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Vanquish

Charged Aerosol Detectors

VH-D20, VF-D20

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 device is referred to as *module*, *device*, *detector* or *charged aerosol detector* in this manual. If other detector types are referenced, they are identified by name.

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

1.2 Conventions

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

1.2.1 Conventions for Safety Messages

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

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

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

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

1.2.2 Special Notices

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

NOTICE

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

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

1.2.3 Typographical Conventions

These typographical conventions apply to the descriptions in this manual:

Data Input and Output

The following appears in **bold** type:

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

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

References and Messages

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

Viewpoint

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

Particularly Important Words

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

Electronic Manual Version (PDF)

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

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

1.3 Reference Documentation

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

Hardware Documentation

Additional hardware documentation includes the following:

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

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

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

Software Documentation

Additional software documentation includes the following:

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

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

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

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

Third-Party Documentation

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

Third-party documentation includes the user documentation for the gas supply, as applicable:

- User documentation for the nitrogen generator
- User documentation for the air compressor

2 Safety

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

2.1 Safety Symbols and Signal Words

2.1.1 Safety Symbols and Signal Words in this Manual

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

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



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



CAUTION

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



WARNING

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

2.1.2 Observing this Manual

Observe the following:


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



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

2.1.3 Safety Symbols on the Device

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

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

2.1.4 Rating Plate

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

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

2.2 Intended Use

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

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

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

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

They are not intended for use in diagnostic procedures.

Laboratory Practice

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

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

2.3 Safety Precautions

2.3.1 General Safety Information

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



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

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

Safety Standard

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

2.3.2 Qualification of the Personnel

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



Installation

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

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



General Operation

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

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

2.3.3 Personal Protective Equipment

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



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

Protective Clothing

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

Protective Eyewear

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

Gloves

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

2.3.4 Electrical Safety Precautions



WARNING—Electric Shock or Damage to the Device

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

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

2.3.5 General Residual Hazards

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

**WARNING—Hazardous Substances**

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

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

**WARNING—Biohazard**

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

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

**WARNING—Self-Ignition of Solvents**

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

Avoid the use of these solvents.

**WARNING—Hazardous Vapors**

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

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

**CAUTION—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 (CHCl₃), 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:

- By default, the system must be used with reversed-phase (RP) compatible solvents and additives only.

TIP The charged aerosol detector can also be used in a Vanquish system with normal-phase (NP) compatible solvents and additives if the system modules have been modified for NP applications. Refer to the *Vanquish System Operating Manual*.

- Use only solvents and additives that are compatible with all parts in the flow path.

Piston Seal Compatibility

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

2.4.2 Allowed pH Ranges

Allowed pH ranges (standard system configuration):

System (Standard Configuration)	Allowed pH ranges	Remarks
Vanquish Core	1-13	<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		

Observe the mobile phase guidelines for the detector. See [Mobile Phase Guidelines for the Detector](#) (▶ page 96).

2.4.3 Allowed Concentrations

Allowed concentrations for the charged aerosol detector:

Concentration	Value
Volatile buffer concentration	Less than or equal to 0.1 mol/L
Chloride concentration	Not recommended

Observe the mobile phase guidelines for the detector. See [Mobile Phase Guidelines for the Detector](#) (► page 96).

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.
- Refer also to the *Operating Manuals* for all modules in the Vanquish system. They may provide additional guidelines and information.

2.5 Compliance Information

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

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 \(▶ page 180\)](#)

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:

- Charged aerosol detection (CAD) method for liquid chromatography for detection of all non-volatile and many semi-volatile analytes
- Detection based on measuring charge that is proportional to the amount of analyte, and, for non-volatile analytes, independent of the chemical structure of the analyte
In comparison to UV detection, a chromophore is not required for detection, and in comparison to mass spectrometry, ionization of the analyte is not necessary.
- Detection with great sub-nanogram sensitivity and a wide dynamic range
- FocusJet™ nebulizer with concentric design for extended low pump flow rate range
- Adjustable evaporation temperature for optimization of analyte response and use with a wider range of eluents
 - ◆ VH-D20 detector: Adjustable range for the evaporation temperature
 - ◆ VF-D20 detector: Selectable evaporation temperatures
- For data collection, the detector supports the following data collection rate:
 - ◆ VH-D20 detector: Up to 200 Hz
 - ◆ VF-D20 detector: Up to 100 Hz

3.2 Operating Principle

The detector is designed for charged aerosol detection with full compatibility in HPLC and UHPLC applications. In charged aerosol detection, an aerosol of dried analyte particles is formed after nebulization of column eluate. Electrical charge is imparted to these dried particles. The detector then measures the charge. Measured charge is proportional to the amount of analyte in the sample.

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

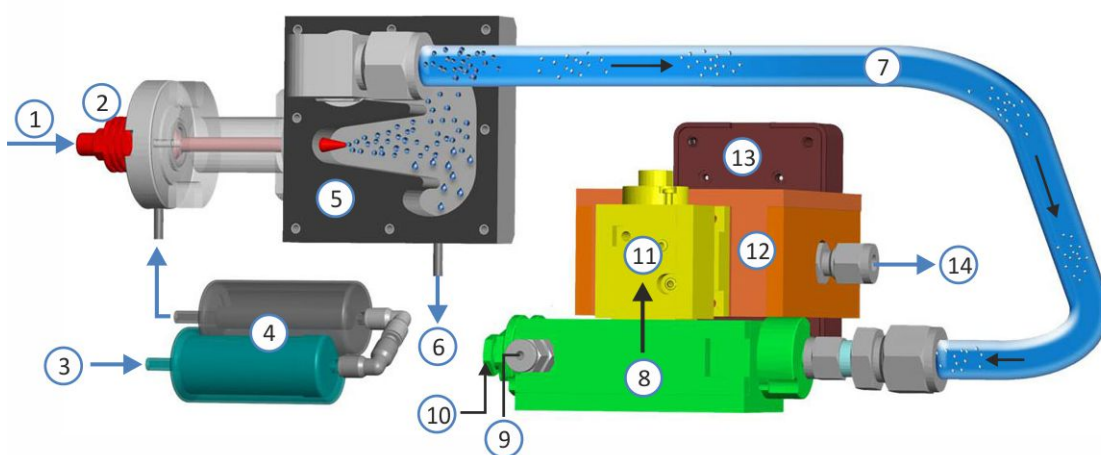


Figure 1: Operating principle of the detector

No.	Description
1	Mobile phase from column
2	Nebulizer
3	Gas inlet
4	Gas filters
5	Spray chamber
6	Drain pump
7	Evaporation tube
8	Mixing chamber
9	Charger gas inlet
10	Corona charger
11	Ion trap
12	Electrometer (detection chamber)
13	Electrometer board
14	Gas exhaust

Mobile phase from the column enters the detector (no. 1) and flows to the nebulizer (no. 2). Pressurized gas streams through the gas inlet (no. 3) and passes through the charcoal gas filter and then the HEPA gas filter (no. 4). In the nebulizer (no. 2), the filtered gas and the mobile phase merge at the nebulizer tip to create an aerosol within the spray chamber (no. 5).

The largest aerosol droplets condense within the spray chamber (no. 5) and are removed by the drain pump (no. 6) through the waste outlet. Smaller droplets pass into a temperature-controlled evaporation tube (no. 7), in which solvent and more volatile components are vaporized.

By the end of the evaporation tube, the resulting aerosol particles enter the mixing chamber (no. 8), where they collide with a secondary stream of ionized gas (no. 9) that has passed through a corona charger (no. 10). Each dried aerosol particle undergoes surface diffusional charging, where the level of charge per particle is proportional to particle size and the cumulative charge of the population is directly related to the analyte amount.

In the ion trap (no. 11), higher mobility ions and smaller charged particles are removed. Lower mobility charged particles pass to a conductive filter and aggregate charge is measured with a sensitive electrometer/detection chamber (no. 12). Signal is processed by the electrometer board (no. 13) and sent to the chromatography data system. The resulting gas flow exits the detector through the gas exhaust (no. 14).

3.3 Interior Components

<Overview_InteriorComp>The user-accessible components of the detector are located directly behind the front doors:

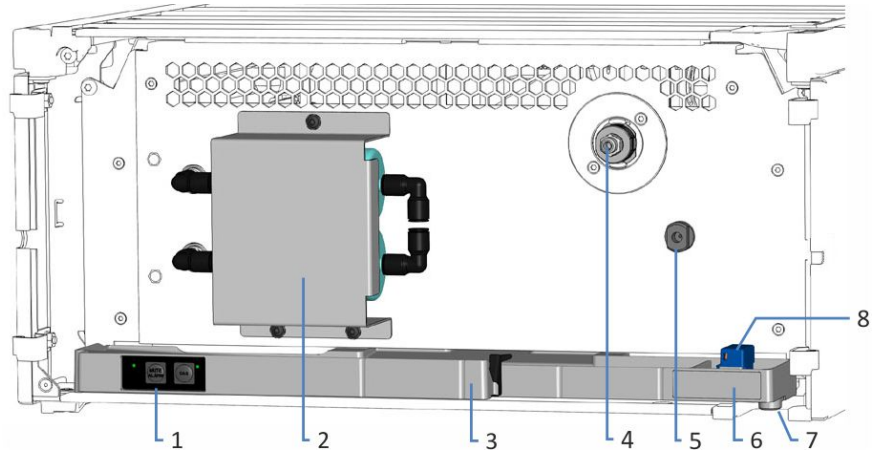


Figure 2: Interior view

No.	Description
1	Keypad with status indicators
2	Gas filter assembly behind the protective cover
3	Leak tray
4	Nebulizer (after installation)
5	Waste outlet
6	Type label, indicating the module name, serial number, part number, and revision number (if any)
7	Drain port
8	Leak sensor

3.4 Nebulizer

The FocusJet nebulizer is the liquid flow inlet of the charged aerosol detector. Eluate from the column flows into the nebulizer and merges with filtered gas that is supplied to the nebulizer. Due to the concentric flow design of the nebulizer, an aerosol is produced within the spray chamber.

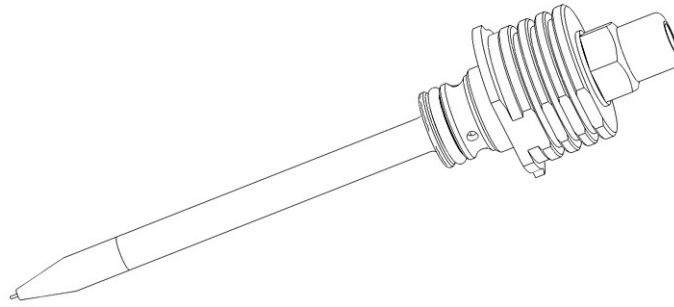


Figure 3: FocusJet nebulizer

3.5 Gas Filter Assembly

An assembly of two gas filters on the front side of the detector filters the supplied gas internally before it is used in the detector. The gas filters consist of a charcoal filter and a high-efficiency particulate air (HEPA) filter. Gas supplied through the gas inlet of the detector is first filtered in the charcoal gas filter (bottom filter) and then in the HEPA gas filter (top filter).

Sufficient filtering of the supplied gas, both externally and internally, ensures that the gas is clean and free from particles.

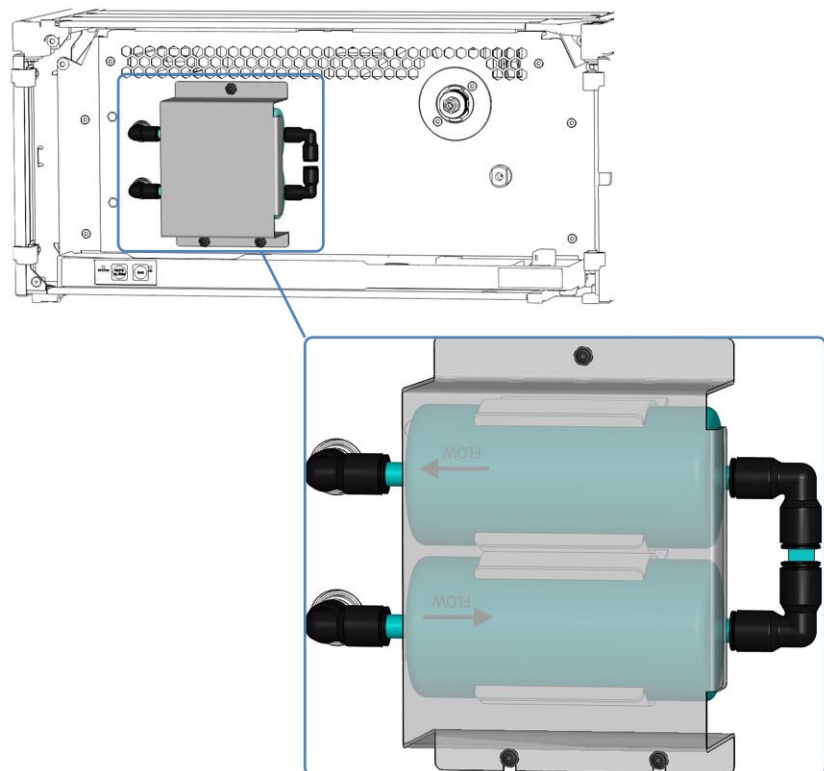


Figure 4: Gas filter assembly behind protective cover

3.6 Excess Liquid and Leak Detection

As leaks are a potential safety issue, sensors in the charged aerosol detector monitor the following:

Excess liquid inside the detection flow path

The liquid sensor monitors the detection flow path and detects accumulated solvent. When excess liquid is present, the liquid sensor is triggered.

When the liquid sensor detects excess liquid (flooding) inside the detector, the status indicators change to red and beeping starts to alert you. The Chromeleon software automatically stops the pump flow and issues a message in the Audit Trail. Follow the instructions in this manual to eliminate the excess liquid.

Liquid leaks

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.

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

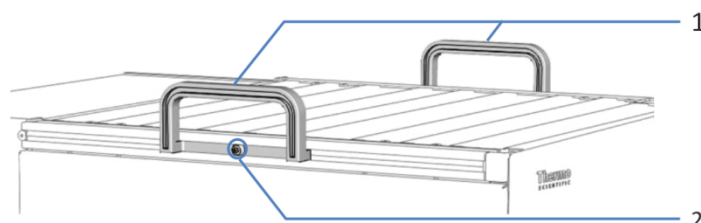


Figure 5: Carrying handles on the device

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

- Place the device on a stable surface.
- 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.
- 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 56)).

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

- 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 with nebulizer
- 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 173).

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*.

When another detector is installed in the system, follow the instructions in this manual to install the charged aerosol detector in addition to the other detector.

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 56).
3. Set up the liquid flow connections. See [Setting Up the Liquid Flow Connections](#) (▶ page 71).
4. Turn on the device. See [Turning On the Device](#) (▶ page 82).

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 83).
6. Prepare the system for operation. Refer to the *Vanquish System Operating Manual*.

7. *Recommended:*

Perform Instrument Installation Qualification.

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

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

NOTICE

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

8. *Recommended:* Perform Operational Qualification.

The qualification kit includes all materials required for the qualification and detailed instructions.

Moving the Device after Installation

If you have to move the device after it has been set up and installed in the Vanquish system, prepare the device for transport and move it to the new location. Follow the instructions in [Transporting or Shipping the Device](#) (▶ page 145).

5.3 Site Requirements

An appropriate 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 169) 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.

To avoid power fluctuations, the use of an uninterruptible power supply (UPS) is recommended.



CAUTION—Electric Shock or Damage to the Device

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

Connect the device to the specified line voltage only.

5.3.2 Power Cord

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

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

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

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

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

5.3.3 Condensation

NOTICE—Condensation in the device can damage the electronics.

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

5.3.4 Ventilation Requirements



CAUTION—Hazardous Fumes

The exhaust gas of the detector may contain hazardous fumes that pose health and safety risks.

- Avoid an accumulation of gas. The exhaust gas must always be removed by proper ventilation.
- Make sure that the installation site is well ventilated. Do not vent directly into the laboratory.

NOTICE

A vacuum in the ventilation can cause a depressurization inside the detector. This can impair detector operation and lead to a decreased performance.

Avoid a vacuum or a negative pressure in the ventilation of the detector.

In addition to the operating conditions for ventilation stated in the *Vanquish System Operating Manual*, make sure that the location fulfils the following requirements.

- Operate the detector nearby the gas supply and ventilation sources.
- Ventilation must be at atmospheric pressure with no vacuum and no positive pressure applied.
- Exhaust ventilation rate must be at least 4 L/min. per charged aerosol detector.
- Install the detector in a well-ventilated laboratory. Exhaust gases (including carrier gas, vaporized eluents and solute micro particles) exit on the right side of the detector through the gas exhaust port. The exhaust gas may contain volatile organic compounds in low concentration. Make sure that the detector is properly vented. Direct the gas exhaust tubing to a fume hood or connect it to another ventilation device such as an industrial vent. Prevent a gas-tight connection and siphons between the gas exhaust port of the detector and the ventilation.

5.3.5 Gas Supply Requirements



CAUTION—Explosion Hazard or Damage to the Detector

When using tetrahydrofuran (THF), the use of air as supplied gas may pose an explosion hazard. This can pose a safety and health risk and damage the detector.

Always use nitrogen with tetrahydrofuran or other highly combustible solvents.



CAUTION—Excessive Gas Supply Pressure

An improper or excessive gas supply pressure can lead to an overpressure in the detector that can cause the safety valve in the detector to release gas. In extreme cases, the excessive pressure can cause the gas filters to rupture. This can pose a health and safety risk.

