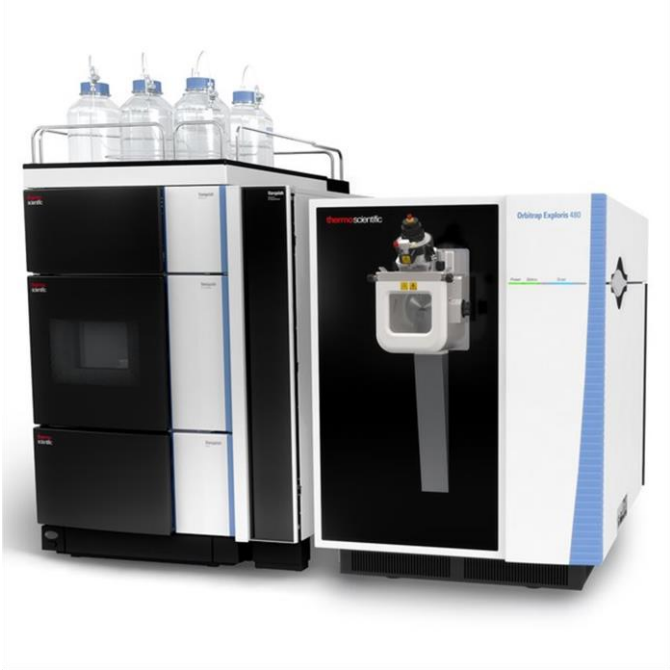

Vanquish

MS Connection Kit for Vanquish UHPLC Systems

Quick Installation Guide

4820.0405 Revision 5.0 • June 2021

thermo scientific

Trademarks

MP35N is a registered trademark of SPS Technologies. PEEK is a trademark of Victrex PLC.

All other trademarks are property of Thermo Fisher Scientific Inc. and its subsidiaries.

Release history

Revision 5.0, released in June 2021.

Revision 4.0, released in March 2019.

Revision 3.0, released in October 2016.

Revision 2.0, released in May 2016.

Revision 1.0, released in November 2014.

The hardware descriptions in this manual revision refer to the following systems: Thermo Scientific™ Vanquish™ Horizon UHPLC System (151 MPa); Thermo Scientific™ Vanquish™ Flex Binary UHPLC System, Thermo Scientific™ Vanquish™ Flex Quaternary UHPLC System (103 MPa), Thermo Scientific™ Vanquish™ Core Binary UHPLC System, Thermo Scientific™ Vanquish™ Core Quaternary UHPLC System (70 MPa).

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Contents

1 Using this Manual

This chapter provides information about this manual and the conventions used throughout the manual.

1.1 About this Manual

This Quick Installation Guide describes how to assemble and connect a dedicated Thermo Scientific™ Vanquish™ UHPLC system with Thermo Scientific mass spectrometers, namely the following instrument families:

- Orbitrap Exactive Mass Spectrometers:

  Exactive™ Plus, Q Exactive™, Q Exactive™ Plus, Q Exactive™ HF.

- Orbitrap Exploris Mass Spectrometers:

  Orbitrap™ Exploris™ 120 MS, Orbitrap™ Exploris™ 240 MS, Orbitrap™ Exploris™ 480 MS.

- Orbitrap Tribrid Mass Spectrometers:

  Orbitrap™ ID-X™ Tribrid MS, Orbitrap™ Fusion™ Lumos™ Tribrid MS, Orbitrap™ Eclipse™ Tribrid MS.

- Linear Ion Trap Mass Spectrometers:

  LTQ XL™

- Triple Quadupole Mass Spectrometers:

  TSQ Fortis™, TSQ Endura™, TSQ Quantis™, TSQ Altis™.

Other combinations might be feasible, but are not supported by this MS Connection Kit. Any use of this kit with instruments others than those listed above is the user's liability. It is assumed that the individual using this manual has sufficient training in the use of Vanquish system, and is aware of the potential hazards including (but not limited to) electrical hazards, chemical solvent hazards, exposure to UV radiation, and exposure to pressurized solvents.

The layout of this manual is designed to provide quick reference to the sections of interest. However, a review of the individual module manuals is recommended to obtain a full understanding of the LC/MS installation and to operate the instruments properly.

The descriptions in this manual refer to a standard one-stack Vanquish system configuration. Not all descriptions necessarily apply to your particular system.

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 system 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 system.

The MS Connection Kits include all components required for the connection (e.g., Thermo Scientific Viper™ fingertight fitting systems and other components), Quick Installation Guide, and installation media for drivers and software interface to run Vanquish out of various Thermo Scientific mass spectrometry programs.

2 Introduction

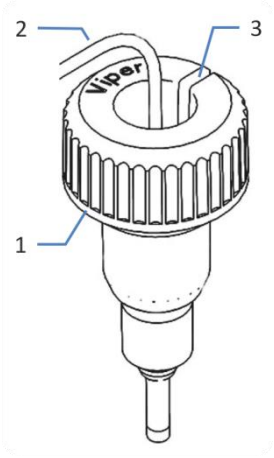
This chapter provides general information about Viper Capillaries.

2.1 Connecting Viper Capillaries

The connection kit is based on the use of the Thermo Scientific Viper™ fitting system.

The Viper capillaries in the kit are made of biocompatible materials (MP35N® or PEEK™).

All Viper flow connections in the Vanquish system are designed to be finger-tight.



No.	Description
1	Knurl
2	Capillary
3	Slot

Figure 1: Viper fitting with knurl

To connect Viper capillaries, follow these steps:

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

1) Insert the Viper capillary into the connection port.

2) Tighten the connection by the knurl.

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

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

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.

3 MS Connection Kit for Vanquish UHPLC Systems

This chapter provides information about the kit content.

3.1 Introduction

This Vanquish MS Connection Kit is designed for quick and easy installation of a Vanquish system front-end to mass spectrometers from Thermo Scientific. It combines all capillaries, cabling and software with quickly accessible information resources for a seamless integration of a Vanquish system with or without optical detection, with or without Charger.

Thermo Scientific recommends individual configurations for the different mass spectrometer types to optimize all fluidic connections for shortest distances between the outlet of the UHPLC column, or of the detector flow cell, and the ion source inlet of the mass spectrometer. Thereby, the unique Viper capillaries provide zero-dead volume connections by design, ensuring best MS detection results of the Ultra-High Performance LC separation.

3.2 Scope of delivery

Table 1. Scope of delivery for 6720.0405 - MS Connection Kit for Vanquish

Description	Quantity	Spare part P/N
Viper capillary (MP35N®), ID x L 0.10 mm/0.004'' x 350 mm	1 pc.	6042.2340
Viper capillary (MP35N®), ID x L 0.10 mm/0.004'' x 550 mm	1 pc.	6042.2360
Viper capillary (MP35N®), ID x L 0.10 mm/0.004'' x 750 mm	1 pc.	6042.2390
Viper capillary (MP35N®), ID x L 0.10 mm/0.004'' x 950 mm	1 pc.	6042.2395
Viper capillary (MP35N®), ID x L 0.13 mm/0.005'' x 750 mm	1 pc.	6042.2373
nanoViper capillary (fused-silica), ID x L 0.15 mm/0.006'' x 1100 mm	1 pc.	6041.5828
Viper Union	1 pc.	6040.2304
Capillary holder	6 pc.	-
SII for Xcalibur software package	1 pc.	7200.0088
Digital I/O signal cable Vanquish, 5 m	1 pc.	6036.0006
Viper Installation and Operation Guide	1 pc.	-
Quick Installation Guide	1 pc.	4820.0405

NOTICE Each module of a Vanquish system comes with a Ship Kit. Viper capillaries from those kits might be required to plumb certain LC/MS combinations.

3.3 Installation procedure

1) Place and stack the Vanquish modules and then plumb the system. The Vanquish modules and the mass spectrometer determine how the fluidic connection is realized. For each Vanquish configuration, MS connections with Vanquish beside and in front of the mass spectrometer are supported.

   a) For Orbitrap Exactive Mass Spectrometers, see pages 21 and 29.

   b) For Orbitrap Exploris, Orbitrap Tribrid, Ion Trap, and Triple Quadrupole Mass Spectrometers, see pages 39 and 48.

