon software.
- If any peaks of interest are less than a few seconds, select a higher data collection rate (10.0 Hz, for example).
- Always consider the data collection rate and response time settings. Set the two parameters together in order to optimize the amount of data points collected, and reduce short-term noise, while still maintaining peak height, symmetry, and resolution.

6.9.4 Selecting the Response Time and Peak Width

As a standard, when setting the data collection rate, Chromeleon automatically sets the optimum response time and peak width. As an advanced option, response time and peak width can be set individually.

TIP

Disabling the link between the data collection parameters and setting these parameters individually may lead to increased noise or increased peak widths.

Observe the following guidelines when changing the response time and peak width proposed by Chromeleon:

- Ensure that response time and peak width match the setting for the data collection rate.
- The response time should be about 30% of the peak width at half-height of the narrowest peak of interest.
  A longer response time allows more averaging of the signal and results in less short-term noise. However, if the selected response time is too long, this can result in reduced peak heights and asymmetrical peak shapes. If a separation of peaks is done that follow closely to each other, the long response time can result in bad peak separation. When set correctly, the response time significantly reduces baseline noise, and reduces peak height only slightly.

TIP For best possible combinations of data collection rate, response time and peak width, enable the **Link data collection parameters** check box in the detector settings of the Chromeleon Instrument Method Wizard or Instrument Method Editor.

6.9.5 Optimizing the Bandwidth and Slit Width Settings

As a standard, a bandwidth of 4 nm and a slit width of 4 nm are defined in Chromeleon. If required, both parameters can be set individually.

The interaction between bandwidth and slit width has a substantial impact on linearity, baseline noise, selectivity as well as the spectral resolution of the peak.

Bandwidth

You can accept the standard bandwidth in Chromeleon, or set the bandwidth to a higher or lower value. For a wider or smaller bandwidth, the device can average several single photodiode signals. This process is referred to *photodiode bunching*.

Note the following:

- The averaging always takes place symmetrically to the selected wavelength.
- *When performing a detection near the edge of the spectral range*
  If the bandwidth setting results in an averaging asymmetrically to the selected wavelength, the device will correct the setting.

  Example: If you perform a detection at a wavelength of 195 nm with a bandwidth of 20 nm, the photodiode bunching is set to 190 to 200 nm, i.e. the largest possible symmetrical range around the detection wavelength. As a result, the bandwidth is changed to 10 nm. This is done to avoid a wavelength shift as would be the case with an asymmetrical averaging.

The following table serves as guidance for selecting the bandwidth based on the spectral features of the analyte to be detected:

Spectral Features	Bandwidth	Effect
Samples with extremely fine spectral features, such as benzene, and very high absorptions.	< 4 nm	May increase baseline noise.
Samples for "normal" analysis with fine spectral features, such as caffeine.	4 nm – 8 nm	Reasonable compromise between low baseline noise, good linearity and low cross-sensitivity
Samples with broad spectral features.	> 8 nm	Most suitable for low noise. A reduced linearity and increased cross-sensitivity may occur.

Slit Width

A narrow slit width results in a smaller optical bandwidth and provides a better optical resolution (the ability of the device to distinguish between single wavelengths) which is required for analytes with fine spectral structures (such as benzene).

Set a value for the slit width that it is not smaller than the smallest value of all bandwidths and bunch widths used for measurement. If the smallest value is greater than 8 nm, select a slit width of 8 nm.

The setting of the slit width affects all signal channels and the 3D field.

6.9.6 Selecting the Reference Wavelength and Bandwidth

Some disturbances on the measured signal from the sample can be corrected by a measured reference signal, which is defined by the parameters reference wavelength and reference bandwidth.

Reference Wavelength

Interfering substances can absorb in addition to the absorption of the analyte in the sample. The absorption of the interferences adds to the measured signal from the analyte. As a result, this can lead to errors in the measurement of the analyte concentration. Interfering absorption frequently results from a changing absorption of the eluent or refractive index effects. Refractive index effects can particularly occur with separations with gradients.

If the interfering substance absorbs over a wide spectrum range, the effect of the interfering absorption on the measured signal can be reduced mathematically. For this purpose, the absorption is measured at the measurement wavelength, and at the same time at a reference wavelength. To correct the signal, the absorbance measured at the reference wavelength is subtracted from the absorption at the measurement wavelength.

TIP The use of a reference wavelength can result in additional interference in the chromatogram.

Use the reference wavelength carefully and only in special cases. In most cases, measurement without a reference will provide better results.

You can set the reference wavelength separately for each signal channel and the 3D field.

Guidelines

To reduce the interference effectively, select the reference wavelength so that it meets the following requirements:

- The absorption of the interfering substance is approximately the same at the measurement wavelength and the reference wavelength.
  If the height of the interfering absorption differs between the measurement wavelength and the reference wavelength, the interference is insufficient or overcompensated.
- The sample does not absorb at the reference wavelength.
  If the sample also absorbs in the spectrum range of the reference wavelength, the measured peak height and peak area are reduced.
- No other substances, such as co-eluting sample components, absorb at the reference wavelength.
  The absorption of additional substances at the reference wavelength can lead to negative peaks in the signal channel.

Reference Bandwidth

If the reference wavelength is used, the reference bandwidth determines how many photodiode signals are averaged for the reference measurement. You can set the reference bandwidth separately for each signal channel and the 3D field.

Select a reference bandwidth that is as broad as possible, such as 30 – 100 nm. It should also be narrow enough to ensure that no analyte absorbs in the reference range.

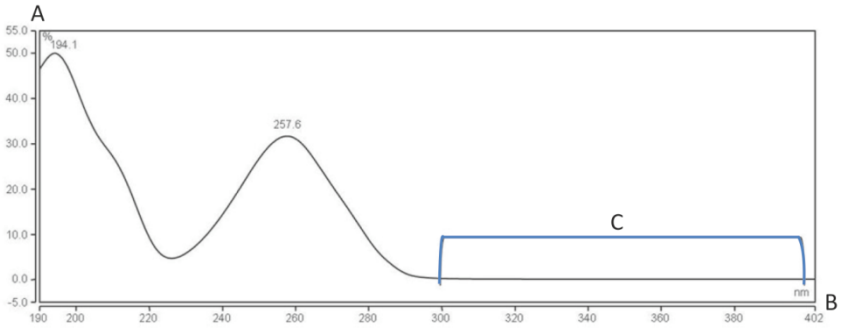

Figure 31: Example for a spectrum with reference bandwidth

No.	Description
A	Relative absorption
B	Wavelength in nm
C	Suitable reference range In this example, the reference wavelength is set to 350 nm and the reference bandwidth is set to 100 nm.

6.10 Shutting Down the Device

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

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

6.10.1 Short-Term Shutdown (Interruption of Operation)

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

- For your Vanquish detector, note the following:

Detector Type	Description
Charged aerosol detector	Check that sufficient gas is available to continue gas flowing through the detector. This is to prevent any build-up of residue from solvents or analytes. Gas must be flowing when pump flow is delivered to the detector.
UV/VIS detectors	The lamp(s) in the detector can remain turned on. *Variable wavelength detector and VH-D10 diode array detector only:* 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.

- For flow cells, note the following:
  - If the pump flow is interrupted and the lamp is turned on, protect the flow cell from the light of the lamp: Close the shutter in the light path before the flow cell, or turn off the lamp.
  - If the pump flow is stopped for a longer time, or if the flow cell is to be shipped or stored, observe the steps in Removing the Flow Cell (▸ page 129).
- 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 Device

To interrupt operation for a longer period, follow the instructions below.

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

1. Turn off the UV lamp.
2. Stop the pump flow.
3. Remove the column from the flow path and replace it by a union connector (for example, the Viper union from the system ship kit)
4. Restart the pump flow.
5. Flush the flow cell with an appropriate solvent (minimum HPLC-grade). Observe the following:

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

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

NOTICE

Residual samples, impurities from the column or buffers with high salt concentrations can deposit in the flow cell. This can lead to damage of the flow cell. In addition, solvents containing acid can damage the flow cell.

- Always flush the flow cell with an appropriate solvent before interrupting operation.
- Fill the flow cell with pure isopropanol using the flushing and injection kit.
- The flow cell should *not* be filled with pure water to avoid the growth of algae. If you want to fill the flow cell with water, you need to add 10% HPLC-grade isopropanol.

6. Turn off the pump flow to the device. Wait until the system pressure is down to zero before you continue the shutdown of the device.
7. Disconnect the capillaries from the flow cell inlet and outlet.
8. After removing the flow connections, protect the flow cell inlet and outlet ports with the plugs supplied with the flow cell. Protect the inlet capillaries with caps.

9. The step depends as follows:

Situation	Steps
Device and all other system modules remain in the system stack and are to be turned off	Turn off the system with the system power button on the system base.
Device shall be transported or shipped after shutdown	If one of the modules shall be removed from the system stack, turn off *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 Transporting or Shipping the Device (▷ page 153).

See also

Connecting the Inlet Capillary (▷ page 68)

Connecting the Detector Waste Line (▷ page 69)

6.10.3 Restart after Long-Term Shutdown

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

1. 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.
2. Flush the components in the flow path before the flow cell before you connect the flow cell to the system flow path.
3. Connect the inlet capillary to the flow cell inlet and the waste line to the flow cell outlet.
4. Turn on the device. Observe the following:

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

5. Before starting an analysis, let the detector equilibrate and be sure that it is ready for operation.

7 Maintenance and Service

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

7.1 Introduction to Maintenance and Service

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

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

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

The maintenance procedures do not require that you remove the doors. However, it is possible to remove a door if this should ever be required for a specific reason or procedure. If you need to remove a door, follow the related steps in Replacing the Doors (▷ page 151).

7.2 Safety Guidelines for Maintenance and Service

7.2.1 General

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

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

WARNING—High Voltage

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

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

WARNING—Escape of Hazardous Substances from Flow Connections

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

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

WARNING—Tilting Liquid Reservoirs

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

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

CAUTION—Spraying Solvent

Solvents can spray when under high pressure.

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

CAUTION—Hot Surfaces

Surfaces inside the device may become hot during operation. Touching hot parts might cause burns.

Allow hot surfaces to cool down before starting replacement or maintenance procedures.

CAUTION—Hydrostatic Pressure

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

- Turn off the pump flow and wait until the system pressure is down to zero.
- Unscrew the caps of the solvent reservoirs and remove the solvent lines together with the caps from the reservoirs.
- Empty the solvent lines. Refer to the *Operating Manual* for the pump.
- Retighten the reservoir caps.

