225-44231B
Nov. 2023

Gas Chromatograph Mass Spectrometer

GCMS-QP2050

Instruction Manual

Read this manual thoroughly before you use the product.
Keep this manual for future reference.

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Introduction

Read this Instruction Manual thoroughly before using the product.

Thank you for purchasing this product.

This manual describes how to use this product and the accessories and options related to this product. Read this manual thoroughly before using the product and operate the product in accordance with the instructions in this manual.

Keep this manual for future reference.

This instruction manual describes the information for the following products.
1 GCMS-QP2050
2 GCMS-QP2050 Entry

IMPORTANT

- If the user or usage location changes, ensure that this manual is always kept together with the product.
- If this manual or a product warning label is lost or damaged, immediately contact your Shimadzu representative to request a replacement.
- To ensure safe operation, read all "GCMS-QP2050 Safety Guideline" before using the product.
- To ensure safe operation, contact your Shimadzu representative if product installation, adjustment, re-installation (after the product is moved), or repair is required.

Notice

- Information in this manual is subject to change without notice and does not represent a commitment on the part of the vendor.
- Any errors or omissions which may have occurred in this manual despite the utmost care taken in its production will be corrected as soon as possible, although not necessarily immediately after detection.
-
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Original version is approved in English.

Indications Used in This Manual

Precaution symbols are indicated using the following conventions:

Indication	Meaning
⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or possibly death.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor to moderate injury or equipment damage.
NOTE	Emphasizes additional information that is provided to ensure the proper use of this product.

The following symbols are used in this manual:

Indication	Meaning
Prohibition	Indicates an action that must not be performed.
Instruction	Indicates an action that must be performed.
Hint	Indicates information provided to improve product performance.
Reference	Indicates the location of related reference information.
Text bracketed by [ ]	On-screen items and screen names are bracketed by square brackets. Example: Click [OK].
Text enclosed by " "	Numbers, texts, keys to be entered are enclosed in double quotation marks. Example: Hold down "Ctrl" key and press "N" key.

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1 Overview

1.1 GCMS-QP2050 Series

This section presents an overview of this instrument.

The instrument is a bench-top type gas chromatograph/mass spectrometer intended for high-precision GC/MS analysis. The instrument enables mass spectrum measurement for qualitative analysis or identification of samples and Selected Ion Monitoring (SIM) measurement for quantitation of trace constituents.

1.2 Features

This section explains the characteristic functions and performance of this instrument.

■ Basic Performance

Improved sensitivity achieved by optimizing the ion optical system

This series features world-class sensitivity and repeatability.

Improved throughput by super-high speed analysis

The super-high scanning speed enables exhaustive Scan mode qualitative analysis while processing more components through quantitative analysis with SIM measurement.

■ Improved Operability

Touch operations

MS start/stop and GC maintenance while MS is active can be run from a GC monitor and tablet terminals linked to the GC in addition to the conventional control PC.

Easier maintenance

The tools and procedures necessary for MS maintenance have been significantly reduced. Even users who have no prior experience using the GC/MS can easily perform maintenance.

■ Ecological

Energy-saving

Compared to normal analysis standby state, the Ecology mode achieves 25 % less energy consumption.

Alternative gas supported

This instrument supports analyses with gases other than standard helium gas, which contributes to the reduction in the consumption of helium, which is a scarce resource.

■ Scalability

Compact design

The mass spectrometer unit is 20 % more compact in design compared to previous models. The smaller footprint enables installation in limited space.

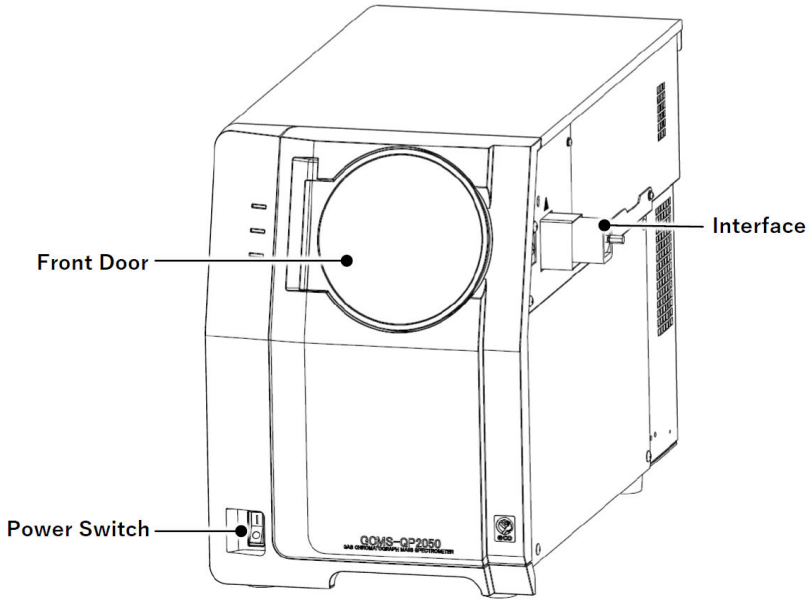
1.3 Component Names

The instrument consists of a gas chromatograph (GC) unit, mass spectrometer (MS) unit, foreline pump, computer (PC) (display, printer, etc.) and other optional products.

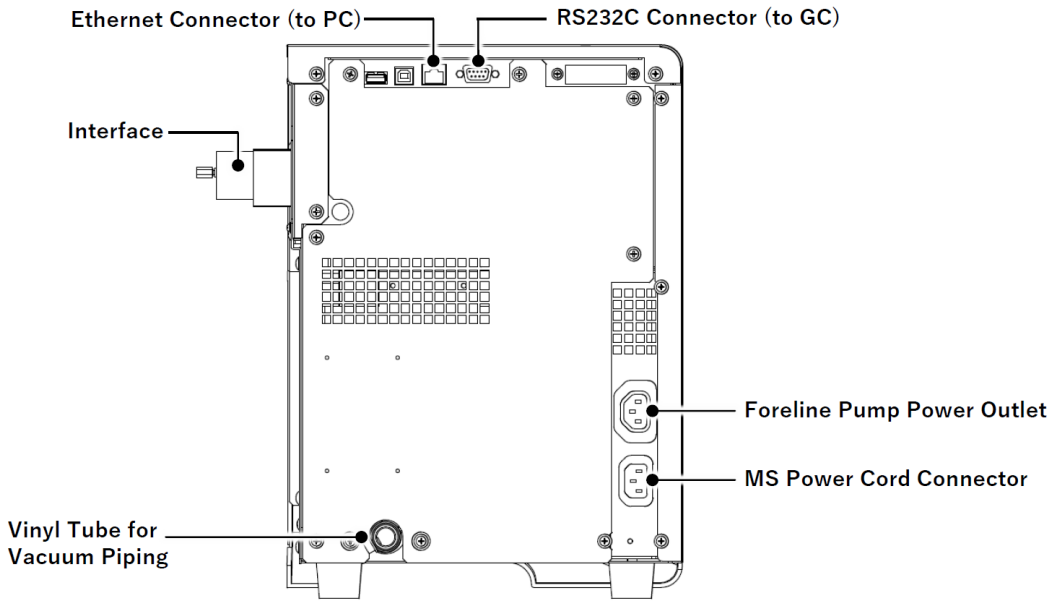
Reference For information on the GC, refer to the instruction manual supplied with the equipment.

1.3.1 Analytical System

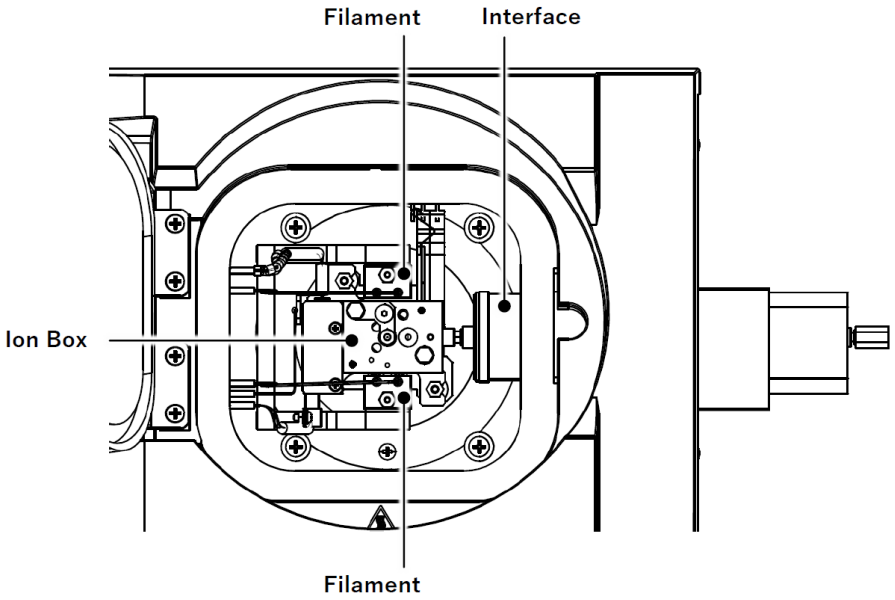
■ Front/Right Side



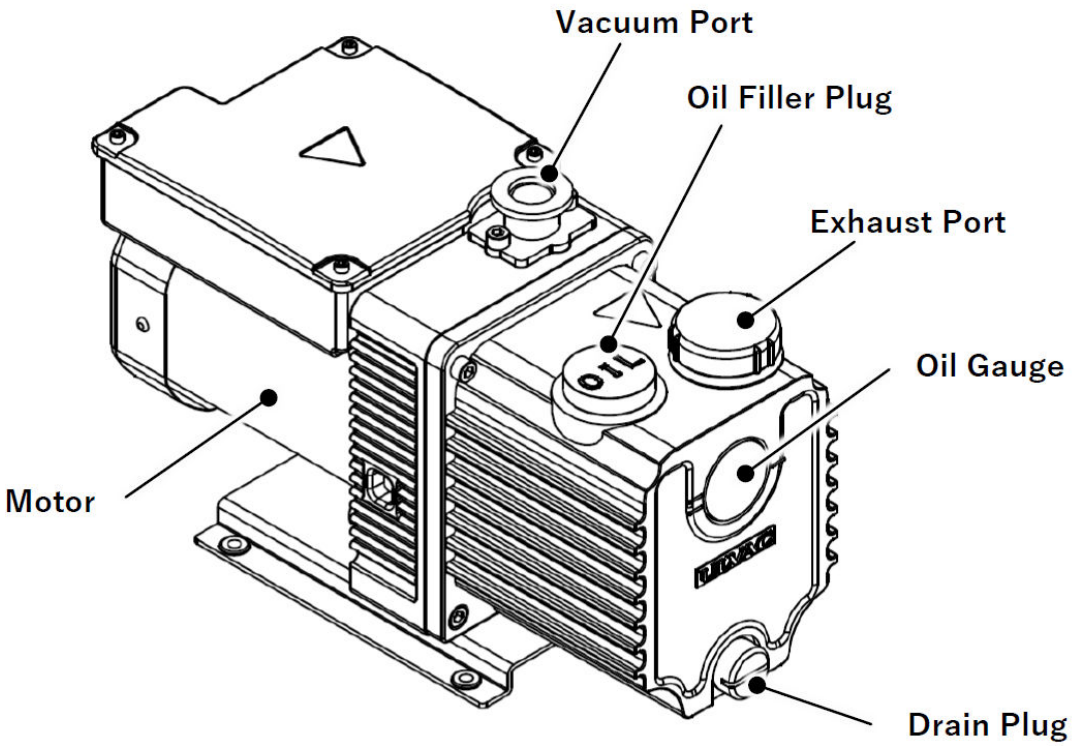
■ Rear Side



1.3.2 Ion Source



1.3.3 Foreline Pump



1.4 Standard Maintenance Parts (Standard Installation Parts)

This section describes the standard maintenance parts (installation parts) for this instrument.

To order any part in this list, contact your Shimadzu representative.

■ Accessory Kit (Parts for MS Installation) : S225-36650-41

P/N	Part Name	Qty
S228-61083-41	Cable, LAN	2
S070-03626-01	Cable, RS232C	1
S225-10023-41	RP hose	1
S016-31331	Vinyl tube	1
S037-61019	Hose clamp	2
S221-72658-91	PIPE,AIR IN,CLEANING	1
S020-46547	SCREW,SST SEMS P3 M4X8	1
S071-36136-01	Terminal board	3

2 Basic Operation

This chapter explains the basic instrument operations using LabSolutions GCMS when the GC is connected.

Reference Refer to the instruction manual for the GC for instructions on how to operate the GC unit independently.

2.1 Preparing for Instrument Startup

2.1.1 Preparing the Carrier Gas

In order to maintain the performance of the instrument, use a carrier gas that satisfies the following specifications:

Helium (supply pressure: 300 to 980 kPa), purity of 99.995 % or higher and oxygen O_2 ≤ 3 ppmV

When using hydrogen or nitrogen, see "6.4 Using Hydrogen and Nitrogen Gas as Carrier Gases". When gas is necessary due to an optional installation, refer to the instruction manual for the optional unit.

Hint Using helium with higher purity (99.999 to 99.9999 %) is recommended for certain applications.

2.1.2 Preparing the Instrument

■ Checking the gas supply

1 **Check that the carrier gas is connected to the GC.**

2 **Open the main valve of the carrier gas cylinder.**

3 **Ensure that the supply pressure, or the pressure at GC carrier gas inlet, is 300 - 980 kPa.**

NOTE When changing gas cylinders, make sure that there are no leaks from the connection at the gas cylinder.

■ Checking the glass insert

Check that the glass insert used is appropriate for the purpose of analysis.

Reference For detailed instructions on how to replace the glass insert and O-ring, refer to the operation guide or maintenance help of the GC unit.

1 Turn the lever counterclockwise while holding the injection port.

2 Gently lift up the injection port.

NOTE Raise the injection port slowly by left hand to prevent damage of glass insert. The glass insert may come with the injection port when it is lifted up. If that happens, gently lift the injection port straight up.

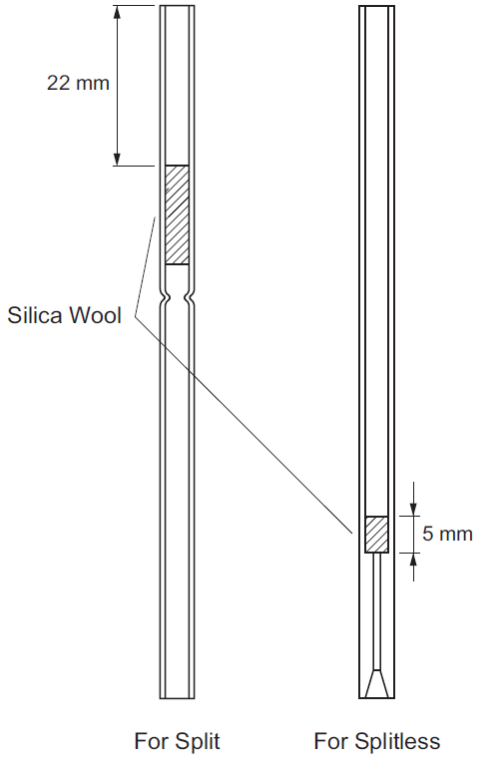
Hint If the O-ring is stuck to the injection port, use tweezers to remove the O-ring before lifting up the injection port in order to prevent the glass insert from breaking.