2) Make the electrical connections for synchronizing the Vanquish system and the mass spectrometer:

   a) For Orbitrap Exactive and Exploris Mass Spectrometers, see page 35.

   b) For Triple Quadrupole Mass Spectrometers, see page 53.

   c) For Ion Trap and Orbitrap Tribrid Mass Spectrometers, see page 55.

3) Install the software on the control PC of the mass spectrometer.

   a) Instructions are on the setup CD.

4 Installation of Vanquish System with Exactive Mass Spectrometers

This chapter describes how to connect a Vanquish system with or without optical detector and with or without Charger to Exactive mass spectrometers.

4.1 Introduction

This section describes how to connect a Vanquish system with or without optical detector, with or without Charger to the following mass spectrometers:

- Orbitrap Exactive Mass Spectrometers:

  Exactive™ Plus, Q Exactive™, Q Exactive™ Plus, Q Exactive™ HF.

NOTICE Before turning on the power to the Vanquish modules or connecting them to the control PC by a USB cable, install the software package. Only then, the USB hardware drivers for the Vanquish system will be installed correctly.

Thermo Scientific recommends individual configurations for the different mass spectrometer types to optimize all fluidic connections for shortest distances between the outlet of the UHPLC column, or of the detector flow cell, and the ion source inlet of the mass spectrometer. Thereby, the unique Viper capillaries provide zero-dead volume connections by design, ensuring best MS detection results of the Ultra-High Performance LC separation.

4.2 Setting with Vanquish System beside the Mass Spectrometer

4.2.1 MS Connection to a Vanquish System

1) Place the Vanquish system approx. 8-10 cm / 3-4'' right to the Exactive mass spectrometer. Make sure that there is enough space between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as show below and make all fluidic connections using Viper capillaries, according to Figure 2. Use the capillary holders where needed. The picture illustrates the course of the flexible Viper capillaries in general. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed. Please note, the capillaries and the Viper union form the autosampler to the column need to be installed inside the pump module. Table 2 provides a detailed overview on the capillaries used and where to find them.

Table 2. Detailed description of capillary connections for Vanquish-Exactive MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Viper Union	0.10 mm/0.004'' x 350 mm MP35N®	MS Connection kit
Viper Union		MS Connection kit
Viper Union - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - MS ion source inlet	0.10 mm/0.004'' x 550 mm MP35N®	MS Connection kit

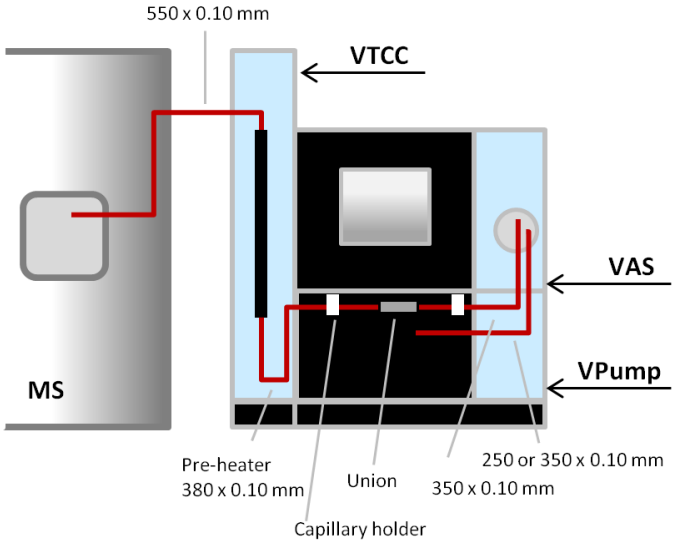


Figure 2. Setup for a Vanquish system as front-end for Exactive mass spectrometers.

NOTICE In order to install the Vanquish Column Compartment H on the left side, a dedicated Vanquish Column Compartment Conversion Kit (6732.0007, Conversion kit, VH/VC-C) is required and must be ordered separately.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

4.2.2 MS Connection to a Vanquish System with Optical Detector

1) Place the Vanquish system approx. 8-10 cm / 3-4'' right to the Exactive mass spectrometer. Make sure that there is enough space between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 3. The picture illustrates the course of the flexible Viper capillaries in general. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed. Table 3 provides a detailed overview on the capillaries used and where to find them.

Table 3. Detailed description of capillary connections for Vanquish-Exactive MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - optical cell inlet	0.10 mm/0.004'' x 300 mm MP35N®, insulated or 0.10 mm/0.004'' x 250 mm MP35N®, post-column cooler	Viper capillary kit, Vanquish system
Detector cell outlet - MS ion source inlet	0.10 mm/0.004'' x 750 mm MP35N® 0.13 mm/0.005'' x 750 mm MP35N®	MS Connection kit

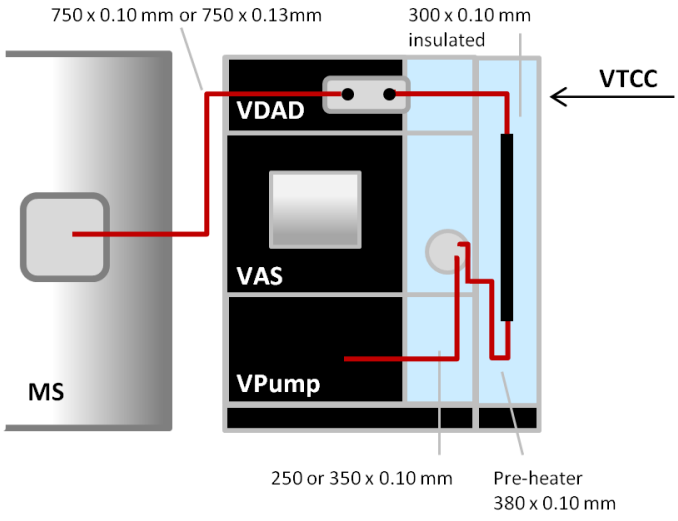


Figure 3. Setup for a Vanquish system with optical detector as front-end for Exactive mass spectrometers.

NOTICE The LightPipe™ flow cell is highly sensitive, with a pressure limit of 60 bar (870 psi). In order to avoid damage of the cell, do NOT exceed this pressure limit throughout your entire analysis. Connect the capillary from the flow cell directly to the MS source. The selection of the connection capillary between the flow cell outlet and the MS source inlet is dependent on the pressure generated by the mobile phase. For mobile phases comprising mixture of water/acetonitrile delivered at a flow rate up to 0.4 mL/min or water/methanol up to 0.3 mL/min, use the connection capillary 0.10 mm/0.004'' x 750 mm MP35N®. These mobile phases are intended with and without the presence of additives and delivered in gradient as well as in isocratic mode in all the possible solvent ratios.
For all the other applications at higher flow rates, use the connection capillary 0.13 mm/0.005'' x 750 mm MP35N®.

NOTICE Install the **Overpressure Relief Valve** to protect pressure sensitive flow cells (e.g. VH-D10 detector flow cells, VF-D5x detector flow cells). 60-bar variant (P/N 6083.9260): For LightPipe™ flow cells of the Vanquish Horizon Diode Array Detector (VH‑D10). This variant opens at a pressure of 60 bar. 40-bar variant (P/N 6079.9240): For the Mirco flow cell of the Vanquish Flex Fluorescence Detector (VF‑D5x). This variant opens at a pressure of 40 bar.
The overpressure relief valve is not intended to be used as pressure controller that is permanently open and that limits the pressure permanently to 40/60 bar.
For further information on the installation, refer to the Overpressure Relief Valve - Operation Manual (P/N 4820.8313)

NOTICE With Vanquish systems including a detector with LightPipe™ flow cell, always use post-column cooling for separations at more than 50 °C to reduce the temperature of the liquid leaving the column to values below 50 °C. Higher temperatures will damage the flow cell.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

4.2.3 MS Connection to a Vanquish System with Charger

1) Place the Vanquish system approx. 8-10 cm / 3-4'' left to the Exactive mass spectrometer. Make sure that there is enough space between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 4. The picture illustrates the course of the flexible Viper capillaries in general. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed. Table 4 provides a detailed overview on the capillaries used and where to find them.

