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Vanquish

Variable Wavelength Detectors

VC-D40, VF-D40

Operating Manual

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ThermoFisher
SCIENTIFIC

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Original Operating Manual

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1 Using this Manual

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

1.1 About this Manual

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

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

Note the following:

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

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

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

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

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

1.2.2 Special Notices

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

NOTICE

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

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

1.2.3 Typographical Conventions

These typographical conventions apply to the descriptions in this manual:

Data Input and Output

The following appears in **bold** type:

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

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

References and Messages

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

Viewpoint

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

Particularly Important Words

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

Electronic Manual Version (PDF)

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

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

1.3 Reference Documentation

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

Hardware Documentation

Additional hardware documentation includes the following:

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

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

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

Software Documentation

Additional software documentation includes the following:

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

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

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

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

Third-Party Documentation

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

2 Safety

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

2.1 Safety Symbols and Signal Words

2.1.1 Safety Symbols and Signal Words in this Manual

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

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



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



CAUTION

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



WARNING

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

2.1.2 Observing this Manual

Observe the following:

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



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

2.1.3 Safety Symbols on the Device

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

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

2.1.4 Rating Plate

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

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

2.2 Intended Use

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

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

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

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

They are not intended for use in diagnostic procedures.

Laboratory Practice

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

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

2.3 Safety Precautions

2.3.1 General Safety Information

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



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

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

Safety Standard

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

2.3.2 Qualification of the Personnel

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



Installation

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

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



General Operation

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

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

2.3.3 Personal Protective Equipment

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



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

Protective Clothing

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

Protective Eyewear

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

Gloves

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

2.3.4 Electrical Safety Precautions



WARNING—Electric Shock or Damage to the Device

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

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

2.3.5 General Residual Hazards

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

**WARNING—Hazardous Substances**

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

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

**WARNING—Biohazard**

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

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

**WARNING—Self-Ignition of Solvents**

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

Avoid the use of these solvents.

**WARNING—Hazardous Vapors**

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

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

**CAUTION—Escape of Hazardous Substances from PEEK Capillaries**

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

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

**CAUTION—Allergic Reaction**

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

**CAUTION—Sparking due to Electrostatic Discharge**

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

Prevent the generation of static electricity near the chromatography system.

2.3.6 In Case of Emergency



WARNING—Safety Hazard

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

2.4 Solvent and Additive Information

2.4.1 General Compatibility

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

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

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

Piston Seal Compatibility

- In rare cases, a shortened lifetime of reversed-phase (UHMW-PE) piston seals has been observed with high pH, ammonium hydroxide containing mobile phases and prolonged exposure.

2.4.2 Allowed pH Ranges

Allowed pH ranges (standard system configuration):

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

2.4.3 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	<i>High chloride concentration:</i> The application time should be as short as possible. Flush the system thoroughly after these applications.
Vanquish Horizon Vanquish Flex	1 mol/L or less	-	

2.4.4 Further Information

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

NOTICE

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

2.5 Compliance Information

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

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

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

See also

 [Compliance Information \(► page 164\)](#)

3 Device Overview

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

3.1 Detector Features

The detector comprises the following main features:

- The detector is a dual-beam, variable wavelength photometer with one measurement and one internal reference beam.
- Two different light sources provide a wavelength detection range from 190 nm to 750 nm (VC-D40) and from 190 nm to 900 nm (VF-D40):
 - ◆ A deuterium lamp (referred to as UV lamp) for ultraviolet and visible detection and
 - ◆ A tungsten lamp (referred to as VIS lamp) for visible and near-infrared detection (optional for VC-D40)
- Internal validation of the wavelength accuracy with holmium oxide filter
- Multi-Wavelength Operation for additional operation functions, measuring simultaneously at up to two (VC-D40) or four (VF-D40) different wavelengths
- Data collection rates of up to 125 Hz (VC-D40) and up to 250 Hz (VF-D40) under Chromeleon 7.2 software or later, in single-channel mode
- Spectra measurements
- Two optical filters for eliminating higher order light
To ensure optimal measurement results over the entire wavelength range, the optical filters automatically move into the light path (also in multi-wavelength operation).
- Automatic wavelength calibration after power-up and when the lamp configuration was changed.
- A shutter (motorized filter paddle) to move into the light path before the flow cell
The shutter can move into the following positions:
 - ◆ Open position for data acquisition
 - ◆ Closed (dark) position for protection of the flow cell and for dark signal measurements
 - ◆ Holmium oxide filter position for validation of wavelength accuracy
- Availability of flow cells for different fields of applications (for details, see [Flow Cell Specifications](#) (► page 154))

3.2 Operating Principle

The detector is a dual-beam spectrophotometer that is designed for ultraviolet (UV), visible (VIS) and near-infrared (NIR) absorption spectrophotometry in combination with HPLC or UHPLC separations.

Photometric detection bases upon the absorption of monochromatic light. The optical system of the detector provides a deuterium lamp (UV), and may provide a tungsten lamp (VIS), which is optional for VC-D40 detectors. A concave mirror (no. 2) focuses the light from the VIS lamp (no. 1) to the aperture of the UV lamp (no. 3). Another mirror (no. 4) receives the combined light from both light sources and focuses it into the entrance slit (no. 6). The shutter (motorized filter paddle, no. 5) can be moved into the light path before the flow cell to protect the flow cell.

The light passes through the entrance slit to the mirror (no.7) and on to the grating (no. 8), where the light beam is diffracted. The angular position of the grating determines the selected wavelength that is focused by the mirror (no.9) and directed to the beamsplitter (no. 10) and flow cell (no. 13).

The beamsplitter (no. 10) directs part of the light beam to the reference diode (no. 11). If the flow cell is removed, a safety shutter (no. 12) blocks the light beam to protect the user from UV radiation. If a flow cell is installed, the remaining light travels through the flow cell (no. 13), and is partly absorbed depending on the sample solution in the flow cell. It travels on to the measurement photodiode (no. 14), where the remaining light intensity is measured. The absorbance of the analyte is calculated from the measured intensities based on the law of Lambert-Beer.

The response of the detector is proportional to the concentration of the analyte. Simultaneously, the reference beam intensity is measured and used to compensate any intensity fluctuations of the light source.

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

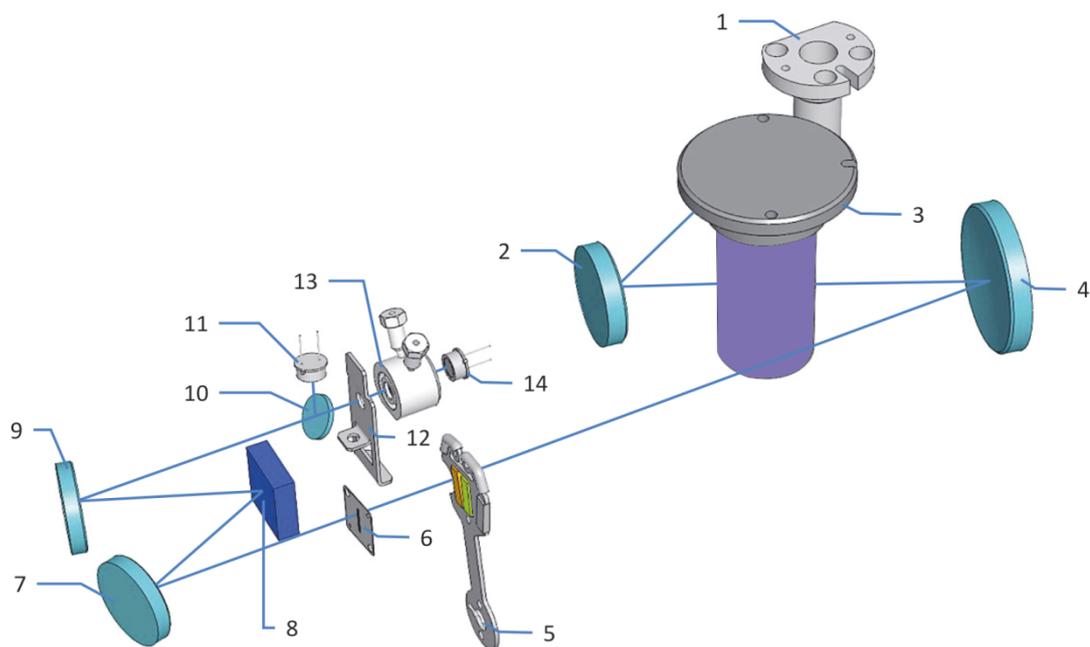


Figure 1: Operating principle of the optics

No.	Description
1	VIS lamp (tungsten lamp)
2	Mirror (VIS)
3	UV lamp (deuterium lamp)
4	Mirror (combined light)
5	Shutter
6	Entrance slit
7	Mirror
8	Grating
9	Mirror
10	Beamsplitter
11	Reference photodiode
12	Safety shutter
13	Flow cell
14	Measurement photodiode

3.3 Interior Components

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

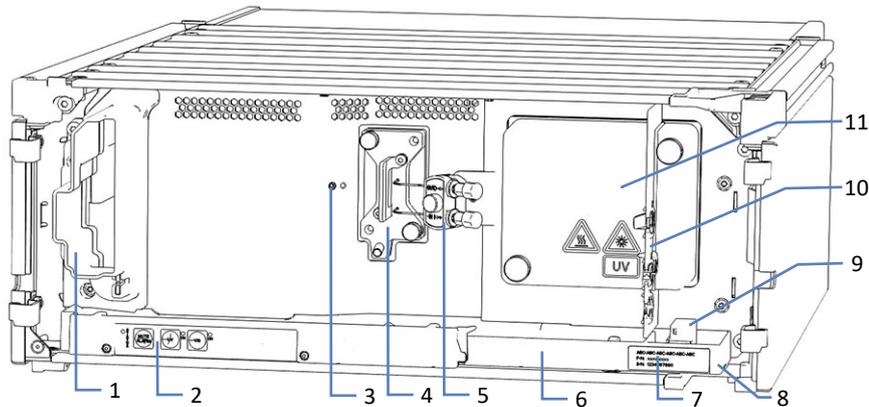


Figure 2: Interior components (here with flow cell with connection unit installed)

No.	Description
1	Cooling air intake
2	Keypad with status indicators
3	Screw holes for connection unit (left-side installation)
4	Flow cell with connection unit
5	Connection unit
6	Leak tray
7	Type label, indicating the module name, serial number, part number, and revision number (if any)
8	Drain port
9	Leak sensor
10	Partition panel The recesses in the partition panel are used to route capillaries with the help of special plugs (see Installing the Partition Panel Plugs (▶ page 65)).
11	Lamp house cover Depending on the detector configuration, a UV lamp or a UV and a VIS lamp are installed in the lamp house.

3.4 Flow Cell

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

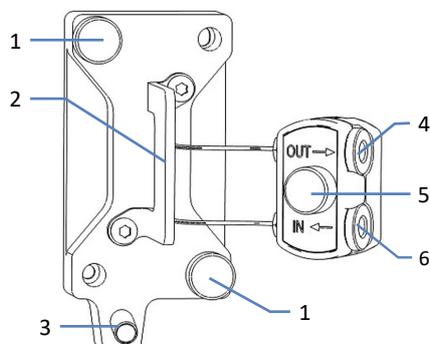


Figure 3: Flow cell (example)

No.	Description
1	Flow cell screws
2	Flow cell handle
3	Drain outlet
4	Connector for outlet capillary
5	Connection unit screw
6	Connector for inlet capillary

Flow Cell Label

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

Flow Cell Identification Chip

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

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

Heat exchanger

Standard flow cells and semi-micro flow cells are equipped with a built-in heat exchanger.

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

The detector is shipped with a diagnostic cell. Replace the diagnostic cell with a flow cell that is appropriate for your application. Depending on the application needs, different types of flow cells are available for the detector.

For flow cell ordering information, see [Optional Accessories](#) (▶ page 160).

For the flow cell specifications, including, for example, materials in the flow path and pressure limit, see [Flow Cell Specifications](#) (▶ page 154).

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

See also

 [Guidelines for Use of Flow Cells](#) (▶ page 84)

3.5 Lamps

Lamp Types

Two different light sources provide the light for a wavelength detection range from 190 nm to 750 nm (VC-D40), or from 190 nm to 900 nm (VF-D40). Note that the VIS lamp is optional for VC-D40.

Refer to the table below to find out which lamp is recommended if at least one of your detection wavelengths is within the range indicated in the left column.

At least one detection wavelength	Recommended lamp(s)
≤ 345 nm	UV
Between 346 and 670 nm	UV and VIS (turn on both lamps)
> 670 nm	VIS

Identification Chip

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

When a lamp is installed, the ID chip is automatically connected to the detector electronics.

3.6 Leak Detection

Leaks are a potential safety issue.

