thermoscientific

Vanquish

Fluorescence Detectors

VC-D50, VC-D51, VF-D50, VF-D51

Operating Manual

4820.7901-EN Revision 2.0 • December 2019

ThermoFisher SCIENTIFIC

Original Operating Manual

The hardware descriptions in this manual revision refer to devices VC-D50-A, VC-D51-A, VF-D50-A, VF-D51-A.

Trademarks

Disclaimer

Printed manual version only

Printed in Germany on 100% chlorine-free bleached, high-white paper that is produced in an environmentally friendly process, leading to a paper profile of zero CO_2 emissions.

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Contacting Us

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For ordering information or sales support for HPLC products, contact your local Thermo Fisher Scientific sales organization. For contact information, go to Contact Us on http://www.thermofisher.com.

Technical Assistance

For technical support for HPLC products, contact your local Thermo Fisher Scientific support organization. For contact information, go to Contact Us on http://www.thermofisher.com.

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.

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

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

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 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 Safety Messages

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

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

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

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

1.2.2 Special Notices and Informational Notes

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

NOTICE

Highlights information necessary to prevent damage to the 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 **Start > All Programs > Thermo Chromeleon 7 > Services Manager > Start Instrument Controller**.

References and Messages

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

Viewpoint

If not otherwise stated, the expressions *left* and *right* in this manual always refer to the viewpoint of a person that is facing the 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), for example, to sections and figures

1.3 Reference Documentation

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

Hardware Documentation

Additional hardware documentation includes the following:

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

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

Software Documentation

Additional software documentation includes the following:

- *Chromeleon™ 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.

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), line and fuse rating, and the manufacturer's address.

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.
- 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

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

CAUTION—Sparking due to Electrostatic Discharge

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

Prevent the generation of static electricity near the chromatography system.

2.3.6 In Case of Emergency

WARNING—Safety Hazard

In case of emergency, disconnect the 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.

TIP In a Vanquish Core system, normal-phase (NP) compatible solvents and additives may be used if the VC-pumps and the VC-autosamplers are modified with the components from the Normal-Phase (NP) kit. Refer to the *Operating Manuals* for the pumps and autosamplers.

2.4.2 Allowed pH Ranges

Allowed pH ranges (standard system configuration):

System (Standard Configuration)	Allowed pH ranges	Remarks
Vanquish Core	1-13	• *pH values of 2 or less*: 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. • *pH values higher than 12*: May affect electrochemical detection. Before using highly alkaline solvents for flushing the system, disconnect the detector from the system. • *Mobile phases containing ammonium hydroxide*: In rare cases, a shortened lifetime of reversed-phase (UHMW-PE) piston seals has been observed with high pH, ammonium hydroxide containing mobile phases and prolonged exposure.
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. • *Mobile phases containing ammonium hydroxide*: In rare cases, a shortened lifetime of reversed-phase (UHMW-PE) piston seals has been observed with high pH, ammonium hydroxide containing mobile phases and prolonged exposure.
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.
- Follow any specific recommendations presented in other sections of this manual. Refer also to the *operating manuals* for all modules in the Vanquish system. They may provide additional guidelines and information.
- 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*.

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 178)

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 xenon flash lamp for the complete excitation wavelength range from 200 nm to 880 nm as the light source of the device
- An optional second photomultiplier tube (PMT) to extend the emission wavelength range to the near-infrared spectral region (up to 900 nm) *without* any loss in sensitivity in the UV/VIS spectral region
- Data collection rates in single channel mode of up to 100 Hz (VC detectors) or 200 Hz (VF detectors under Chromeleon 7 software)
- A wavelength switching time < 250 ms
- Optimized detection for high sensitivity (signal-to-noise ratio higher than 550 for the Raman spectrum of water at 350 nm excitation), over the entire lifetime of the lamp. It is thus possible to detect even smallest peaks.
- Flow cells equipped with an active temperature control to ensure improved reproducibility when ambient temperature fluctuates
- A cut-off filter to suppress the higher-order radiation typical of grating spectrometers and scattering of light. For VF detectors, a filter wheel can be moved to 5 different positions with the help of a motor.
- Measurement of up to 4 data channels (VF detectors only) with independent parameter settings (PMT selection, wavelengths, sensitivity, filter wheel).

3.2 Operating Principle

Fluorescence detectors are optical detectors. In a fluorescence detector, the sample is exposed to light at a defined wavelength. The light is absorbed by the sample substance and causes the substance to be placed in an excited state (excitation). As the sample substance returns to its ground state, it emits light at a higher wavelength (emission). The photomultiplier tube (PMT) is positioned at an angle of 90° to the light source and detects the light that was emitted from the fluorescing substances.

In contrast to UV/VIS detectors, a fluorescence detector measures a very weak light signal rather than the difference between light intensities (absorbance).

Figure 1: Simplified presentation of a molecule absorbing light

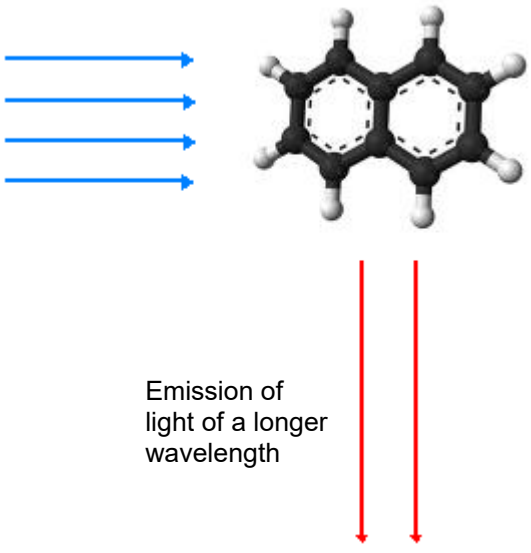

Figure 2: Simplified presentation of a molecule emitting light (fluorescence)

Fluorescence is used, for example, in highlighters or in whitening agents (optical brighteners). Fluorescent paint used in highlighters absorbs in the blue and near, non-visible ultraviolet range of the daylight and emits light at a longer wavelength (typically blue-green, yellow and red).

As shown in the following figure, the light beam from the xenon flash lamp (no. 1) is focused by the lamp optics (no. 2) through the entrance of the excitation monochromator (no. 3). The excitation monochromator transmits only light of the user-selected wavelength to the sample inside the flow cell (no. 4). Most of the light penetrates the sample, stimulating the sample to emit fluorescence light. A reference sensor (no. 5) behind the flow cell measures the intensity of the excitation light. The reference signal is used to compensate fluctuations in lamp intensity and thus improve sensitivity.

Upon exiting the flow cell, the emitted light is focused by the emission optics (no. 6) through the emission monochromator (no. 8).

A cut-off filter, which lets only light above a certain wavelength pass, is located before the emission monochromator. VF detectors have a filter wheel (no. 7) installed, which can be moved to 5 different positions with different cut-off wavelengths with the help of a motor. The selectable filter helps to achieve an even better sensitivity and increases flexibility during method development. With VC detectors, the filter has a fixed cut-off wavelength of 280 nm.

The emission monochromator transmits only the light with the user-selected emission wavelength to a photomultiplier tube (PMT) (no. 9), where the light intensity is measured. A second (optional) red-sensitive photomultiplier tube (no. 10) measures light in the near-infrared region (up to 900 nm).

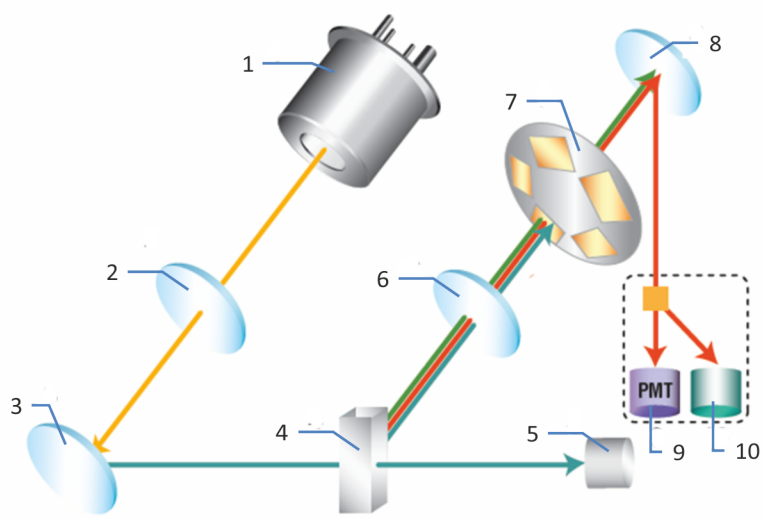

Figure 3: Optics Setup (schematic)

No.	Component	Description
1	Xenon flash lamp	Light source for the UV to near-infrared wavelength range
2	Lamp optics	Focuses the light beam emitted from the xenon flash lamp so that the beam passes through the excitation monochromator
3	Excitation monochromator	Lets only light with the selected excitation wavelength pass
4	Flow cell	The eluent with the analyte travels through the flow cell. The excitation light passes the flow cell to the reference sensor, the fluorescence light exits the flow cell at an angle of 90° to the excitation light.
5	Reference sensor	Measures the excitation light that passes the flow cell and is used to compensate lamp fluctuations
6	Emission optics	Focuses the light beam emitted from the flow cell so that the beam passes through the emission monochromator
7	Filter wheel	Carries the optical filters, which are used to cut off light below the cut-off wavelength of the selected filter
8	Emission monochromator	Lets only light with the selected emission wavelength pass
9	Photomultiplier tube (PMT)	Converts light into a measurable current
10	Second PMT	Measures light in the near-infrared region (up to 900 nm)

3.3 Interior Components

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

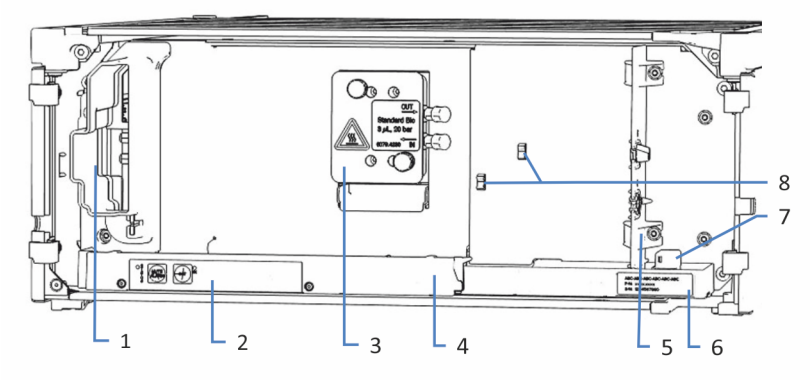

Figure 4: Interior view (here with flow cell installed)

No.	Description
1	Cooling air intake
2	Keypad with status indicators
3	Flow cell
4	Leak tray with leak sensor
5	Partition panel The recesses in the partition panel are used to route capillaries with the help of special plugs.
6	Type label, indicating the module name, serial number, part number, and revision number (if any)
7	Leak sensor
8	Capillary clips

3.4 Flow Cell

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

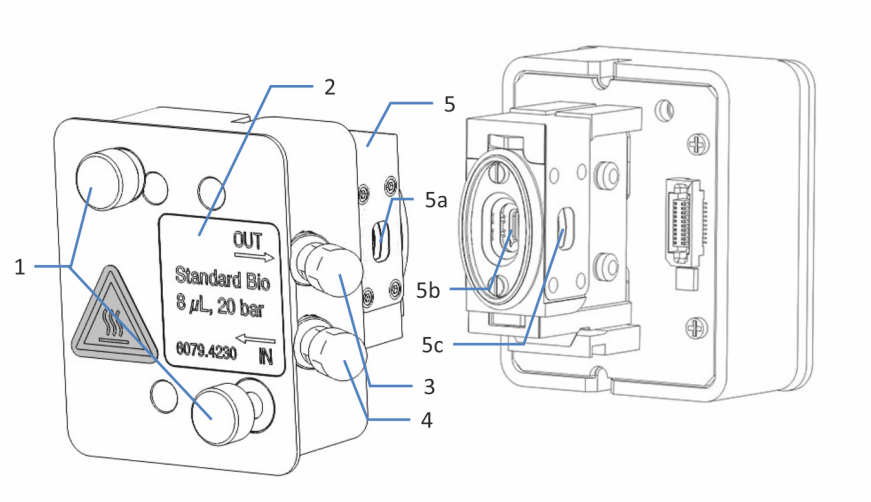

Figure 5: Flow cell (example)

No.	Description
1	Flow cell screws - Used to mount the flow cell to the detector.
2	Flow cell label
3	Outlet - Used to connect the waste line.
4	Inlet - Used to connect the inlet capillary.
5 5a, 5b, 5c	Optical block - Do not touch the optical block. Optical ports

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 and the front doors are closed, the device reads the data from the chip and transfers the flow cell data to the Chromeleon software.

Temperature Control

The flow cells are equipped with a temperature control unit. Flow cell and heat exchanger can be heated to a user-defined temperature.

The heat exchanger helps to adapt the temperature of the mobile phase to the flow cell temperature before the mobile phase enters the optical flow path within the flow cell. Note that the volume of the heat exchanger and inlet capillary influences the retention times and peak widths.

Flow Cell Types

All flow cells are optimized for fast separations with no loss in chromatographic resolution. To ensure optimum performance of the flow cells, observe the guidelines in Guidelines for Use of Flow Cells (▸ page 98).

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

For flow cell ordering information, see Optional Accessories (▸ page 174).

For the flow cell specifications, including materials in the flow path and temperature range, see Flow Cells (▸ page 168).

3.5 Lamp

The light source is a xenon flash lamp.

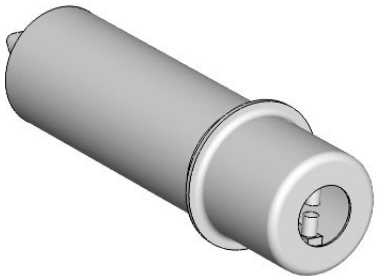

Figure 6: Xenon flash lamp

- The lamp is turned on when data acquisition starts, and automatically turned off after data acquisition was stopped to extend its lifetime.
- The flash frequency of the lamp varies, depending on the selected lamp mode. Selecting a different lamp mode during phases when no peaks of interest elute can extend the lamp lifetime.
- You can monitor the lamp age. This function can help to decide when a lamp is due to be replaced.
- The lamp must be replaced by a Thermo Fisher Scientific service engineer.

For details on the available lamp modes and how to extend the lamp lifetime, see Lamp Mode (▸ page 115).

For details on monitoring the lamp age, see Monitoring the Lamp Age (▸ page 131).

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 detector, allowing you to mute an alarm and initialize the device directly from the detector.

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.

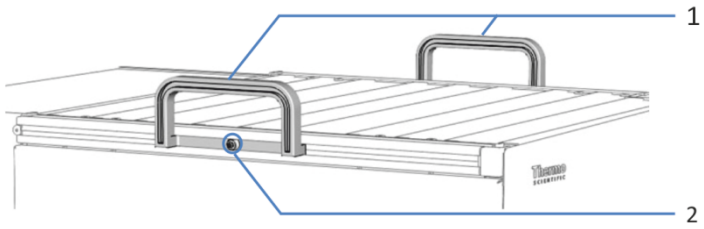

Figure 7: Carrying handles on the device

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 54)).

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.