Table 4. Detailed description of capillary connections for Vanquish-Exactive MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - MS ion source inlet	0.10 mm/0.004'' x 950 mm MP35N®	MS Connection kit

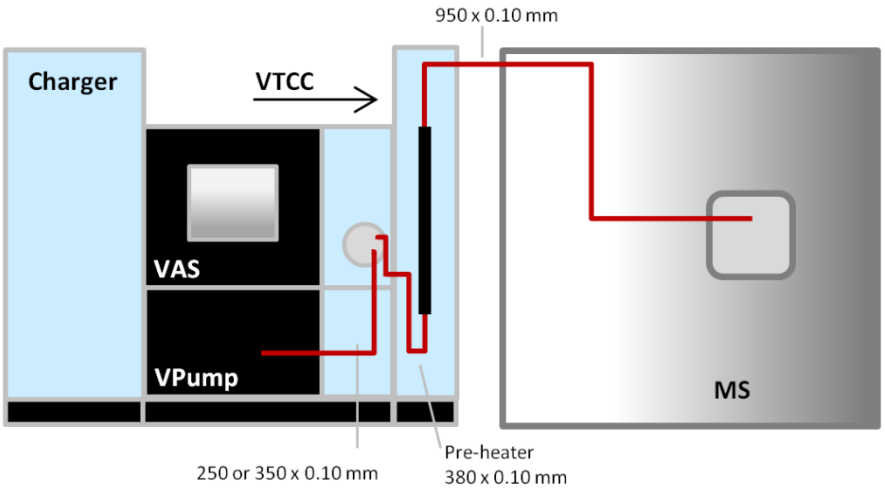


Figure 4. Setup for a Vanquish system with a Charger as front-end for Exactive mass spectrometers.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

4.2.4 MS Connection to a Vanquish System with Optical Detector and Charger

1) Place the Vanquish system approx. 8-10 cm / 3-4'' right to the Exactive mass spectrometer. Make sure that there is enough space between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 5. Use the capillary holders where needed. The picture illustrates the course of the flexible Viper capillaries in general. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed.

Table 5 provides a detailed overview on the capillaries used and where to find them.

Table 5. Detailed description of capillary connections for Vanquish-Exactive MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - Detector cell inlet	0.10 mm/0.004'' x 300 mm MP35N®, insulated or 0.10 mm/0.004'' x 250 mm MP35N®, post-column cooler	Viper capillary kit, Vanquish system
Detector cell outlet - MS ion source inlet	0.15 mm/0.006'' x 1100 mm PEEK™	MS Connection kit

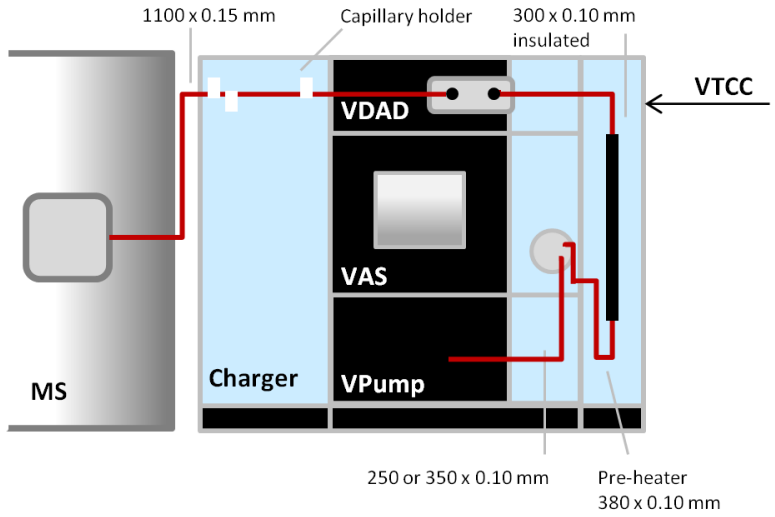


Figure 5. Setup for a Vanquish system with optical detector and Charger as front-end for Exactive mass spectrometers.

NOTICE The LightPipe™ flow cell is highly sensitive, with a pressure limit of 60 bar (870 psi). In order to avoid damage of the cell, do NOT exceed this pressure limit throughout your entire analysis. Connect the capillary from the flow cell directly to the MS source. The selection of the connection capillary between the flow cell outlet and the MS source inlet is dependent on the pressure generated by the mobile phase. For

mobile phases comprising mixture of water/acetonitrile delivered at a flow rate up to 0.4 mL/min or water/methanol up to 0.3 mL/min, use the connection capillary 0.10 mm/0.004'' x 750 mm MP35N®. These mobile phases are intended with and without the presence of additives and delivered in gradient as well as in isocratic mode in all the possible solvent ratios.
For all the other applications at higher flow rates, use the connection capillary 0.13 mm/0.005'' x 750 mm MP35N®.

NOTICE Install the **Overpressure Relief Valve** to protect pressure sensitive flow cells (e.g. VH-D10 detector flow cells, VF-D5x detector flow cells). 60-bar variant (P/N 6083.9260): For LightPipe™ flow cells of the Vanquish Horizon Diode Array Detector (VH‑D10). This variant opens at a pressure of 60 bar. 40-bar variant (P/N 6079.9240): For the Mirco flow cell of the Vanquish Flex Fluorescence Detector (VF‑D5x). This variant opens at a pressure of 40 bar.
The overpressure relief valve is not intended to be used as pressure controller that is permanently open and that limits the pressure permanently to 40/60 bar.
For further information on the installation, refer to the Overpressure Relief Valve - Operation Manual (P/N 4820.8313)

NOTICE With Vanquish systems including a detector with LightPipe™ flow cell, always use post-column cooling for separations at more than 50 °C to reduce the temperature of the liquid leaving the column to values below 50 °C. Higher temperatures will damage the flow cell.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

4.3 Setting with Vanquish System in front of the Mass Spectrometer

Choose this installation for shortest connection between LC outlet and MS inlet. This can be realized by an appropriate bench design or by using movable tables like, e.g., IonBench Liftable tables (P/N 6040.2001 – 6040.2006)

4.3.1 MS Connection to a Vanquish System without Optical Detector

1) Place the right side of the Vanquish system in front of the Exactive mass spectrometer, with the right front corner of the Vanquish close to the ion source. Make sure that there is enough space (approx. 8-10 cm / 3-4'') between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 6. For further details about the course of the flexible Viper capillaries see Figure 4. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed. Table 6 provides a detailed overview on the capillaries used and where to find them.

Table 6. Detailed description of capillary connections for Vanquish-Exactive MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - MS ion source inlet	0.10 mm/0.004'' x 350 mm MP35N®	MS Connection kit