CAUTION—Electric Shock or Damage to the Device

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

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

7.2.2 Flow Cells

NOTICE—Highly sensitive flow cells

Improper use or handling can lead to increased noise, increased drift, increased refractive index sensitivity, clogging, leaks on the flow cell, or even destruction of the flow cell.

- Handle flow cells always with care and use them only and strictly within their specifications of up to 6 MPa and 50 °C.
- Observe all safety notes and guidelines for the flow cell.
- Mechanical shocks, mechanical vibrations or intruding objects can lead to leaks on the flow cell or even destroy it. Avoid exposure of the flow cell to mechanical shocks or vibrations. Do not let it hit hard surfaces. Do not intrude the flow cell enclosure with any objects. Do not open the flow cell enclosure and do not disassemble the flow cell. Use the dedicated packaging when storing or transporting the flow cell. Never use ultrasonic cleaners to clean the flow cells.
- The optical ports of the flow cell are sensitive to contamination and scratches. Do not touch the optical ports of the flow cell or immerse them. To avoid damage to the optical ports of the flow cell, be careful when inserting the flow cell into the flow cell opening of the detector. Have the shipping locks installed and use the dedicated packaging when storing or transporting the flow cell.
- On the rear side of the flow cell, the contact pads for the identification chip are located. Never touch the contact pads. Avoid damage to the electronics of the ID chip.
- Particulate matter, dust and debris can lead to contamination and clogging of the flow cell. If capillaries are removed from the flow cell inlet and outlet, install protective plugs to close the ports and to prevent particles from clogging the flow cell in the next application. Always use the plugs that were installed when the flow cell was shipped.

7.3 General Rules for Maintenance and Service

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

General Rules

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

Opening Flow Path Connections

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

Depot Repair

- If you need to return the device for depot repair, follow the instructions in Transporting or Shipping the Device (page 153).

See also

Consumables and Replacement Parts (page 181)

7.4 Routine and Preventive Maintenance

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

7.4.1 Maintenance Plan

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

Frequency	What you should do...
Daily	• Inspect the flow connections for signs of leakage or blockage. Blockage can be determined by checking the system pressure for unusual values or for increased backpressure. • When you use buffers or salt solutions, flush the device thoroughly after use with an appropriate solvent that does not contain buffers or salts. Monitor the backpressure that the flow cell is exposed to.
Regularly	• Inspect the flow connections for damage, such as cracks, nicks, cuts, or blockage. • Check the lamp age. • Check that all warning labels are still present on the device and clearly legible. If they are not, contact Thermo Fisher Scientific for replacement.
Annually	• Have Thermo Fisher Scientific service personnel perform preventive maintenance once a year. • Perform detector-specific Operational Qualification (OQ) and Performance Qualification (PQ) tests.

TIP The Chromeleon software supports functions for estimating the lifetime of consumables (see Predictive Performance (▶ page 119)).

7.4.2 Cleaning or Decontaminating the Device

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

NOTICE

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

Decontamination

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

Parts required

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

CAUTION—Explosive Gas Mixtures from Alcoholic Cleaning Detergents

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

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

NOTICE

Observe the following:

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

NOTICE—Flow Cell Opening

The optical ports and the contact pad for the identification chip in the flow cell opening are sensitive to electrostatic discharge, contamination and scratches.

Do not touch any surfaces or optical ports in the flow cell opening.

Preparations

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

Follow these steps

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

7.4.3 Predictive Performance

General Overview

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

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

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

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

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

7.5 Performing a Wavelength Validation and Wavelength Calibration

A holmium-oxide glass filter is used to validate the wavelength accuracy. The filter can be moved into the light path between the lamp and the flow cell for the wavelength validation. The detector determines the absorption maxima of the filter and compares them to the nominal holmium oxide values that are stored in the detector firmware.

The accuracy is verified for the wavelengths that are stated in the declaration of conformity for the holmium-oxide glass filter. For information about the declaration, see NIST Compliance (▷ page 185).

A wavelength validation can also be performed with an external standard, such as a pyrene solution. In this case, an accuracy of ± 1 nm can be achieved.

When

A wavelength validation is recommended in the following situations:

- After moving the detector
- After the flow cell has been exchanged
- After a lamp has been replaced

Preparations

Before you start the wavelength validation or wavelength calibration, observe the following notes:

- Allow the flow cell to warm up for 5 minutes.
- Ensure that the baseline is sufficiently stable. The baseline may become unstable, for example, if the solvent composition has been modified, or if air bubbles are present in the light path.
- Verify that the solvent flowing through the flow cell is not strongly absorbing in the wavelength range of the holmium-oxide glass filter that is to be verified.
  This problem occurs, for example, if the flow cell is filled with a mixture of 96% hexane and 4% ethyl acetate. Thermo Fisher Scientific recommends using degassed LC/MS-grade water.
- Allow the lamp to warm up and reach operating temperature. The lamp should be running for at least 1 hour before you start the wavelength validation or wavelength calibration. A lamp spectrum changes significantly during the first few minutes after a lamp has been turned on.

To perform a wavelength validation

1. Turn on the flow at the flow rate that will be used for the analysis.
2. Ensure that the shutter is open.
3. In the chromatography data system, in the **Commands** window, execute the **WavelengthValidation** command.
4. Check whether the wavelength validation passed. If the wavelength validation fails, perform a wavelength calibration (see next section).
5. Close the shutter after the wavelength validation, if required.

To perform a wavelength calibration

1. Verify that the UV lamp is turned on.
2. In the chromatography data system, in the **Commands** window, execute the **WavelengthCalibration** command.
3. Repeat the wavelength validation as described above.

7.6 Replacing the Lamp

When

- The lamp is defective
- After a defined amount of operating hours of the lamp as a preventive measure
- The lamp intensity is too low for demanding applications
- The lamp intensity fluctuates causing artifacts in the baseline

Parts required

- UV lamp
- Optionally:
  - Isopropanol
  - Lint-free tissue

Preparations

1. Turn off the UV lamp.
2. Turn off the device with its main power switch.

Follow these steps

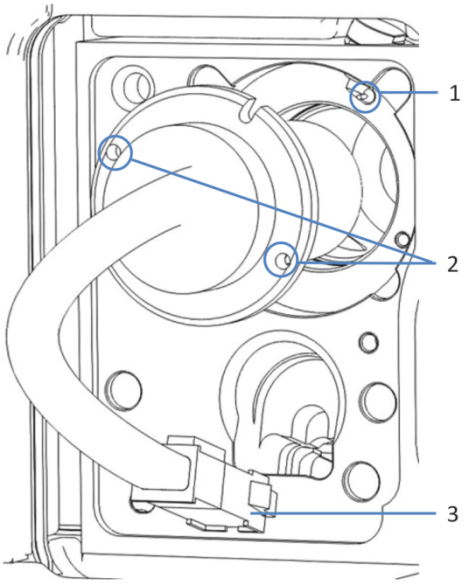

Figure 32: UV lamp

No.	Description
1	UV lamp locating pin
2	Screw bores for UV lamp attachment
3	UV lamp connector

1. Open the doors.
2. Turn the screws on the lamp house cover counterclockwise until the lamp house cover is loose.
   Do not remove the screws completely from the lamp house cover.

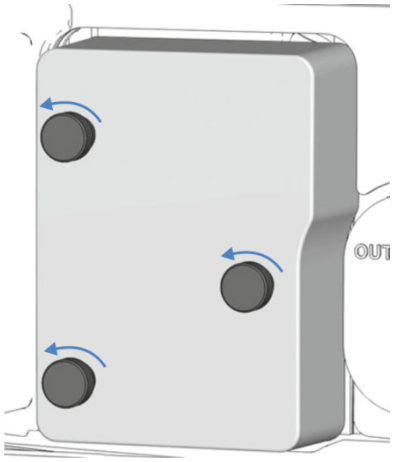

Figure 33: Screws on the lamp house cover

3. Remove the lamp house cover.

CAUTION—Hot surface

The lamp may become hot. Touching a hot lamp might cause burns.

- Touch the lamp briefly and carefully to find out if it is hot before you remove the lamp.
- If it is hot, wait until the lamp has cooled down.

4. Push the clip on the lamp connector and disconnect the connector from the lamp socket on the device.
5. With your hands, loosen the two screws that attach the lamp to the lamp house.
6. Pull out the UV lamp.

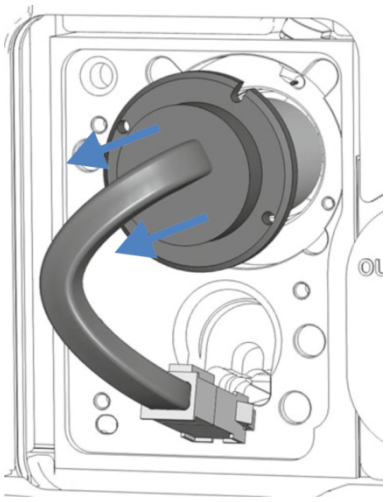

Figure 34: Pulling out the UV lamp

7. Inspect the new UV lamp for signs of fingerprints and dust.
   If necessary, clean the UV lamp with isopropanol and a lint-free tissue before you install it.
8. Align the new lamp with the locating pin.
   When the lamp is in the correct position, push the lamp gently into the lamp house. The lamp socket must be in a level position with the lamp house.
9. When the lamp is properly seated, tighten the two screws to attach the lamp to the lamp house.
10. Reconnect the lamp connector.

11. Mind the routing of the lamp cables.
    Position the lamp cables as indicated in the figure above to prevent the cable from being pinched under the lamp house cover.
12. Reinstall the lamp house cover and fasten the screws on the lamp house cover.
13. Turn on the device with its main power switch.
14. After replacing the lamp, increased noise and strong baseline fluctuations may occur. Before beginning an analysis or performing a wavelength validation, allow the new lamp to run until the noise is reduced and the baseline is stable which typically takes 24 hours.

TIP

The lamp age counter is automatically reset to the value stored on the ID chip of the lamp.

7.7 Flow Cell

This section describes how to flush and exchange flow cells.

To store or ship the flow cell, follow these steps:

1. Flush the flow cell (see Preparing the Flow Cell for Storage (▷ page 126)).
2. Remove the flow cell from the device and place it in its packaging (see Removing the Flow Cell (▷ page 129)).