- Observe the gas supply pressure range that is specified for the detector. Do not exceed the maximum gas supply pressure.
- If you use high-pressure gas cylinders as gas supply, double-check the regulator outlet pressure to ensure that it is within the gas supply specifications of the detector. This is especially important when attaching the gas bottle for the first time and when changing gas bottles.
- If the overpressure relief valve is releasing gas as a result of an overpressure in the detector during operation, turn off the detector immediately. Remedy the situation as described in [Resolving Gas Supply Overpressure](#) (► page 164).



CAUTION—Gas Filter Rupture upon Excessive Gas Supply Pressure

An excessive supply gas pressure can lead to an overpressure in the detector and can cause the gas filters to rupture. This can pose a health and safety risk.

- Turn on the gas supply only when the gas filters are properly connected to the detector and the protective cover is properly installed.
- Observe the gas supply pressure range that is specified for the detector. Do not exceed the maximum gas supply pressure.
- Before you start the replacement of the gas filter assembly, make sure that the gas supply and the detector gas flow are turned off.
- Observe the gas supply requirements. See [Gas Supply Requirements](#) (► page 52).

NOTICE—Gas Specifications

The requirements and specifications for the gas supplied to the detector have major impact on the detector performance. Observe the following notes:

- If the gas supply pressure is varying or dropping below the specified pressure range, it can impair the performance of the detector or even damage the detector.
- Non-volatile hydrocarbons, such as compressor oils, in the gas supplied to the detector can cause permanent damage to the detector.
- If the supply gas is contaminated with particles, water vapor or other non-volatile substances, it can impair the performance or even damage the detector.
- Observe all requirements and specifications for the supply gas in this manual to avoid damage to the detector.

Make sure that the location fulfils the following requirements for the gas supply:

- The gas supply and the gas supply pressure for the detector must meet the gas specifications. See [Performance Specifications](#) (▶ page 170).
- Make sure that the gas supply is regulated to a stable gas pressure that is within the specified gas pressure range.
- The gas supplied to the detector must be either air or nitrogen. Do not use helium or other supply gases.
- Nitrogen gas (typically $\geq 95\%$ nitrogen purity) is recommended for most applications. Air may be used when working with mobile phases of low combustibility.
- With highly combustible mobile phases, such as tetrahydrofuran (THF) and other ethers or ketones, use only nitrogen as supply gas.
- The use of a non-bottled gas source is recommended, such as
 - ◆ A nitrogen generator with suitable air compressor or with a suitable in-house air source
 - ◆ Medical-grade nitrogen from an in-house liquid nitrogen source

TIP Use of smaller compressed nitrogen cylinders or liquid nitrogen containers may be a quick and easy source of nitrogen during installation. However, it is not recommended for routine operation.

- The gas consumption of the detector is typically ≤ 4 L/min.
- The supply gas must be free from water vapor, free from particles, and must not contain non-volatile hydrocarbons, such as compressor oils.
If necessary, use a sub-micron particle filter or carbon filter in combination with a water condensation trap located close to the gas source.
- Make sure that the gas supply is ready for operation. Follow the instructions in the *User Documentation* for the gas supply.

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.

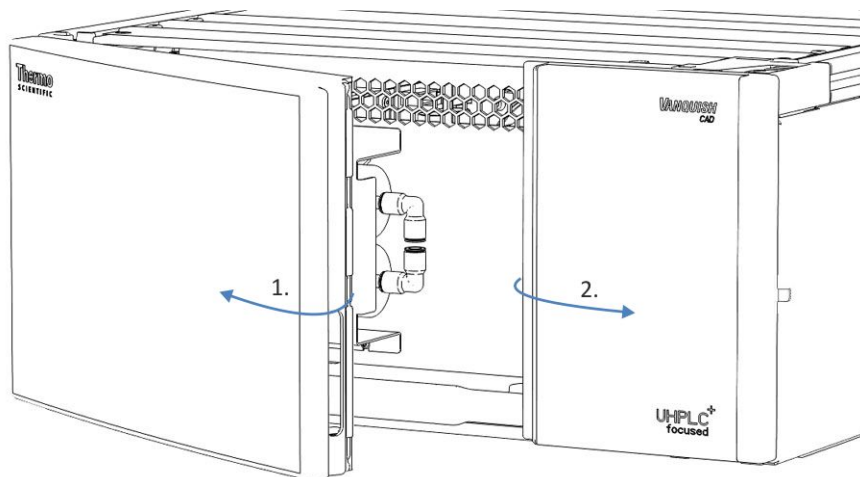


Figure 6: Opening the front doors

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.

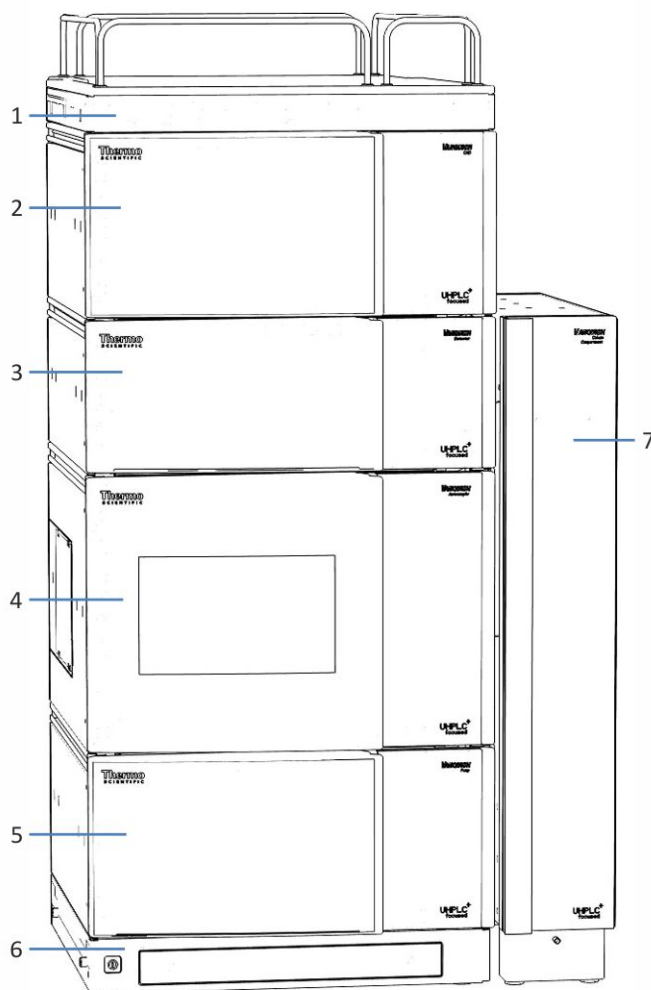


Figure 7: Vanquish system, configuration with charged aerosol detector and diode array detector (example)

No.	Description
1	Solvent Rack
2	Charged Aerosol Detector
3	Diode Array Detector

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

Follow these steps

Depending on the system configuration, follow the steps as required:

System configuration	Steps
If the charged aerosol detector is the only detector in the Vanquish system	Follow the instructions in the <i>Vanquish System Operating Manual</i> to set up the system stack.
If the charged aerosol detector is the second detector in the Vanquish system, for example after a diode array detector	<ol style="list-style-type: none"> 1. Set up the system stack with the first detector in the system, such as the diode array detector. For instructions, refer to the <i>Vanquish System Operating Manual</i>. Do not install the solvent rack and the column compartment yet. 2. To position the charged aerosol detector, lift it by its carrying handles. Place the detector on top of the stack approximately 5 cm before the end of the rails. Lift the front part of the detector and push the detector towards the rear until the detector clicks into place. 3. To remove the carrying handles, follow the corresponding steps in Unpacking (▶ page 41). 4. Place the solvent rack on the detector approximately 5 cm before the end of the rails. Lift the front part of the solvent rack and push the solvent rack towards the rear until it clicks into place. Note: The charged aerosol detector needs to be at the end of the flow path because it is a destructive detector. 5. Install the column compartment. Refer to the <i>Operating Manual</i> for the column compartment.

5.5.2 Connecting the Device

Device Connectors

The following connectors are provided on the device:

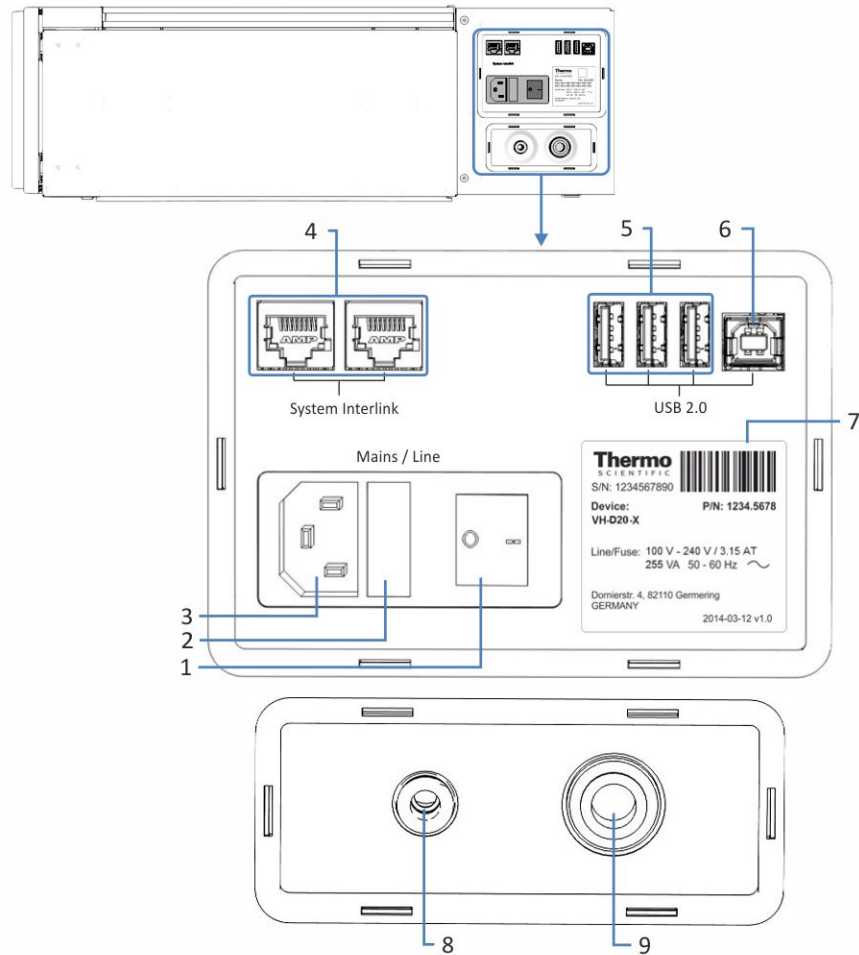


Figure 8: Electrical and gas connectors on the right side of the detector

No.	Description
1	Main power switch (on/off control)
2	Fuse holder
3	Power-inlet connector
4	System Interlink port Allows power on/off control for the detector from the Vanquish system base and device communication For example, the interconnection between charged aerosol detector and pump enables direct communication in case of an operating issue. Certain problems in the charged aerosol detector cause an automatic stop of the pump flow to prevent a build-up of excess liquid inside the detector.

No.	Description
5	USB hub ("A" type connector) Allows connection to other modules in the Vanquish system
6	USB (Universal Serial Bus) port ("B" type connector) Allows connection to other modules in the Vanquish system or the computer on which the data management system is installed, such as the Chromeleon software
7	Rating plate, indicating the serial number, part number, module name, revision number (if any), and the line and fuse rating
8	Gas inlet Allows connection to a gas supply
9	Gas exhaust Allows connection to ventilation

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 detector in the system as required by the system configuration. See [System Arrangement](#) (▶ page 56).
2. Connect the required interface cables to the detector. See [Connecting the Interface Cables](#) (▶ page 60).
3. Connect the power cord (see [Connecting the Power Cord](#) (▶ page 62)).

5.5.3 Connecting the Interface Cables

The procedure depends on the system configuration:

System configuration	Follow these steps
The charged aerosol detector is the only detector in the Vanquish system	Follow the instructions in the <i>Vanquish System Operating Manual</i> to set up the USB and system interlink connections in the system.
The charged aerosol detector is the second detector in the Vanquish system, for example, after a diode array detector	<p>Set up the USB and system interlink connections as follows (see picture below this table for the complete USB and system interlink connections):</p> <ol style="list-style-type: none"> 1. Follow the instructions in the <i>Vanquish System Operating Manual</i> to connect the other modules in the system up to the diode array detector. 2. Connect the "B" connector of a USB cable to the USB port on the charged aerosol detector, and connect the "A" connector of the USB cable from the charged aerosol detector to the USB hub on the diode array detector. 3. Connect the "A" connector of the USB cable from the diode array detector to a USB port (2.0 or higher) on the computer. 4. Connect one end of the system interlink cable to the free System Interlink port on the diode array detector, and the other end to a System Interlink port on the charged aerosol detector. 5. Connect one end of the system interlink cable to the free System Interlink port on the charged aerosol detector, and the other end to a System Interlink port on the column compartment.

This picture shows the USB and system interlink connections if the charged aerosol detector is the second detector in the system, for example, after a diode array detector.

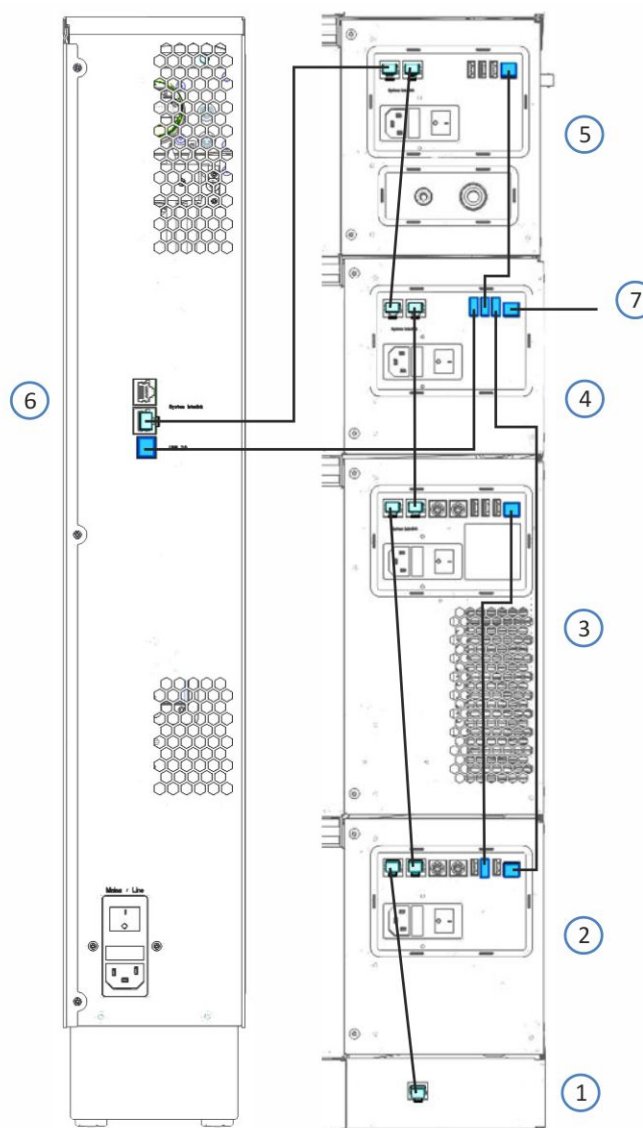


Figure 9: Interface cable connections in the Vanquish system with charged aerosol detector and diode array detector

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

5.5.4 Connecting the Power Cord

NOTICE

Condensation in a device can damage the electronics.

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

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

5.5.5 Installing the Nebulizer

This section describes the installation of the FocusJet nebulizer.



CAUTION—Sharp Tip of the Nebulizer

The capillary inside the nebulizer that protrudes from the nebulizer tip is sharp and may be fragile. Touching the nebulizer capillary can cause personal injury and damage to the capillary.

- To avoid personal injury, always wear safety glasses when handling the nebulizer.
- Do not touch the nebulizer tip.
- Handle the nebulizer with care.

NOTICE—Sensitive Nebulizer

The nebulizer is highly sensitive to contamination and damage. Observe the following safety notes:

- The nebulizer is highly sensitive to contamination. Even minute particles on the nebulizer can lead to contamination and poor detector performance. Always wear powder-free gloves when you install or remove the nebulizer.
- The capillary inside the nebulizer may be fragile and subject to mechanical vibrations during transport. If the nebulizer was packaged separately, visually inspect the nebulizer surfaces and the nebulizer tip prior to installation.
- Operating the nebulizer with a gas pressure other than the pressure specified for this nebulizer can cause unpredictable deviations in performance of the nebulizer and the detector. After installation of the nebulizer, set the nebulizer gas pressure to the pressure that is specified for your nebulizer. The nebulizer gas pressure is defined on the gas pressure certificate that is shipped with the nebulizer.

Parts and additional items required

- Powder-free gloves
- FocusJet nebulizer with dedicated nebulizer gas pressure certificate
- *Optional:* Deionized water

Preparations

1. Wear powder-free gloves.
2. Remove the packed nebulizer from behind the detector doors.

3. Unpack the nebulizer carefully from the packaging. Locate the gas pressure certificate for the nebulizer.
Keep the nebulizer packaging to have it available when transporting the nebulizer.