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

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

3.7 Operation

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

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

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

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

4 Unpacking

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

4.1 Unpacking

Damaged Packaging, Defective on Arrival

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

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

Unpacking the Device



CAUTION—Heavy Load, Bulky Device

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

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

Tools required

Screwdriver, Torx™ T20

Follow these steps

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

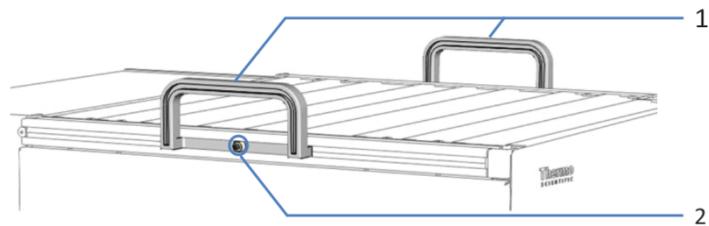


Figure 4: Carrying handles on the device

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

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

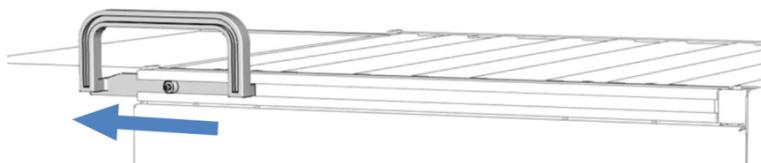


Figure 5: Sliding off the carrying handle from the left rail

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

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

4.2 Scope of Delivery

The following items are included in the delivery:

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

For information on contents of the ship kit or reordering parts, see [Accessories, Consumables and Replacement Parts](#) (▶ page 157).

5 Installation

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

5.1 Safety Guidelines for Installation

Pay attention to the following safety guidelines:



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



CAUTION—Heavy Load, Bulky Device

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

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



CAUTION—Electric Shock or Damage to the Device

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

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

5.2 Installing the Device

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

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

NOTICE

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

1. Pay attention to the safety guidelines and observe all site requirements. See [Safety Guidelines for Installation](#) (▶ page 46) and [Site Requirements](#) (▶ page 49).
2. Set up the device hardware. See [Setting Up the Hardware](#) (▶ page 52).
3. Set up the flow connections. See [Setting Up the Flow Connections](#) (▶ page 62).
4. Turn on the device. See [Turning On the Device](#) (▶ page 73).

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 74).

6. *Recommended:*
Perform Instrument Installation Qualification.

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

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

NOTICE

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

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

Moving the Device after Installation

If you have to move the device after it has been set up and installed in the Vanquish system, prepare the device for transport and move it to the new location. Follow the instructions in [Transporting or Shipping the Device](#) (▶ page 128).

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 151) 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.

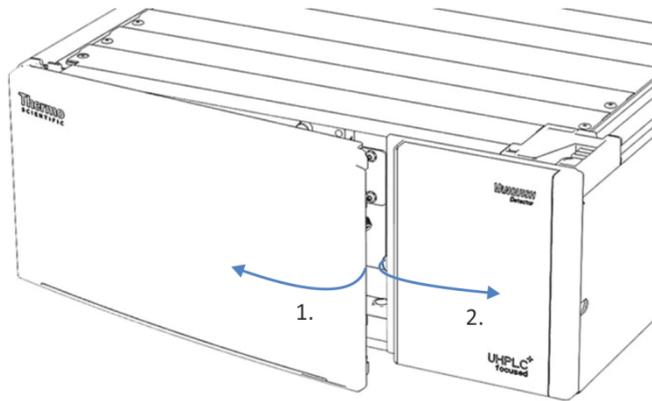


Figure 6: Opening the front doors

5.5 Setting Up the Hardware

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

5.5.1 System Arrangement

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

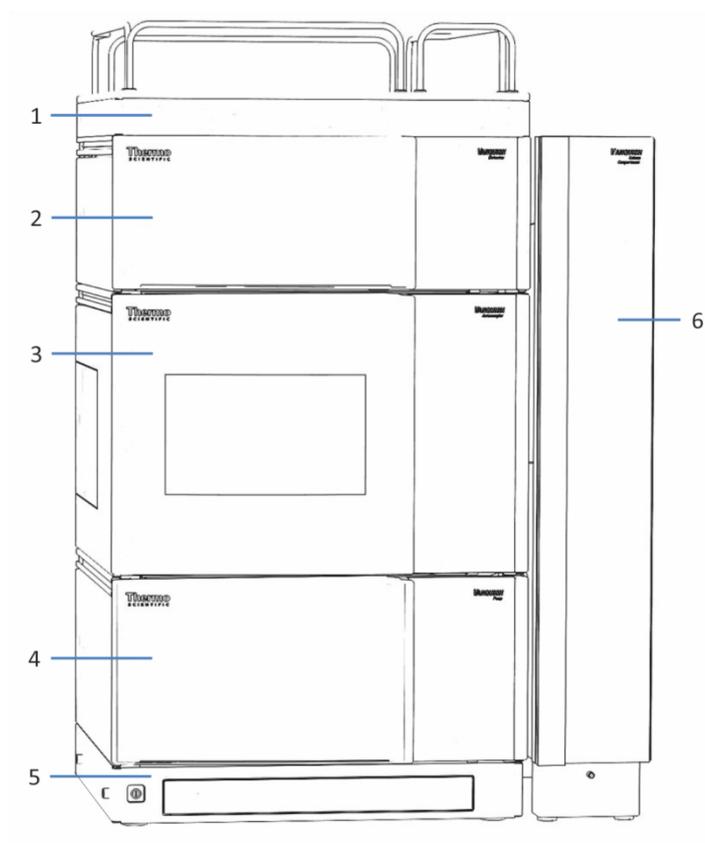


Figure 7: Vanquish system, standard configuration (example)

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

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

5.5.2 Connecting the Device

Device Connectors

The following connectors are provided on the device:

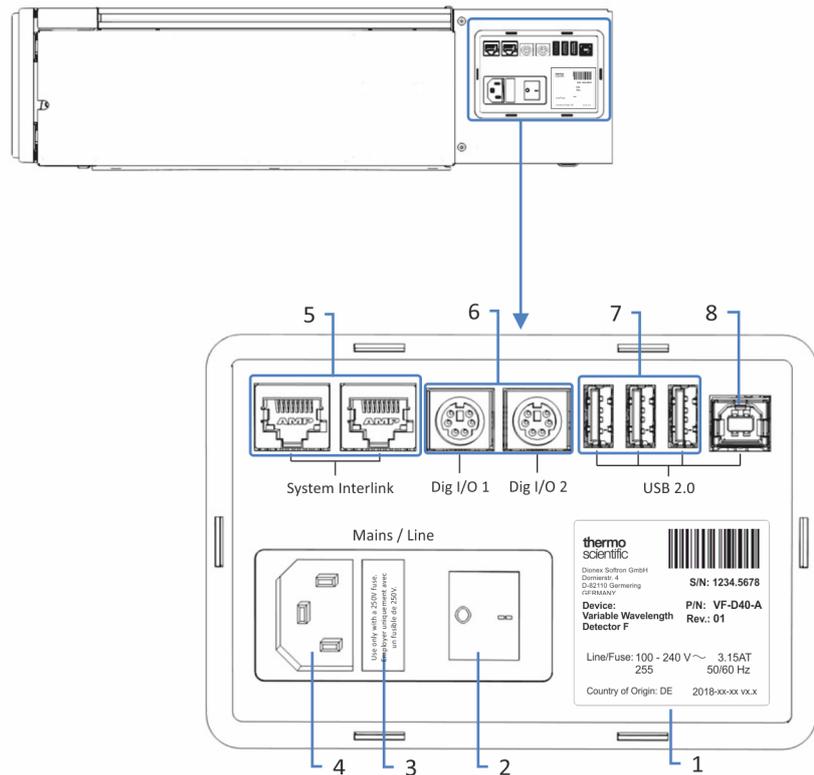


Figure 8: Electrical connectors on the right side of the detector

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

No.	Description
5	<p>System Interlink port</p> <p>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.</p> <p>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.</p>
6	<p>Digital I/O ports (Dig I/O)</p> <p>Allow exchange of digital signals with external instruments</p> <p>Each digital I/O port provides one input and one relay output. For connection and pin assignment information, see Digital I/O (▶ page 168).</p>
7	<p>USB hub ("A"-type connector)</p> <p>Allows connection to other modules in the Vanquish system</p>
8	<p>USB (Universal Serial Bus) port ("B" type connector)</p> <p>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</p>

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

Follow these steps

NOTICE

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

1. Place the device in the system as required by the system configuration. For details, refer to the *Vanquish System Operating Manual*.
2. Connect the required interface cables to the device. For information about how to connect the device to other modules in the Vanquish system or to the chromatography data system computer, refer to the *Vanquish System Operating Manual*.
3. Connect the power cord (see [Connecting the Power Cord](#) (▶ [page 55](#))).

5.5.3 Connecting the Power Cord

NOTICE

Condensation in a device can damage the electronics.

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

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

5.6 Installing a VIS Lamp (Tungsten Lamp) (Optional)

Follow the instructions below to install the optional VIS lamp.

Parts required

VIS lamp

Preparations

1. Turn off the device.

Follow these steps

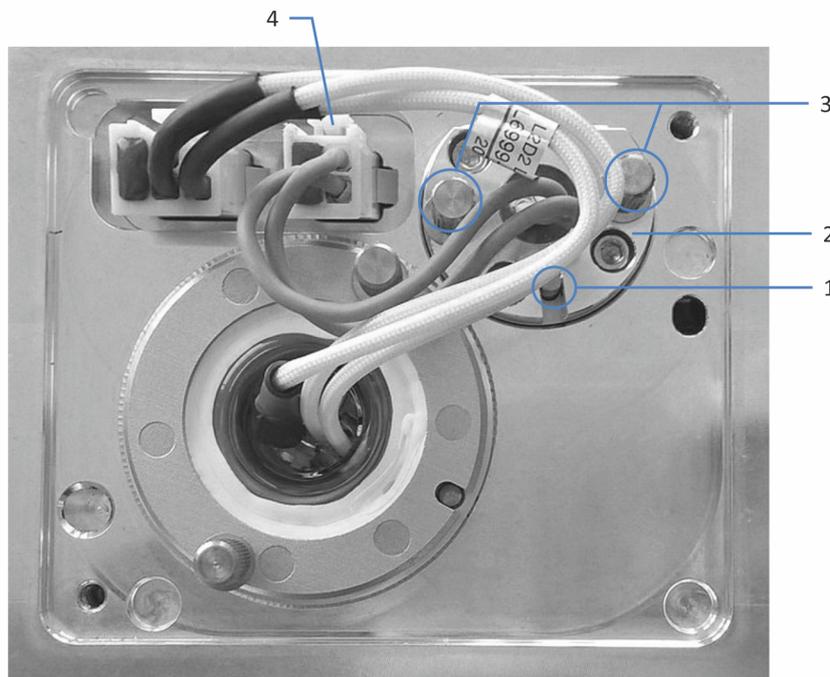


Figure 9: VIS lamp

No.	Description
1	VIS lamp locating pin
2	VIS lamp
3	VIS lamp attachment screw
4	VIS lamp connector

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

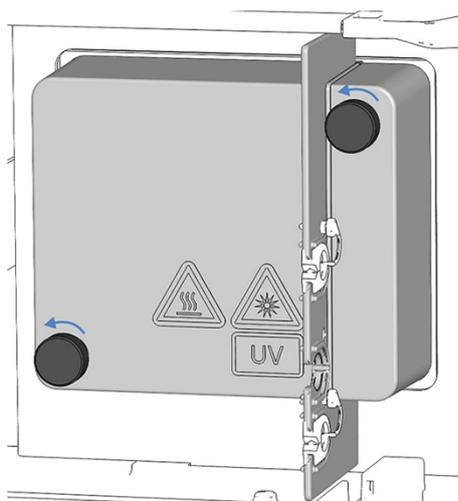


Figure 10: Screws on the lamp house cover

3. Remove the lamp house cover.
4. Loosen the 2 screws of the VIS slot protection plate and remove the plate. Keep the VIS slot protection plate for later use.
5. Align the new lamp with the locating pin.
When the lamp is in the correct position, push the lamp gently into the lamp house. The lamp socket must be in a level position with the lamp house.
6. When the lamp is properly seated, tighten the two screws to attach the lamp to the lamp house.
7. Connect the lamp connector.
8. Mind the routing of the lamp cables.
Position the lamp cables as indicated in [VIS lamp](#) (▶ [page 56](#)) to prevent the cable from being pinched under the lamp house cover.
9. Install the lamp house cover and fasten the screws on the lamp house cover.
10. Turn on the device with its main power switch.
11. *If you install a VIS lamp for the first time, activate the lamp in the chromatography data system:*
Only then, the VIS lamp can be ignited from the chromatography data system.
 - a) Right-click the detector in the Instrument Configuration Manager.
 - b) Select **Properties** on the menu.
 - c) On the **Detector** page, enable the **VIS Lamp** check box.

12. After installing a new lamp, increased noise and strong baseline fluctuations may occur. Before beginning an analysis or performing a wavelength validation, allow the new lamp to run until the noise is reduced and the baseline is stable which typically takes 24 hours.
13. Perform a wavelength validation (see [Performing a Wavelength Validation and Calibration](#) (► page 119)).

5.7 Installing a Flow Cell

This section describes the installation of the flow cell in the detector.