To exchange the flow cell, follow these steps:

1. Remove the flow cell from the device (see Removing the Flow Cell (▷ page 129)).
2. Install the new flow cell to the device (see Installing the Flow Cell (▷ page 130)).

7.7.1 Preparing the Flow Cell for Storage

When

Before the flow cell is stored in its packaging or in the device if one of the following applies:

- Flushing the flow cell with highly pure isopropanol through the system is not possible
- It is shipped

Parts required

- Flushing and injection kit for flow cells, including a syringe and a Viper adapter
- Highly pure solvent that is miscible with isopropanol, such as LC/MS-grade acetonitrile or methanol
- Highly pure isopropanol, such as LC/MS-grade isopropanol
- Plugs for the flow cell inlet and outlet (supplied with the flow cell)

Preparations

1. Remove buffer salts by flushing the flow cell with a mixture of 50% solvent and 50% water.
2. Flush the flow cell with a highly pure solvent that is miscible with isopropanol, such as LC/MS-grade acetonitrile or methanol.

3. Make sure that residual sample components, impurities from the column, aggressive solvents or eluates with salt contents are completely flushed out of the flow cell.
4. *If the UV lamp is turned on*
   Close the shutter in the light path before the flow cell.

   -or-

   Turn off the UV lamp.
5. Stop the pump flow to the flow cell.

Follow these steps

1. Unpack the components from the flushing and injection kit. Remove the protection cap from the Viper fitting. Keep the packaging.
2. Screw the threaded end of the flushing adapter to the syringe.
3. Draw up highly pure isopropanol with the syringe through the Viper adapter, for example 1.0 mL.
4. Disconnect the capillary from the flow cell inlet.
5. Connect the Viper adapter to the flow cell inlet.
6. Push the isopropanol in the syringe into the flow cell. Make sure that no residual air in the syringe is pushed into the flow cell.
7. Disconnect the waste line from the flow cell outlet.
8. Disconnect the flushing adapter from the flow cell inlet.
9. Install the flow cell plugs to the flow cell inlet and flow cell outlet.
10. Unscrew the flushing adapter from the syringe.
11. Make sure that the adapter and the syringe are empty and dry.
12. Put the protection cap onto the Viper adapter.
13. Pack and store the components of the kit in their original packaging.
14. *If the flow cell is to be stored in its packaging*
    Remove the flow cell from the device and store it (see Removing the Flow Cell (▶ page 129)).

7.7.1.1 Performing a Manual Injection

A sample can also be injected manually using the flushing and injection kit.

Parts required

Flushing and injection kit for flow cells, including a syringe and a Viper adapter

NOTICE

Particulate matter from the eluate can deposit in the flow cell and clog it.

- Be careful not to inject any particulate matter into the flow cell.
- Only experienced users should perform a manual injection.

The manual injection requires setting suitable detection parameters, starting acquisition, performing an autozero and data interpretation afterward. The related injection procedures of autozero injection, sample injection and flushing are similar to the flushing procedure described in Preparing the Flow Cell for Storage (▸ page 126).

Observe the following guidelines when performing a manual injection:

- Avoid injecting any particulate matter into the flow cell.
- All solvents used must be miscible.
- Flush the sample completely out of the flow cell after measurement.

7.7.2 Removing the Flow Cell

When

- Storing or transporting the flow cell in its packaging
- Exchanging the flow cell
- Leakage occurred on the flow cell

Parts required

- *If the flow cell is to be stored*
  Packaging of the flow cell, the shipping locks and the plugs
- *If no flow cell is to be installed to the device afterward*
  Cover for the flow cell opening on the device

Preparations

1. *If the flow cell is to be stored*
   Flush the flow cell (see Preparing the Flow Cell for Storage (▷ page 126)).
2. Proceed as required:
   - *If a flow cell or diagnostic cell is to be installed*
     Close the shutter in the light path before the flow cell (if not yet done).
   - *If no flow cell is to be installed afterward*
     Turn off the UV lamp (if not yet done).
3. Wait until the flow cell has cooled down before you remove it.

Follow these steps

1. Disconnect the inlet capillary and waste line from the flow cell inlet and outlet (if not yet done).
2. After removing the flow connections, protect the flow cell inlet and outlet ports with plugs and protect the inlet capillaries and the waste line with caps. For this, use only the plugs and caps supplied with the capillary and waste line.
3. Turn the rotating locks on the flow cell simultaneously counterclockwise to a horizontal position to unlock the flow cell.
4. Carefully pull out the cell from the opening in the device.
5. *If the flow cell is to be stored*:
   a) Install the shipping locks to the flow cell.
   b) Store the flow cell in its original packaging that it was shipped in.

6. *If a flow cell or diagnostic cell is to be installed*: For instructions on installing a flow cell, see Installing the Flow Cell (▸ page 130) and on installing a diagnostic cell, see Installing the Diagnostic Cell (▸ page 142).
7. *If no flow cell is to be installed afterward*: Install the cover to the flow cell opening on the device:
   a) Check the position of the rotating locks on the cover. The rotating locks must be in a horizontal, open position. If required, turn the rotating locks counterclockwise to a horizontal position.
   b) Position the cover onto the flow cell opening. Make sure that the cover is in the correct orientation.
   c) Turn the rotating locks clockwise to a vertical position to close the rotating locks and thus, to cover the flow cell opening.

NOTICE

The flow cell opening on the device is sensitive to dust and debris.

If no flow cell is installed to the device, close the flow cell opening with the cover for the flow cell opening.

7.7.3 Installing the Flow Cell

When

- Exchanging a flow cell
- Installing a flow cell after storage

Parts required

Flow cell

NOTICE—Sensitive Flow Cells

Flow cells are highly sensitive to damage. Observe the following guidelines for use of the flow cell:

- Handle flow cells with care.
- Mechanical shocks, mechanical vibrations or intruding objects can lead to leaks on the flow cell or even destroy it. Avoid exposure of the flow cell to mechanical shocks or vibrations. Do not let it hit hard surfaces. Do not intrude the flow cell enclosure with any objects. Do not open the flow cell enclosure and do not disassemble the flow cell.

- The optical ports of the flow cell are sensitive to contamination and scratches. Do not touch the optical ports of the flow cell or immerse them. To avoid damage to the optical ports of the flow cell, be careful when inserting the flow cell into the flow cell opening of the detector.
- On the rear side of the flow cell, the contact pads for the identification chip are located. Never touch the contact pads. Avoid damage to the electronics of the ID chip.

Preparations

1. *If a flow cell is installed*: Remove the flow cell from the device.
2. *If the cover is installed to the flow cell opening on the device*:
   a) Turn the rotating locks on the cover of the flow cell opening on the device counterclockwise until they are in a horizontal position.
   b) Remove the cover from the flow cell opening. Keep the cover to close the flow cell opening when no flow cell is installed in the device.

NOTICE—Flow Cell Opening

The optical ports and the contact pad for the identification chip in the flow cell opening are sensitive to electrostatic discharge, contamination and scratches.

Do not touch any surfaces or optical ports in the flow cell opening.

3. Unpack the cell.

Follow these steps

1. Remove the shipping locks carefully on the left and right rear side of the flow cell.

TIP Store the shipping locks in the cell packaging to have them easily available when storing or shipping the cell.

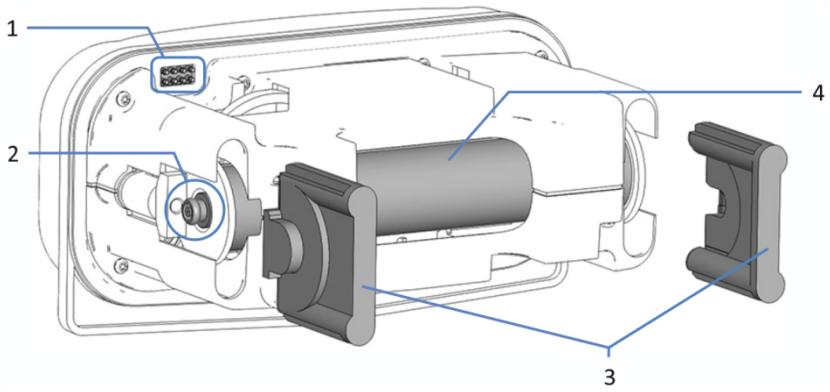

Figure 35: Rear side of the flow cell

No.	Description
1	Identification chip
2	Optical ports on the flow cell (on both sides of the flow cell) The ports are very sensitive and must not be touched.
3	Shipping locks To protect the flow cell during storage and transport.
4	Light pipe

2. Check the position of the rotating locks on the front of the flow cell. If the rotating locks are not in a horizontal position, turn them counterclockwise to a horizontal position. To insert the flow cell, the rotating locks must always be in a horizontal position and thus opened.

3. Carefully insert the flow cell into the flow cell opening in the device. The flow cell must sit completely in the opening.

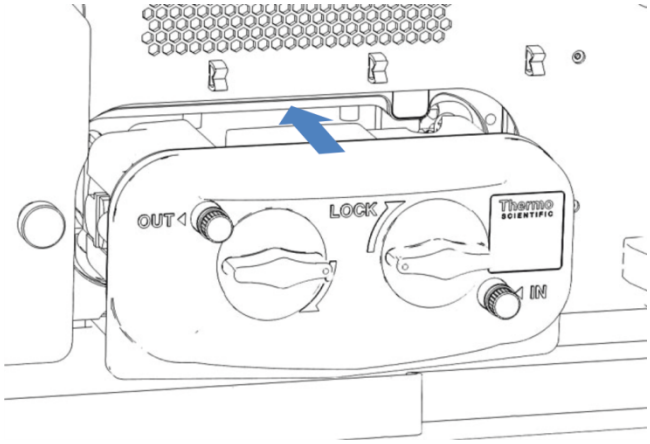

Figure 36: Inserting the flow cell with opened rotating locks

4. Turn the rotating locks simultaneously clockwise until they are in a vertical position. The flow cell is locked in place, when the rotating locks arrest.

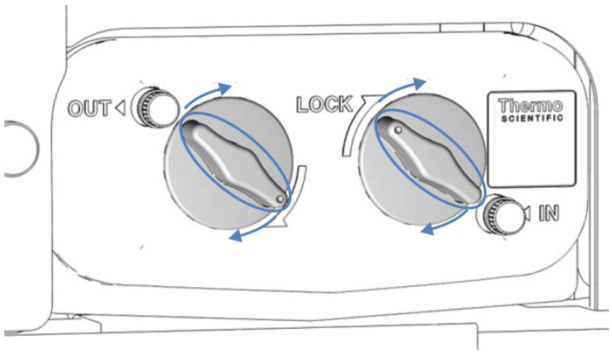

Figure 37: Closing the rotating locks

5. Check that the flow cell sits correctly in the flow cell opening. The front of the flow cell should lie flush with the device front panel.