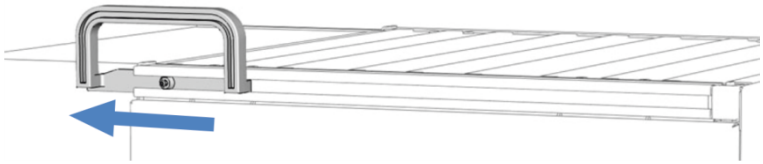

Figure 8: Sliding off the carrying handle from the left rail

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
- Power cord

For information on contents of the ship kit or reordering parts, see Accessories, Consumables and Replacement Parts (page 171).

5 Installation

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

5.1 Safety Guidelines for Installation

Pay attention to the following safety guidelines:

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

CAUTION—Heavy Load, Bulky Device

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

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

CAUTION—Electric Shock or Damage to the Device

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

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

5.2 Installing the Device

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

If personnel other than a Thermo Fisher Scientific service engineer installs the 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 48) and Site Requirements (▸ page 51).
2. Set up the device hardware. See Setting Up the Hardware (▸ page 54).
3. Set up the flow connections. See Setting Up the Flow Connections (▸ page 64).
4. Turn on the device. See Turning On the Device (▸ page 86).

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 87).
6. Perform a wavelength calibration and wavelength validation.

7. *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.

8. *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 146).

See also

- Performing a Wavelength Calibration (▸ page 132)
- Performing a Wavelength Validation (▸ page 134)

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 165) 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 23).

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.

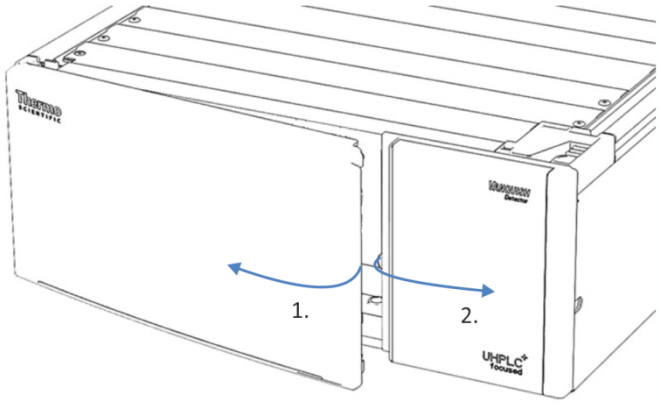

Figure 9: Opening the front doors

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.

The following illustrations show configurations with a single fluorescence detector, and with a fluorescence detector as a second detector on top of a UV/VIS detector.

TIP

Due to the pressure limit of the flow cell, the fluorescence detector should be the last module in the fluidic path whenever possible.

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

System with Single Detector

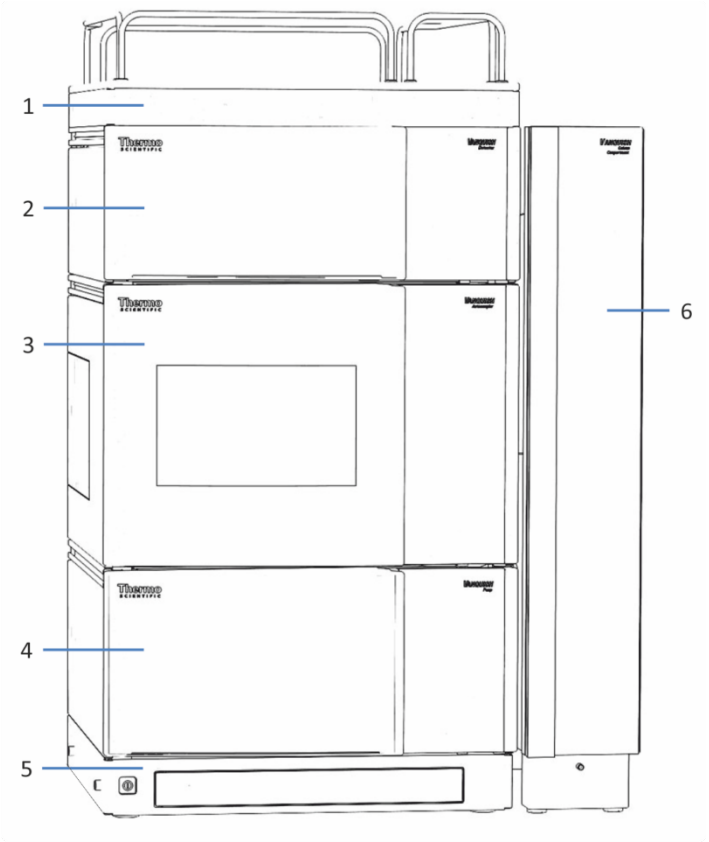

Figure 10: Vanquish system, standard configuration (example)

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

System with Fluorescence Detector as Second Detector

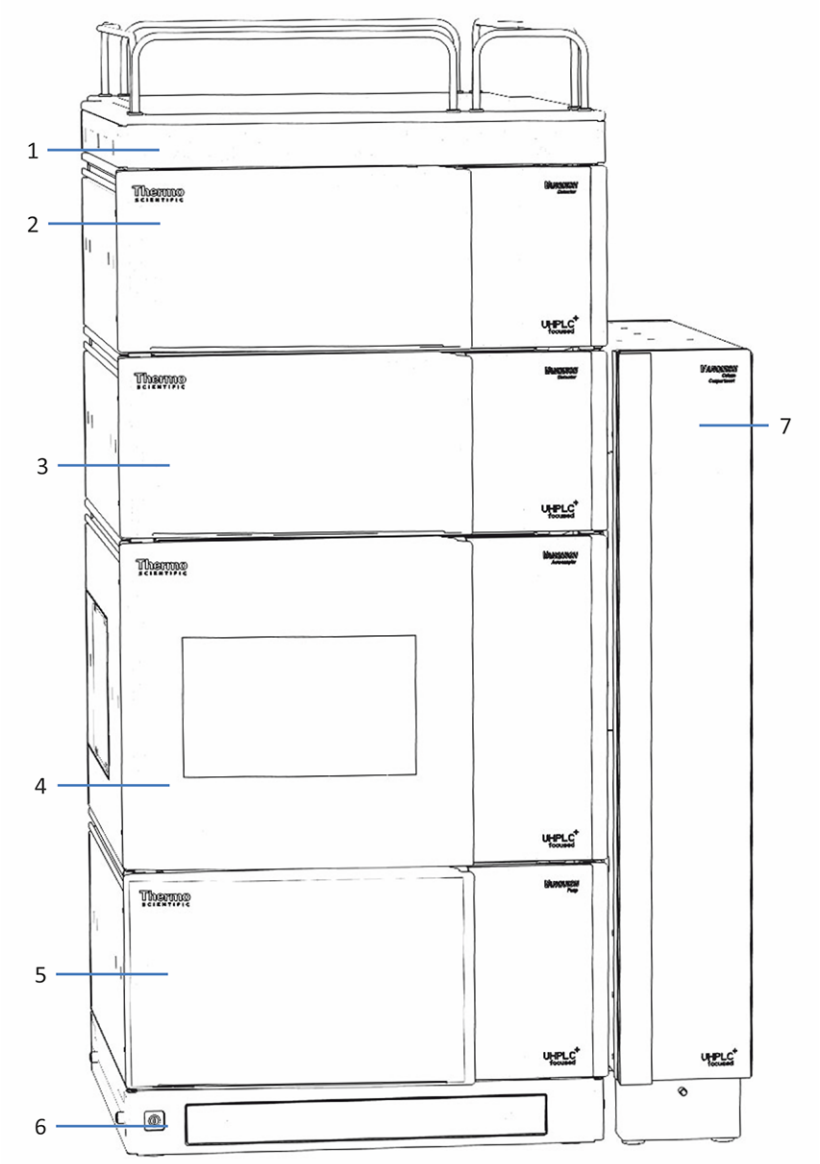

Figure 11: Vanquish system, configuration with two detectors (example)

No.	Description
1	Solvent Rack
2	Fluorescence Detector
3	UV/VIS Detector
4	Autosampler
5	Pump
6	System Base
7	Column Compartment

5.5.2 Connecting the Device

Device Connectors

The following connectors are provided on the device:

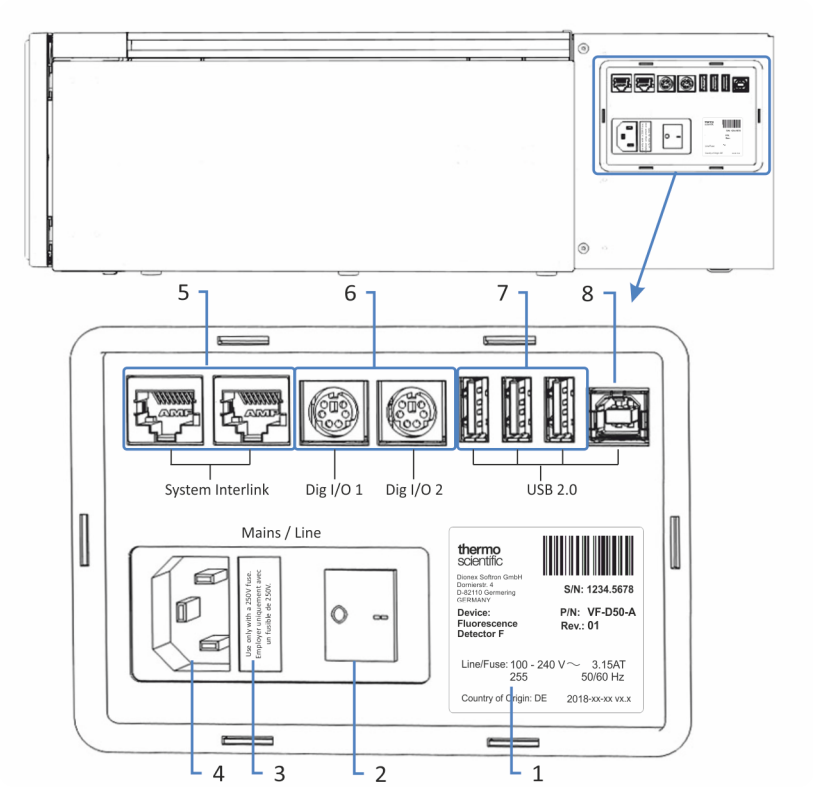

Figure 12: Electrical connectors on the right side of the detector

No.	Description
1	Rating plate, indicating the serial number, part number, module name, revision number (if any), line and fuse rating, and the manufacturer's address
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 detector from the Vanquish system base and device communication and synchronization between the detector and other modules in the Vanquish system. For example, the interconnection between autosampler and detector automatically enables direct synchronization of sample inject and data acquisition start in the detector. As a result, the synchronization improves the retention time reproducibility.

No.	Description
6	Digital I/O ports (Dig I/O)Allow exchange of digital signals with external instruments Each digital I/O port provides one input and one relay output. For connection and pin assignment information, see Digital I/O (▶ page 181).
7	USB hub ("A"-type connector) Allows connection to other modules in the Vanquish system
8	USB (Universal Serial Bus) port ("B" type connector) Allows connection to other modules in the Vanquish system or the computer on which the data management system is installed, such as the Chromeleon software

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

Follow these steps

NOTICE

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

1. Place the device in the system as required by the system configuration. For details, refer to the *Vanquish System Operating Manual*.
2. Connect the required interface cables to the device.
3. Connect the power cord (see Connecting the Power Cord (▶ page 61)).

See also

Connecting the Interface Cables (▶ page 59)

5.5.2.1 Connecting the Interface Cables

The connection of the interface cables depends on whether the detector is used as the only detector or as a second detector in the Vanquish system.

The Detector is the only Detector in the System

Connect the required interface cables to the detector. For information about how to connect the detector to other modules in the Vanquish system or to the chromatography data system computer, refer to the *Vanquish System Operating Manual*.

The Detector is the Second Detector in the System

If the fluorescence detector is the second detector in the Vanquish system (for example, after the diode array detector), set up the USB and system interlink connections as shown in the figure.

1. Follow the instructions in the *Vanquish System Operating Manual* to connect the other modules in the system up to the diode array detector.
2. Connect a USB cable from a free USB port on the diode array detector to the fluorescence detector.
3. Connect a system interlink cable from the free **System Interlink** port on the diode array detector to the fluorescence detector.
4. Connect a system interlink cable from the free **System Interlink** port on the diode array detector to the column compartment.

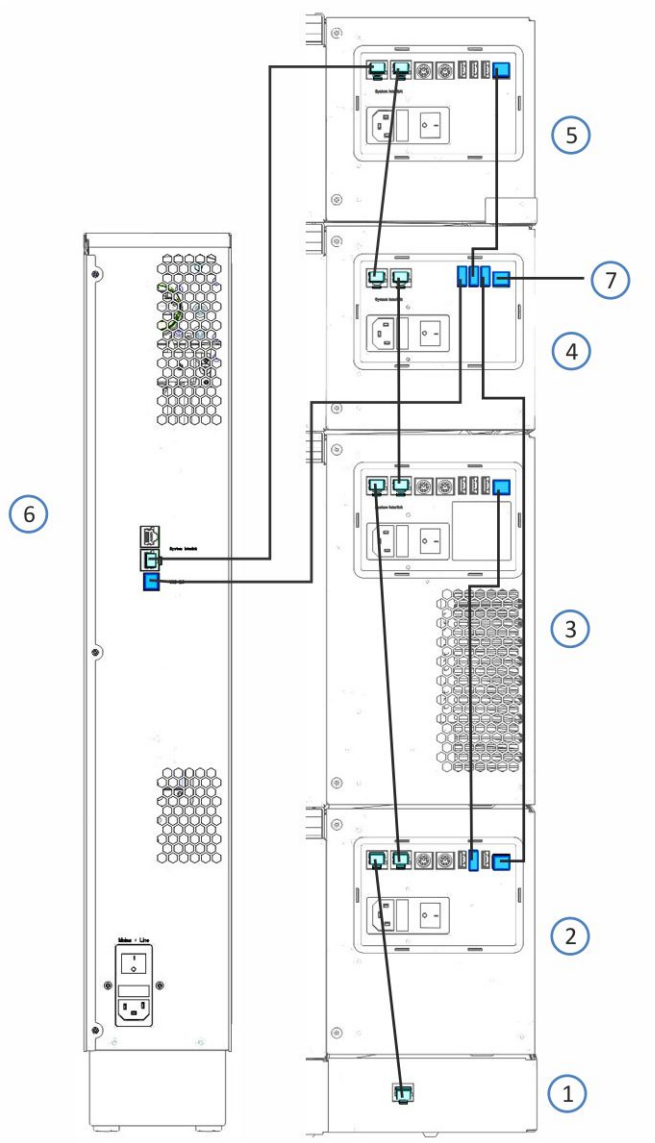

Figure 13: Cable connections in the Vanquish system with fluorescence detector and diode array detector (example)

No.	Description
1	System base
2	Pump
3	Sampler
4	Diode array detector
5	Fluorescence detector
6	Column compartment
7	Connection to computer

5.5.2.2 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.

5.5.3 Installing the Flow Cell

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

For instructions on removing a flow cell or installing a flow cell after storage, see Flow Cell (page 136).

NOTICE

Flow cells are highly sensitive to dirt and dust. Observe the following notes when installing the flow cell to the detector:

- When holding flow cells, do not touch the optical block of the flow cell or the sensitive electronics on the flow cell rear side.
- 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 device.
- 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.

Parts required

Flow cell

Preparations

1. Remove the cover from the flow cell opening. To do so, loosen the two finger-tight screws. The screws are captive in the cover and do not need to be removed.

TIP Keep the cover to close the flow cell opening when no flow cell is installed in the device, especially when the detector is transported or shipped.