- To remove the diagnostic cell, see [Removing the Diagnostic Cell](#) (▶ page 59).
- To install a flow cell without connection unit, see [Installing a Flow Cell without Connection Unit](#) (▶ page 60).
- To install a flow cell with connection unit, see [Installing a Flow Cell with Connection Unit](#) (▶ page 60).

For instructions on cleaning or removing a flow cell or installing a diagnostic cell, see [Flow Cell](#) (▶ page 114).

NOTICE—Sensitive Flow Cells

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

- Hold flow cells by the flow cell handle.
- To avoid damage and/or contamination of the optical block of the flow cell, do not touch the optical block.
- 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.

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.

5.7.1 Removing the Diagnostic Cell

The detector is shipped with a diagnostic cell installed. This section describes the removal of the diagnostic cell.

Follow these steps

1. Open the doors.
2. Loosen the two screws that hold the diagnostic cell in position.
3. Grasp the diagnostic cell by its handle and pull the diagnostic cell out of the detector.

TIP Store the flow cell in a clean place for later use in diagnostic procedures or for transporting the device.

5.7.2 Installing a Flow Cell without Connection Unit

Parts required

Flow cell, as required by the application

Preparations

1. Remove the diagnostic cell. See [Removing the Diagnostic Cell](#) (▶ page 59).
2. Unpack the flow cell.

Follow these steps

1. Push the flow cell into the flow cell opening.
2. Tighten the two flow cell screws hand-tight.
3. Set up the flow connections to the flow cell, see [Setting Up the Flow Connections](#) (▶ page 62).
4. Perform wavelength validation, see [Performing a Wavelength Validation and Calibration](#) (▶ page 119).

TIP If the wavelength validation fails, perform a calibration of wavelengths.

5.7.3 Installing a Flow Cell with Connection Unit

Parts required

Flow cell, as required by the application

Preparations

1. Remove the diagnostic cell. See [Removing the Diagnostic Cell](#) (▶ page 59).
2. Unpack the flow cell.

Follow these steps

1. Push the flow cell partly into the flow cell opening.
2. Place the connection unit on the connection unit socket. Take care that the locating pin is placed in the slot.

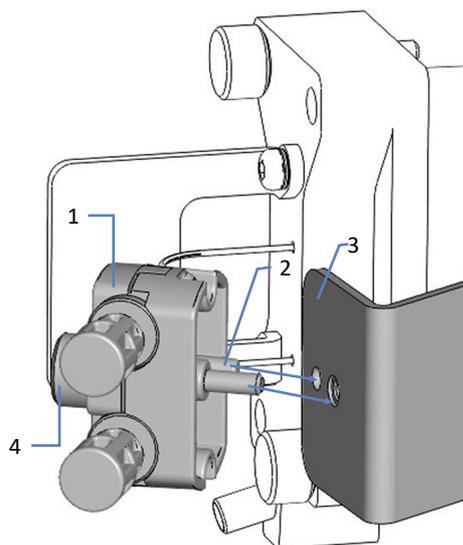


Figure 11: Installing a flow cell with connection unit

No.	Description
1	Connection unit
2	Locating pin
3	Connection unit socket
4	Connection unit screw (knurl)

3. Tighten the connection unit screw hand-tight.
4. Push the flow cell completely into the flow cell opening.
5. Tighten the two flow cell screws hand-tight.
6. Set up the flow connections on the flow cell, see [Setting Up the Flow Connections](#) (▶ page 62).
7. Perform wavelength validation, see [Performing a Wavelength Validation and Calibration](#) (▶ page 119).

TIP If the wavelength validation fails, perform a calibration of wavelengths.

5.8 Setting Up the Flow Connections

5.8.1 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.
- If you install switching valves or fraction collectors downstream of the flow cell, operating those under flow may result in pressure spikes that can destroy the flow cell. Ensure that pressure spikes do not exceed the flow cell pressure specification.

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 68)).
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 66).

5.8.2 Guiding Capillaries and Tubing Through the System

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

Tubing Chase with Tubing Guides

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

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

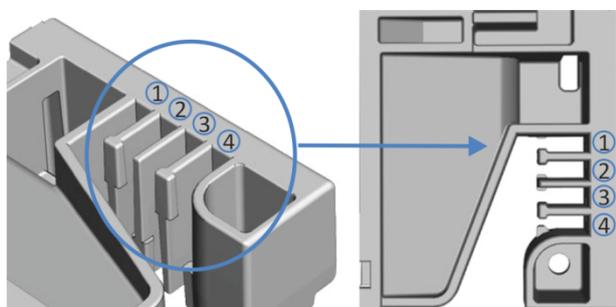


Figure 12: Tubing chase with tubing guides (left: view from inside, right: view from top)

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

Tubing Brackets

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

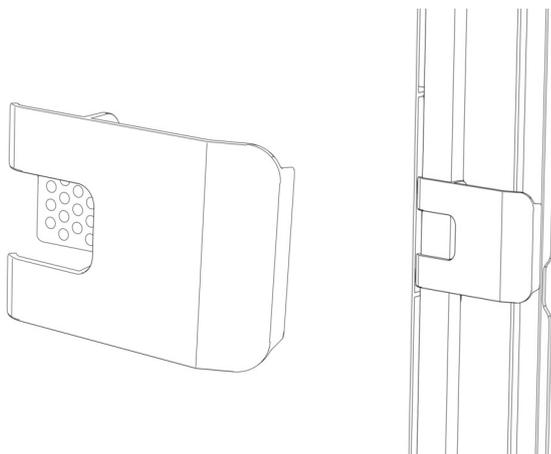


Figure 13: Tubing bracket (left), tubing bracket installed (right)

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.

5.8.3 Installing the Partition Panel Plugs

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



Figure 14: 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.

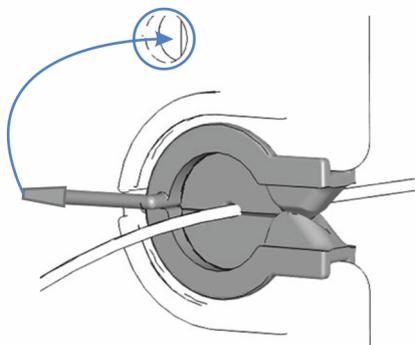


Figure 15: Securing the partition panel plug with slit

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

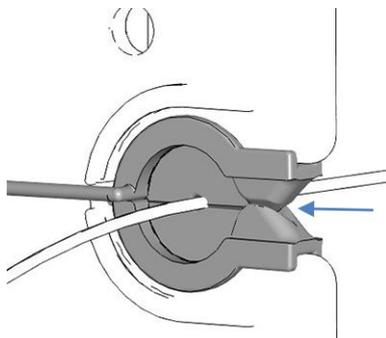


Figure 16: Capillary installed in the plug with slit

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.

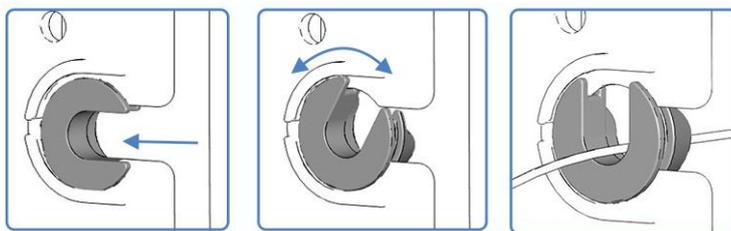


Figure 17: Using the rotating plug

5.8.4 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, stainless steel) or finger-tight fittings (PEEK)

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

5.8.4.1 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.

5.8.4.2 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.

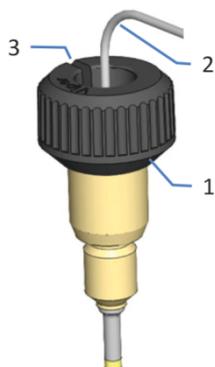


Figure 18: Viper fitting with knurl

No.	Description
1	Knurl
2	Capillary
3	Slot

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

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

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

Resolving Leakage of Viper Fittings with Knurls

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

5.8.5 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.

In addition, observe the guidelines for proper connection of the flow cell in [General Information and Guidelines](#) (▶ page 62).

Parts required

- Inlet capillary
- Detector waste line
For instructions on connecting the waste line, follow the steps in [Connecting the Detector Waste Line](#) (► page 71).

Tools required

For the detector waste line: Tubing cutter (optional)

Preparations

TIP For easier guiding of capillaries to the flow cell inlet, remove the right door of the detector, see [Replacing the Doors](#) (► page 126).

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

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

3. Install the partition panel plugs (if not present yet). See [Installing the Partition Panel Plugs](#) (► page 65).

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 70)
- 📄 [Connecting the Detector Waste Line](#) (► page 71)

5.8.5.1 Connecting the Inlet Capillary

Preparations

See [Flow Connections to the Flow Cell](#) (► page 68).

Follow these steps

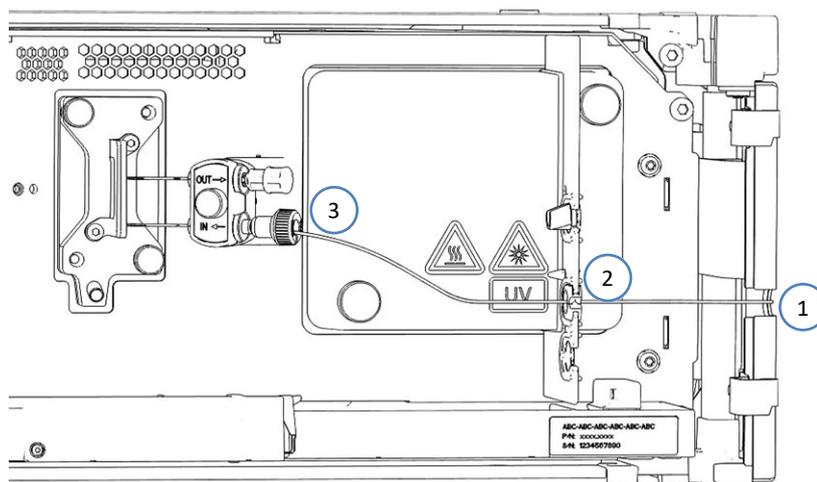


Figure 19: Connecting the inlet capillary from the column compartment (example)

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

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

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

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

3. Connect the inlet capillary to the flow cell inlet or to the inlet (**IN**) on the flow cell connection unit.

5.8.5.2 Connecting the Detector Waste Line

Preparations

1. See [Flow Connections to the Flow Cell](#) (► page 68).

Follow these steps

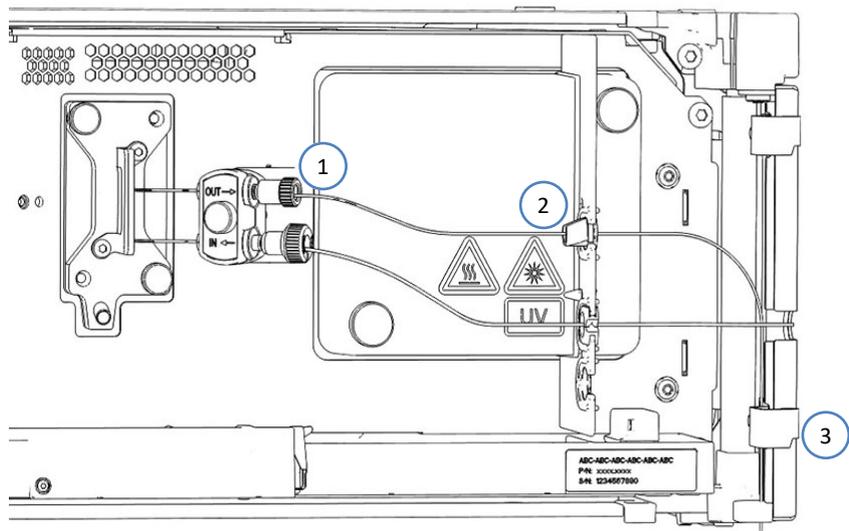


Figure 20: Connecting the detector waste line

1. Connect the waste line to the flow cell outlet or to the outlet (**OUT**) on the flow cell connection unit (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.

5.8.6 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*.

5.9 Turning On the Device

TIP

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

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

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

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

See also

 [Power On/Off Control \(▶ page 81\)](#)

5.10 Setting Up the Device in the Software

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

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

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

6 Operation

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

6.1 Introduction to this Chapter

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

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

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

6.2 Safety Guidelines for Operation

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



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



CAUTION—Hot Surfaces

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

Allow hot surfaces to cool down before you touch them.

6.3 Control Elements

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

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

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

6.3.1 Keypad

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

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

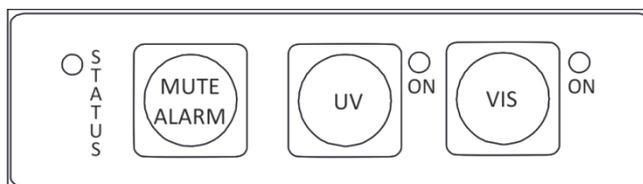


Figure 21: Keypad

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 80).