6. Install the capillaries to the flow cell. Follow the instructions in Flow Connections to the Flow Cell (▸ page 66).

7. When flow is established to the flow cell, you can open the shutter in the light path before the flow cell.

8. Perform a wavelength validation (see Performing a Wavelength Validation and Wavelength Calibration (▸ page 120)).

7.7.4 Back-Flushing the Flow Cell

If a flow cell shows increased backpressure or even blockage, back-flushing the flow cell at a high flow rate can help to regain the original performance of the flow cell. This can also be performed as a remedy if the light transmittance of the flow cell is reduced due to contamination of the light pipe, causing increased noise and instable baseline.

To prevent damage to the flow cell, perform the back-flushing procedure only with the back-flush kit.

With the back-flush capillary, the pressure at the flow cell can be limited securely to the specified pressure range, even with blockages in the flow cell. The pressure that is applied to the flow cell is limited by a bypass flow through an overpressure line during the back-flush procedure. An in-line filter on the back-flush capillary prevents contamination of the flow cell or the overpressure line.

To remove the blockage (all particles and contamination) from the flow cell, it may be required to repeatedly flush the flow cell in alternating directions (backward and forward).

When

- Increased backpressure in the flow cell
- Blockage occurred in the flow cell
- Decreased optical transmission of the flow cell and increased backpressure

Parts required

- Back-flush kit for flow cells

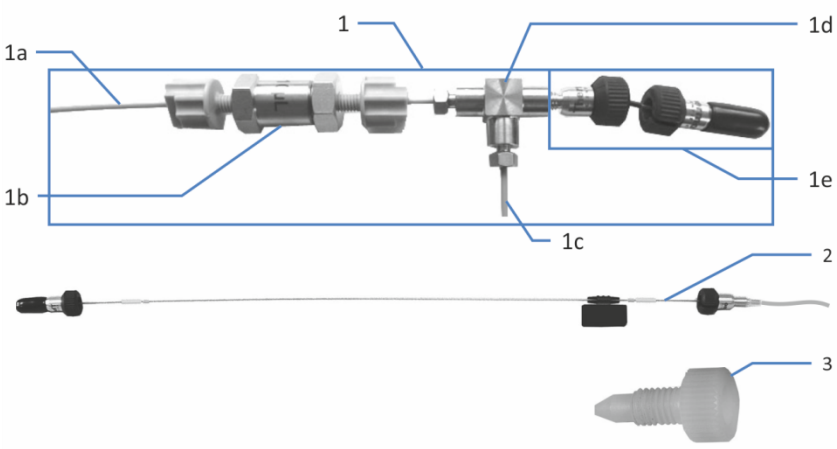

Figure 38: Back-flush kit

No.	Description
1	Back-flush capillary
1a	Inlet line for connection to the pump
1b	In-line filter
1c	Overpressure line to the waste
1d	T piece
1e	Flow cell capillary for connection to the flow cell
2	Back-flush waste line
3	Back-flush plug

- Back-flushing agent to remove the blockage in the flow cell, such as highly pure (e.g. LC/MS-grade) isopropanol, acetonitrile or methanol
- Flow cell shipping locks
- Waste container
- Overpressure relief valve, if available

Preparations

TIP

The numbers in parentheses in the procedures below refer to figure Back-flush kit (▷ page 135) above.

1. Remove the flow cell from the detector (see Removing the Flow Cell (▷ page 129)).
2. Make sure that the solvent in the flow cell is miscible with the back-flushing agent.
3. Install the cover to the flow cell opening on the detector.
4. Install the shipping locks to the flow cell.
5. Position the flow cell on a clean surface, close to the pump.
6. Determine the optimum pump flow (see the *Determining the required pump flow* section below).

TIP During the procedures, liquid will drop out of the tubing on the overpressure line (no. 1c) or waste line (no. 2) that are connected to the T piece (no. 1d). This is considered normal.

Avoid overtightening the connections.

Determining the required pump flow

NOTICE—Flow cells are highly sensitive to high pressures

Even if the pressure exceeds the upper limit for a very short time only, the flow cell may be permanently damaged.

Do not connect the flow cell to the pump for this pump flow determination procedure.

1. Connect the inlet line of the back-flush capillary (no. 1a) to the outlet of the pump.
2. Route the overpressure line of the back-flush capillary (no. 1c) to waste.

3. Disconnect the flow cell capillary from the back-flush capillary (no. 1e) and screw the back-flush plug (no. 3) into to the T piece (no. 1d). The image below shows the finalized setup for determining the pump flow.

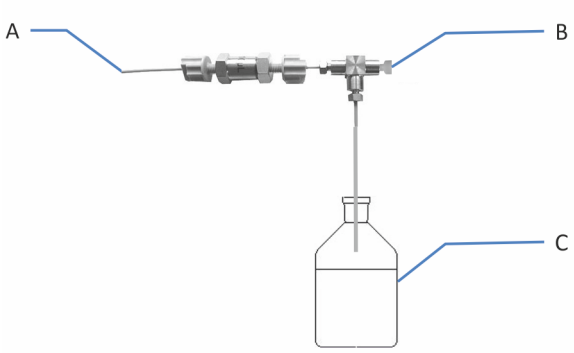

Figure 39: Setup for determining the pump flow

No.	Description
A	To the outlet of the pump
B	Plug
C	Waste container

4. Set the upper pressure limit of the pump to 60% of the specified pressure limit of the flow cell plus 0.5 MPa.
5. Turn on the pump flow at a flow rate of 0.1 mL/min with the back-flushing agent.
6. Slowly increase the pump flow until the pump pressure reaches 60% of the specified pressure limit of the flow cell and write down the determined value. If the pump pressure does not reach the 60%, set the maximum pump flow.
7. Stop the pump flow.
8. Flush the T piece (see the section below).

Flushing the T piece

1. Remove the back-flush plug (no. 3) from the T piece (no. 1d).
2. Connect the back-flush waste line (no. 2) to the back-flush capillary (no. 1) and route the free end of the tubing to waste.
   The image below shows the finalized setup for flushing the T piece.

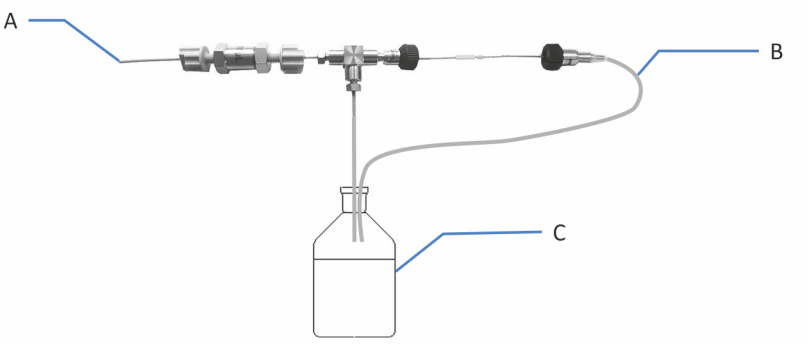

Figure 40: Setup for flushing the T piece

No.	Description
A	To the outlet of the pump
B	Back-flush waste line
C	Waste container

3. Turn on the pump flow with the pressure value determined in the *Determining the required pump flow* section.
4. Flush the T piece for 1 minute.
5. Stop the pump flow.
   If liquid dropped out on any surfaces, dry the surfaces with a tissue.
6. Back-flush the flow cell (see the *Back-flushing* section below).

Back-flushing

1. Disconnect the back-flush waste line (no. 2) from the back-flush capillary (no. 1).
2. Connect the flow cell capillary to the T piece (no. 1d).
3. Connect the back-flush waste line (no. 2) to the flow cell inlet.
4. Route the free end of the back-flush waste line (no. 2) to waste.

NOTICE—Flow cells are highly sensitive to high pressures

Even if the pressure exceeds the upper limit for a very short time only, the flow cell may be permanently damaged.

If available, install an overpressure relief valve between the flow cell outlet and the flow cell capillary for connection to the flow cell (no. 1e).

5. Connect the flow cell capillary of the back-flush kit (no. 1e) to the flow cell outlet.
   The image below shows the finalized setup for back-flushing the flow cell.

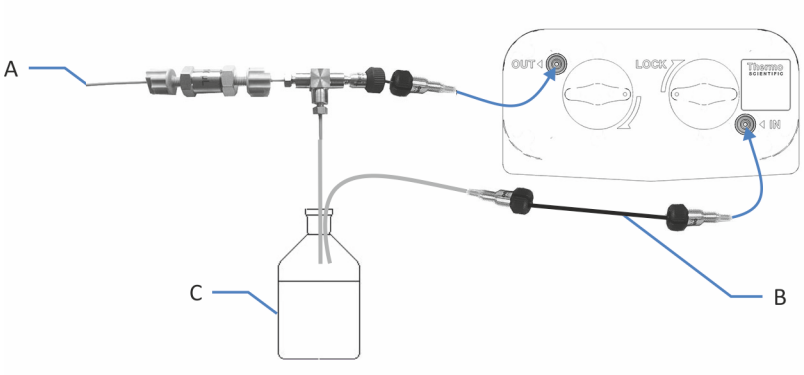

Figure 41: Setup for back-flushing (here: without overpressure relief valve)

No.	Description
A	To the outlet of the pump
B	Back-flush waste line
C	Waste container

6. Turn on the pump flow and operate it at the flow rate as determined in the *Determining the required pump flow* section.
7. Write down the pressure at the beginning of the flushing.
8. Flush the flow cell for 2 minutes with the back-flushing agent.
9. Stop the pump flow.
10. Forward flush the flow cell (see the *Forward flushing* section below).

Forward flushing

1. Switch the capillary connections on the flow cell: Connect the flow cell capillary of the back-flush capillary (no. 1e) to the flow cell inlet and the back-flush waste line (no. 2) to the flow cell outlet.
   The image below shows the finalized setup for forward flushing the flow cell.