2. Unpack the flow cell.

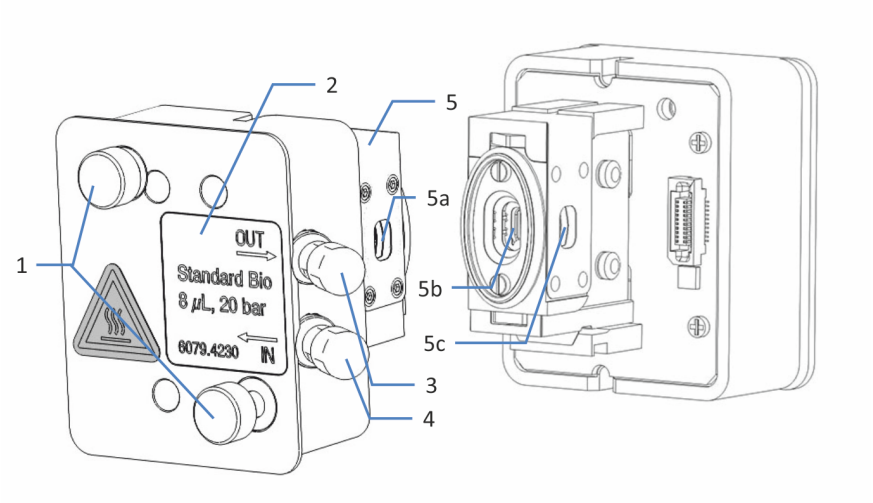

Figure 14: Flow cell of the fluorescence detector

No.	Description
1	Flow cell screws - Used to mount the flow cell to the detector.
2	Flow cell label
3	Outlet - Used to connect the waste line.
4	Inlet - Used to connect the inlet capillary.
5 5a, 5b, 5c	Optical block - Do not touch the optical block. Optical ports

Follow these steps

1. Insert the flow cell straight into the flow cell opening.

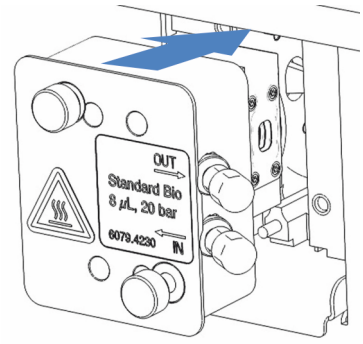

Figure 15: Inserting the flow cell

2. Tighten the flow cell screws hand-tight.

5.6 Setting Up the Flow Connections

5.6.1 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. Do not invert the flow cell inlet and outlet.

- Operating switching valves, fraction collectors, mass spectrometers, or a second detector downstream of the flow cell under flow will result in pressure spikes that can destroy the flow cell. If using those devices, you need to install an overpressure relief valve (available as an accessory for the Micro flow cell, opens at 4 MPa (40 bar)). Even if you use an overpressure relief valve, switching flows may damage the flow cell. Switch the flow rarely and only if it is absolutely necessary.

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 71)).
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 68).

5.6.2 Guiding Capillaries and Tubing Through the System

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

Tubing Chase, Tubing Guide, Tubing Bracket

To guide certain tubes and lines (solvent tubing, wash liquid tubing, detector waste line) from the top module to the bottom module in the Vanquish system stack, the stackable modules have a tubing chase on the inside right.

The tubing chase provides four tubing guides. Each guide can hold up to three tubes or lines.

In each module, push the tube (or line) into the appropriate guide.

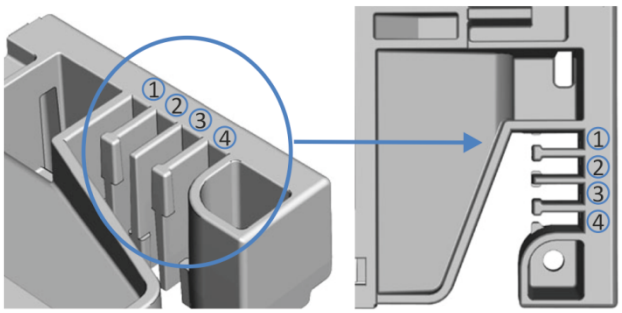

Figure 16: Tubing chase with tubing guides (left: view from inside, right: view from top)

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

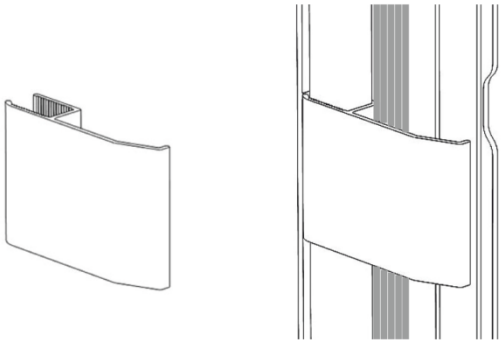

Figure 17: Tubing bracket (left), tubing bracket installed (right)

Dual System Arrangements

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

Guide Holes and Capillary Clips

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

5.6.3 Installing the Partition Panel Plugs

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

Figure 18: 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.

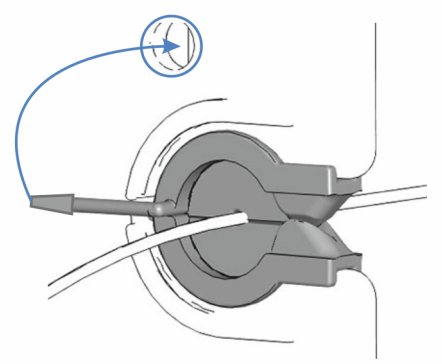

Figure 19: Securing the partition panel plug with slit

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

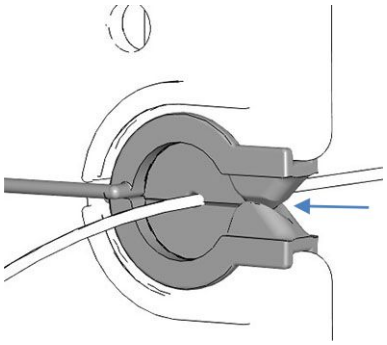

Figure 20: Capillary installed in the plug with slit

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.

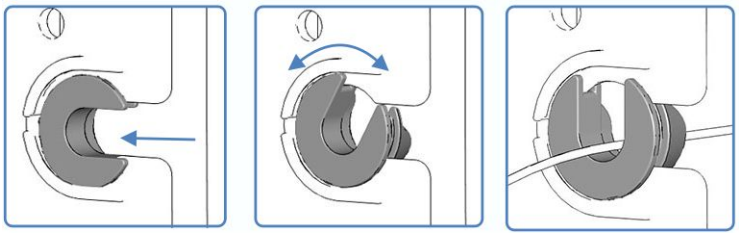

Figure 21: Using the rotating plug

5.6.4 Connecting Fittings, Capillaries, and Tubing

The inlet and outlet ports of the flow cells support the following capillary fittings:

- Viper™
- nanoViper™
- Standard 1/16" HPLC fittings using ferrules (PEEK, SST) or finger-tight fittings (PEEK)

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

5.6.4.1 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.

5.6.4.2 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.

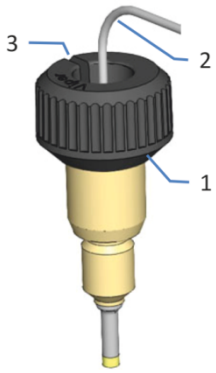

Figure 22: Viper fitting with knurl

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

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

Resolving Leakage of Viper Fittings with Knurls

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

5.6.5 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

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.

In addition, observe the guidelines for proper connection of the flow cell in General Information and Guidelines (▷ page 64).

Parts required

- Inlet capillary, depending on your system arrangement:
  - *The detector is the only detector in the Vanquish system*
    Use the inlet capillary from the system ship kit.
  - *The detector is the second detector in the Vanquish system*
    Use the larger ID capillary shipped with the detector.
- Detector waste line
  For instructions on connecting the waste line, follow the steps in Connecting the Detector Waste Line (▷ page 75).

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. On the flow cell, 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 67).

Follow these steps

1. Connect the inlet capillary to the flow cell.
2. Connect the detector waste line to the flow cell.

See also

Connecting the Inlet Capillary (▷ page 72)
Connecting the Detector Waste Line (▷ page 75)

5.6.5.1 *Connecting the Inlet Capillary*

Depending on the modules in your Vanquish system, you can connect the inlet capillary directly from the column compartment or from a previous detector in the system flow path.

Preparations

See Flow Connections to the Flow Cell (▷ page 71).

Follow these steps

Connect the inlet capillary to the fluorescence detector flow cell inlet as required by the system arrangement:

- Connect the inlet capillary from the column compartment (see below)
  –or–
- Connect the capillary from the outlet of the UV/VIS detector.

Connecting the inlet capillary from the column compartment

Connect the inlet capillary between column compartment and fluorescence detector flow cell inlet. The figure shows the steps to establish the connection from a column compartment as an example.

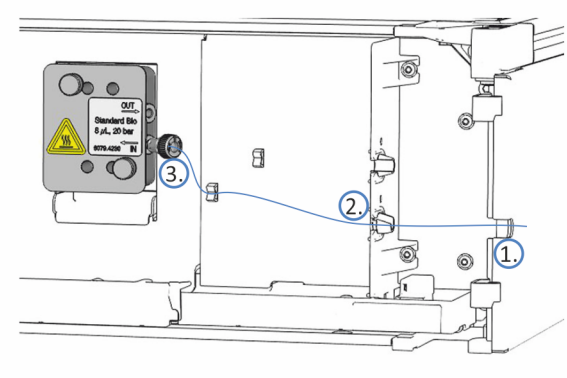

Figure 23: Connecting the inlet capillary from the column compartment (example)

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 dispersion (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 capillary to the flow cell inlet. Make sure that you secure the inlet capillary appropriately in the capillary clip on the front panel.

Connecting the inlet capillary from the UV/VIS detector

Connect the capillary between UV/VIS detector flow cell outlet and fluorescence detector flow cell inlet. The figure shows the steps to establish the connection from a diode array detector as an example. The fluorescence detector must be the last detector connected in the flow path.

NOTICE

Be aware of the backpressure limit of the flow cell in the Vanquish UV/VIS detector connected in the flow path before the fluorescence detector. Connect the capillary from the UV/VIS detector directly to the fluorescence detector flow cell inlet. Avoid connecting any additional components in the flow path between the two detectors. Refer to the *Operating Manual for the UV/VIS detector*.

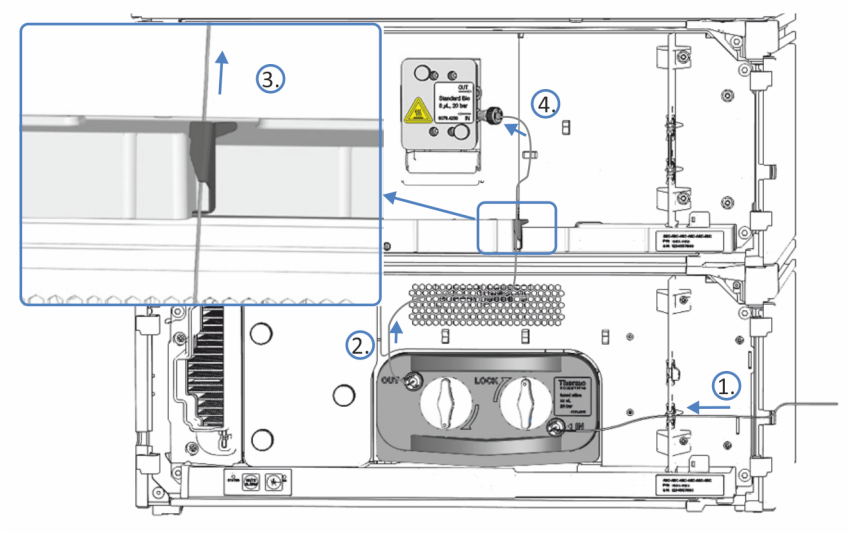

Figure 24: Connecting the inlet capillary from the diode array detector (example)

1. Connect the inlet capillary from the column compartment to the flow cell inlet of the first detector. Refer to the instructions in the *Operating Manual* for the first detector in the Vanquish system flow path.
2. Route the connecting capillary from the flow cell outlet of the first detector upward to the fluorescence detector.
3. On the leak tray of the fluorescence detector, pull the capillary clip carefully to the right to open the clip.
4. Position the capillary behind the capillary clip.
5. Carefully release the clip and take care not to clamp the capillary. The capillary must be secured behind the clip.

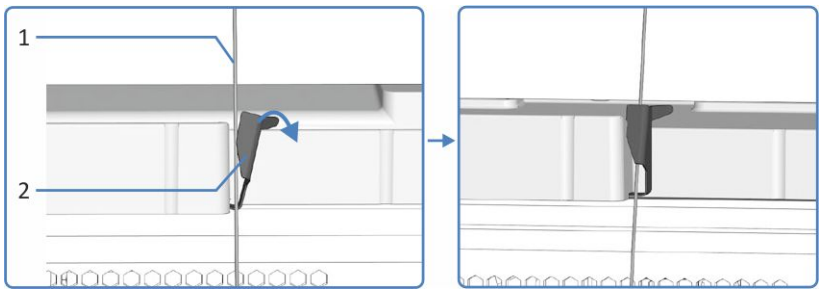

Figure 25: Securing the capillary behind the capillary clip on the leak tray

No.	Description	No.	Description
1	Capillary from the flow cell	2	Capillary clip

6. Connect the inlet capillary to the flow cell inlet of the fluorescence detector. Make sure that you secure the inlet capillary appropriately in the capillary clip on the front panel.

5.6.5.2 Connecting the Detector Waste Line

Preparations

1. See Flow Connections to the Flow Cell (page 71).

Follow these steps

Connect the detector waste line between fluorescence detector flow cell outlet and the waste. The figure shows the steps to establish the connection from the fluorescence detector flow cell outlet.

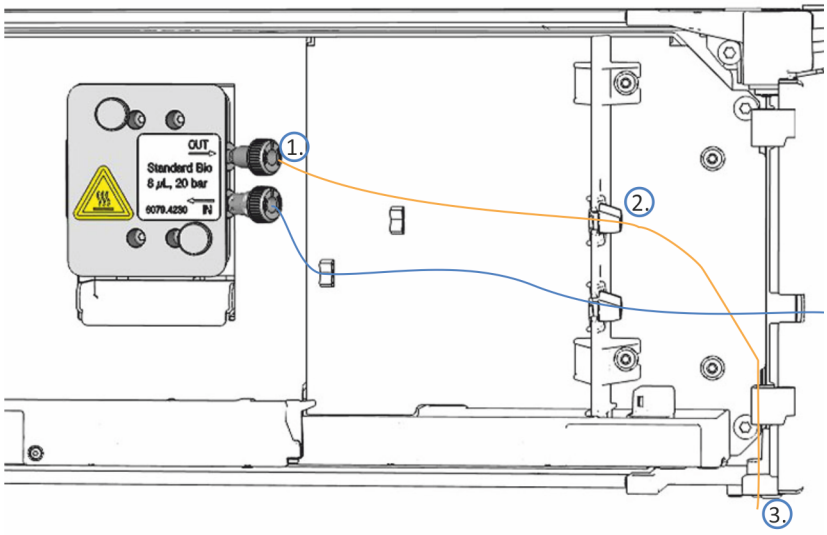

Figure 26: Connecting the detector waste line

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.

5.6.6 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*.

5.7 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.