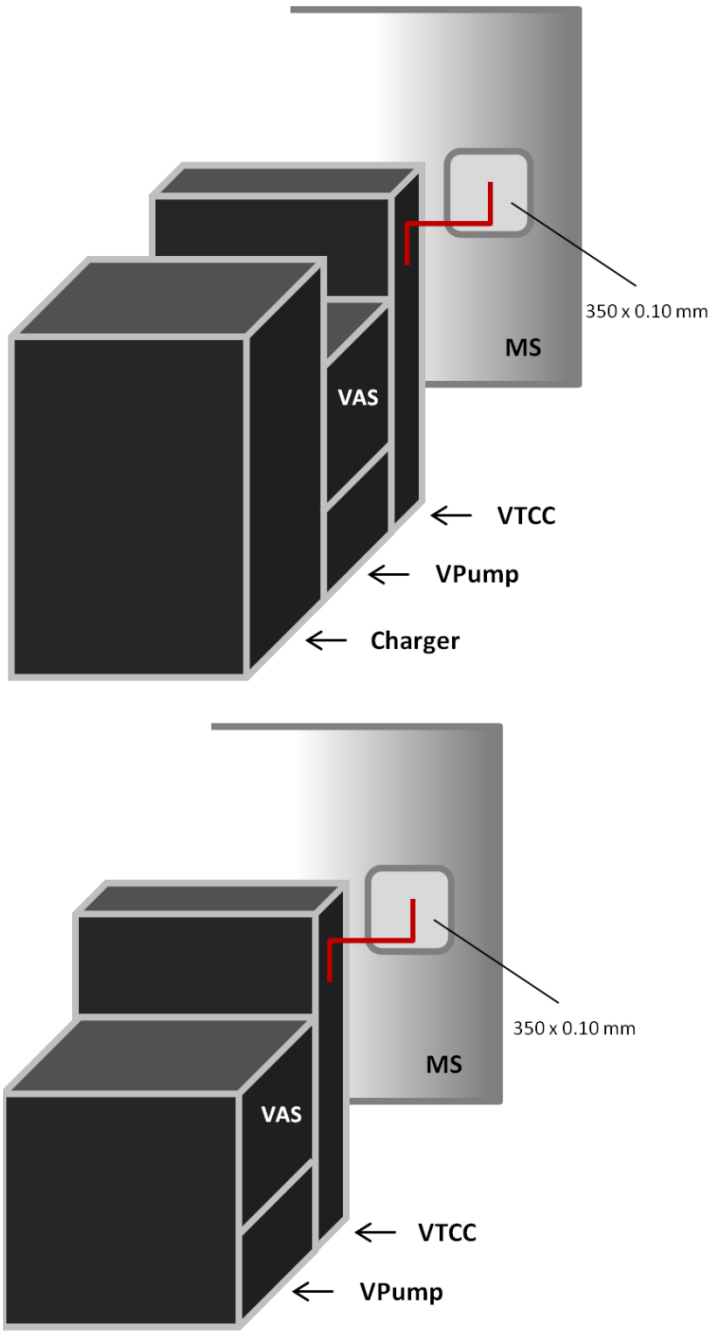


Figure 6. Setup for a Vanquish system with or without Charger as front-end for Exactive mass spectrometers.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

4.3.2 MS Connection to a Vanquish System with Optical Detector

1) Place the right side of the Vanquish system in front of the Exactive mass spectrometer, with the right front corner of the Vanquish close to the ion source. Make sure that there is enough space (approx. 8-10 cm / 3-4'') between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 7. For further details about the course of the flexible Viper capillaries see Figure 3. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed. Table 7 provides a detailed overview on the capillaries used and where to find them.

Table 7. Detailed description of capillary connections for Vanquish-Exactive MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - Detector cell inlet	0.10 mm/0.004'' x 300 mm MP35N®, insulated or 0.10 mm/0.004'' x 250 mm MP35N®, post-column cooler	Viper capillary kit, Vanquish system
Detector cell outlet - MS ion source inlet	0.10 mm/0.004'' x 750 mm MP35N® 0.13 mm/0.005'' x 750 mm MP35N®	MS Connection kit

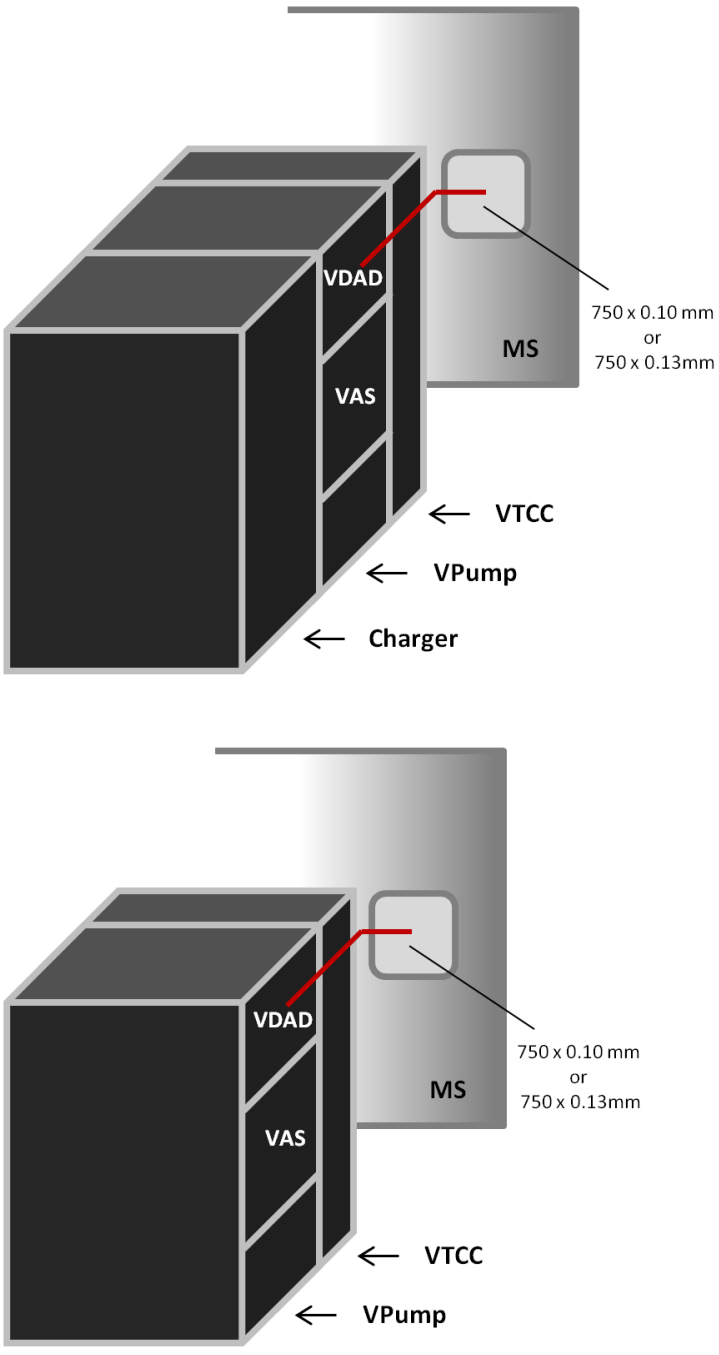


Figure 7. Setup for a Vanquish system with optical detector with or without Charger as front-end for Exactive mass spectrometers.

NOTICE The LightPipe™ flow cell is highly sensitive, with a pressure limit of 60 bar (870 psi). In order to avoid damage of the cell, do NOT exceed this pressure limit throughout your entire analysis. Connect the capillary from the flow cell directly to the MS source. The selection of the connection capillary between the flow cell outlet and the MS source inlet is dependent on the pressure generated by the mobile phase. For mobile phases comprising mixture of water/acetonitrile delivered at a flow rate up to 0.4 mL/min or water/methanol up to 0.3 mL/min, use the connection capillary 0.10 mm/0.004'' x 750 mm MP35N®. These mobile phases are intended with and without the presence of additives and delivered in gradient as well as in isocratic mode in all the possible solvent ratios.
For all the other applications at higher flow rates, use the connection capillary 0.13 mm/0.005'' x 750 mm MP35N®.

NOTICE Install the **Overpressure Relief Valve** to protect pressure sensitive flow cells (e.g. VH-D10 detector flow cells, VF-D5x detector flow cells). 60-bar variant (P/N 6083.9260): For LightPipe™ flow cells of the Vanquish Horizon Diode Array Detector (VH‑D10). This variant opens at a pressure of 60 bar. 40-bar variant (P/N 6079.9240): For the Mirco flow cell of the Vanquish Flex Fluorescence Detector (VF‑D5x). This variant opens at a pressure of 40 bar.
The overpressure relief valve is not intended to be used as pressure controller that is permanently open and that limits the pressure permanently to 40/60 bar.
For further information on the installation, refer to the Overpressure Relief Valve - Operation Manual (P/N 4820.8313)

NOTICE With Vanquish systems including a detector with LightPipe™ flow cell, always use post-column cooling for separations at more than 50 °C to reduce the temperature of the liquid leaving the column to values below 50 °C. Higher temperatures will damage the flow cell.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

4.4 Contact Closure Cable Configuration with Exactive Mass Spectrometers

1) Connect the 6-pin Mini-DIN signal cable (P/N 6036.0006) to the **Start In** pins of the **Peripheral Control connector** on the power entry panel of the Exactive series mass spectrometer. Observe the pin assignment in Table 8. Use a screwdriver to connect the wires of the signal cable and the green plug provided in the Accessories Kit of the mass spectrometer.

Table 8. Wiring an Exactive series mass spectrometer for contact closure with a Vanquish system.