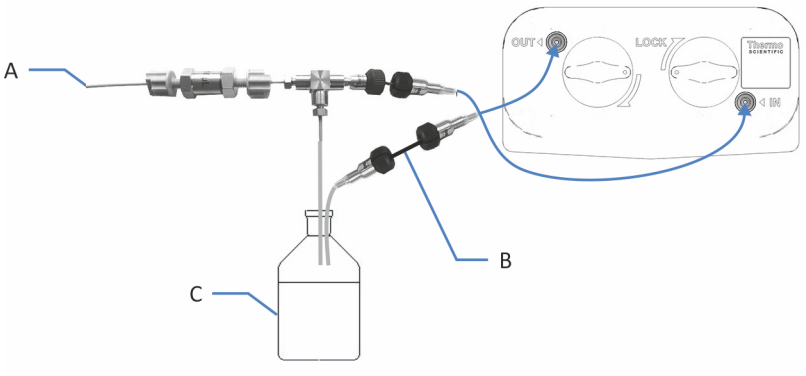

Figure 42: Setup for forward flushing (here: without overpressure relief valve)

No.	Description
A	To the outlet of the pump
B	Back-flush waste line
C	Waste container

NOTICE—Flow cells are highly sensitive to high pressures

Even if the pressure exceeds the upper limit for a very short time only, the flow cell may be permanently damaged.

If available, install an overpressure relief valve between the flow cell inlet and the flow cell capillary for connection to the flow cell (no. 1e).

2. Turn on the pump flow and operate it at the flow rate as determined in the *Determining the required pump flow* section.

3. Flush the flow cell for 2 minutes with the back-flushing agent.

4. Monitor the operating pressure:

Situation	Reason	Steps
If the pressure remains high at a value similar to the value that you wrote down	The clogging was not removed.	Thermo Fisher Scientific recommends performing another backward and forward flushing cycle: 1. Stop the pump flow. 2. Follow the steps starting with the *Back-flushing* section. If repeated flushing did not remove the clogging, proceed with the *Ending the flushing procedure* section below.
If the pressure is decreasing to a normal state and only a little liquid flows through the overpressure line.	The clogging is removed from the flow cell. As the blockage is flushed out, the pressure at the pump is usually decreasing. More of the liquid will flow through the flow cell and less fluid is leaving the overpressure line.	Proceed with the next steps.

Ending the flushing procedure

1. Stop the pump flow.
2. Disconnect the back-flush components:
   a) Disconnect the flow cell capillary and the back-flush waste line (no. 2) from the flow cell.
   b) Disconnect the inlet line (no. 1a) from the pump.
   c) Remove the overpressure line (no. 1c) and back-flush waste line (no. 2) from the waste.
3. Install the protection caps to the open Viper fittings of the flow cell capillary (no. 1e) and of the back-flush waste line (no. 2).
4. Pack and store the components of the kit in their original packaging.
5. Install the flow cell to the detector (see Installing the Flow Cell (▶ page 130)).
   Make sure that the first solvent that is delivered to the flow cell is miscible with the solvent that was used as back-flushing agent.

7.8 Diagnostic Cell

When problems with the baseline noise, baseline drift or during wavelength validation occur, install the diagnostic cell and use it to identify the cause:

- *If the problems disappear with the diagnostic cell*
  The problems are caused by the flow cell that was previously installed or the flow path or components in the flow path before the device.
- *If the problems remain with the diagnostic cell:*
  The device or the UV lamp is defective.

  For details on the possible causes for the problems, refer to the *System Troubleshooting* section in the *Vanquish System Operating Manual*.

7.8.1 Installing the Diagnostic Cell

Parts required

Diagnostic cell

Preparations

1. *If the UV lamp is turned on*
   Close the shutter in the light path before the flow cell.

   -or-

   Turn off the UV lamp.
2. *If a flow cell is installed*: Remove the flow cell from the device.
3. *If the cover is installed to the flow cell opening on the device*:
   a) Turn the rotating locks on the cover of the flow cell opening on the device counterclockwise until they are in a horizontal position.
   b) Remove the cover from the flow cell opening. Keep the cover to close the flow cell opening when no flow cell is installed in the device.

NOTICE—Flow Cell Opening

The optical ports and the contact pad for the identification chip in the flow cell opening are sensitive to electrostatic discharge, contamination and scratches.

Do not touch any surfaces or optical ports in the flow cell opening.

4. Unpack the cell.

Follow these steps

1. Remove the shipping locks carefully on the left and right rear side of the diagnostic cell.

TIP Store the shipping locks in the cell packaging to have them easily available when storing or shipping the cell.

2. Check the position of the rotating locks on the front of the diagnostic cell.
   If the rotating locks are not in a horizontal position, turn them counterclockwise to a horizontal position. To insert the cell, the rotating locks must always be in a horizontal position and thus opened.
3. Carefully insert the diagnostic cell into the flow cell opening of the device. The diagnostic cell must sit completely in the device.
4. Turn the rotating locks simultaneously clockwise until they are in a vertical position. The diagnostic cell is locked in place, when the rotating locks arrest.
5. Close the device doors to allow detection of the diagnostic cell. During this, the device reads the information on the ID chip of the diagnostic cell.
6. If the lamp is turned on, you can open the shutter in the light path before the diagnostic cell.

7.8.2 Removing the Diagnostic Cell

Preparations

- *If no flow cell is to be installed afterward*
  Turn off the UV lamp.
- *If a flow cell is to be installed afterward*
  Close the shutter in the light path before the diagnostic cell.

Follow these steps

1. Turn the rotating locks on the diagnostic cell simultaneously counterclockwise to a horizontal position to unlock the diagnostic cell.
2. Carefully pull out the cell from the opening in the device.
3. Store the diagnostic cell in its packaging.

4. Proceed as required:

Situation	Steps
If a flow cell is to be installed afterward	Install the flow cell to the flow cell opening on the device (see Installing the Flow Cell (▶ page 130)).
If no flow cell is to be installed afterward	Install the cover to the flow cell opening on the device: 1. Check the position of the rotating locks on the cover. The rotating locks must be in a horizontal, open position. If required, turn the rotating locks counterclockwise to a horizontal position. 2. Position the cover onto the flow cell opening. Make sure that the cover is in the correct orientation. 3. Turn the rotating locks clockwise to a vertical position to close the rotating locks and thus, to cover the flow cell opening.

NOTICE

The flow cell opening on the device is sensitive to dust and debris.

If no flow cell is installed to the device, close the flow cell opening with the cover for the flow cell opening.

7.9 Replacing the Waste Line

NOTICE

Backpressures that exceed the specified maximum pressure limit of the flow cell can destroy the flow cell. Observe the following:

- Use only the waste line connection that is provided for your detector.
- Connect the waste line to the flow cell only as described in the manual.
- Do not discharge waste from the flow cell through the open leakage drain system of the Vanquish system.
- Never expose the flow cell to excessive backpressure.
- Avoid clogging of the flow cell or waste line.
- When connecting a component in the flow path after the flow cell, observe the specified backpressure for the flow cell.

When

Blockage or leakage of one or more waste line components

Parts required

Detector waste line

For instructions on connecting the waste line, follow the steps in this section.

The waste line is routed through the system base and connected to the waste. For instructions, refer to the *Vanquish System Operating Manual*.

Tools required

Tubing cutter (optional)

Preparations

1. Close the shutter in the light path of the flow cell.
2. Stop the pump flow to the flow cell.

Follow these steps

1. When removing the waste line from the tubing guides, be careful not to pull on other tubing in the guides.
2. Disconnect the waste line from the flow cell outlet.

3. Remove the waste line from the top recess of the partition panel:
   - *If the waste line is installed in a rotating plug*
     Turn the plug in the top recess to the front and remove the waste line from it.
   - *If the waste line is installed in a plug with slit*
     Pull the waste line out of the slit.
4. Remove the waste line from the device waste port in the system base and from waste.
5. Unpack the replacement waste line.
6. Set up the waste line.

See also

Flow Connections to the Flow Cell (▶ page 66)

7.10 Replacing the Main Power Fuses

When

Blown fuses

Parts required

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

Tools required

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

Preparations

WARNING—Electric Shock

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

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

Follow these steps

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

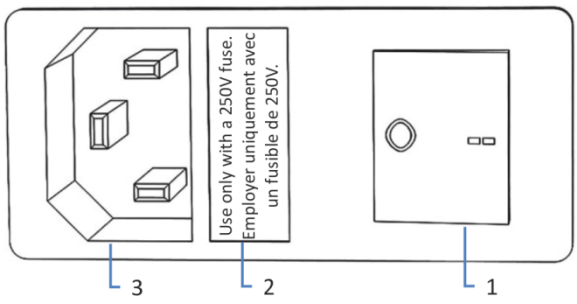

Figure 43: Fuse holder

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

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

7.11 Updating the Device Firmware

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

When

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

Items required

Firmware version/Chromeleon version as appropriate

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

Preparations

1. Read the release notes provided with the firmware and/or Chromeleon version.
2. Connect the device in the Chromeleon software.
3. Stop all operations on the Instrument that includes the device.
4. Wait until the Instrument is idle.

Follow these steps

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

NOTICE

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

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

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

4. Depends on the situation:

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

7.12 Replacing the Doors

When

Damage of door

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

Parts required

Replacement door

Follow these steps

NOTICE

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

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

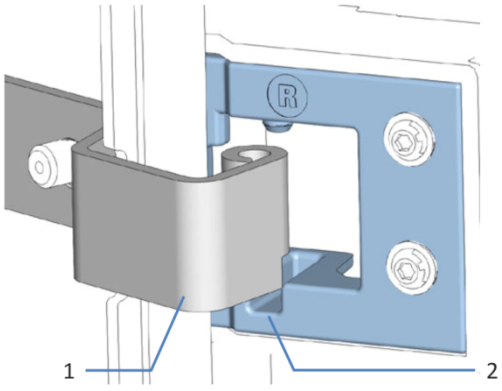

Figure 44: Unhinging a door

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

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

7.13 Transporting or Shipping the Device

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

Observe the following safety guidelines:

CAUTION—Heavy Load, Bulky Device

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

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

Follow these steps

1. Prepare the device for transport. See Preparing the Device for Transport (▷ page 153).
2. The step depends as follows:
   - ♦ To transport the device to a new location, follow the instructions in Transporting the Device to a New Location (▷ page 154).
   - ♦ To ship the device, follow the instructions in Shipping the Device (▷ page 155).

7.13.1 Preparing the Device for Transport

To prepare the device for transport, follow these steps:

1. Perform a long-term shut down of the device (see Long-Term Shutdown (▷ page 107)).
2. Turn off the device with its main power switch and disconnect the power cord.
3. Remove all cables and flow connections to other devices.