When

- If you install additional modules 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
- 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 78)).
   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) (see Measuring the Vanquish System Backpressure (Without Flow Cell) (▶ page 80)).
   Flow path: Pump – autosampler – column – waste line

3. Determine the backpressure of the transfer capillary and the additional module (see Determining the Backpressure of the Transfer Capillary and the Additional Module (Without Flow Cell) (▷ page 81)).
   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 83)).
   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 84)).
   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 Cells (▷ page 168)

5.7.1 Measuring the Backpressure of the Waste Line

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

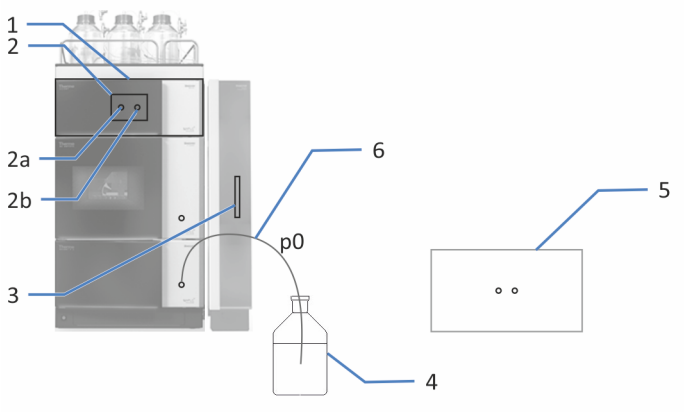

Figure 27: Measuring the backpressure of the waste line

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 162).
   - *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 in Chromeleon and write down the value for p0.
   p0: Pressure drop of 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.

5.7.2 Measuring the Vanquish System Backpressure (Without Flow Cell)

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

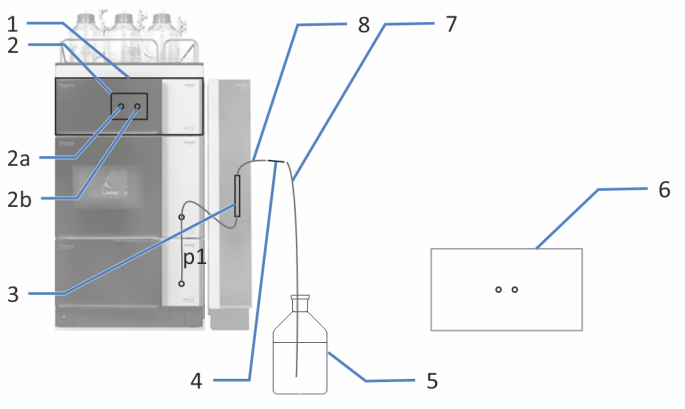

Figure 28: Measuring the Vanquish system backpressure (without flow cell)

No.	Description	No.	Description
1	Detector	4	Union connector
2	Flow cell	5	Waste container
2a	Outlet port of the flow cell	6	Second detector
2b	Inlet port of the flow cell	7	Waste line
3	Column	8	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 162).
   - *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 in Chromeleon and write down the value for p1.
   p1: Pressure drop at the column, detector inlet capillary and the waste line

8. Stop the pump flow.

See also

Flow Connections to the Flow Cell (▶ page 71)

5.7.3 Determining the Backpressure of the Transfer Capillary and the Additional Module (Without Flow Cell)

This procedure first describes how to measure the backpressure of the additional module including that of the column, detector inlet capillary (and waste line) (p2). Afterward, the backpressure of the transfer capillary and the additional module is calculated (p3) by subtracting the backpressure of the column, detector inlet capillary (and the waste line) (p1).

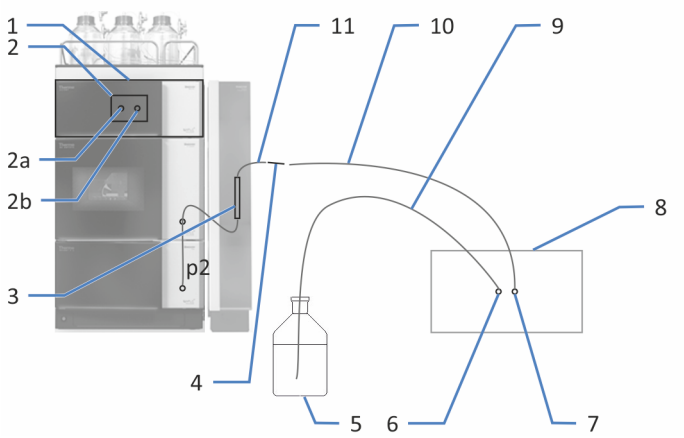

Figure 29: Determining the backpressure of a second detector (example)

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
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 a second detector is used*: 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 162).
   - *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 in Chromeleon and write down the value for p2.
   p2: Pressure drop at the transfer capillary and the additional module including the column, detector inlet capillary and waste line
8. Stop the pump flow.
9. Calculate the difference between the two measured pressure values: p3 = p2 – p1.
   p3: Pressure drop at the transfer capillary and the additional module

   p2: Pressure drop at the transfer capillary and the additional module including the column, detector inlet capillary and waste line

   p1: Pressure drop at the column, detector inlet capillary and 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 83).
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 Cells (▸ page 168)

5.7.4 Determining the Backpressure of the Flow Cell

This procedure first describes how to measure the backpressure of the flow cell (p4) including that of the column, detector inlet capillary and waste line. Afterward, the backpressure of the column, detector inlet capillary and the waste line (p1) is subtracted.

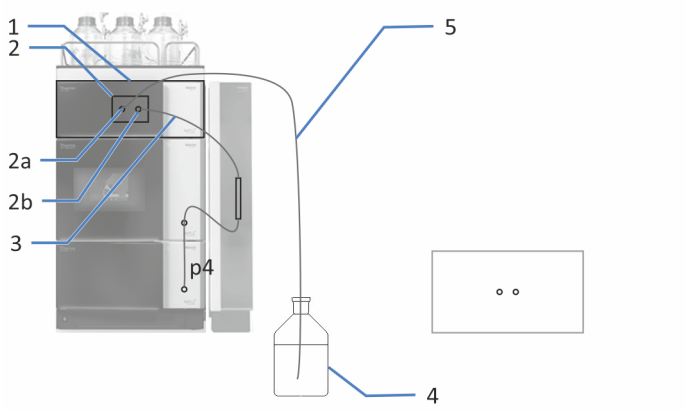

Figure 30: Measuring the backpressure of the flow cell including column, detector inlet capillary and waste line

No.	Description	No.	Description
1	Detector	3	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 71).
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 162).
   - *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 in Chromeleon and write down the value for p4.
   p4: Pressure drop at the flow cell including the column, detector inlet capillary and waste line

5. Stop the pump flow.

6. Calculate the difference between the two measured pressure values: p5 = p4 – p1.
   p5: Pressure drop at the flow cell

   p4: Pressure drop at the flow cell including the column, detector inlet capillary and waste line

   p1: Pressure drop at the column, detector inlet capillary and the waste line

5.7.5 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.

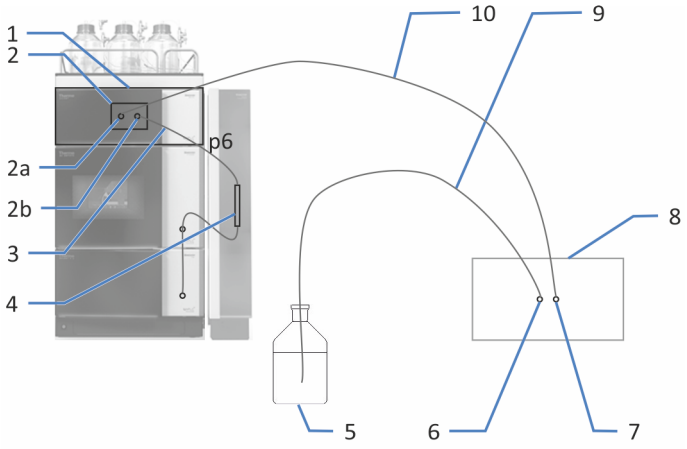

Figure 31: Calculating the pressure at the inlet port of the flow cell in your used system configuration (here with second detector)

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	9	Waste line
4	Column	10	Transfer capillary

1. Calculate p6 = p5 + p3 + p0.
   p6: Pressure at the inlet port of the flow cell

   p5: Pressure drop at the flow cell

   p3: Pressure drop at the transfer capillary and the additional module

   p0: Pressure drop at the waste line

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.

See also

Flow Cells (▶ page 168)

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

See also

Power On/Off Control (▶ page 95)

5.9 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, refer to the instructions in Installation (▷ page 47).

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

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 98).

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.

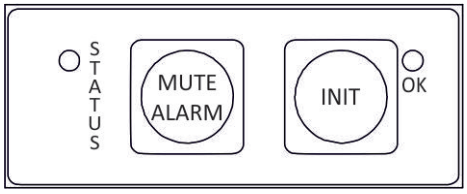

Figure 32: Keypad

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 93).

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.

INIT

The **INIT** button allows you to perform a basic initialization by determining the start positions of the grating motors and the filter wheel. The LED next to the button indicates the initialization status:

LED	Description
Off (dark)	The detector is not initialized, or turned off.
Green, flashing	The detector is initializing.
Green	The detector is initialized.

If the LED turns off after initialization, verify that the flow cell is installed correctly and press the **INIT** button again.

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 provides the information when the device is closed. When the device is connected in the Chromeleon software, the LED bar may provide less 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 Chromeleon software.
Yellow	The device is connected in the Chromeleon software, but the device is not initialized.
Green, flashing	The device is initializing.
Green	The device is initialized, but no data acquisition is running.
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 Chromeleon Audit Trail. For remedial action, see Troubleshooting (▷ page 155).

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 Chromeleon Audit Trail. For remedial action, see Troubleshooting (▶ page 155).

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.

The following sequence of events occurs when the device is powered up and the front doors are closed:

- The device runs a series of internal tests. (The test takes about 30 seconds.) During these self-diagnostics, all of the main components are checked.
- After the self-test, the device starts basic initialization. During this time, the LED bar is flashing green.
- The LED bar turns green if initialization was successful.
  If the LED bar turns red, verify that a flow cell is properly installed, and press the **INIT** button on the keypad to re-initialize. The LED bar, and the LED next to the **INIT** button both turn green if initialization was successful.

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*.
- When operating the device with a flow cell that was stored, the flow cell may be filled with solvent. Use solvents that are miscible with this solvent, or use an appropriate intermediate solvent.

Before Starting Sample Analysis

Before starting an analysis:

- Check the liquid level in the solvent reservoirs. Verify that the amount of solvent is sufficient for the analysis.
- Verify that the doors of all modules in the Vanquish system are closed.
- Observe the guidelines for use of flow cells in Guidelines for Use of Flow Cells (▸ page 98).
- 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*.

6.6 Guidelines for Use of Flow Cells

NOTICE

Flow cells are sensitive to damage and contamination.

- Handle flow cells with care. See Guidelines for Handling Flow Cells (▷ page 136).
- Observe the guidelines below when operating the detector.

Operating conditions

Observe the specified maximum pressure limit for the flow cell. See the specifications for flow cells in Flow Cells (▷ page 168).

Troubleshooting flow cells

If a flow cell leaks, stop the pump flow, remove the flow cell from the detector as quickly as possible, thoroughly remove all liquid from the flow cell opening in the detector, and replace the flow cell.

Interrupted operation

If the pump flow is interrupted, take appropriate measures to protect the flow cell.

- If data acquisition is still running, turn data acquisition off.
- Never leave any substances, particularly any aggressive solvents, in the flow cell without flow for a longer time.

TIP To prevent dust particles from causing damage to the detector optics during periods of detector inactivity, install a flow cell or reinstall the flow cell cover.

Storage

- To avoid the growth of algae, the flow cell should *not* be filled with pure water. Add 10% HPLC-grade isopropanol, for example.
- Close the flow cell inlet and outlet using the flow cell plugs that were installed when the flow cell was shipped. Using different plugs and tightening them may destroy the flow cell.

6.7 Operational Modes of the Detector

The device provides five operational modes:

- Single-channel mode
- Multi-channel mode
- Zero Order Mode
- Single spectrum scan
- FL Field Acquisition

6.7.1 Single-Channel Mode

A fluorescence detector is usually operated in single-channel mode, that is, a *single* excitation/emission wavelength pair is measured over time. Other wavelength pairs and related detection parameters can be set at any time of the separation to adapt to the specifics of the analytes. Preferably this change should take place while no peak is detected. As this mode provides the highest possible data rates and best signal-to-noise ratio, always use the single-channel mode for very small peaks.

6.7.2 Multi-Channel Mode (VF detectors only)

In multi-channel mode, both monochromators quickly switch between the selected wavelengths. A single analysis is sufficient to measure several channels. The detector can acquire up to four wavelength pairs simultaneously. However, note that:

- Each additional channel increases the time that the detector requires to set the grating positions, reduces maximum possible data collection rate, and leads to an increased baseline noise.
- Switching permanently between the wavelengths can lead to wear in the long term. The multi-channel mode is therefore only recommended for method development, but not for continuous routine operation.
- As an alternative, you can switch the wavelengths as often as required between different peaks in a single data channel in the Chromeleon software. In addition to the excitation and emission wavelength, you can switch the sensitivity, the emission filter, PMT and lamp mode.

Setting the Multi-Channel Performance

In multi-channel mode, you can select a measuring performance (multi-channel performance) to determine whether the measurement is performed faster, but with more noise, or whether minimum noise is required, which means a longer measuring time and lower data collection rate. The possible values are: **UltraFast**, **Fast**, **Standard**, **LowNoise**, **UltraLowNoise**.

Response time and data collection rate for multi-channel mode are determined automatically on the basis of the selected multi channel performance and the selected parameters, and adjusted each time wavelengths are switched during the measurement.

Using multiple channels in the Chromeleon software

Use the Instrument Method Wizard (Advanced mode) to define the parameter settings for all channels and the multi-channel performance.

See also

Determining the Optimum Excitation and Emission Wavelength (▷ page 107)

6.7.3 Zero Order Mode

In Zero Order Mode, the grating of the emission monochromator reflects the entire emission spectrum of the sample onto the PMT, rather than only a single wavelength. The excitation monochromator is set to a single wavelength as usual.

Use this mode during method development, if you do not know the retention times and emission wavelengths of the various substances in your sample. As the entire range of emission wavelengths is acquired, you can determine the retention times of all substances in a single run, as long as the substances can be excited at the selected excitation wavelength.

TIP

Use the filter wheel setting (VF detectors only) to cut off undesired wavelengths. For example, set the filter wheel setting to 370 nm to restrict the emission wavelength range to wavelengths above the filter wavelength.

The Zero Order Mode is also suitable for samples that emit light in an exceptionally broad band. In this case, the measured intensity is higher in Zero Order Mode than under normal operation where most of the emitted light is discarded by the emission monochromator. This might allow you to achieve a better limit of detection.

For an example of method development using the Zero Order Mode, refer to the Fluorescence Method Development Handbook.

TIP

To activate the Zero Order Mode in the Chromeleon software, set the **EmWavelength** property to **ZeroOrder**.

See also

Filter Wheel (VF detectors only) (▶ page 112)

6.7.4 Single Spectrum Scan

During a Single Spectrum Scan, the excitation monochromator or emission monochromator (or both simultaneously) moves over a settable wavelength range, while the intensity of the fluorescence signals is measured and recorded continuously for each wavelength. This allows you, for example, to record spectra for determining the optimum emission and excitation wavelengths. There are three different scan modes: excitation scan, emission scan, and synchronous scan.

To achieve stable conditions in the flow cell, it is recommended stopping the pump flow or have the pump deliver at a very low flow rate. If the scan can be completed during the elution of a peak and the scan is significantly faster than the full width at half maximum of the peak, the pump flow can be kept constant. For further information, refer to the *Chromeleon Help*.