3 Using tweezers, pull out the glass insert.

NOTE Pay attention not to damage the installation surface of O-ring on the injection inlet.

4 Check that the glass insert is appropriate for the purpose of analysis.

Check the silica wool to make sure that it is clean and positioned properly.



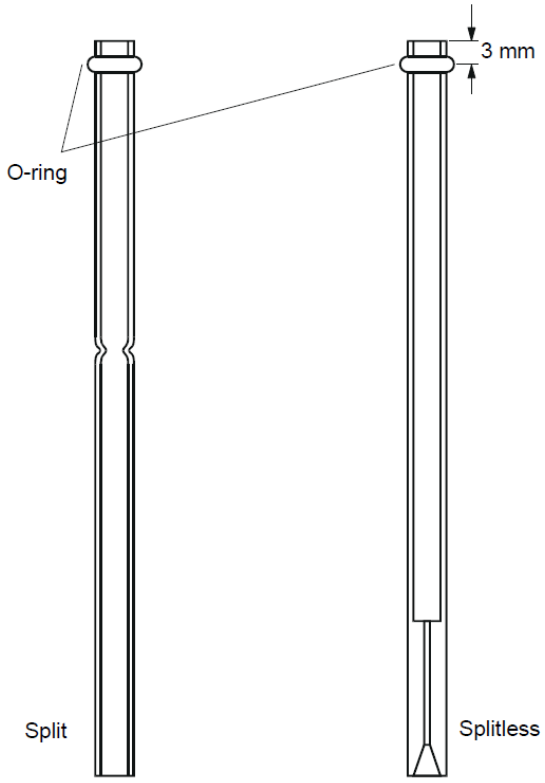
5 **If the silica wool is contaminated, remove the wool, and clean or replace it.**

Pack an appropriate amount of clean silica wool at the specified location. For split injection this is about 10 mg and for splitless about 4 mg. The image above shows the recommended positions for each insert.

6 **Install the glass insert and O-ring as described below.**

Temporarily slide the O-ring onto the glass insert so that it is about 4 mm from the top, as shown in the diagram below.

Guide the glass insert into the injection port until it touches the bottom.
The O-ring will be about 3 mm from the top of the insert when properly positioned.



7 **Install the injection port fitting into the groove.**

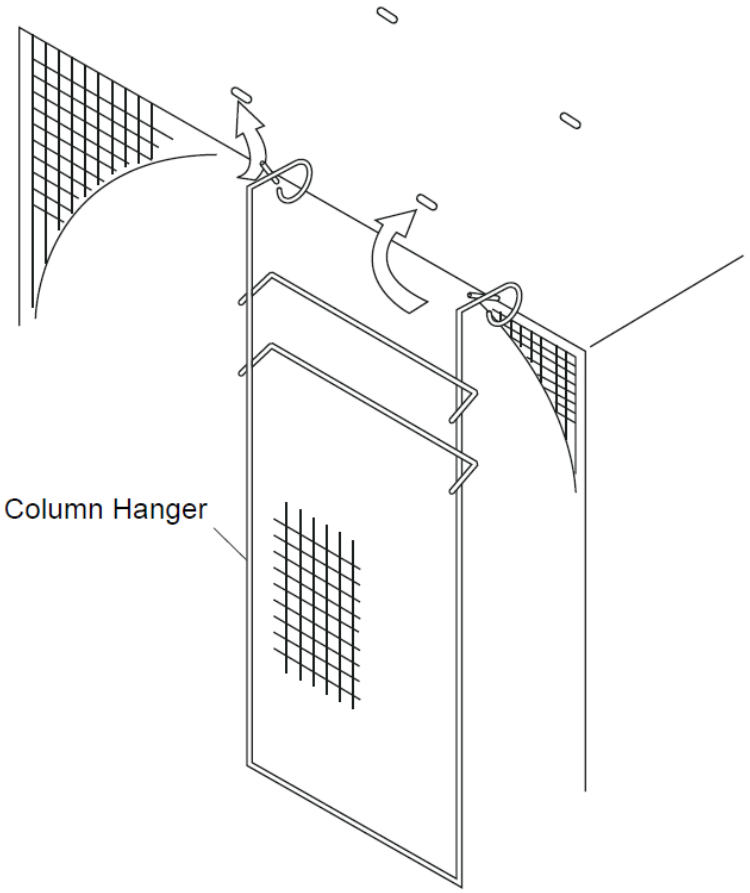
8 **Turn the lever clockwise while holding the injection port.**

■ Attaching the Column

Reference For detailed instructions on how to attach the column, refer to the operation guide or maintenance help of the GC unit.

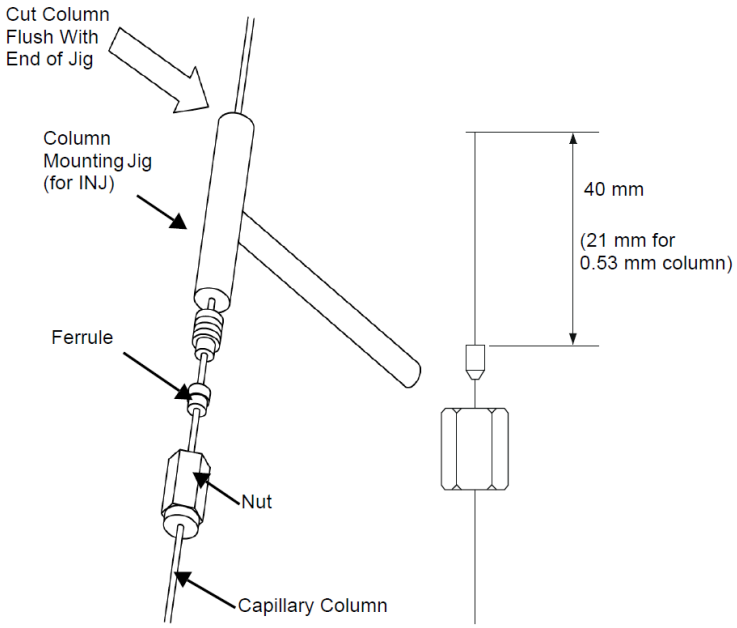
1 **When attaching the column hanger, shrink the width of the upper part of the column hanger to fit into the column hanger mounting holes.**

The standard column mounting position is on the back side of the hanger. When connecting two columns, mount one in front and the other in back.



2 Attach the column to the INJ side.

> **NOTE** The ClickTek connector that is an optional product for GC-2030 cannot be used with this instrument.



1 Pass the capillary column through the Vespel® ferrule and nut.

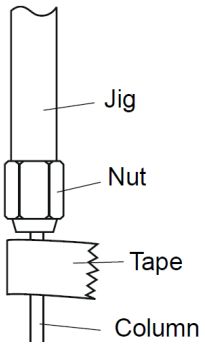
> **NOTE** The thinner side of the Vespel® ferrule should be facing the nut.

2 Insert the tip of the capillary column into the column mounting jig (for INJ) (P/N: S225-01453-95) supplied with the optional tool kit and pull out 1 cm of the capillary column from the end of the pipe.

3 Tighten the nut and cut the part of the capillary column that is sticking out.

4 Using tape, mark the part of the capillary column where the nut is tightened.

NOTE Vespel® ferrule cannot be formed with a jig like graphite ferrule. Use tape for marking. To ensure proper positioning of the column, mark the column beneath the Vespel ferrule and nut with tape. Ensure that the tape is removed after installation. Septum can also be used as a marker instead of tape.



5 Remove the capillary column from the column mounting jig while taking care not to move the mark.

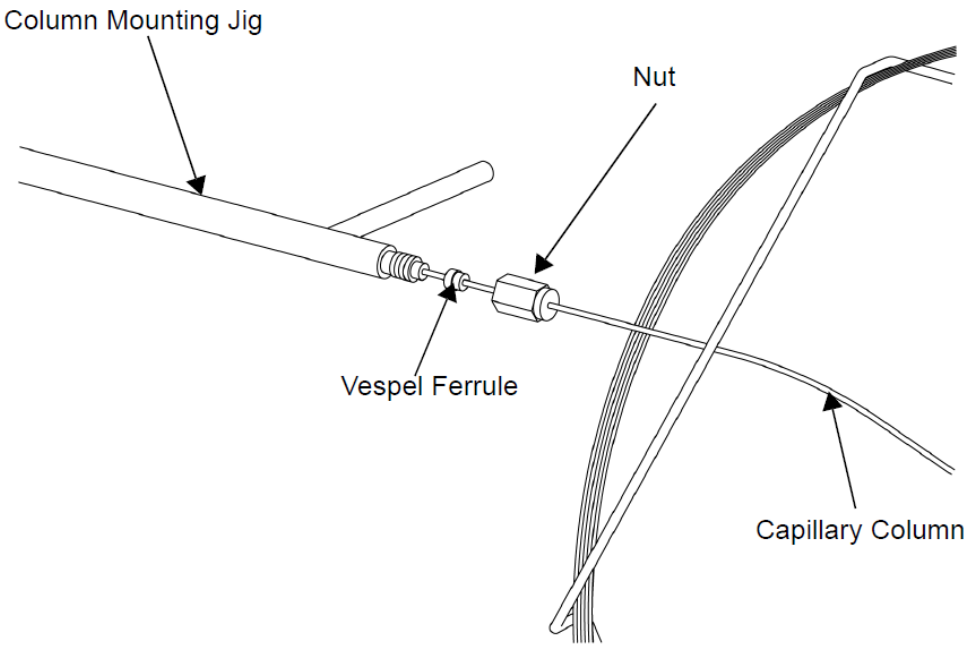
6 After lightly wiping the capillary column with acetone, insert it into the INJ side and tighten the nut.
After tightening the nut by hand, further tighten the nut using the torque wrench supplied in the tool kit.

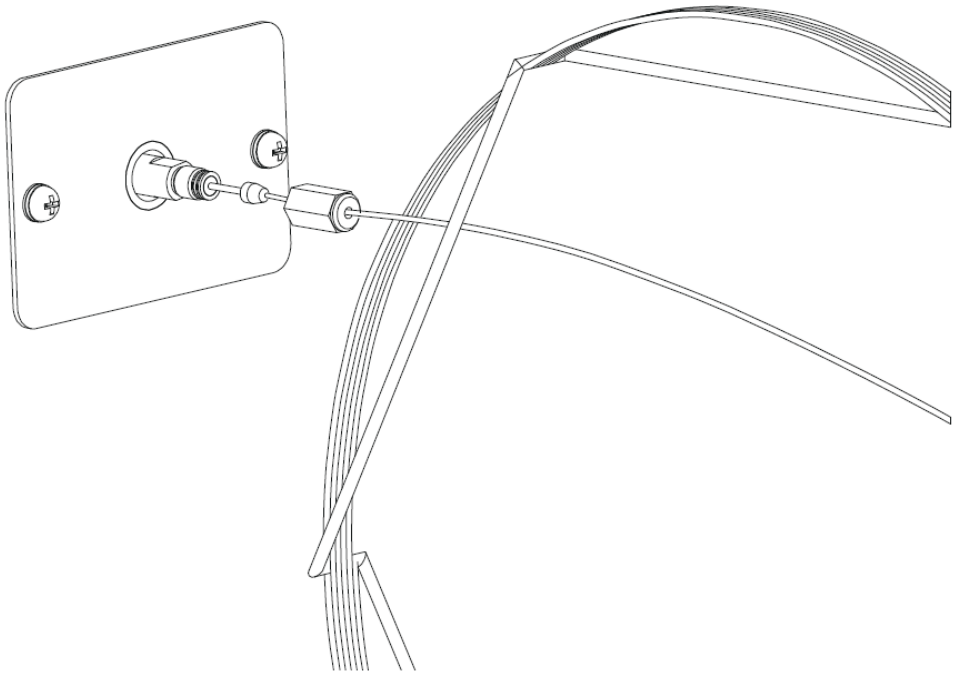
7 Remove the tape used to mark the column.

Part Name	P/N
Vespel® ferrule	670-15003-03 (for 0.25 mm column) (option)
	670-15003-04 (for 0.32 mm column) (option)
	670-15003-07 (for 0.53 mm column) (option)
Column mounting jig (for INJ)	S225-01453-95 (option)
Nut	670-11009 (option)
Capillary column cutter	S221-50595-91 (option)

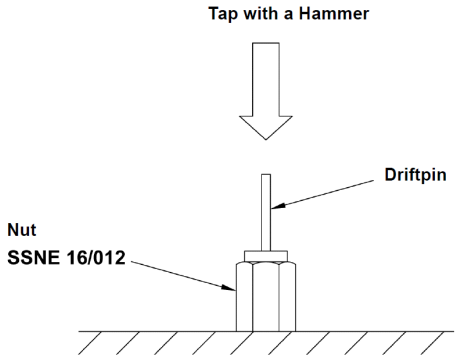
3 **Attach the column to the MS side.**

Aside from using the column mounting jig for MS (P/N: S225-01453-94), this procedure is the same as that for attaching the column on the INJ side.





NOTE The parallel pin is provided in the tool kit (optional product) for the maintenance of the nut SSNE16/012 for attaching the capillary column. This parallel pin is used to remove the ferrule stuck inside the nut when reusing the nut SSNE16/012 that is used to connect the capillary column.
In order to prevent the interface thread from wearing, limit the number of times of reuse of the nut to 2 to 3 times.

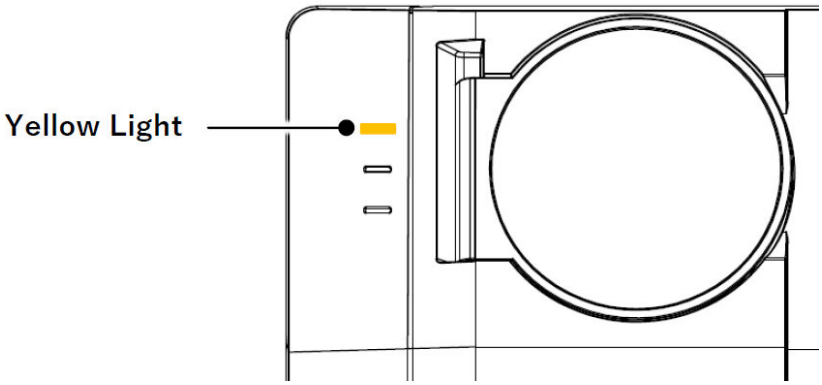


■ Turn on the instrument

If a pre-processing device is connected, turn on the power to the pre-processing device before turning on the MS unit.

1 **Turn on the circuit breaker to which the instrument's power supply is connected, and turn on the GC.**

2 **Turn on the MS.**
On the front side of the MS, the topmost Power LED turns on.



3 **Turn on the PC, printer, and display.**
Windows starts up.

2.1.3 Starting LabSolutions GCMS

Reference Refer to the LabSolutions instruction manual "Getting Started Guide" Section 2.2.