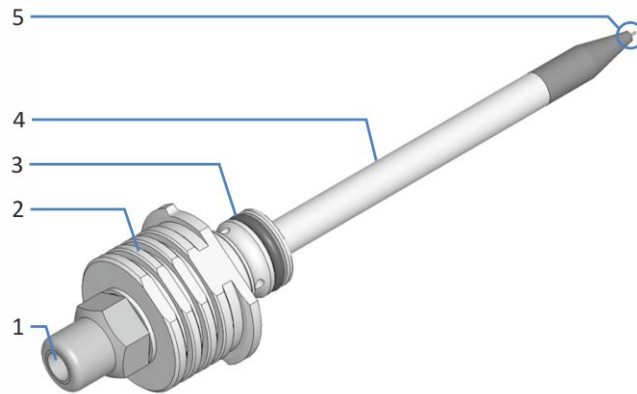


Figure 10: Parts of the nebulizer

No.	Description
1	Liquid flow inlet
2	Handle
3	Sealing bushing with sealing ring
4	Spray pipe
5	Nebulizer capillary on the tip of the spray pipe

4. Remove the protective tubing from the nebulizer spray pipe carefully. Do not touch the nebulizer tip with the protective tubing, as it can damage the tip.
Keep the protective tubing to have it available when transporting the nebulizer.



Figure 11: Nebulizer with protective tubing and plug on the flow inlet

Follow these steps

1. On the front of the detector, remove the dust seal plug from the opening for the nebulizer.

NOTICE—Contaminations at the nebulizer opening

- Store the dust seal plug to have it available when transporting the detector.
- Store it under clean conditions, for example, in the bag the nebulizer was delivered in to prevent contaminations at the nebulizer opening.



Figure 12: Dust seal plug installed in the nebulizer opening

2. Insert the nebulizer in the opening in the front panel of the detector. Observe the following:
 - ◆ The nebulizer tip must point to the opening in the middle of the nebulizer opening. Avoid the nebulizer tip from touching the sides of the nebulizer opening, as this can damage the tip.
 - ◆ Mind the correct orientation of the nebulizer: The gripping sides of the nebulizer are on the top and bottom side of the handle. The protruding sides for attachment are on the left and right side of the handle. See the picture below.

TIP To facilitate inserting the nebulizer in the nebulizer opening, moisten the sealing ring on the sealing bushing with deionized water.

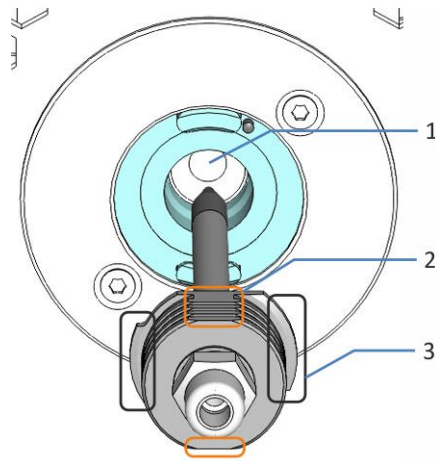


Figure 13: Correct orientation of the nebulizer for installation

No.	Description
1	Center of the nebulizer opening
2	Gripping sides on top and bottom handle side
3	Protruding sides on left and right handle side

3. Push the nebulizer into the opening until the spray pipe and sealing bushing are completely in the opening. The nebulizer handle must lie flush against the nebulizer opening.

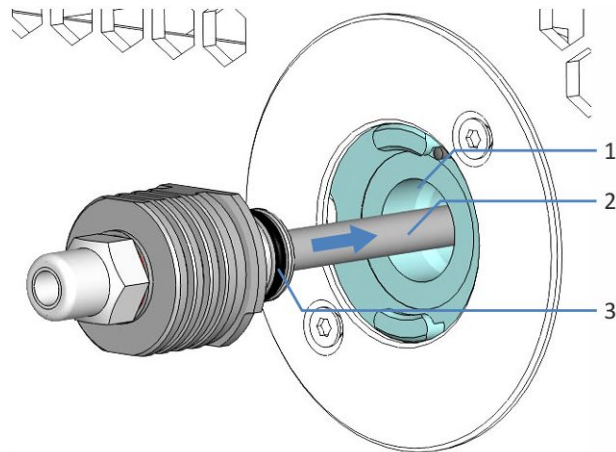


Figure 14: Completely inserting the nebulizer

No.	Description
1	Opening for the nebulizer on the interior panel of the detector
2	Spray pipe
3	Sealing ring in the sealing bushing

4. Turn the nebulizer by 90 degrees clockwise in the opening to lock the nebulizer. Check that the protruding sides on the nebulizer arrest behind the two locks of the opening and lie against the alignment pin.

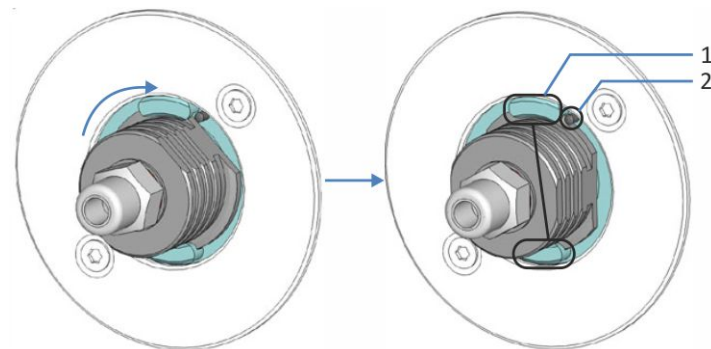


Figure 15: Locking the nebulizer in the detector

No.	Description
1	Locks on the nebulizer opening
2	Alignment pin

5. *After the detector has been turned on:* Set the nebulizer gas pressure that is specified for your nebulizer and enter the nebulizer serial number. See [Setting the Nebulizer Gas Pressure and the Nebulizer Serial Number](#) (▶ page 101).

5.5.6 Connecting the Gas Inlet and Exhaust Tubes

This section describes the connection of the gas inlet and exhaust tubes to the detector.

Parts required

- Gas supply
- Ventilation appliance
- Parts for connecting the gas supply:
 - ◆ Gas inlet elbow connector
 - ◆ Gas inlet tubing
- Parts for connecting the gas exhaust:
 - ◆ Gas exhaust elbow connector
 - ◆ Gas exhaust tubing

Tools required

Tubing cutter (optional)

Preparations

1. Observe the site requirements for the gas supply and the ventilation (see [Ventilation Requirements](#) (▶ page 51) and [Gas Supply Requirements](#) (▶ page 52)).
2. Check the gas tubes and elbow connectors. Observe the following:
 - ◆ Use only the gas tubes and elbow connectors that are shipped with the detector or additional or spare parts 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 gas tubes or connection unions that are stressed, nicked, kinked, or otherwise damaged.

Follow these steps

1. Connect the gas inlet tubing to the gas supply and route it to the detector.
2. Connect the gas exhaust tubing to the ventilation and route it to the detector.
3. Check the length of the gas tubes.
The gas tubes should not form siphons but go straight to the detector. If the gas tubes are longer than required, use a tubing cutter to cut the tubes straight to the required length. Make sure that the cut is at a right angle to the length of the gas tubes.
4. Connect the gas tubes to the elbow connectors. Mind the correct orientation of the elbow connectors.
 - a) Connect the gas inlet tubing to the gas inlet elbow connector.
 - b) Connect the gas exhaust tubing to the gas exhaust elbow connector.

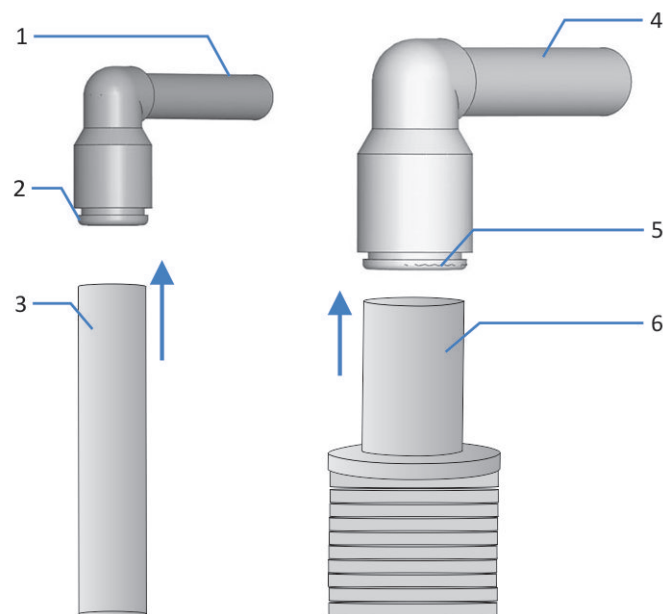


Figure 16: Connecting gas tubes to the elbow connectors

No.	Description
1	Connection stem to gas inlet port
2	Connector for gas inlet tubing
3	Gas inlet tubing
4	Connection stem to gas exhaust port
5	Connector for gas exhaust tubing
6	Gas exhaust tubing

5. On the right side of the detector, connect the elbow connectors.
 - a) On the left port (gas inlet), push the connection stem of the gas inlet elbow connector into the port.
 - b) On the right port (gas exhaust), push the connection stem of the gas exhaust elbow connector into the port.
 - c) Slightly pull on each elbow connector to check that they are properly locked in the ports. If an elbow connector slips out of a port, push it a little bit further into the port and repeat the check.

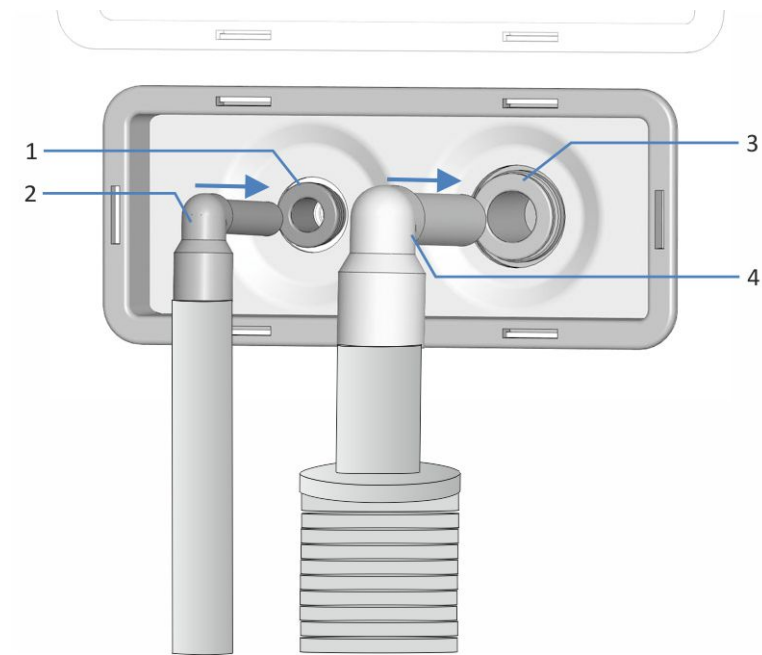


Figure 17: Pushing in the connection unions

No.	Description
1	Gas inlet port
2	Gas inlet elbow connector with gas inlet tubing
3	Gas exhaust port
4	Gas exhaust elbow connector with gas exhaust tubing

5.6 Setting Up the Liquid Flow Connections

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

5.6.1 General Information and Guidelines

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



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

- Dirty components can contaminate the chromatography system. Contamination leads to poor performance of the modules and entire system or can even cause damage to the modules and system. Therefore:
 - ◆ Always wear appropriate gloves.
 - ◆ Place the components only on a clean, lint-free surface.
 - ◆ Keep your tools clean.
 - ◆ Use only lint-free cloth for cleaning.
- For installation instructions and guidelines and for handling recommendations, see [Connecting Fittings, Capillaries, and Tubing](#) (▶ [page 73](#)).

NOTICE

Before you connect the charged aerosol detector in the system flow path:

- 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*.
- Flushing the charged aerosol detector will be performed later during equilibration.

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

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

Follow these steps

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

1. Connect the waste line. See [Connecting the Waste Line](#) (▶ page 75).
2. Connect the inlet capillary to the nebulizer. See [Connecting the Inlet Capillary to the Nebulizer](#) (▶ page 77).
3. Connect the detector to the drain system. See [Guiding Liquid Leaks to Waste](#) (▶ page 81).

5.6.2 Guiding Capillaries and Tubing Through the System

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

Tubing Chase with Tubing Guides

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

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

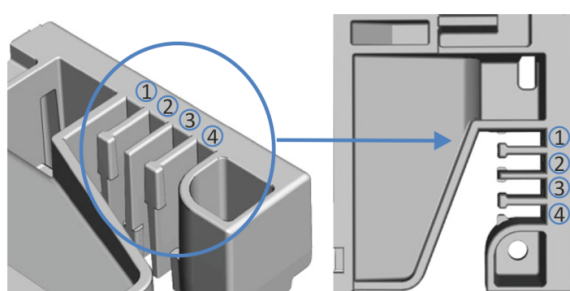


Figure 18: Tubing chase with tubing guides (left: view from inside, right: view from top)

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.

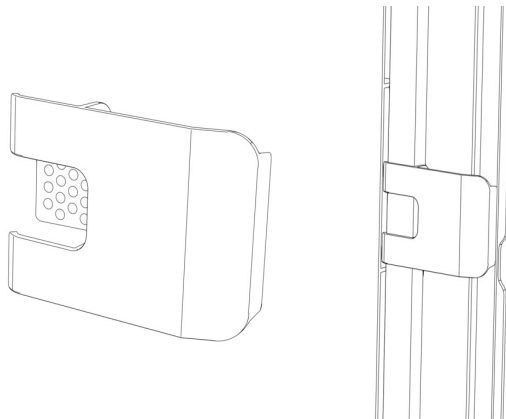


Figure 19: Tubing bracket (left), tubing bracket installed (right)

Dual System Arrangements

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

Guide Holes and Capillary Clips

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

5.6.3 Connecting Fittings, Capillaries, and Tubing

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

5.6.3.1 General Guidelines

When connecting capillaries and tubing, follow these general recommendations:

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

- Do not install capillaries or tubes that are stressed, nicked, kinked, or otherwise damaged.
- Install capillaries and fittings only at the positions for which they are intended.

5.6.3.2 Connecting Viper Capillaries

This section describes how to connect Viper™ capillaries. All Viper flow connections in the Vanquish system are designed to be finger-tight.

To connect Viper capillaries with 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.

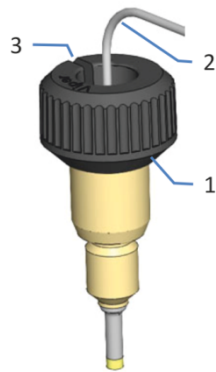


Figure 20: Viper fitting with knurl

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 capillary through this slot if space is limited.

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

Resolving Leakage of Viper Fittings with Knurls

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

5.6.4 Connecting the Waste Line

NOTICE

Extending or combining the waste line can cause a backpressure in the line that can lead to an excess liquid build-up inside the detector. Avoid extending or combining the waste line. Make sure that the waste line drains freely into waste.

Parts required

Waste line for connection between waste outlet and waste container

Tools required

Tubing cutter (optional)

Preparations

1. Route the waste line through the detector waste outlet in the system base to waste. Follow the instructions in the *Vanquish System Operating Manual*.
2. On the waste outlet on the detector, remove the plug.

Follow these steps

1. Route the waste line from the system base to the detector, through the tubing guides of the system modules below the detector.

2. On the waste outlet on the detector, connect the waste line.

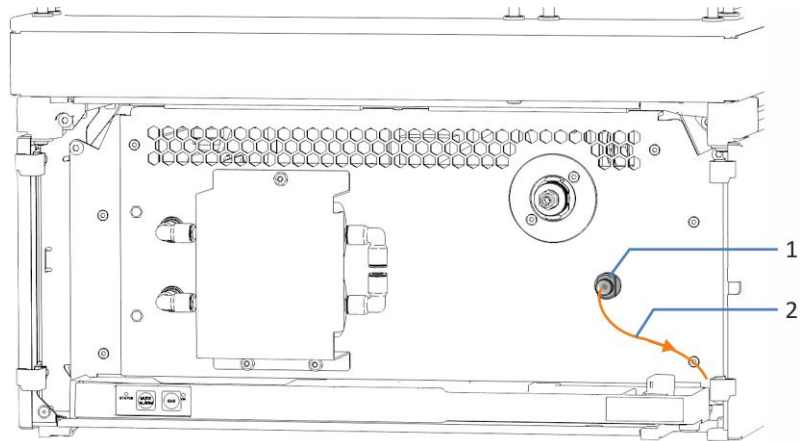


Figure 21: Waste line connected to the waste port

No.	Description
1	Waste outlet
2	Waste line

3. 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.
4. 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.

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.

5.6.5 Connecting the Inlet Capillary to the Nebulizer

Depending on the number of detectors in your system, you can connect the inlet capillary to the nebulizer as follows:

Configuration	Inlet capillary connected to the nebulizer
Charged aerosol detector is the <i>only</i> detector in the system	Directly from the column
Charged aerosol detector is the <i>second</i> detector in the system	From the flow cell of a first detector, such as the diode array detector, in the Vanquish system flow path. In this series liquid flow connection, one flow path from the pump is used for both detectors installed in the system.

Parts required

Inlet capillary for connection to the nebulizer (shipped with the detector)

TIP Keep the capillary connection to the charged aerosol detector as short as possible to minimize peak broadening effects.