Recording a baseline spectrum

A baseline spectrum with the same parameters can be recorded for all scan modes. The baseline spectrum is stored in the Chromeleon software and automatically subtracted from the recorded spectra. The result is a difference spectrum, that is, the autofluorescence of the used solvent is eliminated. Note that Chromeleon issues a warning if the baseline spectrum is missing.

Whenever the parameters for a scan change, the background spectrum is automatically deleted and a new spectrum must be recorded. You can delete a baseline spectrum any time by using the **ClearBaseLine** command.

Excitation Scan

The wavelength on the emission monochromator is kept constant, while the excitation monochromator scans a wavelength range. The result is an excitation spectrum of the sample.

Emission Scan

The wavelength on the excitation monochromator is kept constant, while the emission monochromator scans a wavelength range. The result is an emission spectrum of the sample.

Synchronous Scan

A user-defined excitation wavelength range is scanned, while the emission wavelength is scanned synchronously with a fixed user-defined offset. This allows you to determine a suitable wavelength pair for initial experiments. However, the optimum excitation and emission wavelengths must be determined by using separate excitation scans and emission scans.

To perform a single spectrum scan

For information on spectrum scans as well as instrument method examples, refer to the *Chromeleon Help*.

CAUTION

- During the scan process, no other commands can be sent to the fluorescence detector.
- The duration of the scan process depends on the range to be scanned and the selected scan speed.
- Before each scan, select a detector sensitivity, using the **ScanSensitivity** parameter. If the detector sensitivity is set too high, no spectra will be saved and a message appears in the audit trail.
- Artefacts may occur when scanning near extreme changes in the spectrum (which frequently occur near the excitation wavelength), for example, when scanning the Raman emission spectrum of water near the excitation of 350 nm. In this case, select a greater distance between the wavelength scan range and the edge (greater than the minimum of 20 nm). For the Raman emission scan, for example, select a start wavelength of 385 nm.

6.7.5 FL Field Acquisition

FL Field Acquisition can help you in determining retention times and emission maxima. As opposed to single spectrum scans, where the selected spectral range is scanned *once*, the spectral range is scanned continuously, resulting in a spectral field similar to a 3D field of a diode array detector. Available scan modes are:

- Excitation
- Emission
- Synchronous

It is not possible to simultaneously acquire chromatograms during FL Field Acquisition .

FL Field Acquisition is available in the Chromeleon 7 software only. Use a 3D data field to determine the retention times and optimum emission or excitation wavelengths. For more information about 3D data fields, refer to the *Chromeleon Help*.

For an example of method development using the FL Field Acquisition synchronous scan mode, refer to the Fluorescence Method Development Handbook.

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*.

Parameter	Description
Emission signal parameters	The Emission signal channels (**Emission_x**) are the signal channels for recording an excitation/emission wavelength pair. Signal parameters are settable for each signal channel separately. For guidelines on selecting the signal parameters, see Optimizing the Performance of the Device (▸ page 106).
Excitation wavelength	Sets the excitation wavelength in nm. Select the excitation wavelength at the absorption maximum of the sample component to be analyzed.
Emission wavelength	Sets the emission wavelength in nm. The emission wavelength must be at least 20 nm above the excitation wavelength. **ZeroOrder**: The grating of the emission monochromator is set to the position of zero order. For details, see Zero Order Mode (▸ page 100).
Sensitivity	Sets the detector sensitivity, see Sensitivity (Detector Sensitivity) (▸ page 108).
Data collection rate	Sets the number of data points per second (Hz) that the Chromeleon software collects from the detector and stores as raw data. For further information, see Data Collection Rate and Response Time (Single-Channel Mode) (▸ page 113).
Lamp mode	Sets the mode of operation for the xenon flash lamp. A higher frequency of flashes improves the baseline noise and thus improves sensitivity. A lower flash frequency extends the lifetime of the lamp. For details, see Lamp Mode (▸ page 115).
Effective lamp age	Provides information about the lamp operating hours to help you in estimating the remaining lamp lifetime. For further information, see Monitoring the Lamp Age (▸ page 131).

Parameter	Description
Initialize	Performs a basic calibration by determining the start position of the grating motors and filter wheel. Execute if the message "Not initialized" appears in the Chromeleon Audit Trail after the detector is turned on.
Leak detection	Leak detection is enabled as a standard when the device is shipped (**Leak Sensor Mode = Enabled**). This is the preferred setting.

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.

Fluorescence Method Development Handbook

Basic information about how to optimize the detector performance can be obtained from the following sections of this Operating Manual. In addition, the Fluorescence Method Development Handbook that is shipped with the detector guides you through the different method development and optimization steps, recommends the most suitable procedures, and explains optical effects that might be observed.

See also

Important Operating Parameters (▷ page 104)

6.9.1 General Guidelines

Consider the following guidelines for optimization of the device performance:

- Make sure that the grade of the solvent is compatible with the specific application. In many cases, selecting fluorescence-grade solvents should serve the need for low background fluorescence. However, your normal HPLC-grade solvents may also be suitable.
- In general, fluorescence detection has different requirements for solvent quality compared to UV detection. Fluorescing contaminants or particles may cause background fluorescence and stray light, and thus increase noise and reduce the dynamic range of the detector.
- Experience shows that the solvent suitability for an application strongly depends on the selected detection wavelengths and the required detection performance limits. For information and guidance on how to test the background fluorescence on your mobile phase, refer to the Fluorescence Method Development Handbook.
- 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.

Monitor the lamp age (see Monitoring the Lamp Age (▷ page 131)) and schedule appropriate maintenance intervals.

- 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*.

See also

Overview of Optimization Parameters (▶ page 107)

Monitoring the Lamp Age (▶ page 131)

6.9.2 Overview of Optimization Parameters

The following table serves as an overview of parameters that influence detector performance and indicates the performance characteristics affected. The sections below offer guidelines for selecting the parameters.

Parameter	Affects
Excitation wavelength, emission wavelength	Fluorescence intensity, limit of detection, selectivity
Sensitivity	Baseline noise, max. fluorescence intensity
Filter wheel setting	Baseline noise, permitted wavelength range for emission
PMT	Emission wavelength range (and therefore excitation wavelength range)
Response time	Baseline noise, peak width, peak height
Data collection rate	Peak resolution, disk space, possibly baseline noise
Flow cell temperature	Fluorescence intensity, reproducibility
Lamp mode	Lamp lifetime, baseline noise, maximum data collection rate
Baseline behavior	Course of the baseline after switching the wavelength, sensitivity, filter wheel, or PMT.

6.9.3 Determining the Optimum Excitation and Emission Wavelength

The most important parameters that need to be optimized are the excitation and emission wavelength. Note the following key criteria for determining the wavelength for an analysis:

- Preferably, select an excitation wavelength on the absorption maximum of the sample components.
- Avoid the wavelength range where the solvents absorb (for example, below 220 nm for methanol and below 210 nm for acetonitrile). The excitation wavelength should always be selected

above the UV cutoff of the solvent. For information about the UV cutoff wavelengths of solvents, see UV Cutoff Wavelengths of Solvents (▶ page 180).

- Select an emission wavelength that is at least 20 nm above the excitation wavelength.

TIP Chromeleon 7 supports FL Field Acquisition for the fluorescence detector, which facilitates determining the retention times and absorption maxima.

For further information about selecting the optimum wavelengths, refer to the Fluorescence Method Development Handbook that is shipped with the detector.

Wavelength Switching in the Chromeleon Software

Thermo Fisher Scientific recommends using the single-channel mode to record data by switching the wavelengths in-between the detected peaks of the various sample components, rather than to simultaneously measure all interesting wavelengths in multi-channel mode.

Use the Instrument Method Wizard to set the start wavelengths for one channel. After completion of the wizard, open the method in the Instrument Method Editor. In the Module View for the detector, on the **Timetable** tab page, you can define the times for switching the wavelengths and other parameters.

For details, also see the *Chromeleon Help*.

6.9.4 Sensitivity (Detector Sensitivity)

The Sensitivity setting is used to optimize the signal-to-noise ratio in a chromatogram. Depending on the intensity of the fluorescence, it may be necessary to adjust the sensitivity several times during an analysis. To find the best sensitivity, it is required to determine the maximum emission intensities in a separate sample run.

Sensitivity Setting and Autoranging

A PMT (or two PMTs) measures the intensity of the emission light after the emission monochromator. The sensitivity of the PMT can be adjusted in 8 stages (1 to 8) with the **Sensitivity** setting. With each stage, the sensitivity of the PMTs increases by approximately a factor 2. If a peak with sensitivity = 5 is 15 million counts high, for example, the peak height increases to 30 million counts when the sensitivity = 6.

- If the selected sensitivity is *too small*, the peak height is reduced and the signal-to-noise ratio is not optimal (see figure, *Sensitivity = 1*).

- If the selected sensitivity is *too large*, the PMT signal is saturated. In this case, the detector automatically reduces the sensitivity. Markers appear in the chromatogram at the beginning and at the end of the saturation (see figure, *Sensitivity = 8*). If the detector is not saturated any more, the Sensitivity setting before saturation is restored.

TIP When the sensitivity was automatically reduced or when the initial value was restored, the Chromeleon Audit Trail shows a warning with the new sensitivity value after the adjustment.

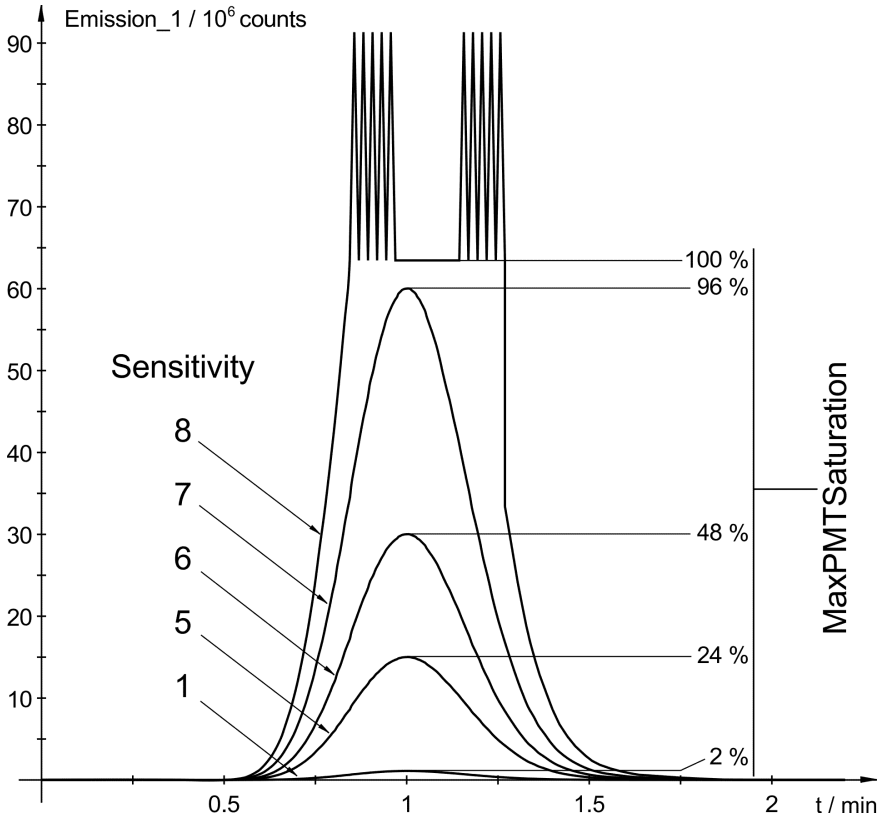

Figure 33: Effects of the Sensitivity setting

With Vanquish fluorescence detectors, the intensity of the emission light (measured by the PMT) is normalized with the intensity of excitation light through the sample (measured by the reference sensor). Therefore, the values (counts) that the emission channel displays cannot be used for optimizing the sensitivity. In the figure, the PMT is saturated at 63 million counts. However, under different measuring conditions, the PMT may be saturated at a value of 100 million counts, for example.

Therefore, use the **MaxPMTSaturation** parameter to optimize the sensitivity for each peak as described below. This parameter continuously records the maximum PMT saturation since the last **ClearMaxPMTSaturation** command. The result is reported in percent of the maximum permitted PMT saturation.

Determining the optimum sensitivity

Determine the optimum sensitivity in a separate sample run after you have determined the optimum wavelengths as described below.

- Use a sample (standard) with the maximum expected concentration of the analytes.
- Select a sensitivity at which a saturation is not expected (for example, 1 or 2).
- If the peak heights of the individual peaks in a chromatogram differ, you can improve the signal-to-noise ratio of the smaller peaks by switching the sensitivity during the run and between the peaks with the help of a timetable.
- Always use the same PMT setting for determining the sensitivity that is used for the analysis.

An instrument method example is available in the *Chromeleon Help*.

Follow these steps

1. Open the method you want to optimize in the **Script Editor**. The required commands must be added to the method manually.
2. Add a **ClearMaxPMTSaturation** command at the beginning of the run.
3. Add a **Log** command for the **MaxPMTSaturation** property after the peak maximum of an expected peak (or group of peaks) to log the maximum saturation value at this time in the Audit Trail (see figure below).
4. Add a **ClearMaxPMTSaturation** command shortly after, before the next peak elutes, to reset the **MaxPMTSaturation** value to zero (see figure below).

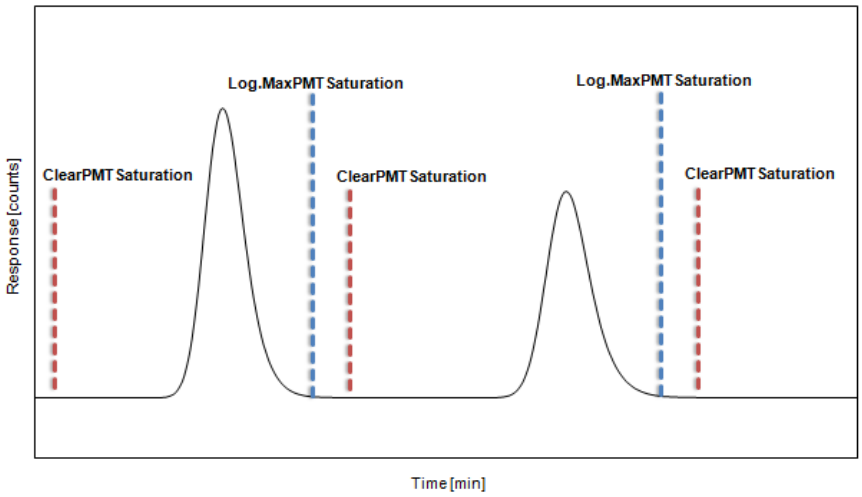

Figure 34: MaxPMTSaturation parameter monitoring

5. Repeat steps 3 through 4 for all peaks.

6. Run a sample and read out the **MaxPMTSaturation** values in the Chromeleon software and evaluate the results:

Value	What you should do…
< 30%	Increase the Sensitivity. The following is a rough guideline: < 30 %: by one stage < 15 %: by two stages Then repeat the optimization, starting with step 1.
30% - 80%	The Sensitivity value is optimal.
80% - 99%	The Sensitivity should be reduced by one stage to prevent unexpected saturation when concentration varies.
≥ 100%	Reduce the Sensitivity by at least one stage. In most cases, the detector has reduced Sensitivity automatically ("autoranging"). Check the Audit Trail for the smallest Sensitivity value after the autoranging and repeat the optimization by using this value, starting with step 1.

If you do not know the expected concentrations of the analytes, reduce the sensitivity even at smaller values of **MaxPMTSaturation**.