MUTE ALARM

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

UV

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

The LED next to the button indicates the lamp status:

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

VIS

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

The LED next to the button indicates the lamp status:

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

When the Device is Connected in the Chromeleon Software

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

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

6.3.2 Status Indicators

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

LED Bar

The LED bar colors provide the following information:

LED Bar	Description
Off (dark)	The power to the device is turned off.
Dimmed	The doors of the device are open.
Yellow, flashing slowly	The power to the device is turned on, but the device is not connected in the chromatography data system.
Yellow	The device is connected in the chromatography data system, but the device is not equilibrated.
Green, flashing	The device is equilibrating. At least one lamp is igniting.
Green	The device is connected and equilibrated, but no data acquisition is running. At least one lamp is turned on.
Blue, running	A data acquisition is running.
Blue	An injection or sequence is running.
Red	A problem or error has occurred. For the related message, check the Instrument Audit Trail. For remedial action, see Troubleshooting (▶ page 137).

STATUS LED

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

STATUS LED	Description
Off (dark)	The power to the device is turned off.
Green	The device is functioning properly.
Red	A problem or error has occurred. For the related message, check the Instrument Audit Trail. For remedial action, see Troubleshooting (▶ page 137).

For information about the LEDs that are present next to the **UV** and **VIS** buttons on the keypad, see [Keypad](#) (▶ page 78).

6.4 Power On/Off Control

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

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

Observe the following:

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

6.5 Preparing the Device for Operation

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

Before Operating the Device for the First Time

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

NOTICE

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

- When you install devices or components to the system, always flush them to waste before connecting them in the system flow path. To flush the Vanquish modules, follow the instructions in the *Vanquish System Operating Manual*.
 - When operating the detector 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. New flow cells are dry or filled with isopropanol when shipped.
-
- To remove the isopropanol from the device components:
 - ◆ Verify that the flow cell and the column are not connected in the flow path.
 - ◆ Purge the pump and then have the pump deliver flow for a short time.
 - Verify that any air bubbles are completely flushed out of the system flow path.
 - Perform a wavelength validation. If the validation fails, perform a wavelength calibration.

Before Starting Sample Analysis

Before starting an analysis:

- Check the liquid level in the solvent reservoirs. Verify that the amount of solvent is sufficient for the analysis.
- Close the doors of all modules in the Vanquish system, if not already done.
- Observe the guidelines for use of flow cells in [Guidelines for Use of Flow Cells](#) (► page 84).
- Make sure that the chromatography system is properly equilibrated (see further down).

System Equilibration

System equilibration should include the following operations:

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

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

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

6.6 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 115).
- 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 Cell Specifications](#) (▶ page 154).

Interrupted operation

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

- Turn off the UV lamp or close the shutter to protect the flow cell from the light of the UV lamp. UV radiation from the lamp may damage the flow cell.
- Never leave any substances in the flow cell without flow. Particularly avoid leaving any aggressive solvents in the flow cell for a longer time.
- Without flow, air bubbles in the flow cell can accelerate the deposition of substances. Never leave air bubbles in the flow cell. If the pump flow is stopped for a longer time, fill the flow cell with a high purity solvent, for example isopropanol.

Troubleshooting flow cells

- If a flow cell leaks, stop the pump flow, remove the flow cell from the detector as quickly as possible, and replace the flow cell.
- For information about how to clean a flow cell, see [Cleaning the Flow Cell](#) (▶ page 115).

Storage and shipment

- Always keep unused flow cells in their original dust-free packaging.
- When shipping the instrument, *remove* the flow cell and install the diagnostic cell to protect the flow cell opening. The flow cell must be shipped in its original packaging.

See also

- 📄 [Removing the Flow Cell](#) (▶ page 116)
- 📄 [Installing a Diagnostic Cell](#) (▶ page 118)

6.7 Turning On the UV Lamp

Prerequisites

The lamp house cover must be installed.

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

Follow these steps

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

In the chromatography data system, turn on the lamp on the ePanel for the detector.

2. Allow the lamp and optics to warm up and stabilize for at least one hour until the working temperature is reached before you start analysis.

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

Turning on the Lamp Automatically

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

6.8 Turning On the VIS Lamp

Prerequisites

The lamp house cover must be installed.

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

When using both lamps, it is recommended to turn on the UV lamp prior to the VIS lamp.

Follow these steps

1. Press the **VIS** button on the keypad of the detector.
- or -
In the chromatography data system, turn on the lamp on the ePanel for the detector.
2. Allow the lamp and optics to warm up and stabilize for at least one hour until the working temperature is reached before you start analysis.

Turning on the Lamp Automatically

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

6.9 Operational Modes of the Device

6.9.1 Single-Channel Mode

Single-channel mode is the default mode of operation for the detector. As this mode provides the highest possible data rates and best signal-to-noise ratio, always use the single-channel mode for routine operation of the detector.

Consider the following for operating the detector in single-channel mode:

- Sample components should absorb strongly at the selected wavelength. Therefore, select a wavelength on an absorption maximum.
- At the selected wavelength no other sample components should absorb that can falsify the peaks of the sample components of interest.
- If the absorbance spectra of the sample components differ significantly, the measurement wavelength can be switched any time and as often as required during an acquisition.
- The switching is considerably shorter than one second and should be performed when no sample components of interest are present in the flow cell.

While the wavelength is switched, no absorption measurement takes place for a short period of time. If the wavelength is switched during an analysis of a sample component, the peak area changes, and a correct quantification is not possible. You can choose between three different baseline behaviors, when switching the wavelength (for details, see [Baseline Behavior](#) (▶ page 94)).

6.9.2 Multi-Channel Mode

The detector provides a multi-channel mode that offers additional operation functions for method development and peak-purity analyses. In multi-channel mode, data can be recorded on more than one channel simultaneously with different, selectable wavelengths. The detector quickly switches between the selected wavelengths. The maximum number of channels depends on your detector variant.

A single analysis is sufficient to measure several channels. Sample components with different absorption characteristics can be analyzed even without complete chromatographic resolution.

Consider the following, when operating the detector in multi-wavelength mode:

- Each additional channel reduces the maximum possible data collection rate, and leads to an increased baseline noise.
- Switching the optical grating permanently between the wavelengths can lead to wear on the mechanical parts of the detector in the long term. The multi-channel operation mode is therefore *only* recommended for method development and peak-purity analysis, but *not* for continuous routine operation.
- As an alternative, you can switch the wavelengths as often as required in a single data channel in the Chromeleon software. For further information on wavelength switching and single-wavelength operation, see [Single-Channel Mode](#) (▶ page 87), and the *Chromeleon Help*.

TIP The optical filters for eliminating higher-order wavelengths are moved automatically into the light path. This applies for multi-channel mode, too.

6.10 Important Operating Parameters

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*.

Parameters	Description
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. The maximum data collection rate depends on the detector type and the software version. For more information on how to set the data collection rate, see Data Collection Rate (▶ page 93).
Lamphouse temperature	The temperature signal channel (Lamphouse Temperature) that is available in the Properties dialog box of the detector, can be used for troubleshooting purposes. The lamps of the detector are very sensitive to changes in temperature. In case of baseline drift problems, the lamphouse temperature signal can help to find the reason for the problem. Select the signal channel to record the temperature. Chromeleon generates the appropriate channel for recording the temperature of the detector lamp house.
Leak detection	Leak detection is enabled as a standard when the detector is shipped (Leak Sensor Mode = Enabled). This is the preferred setting.
Peak width	The peak width is a supporting parameter for the data collection rate setting and the response time. For details on the peak width and selecting it individually, see Response Time and Peak Width (▶ page 93).
Response time	The response time determines how quickly the detector responds to a change in signal. For details on the response time and selecting it individually, see Response Time and Peak Width (▶ page 93).

Parameters	Description
Spectra scanning	<p>To record the absorbance spectra of substances that are used in an analysis, for example, to detect peak impurities, or to identify optimum wavelengths for method development, perform spectra scanning:</p> <p>ScanStartWavelength sets the wavelength at which the scan should start.</p> <p>ScanEndWavelength sets the wavelength at which the scan should end.</p> <p>ScanSpeed sets the speed at which the wavelength range is scanned.</p> <p>ScanBaseline saves a baseline scan based on the current settings.</p> <p>Scan saves an absorbance spectrum based on the current settings.</p> <p>Note: Before you can record an absorbance spectrum, perform a ScanBaseline with the same wavelength settings that you want to use for recording the absorbance spectrum.</p> <p>For further information about the parameters and commands, refer to the <i>Chromeleon Help</i>.</p>
UV lamp VIS lamp	<p>Turn on the UV and/or VIS lamp before starting an analysis (UV_Lamp = On, Visible_Lamp =On). This setting allows turning on and off the UV and VIS lamp of the detector.</p> <p>To turn the UV lamp on automatically after power on, set AutoactivateUV_Lamp to On.</p> <p>To turn the VIS lamp on automatically after power on, set AutoactivateVisible_Lamp to On.</p>
UV_VIS	<p>The UV_VIS signal channels (UV_VIS_x) that are available for data acquisition are listed in the dialog box for the detector in the Instrument Configuration Manager. Select the required signal channels.</p> <p>Recording at more than one signal channel, thus at more than one wavelength, sets the detector into multi-channel mode. For details, see Multi-Channel Mode (▶ page 87).</p>
Wavelength	<p>Sets the wavelength in nm. Select the wavelength at the absorption maximum of the sample component to be analyzed.</p>
Wavelength calibration	<p>If the wavelength validation failed, perform a calibration of wavelengths.</p> <p>The 0-order radiation, which corresponds to 000 nm of the wavelength scale, is used to calibrate the wavelength.</p> <p>For further information, see Performing a Wavelength Validation and Calibration (▶ page 119).</p>
Wavelength validation	<p>Perform the wavelength validation as required. A holmium-oxide glass filter is moved into the light path of the lamp and is used to validate the wavelength accuracy.</p> <p>For further information, see Performing a Wavelength Validation and Calibration (▶ page 119).</p>

6.11 Optimizing the Performance of the Device

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

6.11.1 Guidelines for Optimum Performance

Consider the following guidelines for optimization of the device performance:

- Do not turn off the lamp or lamps during short measurement breaks. Igniting a lamp frequently reduces the lifetime of the lamp. In addition, some time is required for the detector to stabilize after re-ignition of a lamp.
- 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.
- Ensure that the operating conditions are suitable. This includes:
 - ◆ Stable environmental conditions, such as a stable temperature
 - ◆ No air drafts
 - ◆ No vibrations or mechanical shocks caused by external sources
 - ◆ No EMC-related sources of strong interference. Operate only certified laboratory equipment in close proximity to the detector.
 - ◆ Stable backpressure and correct waste line setup
- Monitor the usage of specific components that are subject to wear and stress and schedule appropriate maintenance intervals (see [Predictive Performance](#) (▶ page 106)).
- 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 92)
- 📖 [UV Cutoff Wavelengths of Solvents](#) (▶ page 167)

6.11.2 Overview of Optimization Parameters

The following table serves as an overview of parameters that influence the detector performance and indicates the performance characteristics affected.

Parameter	Affects
Wavelength	Sensitivity, linearity
Data collection rate	Peak resolution, disk space
Response Time/Peak width	Baseline noise, peak width, chromatographic resolution, sensitivity
Baseline behavior	Behavior of the baseline after switching the wavelength

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

6.11.3 Wavelength

The most important parameter that needs to be optimized is the wavelength. Note the following key criteria for determining the wavelength for an analysis:

- Preferably, select a wavelength on the absorption maximum of the sample components.
- Avoid the wavelength range where the solvents absorb strongly (for example, below 220 nm for methanol and below 210 nm for acetonitrile). The 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 167).

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 wavelengths in multi-channel mode.

Use the Instrument Method Wizard to set the start wavelength 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.

6.11.4 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).

Multiple wavelength applications

In multiple wavelength applications, baseline noise increases compared to single-channel data acquisition. This is especially the case if the data rate is set to the maximum or close to the maximum. To improve the signal-to-noise ratio, select a lower data collection rate.

6.11.5 Response Time and Peak Width

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

TIP

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

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

- Ensure that response time and peak width match the setting for the data collection rate.

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

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

6.11.6 Baseline Behavior

If wavelengths are switched during a single-channel data acquisition, the chromatogram may show baseline jumps.

You can 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 the **AutoZero** command (automatic null balancing) any time during data acquisition, that is, the absorption measured at the time of the autozero is subtracted from any absorptions measured thereafter. Always select a time for **AutoZero** at which no sample flows through the cell.

6.12 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*.

6.12.1 Short-Term Shutdown (Interruption of Operation)

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

- For your Vanquish detector, note the following:

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

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

6.12.2 Long-Term Shutdown

Shutting Down the Device

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

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

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

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

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

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

NOTICE

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

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

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

Situation	Steps
Device and all other system modules remain in the system stack and are to be turned off	Turn off the system with the system power button on the system base.

Situation	Steps
Device shall be transported or shipped after shutdown	If one of the modules shall be removed from the system stack, turn off <i>all</i> system modules with their main power switch. Pressing the system power button will not be sufficient to turn off the power to the devices completely. Follow the instructions in Transporting or Shipping the Device (▶ page 128).