Preparations

1. Flush the system modules and capillaries upstream of the detector to waste thoroughly before you connect the detector to the system flow path. Refer to the *Vanquish System Operating Manual*.
2. On the nebulizer, remove the plug from the nebulizer flow inlet.

Follow these steps

Route and connect the capillary to the nebulizer as required by the system arrangement:

Configuration	Step	See
Charged aerosol detector is the <i>only</i> detector in the system	Connect the capillary between column and nebulizer	Connecting the Capillary Between Column and Nebulizer (▶ page 78)
Charged aerosol detector is the <i>second</i> detector in the system	Connect the capillary between flow cell and nebulizer	Connecting the Capillary Between Flow Cell and Nebulizer (▶ page 78)

5.6.5.1 Connecting the Capillary Between Column and Nebulizer

If the charged aerosol detector is the only detector in the Vanquish system flow path, connect the inlet capillary between column and nebulizer.

Preparations

See [Connecting the Inlet Capillary to the Nebulizer](#) (► page 77).

Follow these steps

1. Connect the capillary to the column outlet.
2. Route the inlet capillary from the column compartment through the guide hole in the detector enclosure to the nebulizer. Use the guide hole that is next to the column compartment.
3. Connect the inlet capillary to the nebulizer.

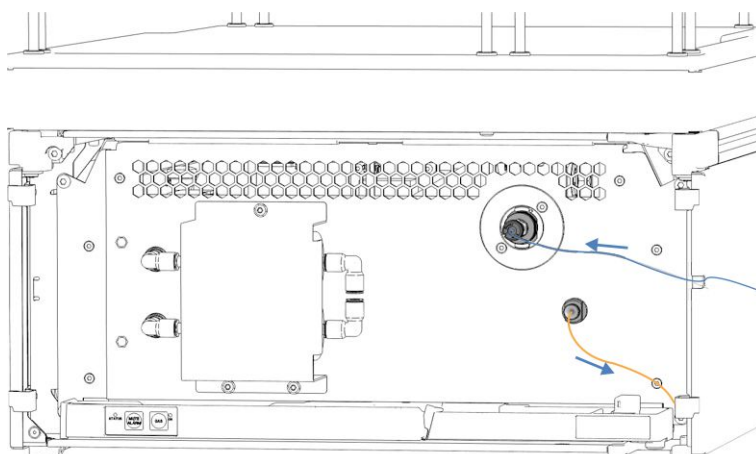


Figure 22: Inlet capillary and waste line connected to/from the detector

5.6.5.2 Connecting the Capillary Between Flow Cell and Nebulizer

If the charged aerosol detector is the second detector in the Vanquish system flow path, for example, after a diode array detector, connect the capillary between flow cell and nebulizer.

Observe the following guidelines for series flow configuration:

- The charged aerosol detector must be the last detector connected in the flow path.
- Other detectors contribute to extra-column volume, which may have an adverse effect on the peak shape measured by the charged aerosol detector.

- Be aware of the pressure limit of the flow cell in the optical detector, especially the pressure limit of the LightPipe™ flow cell. Connect the capillary from the flow cell directly to the nebulizer. Avoid connecting any additional components in the flow path between the two detectors. Refer to the *Operating Manual* for your optical detector.
- If you want to bypass the flow cell, use the Viper union to interconnect the capillary from the column with the capillary connected to the nebulizer. Keep the capillary connection as short as possible to minimize peak broadening effects.

Preparations

- See [Connecting the Inlet Capillary to the Nebulizer](#) (▶ page 77).
- Observe all notes and specifications for the flow cell in the first detector in the Vanquish system. Refer to the *Operating Manual* for this detector.

Follow these steps

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

6. Connect the inlet capillary to the nebulizer of the charged aerosol detector.

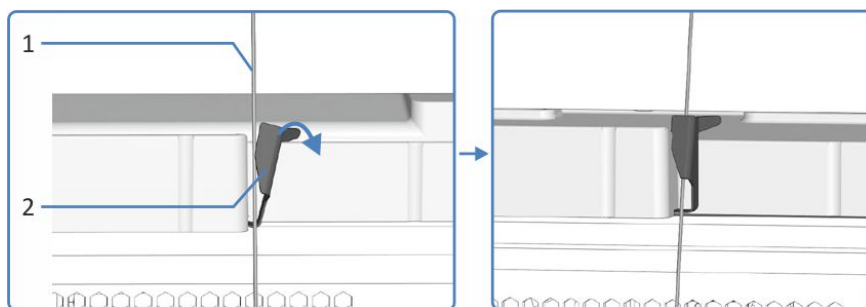


Figure 23: Securing the capillary behind the capillary clip on the leak tray

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

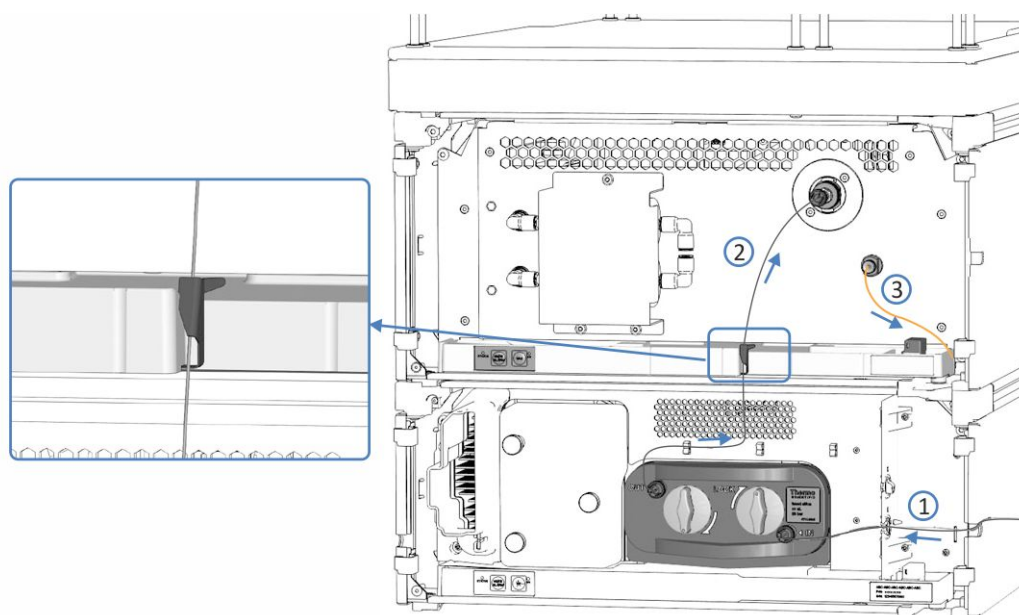


Figure 24: Series flow connection between diode array detector and charged aerosol detector (example)

No.	Description
1	Capillary connection from the column compartment to the flow cell
2	Capillary connection between flow cell and nebulizer
3	Waste line from the charged aerosol detector to the system base

5.6.6 Guiding Liquid Leaks to Waste

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

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

5.7 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.

NOTICE

Make sure that the pump flow to the detector is turned off. To properly turn on the detector gas flow and *only then* turn on the pump flow to the detector, follow the instructions in [Preparing the Device for Operation](#) (▶ page 93).

See also

 [Power On/Off Control](#) (▶ page 92)

5.8 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—Explosion Hazard or Damage to the Detector

When using tetrahydrofuran (THF), the use of air as supplied gas may pose an explosion hazard. This can pose a safety and health risk and damage the detector.

Always use nitrogen with tetrahydrofuran or other highly combustible solvents.

NOTICE

Pay attention also to the following guidelines:

- If there is evidence of leakage in the device, turn off the pump flow while leaving the gas flow on and remedy the situation immediately.
- Pump flow without gas flow causes detector flooding. Verify that the detector gas flow is always turned on before you turn on the pump flow to the detector. Do not direct pump flow to the detector without gas flow being turned on.
- Turn on the gas supply and detector gas flow only when the nebulizer is installed, the components in the gas flow path are properly connected, and the protective cover of the gas filter assembly is installed.
- *To start detector gas flow and pump flow:* Turn on the detector gas flow first, wait at least 5 minutes and only then turn on the pump flow.
- *To stop pump flow and detector gas flow:* Turn off the pump flow first, wait at least 5 minutes and only then turn off the detector gas flow. During the waiting period, the drain pump drains any remaining mobile phase to waste.
- Exceeding the pump flow rate limit will damage the detector. Operate the detector only within the allowed pump flow rate range (see [Performance Specifications](#) (▶ page 170)).
- If the overpressure relief valve is releasing gas as a result of an overpressure in the detector during operation, turn off the detector and the gas supply to the detector immediately. Remedy the situation as described in [Resolving Gas Supply Overpressure](#) (▶ page 164).
- Observe the requirements for gas supply and ventilation. See [Ventilation Requirements](#) (▶ page 51) and [Gas Supply Requirements](#) (▶ page 52).
- Contamination of the mobile phase can damage the detector. Avoid contamination of the mobile phase. See [Mobile Phase Guidelines for the Detector](#) (▶ page 96).
- Observe the specifications for operation. See [Performance Specifications](#) (▶ page 170).

6.3 Control Elements

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

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

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

6.3.1 Keypad

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

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

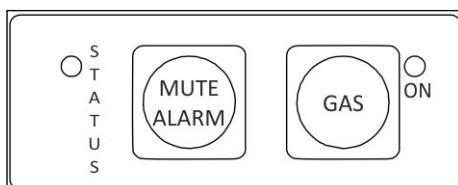


Figure 25: Keypad

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 90).

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.

GAS

Pushing the **GAS** button will turn the detector gas flow on and off.

The LED next to the button indicates the gas status:

LED	Description
Off (dark)	The detector gas flow and drain pump are turned off.
Green	The detector gas flow and drain pump are turned on.

When the Device is Connected in the Chromatography Data System

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

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

6.3.2 Status Indicators

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

LED Bar

The LED bar colors provide the following information:

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

LED Bar	Description
Yellow	The LED bar is yellow when both conditions apply: <ul style="list-style-type: none"> • The detector is connected in the chromatography data system, but the device is not equilibrated. • The detector gas flow is turned off.
Green, flashing	The detector prepares for operation. This comprises the following phases: <ul style="list-style-type: none"> • The detector performs the self-test. • The detector is warming up. <p>If you defined in the chromatography data system that the evaporation temperature must be within a specified temperature range, the evaporation temperature is not yet within this range. For details on the setting, see Important Operating Parameters (▶ page 104).</p> <ul style="list-style-type: none"> • The detector is equilibrating.
Green	The LED bar is green when both conditions apply: <ul style="list-style-type: none"> • The detector is equilibrated, but no data acquisition is running. • The detector gas flow and drain pump are turned on.
Blue, running	A data acquisition is running.
Blue	The LED bar is blue when both conditions apply: <ul style="list-style-type: none"> • An injection or sequence is running. • No data acquisition is running.
Red	A problem or error has occurred. For the related message, check the Instrument Audit Trail. For remedial action, see Troubleshooting (▶ page 155).

STATUS LED

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

STATUS LED	Description
Off (dark)	The power to the device is turned off.
Green	The device is functioning properly.
Red	A problem or error has occurred. For the related message, check the Instrument Audit Trail. For remedial action, see Troubleshooting (▶ page 155).

For information about the LED that is present next to the **GAS** button on the keypad, see [Keypad](#) (▶ page 89).

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.

Upon power up, the detector performs a self-test. If the self-test is not successful, the status indicators are red and the detector is not ready for analysis. Check the Instrument Audit Trail for the related message and take appropriate remedial action.

After the self-test, a warm-up phase follows. During this phase, the detector monitors the temperature of the internal components.

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*.
 - *Before connecting the charged aerosol detector to the system flow path:* 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 the charged aerosol detector is connected in the system flow path:* Flush the detector only when the detector gas flow is turned on. Deliver pump flow to the detector for flushing (see below).
-
- Before operating the detector, verify the nebulizer gas pressure setting. Set the nebulizer gas pressure as specified on the nebulizer certificate. Follow the instructions in [Setting the Nebulizer Gas Pressure and the Nebulizer Serial Number](#) (▶ page 101).
 - To deliver pump flow to the charged aerosol detector, follow these steps:
 - a) Turn on the detector gas flow. See [Turning On/Off the Detector Gas Flow](#) (▶ page 102). The pump flow must be turned off. Wait at least 5 minutes before you continue.
 - b) In Chromeleon, set the pump flow rate limit to the maximum flow rate specified for the charged aerosol detector.
 - c) Turn on the pump flow to the detector. Have the pump deliver flow to the detector.
 - Verify that any air bubbles are completely flushed out of the system flow path.

Before Starting Sample Analysis

Before starting an analysis:

- Check the liquid level in the solvent reservoirs. Verify that the amount of solvent is sufficient for the analysis.
- Close the doors of all modules in the Vanquish system, if not already done.
- Make sure that the pump flow rate that is delivered to the charged aerosol detector is within the specified range. See [Performance Specifications](#) (▶ page 170).
- To deliver pump flow to the charged aerosol detector, follow these steps:
 - a) Turn on the detector gas flow. See [Turning On/Off the Detector Gas Flow](#) (▶ page 102). The pump flow must be turned off. Wait at least 5 minutes before you continue.
 - b) Turn on the pump flow to the detector. Have the pump deliver flow to the detector.
- Make sure that the chromatography system is properly equilibrated (see further down).

System Equilibration

System equilibration should include the following operations:

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

- Monitoring the detector signal and checking whether the detector signal is stable so that the drift and signal noise are within reasonable limits for the application
- Performing an autozero of the detector baseline

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

6.6 Mobile Phase Guidelines for the Detector

Observe the guidelines in the following sections for mobile phase use with the charged aerosol detector:



CAUTION—Explosion Hazard or Damage to the Detector

When using tetrahydrofuran (THF), the use of air as supplied gas may pose an explosion hazard. This can pose a safety and health risk and damage the detector.

Always use nitrogen with tetrahydrofuran or other highly combustible solvents.

NOTICE

Inappropriate or contaminated mobile phase can damage the detector. The quality of the mobile phase significantly influences the performance of the detector. Observe the following guidelines to avoid damage to the detector.

6.6.1 General Guidelines

- Use only volatile mobile phases. All constituents, i.e. solvents and additives, of the mobile phase should be sufficiently volatile to allow evaporation under the conditions used.
- Non-volatile solutes in the mobile phase, even at trace amounts, produce a detector signal (background current, noise, drift). Minimize their concentration.

TIP A careful consideration in the selection of the mobile phase components will be helpful in minimizing the baseline noise and optimizing the performance during analysis.

- Consider other possible sources of mobile phase and eluent contamination.
Examples: Labware, pH electrodes, columns and system components
In many cases, it is preferable to use materials dedicated for use only with volatile mobile phases.
- NP solvents: NP solvents are highly soluble in the gas and might condensate in the gas exhaust tubing.

6.6.2 Mobile Phase Selection

Minimizing non-volatile matter in the mobile phase

NOTICE

Long-term exposure of the detector to non-volatile mobile phases will damage the detector. Do not use non-volatile buffers.

Observe the following guidelines to minimize the concentration of non-volatile matter in the mobile phase:

- Prepare all mobile phases with volatile solvents. As a general rule, use solvents that are at least as volatile as water, that is lower boiling point and higher vapor pressure.
- Use ultra-pure water with high resistivity and low total organic carbon obtained fresh from a thoroughly flushed and well-maintained point-of-use purification system.

TIP Bottled water and stagnant water from a purification system typically contain a higher level of non-volatile impurities than freshly obtained ultra-pure water.

- Choose solvents that are specified to have low residue after evaporation.
For example, LC/MS-grade solvents typically have a lower residue after evaporation specification than HPLC-grade solvents and are often the better choice to achieve consistently low baseline noise.

TIP Many organic solvents have low viscosity, low surface tension and high volatility, which lead to a high mass transport efficiency within the detector. For such solvents, it is especially recommended to select a grade with lowest residue after evaporation.

- If a particular solvent causes high background current or noise, try a different grade or vendor.
- Most HPLC-grade or better solvents are pre-filtered and additional filtration may increase the concentration of impurities within the mobile phase. It is therefore recommended to only filter the aqueous buffer salt portion of a mobile phase.

TIP With solvent gradients, non-volatile impurities in the more polar solvent (for example, water in reversed-phase) can be concentrated on the column and elute later to produce large peaks or baseline artifacts.

- With highly combustible mobile phases, such as tetrahydrofuran (THF) and other ethers or ketones, use only nitrogen as supply gas.
- *When changing the operating mobile phase:* Make sure that the solvents are miscible and will not cause precipitation of buffer salts. If required, use an appropriate intermediate solvent.

TIP Keep this in mind particularly when switching between chromatographic methods.

- Water or highly aqueous (< 5% organic modifier) mobile phases are highly susceptible to microbial growth. Prepare such mobile phases freshly on a daily basis.
- Select an optimal evaporation temperature to selectively evaporate background components of the mobile phase. Observe the guidelines in [Evaporation Temperature](#) (▶ page 110).
- If the detector is inadvertently exposed to a non-volatile mobile phase, use water or appropriate solvent with no additives to remove the salts from the detector.

Typical compatible solvents for use with the detector

- Water
 - Methanol
 - Isopropanol
 - Acetonitrile
 - Acetone
 - Methylene chloride
 - Hexane
 - Chloroform
 - Tetrahydrofuran
- NOTE:** Use THF with nitrogen gas only.