2.2 Instrument Startup and Shutdown

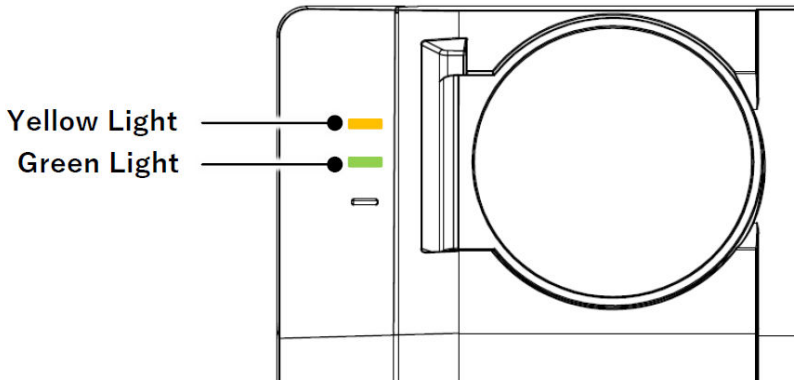
2.2.1 Starting the Instrument

NOTE

- During wintertime, or when the instrument has been stopped for a long time and the room temperature is very low, the oil of the foreline pump is viscous. If the start menu is launched and the foreline pump is activated in this state, the overloaded foreline pump motor may lead to the power switch and circuit breaker on the rear side of the instrument to trip. In such a state, turn on the heating in the room, and start the instrument after the temperature of the foreline pump unit has reached the temperature of the instrument's installation environment (minimum temperature: 18 °C).
- Before starting the machine, read "3.7.1 MS Vacuum Leak Check" and make sure that the O-ring on the connecting part of the column or the front door of the MS section has not been forgotten to be attached, or dust has not adhered.
- If the Vespel® ferrule is new, raising or lowering the column oven temperature will cause a leak in the ferrule section.
  Raise the column oven, the inhection port, and the interface to the temperature to be used for analysis, cool the temperature to 50°C or less, and tighten the nuts on the INJ and MS sides with a torque wrench.
  If the nut is tightened at a high temperature, the sliding part may burn, so be sure to cool the temperature to 50°C or less.
- When replacing a column with one of a larger internal diameter, a large volume of carrier gas may flow into the MS and prevent the vacuum system from starting. Before starting the vacuum system, adjust the pressure for the carrier gas and make sure that the flow into the column is 3 mL/min.

Reference Refer to the LabSolutions instruction manual "Getting Started Guide" Section 2.6.

The Ready LED in the middle of the front of the MS unit will light up when the unit has finished vacuuming.



2.2.2 Shutting Down the Instrument

Reference Refer to the LabSolutions instruction manual "Getting Started Guide" Sections 6.1 and 6.2.

2.3 Daily Startup and Shutdown

When the instrument is used daily, the vacuum system should be left running after each use rather than shutting down and restarting it so that the proper analysis conditions can be met more quickly. This section describes how to set the shutdown parameters when the instrument is standing by for analysis and how to execute a shutdown.

2.3.1 Daily Shutdown

Reference Refer to the LabSolutions instruction manual "Getting Started Guide" Appendix E.

2.3.2 Daily Startup

Follow the procedure below when the vacuum system is already running, as when the daily shutdown procedure has been performed.

1 **In the [Acquisition] menu, select [Download Instrument Parameters].**

NOTE Do not connect or disconnect devices connected via USB (such as USB memory or printers) or switch the power OFF/ON while the [Realtime Analysis] program is running. Doing so could interfere with communications.

2.4 Column Replacement

This section explains column replacement when column performance has deteriorated or with a column more appropriate for the application. If the column is not replaced correctly, a vacuum leak may result.

2.4.1 Shutting Down the Vacuum System

Shut down the vacuum system.

Reference "2.2.2 Shutting Down the Instrument"

2.4.2 Changing the Column

■ Removing the column

Loosen the nuts at the injector and MS connections, and remove the capillary column. If the Vespel ferrule and nut from the MS end are still on the capillary column, the column may be stored with the ferrule and nut attached.

Vespel ferrules and nuts required for the installation of the capillary column are consumables. Purchase a necessary quantity.

Reference "6.1 Consumable Parts and Maintenance Parts List"

■ Installing the column on the INJ side

Reference Refer to "Attach the column to the INJ side" in "2.1.2 Preparing the Instrument"

■ Connecting the capillary column to the MS

Reference Refer to "Attach the column to the MS side" in "2.1.2 Preparing the Instrument"

■ Turning on the instrument

Reference Refer to "Turn on the instument" in "2.1.2 Preparing the Instrument"

■ Starting LabSolutions

Reference Refer to "2.1.3 Starting LabSolutions GCMS"

■ Starting the vacuum system

Reference Refer to "2.2.1 Starting the Instrument"

2.5 System Configuration

This section explains system configuration. Procedures are described for entering the properties for the autosampler, injection port, column, detector, additional temperature control, additional flow, and other installed components.

2.5.1 Opening the [System Configuration] Window

Reference Refer to the LabSolutions instruction manual "Getting Started Guide" Section 2.5.

2.5.2 Checking GC Communication Settings

Reference For information on the PC-GC communication settings, refer to the LabSolutions instruction manual "Operators Guide" 2.1.2 Communication Settings.

2.6 System Adjustment and Validation

2.6.1 System Check

■ Overview

Parameter	Description	Action if System Check fails
Consumables Check	Verifies how long and how many times a GC/MS consumable part has been used.	Replace the part and reset its amount of use.
⬇		
GC Check	Verifies system status of GC.	If adjustment or repairs are recommended, discuss them with your Shimadzu representative.
		If a part replacement is necessary, replace the part as recommended.
⬇		
Report Out	Prints the System Check results.	

▶▶ Reference For the System Check procedure, refer to the LabSolutions instruction manual "Operators Guide" 2.3 Diagnosing the Instrument (System Check).

2.6.2 Tuning

This instrument has an auto tuning function that automatically adjusts the MS control parameters so as to enable the acquisition of a desirable mass spectrum.

▶▶ Reference For information on the auto tuning procedure, refer to the LabSolutions instruction manual "Getting Started Guide" 2.8 Auto Tuning.

3 Maintenance

3.1 Precautions

Read and follow the following MS maintenance precautions to ensure optimal MS performance and prevent accidents.

⚠ WARNING

Before performing the tasks described in this section, make sure to read the precautions and the following information.

Failing to do so may result in an accident.

- Wear clean gloves when touching inside the instrument.
  For more information, refer to Maintenance Help.
- Use clean tools to disassemble parts. Contaminants from dirty tools or gloves can generate background noise.
  Clean any tools used inside the mass spectrometer with a lint-free cloth and acetone.
- Place parts on a clean cloth as they are removed, to ensure that they remain clean.
- When disassembling the removed components, use tools that have been wiped clean using an acetone-infused cloth.
  Remember the assembled state of the components to be disassembled, so that you can assemble them correctly again.
- For any maintenance work other than exchanging the columns or working with the periphery of the ion source (work that requires opening of the MS cover or moving the MS), contact your Shimadzu representative.

3.2 Replacing the GC Consumables

With the GCMS-QP2050, the "Easy sTop" allows GC inserts and septums to be replaced without loosing vacuum of MS.
Easy sTop can be operated from the LabSolution GCMS and the GC itself.

▶▶ Reference For information about how to use Easy sTop, see the following in the Shimadzu GC/GCMS Maintenance Help:
・Operating from LabSolutions GCMS
"Enter maintenance mode using the workstation"
・Operating from GC-2030
"Enter maintenance mode using the the instrument monitor"
・Operating from GC-2050
"Enter maintenance mode using the maintenance button on the instrument"

3.3 Filament Replacement

Vacuum drop, as well as wear due to long hours of use, may cause the filament to break or bend.
Follow the precautions when replacing the filament.

⚠ WARNING

Instruction

Allow the instrument to cool for 10 minutes after shutdown. Check that the instrument has sufficiently cooled before starting work.

The ion source and interface reach high temperatures during operation and can cause burns.

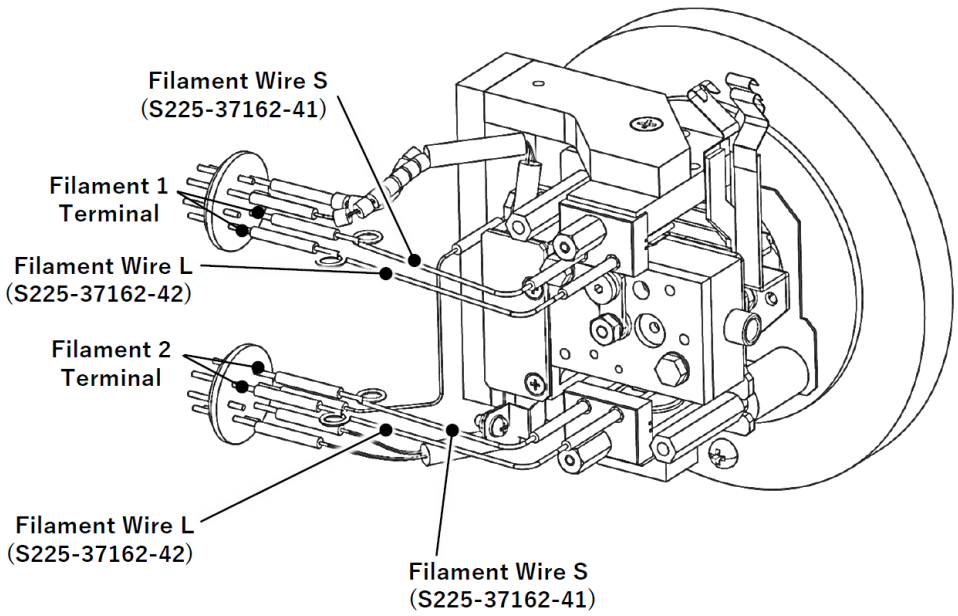
3.3.1 Filament Replacement Procedure

1 **Stop the instrument by following the instrument stop procedure.**

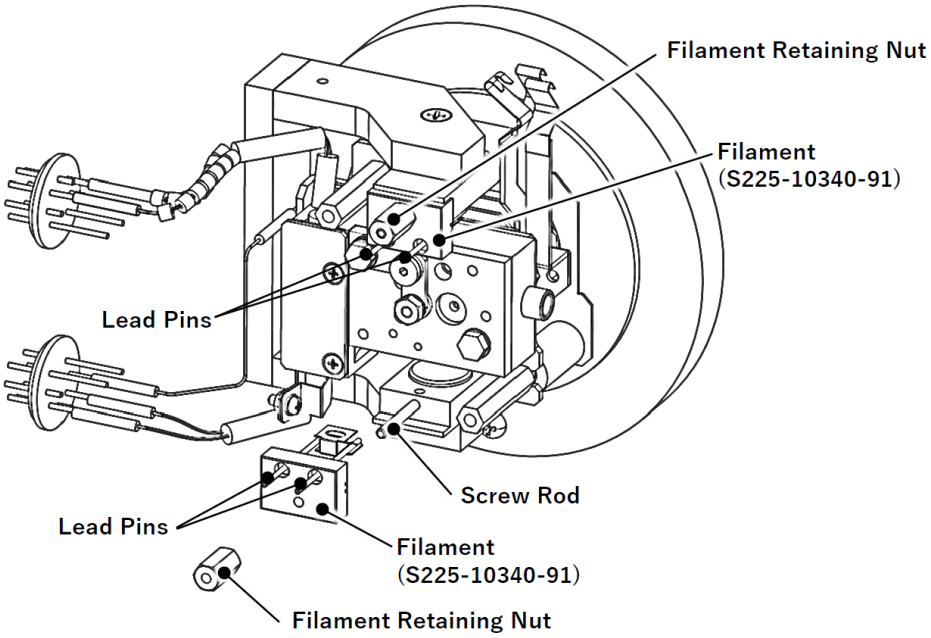
Reference "2.2.2 Shutting Down the Instrument"

2 **Open the front door.**

3 **Remove the filament wires.**



4 **Loosen the filament retaining nuts and remove the filaments.**



5 **Prepare the new filaments and pass them through the screw rods, inserting them firmly, and tighten the filament retaining nuts.**

6 **Insert the filament wires while paying attention to the attachment positions.**

NOTE Precautions during filament installation:

- Insert the filament completely.
- Do not allow the filament leads to contact any other part when the filament is seated.
- If the connection of the lead wire socket and lead pin is not good, request a replacement from a Shimadzu representative.

7 **Start the instrument, and according to the procedure on "3.8 Reset Usage Frequencies/Usage Times of Consumables", set the filament usage time to 0.**

Reference "2.2.1 Starting the Instrument"

3.4 Replacing and Cleaning the Ion Source Box and Lens 1

The ion source box and Lens 1 emit an electron beam at samples to ionize them for extracting ions from samples. Therefore, long-term use will eventually make the ion source box dirty. When the ion source box or lens 1 gets dirty, generated ions will not be effectively extracted, which reduces sensitivity. Therefore, the ion source box and lens 1 ASSY need to be removed for cleaning.
The ion source box and lens 1 can also be replaced with new ones.

⚠ WARNING

Exercise caution when handling the organic solvent used to clean the ion source box and Lens 1.
Provide proper ventilation in areas where organic solvent is used.
The solvents used are flammable and toxic. Without proper ventilation, they can cause poisoning or may ignite and cause fire.

Allow the instrument to cool for 10 minutes after shutdown. Check that the instrument has sufficiently cooled before starting work.
The ion source and interface reach high temperatures during operation and can cause burns.

Allow the ion source box and lens 1 to cool sufficiently before starting work.
The ion source box and lens 1 can be hot after drying and baking, and could cause burns.