See also

 [Connecting the Inlet Capillary](#) (▶ page 70)

 [Connecting the Detector Waste Line](#) (▶ page 71)

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 126).

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 the rules and recommendations below.

General Rules

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

Opening Flow Path Connections

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

Depot Repair

- If you need to return the device for depot repair, follow the instructions in [Transporting or Shipping the Device](#) (▶ page 128).

See also

- 📖 [Consumables and Replacement Parts](#) (▶ page 161)

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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Inspect the flow connections for damage, such as cracks, nicks, cuts, or blockage. 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 estimating the lifetime of consumables (see [Predictive Performance](#) (► page 106)).

7.4.2 Cleaning or Decontaminating the Device

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

NOTICE

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

Decontamination

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

Parts required

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



CAUTION—Explosive Gas Mixtures from Alcoholic Cleaning Detergents

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

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

NOTICE

Observe the following:

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

NOTICE—Flow Cell Opening

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

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

Preparations

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

Follow these steps

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

7.4.3 Predictive Performance

General Overview

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

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

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

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

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

7.5 Lamps

This section describes the replacement and installation of the

- UV lamp (see [Replacing the UV Lamp \(Deuterium Lamp\)](#) (▶ page 107)), and
- VIS lamp (see [Replacing the VIS Lamp \(Tungsten Lamp\)](#) (▶ page 110)).

NOTICE—Damage to the device

Usage of lamps not supplied or approved by Thermo Fisher Scientific for this detector may result in inferior performance, detector malfunction or may damage the detector. Detector guaranty may be voided.

Use only lamps supplied or approved by Thermo Fisher Scientific for this detector.

7.5.1 Replacing the UV Lamp (Deuterium Lamp)

When

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

Parts required

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

Preparations

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

Follow these steps

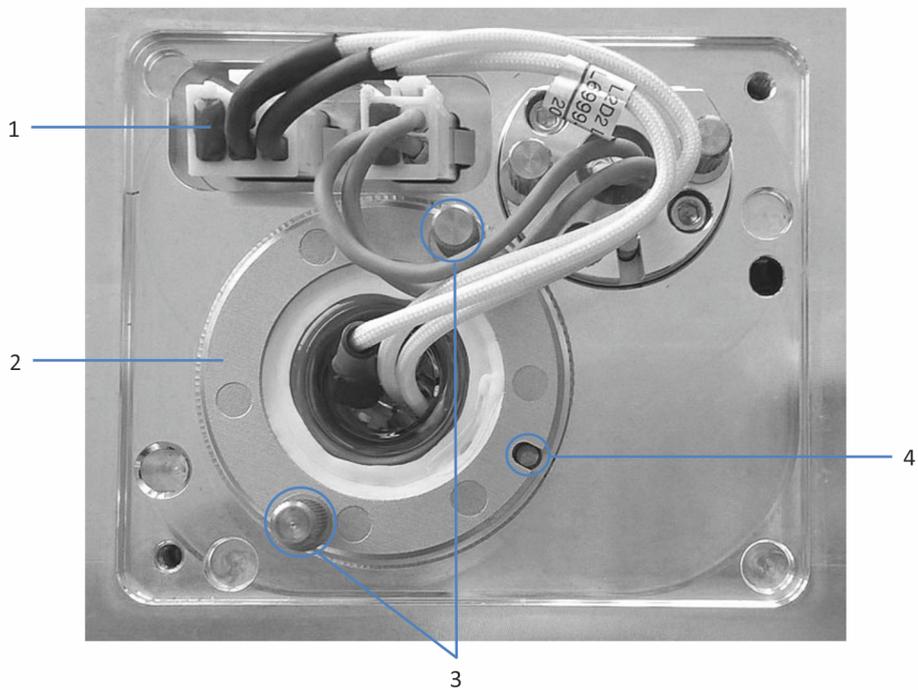


Figure 22: UV lamp

No.	Description
1	UV lamp connector
2	UV lamp
3	UV lamp attachment screw
4	UV lamp locating pin

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

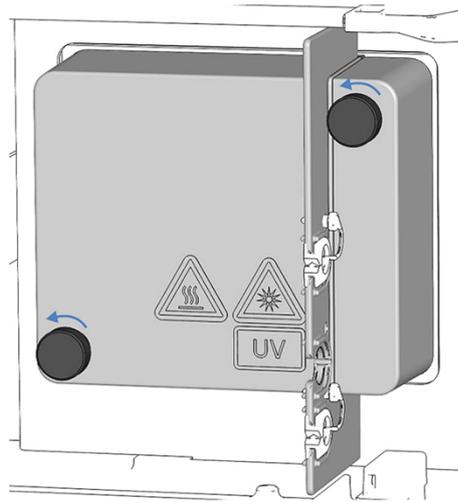


Figure 23: Screws on the lamp house cover

3. Remove the lamp house cover.



CAUTION—Hot surface

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

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

4. Push the clip on the lamp connector and disconnect the connector from the lamp socket on the device.
5. With your hands, loosen the two screws that attach the lamp to the lamp house.
6. Pull out the UV lamp.
7. Inspect the new UV lamp for signs of fingerprints and dust. If necessary, clean the UV lamp with isopropanol and a lint-free tissue before you install it.
8. Align the new lamp with the locating pin. When the lamp is in the correct position, push the lamp gently into the lamp house. The lamp socket must be in a level position with the lamp house.
9. When the lamp is properly seated, tighten the two screws to attach the lamp to the lamp house.
10. Reconnect the lamp connector.

11. Mind the routing of the lamp cables.
Position the lamp cables as indicated in the figure above to prevent the cable from being pinched under the lamp house cover.
12. Reinstall the lamp house cover and fasten the screws on the lamp house cover.
13. Turn on the device with its main power switch.
14. After replacing the lamp, increased noise and strong baseline fluctuations may occur. Before beginning an analysis or performing a wavelength validation, allow the new lamp to run until the noise is reduced and the baseline is stable which typically takes 24 hours.
15. Perform a wavelength validation (see [Performing a Wavelength Validation and Calibration](#) (► page 119)).

TIP

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

See also

 [Turning On the UV Lamp](#) (► page 85)

7.5.2 Replacing the VIS Lamp (Tungsten Lamp)

When

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

Parts required

VIS lamp

Preparations

1. Turn off the VIS lamp.
2. Turn off the device.

Follow these steps

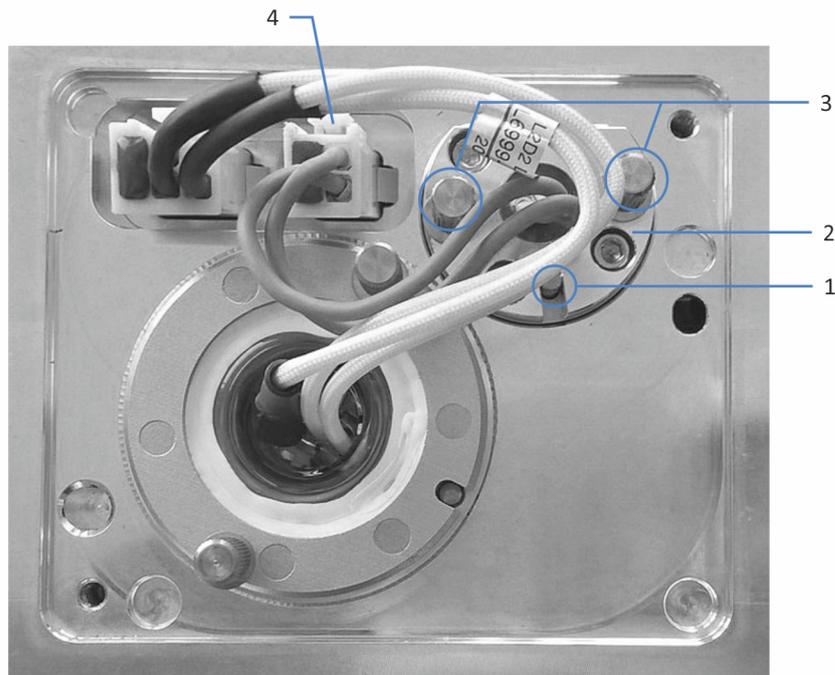


Figure 24: VIS lamp

No.	Description
1	VIS lamp locating pin
2	VIS lamp
3	VIS lamp attachment screw
4	VIS lamp connector

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

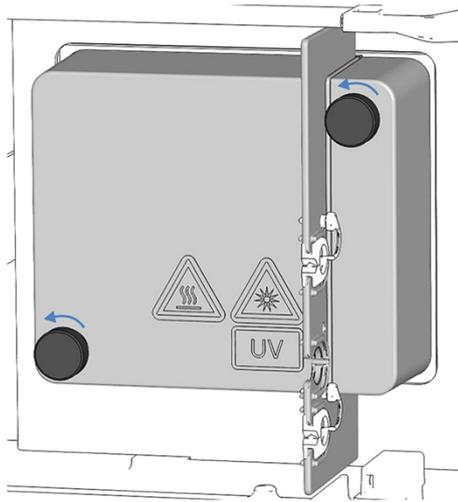


Figure 25: Screws on the lamp house cover

3. Remove the lamp house cover.



CAUTION—Hot surface

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

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

4. Push the clip on the lamp connector and disconnect the connector from the lamp socket on the device.
5. With your hands, loosen the two screws that attach the lamp.
6. Pull out the lamp.
7. Align the new lamp with the locating pin.
When the lamp is in the correct position, push the lamp gently into the lamp house. The lamp socket must be in a level position with the lamp house.
8. When the lamp is properly seated, tighten the two screws to attach the lamp to the lamp house.
9. Connect the lamp connector.
10. Mind the routing of the lamp cables.
Position the lamp cables as indicated in [VIS lamp](#) (► [page 111](#)) to prevent the cable from being pinched under the lamp house cover.

11. Install the lamp house cover and fasten the screws on the lamp house cover.
12. Turn on the device with its main power switch.
13. *If you install a VIS lamp for the first time, activate the lamp in the chromatography data system:*
Only then, the VIS lamp can be ignited from the chromatography data system.
 - a) Right-click the detector in the Instrument Configuration Manager.
 - b) Select **Properties** on the menu.
 - c) On the **Detector** page, enable the **VIS Lamp** check box.
14. After replacing the lamp, increased noise and strong baseline fluctuations may occur. Before beginning an analysis or performing a wavelength validation, allow the new lamp to run until the noise is reduced and the baseline is stable which typically takes 24 hours.
15. Perform a wavelength validation (see [Performing a Wavelength Validation and Calibration](#) (► page 119)).

TIP

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

7.6 Flow Cell

This section describes cleaning, replacement, storage and shipment of flow cells.

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

1. Flush the flow cell with isopropanol.
2. Remove the flow cell from the detector. See [Removing the Flow Cell](#) (▶ page 116).
3. Install the plugs on the flow cell inlet (IN) and outlet (OUT), and place the flow cell in its packaging.

To exchange the flow cell, follow these steps:

1. Flush the flow cell with isopropanol.
2. Remove the flow cell from the detector. See [Removing the Flow Cell](#) (▶ page 116).
3. Install a new flow cell without connection unit to the detector. See [Installing a Flow Cell without Connection Unit](#) (▶ page 60).
– or –
4. Install a new flow cell with connection unit to the detector. See [Installing a Flow Cell with Connection Unit](#) (▶ page 60).

7.6.1 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.

7.6.2 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.

See also

 [Installing a Flow Cell with Connection Unit](#) (► page 60)

 [Installing a Flow Cell without Connection Unit](#) (► page 60)

7.6.3 Removing the Flow Cell

When

- Storing the flow cell in its packaging
- Replacing the flow cell
- Leakage occurred on the flow cell

Parts required

- *If the flow cell is to be stored*
Packaging of the flow cell
- *If no flow cell is to be installed to the detector afterward*
Diagnostic cell

Preparations

1. *If the flow cell is to be stored*
Flush the flow cell with isopropanol.
2. Turn off the pump flow.

Follow these steps

NOTICE

Do not open the tubing connections between the connection unit and the flow cell. The tubing connections are installed at the factory.

1. *Flow cell without connection unit only*

Disconnect the waste line from the outlet of the flow cell, then disconnect the inlet capillary from the inlet of the flow cell (if not yet done).

– or –

Flow cell with connection unit only

Disconnect the waste line from the outlet port (**OUT**) of the flow cell connection unit, then disconnect the inlet capillary inlet port (**IN**) of the flow cell connection unit.

2. Loosen the two screws that hold the cell in position.

3. *Flow cell with connection unit only*

Loosen the screw that holds the connection unit in position and remove the connection unit from the connection unit socket.

4. Carefully pull out the cell from the opening in the detector.

5. Install the flow cell plugs on the inlet and outlet ports.

6. *If the flow cell is to be stored*

Store the flow cell in its original packaging that it was shipped in.

7. Proceed as required:

- ◆ Install a flow cell

- or -

- ◆ Install the diagnostic cell to the opening of the detector.

NOTICE

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

If no flow cell is installed to the detector, install a diagnostic cell to the flow cell opening of the detector.