4. Remove the flow cell from the device and store it in its packaging. Ensure that you install the flow cell cover to the flow cell opening. Flow cells must be shipped in their original packaging.

NOTICE—Sensitive Flow Cells

Transporting the detector with a flow cell installed can lead to destruction of the flow cell.

Therefore, remove the flow cell before transporting the detector.

NOTICE

The flow cell opening on the device is sensitive to dust and debris.

If no flow cell is installed to the device, close the flow cell opening with the cover for the flow cell opening.

5. Remove the device or slide-in module from the system stack as required:
   Install the carrying handles and remove the device from the Vanquish system. Follow the instructions on dismounting the system stack in the *Transporting or Shipping the System* section of the *Vanquish System Operating Manual*.

   -or-

   Remove the slide-in module from the device enclosure in the system stack (see Removing the Slide-In Module (▸ page 156)).

7.13.2 Transporting the Device to a New Location

Preparations

Prepare the device for transport. See Preparing the Device for Transport (▸ page 153).

Follow these steps

1. Observe the notes for handling and lifting the device safely.
2. Transport the device to the new location.
3. Install and set up the device in the system stack. Follow the instructions on mounting the system stack in the *Vanquish System Operating Manual*.

4. Set up the device:
   a) Connect the device and set up flow connections (see Installation (▷ page 45)).
   b) Prepare the device for operation (see Preparing the Device for Operation (▷ page 90)).
5. Before starting an analysis, let the device equilibrate and be sure that it is ready for operation.

7.13.3 Shipping the Device

Preparations

Prepare the device for transport. See Preparing the Device for Transport (▷ page 153).

CAUTION—Possible Contamination

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

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

Follow these steps

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

Restarting the Device after Shipping

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

7.14 Replacing the Slide-In Module

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

7.14.1 Removing the Slide-In Module

CAUTION—Heavy Load, Bulky Device

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

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

Tools required

Screwdriver, Torx T20

Preparations

1. Prepare the device for transport. See Transporting or Shipping the Device (▷ page 153).

Follow these steps

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

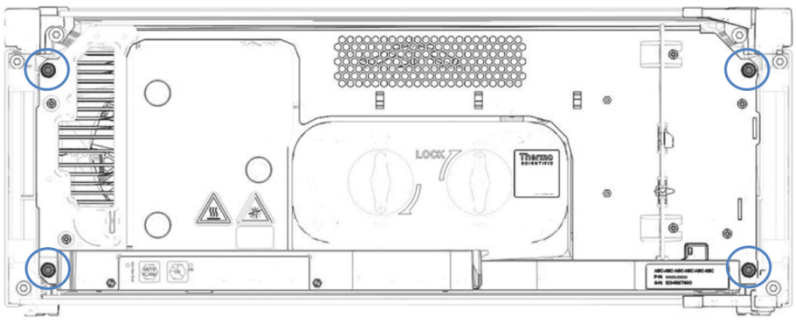

Figure 45: Captive screws on the slide-in module (doors not shown)

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, or by the lamp house cover and the partition panel, and pull the module out of the enclosure by approximately 10 cm.

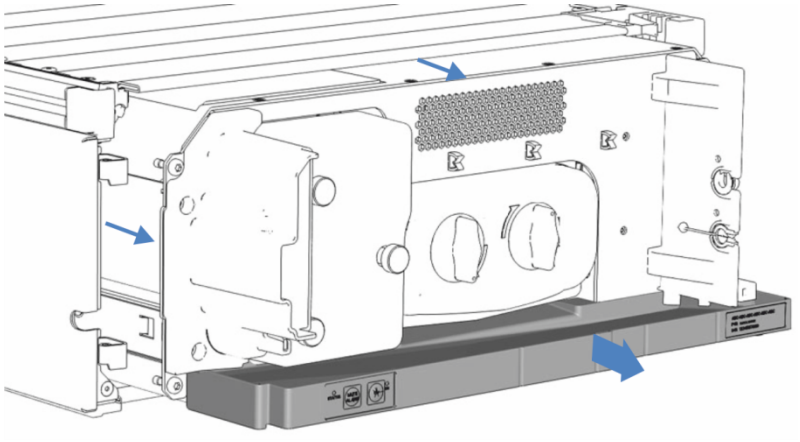

Figure 46: Pulling out the slide-in module (doors not shown)

NOTICE

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

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

4. Remove the slide-in module from the enclosure. The following steps require a team effort:

   a) Take the slide-in module on both sides from below.

   b) Pull the slide-in module from the rails towards the front.

   c) Place the slide-in module on a clean and stable surface.

7.14.2 Returning the Slide-In Module

CAUTION—Possible Contamination

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

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

Preparations

1. Remove the slide-in module from the enclosure. See Removing the Slide-In Module (▷ page 156).
2. If you have installed an expansion board, contact Service.

Follow these steps

1. Install the slide-in module to the enclosure of the replacement device. Follow the steps for inserting the slide-in module in the enclosure and tightening the captive screws in Installing the Slide-In Module (▷ page 158).
2. Follow the instructions in Shipping the Device (▷ page 155).

NOTICE

Shipping the slide-in module improperly leads to damage to the device.

Always ship the slide-in module as described in this operating manual.

7.14.3 Installing the Slide-In Module

CAUTION—Heavy Load, Bulky Device

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

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

Tools required

Screwdriver, Torx T20

Preparations

1. Unpack the replacement device. Remove the slide-in module from its enclosure as described in Removing the Slide-In Module (▸ page 156).
2. Verify that the device enclosure into which the slide-in module shall be installed is clean. If required, clean the inner and outer surfaces of the enclosure. See Cleaning or Decontaminating the Device (▸ page 117).
3. When installing the slide-in module to an enclosure in the system stack, check that the enclosure is placed correctly in the stack.

Follow these steps

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

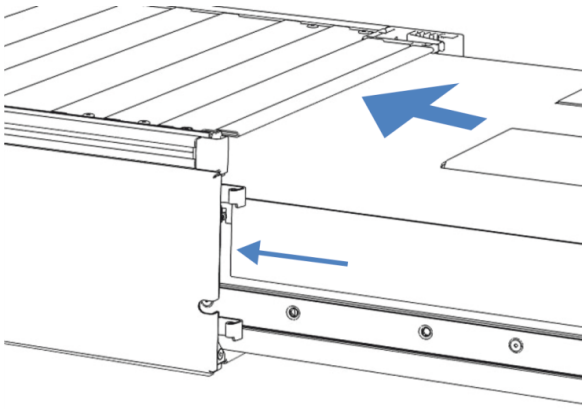

Figure 47: Inserting the slide-in module

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

NOTICE

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

8. Set up and restart the device.

7.14.4 Setting Up the Slide-In Module

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

Follow these steps

1. Set up the slide-in module:
   a) Connect the slide-in module and set up flow connections (see Installation (▸ page 45)).
   b) Prepare the slide-in module for first-time operation (see Preparing the Device for Operation (▸ page 90)).
   c) If you installed a replacement slide-in module, update the instrument configuration in the chromatography data system accordingly.
2. Prepare *all other* modules of the Vanquish system for operation and restart them. Refer to the *Operating Manuals* for the modules.
3. Before starting an analysis, let the chromatography system equilibrate and be sure that it is ready for operation.
4. In the Chromeleon software, run the device-specific **Performance Qualification** (PQ) tests.
5. When the test is completed, update the **QualificationDone** parameter.

8 Troubleshooting

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

8.1 General Information about Troubleshooting

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

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

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

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

Status Indicators

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

Alarms

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

Instrument Audit Trail Messages

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

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

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

Messages in the Instrument Audit Trail are preceded by an icon. The icon identifies the seriousness of the problem. For possible causes and remedial actions, see Messages (▶ page 164).

Firmware Failure

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

In this case, observe the following:

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

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

8.2 Messages

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

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

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

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

Message and Code	Description and Remedial Action
Unexpected module behavior. Code xx	xx = Two-digit to 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. **TIP** If the message appears with *code 103*, additional remedial actions are available. See further down this table. If the message appears again, contact Technical Support.
Module malfunction detected. Code xx	xx = two-digit to four-digit code number When the message appears, write down the message code. Turn off the module and contact Technical Support.
Code 22 X not detected	If the lamp is not detected, check whether the lamp is installed properly. Make sure that you use a lamp that is provided or recommended for your detector. If required, replace the lamp (see Replacing the Lamp (▸ page 122)). For all other undetected devices, contact Technical Support.
Code 33 Leak detected – eliminate within approx. xx seconds.	xx = the number of seconds within the leak must be resolved Find and eliminate the source for the leakage (see Resolving Liquid Leaks (▸ page 170)).
Code 34 Leak detected.	Find and eliminate the source for the leakage (see Resolving Liquid Leaks (▸ page 170)).

Message and Code	Description and Remedial Action
Code 36 Download failed.	The firmware download has not been successful. Repeat the download.
Code 37 Download firmware mismatch.	The firmware download has not been successful. The firmware is not suitable for the detector. Verify that the correct firmware file was selected. Repeat the download.
Code 52 Module software incomplete. Download firmware (again).	The firmware is incomplete, for example, because the communication between the chromatography data system and the module was interrupted during the firmware download. Repeat the download.
Code 89 Liquid leak sensor missing or defective.	Contact Thermo Fisher Scientific Technical Support for assistance. To operate the device nevertheless, you can disable the leak sensor functionality in the chromatography data system by setting **Leak Sensor Mode** to **Disabled**.
Code 90 Download firmware mismatch – invalid version.	You tried to download an incompatible firmware with an earlier version number than the firmware that is currently installed in the module. Downgrading the firmware may result in loss of functionality or malfunctioning of the module. If required, repeat the download with a firmware version later than the version currently installed in the module.
Code 118 USB Buffer Overflow.	This is a software problem. The module produces data faster than the computer on which the chromatography data system is running can process the data. 1. In the chromatography data system, disconnect and reconnect the module. 2. If this does not solve the problem, update the firmware or the chromatography data system version. 3. If the problem persists: Also, third-party software on the computer, for example, virus scanners or poor computer performance can cause the problem. Contact the onsite IT department.
Code 120 System interlink request timed out.	Communication with the module failed. The module did not respond in time. For the module for which the message appears: 1. Turn on the module if it is not yet turned on. 2. Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. 3. If the message persists, replace the system interlink cables.
Code 136 Lock request rejected – already locked by X.	X = lock holder ID, with keypad button ID, USB address referring to the chromatography data system or system interlink address referring to the system controller or a module The module is already locked by another software (system controller or chromatography data system) or a keypad button. Wait until the module is released from the locked state.
Code 137 Lock by X expired.	X = lock holder ID, with keypad button ID, USB address referring to the chromatography data system or system interlink address referring to the system controller or a module Inform Thermo Fisher Scientific about the occurrence. No further action required.