Mini-DIN signal cable	Label	MS Start In
brown wire	MS: Start IN (-), Relay_NO	Pin 1 (left) – Start In -
white wire	MS: Start IN (+), Relay_COM	Pin 2 (right) – Start In +

2) Plug the green connector of the contact closure cable into the **Input socket on the Peripheral Control port** located on the power panel.of the Exactive series MS detector on the left bottom side of the instrument.

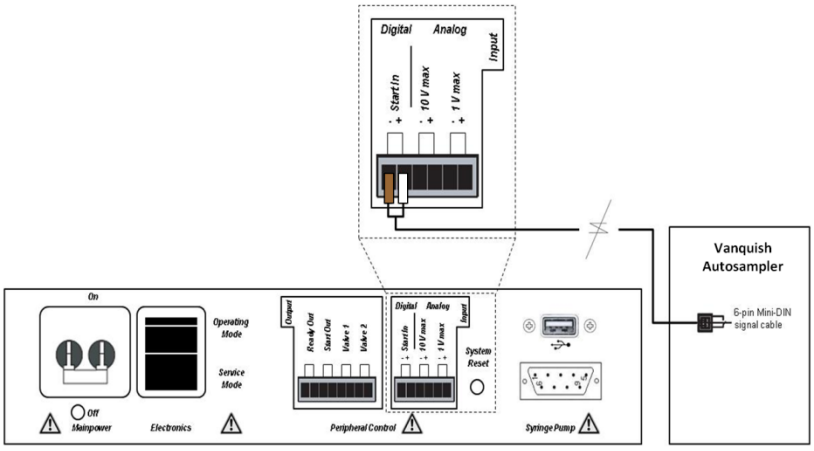


Figure 8. Schematic of the contact closure between the Vanquish system and an Exactive mass spectrometer.

3) Connect the Mini-DIN signal cable to the **Digital I/O Relay 2** terminal on the right side panel of the Vanquish Autosampler.

NOTICE To start data acquisition on an Exactive mass spectrometer the output (start) signal from the external device must be normally High (+5 V) and momentarily go to Low (GND).

5 Installation of Vanquish System with Orbitrap Exploris, Orbitrap Tribrid, Ion Trap, and Triple Quadrupole Mass Spectrometers

This chapter describes how to connect a Vanquish system with or without optical detector and with or without Charger to Orbitrap Exploris, Orbitrap Tribrid, Ion Trap, and Triple Quadrupole Mass Spectrometers.

5.1 Introduction

This section describes how to connect a Vanquish system with or without optical detector, with or without Charger to the following mass spectrometers:

- Orbitrap Exploris Mass Spectrometers:

  Orbitrap™ Exploris™ 120 MS, Orbitrap™ Exploris™ 240 MS, Orbitrap™ Exploris™ 480 MS.

- Orbitrap Tribrid Mass Spectrometers:

  Orbitrap™ ID-X™ Tribrid MS, Orbitrap™ Fusion™ Lumos™ Tribrid MS, Orbitrap™ Eclipse™ Tribrid MS.

- Linear Ion Trap Mass Spectrometers:

  LTQ XL™

- Triple Quadupole Mass Spectrometers:

  TSQ Fortis™, TSQ Endura™, TSQ Quantis™, TSQ Altis™.

NOTICE Before turning on the power to the Vanquish modules or connecting them to the control PC by a USB cable, install the software package. Only then, the USB hardware drivers for the Vanquish system will be installed correctly.

Thermo Scientific recommends individual configurations for the different mass spectrometer types to optimize all fluidic connections for shortest distances between the outlet of the UHPLC column, or of the detector flow cell, and the ion source inlet of the mass spectrometer. Thereby, the unique Viper capillaries provide zero-dead volume connections by design, ensuring best MS detection results of the Ultra-High Performance LC separation.

5.2 Setting with Vanquish System beside the Mass Spectrometer

5.2.1 MS Connection to a Vanquish System

1) Place the Vanquish system approx. 8-10 cm / 3-4'' left to the Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometer. Make sure that there is enough space between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 9. The picture illustrates the course of the flexible Viper capillaries in general. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed. Table 9 provides a detailed overview on the capillaries used and where to find them.

Table 9. Detailed description of capillary connections for Vanquish-Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - MS ion source inlet	0.10 mm/0.004'' x 550 mm MP35N®	MS Connection kit

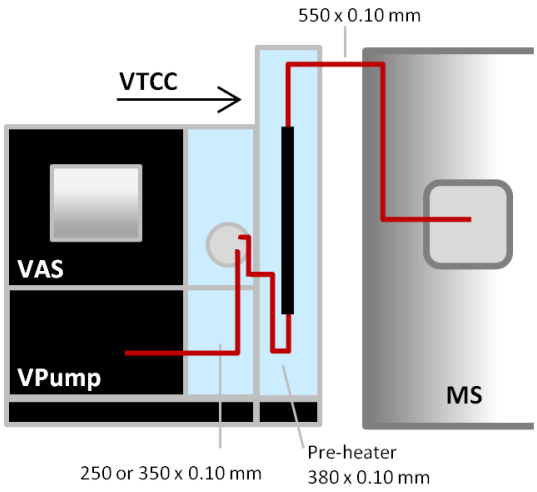


Figure 9. Setup for a Vanquish system as front-end for Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometers.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

5.2.2 MS Connection to a Vanquish System with Optical Detector

1) Place the Vanquish system approx. 8-10 cm / 3-4'' left to the Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometer. Make sure that there is enough space between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 10. The picture illustrates the course of the flexible Viper capillaries in general. Thermo Fisher

Scientific recommends installing all capillaries inside the modules as needed. Table 10 provides a detailed overview on the capillaries used and where to find them.

Table 10. Detailed description of capillary connections for Vanquish-Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - Detector cell inlet	0.10 mm/0.004'' x 300 mm MP35N®, insulated or 0.10 mm/0.004'' x 250 mm MP35N®, post-column cooler	Viper capillary kit, Vanquish system
Detector cell outlet - MS ion source inlet	0.10 mm/0.004'' x 750 mm MP35N® 0.13 mm/0.005'' x 750 mm MP35N®	MS Connection kit

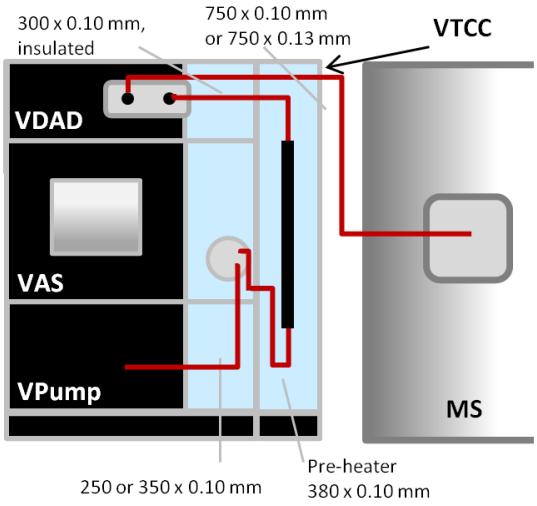


Figure 10. Setup for a Vanquish system with optical detector as front-end for Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometers.

NOTICE The LightPipe™ flow cell is highly sensitive, with a pressure limit of 60 bar (870 psi). In order to avoid damage of the cell, do NOT exceed this pressure limit throughout your entire analysis. Connect the capillary from the flow cell directly to the MS source. The selection of the connection capillary between the flow cell outlet and the MS source inlet is dependent on the pressure generated by the mobile phase. For mobile phases comprising mixture of water/acetonitrile delivered at a flow rate up to 0.4 mL/min or water/methanol up to 0.3 mL/min, use the connection capillary 0.10 mm/0.004'' x 750 mm MP35N®. These mobile phases are intended with and without the presence of additives and delivered in gradient as well as in isocratic mode in all the possible solvent ratios.
For all the other applications at higher flow rates, use the connection capillary 0.13 mm/0.005'' x 750 mm MP35N®.