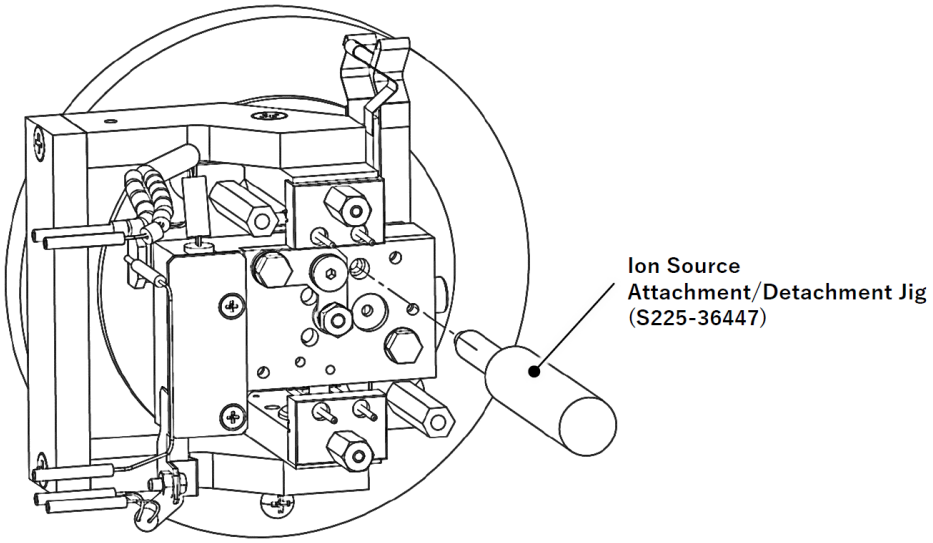
3.4.1 Attaching/Detaching the Ion Source ASSY

1 **Stop the instrument by following the instrument stop procedure.**

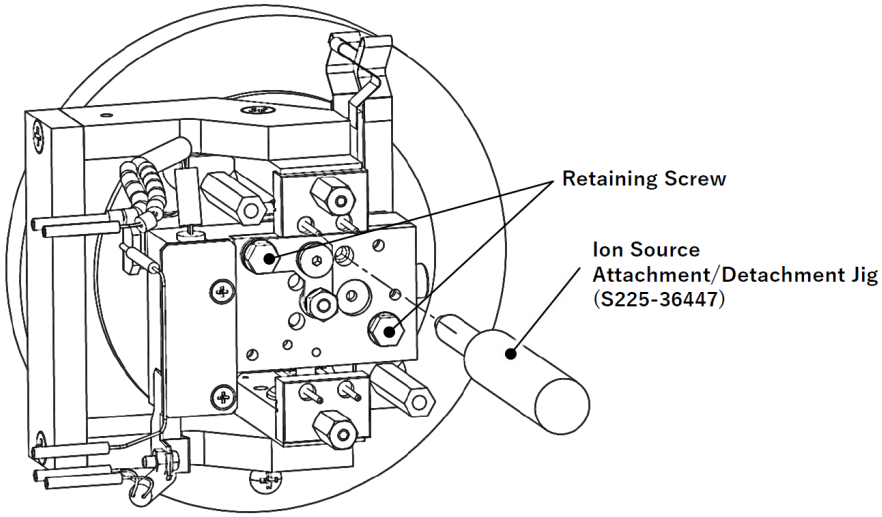
Reference "2.2.2 Shutting Down the Instrument"

2 **Open the front door.**

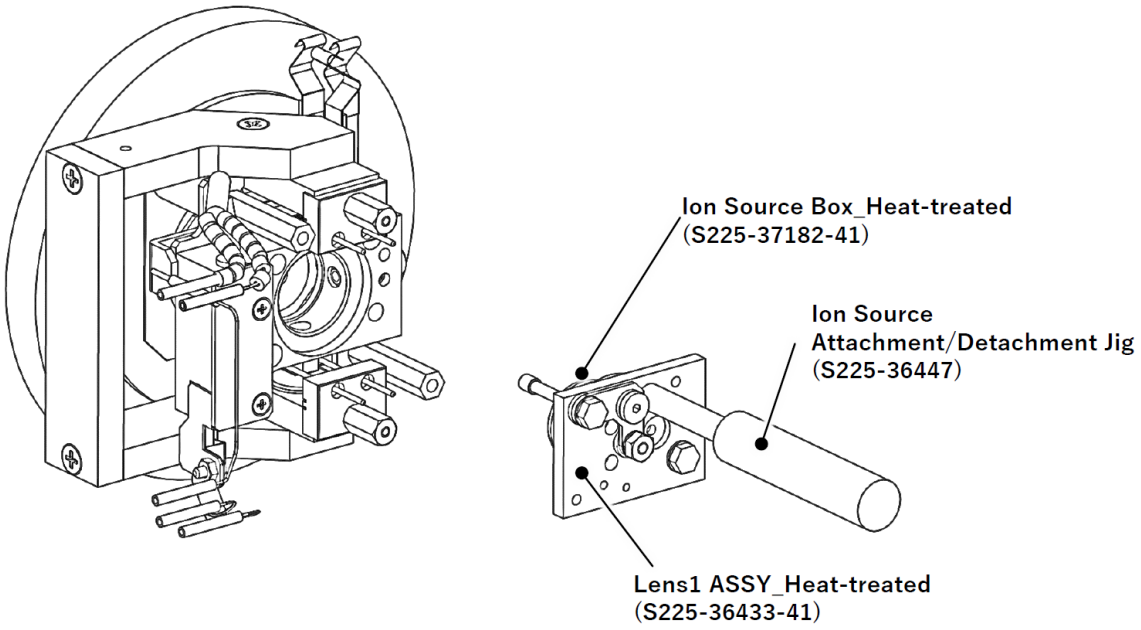
3 Screw the ion source ASSY attachment/detachment jig into the screw hole of the ion source box.



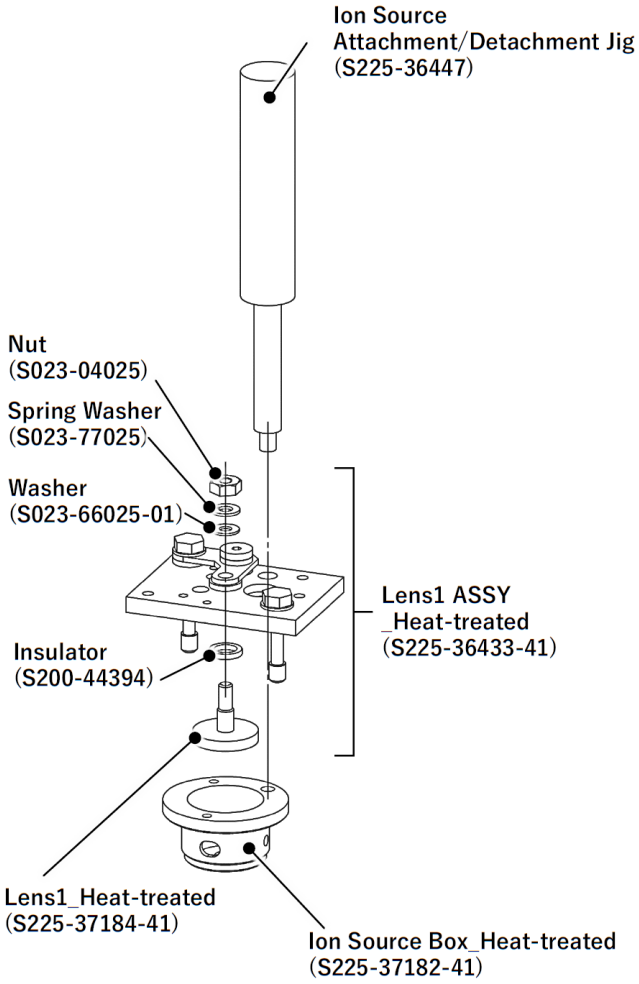
4 Loosen the two retaining screws.



5 **Hold the ion source ASSY attachment/detachment jig and remove the ion source ASSY.**



6 **Remove the ion source ASSY attachment/detachment jig and separate the ion source box and lens 1 ASSY.**



7 **Loosen the nut on lens 1 ASSY and remove lens 1.**

3.4.2 Cleaning the Ion Source Box and Lens 1

The GCMS-QP2050 recommends that you replace the ion source box and lens 1 with new ones. This section explains how to clean them when they are reused.

> **NOTE** Do not clean the insulator. Replace a dirty insulator with a new one. (P/N: S200-44394)

■ Required Materials

Abrasive paper

If parts are extremely contaminated, polish with general finishing paper followed by extra-fine finishing paper. If parts are only slightly contaminated, polish with extra-fine finishing paper only.

- P/N：S085-35124-02 (general finishing, 20 sheets)
- P/N：S085-35124-03 (extra-fine finishing, 20 sheets)

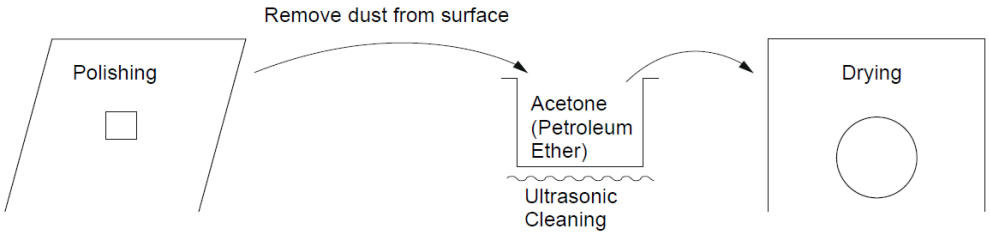
1 **Polish parts with abrasive paper.**

2 **Remove dust from the surface with a clean compressed air source.**

3 **Perform ultrasonic cleaning in acetone or petroleum ether.**

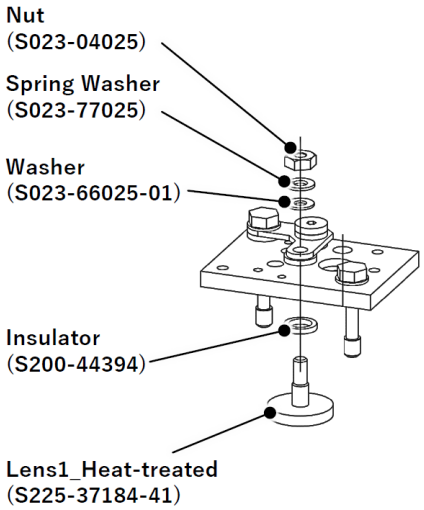
4 **Bake the ion source box and repeller electrode at 400 °C for about 1 hour.**
Use commercially-available electric furnace, etc.

5 **Save the ion source box and lens 1 in a clean box after baking.**



3.4.3 Assembling Lens 1 ASSY and Attaching the Ion Source Box

1 **Assemble lens 1 ASSY.**



2 **Stack lens 1 ASSY and the ion source box, and screw the ion source ASSY attachment/detachment jig into the screw hole of the ion source box.**

Reference Figure for step 6 in"3.4.1 Attaching/Detaching the Ion Source ASSY"

3 **Hold the ion source ASSY attachment/detachment jig and lock it into the instrument.**

4 **Tighten the retaining screws.**

5 **Start the instrument, and according to the procedure on "3.8 Reset Usage Frequencies/Usage Times of Consumables", set the ion source usage time to 0.**

Reference "2.2.1 Starting the Instrument"

3.5 Vacuum Pump Maintenance

This section describes how to carry out maintenance work on the foreline pump and the turbomolecular pump.

If the foreline pump is used instead of a rotary pump, it requires oil change. The rotary pump oil is still hot right after the instrument is stopped. Allow the oil to cool for 10 minutes after instrument shutdown. Check that the oil has sufficiently cooled before starting work.

3.5.1 Changing the Oil in the Foreline Pump

The foreline pump requires an oil change every 3000 hours.
The oil must be changed to prevent vacuum level deterioration, oil leaks and excessive noise.
The oil must have the proper characteristics for the pump. Use only pure oil of the specification.

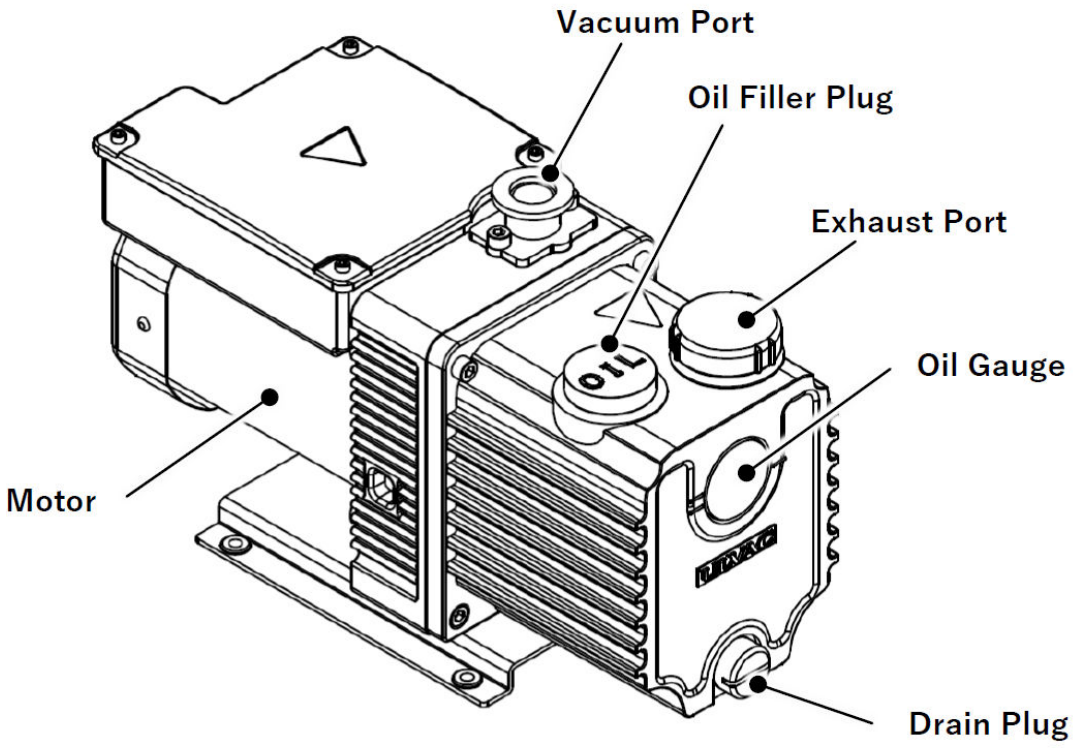
■ Oil Change Procedure

⚠ CAUTION

Instruction

Allow the instrument to cool for 10 minutes after shutdown. Check that the instrument has sufficiently cooled before starting work.

The foreline pump oil is still hot (about 30 °C above room temperature) right after the instrument is stopped and could cause burns.



1 **Stop the instrument by following the instrument stop procedure.**

Reference Refer to the LabSolutions instruction manual "Getting Started Guide" Section 6.1.

2 **Wait at least 10 min.**

3 **With a tray or a plastic bag ready to receive the oil, discharge the oil by removing the drain plug.**

NOTE Use caution to prevent oil splatters when removing the drain plug.

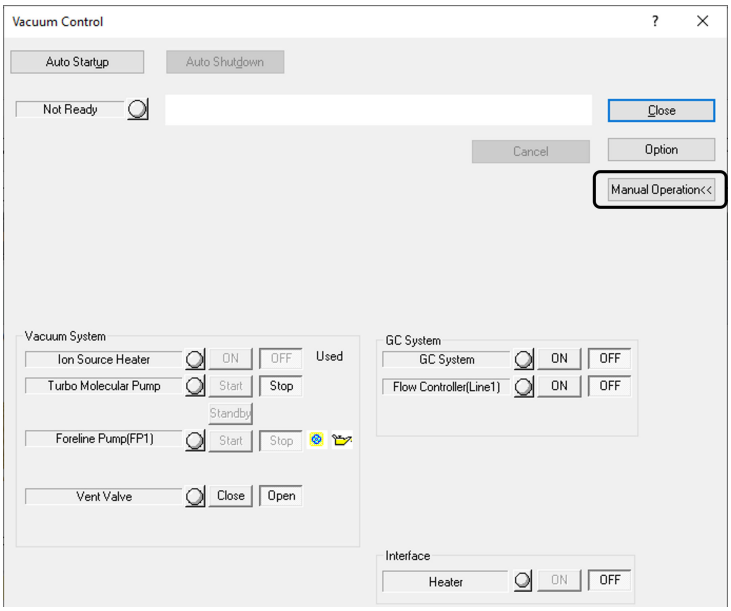
4 **When the oil has finished draining, close the drain plug temporarily.**

5 **Click the Instrument Start/Stop icon  on the [Main] assistant bar.**

The [System Control] window opens.

6 **Click [Manual Operation].**

The manual operation window opens on the bottom side of the window.



7 **In the [Vacuum System] group, click the [Start] button for the foreline pump for which the oil is to be changed.**

8 **Turn on the motor switch for the foreline pump for about 5 to 10 seconds.**

Run the pump to discharge the oil out of the pump.

9 **Click the [Stop] button for the foreline pump for which the oil is to be changed.**

10 **Remove the drain plug, and drain the remaining oil.**

11 **Close the drain plug.**

12 **Remove the oil filler plug and supply new oil into the center of the oil gauge. (approx. 0.28 L).**

13 **Close the oil filler plug.**

14 **Set the usage time of the foreline pump oil to "0" according to the procedure described in "3.8 Reset Usage Frequencies/Usage Times of Consumables".**

NOTE In addition to the oil changing procedure, pump overhaul should be performed every 1500 hours. Refer to the User's Manual for foreline pump.