6.6.3 Mobile Phase Delivery System

- The pump should deliver continuous flow and at the same time ensure the intermixing of solvents from different reservoirs, if applicable.
- The mobile phase reservoirs should be clean borosilicate glass that is dedicated for use with volatile mobile phases. In some applications, however, it may be necessary to use plastic reservoirs, for example when using extreme pH aqueous eluents (such as > pH 12).

- Consider the pump flow rate limit of the detector when preparing analysis. Operate the detector only within the allowed pump flow rate range.
- It is recommended to use online degassers for HPLC systems with the detector. Make sure to thoroughly flush any degasser channel that has been exposed to non-volatile buffers. In some cases, it may be necessary to dedicate degasser channels to only use volatile mobile phases.

6.6.4 Additives

General Guidelines for Additives

- Use only high-purity volatile additives for the mobile phase, such as pH modifiers, buffer salts and ion pairing reagents.
- Choose the grade of additives that has the lowest concentration of non-volatile impurities. Common impurities are iron, copper, sodium and potassium.
- Avoid using non-volatile additives, such as citrate, phosphate, potassium, sodium, sulfonic acids and Tris.
- Use the lowest concentration of non-volatile additive required to achieve the desired chromatographic performance.
- Make sure that the mobile phase pH is within the allowed range of the detector: 2-12. More importantly, make sure that the mobile phase pH is well within the operating range of the LC column and the system.

TIP Many columns will exhibit bleed, which refers to the release of non-volatile impurities into the eluent, if operated near the extremes of their pH range. For most silica-based columns, the pH range is 2 to 8.

Overview of typical additives and buffers for use with the detector

Additive/Buffer	pKa	Buffer range	Recommended max. concentration	pH at max. concentration in water
Acetic acid	4.76	3.8 – 5.8	0.3% v/v	3
Ammonium acetate	4.76	3.8 – 5.8	10 mM	
Ammonium bicarbonate	7.8, 9.8, 10.3	7 – 11	10 mM	

Additive/Buffer	pKa	Buffer range	Recommended max. concentration	pH at max. concentration in water
Ammonium formate	3.75	2.8 – 4.8	10 mM	
Formic acid	3.75	2.8 – 4.8	0.3% v/v	2.5
Trifluoroacetic acid (TFA)	0.3	--	0.1% v/v	1.9

- Acetic acid (AA) and especially formic acid (FA) are recommended as primary choices of acidic modifier for use with the detector. They are relatively volatile and the pH at typical concentrations is well within the compatibility range of most columns.
- Trifluoroacetic acid (TFA) is frequently used as acidic modifier with the detector. However, as indicated in the table above, the pH of 0.1% v/v TFA is beyond the range of many columns. Use a lower concentration, if possible, to minimize column bleed.
- TFA and other perfluorocarboxylic acids, such as heptafluorobutyric acid (HFBA), can function both as acidic modifiers and anionic ion pairing reagents. These additives are less volatile than AA and FA and will more readily form non-volatile salts with other additives or sample components. If you use these additives, do not use basic additives, such as ammonium salts or amines.
- TFA is known to be unstable after exposure to air. Single-use ampoules of TFA are therefore recommended if choosing this additive.
- If using cationic ion pairing reagents, such as TEA, practice the same precautions as with anionic pairing reagents to avoid formation of non-volatile salts with other additives and to stay within the range of column and detector pH compatibility.
- AA and FA and their corresponding ammonium salts are recommended as primary choices to control pH within the above indicated buffer range.
- Ammonium bicarbonate may be used to control pH at higher levels but requires use of an elevated evaporation temperature, such as 50 °C. Although the buffer range extends to pH 11, make sure to keep the pH below the detector maximum of 12. More importantly, make sure to keep the pH well below the compatibility range of your column.
- If using a pH electrode to adjust buffer pH, only do so in aqueous solutions without organic modifiers. Always make pH measurements in separate aliquots of the aqueous solution to avoid cross-contaminating the mobile phase buffers with non-volatile salts from the pH electrode calibrations.

6.7 Setting the Nebulizer Gas Pressure and the Nebulizer Serial Number

Before operating the detector, verify the nebulizer gas pressure setting and the nebulizer serial number.

NOTICE

Operating the nebulizer with a gas pressure other than the pressure specified for this nebulizer can cause unpredictable deviations in performance of the nebulizer and the detector. After installation of the nebulizer, set the nebulizer gas pressure to the pressure that is specified for your nebulizer. The nebulizer gas pressure is defined on the gas pressure certificate that is shipped with the nebulizer.

1. In Chromeleon, open the **Command** window. Navigate to the **Gas Regulator Pressure Nominal** parameter.
2. Check if the gas pressure on the nebulizer certificate matches the nebulizer gas pressure set in the **Gas Regulator Pressure Nominal** parameter.
If the nebulizer gas pressure deviates from the pressure on the nebulizer certificate, enter the gas pressure from the nebulizer certificate.
3. Check whether the nebulizer serial number on the nebulizer certificate matches the nebulizer serial number set in the **Nebulizer Serial Number** parameter.
If the nebulizer serial number deviates from the serial number on the nebulizer certificate, enter the serial number from the nebulizer certificate.
4. Close the **Command** window.
5. Monitor the **Gas Regulator Pressure** until it reaches the setpoint.

6.8 Turning On/Off the Detector Gas Flow

Follow the instructions in this section to turn on or turn off the detector gas flow.



CAUTION—Escaping Gas

Gas can escape from open gas connections when the detector gas flow and/or the gas supply is turned on. The escaping gas can pose a health and safety risk.

- Make sure that the detector gas flow and the gas supply are turned off before you remove the nebulizer, disconnect the gas tubes or remove the gas filter assembly from the detector.
- Turn on the gas supply and detector gas flow only when the nebulizer is installed, the components in the gas flow path are properly connected, and the protective cover of the gas filter assembly is installed.

NOTICE—Detector Gas Flow and Pump Flow

Improper handling of detector gas flow and pump flow start and stop can damage the detector. Observe the respective order of steps:

- *To start detector gas flow and pump flow:* Turn on the detector gas flow first, wait at least 5 minutes and only then turn on the pump flow.
- *To stop pump flow and detector gas flow:* Turn off the pump flow first, wait at least 5 minutes and only then turn off the detector gas flow. During the waiting period, the drain pump drains any remaining mobile phase to waste.

Turning On the Detector Gas Flow

1. Make sure that you observe the site requirements for the gas supply. See [Gas Supply Requirements](#) (▶ page 52).
2. Make sure that the following prerequisites are met:
 - ◆ The nebulizer is installed.
 - ◆ The components in the gas flow path are properly connected.
 - ◆ The protective cover of the gas filter assembly is installed.
3. Turn on the gas supply to the detector. Observe the *Gas specifications* for the gas supply pressure. See [Performance Specifications](#) (▶ page 170).

4. Turn on the gas flow in the detector using the **GAS** button on the keypad of the detector or using the chromatography data system.
5. Close the detector doors.
6. Wait at least 5 minutes and only then turn on the pump flow, if needed.

Turning Off the Detector Gas Flow

This procedure depends on whether the pump flow is on.

Pump flow is off	Pump flow is on
Turn off the gas flow in the detector using the GAS button on the keypad of the detector or using the chromatography data system.	<ol style="list-style-type: none">1. Turn off the pump flow.2. Wait at least 5 minutes and only then turn off the detector gas flow using the GAS button on the keypad of the detector or using the chromatography data system.

6.9 Important Operating Parameters

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

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

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

Signal channels

The signal channels are available for the detector in the **Instrument Configuration Manager**.

Parameters	Description
Background current	Records and monitors the background current of the detector during data acquisition without autozero or filter constant applied. As a standard, the detector measures the current in pA . For further information, see Signal Channels (▶ page 109).
CAD_1	The CAD_1 signal channel is available for data acquisition. As a standard, the detector measures the current in pA .
Evaporation tube temperature	Records and monitors the actual temperature of the evaporation tube during data acquisition. The temperature is recorded in °C as a default. For further information, see Signal Channels (▶ page 109).
Gas regulator pressure	Records and monitors the nebulizer pressure during data acquisition. The default unit setting for the gas pressure corresponds to the Pressure Unit that is defined on the detector configuration pages in the Chromeleon software. For further information, see Signal Channels (▶ page 109).

Gas parameters

The default unit setting for the gas pressure corresponds to the **Pressure Unit** that is defined on the detector configuration pages in the Chromeleon software.

Parameters	Description
Gas regulation mode	<p>Sets a specific nebulizer gas pressure for the analysis, based on the gas pressure specified for the nebulizer from the nebulizer certificate.</p> <p>As a standard, the Analytical mode is set.</p> <p><i>For VH-D20 detector only:</i></p> <p>Two modes for regulating the nebulizer gas pressure in the detector are available: Analytical mode and MicroLC mode.</p> <p>For details on the gas regulation modes, see Gas Regulation Mode (VH-D20 Detector only) (▶ page 112).</p>
Gas regulator pressure nominal	<p>Specifies the nebulizer gas pressure as specified on the certificate that was shipped with the nebulizer.</p> <p>Observe the notes in Setting the Nebulizer Gas Pressure and the Nebulizer Serial Number (▶ page 101).</p>
Gas regulator pressure	<p>Displays the actual pressure of the gas supplied to the nebulizer.</p> <p>After you have set the nebulizer gas pressure, monitor the GasRegPressure parameter until it reaches the setpoint.</p>
Gas state	<p>Turns the detector gas flow On or Off.</p> <p>Observe the notes in Turning On/Off the Detector Gas Flow (▶ page 102).</p>

Evaporation temperature parameters

Parameters	Description
Evaporator temperature control	<p>Temperature control for the evaporation tube is enabled as a standard when the detector is shipped.</p>
Evaporator temperature nominal	<p>Specifies the setpoint for the evaporation temperature.</p> <p>As a standard, the Evaporator Temperature Nominal is set to 35 °C.</p> <p>For further information, see Evaporation Temperature (▶ page 110).</p>
Evaporator temperature	<p>Displays the actual temperature of the evaporation tube.</p> <p>The actual temperature depends on several factors, including mobile phase composition and temperature, pump flow rate, gas temperature, and ambient temperature.</p> <p>As a standard, the temperature unit is °C.</p>

Other parameters

Parameters	Description
Autozero	Performs an automatic null balancing. The current detector signal is interpreted as 0 at the current range in use.
Data collection rate	Defines the number of data points per second (Hz) that the Chromeleon software collects from the detector and stores as raw data. For further information, see Data Collection Rate and Filter Constant (▶ page 108).
Filter constant	Applies a filter constant to the output current to electronically reduce the baseline noise during the analysis. For further information, see Data Collection Rate and Filter Constant (▶ page 108).
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	Defines the width of a chromatographic peak at the half of the peak height. Specify a peak width for the narrowest expected peak in your chromatogram. As a standard, when you set the Peak Width , Chromeleon automatically calculates values for the Data Collection Rate and the Filter Constant .
Power function	Sets by what factor a linearization is applied to the data output. As a standard, the Power Function is set to 1.00 . For further information, see Power Function Value (▶ page 112).

6.10 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.

6.10.1 General Guidelines

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

- Monitor the usage of specific device components that are subject to wear and stress and schedule appropriate maintenance intervals (see [Predictive Performance](#) (► page 127)).
- Consider the influences of the parameters on the detection. See [Overview of Optimization Parameters](#) (► page 108).
- 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
 - ◆ Stable backpressure and correct waste line setup
- Degas the solvent in the Vanquish pump.
- For guidelines and recommendations on the use of mobile phases with the charged aerosol detector, see [Mobile Phase Guidelines for the Detector](#) (► page 96).
- Maintain the nitrogen or air source for your detector at regular intervals to ensure optimum performance. Observe the instructions in the *User Documentation for the nitrogen generator*.
- Use a dedicated column for each specific analysis to avoid cross-contamination of the column.
- Do not use a column that has been used with non-volatile mobile phases.
- Columns that are unstable and/or have a tendency to release particles from the column bed (i.e. "column bleed") will produce noise in the detector. Avoid such columns.
- When the mobile phase was stored over a period of time, high background current may be observed. Replace old mobile phase with freshly prepared mobile phase.
- If you use the detector for the analysis of complex biological samples, proper sample preparation is especially important.
- If you perform a gradient, it is recommended to perform blank injections with the desired method gradient profile prior to analysis. This "pre-conditioning" of the column improves the performance of both, the analytical column and the detector.

6.10.2 Overview of Optimization Parameters

The following table serves as an overview of parameters that influence the performance of the detector during data acquisition.

Parameter	Affects
Filter constant	Sensitivity, baseline noise
Evaporation temperature	Baseline noise, background current
Power function value	Linear range
Data collection rate	Peak resolution, disk space, possibly baseline noise

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

6.10.3 Data Collection Rate and Filter Constant

The Chromeleon software automatically calculates the best data collection rate and filter constant, based on the value you enter for the peak width in the Instrument Method Wizard.

If you want to select a different data collection rate and filter constant, note the guidelines below.

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).
- Consider also the filter constant when setting the data collection rate. Set the two parameters together in order to optimize the amount of data points collected, and reduce short-term noise, while still maintaining peak height, symmetry, and resolution. See below.

Filter Constant

The filter constant is applied to the output current to electronically reduce the baseline noise during the analysis.

When setting a filter constant, observe the following:

- A small filter constant, such as 0.2 seconds, removes little baseline noise.
- A large filter constant, such as 10.0 seconds, smoothes the baseline significantly.

6.10.4 Signal Channels

The following signal channels are available for the detector:

CAD_1

The signal channel is available for data acquisition.

Background current

- The signal channel displays the background current of the detector during data acquisition without autozero or filter constant applied.
- It is recommended to always record the background current signal channel.
- If a problem occurs, the information from the signal channel can provide helpful information to identify and eliminate the source for the problem.

Gas regulator pressure

- The signal channel records and monitors the nebulizer gas pressure during data acquisition.
- It is recommended to record the signal channel for troubleshooting purposes.
- For proper gas pressure regulation, or if baseline noise or poor precision occurs, the information from the signal channel can provide helpful information to identify and eliminate the source for the problem.

Evaporation tube temperature

- The signal channel records and monitors the actual temperature of the evaporation tube during data acquisition.
- It is recommended to always record the evaporation temperature signal channel for troubleshooting purposes.
- If a problem occurs, the information from the signal channel can provide helpful information to identify and eliminate the source for the problem.

6.10.5 Evaporation Temperature

The temperature-controlled evaporation tube dries the aerosol droplets that come from the spray chamber. The evaporation tube evaporates the more volatile components in the mobile phase to produce dried particles composed of non-volatile analyte and background residue.

The efficiency of the drying procedure depends on the set temperature. Additional factors, such as the mobile phase composition, the pump flow rate and the sample composition, also play an important role.

Note the following when selecting an evaporation temperature:

- As a standard, the **Evaporator Temperature Nominal** is set to 35 °C.
- When selecting a different evaporation temperature, observe the evaporation temperature specification for the detector. See [Performance Specifications](#) (► page 170).
- Changes in the evaporation temperature affect the response of the detector.
- When the temperature was changed, the evaporation tube requires time to equilibrate. The **Wait For Temp Ready** parameter makes sure that the detector is only ready for analysis when the evaporation tube is equilibrated.
If the parameter is disabled, it is recommended to wait approximately 30 minutes before you start sample analysis.

How to optimize the evaporation temperature

- Perform three or more injections of a reference standard for the analytical method for which you want to optimize the evaporation temperature.
- Use a different evaporation temperature setting for each reference injection, ranging from low to high temperature. Select the most appropriate setting as starting point. See the *Guidelines for selecting the evaporation temperature* below.

TIP Using performance metrics such as the precision and sensitivity of the detector can help to receive the optimal evaporation temperature.

Guidelines for selecting the evaporation temperature

The following guidelines are recommended for selecting an optimal evaporation temperature:

- In general, use the lowest evaporation temperature within the specified temperature range that provides acceptable limits of sensitivity.
- As a starting point, use an evaporation temperature of 35 °C.
- Higher evaporation temperature settings can be used when analytes of interest have low volatility, relative to the background. Since the volatility of background residue is typically unknown, experimentation is required for optimizing this parameter for a given method.
- Perform screening runs at two evaporation temperature settings.
 - ◆ VH-D20 detector: Use a minimum of two evaporation temperatures. Typically, 35 °C and 40 °C are appropriate if the temperature range is unknown. If required, perform additional tests in a maximum of 5 °C increments.
 - ◆ VF-D20 detector: Use two evaporation temperatures, depending on whether the temperature range is known. If the temperature range is unknown, 35 °C and 50 °C are an appropriate starting point for screening runs.
- Consider that higher evaporation temperature settings may inadvertently reduce response for low-analyte levels, even if they are considered as non-volatile analytes.
- Remember to check the limits of sensitivity by actual analysis of low-level standards. Also, check the analyte signal reproducibility at each evaporation temperature setting.
- For detection of semi-volatile analytes, you can use lower evaporation temperature settings. However, this may lead to higher background levels and noise.

NOTICE

Do not use non-volatile modifiers, such as sodium phosphate. Observe the mobile phase guidelines in this manual. See [Mobile Phase Guidelines for the Detector](#) (► page 96).

6.10.6 Gas Regulation Mode (VH-D20 Detector only)

This section applies only to the VH-D20 detector.