TIP

- The maximum saturation indicated by **MaxPMTSaturation** always refers to the signals of both PMTs at the parameter settings for all channels.
- You can completely turn off fluorescence detection by setting the sensitivity to **Off**. This may be required, for example, if you want to record the incoming signal from a UV detector for a sample of high concentration, or to suppress an extremely high peak that is not of interest for you but triggers an automatic adjustment of the sensitivity.

6.9.5 Filter Wheel (VF detectors only)

To prevent stray light from reaching the PMT, additional optical edge filters are installed on a filter wheel in the light path between the flow cell and the emission monochromator. This reduces direct scattering of light from the light source. In addition, a grating monochromator lets unwanted fractions (the half, one third, ...) of a selected wavelength pass. If the monochromator is set to 500 nm, for example, second-order light at 250 nm from the sample may reach the PMT. The filters also eliminate this higher-order stray light.

Ideally, these filters can be passed by wavelengths above their cut-off wavelength, while light with a smaller wavelength than the cut-off wavelength is blocked. In practice, there is a transition area where the transmission of the light increases from the lower wavelengths near the range where the light is cut off to the higher wavelengths near the range where the light passes. At the cut-off wavelength, the filters let 50% of the light pass. The figure shows the transmission behavior of the 280 nm filter as an example.

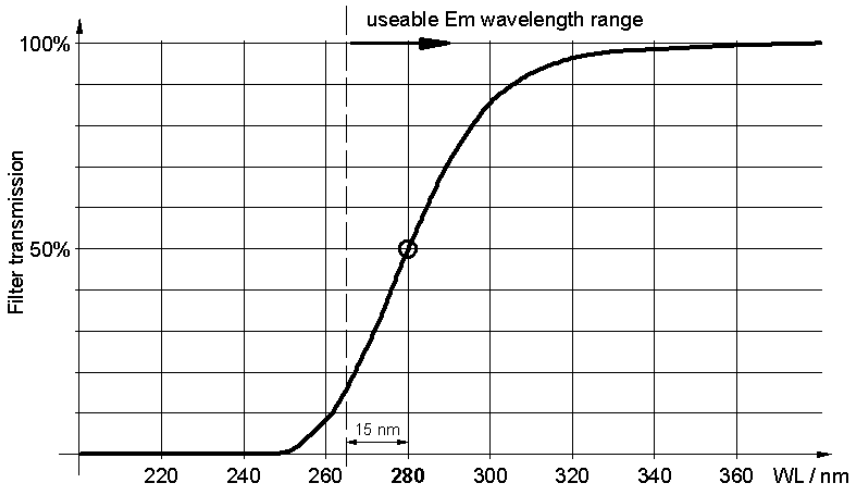

Figure 35: Transmission behavior of the 280 nm filter

The filter wheel setting can be selected automatically or manually:

- If the filter wheel mode is set to **Auto**, the detector automatically selects a filter wheel position. It selects the first filter with a cut-off wavelength below the selected emission wavelength. This mode is selected by default and provides best results for most applications.
- You can manually select the filter wavelength (that is, the cut-off wavelength). Available filters are 280 nm, 370 nm, 435 nm or 530 nm. In special situations (for example, if the emission

wavelength is near the cut-off wavelength of a filter), setting the filter manually may provide better results than the **Auto** setting. Note the following:

- The selected emission wavelength must not be more than 15 nm below the filter wavelength.
- If you select **Open**, the filter wheel remains in an open position. Use this setting if you want to measure with an emission wavelength between 220 nm and 280 nm.
- Manually select the filter wheel position, for example, in combination with the Zero Order Mode . The emission monochromator opens and the emitted light is measured over the entire wavelength range. Use the cut-off filter to suppress light below the wavelength range you are interested in. Note that this setting usually requires a lower sensitivity setting due to the stray light and auto fluorescence of the eluent (the entire spectral range is recorded).

For further information about selecting the filter wheel setting, refer to the Fluorescence Method Development Handbook that is shipped with the device.

6.9.6 PMT (only if second PMT is installed)

Detectors can be equipped with a second PMT for the near-infrared region (up to 900 nm). If the PMT setting is set to **Auto**, the detector selects the suitable PMT for each measurement. As an alternative, you can manually select which PMT should be used. Use PMT1 for measurements in the UV/VIS region. Use PMT2 for measurements in the infrared region.

TIP Always use the same PMT setting for calibration and quantification. A calibration performed with PMT1 may not be valid for measurements with PMT2.

6.9.7 Data Collection Rate and Response Time (Single-Channel Mode)

The Chromeleon software automatically calculates the best response time, based on the value you enter for the data collection rate in the Instrument Method Wizard. Note the guidelines below for selecting the data collection rate. If you want to select a different response time, this section also provides a few guidelines.

TIP In Multi-Channel mode, the response time and data collection rate are always determined automatically. You can influence these parameters by selecting a different multi-channel performance.

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).
- The selected lamp mode also has an effect on the maximum data collection rate.

Response Time

The response time is a measure of how quickly the detector responds to a change in signal.

- Select a response that is about 1/3 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, and thus improves the signal-to-noise ratio.
- However, if the selected response time is too long, this can result in reduced peak heights and asymmetrical peak shapes. Peaks that elute shortly after each other may not be separated properly. When set correctly, the response time significantly reduces baseline noise, but 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.

See also

Lamp Mode (▷ page 115)

6.9.8 Flow Cell Temperature

The temperature of a sample influences its fluorescence. Thus, a problem with fluorescence detection is that the results can strongly be influenced by fluctuations in ambient temperature. Vanquish fluorescence detectors allow you to heat the flow cell and thus keep temperatures inside the flow cell at a constant level, even if ambient temperatures change.

In most analytes, the fluorescence of a sample decreases as temperature increases. Therefore, the temperature must not be selected too high. However, it must be above the temperature inside the detector optics, which is influenced by the ambient temperature. Therefore, select a temperature that is roughly 15°C above the expected ambient temperature.

Example: The expected maximum temperature in the laboratory is 27°C (80.6 F). Set the flow cell temperature to 42°C (107.6 F).

TIP Thermo Fisher Scientific recommends always recording the **FLD_FlowCell** signal channel. If a problem occurs, the temperature channel can provide helpful information to identify and eliminate the source for the problem.

6.9.9 Lamp Mode

The detector offers three different flash frequencies for the xenon flash lamp. Selecting a different lamp mode during phases when no peaks of interest elute can extend the lamp lifetime.

When calculating the lamp lifetime, only the time when the lamp flashes is taken into account. This roughly corresponds to the acquisition time.

Extending the lamp lifetime

To extend the lamp lifetime, you can do the following:

- Turn off the lamp by stopping data acquisition if you are not interested in the baseline. It is not generally required that the lamp remains turned on during the entire chromatographic separation.
- Change the lamp mode during a chromatographic run, for example, from **LongLife** mode (between the peaks) to **Standard** or **HighPower** mode (for the interesting peaks). This extends the lamp lifetime, without any loss in sensitivity in the important areas.
  Use the Instrument Method Wizard to set the basic lamp mode. After completion of the wizard, open the method in the Instrument Method Editor. In the Module View for the detector, on the **Timetable** tab page, you can define the times for switching the lamp mode and other parameters.

For an example of smart use of the xenon flash lamp modes, refer to the Fluorescence Method Development Handbook .

HighPower Mode

The lamp flashes at the highest frequency of 300 Hz. The sensitivity is roughly twice the sensitivity in **Standard** mode. The expected lifetime of the lamp is approximately 1300 hours.

This mode is recommended for applications that require highest sensitivity.

Standard Mode

The lamp flashes at a medium frequency of 100 Hz. The expected lifetime of the lamp is approximately 4000 hours. This mode supports data collection rates up to 100 Hz.

This mode is recommended for applications that require a high sensitivity.

LongLife Mode

The lamp flashes at a lower frequency of 20 Hz. When the lamp is operated in this mode, the lamp lifetime is approximately four times the lifetime in **Standard** mode. The expected lifetime of the lamp is approximately 16000 hours. However, note that signal-to-noise ratio is reduced to roughly the half compared to **Standard** mode. This mode only supports data collection rates up to 20 Hz.

This mode is recommended for regions of the chromatogram when signal-to-noise is less important, for example:

- when no peaks of interest elute
- during the wash and re-equilibration phase

6.9.10 Baseline Behavior

If wavelengths are switched or the sensitivity, filter wheel, or PMT setting are changed during the method, the chromatogram may show baseline jumps because of the background fluorescence at the new wavelength setting. Three baseline behavior mode settings define how the baseline behaves in these cases:

- **Zero**: sets the baseline to zero
- **Append**: appends the baseline to the previous signal
- **Free**: lets the baseline "jump" to the current absolute value

TIP You can perform **Autozero** command (automatic null balancing) any time, that is, the intensity measured at the time of the autozero is subtracted from any intensities measured thereafter. Always select a time for null balancing at which no sample flows through the flow cell. The values are stored and can be reset using the **ClearAutozero** command.

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.
- 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. Stop the pump flow.
2. Remove the column.
3. Connect the free ends of the column compartment capillaries using a union connector (for example, the Viper union from the system ship kit) and restart the pump flow.
4. Flush the flow cell with an appropriate solvent (minimum HPLC-grade). Observe the following:

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

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.

5. 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.
6. Disconnect the capillaries from the flow cell inlet and outlet.
7. 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.
8. 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.

Situation	Steps
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 146).

TIP To prevent dust particles from causing damage to the detector optics during periods of detector inactivity, install a flow cell or reinstall the flow cell cover.

See also

- Connecting the Inlet Capillary (▸ page 72)
- Connecting the Detector Waste Line (▸ page 75)

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 144).

7.2 Safety Guidelines for Maintenance and Service

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

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

WARNING—High Voltage

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

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

WARNING—Escape of Hazardous Substances from Flow Connections

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

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

WARNING—Tilting Liquid Reservoirs

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

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

CAUTION—Spraying Solvent

Solvents can spray when under high pressure.

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

CAUTION—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.

7.3 General Rules for Maintenance and Service

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

- Before starting maintenance or service procedures, shut down the 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.
- 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.
- If you need to return the device for depot repair, follow the instructions in Transporting or Shipping the Device (▶ page 146).

See also

Consumables and Replacement Parts (▶ page 175)

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. • 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. • Perform operational qualification and check the lamp age as required by the application. • 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.

TIP The Chromeleon software supports functions for monitoring and recording service and qualification information (see Monitoring the Lamp Age (▷ page 131)).

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

The Chromeleon software supports functions for monitoring and recording service and qualification information about the device.

Monitoring service and qualification intervals

On special service and qualification panels, you can define intervals for service procedures or qualification procedures. These functions, which are called Predictive Performance, allow you to schedule these procedures based on the actual operating and usage conditions of the device. In addition, you can set limits to alert you before and when the service or qualification is due.

Color-coded bars 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.

Service and qualification 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 service, or qualification procedure has been performed.

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

7.4.4 Monitoring the Lamp Age

The Chromeleon software supports functions for monitoring the lamp age. This function can help to decide when a lamp is due to be replaced.

The flash lamp can produce about 1-1.5x10^9 flashes before it needs replacement only if the performance of the detector is no longer sufficient. Thus, the lifetime for the flash lamp depends on the flash frequency, and therefore the selected lamp mode. Based on the number of lamp flashes, the Chromeleon software calculates a value that indicates how many hours the lamp was operated. The value is based on the assumption that the lamp was operated in **Standard** mode. For the calculation of the expected lamp lifetime, one operating hour is weighted depending on the selected lamp mode.

Mode	1 operating hour is counted as ...	Expected lamp lifetime
LongLife	0.25 hours	approx. 16000 hours
Standard	1 hour	approx. 4000 hours
HighPower	3 hours	approx. 1300 hours

Example: If the lamp age in Chromeleon indicates 2000 hours, this means that the lamp has reached about the half of its lifetime. Thus, if the lamp is operated in **LongLife** mode, it is expected to operate for another 8000 hours.

In Chromeleon, check the **EffectiveLampAge** parameter. If the value exceeds 4000 hours, the lamp should be replaced. Note that the lamp must be replaced only by a Thermo Fisher Scientific service engineer. The service engineer will reset the lamp age counter to zero after the lamp was replaced.

TIP You can extend the lifetime of the xenon flash lamp by switching between lamp modes during a chromatographic run.

See also

Lamp Mode (▷ page 115)

7.5 Performing a Wavelength Calibration

A simple initialization procedure is performed after power-up of the detector. This requires that a flow cell is installed in the detector. For details, see Power On/Off Control (▶ page 95).

To ensure optimum performance and wavelength accuracy, perform a wavelength calibration using water (Raman measurement). During wavelength calibration, the light spectrum of the xenon flash lamp is used to calibrate the excitation wavelength. Afterward, the emission monochromator is adjusted with the help of the maximum of the Raman emission spectrum (397 nm).

When

- After the flow cell has been installed or replaced
- After the lamp has been replaced (performed by service engineer)
- If wavelength validation fails

Preparations

The following conditions *must* be met for both wavelength validation and Raman wavelength calibration:

- The system is equilibrated and environmental conditions are stable.
- There are no air bubbles in the flow cell. We recommend degassing the water. Set a flow rate of 0.5 mL/min and wait about 15 minutes before you begin, until the baseline is stable.
- The water has no impurities. Always use fluorescence-grade water and consider using a filter or a suitable column before the detector.

To perform a wavelength calibration

You can perform wavelength calibration via Chromeleon. Wavelength calibration can take a few minutes. During this time, data acquisition is not possible.

1. Execute the **CalibrateRaman** command to start the calibration. The following message appears in Chromeleon:

   Make sure that

   - the system is equilibrated and conditions are stable
   - fluorescence-grade water is flowing through the cell
   - the water is degassed (no air bubbles) and free of particles

2. Confirm with **OK** if you are sure that the above conditions are met. The calibration run may take up to five minutes. The new calibration values are stored in the detector.

3. Perform wavelength validation.

See also

Performing a Wavelength Validation (▷ page 134)

7.6 Performing a Wavelength Validation

You can validate the wavelength calibration using water (Raman measurement). If validation fails, that is, if the measured values significantly deviate from the calibration values, you can perform a wavelength calibration using water (Raman measurement). The light spectrum of the xenon flash lamp is used to validate the excitation wavelength.

When

- After (re)installation of the detector
- After wavelength calibration

Preparations

The following conditions *must* be met for both wavelength validation and Raman wavelength calibration:

- The system is equilibrated and environmental conditions are stable.
- There are no air bubbles in the flow cell. We recommend degassing the water. Set a flow rate of 0.5 mL/min and wait about 15 minutes before you begin, until the baseline is stable.
- The water has no impurities. Always use fluorescence-grade water and consider using a filter or a suitable column before the detector.

To perform a wavelength validation

You can perform wavelength validation via Chromeleon. Wavelength validation can take a few minutes. During this time, data acquisition is not possible.

1. Execute the **ValidateRaman** command to start the validation. The following message appears in Chromeleon:

   Make sure that

   - the system is equilibrated and conditions are stable
   - fluorescence-grade water is flowing through the cell
   - the water is degassed (no air bubbles) and free of particles

2. Confirm with **OK** if you are sure that the above conditions are met. The validation run may take up to five minutes. The result ("passed"/"failed") is displayed in the Chromeleon Audit Trail.
   - **Passed:** The wavelength accuracy is within specification. The exact wavelength can be found under **RamanValidationWL**. The ideal value for the measurement is 397 nm.
   - **Failed:** The calibration of the detector is not sufficient. Perform a wavelength calibration. If wavelength validation fails again after the recalibration, check the causes and remedial actions outlined below.