3.5.2 Maintenance for the Turbomolecular Pump

When running continuously in conjunction with the GCMS-QP2050, no special maintenance is required. However, the rotating parts have a limited working life and should be replaced every 3 years to prevent accidents.

If the equipment will not be used for a long period, it should be operated for 8 hours at least one every 6 months. If it is left unused for more than 6 months, malfunctions may occur.

Contact your Shimadzu representative for the replacement of the turbomolecular pump.

3.6 Cleaning the Fan

The fan and fan guard must be periodically cleaned.

NOTE Do not use the instrument if dust has accumulated on the fan or fan guard. Insufficient cooling could compromise performance.

⚠ CAUTION

Instruction

To prevent injuries or accidents when cleaning the fan and fan guard, ensure that instrument is shut down and verify that all power switches are off. Failing to do so may cause injury or equipment failure.

1 **Shut down the instrument according to the procedure.**

Reference "2.2.2 Shutting Down the Instrument"

Ensure that all of the power switches are off.

2 **Vacuum dust from the vents of the MS.**

3 **Vacuum dust from the fan and fan guard on the back of the GC.**

4 **Vacuum dust from the vents of the PC system and any other instrument modules, such as the autosampler.**

3.7 Checking for MS Vacuum Leak

This instrument automatically runs a vacuum leak check when it is started up according to "2.2.1 Starting the Instrument". If a vacuum leak is found, identify the vacuum leak location and take action according to "3.7.1 MS Vacuum Leak Check".
If any leak is found in the GC, refer to the instruction manual for the GC for troubleshooting.

Operating an instrument with an air leak can cause a decrease in sensitivity, an increase in noise, filament burnout or other problems. Always check for leaks after performing maintenance.
In addition, perform autotuning after starting the device and confirm that there is no vacuum leakage.

Reference For instructions on auto tuning, refer to "2.8 Auto Tuning" in the LabSolutions User's Guide.

3.7.1 MS Vacuum Leak Check

This section describes MS vacuum leak check procedures. Leaks can be large enough to take the foreline pump off-line, or small enough to allow the turbomolecular pump to function almost normally.

The instrument door should have an O-ring. If the seal of the O-ring is incomplete, it can result in leakage. Follow the precautions below when opening and closing the door:

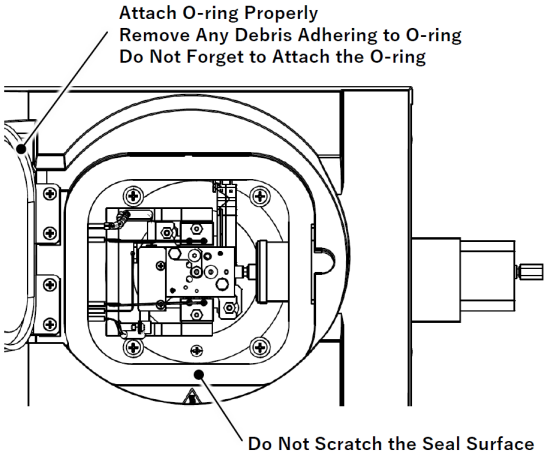
- Do not forget to install the O-ring.
- Install the O-ring properly.
- Remove any foreign material from the O-ring.
- Remove foreign material, including pieces of O-ring, from sealing surfaces.
- Do not scratch sealing surfaces.
- Do not forget to install the Vespel® ferrule where the column connects to the interface.
- Firmly tighten the column interface nut.
- Change the GC septum on a regular basis (around 80 to 100 injections).

■ **If the foreline or turbomolecular pumps are not functioning properly:**

- The sound of air exhausting from the foreline pump does not diminish after a few minutes.
- The turbomolecular pump operates, but the vacuum system power shuts down after about 5 minutes.

If the situation described above occurs, a vacuum leak is indicated. Wait for the MS to vent, then check the front door and the connection between the column and interface according to the above precautions for preventing vacuum leaks. If a vacuum leak occurs in a location other than the front door or connection between the column and interface, contact your Shimadzu Service Representative.

Front Door and Sealing Surface



3.8 Reset Usage Frequencies/Usage Times of Consumables

Reference Refer to the LabSolutions instruction manual "Getting Started Guide" Section K.2.

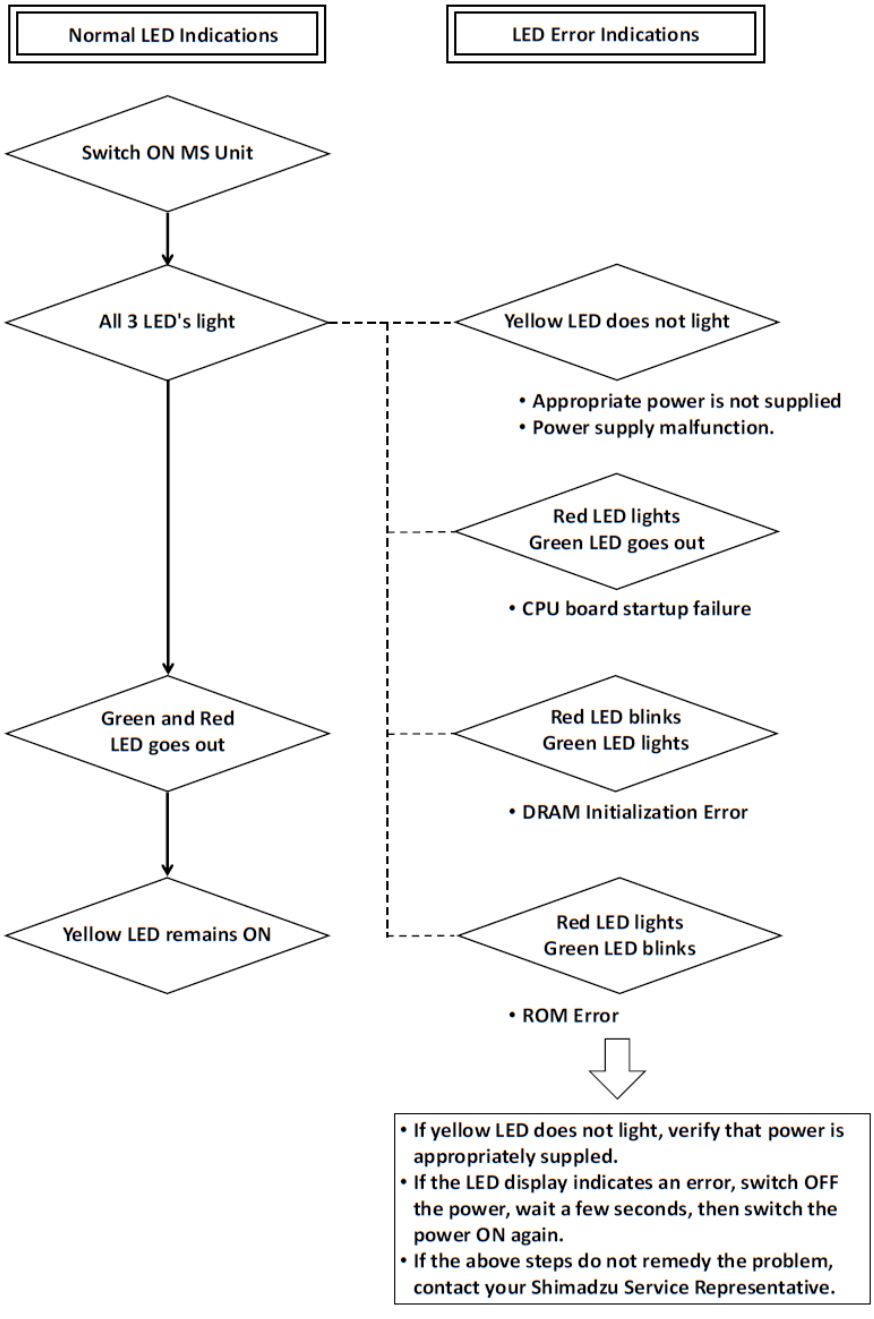
4 Troubleshooting

This chapter explains the problems that may occur to the instrument, the possible causes thereof, and how to deal with them.

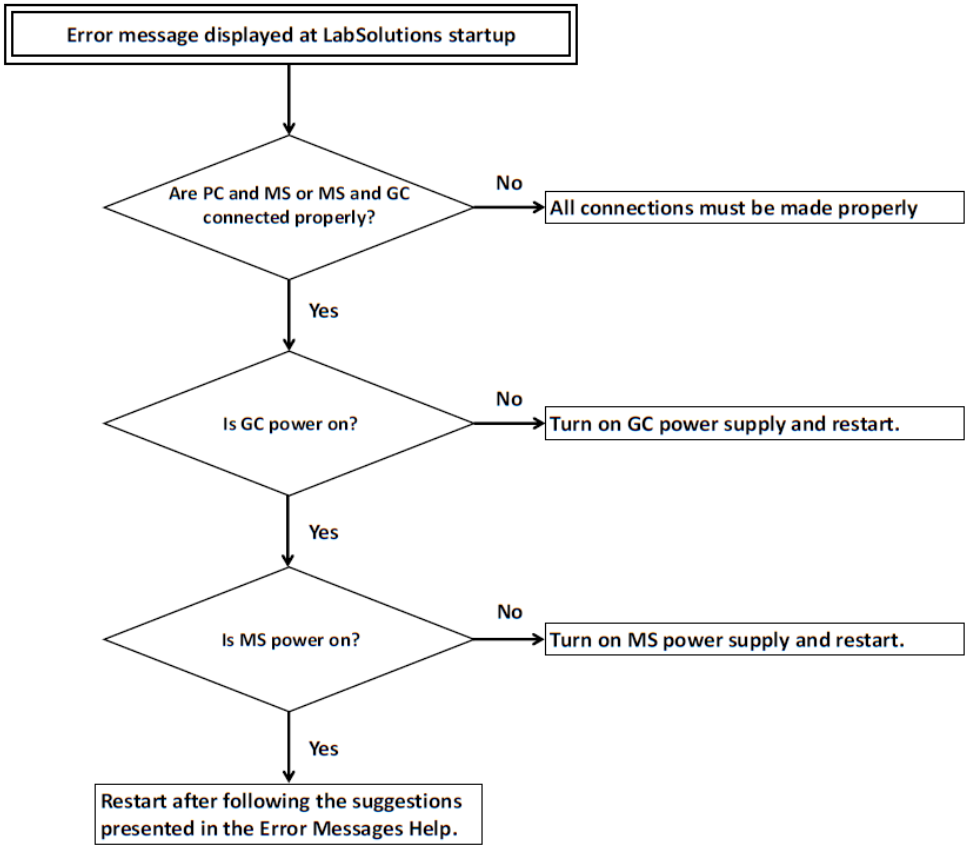
Contact your Shimadzu Service Representative if symptoms persists after remedial action, or if other problems arise.