See also

-  [Installing a Flow Cell without Connection Unit \(▶ page 60\)](#)
-  [Installing a Flow Cell with Connection Unit \(▶ page 60\)](#)
-  [Installing a Diagnostic Cell \(▶ page 118\)](#)

7.6.4 Installing a Diagnostic Cell

Parts required

Diagnostic cell

Follow these steps

1. Push the diagnostic cell into the flow cell opening.
2. Tighten the two screws of the diagnostic cell hand-tight.

7.7 Performing a Wavelength Validation and Calibration

A holmium-oxide glass filter is used to validate the wavelength accuracy. The filter can be moved into the light path in front of the entrance slit for the wavelength validation. The detector determines the wavelengths of several absorption peaks in the resulting spectrum and compares them to the nominal holmium oxide values that are stored in the detector firmware.

A validation can be performed for all lamp configurations (both lamps turned on, only UV lamp turned on, and, but least favorable, only VIS lamp turned on (if available)).

The accuracy is verified for the wavelengths that are stated in the declaration of conformity for the holmium-oxide glass filter. For information about the declaration, see [NIST Compliance](#) (► page 165).

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

When

A wavelength validation is recommended in the following situations:

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

Preparations

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

- Allow the flow cell to warm up for 5 minutes.
- Ensure that the baseline is sufficiently stable. The baseline may become unstable, for example, if the solvent composition has been modified, or if air bubbles are present in the light path.
- Verify that the solvent flowing through the flow cell is not strongly absorbing in the wavelength range of the holmium-oxide glass filter that is to be verified.

This problem occurs, for example, if the flow cell is filled with a mixture of 96% hexane and 4% ethyl acetate. Thermo Fisher Scientific recommends using degassed LC/MS-grade water.

- Allow the lamps to warm up and reach operating temperature. The lamps should be running for at least 1 hour before you start the wavelength validation or wavelength calibration. A lamp spectrum changes significantly during the first few minutes after a lamp has been turned on.

To perform a wavelength validation

1. Turn on the flow at the flow rate that will be used for the analysis.
2. In the chromatography data system, in the **Commands** window, execute the **WavelengthValidation** command.
3. If the wavelength validation fails, perform a wavelength calibration.

To perform a wavelength calibration

1. In the chromatography data system, in the **Commands** window, execute the **WavelengthCalibration** command.

7.8 Replacing the Waste Line

When

Blockage or leakage of one or more waste line components

Parts required

Detector waste line

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

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

Tools required

Tubing cutter (optional)

Preparations

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

Follow these steps

1. When removing the waste line from the tubing guides, be careful not to pull on other tubing in the guides.
2. Disconnect the waste line from the flow cell outlet or the outlet (OUT) of the flow cell connection unit.
3. Remove the waste line from the capillary guide of the partition panel. Turn the plug in the top capillary guide to the front and remove the waste line from it.
4. Remove the waste line from the detector waste port in the system base and from waste.
5. Unpack the replacement waste line.
6. Connect the waste line. Follow the instructions for connecting the waste line in [Connecting the Detector Waste Line](#) (► page 71).

7.9 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.

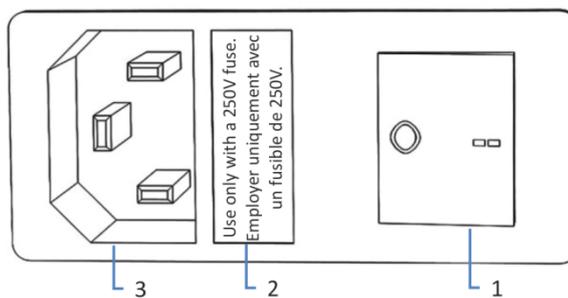


Figure 26: Fuse holder

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.

7.10 Updating the Device Firmware

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

When

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

Items required

Firmware version/Chromeleon version as appropriate

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

Preparations

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

Follow these steps

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

The firmware update may take several minutes.

NOTICE

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

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

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

4. Depends on the situation:

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

7.11 Replacing the Doors

When

Damage of door

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

Parts required

Replacement door

Preparations

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

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

Follow these steps

NOTICE

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

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

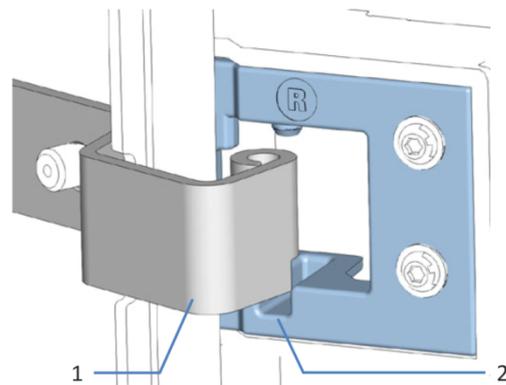


Figure 27: Unhinging a door

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

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

7.12 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 128).
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 129).
 - ◆ To ship the device, follow the instructions in [Shipping the Device](#) (► page 130).

7.12.1 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 96)).
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 detector, and store the flow cell in its packaging. Install the diagnostic cell to the flow cell opening of the detector.

NOTICE

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

If no flow cell is installed to the detector, install a diagnostic cell to the flow cell opening of the detector.

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 dismantling the system stack in the *Transporting or Shipping the System* section of the *Vanquish System Operating Manual*.

-or-

Remove the slide-in module from the device enclosure in the system stack (see [Removing the Slide-In Module](#) (▶ page 131)).

See also

- 📄 [Removing the Flow Cell](#) (▶ page 116)
- 📄 [Installing a Diagnostic Cell](#) (▶ page 118)

7.12.2 Transporting the Device to a New Location

Preparations

Prepare the device for transport. See [Preparing the Device for Transport](#) (▶ page 128).

Follow these steps

1. Observe the notes for handling and lifting the device safely.
2. Transport the device to the new location.
3. Install and set up the device in the system stack. Follow the instructions on mounting the system stack in the *Vanquish System Operating Manual*.
4. Set up the device:
 - a) Connect the device and set up flow connections (see [Installation](#) (▶ page 45)).
 - b) Prepare the device for operation (see [Preparing the Device for Operation](#) (▶ page 82)).
5. Before starting an analysis, let the device equilibrate and be sure that it is ready for operation.

7.12.3 Shipping the Device

Preparations

Prepare the device for transport. See [Preparing the Device for Transport](#) (▶ page 128).



CAUTION—Possible Contamination

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

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

Follow these steps

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

Restarting the Device after Shipping

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

7.13 Replacing the Slide-In Module

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

7.13.1 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 128).

Follow these steps

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

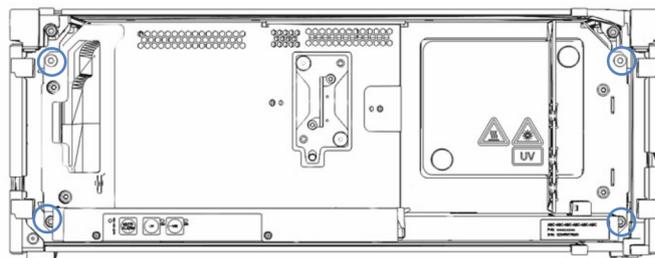


Figure 28: Captive screws on the slide-in module (doors not shown)

2. Push all tubing and capillaries, which are present in the tubing chase of the Vanquish system modules, into the tubing chase. Otherwise, you will not be able to remove the slide-in module properly from the enclosure in the next step.

3. Grasp the slide-in module by the leak tray, or by the lamp house cover and the partition panel, and pull the module out of the enclosure by approximately 10 cm.

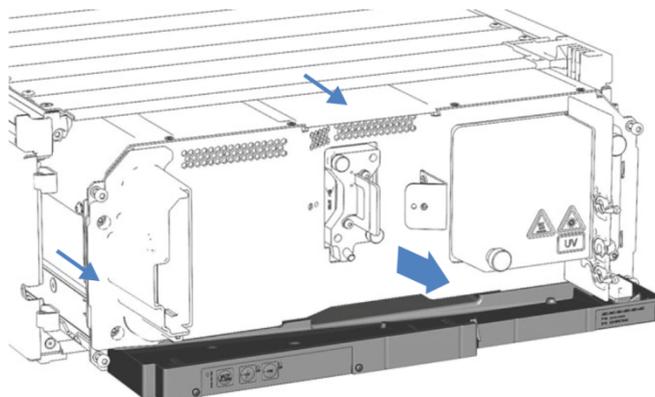


Figure 29: Pulling out the slide-in module (doors not shown)

NOTICE

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

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

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

7.13.2 Returning the Slide-In Module



CAUTION—Possible Contamination

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

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

Preparations

1. Remove the slide-in module from the enclosure. See [Removing the Slide-In Module](#) (▶ page 131).
2. If you have installed an expansion board, contact Service.

Follow these steps

1. Install the slide-in module to the enclosure of the replacement device. Follow the steps for inserting the slide-in module in the enclosure and tightening the captive screws in [Installing the Slide-In Module](#) (▶ page 133).
2. Follow the instructions in [Shipping the Device](#) (▶ page 130).

NOTICE

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

7.13.3 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 131).
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 104).

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.

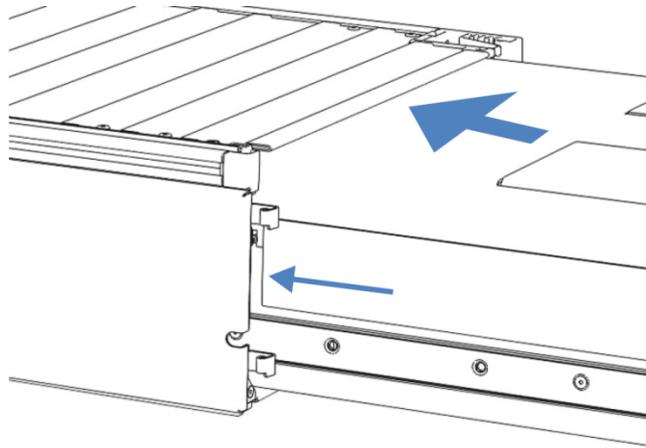


Figure 30: Inserting the slide-in module

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.

7.13.4 Setting Up the Slide-In Module

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

Follow these steps

1. Set up the slide-in module:
 - a) Connect the slide-in module and set up flow connections (see [Installation](#) (► page 45)).
 - b) Prepare the slide-in module for first-time operation (see [Preparing the Device for Operation](#) (► page 82)).
 - c) If you installed a replacement slide-in module, update the instrument configuration in the chromatography data system accordingly.
2. Prepare *all other* modules of the Vanquish system for operation and restart them. Refer to the *Operating Manuals* for the modules.
3. Before starting an analysis, let the chromatography system equilibrate and be sure that it is ready for operation.
4. In the Chromeleon software, run the device-specific **Performance Qualification** (PQ) tests.
5. When the test is completed, update the **QualificationDone** parameter.

8 Troubleshooting

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

8.1 General Information about Troubleshooting

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

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

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

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

Status Indicators

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

Alarms

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

Instrument Audit Trail Messages

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

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

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

Messages in the Instrument Audit Trail are preceded by an icon. The icon identifies the seriousness of the problem. For possible causes and remedial actions, see [Messages](#) (▶ [page 140](#)).

Firmware Failure

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

In this case, observe the following:

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

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

8.2 Messages

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

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

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

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

Message and Code	Description and Remedial Action
Unexpected module behavior. Code xx	xx = Two-digit to four-digit code number. When the message appears, write down the message code and turn off the module. Wait for 5 seconds and turn on the module again.
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 147)).
Code 34 Leak detected.	Find and eliminate the source for the leakage (see Resolving Liquid Leaks (▶ page 147)).
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.
Code 52 Module software incomplete. Download firmware (again).	The firmware is incomplete, for example, because the communication between the chromatography data system and the module was interrupted during the firmware download. Repeat the download.
Code 89 Liquid leak sensor missing.	Contact Thermo Fisher Scientific Technical Support for assistance. Note that the module can be operated nevertheless, even if the leak sensor is defective or not present, if leak detection is disabled.

Message and Code	Description and Remedial Action
Code 90 Download firmware mismatch – invalid version.	You tried to download an incompatible firmware with an earlier version number than the firmware that is currently installed in the module. Downgrading the firmware may result in loss of functionality or malfunctioning of the module. If required, repeat the download with a firmware version later than the version currently installed in the module.
Code 118 USB Buffer Overflow.	This is a software problem. The module produces data faster than the computer on which the chromatography data system is running can process the data. <ol style="list-style-type: none"> 1. In the chromatography data system, disconnect and reconnect the module. 2. If this does not solve the problem, update the firmware or the chromatography data system version. 3. If the problem persists: Also, third-party software on the computer, for example, virus scanners or poor computer performance can cause the problem. Contact the onsite IT department.
Code 120 System interlink request timed out.	Communication with the module failed. The module did not respond in time. For the module for which the message appears: <ol style="list-style-type: none"> 1. Turn on the module if it is not yet turned on. 2. Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. 3. If the message persists, replace the system interlink cables.
Code 126 Device lost system interlink connection.	A system interlink cable may be disconnected from the module or defective. <ol style="list-style-type: none"> 1. Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. 2. If the message persists, replace the system interlink cables.
Code 128 System interlink data errors.	A system interlink cable may be disconnected from the module or defective. <ol style="list-style-type: none"> 1. Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. 2. If the message persists, replace the system interlink cables.
Code 129 Device X not found on system interlink.	X = serial number The module with the given serial number may be disconnected, turned off or a firmware update is running. <ol style="list-style-type: none"> 1. Check the system interlink connections to the module. 2. If the message persists, check the module operational status.
Code 131 System interlink bus not operable.	A system interlink cable may be disconnected from the module or defective. <ol style="list-style-type: none"> 1. Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. 2. If the message persists, replace the system interlink cables.