The detector provides two gas regulation modes to optimize the efficiency of the nebulizer: Analytical mode and MicroLC mode. Each mode sets a specific nebulizer gas pressure for the analysis, based on the gas pressure specified for the nebulizer from the nebulizer certificate.

To select the gas regulation mode for your application, note the following:

- Analytical mode*
- The pressure for the gas regulator is set to the nebulizer gas pressure setting as defined on the nebulizer certificate.
 - For use with high pump flow rates within the pump flow range allowed for the detector

This mode is set as a default in Chromeleon.

- MicroLC mode*
- The nebulizer gas pressure setting is automatically reduced by a fixed fraction of the nebulizer pressure.
 - This mode optimizes the nebulizer gas pressure for certain pump flow rates and certain types of mobile phase compositions.
 - For use with very low pump flow rates within the pump flow range allowed for the detector

TIP The resulting nebulizer gas pressure will be below the gas pressure specified in the nebulizer certificate (for example, below 55 psi or 3.8 bar or 379 kPa).

6.10.7 Power Function Value

The signal of the detector has a wide dynamic range with over four orders of magnitude. The nature of the response is inherently nonlinear.

The *Power Function Value* (PFV) applies a power transformation to the data output of the detector. Power transformations can improve the linearity of response over a given range of interest.

The transformation is applied to the data output in real time. The data output is raised to the selected power.

As a standard, the **Power Function** is set to 1.00. For most applications and compounds, this is a good universal setting.

Guidelines for selecting a power function value

To optimize the power function value, observe the following guidelines:

- An optimal power function value improves the linearity of response over a given range of interest.
- Selecting the optimal value depends primarily on the analysis conditions and the desired range of quantitation.

6.10.8 Baseline Noise

Baseline noise can originate from many factors. To minimize the baseline noise, observe the following:

- The quality of the mobile phase has a major impact on the performance of the detector. Only use mobile phases of the highest quality available. Keep impurities and contaminants to a minimum. Observe the mobile phase guidelines in this manual. See [Mobile Phase Guidelines for the Detector](#) (▶ page 96).
- Flush the system modules at regular intervals to remove any non-volatile residues from the mobile phase, if applicable.
- Follow the maintenance schedules to keep the system modules in optimum performance state.
- Keep the supplied gas in optimum quality for the detector.

6.11 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*.

6.11.1 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.

6.11.2 Long-Term Shutdown

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

NOTICE

Observe the following to avoid damage to the charged aerosol detector:

- Always flush the detector with an appropriate pure solvent before interrupting operation. Follow the steps below.
- Avoid leaving the detector exposed to highly acidic or basic mobile phases for long periods.
- If the detector was operated with organic solvents in high concentration that may form peroxides upon evaporation, such as un-stabilized tetrahydrofuran or isopropanol, flush the detector with LC/MS-grade water before shutdown.

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

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

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

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

Make sure that residual sample components, impurities from the column or buffers are completely removed from the detector.

TIP As an intermediate solvent, you can use 100% methanol to flush the charged aerosol detector.

3. Turn off the pump flow and then the gas flow:
 - a) Turn off the pump flow to the detector.
 - b) Wait at least 30 minutes. During the waiting period, the detector drains any remaining mobile phase to waste.

NOTICE—Damage to the detector

Turning off the gas flow too early may result in condensation and, thus, to deterioration of detector parts and/or flooding.

Wait for at least 30 minutes before you turn off the gas flow to the detector.

- c) Turn off the gas flow on the detector.
- d) Wait until the system pressure is down to zero before you continue.
- e) Turn off the gas supply to the detector.

4. The step depends as follows:

Situation	Steps
Device and all other system modules remain in the system stack and are to be turned off	Turn off the system with the system power button on the system base.
Device shall be transported or shipped after shutdown	If one of the modules shall be removed from the system stack, turn off <i>all</i> system modules with their main power switch. Pressing the system power button will not be sufficient to turn off the power to the devices completely. Follow the instructions in Transporting or Shipping the Device (▶ page 145).

6.11.3 Restart after Long-Term Shutdown

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

1. Prepare and restart the other modules in the Vanquish system, following the instructions in the *Operating Manuals* for the modules. Pay special attention to the *Preparing the Device for Operation* section.
2. Flush the components in the flow path before the detector before you connect the detector to the system flow path.
3. Turn on the device. Observe the following:

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

4. Before starting an analysis, let the device equilibrate and be sure that it is ready for operation. See [Preparing the Device for Operation](#) (▶ page 93).

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 143).

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.

NOTICE—Detector Gas Flow and Pump Flow

Improper handling of detector gas flow and pump flow start and stop can damage the detector. Observe the respective order of steps:

- *To start detector gas flow and pump flow:* Turn on the detector gas flow first, wait at least 5 minutes and only then turn on the pump flow.
- *To stop pump flow and detector gas flow:* Turn off the pump flow first, wait at least 5 minutes and only then turn off the detector gas flow. During the waiting period, the drain pump drains any remaining mobile phase to waste.

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 145).

See also

- 📖 [Consumables and Replacement Parts](#) (▶ page 177)

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. Water or highly aqueous (< 5% organic modifier) mobile phases are highly susceptible to microbial growth. Prepare such mobile phases freshly on a daily basis.
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	<ul style="list-style-type: none"> 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 127)).

7.4.2 Flushing the Detector Between Analyses

Observe the following guidelines to prevent build-up or accumulation of residue from the mobile phase, sample matrix and analytes within the detector between the analyses. This helps maintain consistent response, optimum performance and reduced detector downtime:

- Periodically flush the detector with the detector gas flow being turned on. When using buffer solutions and other additives, it is recommended to flush the detector daily using compatible solvents that do not contain additives.
- Use the solvent with the best solubility characteristics for the sample matrix and analyte(s) of the analytical method in question.

- If flushing is done with a less polar solvent (for example, methanol instead of water) than used for your method, disconnect the detector from the system flow path first and flush the system to waste (for example, with 20 column volumes). Then reconnect the detector to the system flow path, turn on the gas flow and repeat the flushing.
- Use an evaporation temperature setting of 35 °C when flushing the detector.

To continue with an analysis, prepare the detector for analysis following the guidelines in [Preparing the Device for Operation](#) (▶ page 93).

7.4.3 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 with air.

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

NOTICE

Observe the following:

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

Preparations

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

Follow these steps

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

7.4.4 Predictive Performance

General Overview

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

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

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

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

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

Available Parameters for the Detector

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

- **FilterChanged**
If you have replaced the gas filter assembly, consider resetting this counter after replacement of the gas filter assembly.
- **QualificationDone**
- **ServiceDone**

7.5 Disconnecting the Gas Inlet and Exhaust Tubes



CAUTION—Escaping Gas

Gas can escape from open gas connections when the detector gas flow and/or the gas supply is turned on. The escaping gas can pose a health and safety risk.

- Make sure that the detector gas flow and the gas supply are turned off before you remove the nebulizer, disconnect the gas tubes or remove the gas filter assembly from the detector.
- Turn on the gas supply and detector gas flow only when the nebulizer is installed, the components in the gas flow path are properly connected, and the protective cover of the gas filter assembly is installed.

Parts and tools required

Only required if gas tubing is to be replaced

- For replacement of the gas inlet tubing:
 - ◆ Gas inlet elbow connector
 - ◆ Gas inlet tubing
- For replacement of the gas exhaust tubing:
 - ◆ Gas exhaust elbow connector
 - ◆ Gas exhaust tubing
- Tubing cutter (optional)

Preparations

1. Flush the detector with the detector gas flow being turned on. For recommendations on flushing the detector, see [Flushing the Detector Between Analyses](#) (▶ page 124).
2. Turn off the pump flow and then the gas flow:
 - a) Turn off the pump flow to the detector. Wait at least 5 minutes. During the waiting period, the detector drains any remaining mobile phase to waste.
 - b) Turn off the gas flow on the detector.
 - c) Wait until the system pressure is down to zero before you continue.
 - d) Turn off the gas supply to the detector.
3. Turn off the detector with the main power switch.

Follow these steps

On the gas port on the detector, disconnect the elbow connectors of the gas tubes from the port.

To re-install the gas tubes or install new gas tubes, follow the steps in [Connecting the Gas Inlet and Exhaust Tubes](#) (▶ page 68).

7.6 Disconnecting the Waste Line

Parts and tools required

- *If no new waste line is to be installed*
Seal plug for the waste outlet
- *If the waste line is to be replaced*
 - ◆ Replacement waste line
 - ◆ Tubing cutter (optional)

Preparations

1. Flush the detector with the detector gas flow being turned on. For recommendations on flushing the detector, see [Flushing the Detector Between Analyses](#) (▶ page 124).
2. Turn off the pump flow and then the gas flow:
 - a) Turn off the pump flow to the detector. Wait at least 5 minutes. During the waiting period, the detector drains any remaining mobile phase to waste.
 - b) Turn off the gas flow on the detector.
 - c) Wait until the system pressure is down to zero before you continue.
 - d) Turn off the gas supply to the detector.
3. Turn off the detector with the main power switch.

Follow these steps

1. On the waste outlet on the front of the detector, disconnect the waste line.
2. Proceed as required:

Situation	Steps
If no new waste line is to be installed	Close the waste outlet with the seal plug.
If the waste line is to be replaced	Follow the steps in Connecting the Waste Line (▶ page 75).

7.7 Removing the Nebulizer



CAUTION—Sharp Tip of the Nebulizer

The capillary inside the nebulizer that protrudes from the nebulizer tip is sharp and may be fragile. Touching the nebulizer capillary can cause personal injury and damage to the capillary.

- To avoid personal injury, always wear safety glasses when handling the nebulizer.
- Do not touch the nebulizer tip.
- Handle the nebulizer with care.



CAUTION—Escaping Gas

Gas can escape from open gas connections when the detector gas flow and/or the gas supply is turned on. The escaping gas can pose a health and safety risk.

- Make sure that the detector gas flow and the gas supply are turned off before you remove the nebulizer, disconnect the gas tubes or remove the gas filter assembly from the detector.
- Turn on the gas supply and detector gas flow only when the nebulizer is installed, the components in the gas flow path are properly connected, and the protective cover of the gas filter assembly is installed.

NOTICE

The nebulizer is highly sensitive to contamination. Even minute particles on the nebulizer can lead to contamination and poor detector performance. Always wear powder-free gloves when you install or remove the nebulizer.

Preparations

1. Flush the detector with the detector gas flow being turned on. For recommendations on flushing the detector, see [Flushing the Detector Between Analyses](#) (▶ page 124).
2. Turn off the pump flow and then the gas flow:
 - a) Turn off the pump flow to the detector. Wait at least 5 minutes. During the waiting period, the detector drains any remaining mobile phase to waste.
 - b) Turn off the gas flow on the detector.
 - c) Wait until the system pressure is down to zero before you continue.
 - d) Turn off the gas supply to the detector.
3. Turn off the detector with the main power switch.
4. Disconnect the inlet capillary from the nebulizer.

Follow these steps

1. Turn the nebulizer by 90 degrees counter-clockwise in the opening until it releases from the two locking points.
Mind the correct orientation of the nebulizer when it is unlocked:

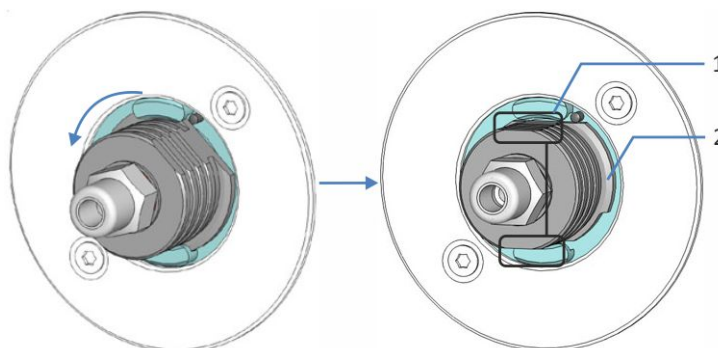


Figure 26: Unlocking the nebulizer

No.	Description
1	Gripping sides of the nebulizer on the top and bottom handle side
2	Protruding attachment locks of the nebulizer on the left and right handle side

2. Pull the nebulizer straight out of the nebulizer opening.

NOTICE

Avoid the nebulizer tip from touching the sides of the nebulizer opening, as this can damage the tip.

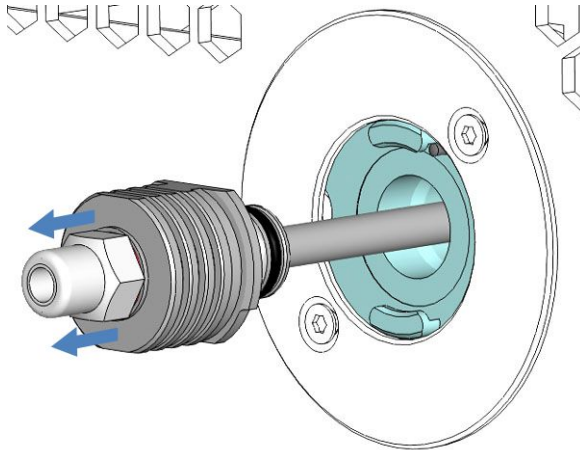


Figure 27: Removing the nebulizer

3. Install the dust seal plug to the opening for the nebulizer.
4. *If the nebulizer is to be transported:* Pack the nebulizer:
 - a) Carefully install the protective tubing to the nebulizer spray pipe. Do not touch the nebulizer tip with the protective tubing, as it can damage the tip.
 - b) Install the plug to the nebulizer flow inlet.



Figure 28: Nebulizer with protective tubing and plug on the flow inlet

- c) Pack the nebulizer in its original packaging that it was shipped in.

To re-install the nebulizer, follow the instructions in [Installing the Nebulizer](#) (► page 62).

7.8 Replacing the Gas Filter Assembly



CAUTION—Gas Filter Rupture upon Excessive Gas Supply Pressure

An excessive supply gas pressure can lead to an overpressure in the detector and can cause the gas filters to rupture. This can pose a health and safety risk.

- Turn on the gas supply only when the gas filters are properly connected to the detector and the protective cover is properly installed.
- Observe the gas supply pressure range that is specified for the detector. Do not exceed the maximum gas supply pressure.
- Before you start the replacement of the gas filter assembly, make sure that the gas supply and the detector gas flow are turned off.
- Observe the gas supply requirements. See [Gas Supply Requirements](#) (▶ page 52).



CAUTION—Escaping Gas

Gas can escape from open gas connections when the detector gas flow and/or the gas supply is turned on. The escaping gas can pose a health and safety risk.

- Make sure that the detector gas flow and the gas supply are turned off before you remove the nebulizer, disconnect the gas tubes or remove the gas filter assembly from the detector.
- Turn on the gas supply and detector gas flow only when the nebulizer is installed, the components in the gas flow path are properly connected, and the protective cover of the gas filter assembly is installed.

When

Interval for gas filter replacement has expired

Parts required

Gas filter assembly consisting of a charcoal gas filter and a HEPA gas filter

Tools required

Screwdriver, Torx T10

Preparations

1. Flush the detector with the detector gas flow being turned on. For recommendations on flushing the detector, see [Flushing the Detector Between Analyses](#) (▶ page 124).
2. Turn off the pump flow and then the gas flow:
 - a) Turn off the pump flow to the detector. Wait at least 5 minutes. During the waiting period, the detector drains any remaining mobile phase to waste.
 - b) Turn off the gas flow on the detector.
 - c) Wait until the system pressure is down to zero before you continue.
 - d) Turn off the gas supply to the detector.
3. Turn off the detector with the main power switch.

Follow these steps

1. With the screwdriver, loosen and remove the top screw on the protective cover for the gas filter assembly.

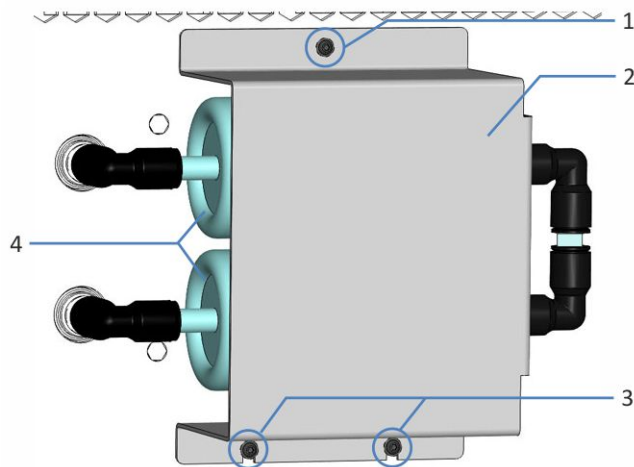


Figure 29: Gas filter assembly with protective cover

No.	Description
1	Top screw on protective cover
2	Protective cover
3	Bottom screws (slightly loosened)
4	Gas filters

2. Slightly loosen the two bottom screws on the protective cover. Leave the two screws attached loosely in the bores. Do not remove the screws.
3. Push the protective cover upward to release it from the two bottom screws (no. 1 in the image below). Lift the protective cover away from the front panel (no. 2 in the image below).