4.1 Troubleshooting for Normal Operation

4.1.1 Error Status Indicated by LED on MS

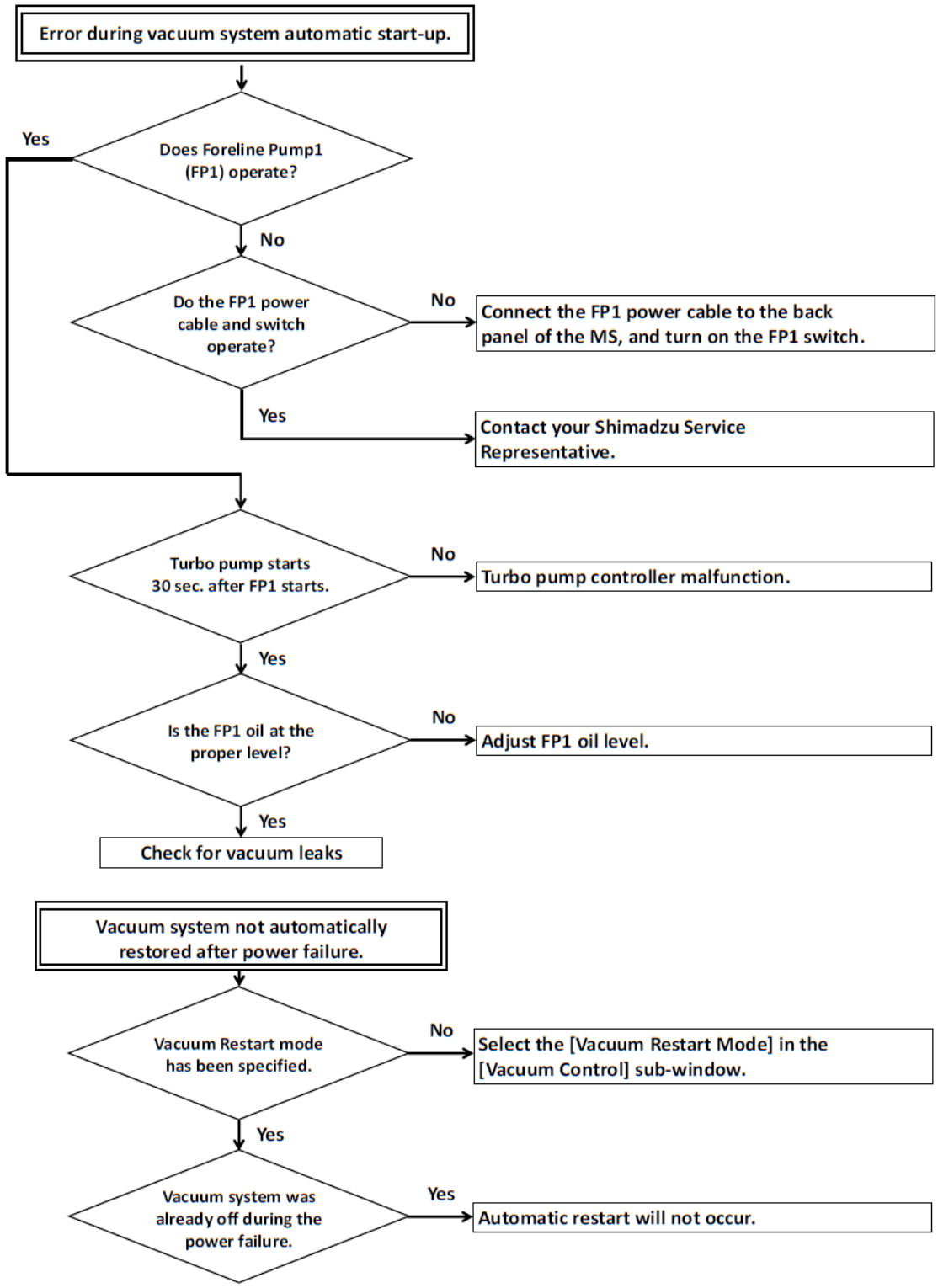


4.1.2 LabSolutions Software Startup Errors



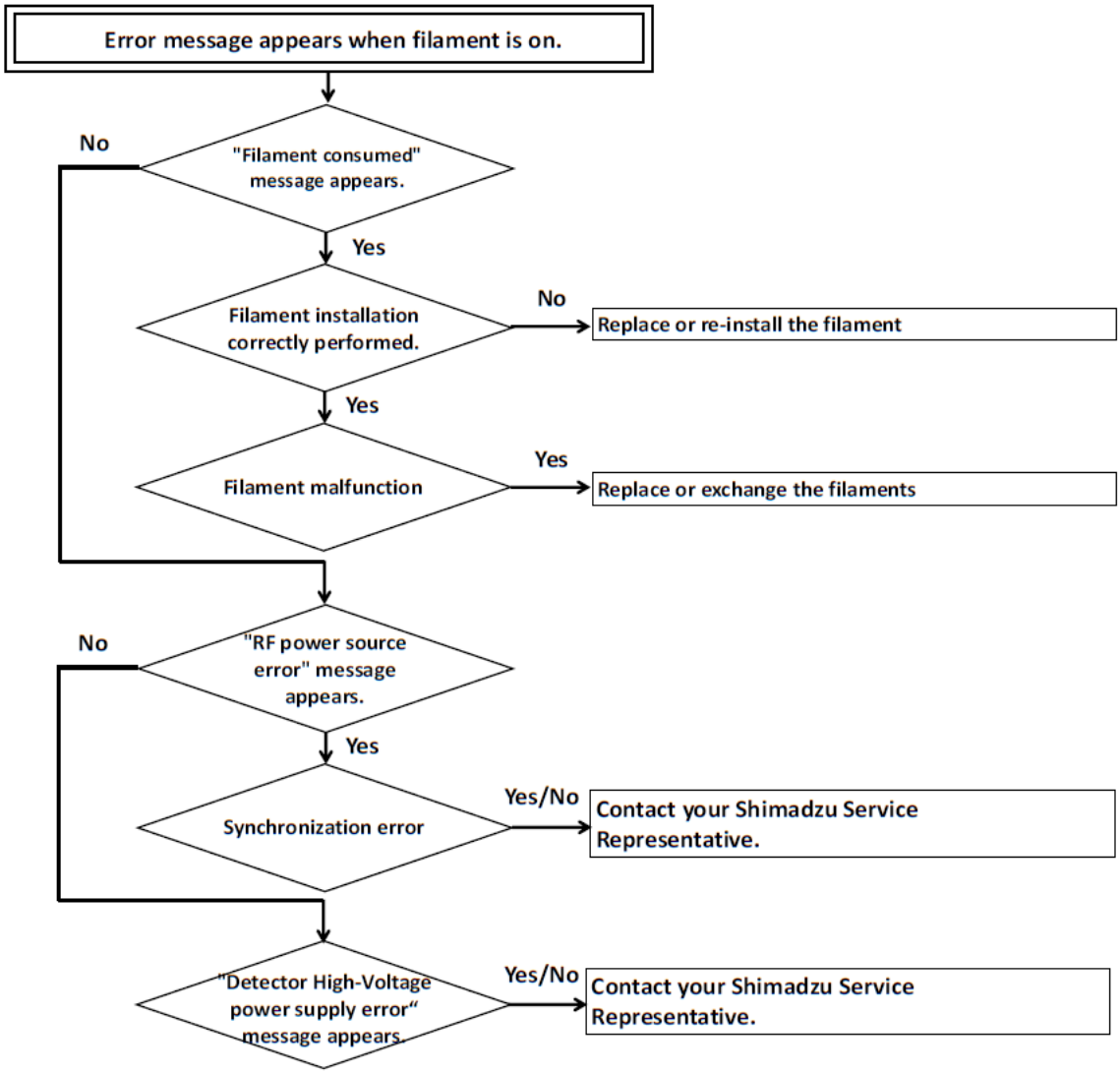
Reference "1.3.1 Analytical System"

4.1.3 Vacuum System Auto Startup Errors



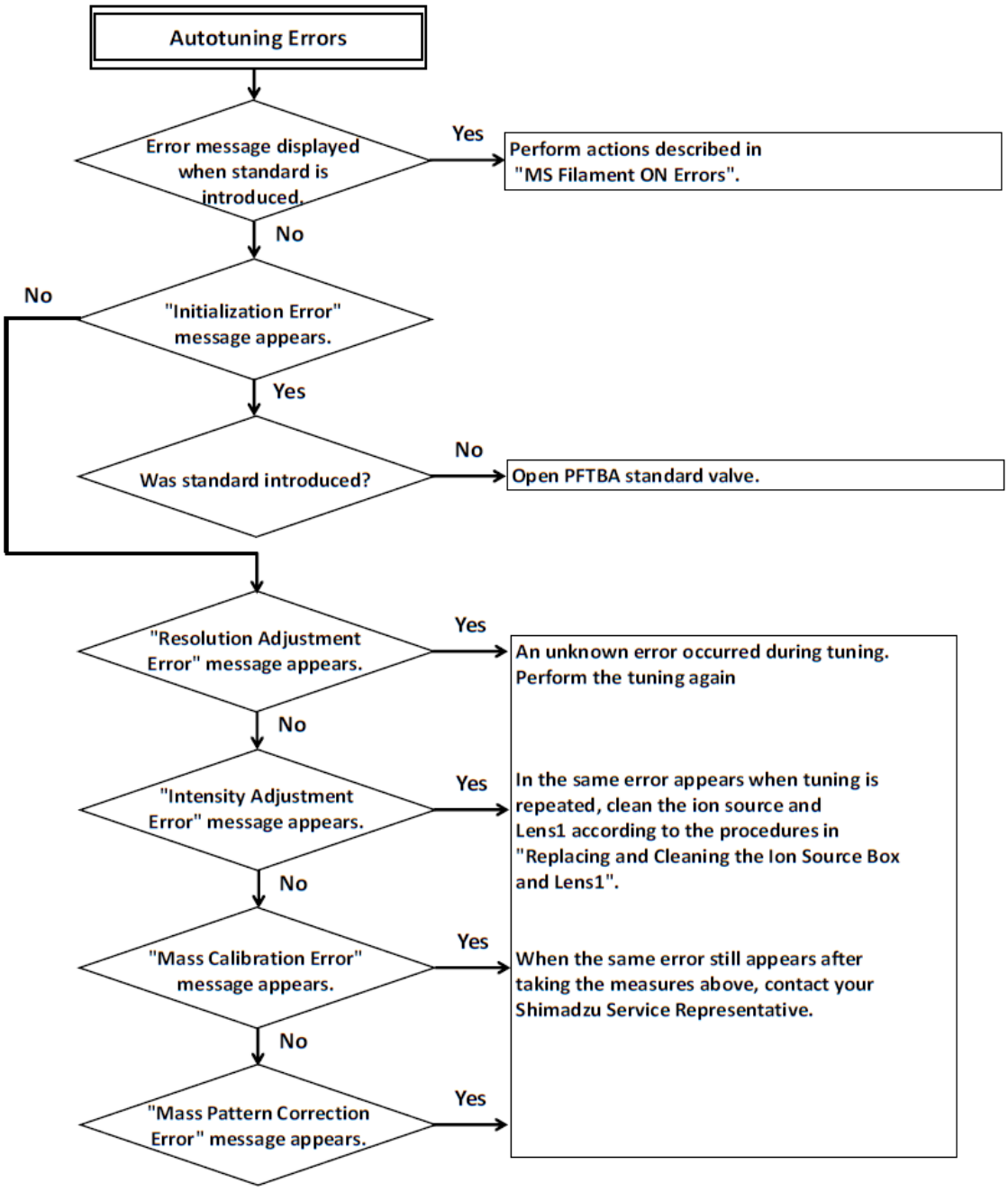
Reference "3.7 Checking for MS Vacuum Leak"

4.1.4 Filament ON Errors

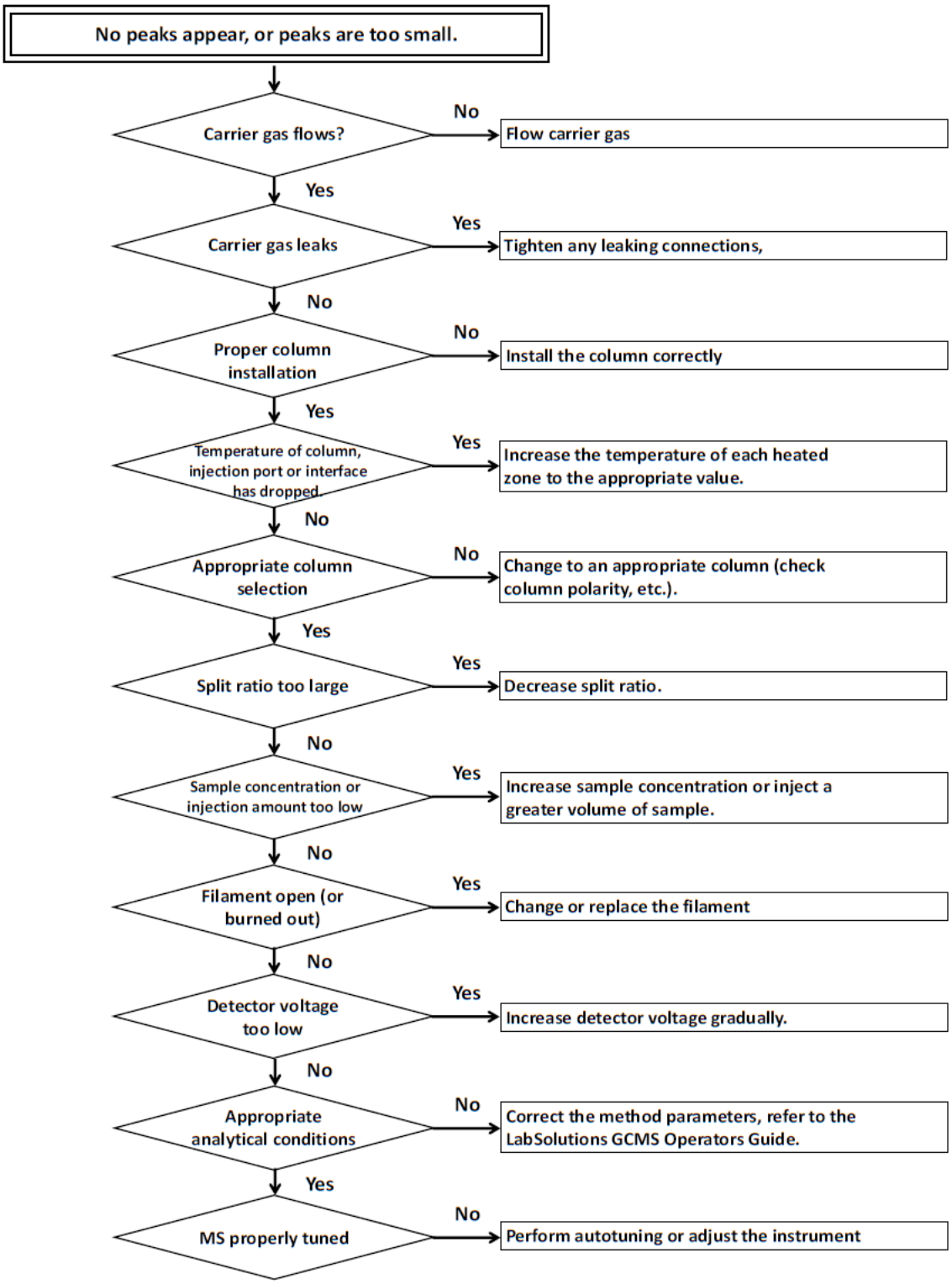


Reference "3.3 Filament Replacement"

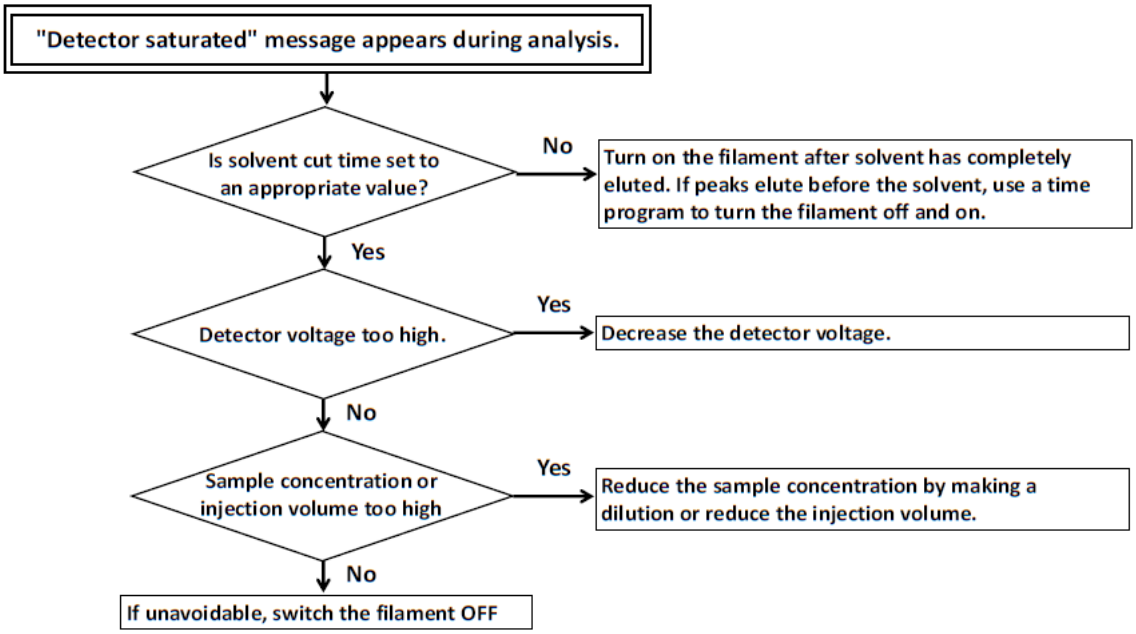
4.1.5 Autotuning and Analysis Errors



Reference "4.1.4 Filament ON Errors"
"3.4 Replacing and Cleaning the Ion Source Box and Lens 1"



Reference "2.1.2 Preparing the Instrument"
"2.2 Instrument Startup and Shutdown"
"2.6 System Adjustment and Validation"
"3.3 Filament Replacement"
"3.7 Checking for MS Vacuum Leak"


"Detector saturated" message appears during analysis.
Is solvent cut time set to an appropriate value?
No
Turn on the filament after solvent has completely eluted. If peaks elute before the solvent, use a time program to turn the filament off and on.
Yes
Detector voltage too high.
Yes
Decrease the detector voltage.
No
Sample concentration or injection volume too high
Yes
Reduce the sample concentration by making a dilution or reduce the injection volume.
No
If unavoidable, switch the filament OFF

4.2 Vacuum System Protection Functions

This section describes the protection functions when something abnormal is detected in the vacuum system.

4.2.1 Overview

Three items are monitored during evacuation in the GCMS-QP2050. System protection occurs when something abnormal is detected.

- Status of the turbomolecular pump.
- Back pressure of the turbomolecular pump. (Low vacuum in "Instrument Monitor" shows the backpressure)
- Vacuum of analyzer housing. (High vacuum in "Instrument Monitor" shows the vacuum)

When the Ion Gauge is set to "None" in the System Configuration window, high vacuum is not displayed.

4.2.2 Protection Functionality

■ Protection for the RF, detector, and filament

- Low vacuum (monitored by Pirani gauge) is greater than 300.0 Pa.
- Turbomolecular pump is not in "Ready" condition.
- High vacuum (monitored by ionization gauge (option)) is larger than 1.0E-1 Pa.