Message and Code	Description and Remedial Action
Code 3013 Unexpected optics behavior – flush flow cell with water.	Check whether the flow cell is installed correctly. Flush the flow cell with HPLC-grade water. If the error persists, contact Technical Support.
Code 3017 Command rejected – no or unspecified lamp.	Check that the lamp is installed properly. Make sure that you use a lamp that is provided for your device. If required, replace the lamp (see Replacing the Lamp (▸ page 122)).
Code 3020/3021 Unexpected module behavior. Code 3020/3021 xx	xx = defective part 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 and the messages indicates a customer replacement part (for example, lamp or flow cell), replace it. If the message appears again and the messages indicates a service replacement part, contact Technical Support. If code 3020/3021 appears together with code 22, perform the steps mentioned for code 22.
Code 3102 UV lamp malfunction. Code 3104 UV lamp malfunction.	Turn on the lamp once more. Check the lamp connector. Check that the lamp cover is installed properly. If the message appears again, replace the lamp (see Replacing the Lamp (▸ page 122)).
Code 3116 Data transfer error from detector to PC – check USB connection.	Check the USB connection. Use only the USB cables provided by Thermo Fisher Scientific for the device. Avoid CPU-intensive and time-consuming operations on the PC during high-speed data acquisition.
Code 3121 Unexpected high light intensity measured – check flow cell installation.	Turn the device off and on. If the message still appears, proceed as follows: • Check the flow cell (see Checking the Flow Cell (▸ page 169)). • Check the light intensity from the sample in the Audit Trail. • Replace the flow cell (see Flow Cell (▸ page 126)).
Code 3125 Wavelength calibration failed – check and flush the flow cell.	• Check the flow cell (see Checking the Flow Cell (▸ page 169)). If the message still appears, proceed as follows: • Check the lamp: If the lamp was newly installed, ensure that it is installed properly. If the lamp is old (counting, for example, more than 2000 operating hours), replace the lamp (see Replacing the Lamp (▸ page 122)). • Repeat the wavelength calibration.
Code 3132 Holmium validation failed – wavelength outside limits.	Repeat the validation. If the message still appears, proceed as follows: • Perform a calibration and repeat the validation again. • Ensure that the flow cell is installed properly. Remove and install the flow cell. Flush the flow cell with pure LC/MS-grade water with a flow rate of > 1 mL/min for several minutes. • Check the lamp: If the lamp was newly installed, ensure that it is installed properly. If the lamp is old (counting, for example, more than 2000 operating hours), replace the lamp (see Replacing the Lamp (▸ page 122)). • Install a different flow cell or, if available, a diagnostic cell. Perform a validation. Perform a calibration and repeat the validation again. If the message disappears with a different cell, the flow cell that was previously installed may be clogged. Perform a back-flushing procedure with this cell (see Back-Flushing the Flow Cell (▸ page 134)).

Message and Code	Description and Remedial Action
Code 3133 Holmium validation failed – specified wavelength not found.	Repeat the validation. If the message still appears, proceed as follows: • Perform a calibration and repeat the validation again. • Ensure that the flow cell is installed properly. Remove and install the flow cell. Flush the flow cell with pure LC/MS-grade water with a flow rate of > 1 mL/min for several minutes. • Check the lamp: If the lamp was newly installed, ensure that it is installed properly. If the lamp is old (counting, for example, more than 2000 operating hours), replace the lamp (see Replacing the Lamp (▸ page 122)). • Install a different flow cell or, if available, a diagnostic cell. Perform a validation. Perform a calibration and repeat the validation again. If the message disappears with a different cell, the flow cell that was previously installed may be clogged. Perform a back-flushing procedure with this cell (see Back-Flushing the Flow Cell (▸ page 134)).
Code 3142 Invalid data rate/ response time combination. Filter not effective.	Select a higher data rate or longer response time for the response time filter to be effective. Use the Chromeleon Instrument Method Wizard for valid combinations.
Code 3153 Bad calibration – check flow cell.	An error occurred during wavelength calibration. Check the flow cell (see Checking the Flow Cell (▸ page 169)). If the message still appears, check that the lamp is installed properly. Repeat the wavelength calibration.
Code 3156 Calibration failed. D-alpha line not found – check flow cell.	Repeat calibration. If the message still appears, check the flow cell (see Checking the Flow Cell (▸ page 169)). If the message still appears, install a different flow cell or, if available, a diagnostic cell. If the message still appears, check that the lamp is installed properly. Replace the lamp (see Replacing the Lamp (▸ page 122)).
Code 3162 xx over-temperature – emergency standby entered now.	xx = affected component (system or lamp house) Power the module off and let it cool down. Check for cooling air blockage. Lower the environmental temperature.
Code 3164 Data transfer error from detector to PC – check USB connection.	Check the USB connection. Use only the USB cables provided by Thermo Fisher Scientific for the device. Avoid CPU-intensive and time-consuming operations on the PC during high-speed data acquisition.
Code 3187 UV lamp cover not in place – check cover position.	Install the lamp cover correctly. Follow the installation steps for the lamp cover in Replacing the Lamp (▸ page 122).
Code 3193 UV lamp/Flow cell not installed.	• UV Lamp: Check that the lamp is installed properly. Make sure that you use a lamp that is provided for your device. If required, replace the lamp (see Replacing the Lamp (▸ page 122)). • Flow cell: Check the flow cell (see Checking the Flow Cell (▸ page 169)). Remove and install the flow cell.
Code 3197 Unsupported data rate. Please choose a different rate.	Set an appropriate data collection rate. See Selecting the Data Collection Rate (▸ page 101).
Code 3198 Invalid spectral data. Check flow cell.	• Make sure that the mobile phase does not show excessive absorption for the selected channel wavelength(s). • Check the flow cell (see Checking the Flow Cell (▸ page 169)). If the message still appears, check that the lamp is installed properly. Replace the lamp (see Replacing the Lamp (▸ page 122)).

Message and Code	Description and Remedial Action
Code 3199 Invalid auto-zero spectral data. Check flow cell.	The auto-zero data is close to dark current limit (very low intensity). • Make sure that the mobile phase does not show excessive absorption for the selected channel wavelength(s) during autozero. • Select a different start time for the autozero. • Check the flow cell (see Checking the Flow Cell (▷ page 169)). If the message still appears, check that the lamp is installed properly. Replace the lamp (see Replacing the Lamp (▷ page 122)).
Code 3210 Unexpected module behavior.	Check whether the lamp house cover is installed.

8.3 Checking the Flow Cell

When

Related messages that require a flow cell check appear in the Audit Trail.

Follow these steps

1. Check that the flow cell is installed properly.
2. Remove and re-install the flow cell.
3. Flush the flow cell with pure HPLC-grade water with a flow rate of >1 mL/min for several minutes.
4. Install a different flow cell and repeat the action during which the message appeared with the flow cell that was previously installed.

Result	Steps
If the message disappears with a different flow cell	The problems are caused by the flow cell that was previously installed or the flow path or components in the flow path before the detector. If you suspect a contamination or an elevated backpressure in the flow cell, perform a back-flushing procedure with the flow cell that was previously installed (see Back-Flushing the Flow Cell (▶ page 134)).
If the message still appears	The problem is caused by the flow path or components in the flow path before the detector or by the detector. Install a diagnostic cell and repeat the action during which the message appeared with the flow cell that was previously installed. • *If the message disappears with the diagnostic cell*: The problems are caused by the flow path or components in the flow path before the detector. • *If the message still appears*: The problems are caused by the detector.

See also

Messages (▶ page 164)

8.4 Resolving Liquid Leaks

When

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

Parts and additional items required

- Replacement part as required
- Cloth or tissue

Preparations

When resolving leakage, observe the safety guidelines and general rules for maintenance and service as presented in Maintenance and Service (▸ page 111).

Follow these steps

1. Locate the source of the leak. Leakage usually occurs at a connection. However, leakage may also have occurred inside the flow cell. If your configuration includes an overpressure relief valve, the leakage could also be caused by the overpressure relief valve.

Situation	Steps
Flow cell inlet and/or outlet	1. Tighten the connection where liquid is visible. 2. If the connection seems tight but is still leaking, remove the connection/fitting and check for damage. 3. If necessary, replace the inlet capillary or waste line.
If the overpressure relief valve releases liquid	1. Check whether the overpressure relief valve has opened due to an overpressure or whether it leaks due to dirt inside the overpressure relief valve. 2. Find and resolve the root cause for the overpressure or remove the dirt from the overpressure relief valve (refer to the *Overpressure Relief Valve Installation Guide*).
If liquid is in the leak tray but the flow cell inlet or outlet or the overpressure relief valve is not leaking	1. Remove the flow cell from the detector and inspect the flow cell for signs of leakage. 2. If signs of leakage are present at the flow cell, the flow is damaged and needs to be replaced. Carefully dry the flow cell opening in the detector and let remaining moisture evaporate before you replace the flow cell.

2. With a cloth or tissue, thoroughly absorb all liquid that has collected in the leak tray and under the leak sensor. Be careful not to bend the sensor.
3. Allow the sensor to adjust to the ambient temperature for a few minutes.
4. If leakage is no longer reported, you can resume operation.

9 Specifications

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

9.1 Performance Specifications

9.1.1 Detector Specifications

The device performance is specified as follows:

Type	Specification
Optical design	• Single-beam, reverse-optics design with concave holographic grating • High Numerical Aperture (NA) achromatic optics • 1024-element photodiode array
Light source	Deuterium lamp for UV and VIS wavelength range (30 W)
Wavelength range	190 – 680 nm
Spectral bandwidth	0.5 nm pixel resolution at average; optical resolution down to 1 nm with smallest slit
Diode bunching	1 – 100 nm, individually programmable for each signal channel and 3D field
Wavelength accuracy	± 1 nm
Wavelength repeatability	± 0.1 nm
Wavelength calibration	Internal calibration with D-alpha line of the deuterium lamp
Wavelength validation	Internal validation with holmium-oxide glass filter
Signal channels	10 signal channels
Data collection rate	Adjustable, 0.2 Hz – 200 Hz
Filter response times (in seconds)	0 (no filter), 0.02, 0.04, 0.1, 0.2, 0.4, 1, 2, 4, 10, 20
Spectra scan	3D field with full spectral range 200 Hz
Slit width	1 nm, 2 nm, 4 nm, 8 nm
Noise	<± 3 µAU at 230 nm ASTM <± 10 µAU at 520 nm ASTM Reference conditions: • Wavelength: as listed; bandwidth 4 nm; reference wavelength not used; slit width: 4 nm • Time constant: 2 sec (response time = 2.2 x time constant as proposed in ASTM). For details, see below this table. • Flow cell: 10 mm standard fused-silica flow cell • Flow: 0.5 mL/min LC/MS-grade water; column installed in flow path before flow cell; pump pressure: >7 MPa • See the temperature conditions below this table.