Possible Cause	Remedial Action
Flow cell incorrectly installed	Verify that the flow cell is seated correctly and that the screws are tightened finger-tight.
The system does not meet the required conditions.	Observe the conditions for wavelength validation and calibration. If the procedure is repeatedly interrupted, contact Service.
Flow cell contaminated	Clean the flow cell.

See also

Performing a Wavelength Calibration (▸ page 132)

Cleaning the Flow Cell (▸ page 138)

7.7 Flow Cell

This section describes cleaning and replacement of flow cells. No tools are required to remove and install a flow cell.

7.7.1 Guidelines for Handling Flow Cells

NOTICE

Flow cells are highly sensitive to dirt and dust. Observe the following notes when handling flow cells:

- When holding flow cells, do not touch the optical block of the flow cell or the sensitive electronics on the flow cell rear side.
- 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 device.
- 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.
- Use the dedicated packaging when storing or transporting the flow cell.

7.7.2 Removing the Flow Cell

Parts required

- Flow cell packaging
- Cover for the flow cell opening on the device

Preparations

1. Flush the flow cell, for example, with isopropanol to rinse out any solvents.
2. Stop the pump flow.

Follow these steps

CAUTION—Hot surface

The flow cell may become hot. Touching a hot flow cell might cause burns.

- Touch the flow cell briefly and carefully to find out if it is hot before you remove the flow cell.
- If the flow cell is hot, allow the flow cell to cool down before you remove it. Make sure the flow cell temperature control is turned off.

1. Disconnect the capillaries from the flow cell inlet and outlet.
2. Close the flow cell inlet and outlet with the flow cell plugs that were installed when the flow cell was shipped.
3. Loosen the two flow cell screws until they are loose. The screws are captive in the flow cell and do not need to be removed.
4. Remove the flow cell from the flow cell opening.
5. Install the flow cell cover to the flow cell opening. Tighten the two screws finger-tight (no tools required).

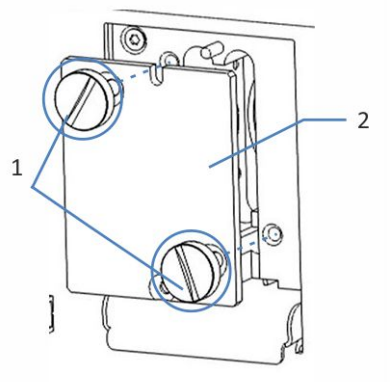

Figure 36: Installing the flow cell cover

No.	Description
1	Flow cell cover screws
2	Flow cell cover

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.

6. To store or ship the flow cell, place it in its packaging.

7.7.3 Cleaning the Flow Cell

When

When you suspect that eluent or sample components may have deposited on the flow cell windows.

Parts required

- Flushing and injection kit for flow cells (optional)
- HPLC-grade water
- 0.1 M nitric acid

WARNING—Health Risk

The handling of solvents can pose health and safety risks.

Wear personal protective equipment as required by the hazard and follow good laboratory practice. Refer to the material handling and safety data sheet provided by the vendor.

Follow these steps

You can perform the following procedure by using the optional flushing and injection kit.

1. Flush the flow cell with HPLC-grade water.
2. Fill the flow cell with 0.1 M nitric acid using the optional flushing and injection kit.
3. Flush the flow cell with HPLC-grade water until the solvent leaving the flow cell is neutral (pH 7).
4. If cleaning the flow cell does not eliminate the problem, install a new flow cell.

7.7.4 Installing the Flow Cell

Parts required

Flow cell

Follow these steps

1. Insert the flow cell straight into the flow cell opening.

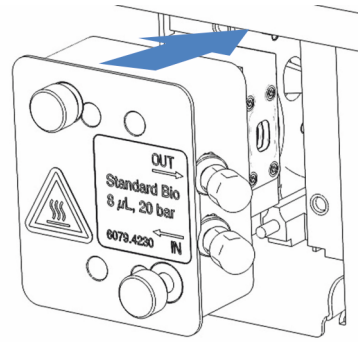

Figure 37: Inserting the flow cell

2. Tighten the flow cell screws hand-tight.
3. Install the capillaries to the flow cell. Follow the instructions in Setting Up the Flow Connections (▷ page 64). Turn on the flow and check that all connections are tight.
4. Close the device doors to allow detection of the flow cell. As an alternative, press the **INIT** button on the keypad.
5. Perform wavelength calibration.

See also

Performing a Wavelength Calibration (▷ page 132)

7.8 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.

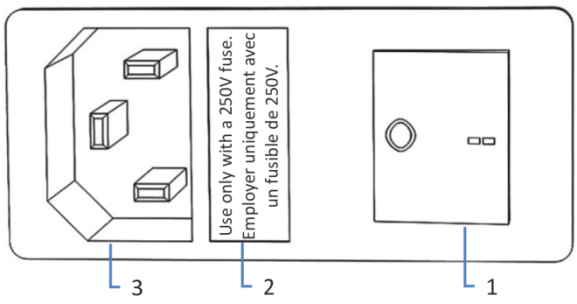

Figure 38: Fuse holder

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.

7.9 Updating the Device Firmware

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.
   - If the firmware update failed, turn the device off and on again and repeat the firmware update.
   - If the firmware update fails repeatedly, contact Thermo Fisher Scientific Technical Support for assistance.
4. After a successful firmware update, requalification of the device may be required. See the release notes for a recommendation.

7.10 Replacing the Doors

When

Damage of door

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

Parts required

Replacement door

Follow these steps

NOTICE

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

1. To remove a door, push the door upward while opening.
   Open the door to a position in which the two hinges on the housing are aligned in the grooves on the door. You can remove the door only when the hinges are in the grooves.

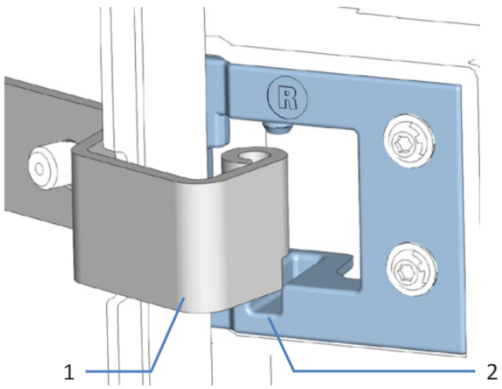

Figure 39: Unhinging a door

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

2. Slightly tilt the door to the outside, away from the housing, and remove the door.

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

7.11 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 146).
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 147).
   - ♦ To ship the device, follow the instructions in Shipping the Device (▷ page 148).

7.11.1 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 119)).
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

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 149)).

See also

Removing the Flow Cell (▸ page 136)

7.11.2 Transporting the Device to a New Location

Preparations

Prepare the device for transport. See Preparing the Device for Transport (▸ page 146).

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 47)).
   b) Prepare the device for operation (see Preparing the Device for Operation (▸ page 96)).
5. Before starting an analysis, let the device equilibrate and be sure that it is ready for operation.

7.11.3 Shipping the Device

Preparations

Prepare the device for transport. See Preparing the Device for Transport (▸ page 146).

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.

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.

Restarting the Device after Shipping

To restart the device after shipping, follow these steps:

1. Follow the unpacking instruction in this operating manual.
2. Install and set up the device in the system stack. Follow the instructions on mounting the system stack in the *Vanquish System Operating Manual*.
3. Set up the device:
   a) Connect the device and set up flow connections (see Installation (▸ page 47)).
   b) Prepare the device for first-time operation (see Preparing the Device for Operation (▸ page 96)).
4. Before starting an analysis, let the device equilibrate and be sure that it is ready for operation.

7.12 Replacing the Slide-In Module

7.12.1 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 146).

Follow these steps

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

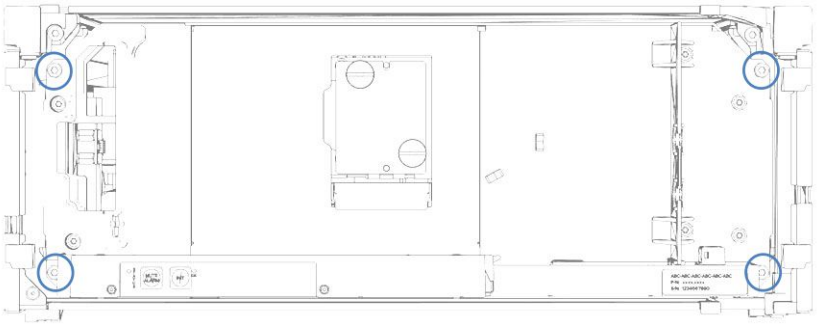

Figure 40: Captive screws on the slide-in module

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

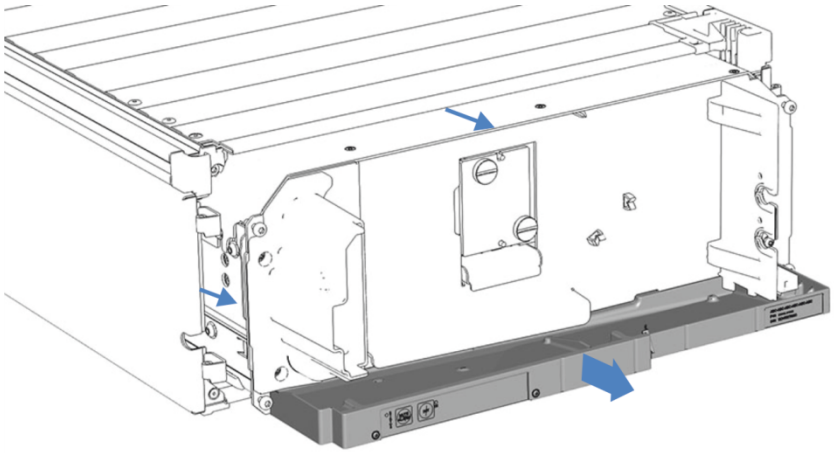

Figure 41: Pulling out the slide-in module

NOTICE

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

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

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

7.12.2 Returning the Slide-In Module

Preparation

If not yet done: Remove the slide-in module from the enclosure. See Removing the Slide-In Module (▷ page 149).

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 151).
2. Follow the instructions in Shipping the Device (▷ page 148).

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.

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.

7.12.3 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 149).
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 128).
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.

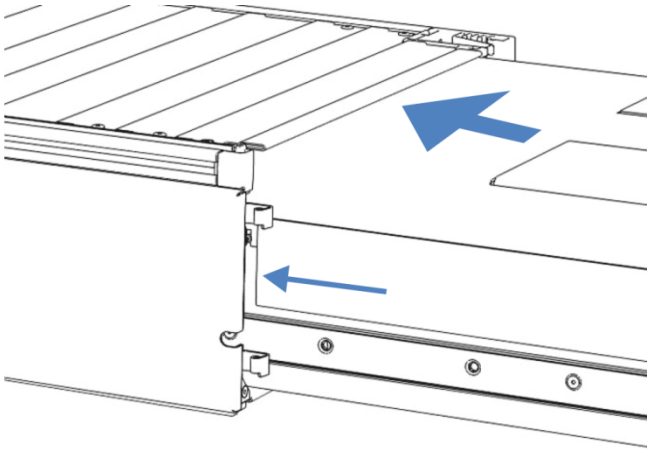

Figure 42: Inserting the slide-in module

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.

7.12.4 Setting Up the Slide-In Module

After you have reinstalled 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 47)).
   b) Prepare the slide-in module for first-time operation (see Preparing the Device for Operation (▷ page 96)).
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. The problem is reported to the Chromeleon software and a message appears in the Audit Trail.

Alarms

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

Chromeleon Audit Trail Messages

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

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

Messages in the Chromeleon Audit Trail are preceded by an icon. The icon identifies the seriousness of the problem (refer to the *Chromeleon Help*). For possible causes and remedial actions, see Messages (▷ page 158).

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 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 162)).
Code 34 Leak detected.	Find and eliminate the source for the leakage (see Resolving Liquid Leaks (▶ page 162)).
Code 36 Download failed.	The firmware download has not been successful. Verify that the correct firmware file was selected. Repeat the download.
Code 37 Download firmware mismatch.	The firmware download has not been successful. Verify that the correct firmware file was selected. Repeat the download.

Message and Code	Description and Remedial Action
Code 89 Liquid leak sensor missing or defective.	Verify that the leak sensor is installed and the cable connector is properly connected. Contact Thermo Fisher Scientific Technical Support for assistance if the leak sensor is defective. To operate the device nevertheless, you can disable the leak sensor functionality in the Chromeleon software by setting **LeakSensorMode** to **Disabled**.
Code 90 Download firmware mismatch – invalid version.	You tried to download a firmware with an earlier version number than the firmware that is currently installed in the device. Downgrading the firmware may result in loss of functionality or malfunctioning of the device. If required, repeat the download with a firmware version later than the version currently installed in the device.
Code 103 Unexpected module behavior – limited features available.	The firmware may be defective or a firmware downgrade has been performed. Update the firmware to the current revision. See Updating the Device Firmware (▶ page 142).
Code 118 USB Buffer Overflow.	This is a software problem. The module produces data faster than the computer on which the Chromeleon software is running reads the data. 1. In the Chromeleon software, disconnect and reconnect the module. 2. If this does not solve the problem, update the firmware or the Chromeleon software version. 3. If the problem persists: Also, third-party software on the computer, for example, virus scanners, can cause the problem. Contact the onsite IT department.
Code 120 The 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 cables for proper connection.
Code 8013 No flow cell detected	Verify that the flow cell is properly installed. The lamp is automatically turned off when a flow cell is missing.
Code 8032 Unexpected module behavior. Flow cell Code 8033 Unexpected module behavior. Flow cell	If the message indicates "Flow cell": Verify that the flow cell is properly installed. Open and close the doors. Turn off the detector. Wait for 5 seconds and turn on the detector again. Replace the flow cell and try again. If the message appears again, contact Technical Support.
Code 8035 Signal overflow in <channel name>	The reference signal is too low, or the PMT signal is too high. Check if the flow cell is contaminated. Consider cleaning or replacing the flow cell. Check if the sample concentration is too high, and make sure that the excitation wavelength is set to a wavelength above the UV cutoff wavelength of the eluent. The lamp may be too old and may have to be replaced.
Code 8036 Reference signal too low in <channel name>	The reference signal is too low (high absorption). Check if the flow cell is contaminated. Consider cleaning or replacing the flow cell. Check if the sample concentration is too high, and make sure that the excitation wavelength is set to a wavelength above the UV cutoff wavelength of the eluent. The lamp may be too old and may have to be replaced.