If any of the above conditions occurs, the protection function kicks in to turn off the MS filaments, detector, and RF voltage.

Filament, detector high voltage and RF voltage are turned on again when the following conditions are satisfied.

- Low vacuum (monitored by Pirani gauge) is smaller than 80.0 Pa.
- Turbomolecular pump is in "Ready" condition.
- High vacuum (monitored by ionization gauge (option)) is smaller than 8.0E-2 Pa.

■ Protection for the vacuum system

- Low vacuum (monitored by pirani gauge) is larger than 300.0 Pa.
- Turbomolecular pump is not in "Ready" condition.

If either of the above persists for 10 minutes, the vacuum system comes to an automatic stop.

The vacuum system LED is red and blinks when the vacuum system is stopped.

5 Product Specifications

5.1 Performance

See the specifications sheet.

5.2 Hardware

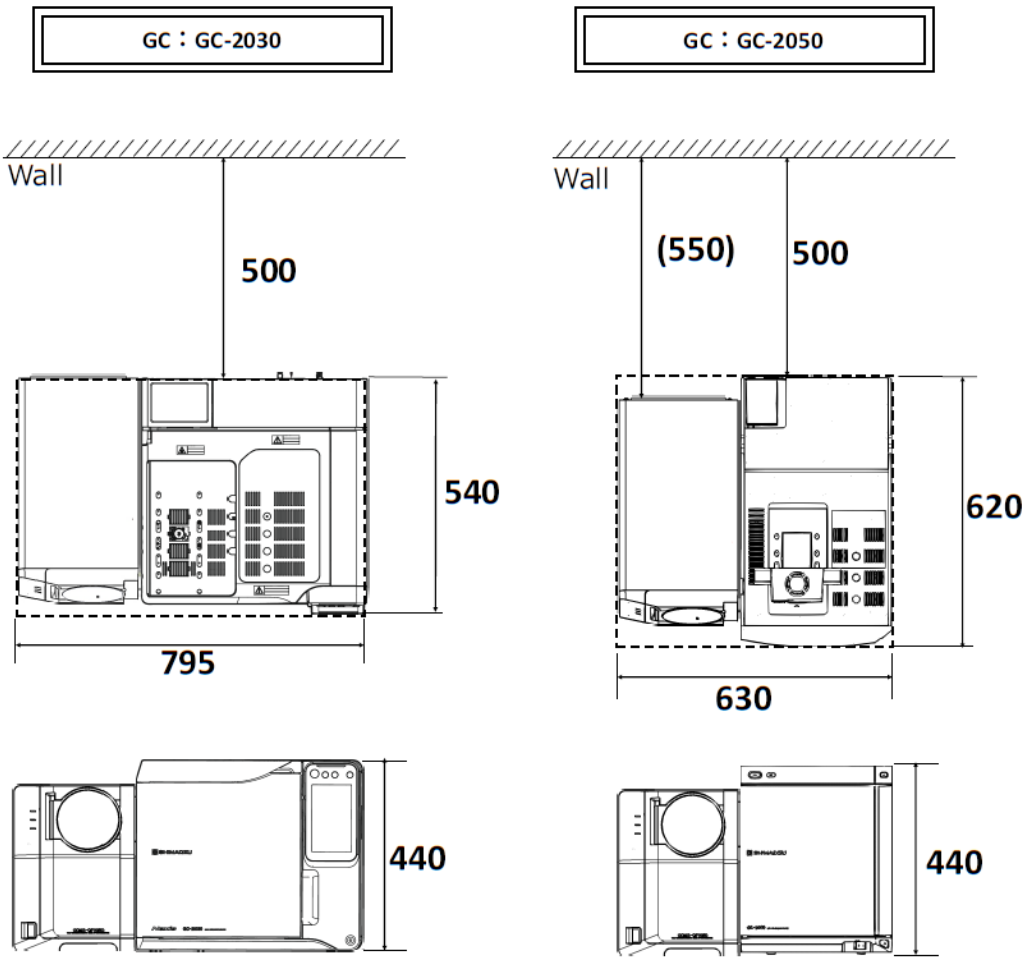
GC/MS interface	Model	Capillary column direct interface
	Temperature	Room temperature - 400 °C
Ion source	Ionization type	EI
	Temperature	Temperature control: 140 - 300 °C 4.4
	Filament	Dual filament (automatic switching)
	Electron voltage setting range	10 - 250 V
	Electron current setting range	10 - 250 µA
Analysis part	Cylindrical quadrupole with pre-rod	
Detector	Secondary electron multiplier with conversion dynode	
Vacuum system (Turbomolecular pump)	255 L/sec (He) class or 60 L/sec (He) class	

5.3 Installation Requirements

Power supply	Frequency	50/60 Hz
	For GC	Refer to the instruction manual provided with the GC unit.
	For MS	Single phase 100-120 V AC, 220-240 V AC 1000 VA NOTE When supplying power to the foreline pump from the MS, check the power supply specifications of the foreline pump, and use the power supply voltage of the MS main unit at a power supply voltage that matches the specifications of the pump.
	Voltage fluctuation	±10 %
	Overvoltage	Installation Category II (IEC)
	Protection Class	Class I (IEC)
	Short-circuit Current Rating	1000 A
	* A dedicated power source with a circuit breaker should be provided for the unit. Do not share power supply with another device.	
	* With regards to voltage fluctuations, the device is designed to work in a range ±10 % including fluctuations caused by high frequency noise, but it is recommended that it be kept within ±5 % including noise to ensure the best efficiency. The current frequency fluctuation should be kept within ±0.5 Hz.	
	* Power supplies for PC, monitor and printer are also required.	
	Grounding	100 Ω or less
		Connect the GC, MS, computer, and optional power supply to an equipotential ground.
Environmental requirements	Although this instrument can operate within the temperature range from 15 to 35 °C, and humidity range from 5 to 90 %, it is recommended to use the instrument within the ranges described below to maintain performance. • Temperature range: Constant temperature from 18 to 28 °C • Humidity range: 40 to 70 % (Be sure to avoid dew condensation)	
	Other	Dust, vibrations, spatial noise and corrosive gases should be also avoided.
	Altitude	2000 m max.
	Pollution degree	Pollution degree 2 (IEC)

5.3.1 Installation Examples

The system size when the front GC is GC-2030 or GC-2050 is shown below.
PC and Printer are omitted because they vary in size depending on the model.



NOTE Hot air is vented at the back of the unit when the column oven cools. Do not place any flammable materials behind the unit. Allow a clearance of 50 cm or more between the back cover and the wall. When the optional exhaust duct (S221-80955-41) is used, the clearance from the wall can be a minimum of 25 cm.

Installation Example (dimension will vary depending on the PC and printer used.)
Tubing and cable lengths are as follows.

MS-foreline pump	Vacuum tubing	1.5 m approx.
	Power cord	1.5 m approx.
PC-MS	Cable	2 m approx.
PC-GC	Cable	2 m approx.
Foreline pump exhaust	Tubing	4 m approx.

6 Appendix

6.1 Consumable Parts and Maintenance Parts List

This section describes the consumable and maintenance parts for this instrument.
To order any part in this list, contact your Shimadzu representative.

■ List of consumable/maintenance parts (to be replaced by user)

Unit Name	P/N	Part Name	Remarks	Division
GC	S221-76650-01	SEPTUM CRS	25 pcs	Consumable Parts
	227-35005-01	Fluororubber O-RING	10 pcs Contact: Shimadzu GLC Ltd.	Consumable Parts
	S221-48600	DEACTIVATED SILICA WOOL		Consumable Parts
	227-35007-01	DEACTIVATED GLASS INSERT, SPLIT	5 pcs Contact: Shimadzu GLC Ltd.	Consumable Parts
	227-35008-01	DEACTIVATED GLASS INSERT, SLESS	5 pcs Contact: Shimadzu GLC Ltd.	Consumable Parts
	GLC No.567366	Custom Sky Liner Single gooseneck liner, with wool	Contact: Shimadzu GLC Ltd.	Consumable Parts
	S221-49065-91	AU GASKET 5/PKT	1 pc 221-48990	Consumable Parts
MS Direct Interface	670-15003-03	FERRULE, GVF/004, 10/PKT	For less than 0.25 mm bore capillary column	Consumable Parts
	670-15003-04	FERRULE, GVF/005, 10/PKT	For 0.32 mm bore capillary column	Consumable Parts
	670-15003-07	FERRULE, GVF/008, 10/PKT	For 0.53 mm bore capillary column	Consumable Parts
	670-11009	NUT, SSNE16/012	5 pcs	Consumable Parts

Unit Name	P/N	Part Name	Remarks	Division
ION SOURCE	S225-10340-91	FILAMENT		Consumable Parts
	S225-41730-91	LONG-LIFE FILAMENT		Consumable Parts
	S225-37182-41	BOX EI (HEAT TREATED)		Maintenance Parts
	S225-37184-41	LENS 1 (HEAT TREATED)		Maintenance Parts
	S225-37162-91	WIRE SET,FILAMENT		Maintenance Parts
	S225-01068	INSULATOR		Maintenance Parts
VACUUM	S225-38992-02	FORELINE PUMP OIL ULVOIL R-2 1L		Consumable Parts

■ Tool Kit (Option): S225-45181-91 6

P/N	Part Name	Qty
S086-00476-02	TORQUE WRENCH,CSP3N4X8DX1.*	1 pc
S086-00474-87	SOCKET WRENCH,SH8D X1/4	1 pc
S086-16111-01	TWEEZERS,TSP-21	1 pc
S086-10414-01	SCREWDRIVER, #300 (+2X100)	1 pc
S086-12045-02	NUTDRIVER	1 pc
S086-10403	SCREW-DRIVER, MINUS #100	1 pc
S225-36447	JIG, IS	1 pc
S225-37026-41	JIG1 ASSY,LENS,NT	1 pc
S225-37155	JIG,LENS,NT	1 pc
S086-03047-02	SPANNER,DOUBLE OPEN END 10X12-R	2 pcs
S086-03047-01	SPANNER,DOUBLE OPEN END 6X8-R	2 pcs
S225-01453-94	JIG FOR COLUMN CONNECTION	1 pc
S225-01453-95	JIG FOR COLUMN CONNECTION(INJ)	1 pc
S221-50595-91	CUTTER,CAPILLARY TUBE	1 pc
S026-11007-02	PARALLEL PIN, SUS304 1X12	1 pc
S221-35566-92	STOP JOINT, with RING	1 pc
S018-20211-11	TAPE, 631S#25-10X30 YELLOW	1 pc

■ GCMS Entry Kit (Option): S227-37171-01 6

P/N	Part Name	Qty
221-34618 10µl, SSOT-221-34618	SYRINGE, FOR AOC-20, AOC-30	1 pc
227-35004-01	PREMIUM GREEN SEPTUM (50/PKT)	1 pc
670-15003-03	VESPEL® FERRULE 0.4 (10/PKT)	1 pc
670-15003-04	VESPEL® FERRULE 0.5 (10/PKT)	1 pc
227-35005-01	O-RING, INSERT (10/PKT)	1 pc
227-35007-01	DEACTIVATED GLASS INSERT, SPLIT (5/PKT)	1 pc
227-35008-01	DEACTIVATED GLASS INSERT, SLESS (5/PKT)	1 pc
670-11009	NUT, 5 PCS	1 pc

■ Maintenance Kit for QP2050 (Option): S225-38070-92 6

P/N	Part Name	Qty
S221-77580-42	SPLIT FILTER, FOR GC-2030	1 pc
S221-48990	AU GASKET 1/PKT	1 pc
S225-10340-91	FILAMENT	1 pc
S225-41730-91	LONG-LIFE FILAMENT	1 pc
S225-37182-41	BOX EI (HEAT TREATED)	1 pc
S225-37184-41	LENS 1 (HEAT TREATED)	1 pc
S225-20804-91	ABRASIVE CLOTH, WITH CUT (for polishing the ion source)	1 pc
S225-01068	INSULATOR	1 pc

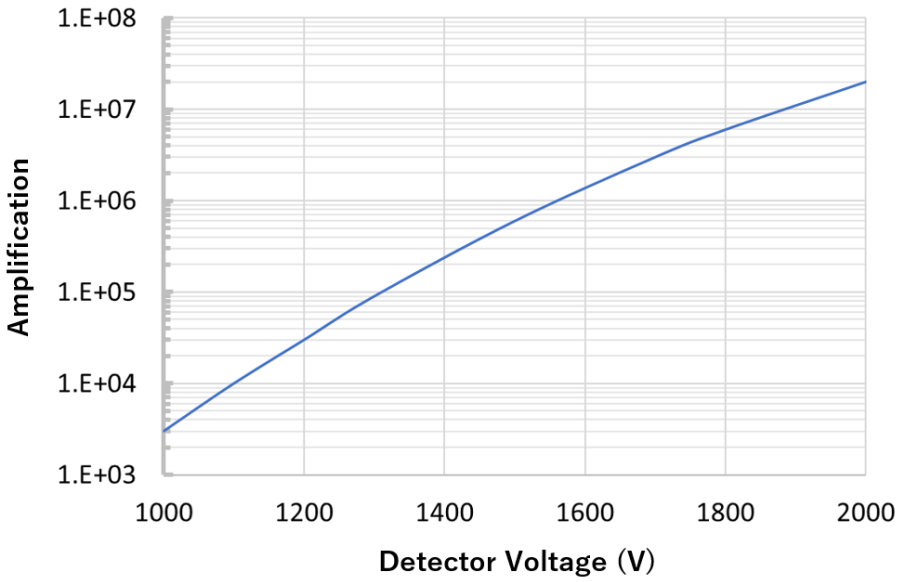
6.2 Technical Notes

6.2.1 Vacuum Characteristics

A variation of roughly ±20% in the vacuum may be observed depending on the ionization interval. Outgassing from vacuum components may affect the vacuum, especially at low flow rates or when monitored in a short time after starting evacuation.

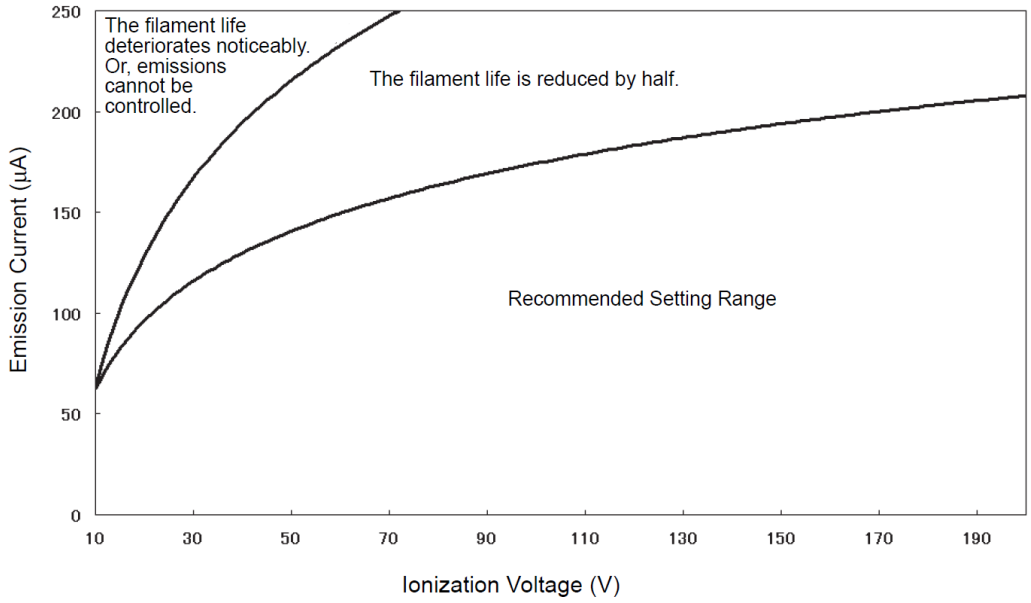
6.2.2 Detector Amplification

The characteristic graph shown in the figure below indicates average values. There will be slight variations depending on the detector.