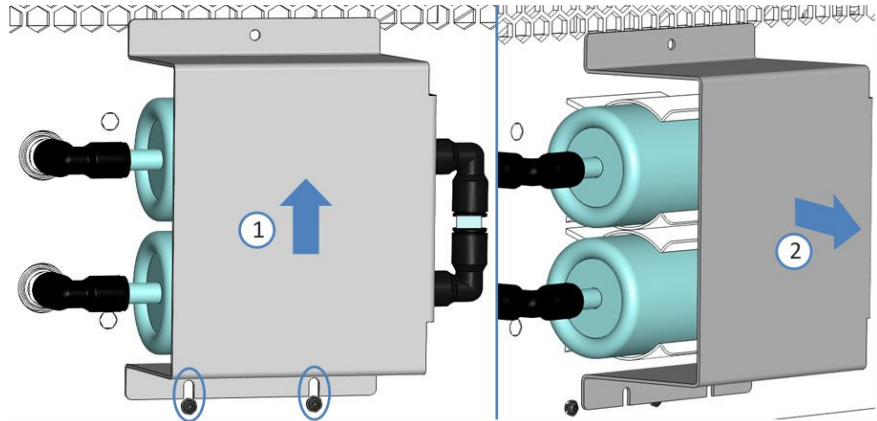


Figure 30: Removing the protective cover

The gas filters are uncovered now:

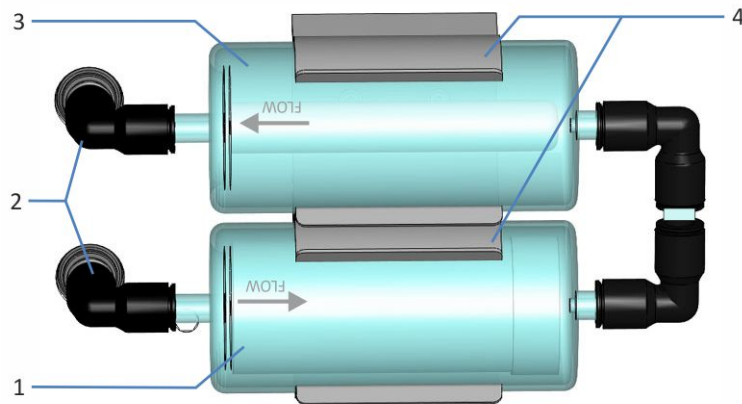


Figure 31: Gas filter assembly

No.	Description
1	Charcoal gas filter
2	Elbow fittings
3	HEPA gas filter
4	Gas filter clamps

4. Disconnect the gas filter assembly from the gas connectors on the detector:
 - a) On the two (push-in) elbow fittings on the detector gas connectors, push in the locking ring on each elbow fitting (no. 1 in the image below) and keep pushing it while performing the next step.
Leave the elbow fittings connected to the gas filter assembly.
 - b) Pull the two elbow fittings off from the gas connectors on the detector (no. 2 in the image below).

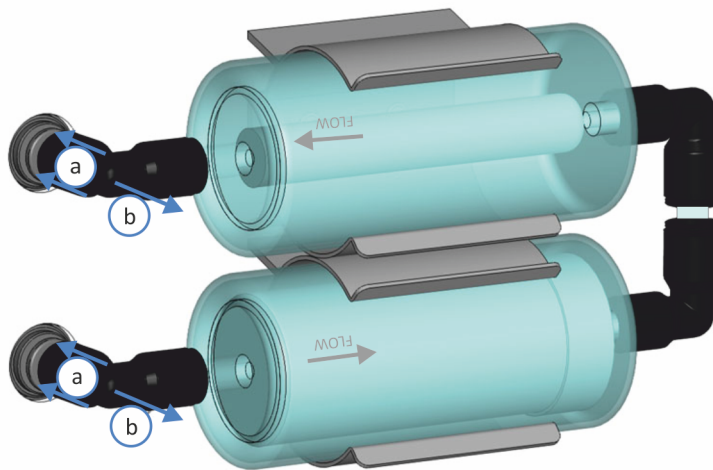


Figure 32: Unlocking an elbow fitting

5. Pull the gas filter assembly out of the clamps.

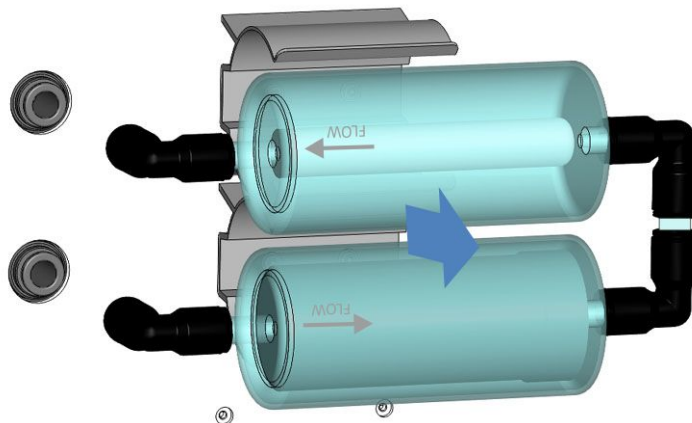


Figure 33: Pulling the gas filter assembly out of the clamps

6. With the new gas filter assembly, mind the correct orientation for the gas flow for installation. Observe the flow direction signs on the filters.
 - ◆ The bottom gas filter must be the charcoal gas filter (thick black inner filter cylinder; no. 2 in the image below).
 - ◆ The top gas filter must be the HEPA gas filter (thin white inner filter cylinder; no. 1 in the image below).
7. Push the new gas filter assembly into the clamps observing the orientation signs for the gas flow on the gas filters. See image below.

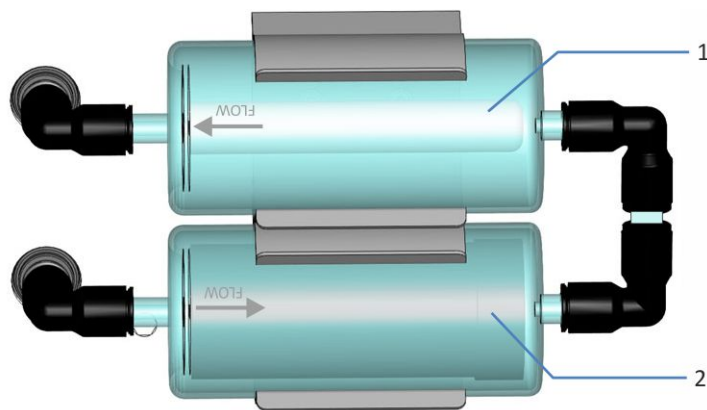


Figure 34: Correct orientation of the gas filter assembly

No.	Description
1	HEPA gas filter
2	Charcoal gas filter

8. Push the (push-in) elbow fittings into the gas connectors on the detector. Check that the connections are secure: Slightly pull on the fittings. If a fitting slides out, repeat this step.
9. Install the protective cover: Hold the protective cover onto the interior panel. Slide it downward carefully so that the bottom screws match the recesses.
10. With the screwdriver, tighten the three screws on the protective cover.
11. Turn on the detector with its main power switch.
12. In Chromeleon, consider updating the Predictive Performance information for the gas filter assembly.
13. Turn on the gas flow. See [Turning On/Off the Detector Gas Flow](#) (▶ page 102).

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.

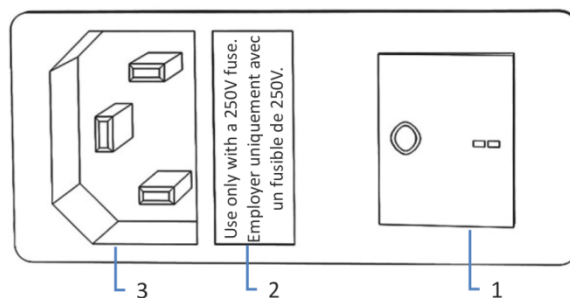


Figure 35: Fuse holder

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.

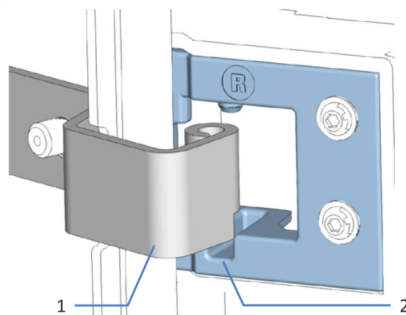


Figure 36: Unhinging a door

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 145).
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 146).
 - ◆ To ship the device, follow the instructions in [Shipping the Device](#) (▶ page 147).

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 115)).
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. Disconnect the gas inlet and exhaust tubes from the detector. See [Disconnecting the Gas Inlet and Exhaust Tubes](#) (▶ page 128).

5. Disconnect the waste line from the detector. See [Disconnecting the Waste Line](#) (▶ page 130).
6. Remove the nebulizer. See [Removing the Nebulizer](#) (▶ page 131).
7. 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 148)).

7.12.2 Transporting the Device to a New Location

Preparations

Prepare the device for transport. See [Preparing the Device for Transport](#) (▶ page 145).

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 93)).
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 145).



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—Damaged Gas Tubes and Compressed Gas

Trying to remove the slide-in module with the gas tubes being connected to the detector can damage the gas tubes and the connectors on the detector. Using damaged gas tubes with compressed air can pose health and safety risks.

Disconnect the gas tubes always before you remove the slide-in module from the enclosure.



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 145).

Follow these steps

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

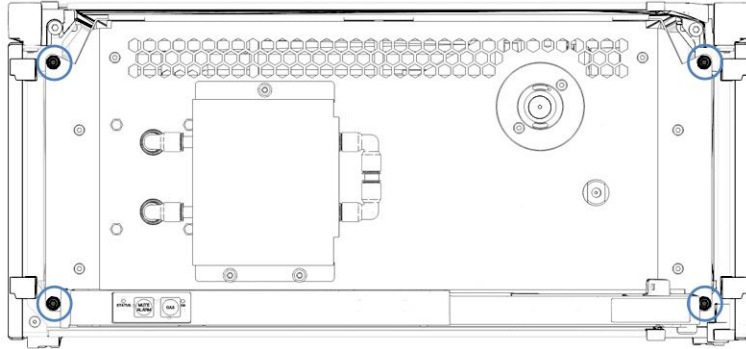


Figure 37: Captive screws on the slide-in module (doors not shown)

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 protective cover of the gas filter assembly, and pull the module out of the enclosure by approximately 10 cm.

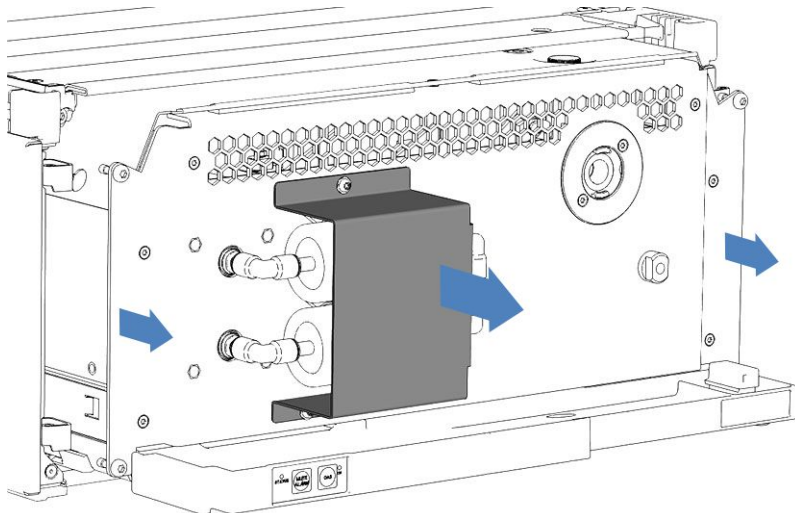


Figure 38: Pulling out the slide-in module (doors not shown)

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 148).

Follow these steps

1. Install the slide-in module to the enclosure of the replacement device. Follow the steps for inserting the slide-in module in the enclosure and tightening the captive screws in [Installing the Slide-In Module](#) (▶ page 151).
2. Follow the instructions in [Shipping the Device](#) (▶ page 147).

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 the enclosure. See [Removing the Slide-In Module](#) (▶ page 148).
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 125).
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.

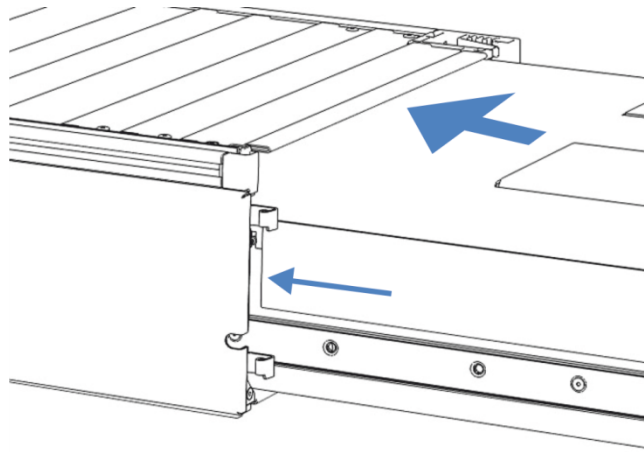


Figure 39: Inserting the slide-in module

4. To facilitate tightening the slide-in module in the enclosure, pull out the module approximately 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 93)).
 - 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.

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, 2023, is named 20230515.

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 may be preceded by an icon. The icon identifies the seriousness of the problem. For possible causes and remedial actions, see [Messages](#) (▶ page 158).

Troubleshooting Parameters

The following parameters provide helpful information for troubleshooting if a problem occurs in the charged aerosol detector:

Parameters	Description
Gas flow ratio	Displays the ratio of the nebulizer gas pressure to the charging gas pressure. As a standard, the Gas Flow Ratio is Normal . For troubleshooting information on the gas flow ratio, see Additional Device Operating Issues (▶ page 166).
Charger voltage	Displays the voltage applied to the corona needle to charge the (secondary) ion gas stream. Typical value ranges from 2.0 - 3.0 kV. If the value is outside of this range, contact Technical Support.
Charger current	Displays the current that is required to charge the (secondary) ion gas stream. Typical value ranges from 0.98 - 1.02 μ A. If the value is subject to fluctuations or outside of this range, contact Technical Support.

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	<p>xx = Two-digit to four-digit code number.</p> <p>When the message appears, write down the message code and turn off the module. Wait for 5 seconds and turn on the module again.</p> <p>TIP If the message appears with <i>code 103</i>, additional remedial actions are available. See further down this table.</p> <p>If the message appears again, contact Technical Support.</p>
Module malfunction detected. Code xx	<p>xx = two-digit to four-digit code number</p> <p>When the message appears, write down the message code. Turn off the module and contact Technical Support.</p> <p>Note: If the message appears with <i>code 6008</i>, the detector gas flow and the pump flow are automatically stopped. The drain pump remains turned on for a short period longer and is then turned off. Turn the detector off and on. If the message appears again, contact Technical Support.</p>
Code 33 Leak detected – eliminate within approx. xx seconds.	<p>xx = the number of seconds within the leak must be resolved</p> <p>Find and eliminate the source for the leakage (see Resolving Liquid Leaks (▶ page 163)).</p>
Code 34 Leak detected.	<p>Find and eliminate the source for the leakage (see Resolving Liquid Leaks (▶ page 163)).</p>
Code 36 Download failed.	<p>The firmware download has not been successful. Verify that the correct firmware file was selected. Repeat the download.</p>

Message and Code	Description and Remedial Action
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 or defective.	Contact Thermo Fisher Scientific Technical Support for assistance. To operate the device nevertheless, you can disable the leak sensor functionality in the chromatography data system by setting Leak Sensor Mode to Disabled .
Code 90 Download firmware mismatch – invalid version.	You tried to download an incompatible firmware with an earlier version number than the firmware that is currently installed in the module. Downgrading the firmware may result in loss of functionality or malfunctioning of the module. If required, repeat the download with a firmware version later than the version currently installed in the module.
Code 103 Unexpected module behavior – limited features available.	The firmware may be defective or a firmware downgrade has been performed. Update the firmware to the current revision. See Updating the Device Firmware (► page 141).
Code 118 USB Buffer Overflow.	This is a software problem. The module produces data faster than the computer on which the chromatography data system is running can process the data. 1. In the chromatography data system, disconnect and reconnect the module. 2. If this does not solve the problem, update the firmware or the chromatography data system version. 3. If the problem persists: Also, third-party software on the computer, for example, virus scanners or poor computer performance can cause the problem. Contact the onsite IT department.
Code 120 System interlink request timed out.	Communication with the module failed. The module did not respond in time. For the module for which the message appears: 1. Turn on the module if it is not yet turned on. 2. Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. 3. If the message persists, replace the system interlink cables.
Code 126 Device lost system interlink connection.	All other modules on the system interlink bus are turned off or a firmware download is performed on all other modules. 1. Check whether all other modules have been turned off or a firmware download is performed on all other modules on the bus. 2. Wait until one of the modules on the bus is turned on or the firmware download is complete. 3. A system interlink cable may be disconnected from the module or is defective. Check the system interlink connections to the module. Verify that all system interlink cables are connected at both ends. 4. If the message persists, replace the system interlink cables.