Message and Code	Description and Remedial Action
Code 136 Lock request rejected – already locked by X.	X = lock holder ID, with keypad button ID, USB address referring to the chromatography data system or system interlink address referring to the system controller or a module The module is already locked by another software (system controller or chromatography data system) or a keypad button. Wait until the module is released from the locked state.
Code 137 Lock by X expired.	X = lock holder ID, with keypad button ID, USB address referring to the chromatography data system or system interlink address referring to the system controller or a module Inform Thermo Fisher Scientific about the occurrence. No further action required.
Code 145 Lock holder X lost.	X = lock holder ID, with keypad button ID, USB address referring to the chromatography data system or system interlink address referring to the system controller or a module The lock was released automatically since its holder disappeared from system interlink. 1. Check if the module holding the lock was turned off. 2. Check the system interlink connections to the module.
Code 152 Assignment or command rejected – device locked.	Module is not ready to accept command or property assignment since locked by another software (system controller or chromatography data system). Wait until module is released by the current software (system controller or chromatography data system).
Code 7026 UV lamp malfunction Code 7028 UV lamp malfunction	Turn on the lamp once more. Check if a UV lamp is installed. Check the lamp connector. Check that the lamp cover is installed properly. If the message appears again, replace the UV lamp (see Replacing the UV Lamp (Deuterium Lamp) (▶ page 107)).
Code 7029 VIS lamp malfunction Code 7030 VIS lamp malfunction	Turn on the lamp once more. Check if a VIS lamp is installed. Check the lamp connector. Check that the lamp cover is installed properly. If the message appears again, replace the VIS lamp (see Replacing the VIS Lamp (Tungsten Lamp) (▶ page 110)).
Code 7040 Data transfer error from detector to PC – check USB connection.	Check the USB connection. Use only the USB cables provided by Thermo Fisher Scientific for the detector. Avoid CPU-intensive and time-consuming operations on the PC during high-speed data acquisition.
Code 7041 Command rejected – switch lamp on first.	Make sure that either the UV and/or VIS lamp are on. Operation can be performed only if any of the lamps or both lamps are on.
Code 7044 Unexpected low light intensity - check lamp(s) for correct installation.	Check the lamp installation.

Message and Code	Description and Remedial Action
Code 7045 Unexpected high light intensity measured –check flow cell installation.	<p>Check if the environmental conditions (ambient humidity and ambient temperature) are within the specified operating range (see Physical Specifications (▶ page 155)).</p> <p>Check the flow cell (see Checking the Flow Cell (▶ page 146)).</p> <p>Run the detector over night (at least 12 hours, recommended 24 hours) with an installed diagnostic cell and with the UV lamp (and VIS lamp, if available) turned on.</p> <p>If the message still appears, install a different flow cell or a diagnostic cell. Turn on any lamp (UV or VIS) and perform an auto-zero.</p>
Code 7046 xx over-temperature - emergency standby in yy seconds. Code 7047 xx over-temperature - emergency standby after acquisition completed (force shutdown in yy s). Code 7086 xx over-temperature – emergency standby entered now.	<p>With xx = system or lamp house, yy = the number of seconds before emergency standby or shutdown is entered</p> <p>An over-temperature condition was detected.</p> <p>Turn off the detector and let the detector cool down.</p> <p>Check that the detector is operated within the specified environmental conditions (ambient temperature), see Physical Specifications (▶ page 155).</p> <p>Check the cooling air intake and the ventilation holes on the rear side of the detector for dust. If dust is present, aspirate the dust and loose particles with a vacuum cleaner.</p>
Code 7049 Wavelength calibration failed – check and flush flow cell.	<p>Check the flow cell (see Checking the Flow Cell (▶ page 146)). If the message still appears, proceed as follows:</p> <p>Check the lamps: If a lamp was newly installed, ensure that it is installed properly. If a lamp is old (counting, for example, more than 2000 operating hours), replace the lamp (see Lamps (▶ page 107)).</p>
Code 7051 Bad flow cell position.	<p>The flow cell is not correctly positioned inside the flow cell opening.</p> <p>Check the flow cell installation (see Checking the Flow Cell (▶ page 146)).</p> <p>Check the flow cell contact pins for proper alignment inside the flow cell opening.</p>
Code 7056 Holmium validation failed – wavelength outside limits.	<p>Repeat the validation (see Performing a Wavelength Validation and Calibration (▶ page 119)). If the message still appears, proceed as follows:</p> <p>Perform a calibration and repeat the validation again.</p> <p>Remove and install the flow cell. Flush the flow cell with pure HPLC-grade water with a flow rate of > 1 mL/min for several minutes (Nano flow cells: Flush with pure HPLC-grade water with the maximum possible flow rate for the respective range for several minutes).</p> <p>Install a different flow cell or a diagnostic cell (see Installing a Flow Cell (▶ page 59) or Installing a Diagnostic Cell (▶ page 118)).</p> <p>Perform a validation. Perform a calibration and repeat the validation again. If the message disappears with a different cell, the flow cell that was previously installed may be clogged.</p> <p>If the error message persists, contact Technical Support.</p>

Message and Code	Description and Remedial Action
Code 7057 Holmium validation failed – specified wavelength not found.	<p>Repeat the validation. If the message still appears, proceed as follows:</p> <p>Perform a calibration and repeat the validation again.</p> <p>Remove and install the flow cell. Flush the flow cell with pure HPLC-grade water with a flow rate of > 1 mL/min for several minutes (Nano flow cells: Flush with pure HPLC-grade water with the maximum possible flow rate for the respective range for several minutes).</p> <p>Check the lamp: If the lamp was newly installed, ensure that it is installed properly. If the lamp is old (counting, for example, more than 2000 operating hours), replace the lamp. See Lamps (▶ page 107).</p> <p>Install a different flow cell (see Installing a Flow Cell (▶ page 59)).</p> <p>Perform a validation. Perform a calibration and repeat the validation again. If the message disappears with a different cell, the flow cell that was previously installed may be clogged.</p>
Code 7059 Calibration failed – values outside specs.	<p>Remove and install the flow cell.</p> <p>Flush the flow cell with pure HPLC-grade water with a flow rate of >1 mL/min for several minutes (Nano flow cells: Flush with pure HPLC-grade water with the maximum possible flow rate for the respective range for several minutes).</p> <p>If the error message persists, install a different flow cell or a diagnostic cell (see Installing a Flow Cell (▶ page 59)).</p>
Code 7066 Invalid data rate/response time combination. Filter not effective.	<p>Select a higher data rate or longer response time for the response time filter to be effective. Use the Instrument Method Wizard for valid combinations.</p>
Code 7111 Lamp cover not in place - check cover position.	<p>Check that the lamp cover is installed properly. For correct installation of the lamp house cover, see Lamps (▶ page 107).</p>
Code 7124 Unexpected low light intensity - check flow cell for correct installation.	<p>There is no light on measurement diode.</p> <p>Check the flow cell installation (see Checking the Flow Cell (▶ page 146)).</p> <p>Flush the flow cell with pure HPLC-grade water for several minutes (flow > 1 mL/min., Nano flow cells: Flush with pure HPLC-grade water with the maximum possible flow rate for the respective range for several minutes).</p> <p>If the error message persists, replace the flow cell.</p>
Code 7125 Reference/measurement channel calibration mismatch.	<p>There is a significant deviation between reference channel and measurement channel calibration values.</p> <p>Check the flow cell installation (see Checking the Flow Cell (▶ page 146)).</p> <p>Check that the lamp is properly installed.</p> <p>Ensure that the eluent does not show excessive absorption during calibration.</p> <p>If the error message persists, replace the flow cell.</p>
Code 7130 Command rejected - baseline adjustment in progress.	<p>An auto-zero append process is collecting data.</p> <ul style="list-style-type: none"> • Wait until the auto-zero append process is completed. • Repeat the auto-zero command.

Message and Code	Description and Remedial Action
Code 7133 Acquisition aborted – data rate limit exceeded.	The data collection rate is too high and exceeds the limits for the selected wavelength configuration. Select a lower data collection rate or reduce the number of wavelengths selected.
Code 7136 Invalid measurement channel zero order position - check flow cell and lamp installation.	Remove and install the flow cell. Flush the flow cell with pure HPLC-grade water with a flow rate of >1 mL/min for several minutes (Nano flow cells: Flush with pure HPLC-grade water with the maximum possible flow rate for the respective range for several minutes).
Code 7139 Reference scan speed mismatch.	The baseline (reference) scan speed and the absorption scan speed do not match. The absorption calculation may be affected. Repeat the baseline scan with the same scan speed that is used for the scan.
Code 7140 No or unknown xx installed.	With xx = flow cell, lamp, or optics The flow cell or lamp is not installed or does not have an ID chip. Install a flow cell (see Installing a Flow Cell (▶ page 59)) or install a lamp (see Lamps (▶ page 107)). Use lamp(s) or a flow cell with ID chip. If the optics is affected, contact Technical Support.
Code 7141 Acquisition aborted (flow cell removed).	The flow cell has been removed while an acquisition is running. <ul style="list-style-type: none"> • Re-install a flow cell (see Installing a Flow Cell (▶ page 59)). • Restart acquisition.
Code 7143 Internal process failed – no flow cell.	The flow cell has been removed while an internal process was running. Re-install a flow cell (see Installing a Flow Cell (▶ page 59)). It may be necessary to repeat the previous command or operation.

8.3 Checking the Flow Cell

When

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

Follow these steps

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

Result	Steps
If the message disappears with a different flow cell	The problems are caused by the flow cell that was previously installed or the flow path or components in the flow path before the detector.
If the message still appears	<p>The problem is caused by the flow path or components in the flow path before the detector or by the detector.</p> <p>Install a diagnostic cell and repeat the action during which the message appeared with the flow cell that was previously installed.</p> <ul style="list-style-type: none"> • <i>If the message disappears with the diagnostic cell:</i> The problems are caused by the flow path or components in the flow path before the detector. • <i>If the message still appears:</i> The problems are caused by the detector.

See also

 [Messages](#) (▶ page 140)

8.4 Resolving Liquid Leaks

When

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

Parts and additional items required

- Replacement part as required
- Cloth or tissue

Preparations

When resolving leakage, observe the safety guidelines and general rules for maintenance and service as presented in [Maintenance and Service](#) (▶ page 99).

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. In this case, leakage may occur at the drain outlet of the flow cell (see figure).

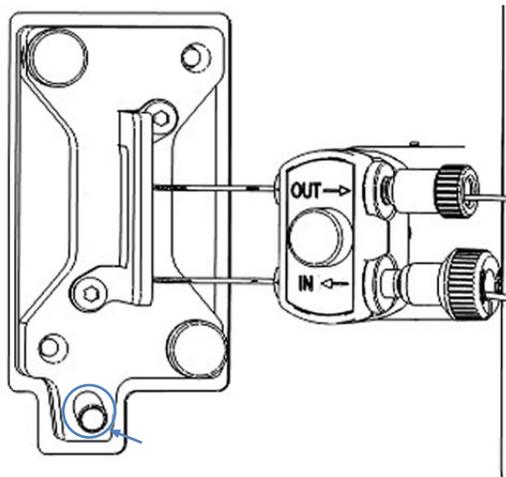


Figure 31: Flow cell drain outlet

Follow the steps depending on the location of the leak:

Location of the leak	Steps
Flow cell inlet and/or outlet	<ol style="list-style-type: none"> 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.
Drain outlet of the flow cell (see figure), or connection from flow cell to connection unit	<ol style="list-style-type: none"> 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, replace the flow cell.

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

See also

-  [Installing a Flow Cell without Connection Unit \(▶ page 60\)](#)
-  [Installing a Flow Cell with Connection Unit \(▶ page 60\)](#)
-  [Removing the Flow Cell \(▶ page 116\)](#)

8.5 Diagnostic Tests

The Chromeleon software supports diagnostic tests for the detector. You can use these tests to check and monitor the performance and reliability of certain components.

Depending on the Vanquish system configuration and Chromeleon version, the available tests may vary. If a test is grayed out in the Chromeleon software, the test is currently not available.

When a test is running, the LED bar on the module shows a blue running light.

8.5.1 Intensity Test

The **Intensity Test** is a test to measure the intensity of the lamps and the transmission performance ("intensity") of the optics.