NOTICE Install the **Overpressure Relief Valve** to protect pressure sensitive flow cells (e.g. VH-D10 detector flow cells, VF-D5x detector flow cells). 60-bar variant (P/N 6083.9260): For LightPipe™ flow cells of the Vanquish Horizon Diode Array Detector (VH‑D10). This variant opens at a pressure of 60 bar. 40-bar variant (P/N 6079.9240): For the Mirco flow cell of the Vanquish Flex Fluorescence Detector (VF‑D5x). This variant opens at a pressure of 40 bar.
The overpressure relief valve is not intended to be used as pressure controller that is permanently open and that limits the pressure permanently to 40/60 bar.
For further information on the installation, refer to the Overpressure Relief Valve - Operation Manual (P/N 4820.8313)

NOTICE With Vanquish systems including a detector with LightPipe™ flow cell, always use post-column cooling for separations at more than 50 °C to reduce the temperature of the liquid leaving the column to values below 50 °C. Higher temperatures will damage the flow cell.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

5.2.3 MS Connection to a Vanquish System with Charger

1) Place the Vanquish system approx. 8-10 cm / 3-4'' left to the Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometer. Make sure that there is enough space between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 11. The picture illustrates the course of the flexible Viper capillaries in general. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed. Table 11 provides a detailed overview on the capillaries used and where to find them.

Table 11. Detailed description of capillary connections for Vanquish-Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - MS ion source inlet	0.10 mm/0.004'' x 550 mm MP35N®	MS Connection kit

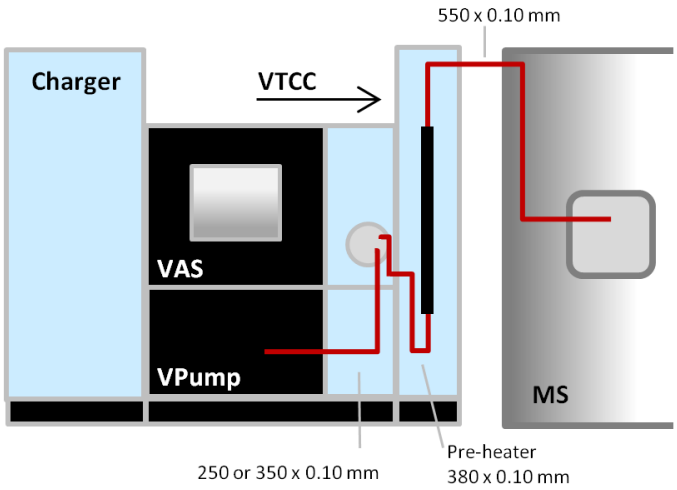


Figure 11. Setup for a Vanquish system with a Charger as front-end for Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometers.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

5.2.4 MS Connection to a Vanquish System with Optical Detector and Charger

1) Place the Vanquish system approx. 8-10 cm / 3-4'' left to the Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometer. Make sure that there is enough space between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 12. The picture illustrates the course of the flexible Viper capillaries in general. Thermo Fisher

Scientific recommends installing all capillaries inside the modules as needed. Table 12 provides a detailed overview on the capillaries used and where to find them.

Table 12. Detailed description of capillary connections for Vanquish-Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - Detector cell inlet	0.10 mm/0.004'' x 300 mm MP35N®, insulated or 0.10 mm/0.004'' x 250 mm MP35N®, post-column cooler	Viper capillary kit, Vanquish system
Detector cell outlet - MS ion source inlet	0.10 mm/0.004'' x 750 mm MP35N® 0.13 mm/0.005'' x 750 mm MP35N®	MS Connection kit

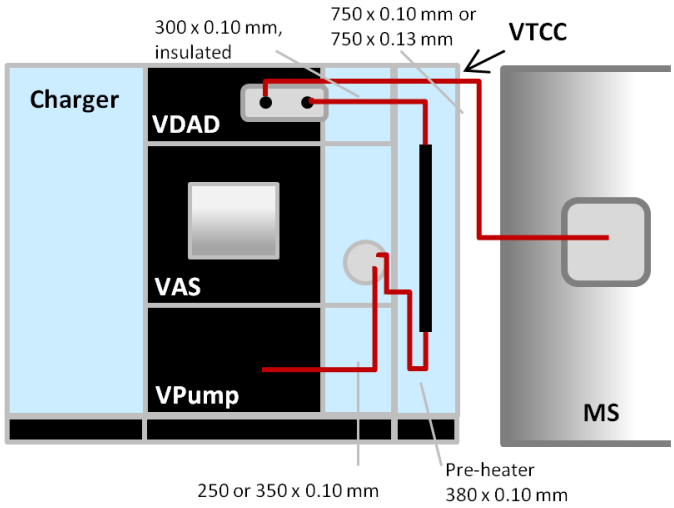


Figure 12. Setup for a Vanquish system with optical detector and Charger as front-end for Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometers.

NOTICE The LightPipe™ flow cell is highly sensitive, with a pressure limit of 60 bar (870 psi). In order to avoid damage of the cell, do NOT exceed this pressure limit throughout your entire analysis. Connect the capillary from the flow cell directly to the MS source. The selection of the connection capillary between the flow cell outlet and the MS source inlet is dependent on the pressure generated by the mobile phase. For mobile phases comprising mixture of water/acetonitrile delivered at a flow rate up to 0.4 mL/min or water/methanol up to 0.3 mL/min, use the connection capillary 0.10 mm/0.004'' x 750 mm MP35N®. These mobile phases are intended with and without the presence of additives and delivered in gradient as well as in isocratic mode in all the possible solvent ratios.
For all the other applications at higher flow rates, use the connection capillary 0.13 mm/0.005'' x 750 mm MP35N®.

NOTICE Install the **Overpressure Relief Valve** to protect pressure sensitive flow cells (e.g. VH-D10 detector flow cells, VF-D5x detector flow cells). 60-bar variant (P/N 6083.9260): For LightPipe™ flow cells of the Vanquish Horizon Diode Array Detector (VH‑D10). This variant opens at a pressure of 60 bar. 40-bar variant (P/N 6079.9240): For the Mirco flow cell of the Vanquish Flex Fluorescence Detector (VF‑D5x). This variant opens at a pressure of 40 bar.
The overpressure relief valve is not intended to be used as pressure controller that is permanently open and that limits the pressure permanently to 40/60 bar.
For further information on the installation, refer to the Overpressure Relief Valve - Operation Manual (P/N 4820.8313)

NOTICE With Vanquish systems including a detector with LightPipe™ flow cell, always use post-column cooling for separations at more than 50 °C to reduce the temperature of the liquid leaving the column to values below 50 °C. Higher temperatures will damage the flow cell.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

5.3 Setting with Vanquish System in front of the Mass Spectrometer

Choose this installation for shortest connection between LC outlet and MS inlet. This can be realized by an appropriate bench design or by using movable tables like, e.g., IonBench Liftable tables (P/N 6040.2001 – 6040.2006)

5.3.1 MS Connection to a Vanquish System without Optical Detector

1) Place the right side of the Vanquish system in front of the Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometer, with the right front corner of the Vanquish close to the ion source. Make sure that there is enough space (approx. 8-10 cm / 3-4'') between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 13. For further details about the course of the flexible Viper capillaries see Figure 9. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed. Table 13 provides a detailed overview on the capillaries used and where to find them.