Message and Code	Description and Remedial Action
Code 128 System interlink data errors.	<p>A system interlink cable may be disconnected from the module or defective.</p> <ol style="list-style-type: none"> 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.	<p>X = serial number</p> <p>The module with the given serial number may be disconnected, turned off or a firmware update is running.</p> <ol style="list-style-type: none"> 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.	<p>A system interlink cable may be disconnected from the module or defective.</p> <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 6006 Unexpected module behavior.	<p>The ion trap voltage is too low. Liquid may be present in the ion trap. The voltage may have been shorted due to detector flooding.</p> <p>The detector gas flow and the drain pump are automatically turned on and the pump flow is stopped.</p> <p><i>To resolve the problem:</i></p> <p>Make sure that the gas flow and drain pump are turned on. Check that liquid flows out of the waste line. Keep in mind that liquid may not be seen leaving the detector for certain mobile phases with high volatility or with low flow rates. Resolve the flooding.</p> <p>See Resolving Flooding In the Detector (▶ page 165).</p>
Code 6007 Gas flow too low.	<p>The gas flow ratio is below the specified range for more than 60 seconds.</p> <p>The detector gas flow and the pump flow are automatically stopped. The drain pump remains turned on for a short period longer and is then turned off.</p> <p><i>To resolve the problem:</i></p> <ul style="list-style-type: none"> • Make sure that gas is still supplied to the detector. Check that the gas supply pressure is within the allowed range. Observe the gas specifications for the detector. • Check that the nebulizer pressure is set as specified on the nebulizer gas pressure certificate. • Turn the detector off and on. Check the self-test results. • Check the Gas Flow Ratio. The value should be within the allowed range. <p>If the message persists, contact Technical Support.</p>
Code 6008 Module malfunction detected.	<p>The detector gas flow and the pump flow are automatically stopped. The drain pump remains turned on for a short period longer and is then turned off. Turn the detector off and on. If the message appears again, contact Technical Support.</p>

Message and Code	Description and Remedial Action
Code 6009 Nebulizer gas pressure too low.	<p>The nebulizer gas pressure has dropped below the minimum limit. The detector gas flow and the pump flow are automatically stopped. The drain pump remains turned on for a short period longer and is then turned off.</p> <ul style="list-style-type: none"> • Make sure that gas is still supplied to the detector. Check that the gas supply pressure is within the allowed range. Observe the gas specifications for the detector. • Check that the nebulizer gas pressure is set as specified on the nebulizer gas pressure certificate. • Check the gas inlet tubing and gas filter assembly for signs of gas leakage and proper connection to the detector. Turn on gas flow and check for any unusual noise. • Turn the detector off and on. Check the self-test results. • Turn the gas flow off and on to check that the internal gas solenoid valve functions properly. <p>If the message persists, contact Technical Support.</p>
Code 6010 Nebulizer gas pressure too high.	<p>The nebulizer gas pressure has exceeded the maximum limit. The detector gas flow and the pump flow are automatically stopped. The drain pump remains turned on for a short period longer and is then turned off.</p> <p><i>To resolve the problem:</i></p> <ul style="list-style-type: none"> • Make sure that gas is still supplied to the detector. Check that the gas supply pressure is within the allowed range. Observe the gas specifications for the detector. • If the gas supply pressure exceeds 620 kPa (6.2 bar, 90 psi), the overpressure relief valve will open. This creates a loud hissing sound. To remedy the gas supply overpressure, see Resolving Gas Supply Overpressure (▶ page 164). • Check that the nebulizer gas pressure is set as specified on the nebulizer gas pressure certificate. • Check the gas inlet tubing and gas filter assembly for proper connection to the detector. • Turn the detector off and on. Check the self-test results. <p>If the message persists, contact Technical Support.</p>
Code 6011 Detection chamber flooded. Stop pump immediately.	<p>Excess liquid is present inside the detector.</p> <p>The detector gas flow and the drain pump are automatically turned on and the pump flow is stopped.</p> <p>See Resolving Flooding In the Detector (▶ page 165).</p>
Code 6029 Filter interval expired.	<p>The allowed interval for the next gas filter replacement has expired.</p> <p>Replace the gas filter assembly. See Replacing the Gas Filter Assembly (▶ page 134).</p>
Code 6030 Filter interval warning – XX days remaining.	<p>The allowed interval for the next gas filter replacement will expire after the stated amount of days. Consider replacing the gas filter assembly. See Replacing the Gas Filter Assembly (▶ page 134).</p>

Message and Code	Description and Remedial Action
Code 6031 Data transfer error from detector to PC – check USB connection.	Check the USB connection. Test the transmission speed of the data source (the network may be too slow).
Code 6032 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.

8.3 Operating Issues

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

8.3.1 Resolving Liquid Leaks

When

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

Parts and additional items required

- Replacement part as required
- Cloth or tissue

Preparations

When resolving leakage, observe the safety guidelines and general rules for maintenance and service as presented in [Maintenance and Service](#) (▶ page 119).

Follow these steps

1. Locate the source of the leak.

Location of the leak	Steps
Flow connection	<ol style="list-style-type: none"> 1. As leakage usually occurs at a connection, visually inspect all components and connections in the flow path. 2. Tighten or replace the connection or component as required. 3. Proceed with the steps below.
Nebulizer	<p>If liquid is visible on the nebulizer, leakage may have occurred in the nebulizer.</p> <ol style="list-style-type: none"> 1. Remove the nebulizer from the detector (see Removing the Nebulizer (▶ page 131)). 2. Inspect the nebulizer for signs of leakage. 3. If no signs for leakage are present, re-install the nebulizer (see Installing the Nebulizer (▶ page 62)). 4. If signs of leakage are present, tighten or replace the connection or component as required. 5. Proceed with the steps below.

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

8.3.2 Resolving Gas Supply Overpressure



CAUTION—Excessive Gas Supply Pressure

An improper or excessive gas supply pressure can lead to an overpressure in the detector that can cause the safety valve in the detector to release gas. In extreme cases, the excessive pressure can cause the gas filters to rupture. This can pose a health and safety risk.

- Observe the gas supply pressure range that is specified for the detector. Do not exceed the maximum gas supply pressure.
- If you use high-pressure gas cylinders as gas supply, double-check the regulator outlet pressure to ensure that it is within the gas supply specifications of the detector. This is especially important when attaching the gas bottle for the first time and when changing gas bottles.
- If the overpressure relief valve is releasing gas as a result of an overpressure in the detector during operation, turn off the detector immediately. Remedy the situation as described in [Resolving Gas Supply Overpressure](#) (► page 164).

When

The gas supply pressure has exceeded 620 kPa (6.2 bar, 90 psi). The detector cannot pressurize properly.

The overpressure relief valve on the gas inlet inside the detector will open and release gas pressure to prevent damage to the detector. This creates a loud hissing sound.

Follow these steps

To remedy the situation, follow these steps:

1. Turn off the pump flow and then the gas flow:
 - a) Turn off the pump flow to the detector. Wait at least 5 minutes. During the waiting period, the detector drains any remaining mobile phase to waste.
 - b) Turn off the gas flow on the detector.
 - c) Wait until the system pressure is down to zero before you continue.
 - d) Turn off the gas supply to the detector.
2. Check that the gas supply pressure is within the allowed range. For the allowed range, see [Performance Specifications](#) (► page 170).

3. On the gas supply, turn on the gas flow to the detector. Follow the instructions depending on the situation:

Situation	Steps
The gas supply pressure has fallen within the allowed range. The overpressure relief valve will remain closed.	<ol style="list-style-type: none"> 1. Turn on the gas flow in the detector. See Turning On/Off the Detector Gas Flow (▶ page 102). 2. Check that the nebulizer gas pressure reading has returned to the allowed range: In Chromeleon, check the Gas Regulator Pressure parameter. 3. If the problem persists, check if the gas pressure on the nebulizer certificate matches the nebulizer gas pressure set in the Gas Regulator Pressure Nominal parameter. If not, adapt it to the value given on the nebulizer certificate. Check whether the Gas Regulator Pressure parameter has returned to the allowed range. 4. If the problem persists, contact Thermo Fisher Scientific Technical Support for assistance.
The overpressure relief valve is still open and releasing gas while the gas flow in the detector is turned off	If the problem persists, contact Thermo Fisher Scientific Technical Support for assistance.

8.3.3 Resolving Flooding In the Detector

When

The liquid sensor inside the detector detected a build-up of excess liquid (flooding) inside the detector.

A related message appears in the Audit Trail. See [Messages](#) (▶ page 158).

Follow these steps

1. Leave the detector gas flow turned on to dry the excess liquid. The period for leaving the gas flow turned on depends on the severity of the excess liquid that has built up:
 - ◆ If the flooding is minor, the liquid may evaporate when leaving on gas flow overnight.
 - ◆ If the flooding is major, leave the gas flow turned on for 24 hours.

- If the message has disappeared, turn the detector gas flow off and on. Check the following indicators:

Situation	Steps
If the status indicators are no longer red and the message in the Instrument Audit Trail no longer appears	The excess liquid build-up is removed. Resume operation.
If the status indicators are still red and the message in the Instrument Audit Trail still appears	Write down the code and wording of the message, and contact Thermo Fisher Scientific Technical Support for assistance.

8.3.4 Additional Device Operating Issues

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

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

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

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

Baseline noise and/or poor precision

Possible Cause	Remedial Action
Change in background current	If the Background_Current signal channel is changing, this can indicate a contamination in the flow path of the system. Make sure that all components in the liquid flow path are free from contamination.
Unstable gas regulator pressure	If the GasReg_Pressure signal channel shows an instability in the nebulizer gas pressure, this can lead to baseline noise and/or poor precision. Check that the gas supply pressure is stable. If the instability remains, contact Technical Support.
Unstable evaporation temperature	If the Evap_Tube_Temp signal channel is unstable, this can lead to higher baseline noise and/or poor precision. Contact Technical Support.

High/low gas flow ratio

Possible Cause	Remedial Action
Clogging in the detector	Contact Technical Support.
Gas leak	Check the Audit Trail for the respective message. See Messages (▶ page 158).

High backpressure

Possible Cause	Remedial Action
Nebulizer nozzle/ capillary clogged	<p>Poor solubility of analyte during nebulization/analyte build-up. Check the backpressure of the nebulizer:</p> <ol style="list-style-type: none"> 1. Remove the nebulizer from the detector. See Removing the Nebulizer (▶ page 131). 2. Set up a direct flow connection from the pump to the nebulizer. Make sure no other module is connected in between. 3. Carefully flow liquid through the nebulizer capillary from the pump. The backpressure of the nebulizer is typically below 10 bars. Liquid should exit the capillary in drops. If the backpressure rises in the pump, then a blockage is present in the nebulizer capillary. Contact Technical Support. <p>To avoid blockage in the nebulizer, always use the detector with an appropriate mobile-phase composition to maintain solubility.</p>

Negative peaks

Possible Cause	Remedial Action
Wrong polarization of the analog output	Contact Technical Support.

Loss of response

Possible Cause	Remedial Action
Change in parameters	Check that the detector is turned on and the data acquisition is on. Check the parameter settings.
Drain pump failed	Check whether you can hear the drain pump running. If not, the drain pump may be defective. Contact Technical Support.
Gas flow turned off	Check that the gas flow is turned on in the detector and the gas supply.
Reduced gas flow	<ul style="list-style-type: none"> • Make sure that the gas is flowing into the detector. • Check the nebulizer gas pressure and the gas supply pressure. • Check gas filter assembly. If necessary, replace the gas filter assembly. See Replacing the Gas Filter Assembly (▶ page 134).
Gas leaking	Check the gas connections and the gas inlet and exhaust tubes. Remedy the gas leak and/or replace the gas tubes (see Disconnecting the Gas Inlet and Exhaust Tubes (▶ page 128)).

Inability to autozero the signal

Possible Cause	Remedial Action
Autozero on a peak or void signal	The Autozero occurred on a relatively flat section of the chromatogram.
Autozero on a very noisy signal	Reduce the noise or increase the current range.

Liquid in the gas exhaust

Possible Cause	Remedial Action
Flooding inside the detector (pump flow turned on while no gas flow present)	Flooding can occur if the detector is turned off while liquid is still flowing into the detector. See Resolving Flooding In the Detector (► page 165).

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

The detector performance is specified as follows:

Type	Specification	
	VH-D20	VF-D20
Detection type	Charged aerosol detection	
Nebulization	FocusJet, concentric	
Pump flow rate	0.01 – 2.0 mL/min	0.2 – 2.0 mL/min
Evaporation temperature	Adjustable range: ambient +5 to +100°C	Selectable temperatures: +35°C, +50°C, +70°C
Data collection rate	Adjustable, 2.0 Hz – 200 Hz	Adjustable, 2.0 Hz – 100 Hz
Filter response time	Digital filter, selectable in numerical sequence (1-2-5 increments)	
Digital filter constants	Selectable between 0.1, 0.2, 0.5, 1.0, 2.0, 3.6, 5.0 10.0 seconds	
Dynamic range	Up to 4 orders of magnitude	
Gas pressure control	Electronically controlled	
Supply gas	Compressed air or nitrogen	
Gas supply pressure	482 - 551 kPa (4.8 - 5.5 bar, 70 - 80 psi)	
USB	1 USB port (USB 2.0, "B" type connector) 1 USB hub with 3 ports (USB 2.0, "A" type connectors)	
System Interlink	2 system interlink ports (RJ45-8 connectors)	
Analog output	Installable option; 1 BNC-type analog output connector	
Full-scale analog output range	1 pA to 500 pA in 1-2-5 sequence	
Analog signal output	0 – 1 V DC	
Control	Chromeleon 7 The detector can be operated also with other data systems. For details, contact the Thermo Fisher Scientific sales organization. Keypad with 2 buttons for performing certain functions directly from the detector	
Materials in the flow path	Stainless steel (type 316), SimRiz™ NOTICE For information about the chemical resistance of materials refer to the technical literature.	
Solvent and additive information	See Solvent and Additive Information (▶ page 27).	

Type	Specification	
	VH-D20	VF-D20
Safety features	<ul style="list-style-type: none"> • Overpressure relief valve on gas inlet • Liquid detection inside the detector and safe leak handling • Detection of high evaporation temperatures • Pump flow shutdown • Leak detection and safe leak handling 	
Good Laboratory Practice (GLP) features	<p>Predictive Performance functions for scheduling maintenance procedures based on the actual operating and usage conditions of the detector.</p> <p>This includes monitoring of the replacement interval for the gas filter assembly and the service interval.</p> <p>All system parameters are logged in the Chromeleon Audit Trail.</p>	

9.2 Physical Specifications

The physical conditions of the device are specified as follows:

Type	Specification
Range of use	Indoor use only
Ambient operating temperature	5 °C - 35 °C
Ambient storage temperature	-20 °C - 45 °C
Ambient operating humidity	20% - 80% relative humidity (non-condensing)
Ambient storage humidity	Maximum 60% relative humidity (non-condensing)
Operating altitude	Maximum 2000 m above sea level
Pollution degree	2
Power requirements	100 – 240 V AC, ± 10 %; 50/60 Hz; max. 150 W / 255 VA
Overvoltage category	II
Emission sound pressure level	typically < 50 dB(A)
Dimensions (height x width x depth)	19.2 x 42 x 62 cm
Weight	Approx. 18 kg

10 Accessories, Consumables and Replacement Parts

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

10.1 General Information

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

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

10.2 Ship Kit

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

Ship kit

Item	Quantity in shipment
Tubing adapter, inch to metric, OD 1/4"	1
Tubing cutter	1
Tubing kit, including: <ul style="list-style-type: none"> • Gas inlet elbow connector • Gas inlet tubing • Gas exhaust elbow connector • Gas exhaust tubing • Waste line 	1
Viper Capillary, I.D. x length 0.1 mm x 350 mm	1
System interlink cable	1
USB cable, USB 2.0, high-speed, type A to type B, 1 m	1
Tubing bracket	1

For reordering information, see [Consumables and Replacement Parts](#) (▶ page 177).

10.3 Optional Accessories

Item	Part No.
Corona nitrogen generator 1010 Provides on-demand, uninterrupted supply of dry nitrogen from a compressed air source.	6295.0200
Corona air compressor 230 V Supplies the required amount of air pressure for operation of the detector.	6295.0300
Corona air compressor 110 V Supplies the required amount of air pressure for operation of the detector.	6295.0350
Analog signal output kit Includes all components required for installation of an analog signal output to the detector. Installation must be performed by a Thermo Fisher Scientific service engineer.	Contact Service.

10.4 Consumables and Replacement Parts

Capillaries, tubing and tubing tools

Description	Part No.
Viper Capillary, I.D. x length 0.13 mm x 350 mm	6040.2335
Viper union	6040.2304
Tubing cutter	70-7112

For system capillaries, refer to the *Vanquish System Operating Manual*.

Gas components and nebulizer

Description	Part No.
Gas filter assembly kit, consisting of charcoal gas filter and HEPA gas filter	6081.7062
Nebulizer, stainless steel	6081.1247

Miscellaneous

Description	Part No.
Front door kit, including right door and left door	6036.1920
Torx screwdriver kit, containing screwdrivers Torx T10 and T20	6040.0010
Fuses kit, Vanquish system The kit includes the appropriate fuses for the Vanquish system modules. For the detector, use only 3.15 AT, 250 V AC, slow-blow fuses.	6036.0002

Interface cables

Description	Part No.
System interlink cable (RJ45), 0.5 m	6036.0004
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 1 m	6035.9035A
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 5 m	6911.0002A

Power cords

Description	Part No.
Power cord, Australia	6000.1060
Power cord, China	6000.1080
Power cord, Denmark	6000.1070
Power cord, EU	6000.1000

Description	Part No.
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.

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 40: WEEE symbol

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

11.1.3 FCC Compliance

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

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

11.1.4 Manual Release History

Revision	Covering
3.0	VH-D20, VF-D20
2.1	VH-D20, VF-D20
2.0a	VH-D20, VF-D20
2.0	VH-D20, VF-D20
1.1	VH-D20

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

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