Follow these steps

1. Install the diagnostic cell in the detector.
2. Turn on the detector lamps (one or both) that you want to test.
3. Run the test from the Chromeleon software. Refer to the *Chromeleon Help*.
4. Depends on the test result:

Test result	Action
Passed	Reinstall the flow cell of your application.
Failed	<ol style="list-style-type: none"> 1. Check the failure reason for the intensity test in the Instrument Audit Trail: <ul style="list-style-type: none"> • If the intensity test fails for a range < 300 nm, replace the UV lamp. See Replacing the UV Lamp (Deuterium Lamp) (▶ page 107). • If the intensity test fails for a range > 400nm, replace the VIS lamp. See Replacing the VIS Lamp (Tungsten Lamp) (▶ page 110). 2. If the test fails with the new lamp, the optics may be defective. Contact Thermo Fisher Technical Support.

8.5.2 Grating Motor Test

The **Grating Motor Test** checks the mechanical stability of the grating drive.

Follow these steps

1. Install the diagnostic cell in the detector.
2. Run the test from the Chromeleon software. Refer to the *Chromeleon Help*.
3. Depends on the test result:

Test result	Action
Passed	Reinstall the flow cell of your application.
Failed	Contact Thermo Fisher Scientific Technical Support.

8.5.3 Shutter Motor Test

The **Shutting Motor Test** checks the mechanical stability of the shutter motor and filter paddle.

Follow these steps

1. Install the diagnostic cell in the detector.
2. Turn on the detector lamps (one or both).
3. Run the test from the Chromeleon software. Refer to the *Chromeleon Help*.
4. Depends on the test result:

Test result	Action
Passed	Reinstall the flow cell of your application.
Failed	Contact Thermo Fisher Scientific Technical Support.

9 Specifications

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

9.1 Performance Specifications

9.1.1 Detector Specifications

The device performance is specified as follows:

Type	Specification
Optical design	UV/VIS/NIR photometer (tunable Czerny-Turner monochromator) with additional internal reference beam
Light source	<ul style="list-style-type: none"> • Deuterium lamp for UV and VIS • Tungsten lamp for VIS and NIR (optional for VC-D40) • Lamp house temperature control for stable operation
Wavelength range	VC-D40: 190 to 750 nm VF-D40: 190 to 900 nm The tungsten lamp is recommended for wavelengths > 345 nm.
Spectral bandwidth	typ. 6 nm at 254 nm
Wavelength Accuracy	± 1 nm
Wavelength Repeatability	± 0.1 nm
Wavelength Calibration	Internal calibration with zero order of monochromator spectrum
Wavelength Validation	Internal validation with holmium-oxide filter
Signal channels	VC-D40: Up to 2 signal channels VF-D40: Up to 4 signal channels
Reference channel	Reference beam with same wavelength as measurement beam
Data collection rates	Data collection rates under Chromeleon 7 data system. Other maximum data rates may be applicable under different data systems. Single-channel: VC-D40: Adjustable, 0.2 Hz– 125 Hz VF-D40: Adjustable, 0.2 Hz– 250 Hz Multi-channel Adjustable, up to 5 Hz, depending on the number of wavelengths and the distance between the wavelengths (in nm)
Filter response times (in seconds)	0s (no filter) to 20s
Spectra scans	5 scan speeds up to max. 100 nm/s
Noise (Single-channel mode)	< ± 2.5 µAU, wavelength 254 nm, only deuterium lamp on < ± 5.0 µAU, wavelength 520 nm, only tungsten lamp turned on Standard flow cell with 1 mL/min HPLC-grade water, degassed, column in flow path, time constant: 2 seconds, data collection rate: 1 Hz All values reached within 60 minutes of warm-up (typical).

Type	Specification
Noise (Multi-channel mode)	<p><± 10.0 µAU (typical: <± 7.0 µAU), wavelengths: 254 nm and 280 nm, only deuterium lamp turned on</p> <p><± 10.0 µAU (typical: <± 7.0 µAU), wavelengths: 450 nm and 520 nm, only tungsten lamp turned on</p> <p>Standard flow cell with 1 mL/min HPLC-grade water, degassed, column in flow path, time constant: 2 seconds, data collection rate: 1 Hz</p> <p>All values reached within 60 minutes of warm-up (typical).</p>
Drift	<p>< 0.1 mAU/hour, wavelength: 254 nm, only deuterium lamp turned on</p> <p>< 0.1 mAU/hour, wavelength: 520 nm, only tungsten lamp turned on</p> <p>Standard flow cell with 1 mL/min HPLC-grade water, degassed, column in flow path, time constant: 2 seconds</p> <p>All values reached within 60 minutes of warm-up (typical).</p>
Linearity	<p>< 5% at 2.5 AU (ASTM), wavelength: 272 nm, component: caffeine, only deuterium lamp turned on</p> <p>Standard flow cell</p>
USB communication	<p>1 USB port (USB 2.0, "B" type connector)</p> <p>1 USB hub with 3 ports (USB 2.0, "A" type connectors)</p>
I/O Interface	2 digital I/O ports
System Interlink	2 System Interlink ports (RJ45-8 connectors)
Analog output	<p>2 analog outputs via optional plug-in expansion board to output absorption channels</p> <p>Resolution: 20 bit</p> <p>Maximum data rate: 50 Hz</p> <p>Outputs can be configured via software (output voltage range 0 to 1 V or 0 to 10 V, sensitivity and offset)</p>
Control	<p>Chromeleon 7</p> <p>The device can be operated also with other data systems. For details, contact the Thermo Fisher Scientific sales organization.</p> <p>Keypad with 3 buttons for performing certain functions directly from the device</p>
Materials in the flow path	<p>See the <i>Specifications</i> for the flow cells.</p> <p>NOTICE For information about the chemical resistance of materials refer to the technical literature.</p>
Safety features	<p>Power-up check of optics, cooling fans, motors and electronics</p> <p>Leak detection and safe leak handling</p>
Good Laboratory Practice (GLP) features	<p>Predictive Performance functions for scheduling maintenance procedures based on the actual operating and usage conditions of the device. This includes monitoring of lamp age, and lamp ignitions for UV and VIS lamp.</p> <p>All system parameters are logged in the Chromeleon Audit Trail.</p>

Temperature reference conditions for noise, drift and linearity specifications

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

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

Time constant and response time

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

9.1.2 Flow Cell Specifications

The flow cell specifications are as follows:

High-flow flow cells

Specification	Standard flow cell, SST	Standard Bio flow cell, PEEK	Semi-micro flow cell, SST	Semi-micro Bio flow cell, PEEK	Semi preparative flow cell
Path length	10 mm	10 mm	7 mm	7 mm	0.4 mm
Illuminated volume	11 µL	11 µL	2.5 µL	2.5 µL	0.7 µL
Pressure limit	12 MPa	5 MPa	12 MPa	5 MPa	10 MPa
Materials in the flow path	Stainless steel, fused silica, PEEK, fluoropolymers, titanium	PEEK, fused silica	Stainless steel, fused silica, PEEK, fluoropolymers, titanium	PEEK, fused silica	PEEK, fused silica
Biocompatibility	No	Yes	No	Yes	Yes
Normal-phase compatibility	Yes	No	Yes	No	No

Low-flow flow cells

Specification	Nano flow cell	Capillary flow cell	Ultra-low dispersion UV monitor
Path length	10 mm*	10 mm*	Not defined
Illuminated volume	3 nL	45 nL	45 nL
Pressure limit	30 MPa	30 MPa	30 MPa
Materials in the flow path	Fused silica	Fused silica	PEEK, fused silica
Biocompatibility	Yes	Yes	Yes
Normal-phase compatibility	No	No	No

* There is no exact definition of the light path in capillary flow cells as is for conventional flow cells. Therefore, you should not use this value for calculating the absorption coefficient or the detector sensitivity according to the Lambert-Beer law.

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	typically < 61 dB(A)
Dimensions (height x width x depth)	15.9 x 42 x 62 cm
Weight	16 kg (with diagnostic cell installed)

10 Accessories, Consumables and Replacement Parts

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

10.1 General Information

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

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

10.2 Ship Kit

The ship kit includes the items listed in the table. The kit content is subject to change and may vary from the information in this manual. Refer to the content list included in the kit for the most recent information about the kit content at the time when the device is shipped.

VC-D40 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, I.D. x length 0.13 x 350 mm, stainless steel, connection column compartment – detector	1
Waste line	1

VF-D40 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, I.D. x length 0.1 x 350 mm, MP35N, connection column compartment – detector	1
Waste line	1

For reordering information, see [Consumables and Replacement Parts](#) (▶ page 161).

10.3 Optional Accessories

Flow cells and flow cell accessories

Item	Part No.
Standard flow cell, SST, 10 mm	6077.0250
Semi-micro flow cell, SST, 7 mm	6077.0360
Standard Bio flow cell, PEEK, 10 mm	6077.0200
Semi-micro Bio flow cell, PEEK, 7 mm	6077.0300
Nano flow cell, fused silica, 10 mm*	6074.0270
Capillary flow cell, fused silica, 10 mm*	6074.0280
UV monitor, fused silica, 45 nL	6074.0285
Semi-preparative flow cell, PEEK, 0.4 mm	6074.0320
Diagnostic cell	6077.0190A
Flushing and injection kit for flow cells, including syringe	6078.4200
Viper capillary, 0.13 x 450 mm, stainless steel For connecting column and flow cell inlet when using UltiMate 3000 flow cells	6040.2345

* There is no exact definition of the light path in capillary flow cells as is for conventional flow cells. Therefore, you should not use this value for calculating the absorption coefficient or the detector sensitivity according to the Lambert-Beer law.

TIP UltiMate 3000 variable wavelength detector flow cells have the connection unit on the left side. To connect the column outlet to the connection unit installed on the left side of the flow cell in a Vanquish variable wavelength detector, Thermo Fisher Scientific recommends using the capillary of 450 mm length listed in the table above.

Miscellaneous

Item	Part No.
VIS lamp (tungsten lamp)	6083.2000
DAC board Provides two analog outputs. Contact Thermo Fisher Scientific Technical Support for installation.	6083.0900

10.4 Consumables and Replacement Parts

Capillaries and tubing

Description	Part No.
Viper capillary, I.D. x length 0.13 x 350 mm, stainless steel, connection column compartment - detector (VC-D40)	6040.2335
Viper capillary, I.D. x length 0.1 x 350 mm, MP35N, connection column compartment – detector (VF-D40)	6042.2340
Waste line	6036.2425
For system capillaries, refer to the <i>Vanquish System Operating Manual</i> .	

Lamps

Description	Part No.
Standard UV lamp (deuterium lamp)	6077.1110
High sensitivity UV lamp (deuterium lamp)	6077.1111
VIS lamp (tungsten lamp)	6083.2000

Miscellaneous

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

Interface cables

Description	Part No.
System interlink cable (RJ45), 0.5 m	6036.0004
Digital I/O signaling cable, 6-pin, cable length: 5 m	6036.0006
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 1 m	6035.9035A
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 5 m	6911.0002A

Power cords

Description	Part No.
Power cord, Australia	6000.1060
Power cord, China	6000.1080
Power cord, Denmark	6000.1070
Power cord, EU	6000.1000
Power cord, India, SA	6000.1090
Power cord, Italy	6000.1040
Power cord, Japan	6000.1050
Power cord, UK	6000.1020
Power cord, USA	6000.1001
Power cord, Switzerland	6000.1030

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.

EAC Declaration of Conformity

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

RoHS Compliance

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

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

The CE mark on the device indicates that the product is compliant with the directive.
- *China RoHS regulations*
Measures for Administration of the Pollution Control of Electronic Information Products

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

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

UKCA Declaration of Conformity

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

UL/CSA 61010-1 Compliance

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

11.1.2 WEEE Compliance

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



Figure 32: WEEE symbol

Thermo Fisher Scientific has contracted with one or more recycling or disposal companies in each European Union (EU) Member State, and these companies should dispose of or recycle this product. For further information, contact Thermo Fisher Scientific.

11.1.3 FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the U.S. FCC Rules.

These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his expense.

11.1.4 NIST Compliance

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

11.1.5 Manual Release History

Revision	Covering
3.0	VC-D40, VF-D40
2.0	VC-D40, VF-D40
1.1a	VF-D40
1.1	VF-D40

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

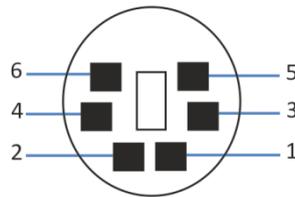


Figure 33: Digital I/O port

Pin	Description — Signal Name
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: <ul style="list-style-type: none"> • The maximum input voltage at the input must not exceed +5 V with reference to ground. • The minimum input voltage must not be lower than the ground potential.
5	White	Relay output — Relay_COM	Potential free	Common contact for NO and NC
6	Brown	Relay output — Relay_NO	Potential free 0-24 V, 0-100 mA	Closing contact

Prerequisites

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

- The digital I/O port is connected to the external device with the digital I/O signaling cable.
- The inputs and outputs that you want to use are selected in the Instrument Configuration Manager.

Connecting a Digital I/O Port

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

Selecting the inputs and outputs in the chromatography data system

1. In the dialog box for the 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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