Table 13. Detailed description of capillary connections for Vanquish-Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - MS ion source inlet	0.10 mm/0.004'' x 350 mm MP35N®	MS Connection kit

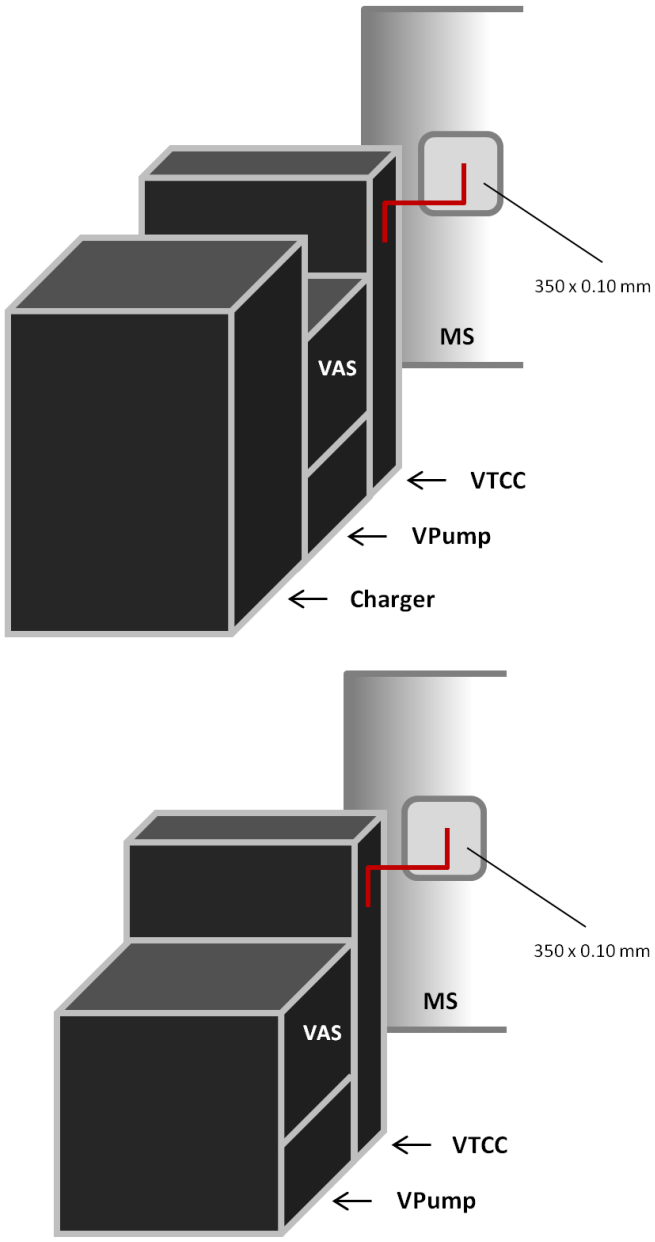


Figure 13. Setup for a Vanquish system with or without Charger as front-end for for Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometers.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

5.3.2 MS Connection to a Vanquish System with Optical Detector

1) Place the right side of the Vanquish system in front of the Orbitrap Exploris and Tribrid/Ion Trap/Triple Quadrupole mass spectrometer, with the right front corner of the Vanquish close to the ion source. Make sure that there is enough space (approx. 8-10 cm / 3-4'') between the LC and the MS. This is to ensure free air circulation to avoid system overheating.

2) Stack the modules as shown below and make all fluidic connections using Viper capillaries, according to Figure 14. For further details about the course of the flexible Viper capillaries see Figure 10. Thermo Fisher Scientific recommends installing all capillaries inside the modules as needed. Table 14 provides a detailed overview on the capillaries used and where to find them.

Table 14. Detailed description of capillary connections for Vanquish-Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole MS installation.

Description of Connections	Capillary Dimensions (ID x L)	Where to find
Pump outlet - VAS, port 1	0.10 mm/0.004'' x 250 or 350 mm MP35N®	Viper capillary kit, Vanquish system
VAS, port 2 - Column	0.10 mm/0.004'' x 380 mm MP35N®, including pre-heater	Viper capillary kit, Vanquish system
Column - Detector cell inlet	0.10 mm/0.004'' x 300 mm MP35N®, insulated or 0.10 mm/0.004'' x 250 mm MP35N®, post-column cooler	Viper capillary kit, Vanquish system
Detector cell outlet - MS ion source inlet	0.10 mm/0.004'' x 750 mm MP35N® 0.13 mm/0.005'' x 750 mm MP35N®	MS Connection kit

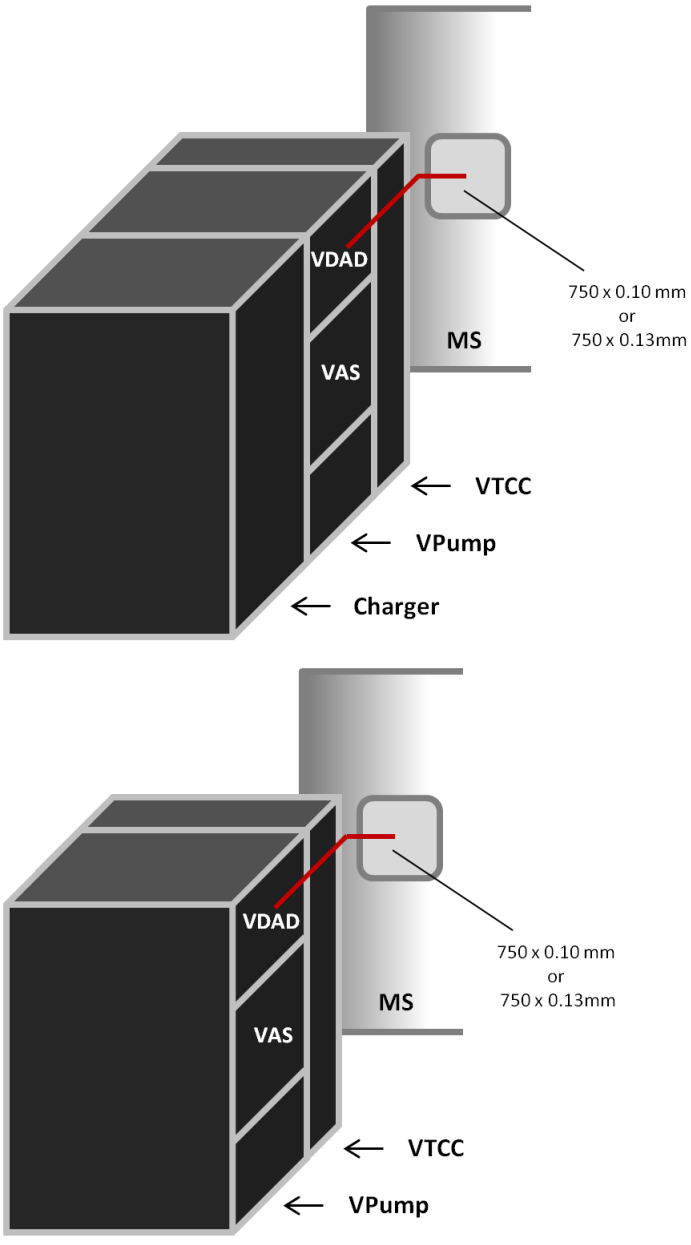


Figure 14. Setup for a Vanquish system with optical detector with or without Charger as front-end for Orbitrap Exploris/Orbitrap Tribrid/Ion Trap/Triple Quadrupole mass spectrometers.

NOTICE The LightPipe™ flow cell is highly sensitive, with a pressure limit of 60 bar (870 psi). In order to avoid damage of the cell, do NOT exceed this pressure limit throughout your entire analysis. Connect the capillary from the flow cell directly to the MS source. The selection of the connection capillary between the flow cell outlet and the MS source

inlet is dependent on the pressure generated by the mobile phase. For mobile phases comprising mixture of water/acetonitrile delivered at a flow rate up to 0.4 mL/min or water/methanol up to 0.3 mL/min, use the connection capillary 0.10 mm/0.004'' x 750 mm MP35N®. These mobile phases are intended with and without the presence of additives and delivered in gradient as well as in isocratic mode in all the possible solvent ratios.
For all the other applications at higher flow rates, use the connection capillary 0.13 mm/0.005'' x 750 mm MP35N®.

NOTICE Install the **Overpressure Relief Valve** to protect pressure sensitive flow cells (e.g. VH-D10 detector flow cells, VF-D5x detector flow cells). 60-bar variant (P/N 6083.9260): For LightPipe™ flow cells of the Vanquish Horizon Diode Array Detector (VH‑D10). This variant opens at a pressure of 60 bar. 40-bar variant (P/N 6079.9240): For the Mirco flow cell of the Vanquish Flex Fluorescence Detector (VF‑D5x). This variant opens at a pressure of 40 bar.
The overpressure relief valve is not intended to be used as pressure controller that is permanently open and that limits the pressure permanently to 40/60 bar.
For further information on the installation, refer to the Overpressure Relief Valve - Operation Manual (P/N 4820.8313)

NOTICE With Vanquish systems including a detector with LightPipe™ flow cell, always use post-column cooling for separations at more than 50 °C to reduce the temperature of the liquid leaving the column to values below 50 °C. Higher temperatures will damage the flow cell.