Type	Specification
Drift	<± 0.5 mAU/h at 230 nm Reference conditions: • Wavelength: as listed; bandwidth 4 nm; reference wavelength not used; slit width: 4 nm • Time constant: 2 sec (response time = 2.2 x time constant as proposed in ASTM). For details, see below this table. • Flow cell: 10 mm standard fused-silica flow cell • Flow: 0.5 mL/min LC/MS-grade water; column installed in flow path before flow cell; pump pressure: >7 MPa • See the temperature conditions below this table.
Linearity	<5% at 2.0 AU Typ. <5% at 2.5 AU Reference conditions: • Sample substance: caffeine • Wavelength: 272 nm; bandwidth 4 nm; reference wavelength not used; slit width: 4 nm • Time constant: 2 sec (response time = 2.2 x time constant as proposed in ASTM). For details, see below this table. • Flow cell: 10 mm standard fused-silica flow cell • See the temperature conditions below this table.
Communication	USB: • 1 USB port (USB 2.0, "B" type connector) • 1 USB hub with 3 ports (USB 2.0, "A" type connectors) System Interlink: 2 system interlink ports (RJ45-8 connectors)
Control	Chromeleon 7 The device can be operated also with other data systems. For details, contact the Thermo Fisher Scientific sales organization. Keypad with 2 buttons for performing certain functions directly from the device
Materials in the flow path	See the *Specifications* for the flow cells. **NOTICE** For information about the chemical resistance of materials refer to the technical literature.
Solvent and additive information	See Solvent and Additive Information (▶ page 27).
Safety features	Power-up check of optics, cooling fans, motors and electronics Leak detection and safe leak handling
Good Laboratory Practice (GLP) features	Predictive Performance functions for scheduling maintenance procedures based on the actual operating and usage conditions of the device. This includes monitoring of lamp age, lamp ignitions and lamp intensity. All system parameters are logged in the Chromeleon Audit Trail.

Temperature reference conditions for noise, drift and linearity specifications

For drift tests, ASTM requires that temperature changes stay below 2 °C/hour over a period of one hour. The drift specification above is based on these conditions. Larger changes in the ambient temperature will result in a larger drift.

For best performance, minimize the frequency and the amplitude of changes in the ambient temperature to 1 °C/hour.

All performance tests should be done with a completely warmed up optical unit (lamp turned on for more than two hours). ASTM requires that the detector should be turned on for at least 24 hours before the testing is started.

TIP Flow cells may show an increased drift for several hours after storage, contamination, or if the flow was stopped for some time.

Consider this when testing the drift specification of the device.

Time constant and response time

According to ASTM E1657-98, the time constant is converted to the response time by multiplying by the factor 2.2 (i.e., response time = 2.2 x time constant).

9.1.2 Flow Cell Specifications

The flow cell performances are specified as follows:

Specification	LightPipe flow cell, standard, 10 mm	LightPipe flow cell, high sensitivity, 60 mm
Path length	10 mm	60 mm
Illuminated volume	2 µL	13 µL
Dispersion volume	0.8 µL	4.0 µL
Pressure limit	6 MPa	6 MPa
Max. eluate temperature limit	50 °C	50 °C
Materials in the flow path	Fused silica, PEEK, perfluoro-elastomer, titanium	Fused silica, PEEK, perfluoro-elastomer, titanium
Biocompatibility	Yes	Yes
Normal-phase compatibility	No	No

9.2 Physical Specifications

The physical conditions of the device are specified as follows:

Type	Specification
Range of use	Indoor use only
Ambient operating temperature	5 °C - 35 °C
Ambient storage temperature	-20 °C - 45 °C
Ambient operating humidity	20% - 80% relative humidity (non-condensing)
Ambient storage humidity	Maximum 60% relative humidity (non-condensing)
Operating altitude	Maximum 2000 m above sea level
Pollution degree	2
Power requirements	100 – 240 V AC, ± 10 %; 50/60 Hz; max. 245 W / 255 VA
Overvoltage category	II
Emission sound pressure level	typically < 50 dB(A)
Dimensions (height x width x depth)	15.9 x 42 x 62 cm
Weight	Approx. 17 kg

10 Accessories, Consumables and Replacement Parts

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

10.1 General Information

The device must be operated only with the replacement parts and additional components, options, and peripherals specifically authorized and qualified by Thermo Fisher Scientific.

Accessories, consumables, and replacement parts are always maintained at the latest technical standard. Therefore, part numbers are subject to change. If not otherwise stated, updated parts will be compatible with the parts they replace.

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. Refer to the content list included in the kit for the most recent information about the kit content at the time when the device is shipped.

Item	Quantity in shipment
Partition panel plug for guiding insulated capillaries	1
Post-column cooler for column compartment, 1 µL, I.D. x length 0.1 x 240 mm, MP35N, connection column compartment - detector	1
System interlink cable	1
Tubing bracket	1
USB cable, USB 2.0, high-speed, type A to type B	1
Viper capillary, column compartment - detector	1
Waste line	1

For reordering information, see Consumables and Replacement Parts (▷ page 181).

10.3 Optional Accessories

Flow cells and Flow cells accessories

Item	Part No.
Back-flush kit for flow cells	6083.4210
Diagnostic cell	6083.0300
LightPipe flow cell, high sensitivity, fused silica, 60 mm	6083.0200B
LightPipe flow cell, standard, fused silica, 10 mm	6083.0100B
Flushing and injection kit for flow cells, including syringe	6083.4200
nanoViper™ capillary, I.D. x length 0.075 mm x 300 mm, fused silica/PEEK, insulated, connection column compartment - detector	6083.2415
Viper capillary, I.D. x length 0.13 mm x 350 mm, MP35N, insulated, connection column compartment - detector	6083.2410
Viper capillary, I.D. x length 0.1 mm x 250 mm, MP35N, insulated, connection column compartment - detector	6083.2406
Waste line	6083.2425

Miscellaneous

Item	Part No.
DAC board Provides two analog outputs. Contact Thermo Fisher Scientific Technical Support for installation.	6083.0900
Overpressure relief valve, 60 MPa Protects the flow cell when using switching valves, fraction collectors, mass spectrometers, or a second detector downstream of the flow cell.	6083.9260

10.4 Consumables and Replacement Parts

Lamp

Description	Part No.
UV lamp (deuterium lamp)	6083.1110

Capillaries and tubing for flow cells

Description	Part No.
Viper capillary, I.D. x length 0.10 mm x 300 mm, MP35N, insulated, connection column compartment - detector	6083.2405
Waste line, universal usage	6036.2425
For system capillaries, refer to the *Vanquish System Operating Manual.*	

Miscellaneous

Description	Part No.
Front door kit, including right door and left door	6083.3018
Packing material for the detector	6083.0090
Fuses kit, Vanquish system The kit includes the appropriate fuses for the Vanquish system modules. For the detector, use only 3.15 AT, 250 V AC, slow-blow fuses.	6036.0002

Interface cables

Description	Part No.
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 1 m	6035.9035A
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 5 m	6911.0002A

Power cords

Description	Part No.
Power cord, Australia	6000.1060
Power cord, China	6000.1080
Power cord, Denmark	6000.1070
Power cord, EU	6000.1000
Power cord, India, SA	6000.1090
Power cord, Italy	6000.1040
Power cord, Japan	6000.1050

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 UV cutoff wavelengths.

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.

EAC Declaration of Conformity

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

RoHS Compliance

This product complies with the RoHS (Restrictions of Hazardous Substances) directives:

- *European RoHS Directive*
  Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment

  The CE mark on the device indicates that the product is compliant with the directive.

- *China RoHS regulations*
  Measures for Administration of the Pollution Control of Electronic Information Products

  One of the following logos may be present on the device if applicable:

Logo	Description
	The green logo marks items that do not contain the hazardous substances identified by the regulations.
	The orange logo including a one-digit or two-digit number marks items that contain hazardous substances identified by the regulations. The number indicates the environment-friendly use period (EFUP) of the item. During this period, the item (when used as intended) will not cause serious damage to human health or environment. For more information, go to http://www.thermofisher.com/us/en/home/technical-resources/rohs-certificates.html

UKCA Declaration of Conformity

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

UL/CSA 61010-1 Compliance

The label of the NRTL Lab on the device (for example, cTUVus or CSA mark) indicates that the device has satisfied the requirements of the applicable standards.

11.1.2 WEEE Compliance

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

Figure 48: 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.

11.1.4 NIST Compliance

The holmium-oxide glass filter that is used in the device meets the requirements of the National Institute of Standards and Technology (NIST). For further information, refer to the *Declaration of Conformity for the Holmium-Oxide Glass Filter*.

11.1.5 Manual Release History

Revision	Covering
3.0	VH-D10
2.0a	VH-D10
2.0	VH-D10
1.0	VH-D10

The instructions were prepared in English (original instructions). Other language versions are translations based on the English original instructions.

11.2 UV Cutoff Wavelengths of Solvents

The UV cutoff wavelength is the minimum effective wavelength for the measurement. The mobile phase composition affects its UV cutoff wavelength.

In general, mobile phases are solvents, such as, water, acetonitrile, methanol, or other substances. They may also contain salts, such as sodium hydroxide (NaOH).

Most solvents have a UV cutoff wavelength within the spectral range of the device. For optimum measurement results, perform quantitative measurements at a wavelength that is sufficiently above the UV cutoff wavelength. The UV cutoff wavelength also depends on the quality of the solvent. For information about the UV cutoff wavelength for a solvent, contact the manufacturer of the solvent.

The refractive index of different solvents can differ. Therefore, changing the mobile phase composition can lead to baseline fluctuations.

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