Message and Code	Description and Remedial Action
Code 8049 Command rejected - close front door first	It is not possible to start data acquisition with the front doors open. Close the doors and try again.
Code 8051 Flow cell detected. It is recommended executing the command CalibrateRaman	A new flow cell was found. It is recommended to perform a Raman wavelength calibration (see Performing a Wavelength Calibration (▸ page 132)); without calibration, wavelengths may deviate from the actual wavelength by up to a few nanometers.
Code 8064 PMT x signal overflow in <channel name> Code 8065 PMT x signal overflow during scan	With x = PMT 1 or 2 Signal overflow in PMT 1 or 2 occurred. Repeat the run or scan with a lower sensitivity or lower concentration of the sample.
Code 8071 PMT Sensitivity autorange for <channel name> -new Sensitivity is x	With x = The new sensitivity value after the adjustment. The detector had to automatically reduce the Sensitivity. Select a suitable Sensitivity (see Sensitivity (Detector Sensitivity) (▸ page 108)) and repeat. x indicates the new sensitivity value after the adjustment. Use this value, or a smaller value, in your method when you expect similar concentrations.
Code 8078 PMT Autorange for <channel name> not possible - already minimal Sensitivity	The detector could not automatically reduce the Sensitivity, as the Sensitivity setting is already set to a minimum. Repeat with a lower concentration of the sample, or smaller injection volume.
Code 8087 System Interlink error	The System Interlink connection got lost. Check that all System Interlink cables on the Vanquish system are properly connected.
Code 8093 Not initialized	The detector is not initialized. Verify that a flow cell is installed correctly and that the eluent composition in the flow cell does not change and no air bubbles are present. Then open and close the doors, or press **INIT** on the keypad.
Code 8100 - Code 8109 Calibration of xx failed.	With x = Name of the component for which calibration failed. *Cause details* • Raman calibration failed. • The flow cell may be installed incorrectly. • The flow cell may be contaminated. *Remedial actions* • Observe the conditions for wavelength calibration (see Performing a Wavelength Calibration (▸ page 132)) and wavelength validation (see Performing a Wavelength Validation (▸ page 134)). • Verify that the flow cell is installed correctly and that the screws are tightened finger-tight. • Clean the flow cell (see Cleaning the Flow Cell (▸ page 138)) if necessary. • Make sure that the flow cell is properly equilibrated. Make sure that you use degassed solvents. If the procedure is repeatedly interrupted, contact Technical Support.

Message and Code	Description and Remedial Action
Code 8111 - Code 8115 Calibration of xx failed.	With x = Name of the component for which calibration failed *Cause details* Raman calibration failed. *Remedial actions* • Observe the conditions for wavelength calibration (see Performing a Wavelength Calibration (▸ page 132)) and wavelength validation (see Performing a Wavelength Validation (▸ page 134)). • Verify that the flow cell is installed correctly and that the screws are tightened finger-tight. • Clean the flow cell (see Cleaning the Flow Cell (▸ page 138)) if necessary. • Make sure that the flow cell is properly equilibrated and no air bubbles are present. Make sure that you use degassed solvents. If the procedure is repeatedly interrupted, contact Technical Support.
Code 8116 and 8118 to 8121 Initialization failed	*Cause details* • The detector could not initialize. • The flow cell may be contaminated. *Remedial actions* • Verify that a flow cell is installed correctly. • Verify that the eluent composition in the flow cell does not change and no air bubbles are present. Make sure that you use degassed solvents. • Clean the flow cell (see Cleaning the Flow Cell (▸ page 138)) if necessary.

8.3 Operating Issues

This section gives an overview of possible operating issues and remedial actions.

8.3.1 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 123).

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.

Location of the leak	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.
Leak tray but not flow cell inlet or outlet	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, carefully dry the flow cell opening in the detector and let remaining moisture evaporate before you replace the flow cell.

3. With a cloth or tissue, thoroughly absorb all liquid that has collected in the leak tray and under the leak sensor. Be careful not to bend the sensor.

4. Allow the sensor to adjust to the ambient temperature for a few minutes.
5. If leakage is no longer reported, you can resume operation.

See also

Removing the Flow Cell (▷ page 136)
Installing the Flow Cell (▷ page 139)

8.3.2 Additional Device Operating Issues

This section provides additional issues that may arise during operation of the Vanquish device. Locate the table for the type of symptom you have, find the possible cause, and use the description of the solution to help you solve your problem quickly.

Also check the Chromeleon Audit Trail for a related message if an operating problem occurs. The message may provide additional information.

Note that this section provides information on symptoms and causes directly related to the Vanquish device. For information about troubleshooting for the Vanquish system, refer to the *Vanquish System Operating Manual*.

TIP 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.

Symptom	Possible Cause	Remedial Action
Peak tailing	Fluorescence detector flow cell inlet and outlet exchanged	Verify that the flow cell inlet and outlet in a fluorescence detector are connected correctly.
Negative peaks	Absorption/fluorescence of analyte lower than of mobile phase	Select different UV or fluorescence detection wavelengths. Use a mobile phase with less background absorption/ fluorescence. Dissolve the sample in mobile phase.
	Fluorescence of the substance or eluent is quenched by other components	Consider using the negative peaks for quantification.
Markers in fluorescence signal	The Sensitivity was automatically reduced	Select a lower Sensitivity for your application. The sample audit trail informs to which level the Sensitivity was reduced to.

Symptom	Possible Cause	Remedial Action
Spikes	Xenon flash lamp old, defective, or not properly installed	Contact Technical Support.
	Fluorescence detector flow cell temperature near boiling point of mobile phase	Turn off flow cell temperature control or reduce the temperature setting.
Inappropriate device settings	Improper wavelength, e.g., in a UV spectrum flank	Choose a detection wavelength or an excitation/ emission wavelength pair that is located near the apex of the spectrum.
	The Sensitivity of the fluorescence detector was automatically reduced	Select a lower Sensitivity for your application.
High baseline drift	Absorption of eluent changes when gradient is run	Absorbing additives may change the absorption spectrum, depending on the solvent. Consider varying additive concentrations to level the drift.
Non-periodic baseline fluctuation, high noise	Xenon flash lamp in fluorescence detector too old	Contact Technical Support.
Flow cell in fluorescence detector does not reach set temperature	Set flow cell temperature too high or too low	At high flow rates, the flow cell may not reach the desired temperature. Select a lower flow cell temperature. The temperature might also be too low, e.g. below ambient temperature. Correct the temperature setting or switch off temperature control.

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

The device performance is specified as follows:

Type	Specification
Optical design	Two monochromators with concave holographic gratings and elliptic mirrors for highest efficiency in light transmission
Light source	Xenon flash lamp (15W); Three different flash frequencies (HighPower, Standard, LongLife) can be selected.
Reference system	Reference sensor behind flow cell for compensation of lamp intensity fluctuations
Wavelength range	VC-D50: Excitation: 200 nm - 630 nm Emission: 265 nm - 650 nm Number of photomultipliers: 1 VC-D51: Excitation: 200 nm - 880 nm Emission: 265 nm - 900 nm Number of photomultipliers: 2 VF-D50: Excitation: 200 nm - 630 nm Emission: 220 nm - 650 nm Number of photomultipliers: 1 VF-D51: Excitation: 200 nm - 880 nm Emission: 220 nm - 900 nm Number of photomultipliers: 2
Spectral bandwidth	Excitation: 20 nm Emission: 20 nm
Spectra scanning modes	Single spectrum scan modes: Excitation, Emission, Synchronous Under Chromeleon 7 software: FL Field Acquisition scan modes: Excitation, Emission, Synchronous
Emission filter	VC-D50, VC-D51: fixed filter with 280 nm VF-D50, VF-D51: 5 programmable positions (Open, 280 nm, 370 nm, 435 nm, 530 nm)
Excitation/emission wavelength switching time	< 250 ms
Number of channels	VC-D50, VC-D51: single channel VF-D50, VF-D51: up to 4 signal channels

Type	Specification
Data collection rate	Adjustable: up to 100 Hz (VC-D50, VC-D51) up to 200 Hz (VF-D50, VF-D51 under Chromeleon 7 software in single-channel mode) up to 4 Hz (VF-D50, VF-D51 in multi-channel mode)
Sensitivity	PMT 1: Raman signal-to-noise ratio: >550 ASTM over the entire lifetime of the lamp; test conditions: standard flow cell, fluorescence grade water, excitation 350 nm, emission 397 nm (>2100 with dark current as reference); test conditions: standard flow cell, fluorescence grade water, excitation 350 nm, emission 450 nm PMT 2 (VF-D51 only): Raman signal-to-noise ratio: >225 ASTM; test conditions: standard flow cell, fluorescence grade water, excitation 350 nm, emission 397 nm (>1050 with dark current as reference); test conditions: standard flow cell, fluorescence grade water, excitation 350 nm, emission 450 nm
Wavelength accuracy	± 2 nm (over detector lifetime; excitation and emission monochromators individually)
Wavelength repeatability	± 0.2 nm
Wavelength calibration	Internal calibration, excitation monochromator with emission lines of xenon flash lamp, emission monochromator with Raman shift of water and emission lines of xenon lamp.
Wavelength validation	Internal validation, excitation monochromator with emission lines of xenon flash lamp, emission monochromator with Raman shift of water and emission lines of xenon lamp. As the wavelength reading of the Raman peak depends on both excitation and emission wavelength accuracy, the permitted deviation is ± 3 nm.
USB	1 USB port (USB 2.0, "B" type connector) 1 USB hub with 3 ports (USB 2.0, "A" type connectors)
I/O Interface	2 digital I/O ports (mini-DIN), each providing one input and one relay output
System Interlink	2 System Interlink ports (RJ45-8 connectors)
Analog output	2 analog outputs via optional plug-in expansion board to output emission channels Resolution: 20 bit Maximum data rate: 50 Hz Outputs can be configured via software (output voltage range 0 to 1 V or 0 to 10 V, sensitivity and offset)
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.

Type	Specification
Safety features	Power-up check of optics and motors (initialization) Monitoring of cooling fans and electronics Leak detection and safe leak handling Flow cell identification and documentation of the flow cell type
Good Laboratory Practice (GLP) features	All system parameters are logged in the Chromeleon Audit Trail. Functions for monitoring the operating and usage conditions of the device. This includes monitoring of lamp age, PMT workload, grating and filter movements, and service and qualification intervals via the Chromeleon software.

9.1.2 Flow Cells

The flow cell performances are specified as follows:

Type	Standard Flow Cell	Micro Flow Cell
Flow cell volume	8 µL	2 µL
Volume heat exchanger and/or inlet capillary	6.3 µL	3.3 µL
Pressure limit	2 MPa	4 MPa
Recommendations for use	Higher sensitivity and optimum signal-to-noise ratio, for columns with > 2.1 mm ID	Best resolution in UHPLC, for columns with ≤ 2.1 mm ID
Temperature control	15 °C above ambient to 50 °C absolute	
Biocompatibility	yes	
Materials in the flow path	Fused silica, MP35N, PEEK, titanium, fluoropolymers **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). *Maximum allowed solvent temperature: 80°C.*	
Good Laboratory Practice (GLP) features	Identification chip	

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	Wide range, 100 – 240 V AC, ± 10 %; 50/60 Hz; max. 245 W / 255 VA
Overvoltage category	II
Emission sound pressure level	< 50 dB(A)
Dimensions (height x width x depth)	15.9 x 42 x 62 cm
Weight	Approx. 21 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. See the content list included in the kit for the most recent information about the kit content at the time when the device is shipped.

Ship kit

Item	Quantity in shipment
Partition panel plug for guiding insulated capillaries	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 – fluorescence detector	1
Viper capillary, UV/VIS detector – fluorescence detector, 0,18 mm I.D.	1
Waste line	1

For reordering information, see Consumables and Replacement Parts (▸ page 175).

10.3 Optional Accessories

Flow cells and Flow cells accessories

Item	Part No.
Standard flow cell, biocompatible	6079.4230
Micro flow cell, biocompatible	6079.4330
Flushing and injection kit for flow cells, including syringe	6078.4200
Viper capillary, I.D. x length 0.18 x 450 mm, stainless steel For connecting column and flow cell inlet when using UltiMate 3000 flow cells.	6040.2365
Overpressure relief valve Suitable to protect the Micro flow cell of the fluorescence detector against overpressure. The valve opens at a pressure of 4 MPa (40 bar).	6079.9240

TIP UltiMate 3000 fluorescence detector flow cells have the inlet and outlet on the left side. To connect the column outlet to the left side of the flow cell in a Vanquish fluorescence detector, we recommend using the capillary of 450 mm length listed in the table above.

Miscellaneous

Item	Part No.
DAC board Provides two analog outputs. Contact Thermo Fisher Scientific Technical Support for installation.	6083.0900
Dual-PMT option Provides a second PMT for the near infrared region as an upgrade. Contact Thermo Fisher Scientific Technical Support for installation.	6078.5360

10.4 Consumables and Replacement Parts

Capillaries and tubing

Description	Part No.
Viper capillary, 350 mm length, MP35N, for connection to the column	6042.2340
Viper capillary, 300 mm length, MP35N, for connection from a UV/VIS detector to the fluorescence detector	6042.2322
Waste line	6036.2425
Flow cell plugs for inlet and outlet	6200.5502
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
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, slowblow fuses.	6036.0002
Packing material for detector with enclosure	6083.0090

Interface cables

Description	Part No.
Digital I/O signaling cable, 6-pin, cable length: 5 m	6036.0006
System interlink cable	6036.0004
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 0.5 m	6720.8910
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 1 m	6035.9035
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 5 m	6911.0002

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

Description	Part No.
Power cord, Italy	6000.1040
Power cord, Japan	6000.1050
Power cord, UK	6000.1020
Power cord, USA	6000.1001
Power cord, Switzerland	6000.1030

11 Appendix

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

11.1 Compliance Information

11.1.1 Declarations of Conformity

CE Declaration of Conformity

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

cTUVus Compliance

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

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

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 43: 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 Manual Release History

Revision	Covering
2.0	VC-D50, VC-D51, VF-D50, VF-D51
1.2a	VF-D50, VF-D51
1.2	VF-D50, VF-D51
1.1	VF-D50, VF-D51

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.

11.3 Digital I/O

The digital I/O ports (Dig I/O) can be used to exchange digital signals with external devices. Each port provides:

- one digital input
- one relay output

Pin Assignment

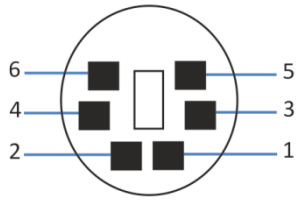

Figure 44: Digital I/O port

Pin	Description
1	Not used
2	Relay output — Relay_NC (Normally Closed contact)
3	Ground — GND
4	Digital input — Input
5	Relay output — Relay_COM COM is the common contact for NO and NC. If the relay is not activated or if the device is turned off, the connection is between COM and NC. If the relay is activated, the connection is between COM and NO.
6	Relay output — Relay_NO (Normally Open contact)

The next table lists the functions assigned to the connector pins and the color of the cable wire connected to each pin.

Pin	Wire Color	Signal Name	Signal Level	Remarks
1	Pink			Not used
2	Gray	Relay output — Relay_NC	Potential free 0-24 V, 0-100 mA	Opening contact
3	Green	Ground — GND	Ground	Reference potential

Pin	Wire Color	Signal Name	Signal Level	Remarks
4	Yellow	Digital input — Input	Input (low active): On: 0-0.4 V Off: 2.2-5 V Pull-up resistor: 47 kΩ to 5 V	Digital input; reference potential is ground. Note the following: • The maximum input voltage at the input must not exceed +5 V with reference to ground. • The minimum input voltage must not be lower than the ground potential.
5	White	Relay output — Relay_COM	Potential free	Common contact for NO and NC
6	Brown	Relay output — Relay_NO	Potential free 0-24 V, 0-100 mA	Closing contact

Prerequisites

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

- The digital I/O port must be connected to the external device with the digital I/O signaling cable (part no. 6036.0006).
- The inputs and outputs that you want to use must be selected in the Instrument Configuration Manager.

Connecting a Digital I/O Port

1. Plug the 6-pin connector of the cable into the digital I/O port that you want to use.
2. For each relay output or digital input to be used, connect the appropriate signal wire and ground wire to the corresponding connectors on the external device. For details, refer to the documentation provided with the external device.

Selecting the inputs and outputs in the Chromeleon software

1. In the dialog box for the device, on the **Inputs** and **Outputs** pages, select the inputs and outputs that you want to use. The numbering in the dialog box corresponds to the numbers on the port.

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