NOTICE For further information on the installation of the individual modules, refer to the relative Operation Manuals.

NOTICE All modules are primed with 2-propanol at the factory. Prior to initial operation of the system, make sure that all used solvents are miscible with 2-propanol and equilibrate your system. Otherwise, perform appropriate intermediate flushing steps.

5.4 Contact Closure Configuration with Triple Quadrupole Mass Spectrometers

1) Connect the 6-pin Mini-DIN signal cable (P/N 6036.0006) to the **Start In** pins of the **Peripheral Control** connector on the power entry panel of the Triple Quadrupole mass spectrometer. Observe the pin assignment in Table 15. Use a screwdriver to connect the wires of the signal cable and the green plug provided in the Accessories Kit of the mass spectrometer.

Table 15. Wiring a Triple Quadrupole mass spectrometer for contact closure with a Vanquish system.

Mini-DIN signal cable	Label	MS Start In
brown wire	MS: Start IN (-), Relay_NO	Pin 1 – Ground
white wire	MS: Start IN (+), Relay_COM	Pin 4 – Start In

2) Plug the green connector of the contact closure cable into the socket on the **Peripheral Control port** located on the power panel of the Triple Quadrupole mass detector.

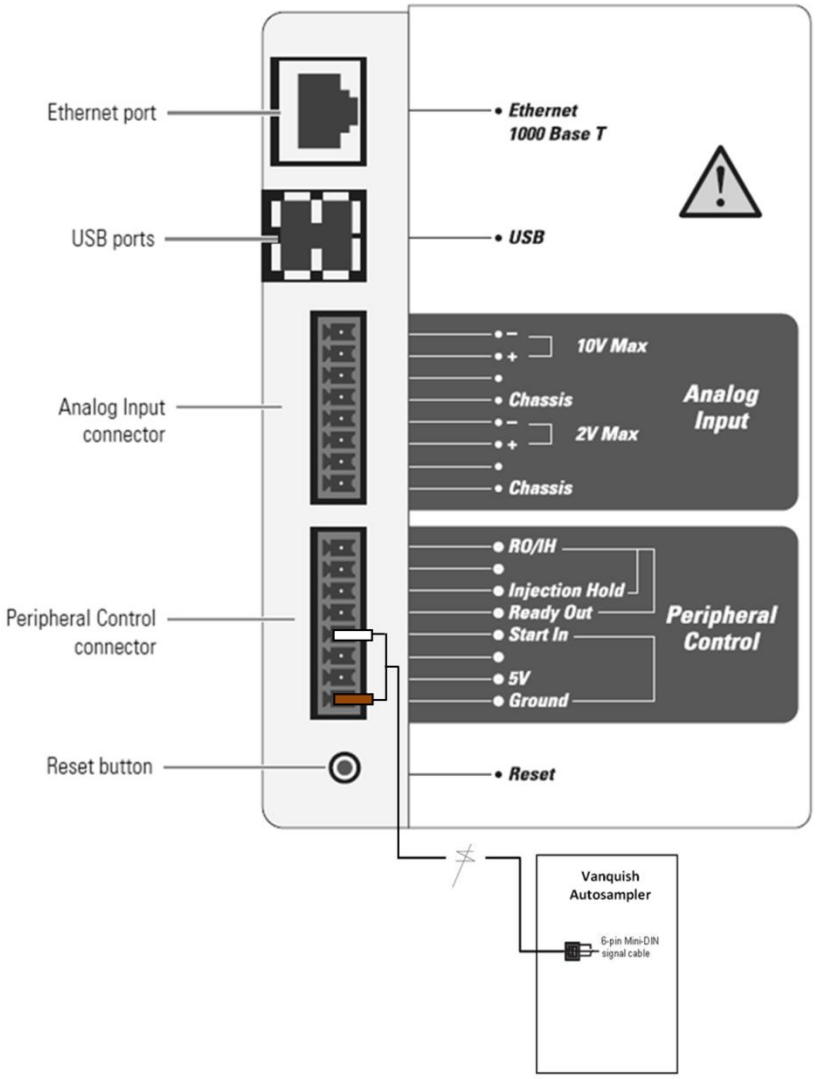


Figure 15. Schematic of the contact closure between the Vanquish system and a Triple Quadrupole mass spectrometer.

3) Connect the Mini-DIN signal cable to the **Digital I/O Relay 2** terminal on the right side panel of the Vanquish Autosampler.

NOTICE To start data acquisition on a Triple Quadrupole mass spectrometer the output (start) signal from the external device must be normally High (+5 V) and momentarily go to Low (GND).

5.5 Contact Closure Configuration with Orbitrap Exploris, Orbitrap Tribrid, Ion Trap Mass Spectrometers

1) Connect the 6-pin Mini-DIN signal cable (P/N 6036.0006) to the **Start In** pins of the **Peripheral Control** connector on the power entry panel of the Ion Trap or Orbitrap Exploris and Tribrid mass spectrometer. Observe the pin assignment in Table 16. Use a screwdriver to connect the wires of the signal cable and the green plug provided in the Accessories Kit of the mass spectrometer.

Table 16. Wiring an Orbitrap Exploris/Orbitrap Tribrid/Ion Trap mass spectrometer for contact closure with a Vanquish system.

Mini-DIN signal cable	Label	MS Start In
brown wire	MS: Start IN (-), Relay_NO	Pin 2 (right) – Start In -
white wire	MS: Start IN (+), Relay_COM	Pin 1 (left) – Start In +

2) Plug the green connector of the contact closure cable into the socket on the **Peripheral Control port** located on the power panel of the MS detector.

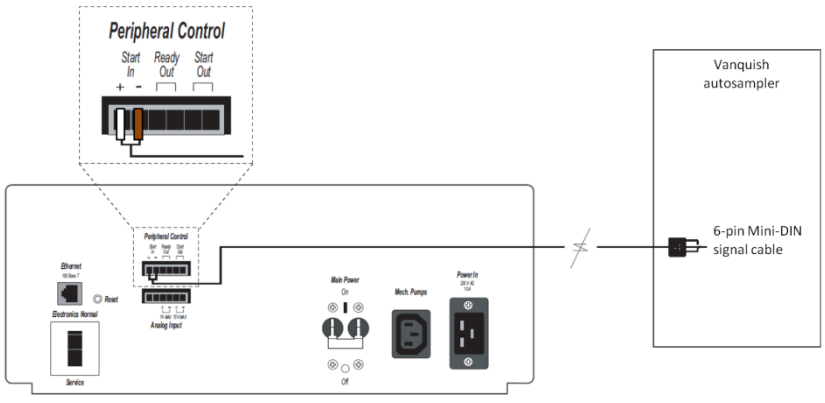


Figure 16. Schematic of the contact closure between the Vanquish system and an Orbitrap Exploris/Orbitrap Tribrid/Ion Trap mass spectrometer.

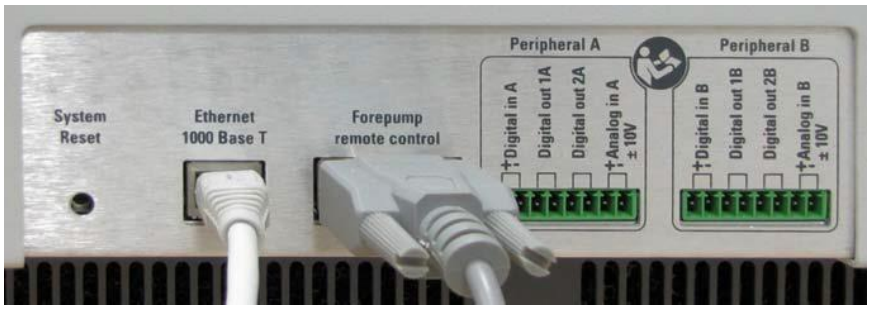


Figure 17. Control panel of Orbitrap Exploris mass spectrometer

3) Connect the Mini-DIN signal cable to the **Digital I/O Relay 2** terminal on the right side panel of the Vanquish Autosampler.

NOTICE To start data acquisition on an Orbitrap Exploris/Orbitrap Tribrid/Ion Trap mass spectrometer the output (start) signal from the external device must be normally High (+5 V) and momentarily go to Low (GND).

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