6.2.3 Ionization Voltage/Emission Current and Filament Life

Ionization voltage and emission current can be changed; however, parameter setting may affect the life of the filament. Refer to the graph below when changing these parameters.



6.3 Glossary of GCMS Terms

6.3.1 Abbreviations

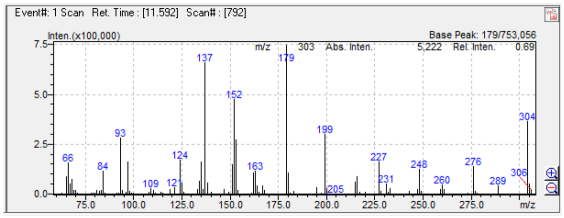
Abbreviations	Full forms
AOC	Automatic Operation Contoroller
CI	Chemical Ionization
DI	Direct Inlet
EI	Electron Ionization
FP	Foreline Pump
GC	Gas Chromatograph
GC/MS	Gas Chromatograph / Mass Spectrometer
MC	Mass Chromatogram
MC	Mass Chromatography
MS	Mass Spectrometer
m/z	Mass-to-charge Ratio
NCI	Negative Chemical Ionization
PFTBA	Perfluorotributylamine
RF	Radio Frequency
SIM	Selected Ion Monitoring
S/N	Signal-to-Noise ratio
SP/SPL	Split / Splitless
TIC	Total Ion Current Chromatogram
TMP	Turbo Moleculer Pump

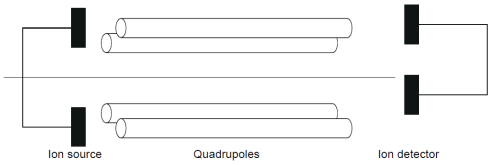
6.3.2 Glossary

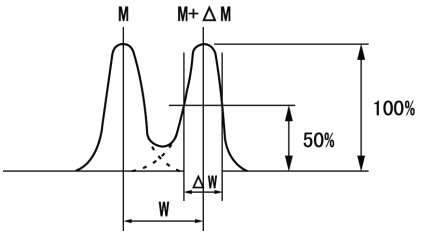
A	
AMU (atomic mass unit)	This is the unit in which atomic masses are measured, defined as 1/12 the mass of Carbon 12. The mass of one Carbon 12 atom is exactly 12 u. The atomic mass of hydrogen is 1.007825.
AOC	Refers to one of the autosamplers that work with the GC system. The AOC injects samples sequentially into the GC injection port. Injections are reliable and automated.
Autotuning	The Autotune program optimizes the performance of the ion lenses. PFTBA calibration gas is introduced and the ion source lens voltages, RF parameters and analyzer voltages are automatically adjusted. The user can edit tuning conditions for resolution adjustment, mass calibration, and sensitivity adjustment (target mass or mass pattern). The final tuning results are printed and can be saved as a tuning file.
B	
Blank nut	This is a GC accessory used to seal a flow line, such as the carrier gas or split/purge lines. It is also referred to as a blind nut.
C	
Capillary column	A capillary column is made of quartz glass capillary tubing; the inner surface is coated with a chemically bonded stationary liquid phase, and the outer surface is coated with a polyamide resin to prevent breakage. The column separates the components of a sample injected into the GC injection port. Except for samples injected with a DI (optional), the column separates all samples. In its standard configuration, the GCMS-QP2050 accepts columns with an inner diameter of less than 0.32 mm. The maximum carrier gas flow rate is 15 mL/min, enabling direct connection of a 0.53 mm column to the MS.
Chromatogram	This is the graphic output (plot) obtained by detecting compounds as they elute from a chromatograph.
CI (Chemical Ionization)	This is an ionization method where reagent gas reacts with the sample molecule to produce ions. Fewer peaks are produced compared to EI, but since it is a "soft" ionization method (with a complex ionization mechanism), it has the advantage of being able to obtain molecular weight information for compounds that cannot be analyzed by EI. When detecting negative ions, this method is called negative ion chemical ionization (NCI).
Condensation	Water droplets can form and adhere to the surface and interior of the instrument. Since condensation is damaging to the instrument, exercise caution during installation.
Consumable parts	These are parts that wear out during use of the GCMS-QP2050, e.g., the GC injection port septum or ion source filament. Maintain adequate supplies of these parts.

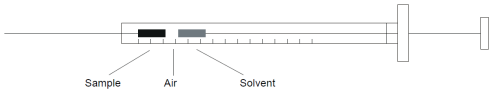
Conversion Dynode	The conversion dynode is located at the entrance to the detector. A high voltage electrode, it efficiently converts positive ions into electrons or negative ions into positive ions, according to polarity. It increases sensitivity, particularly in the high mass range, and facilitates the detection of negative ions. It is used as the detector in the GCMS-QP2050.
D	
Detector	This component converts measured sample characteristics into an electrical signal. The sample is ionized and passes through the ion source box. The ions are massseparated by the quadrupole rods and then converted into an electrical signal by the detector. The GCMS-QP2050 uses an electron multiplier equipped with a conversion dynode.
DI (Direct Sample Introduction)	The sample is inserted directly into the MS with a DI probe. The probe is heated to vaporize the sample, which is not separated by the GC column.
E	
EI (Electron Impact Ionization)	This common method obtains ions from sample molecules. Electrons from a filament are accelerated to 70eV and directed into an ionization chamber, where they impact with the sample molecules present. Because this is a "hard" ionization method, the molecules are cleaved and fragments are produced. Structural information can be obtained from the generated mass spectra, and a database of mass spectra makes library searches possible. This is a highly reproducible and reliable method for qualitative and quantitative analysis.
Electron Volts (eV)	This is the energy applied to the electrons for ionizing a molecule or atom.
F	
Feed-through	Terminal where electrical signals enter without compromising the vacuum in the MS.
Filament	The filament is made of rhenium. Connected to the ion source box, it generates the electron beam necessary for ionizing the samples. Two filaments are present so that if there is a problem with one of the filaments, the operator can switch to the other one.
File	In computer terminology, a compilation of data into a single unit is referred to as a file. In the LabSolutions software, the data, tuning conditions, methods, batch schedule, report format, and libraries are each compiled into files, and are saved with the extensions shown below. Data file (*.gcd) Tuning file (*.gct) Method file (*.gcm) Batch schedule file (*.gcb) Report format file (*.lsr) Library file (*.lib)
Foreline pump	A type of mechanical vacuum pump and it is used as the backing pump for the turbo molecular pump in GCMS-QP2050 system.
G	

GC pressure parameters	The pressure parameters precisely control the pressure of carrier gas flowing through the GC column at each stage of an analysis.
GC temperature parameters	The temperature parameters precisely control the temperature of the column oven at each stage of an analysis. Injection port and interface temperatures can also be specified.
I	
Interface	See Transfer line interface.
Ionization	See EI (Electron Impact Ionization). See CI (Chemical Ionization).
Ion source	This component ionizes the eluted compound from the column. It consists of the ion source box and lens 1 electrode. Ion source and lens stack are called ion source box.
Ion source box	The Ion source box consists of the ion source and lens stack. It is used to ionize the sample molecules and direct those ions to the quadrupoles.
L	
Lens 1	This is the repeller electrode for the ion source box.
Library (library file)	This is the group of mass spectrum data used for library search. The data is stored with a file extension of .lib. When a library search is run, the system searches for similar data in the specified library files.
Library search	This search method picks out the most similar mass spectrum from the search target library files. This method is used when correcting measurement results.
M	
Main rod	See quadrupole rods.
Maintenance parts	These are parts that are necessary for the safe and optimal operation of the GCMS-QP2050. These parts are not changed frequently, but should be changed as they deteriorate.
Mass calibration	M/z and control digital values are calibrated for the entire mass range by aligning specific m/z values with the center of corresponding peaks using samples with known ion peaks (such as PFTBA).
MC法 （Mass Chromatography）	This method repeatedly collects mass spectra at regular intervals during GC measurement, stores this information in memory, selects an arbitrary m/z value, and obtains a chromatogram for each m/z. The chromatogram obtained by this method is called a mass chromatogram.
Mass pattern adjustment	In the GCMS-QP2050, the mass pattern can be adjusted to any pattern (intensity ratio) using the Tuning application. The mass pattern adjustment refers to the process of adjusting a mass spectrum (raw data) acquired by a quadrupole mass spectrometer using the mass patterns from a magnetic field mass spectrometer as a standard. Otherwise, the patterns acquired with a quadrupole mass spectrometer would differ from those acquired with a magnetic field mass spectrometer, even though the mass spectra (raw data) are identical. The mass pattern from a magnetic field mass spectrometer is used as the standard because of the vast amount of data accumulated and used over its long history.

Mass spectrum	This refers to the bar graph display of the intensities of ions in their *m/z* order. 
Method	This refers to a compilation of the parameters controlling the MS and GC units for data acquisition and data processing. Methods are saved as method files. It is saved with the extension .qgm. The advantages of using methods are listed below. • When analyzing samples similar to those analyzed in the past, analyses can be performed with a previously developed method, without having to reset the various parameters. • By using a Batch Table, automated analyses can be performed using a different method for each sample in the autosampler. • Since analysis parameters and data processing parameters can be saved as a single file, data management is simplified.
Middle bore capillary column	This is the general term for capillary columns with an inside diameter of 0.2 - 0.25 mm. This is the standard column used in the GCMS-QP2050.
Molecular ion	A molecular ion is formed from the loss of one electron from a molecule, without breaking any intramolecular bonds. Since many compounds have isotopic atoms, the molecular weight of a pure compound and the m/z value of the molecular ion peak are defined as the most abundant isotope peak found at the highest value of m/z in the spectrum. For benzene, which has substantial m/z 79 and m/z 80 peaks, the molecular ion is considered to be at mass 78.
m/z (mass-to-charge ratio)	This is a value that divides the mass of an ion by its electrical charge number.
N	
NCI (Negative ion Chemical Ionization)	See CI (Chemical Ionization)
O	
O-ring	This is a rubber ring that is installed at the interface between certain types of connections, for example, at the contact surfaces between the door and the analyzer housing. The O-ring seals the two surfaces and prevents vacuum leaks.
P	
PFTBA	This is the acronym for perfluorotributylamine. PFTBA is one of the tuning standards normally used for mass analysis when ions with a mass of up to 700 are analyzed. It is used when performing resolution adjustment, sensitivity adjustment (mass pattern or target mass), and mass calibration. Molecular formula: $(C_4F_9)_3N$

Pre-amp	The pre-amp amplifies the output current from the secondary electron multiplier.
Pre-rod	See Quadrupole rods.
Pt sensor	Platinum is used as a temperature sensor because its resistance is dependent on the temperature. For example, a Pt sensor is used to control the transfer line interface temperature.
Q	
Quadrupole mass filter	An electromagnetic field is obtained by applying RF amplitude and DC voltage to the quadrupole rods, creating a mass filter that allows passage of only the ions with a specified mass.
Quadrupole mass spectrometer	This consists of an ion source, four quadrupole rods, and a detector, as shown in the figure below. As the ions pass through the quadrupoles, they are separated by mass. 
Quadrupole rods	The four quadrupole rods operate in rod pairs to form a hyperbolic electrical field. The main rods have both RF and DC voltage applied. The GCMS-QP2050 also uses pre-rods, where only RF voltage is applied. This keeps the main quadrupoles clean and improves ion transmission.
R	

Resolution	Resolution expresses the degree to which two adjacent peaks are separated. Resolution adjustment refers to adjusting the peak width of mass peaks. The resolution when analysis is performed by a quadrupole MS is shown by the following formula. $R = \frac{W}{\Delta W} \times \frac{M}{\Delta M}$ R : Resolution M : Mass of measured peak ΔM : Mass difference between measured peak and adjacent peak W : Interval between measured peak and adjacent peak ΔW : Measured peak width  For a quadrupole MS, the following expression is used. $\frac{W}{\Delta W} \times \frac{1}{\Delta M} \cdot M$ In cases where the above expression is equal to 2, subsequent multiples of the peak height can be expressed as: $\frac{W}{\Delta W} \times \frac{1}{\Delta M} = 2$
RF power supply	This is the power supply that generates the high frequency voltage and direct current voltage applied to the quadrupoles.
S	
Scan	This is the process of analyzing mass spectra by continuously changing the RF voltage or DC voltage in one direction as applied to the quadrupoles. The interval of the change is called the Event Time and the rate of the change is called the scan speed.
Scan speed	See scan.
Sensitivity adjustment	This consists of adjusting the ion source lens voltages, RF parameters and detector voltage to obtain the best intensity and peak shape for a specific PFTBA mass peak chosen in "Edit Tuning Condition" window in Auto Tuning.
Septum purge	This is a flow path, located just under the septum in the injection port, that uses carrier gas to sweep any contaminants from the injection port and reduces or eliminates large tailing solvent peaks.
SIM (Selected Ion Monitoring)	This method detects only specific masses. As with MC, chromatograms are obtained for each mass. The ions to be detected are specified prior to analysis. Since the number of ions detected is limited, detection sensitivity is extremely high, making it possible to measure picogram quantities of compounds.

Solvent flush method	In this injection method, sample, air and then solvent are injected in that order, by drawing them into the syringe in the opposite order, as shown in the figure below. Solvent flush injection of samples can be performed reliably by a variety of methods with the AOC autosampler. 
Split injection	This is a sample introduction technique used primarily in capillary chromatography when sample concentrations are high. The sample is introduced into the injection port, where it is divided into two flow paths. One flow path enters the analytical column, while the other is vented.
Splitless injection	This is a sample introduction technique used primarily in capillary chromatography when sample concentrations are low. Sample is introduced into a hot split/splitless injection port, where the solvent is vaporized, but not the analytes. A small amount of solvent flows into the relatively cool column and recondenses. The analyte compounds collect in the recondensed solvent located at the head of the column. After a period of time has elapsed (the sampling time), the split vent opens and sweeps the excess solvent vapor out of the injection port. A temperature program then begins in the column oven.
T	
Temperature control zones (heated zones)	These are components of the system with temperature control.
TIC (Total Ion Chromatogram)	The TIC represents the sum of the ion intensities at a particular time. The TIC is similar to chromatograms detected by gas chromatography using a FID (Flame Ionization Detector) detector.
Transfer line interface	This component connects the capillary column to the MS ion source.
Tuning	Tuning is the process of optimizing the MS. Tuning of the MS is performed in order to: • Verify that there are no abnormalities in the status of the instrument, and trace the cause of any problems. • Determine the optimum operation parameters. The types of adjustments include mass calibration, resolution (peak width) adjustment and intensity adjustment. Intensity adjustment can be performed by sensitivity adjustment, either by specifying a target mass, or by relative intensity adjustment (mass pattern adjustment).
Turbomolecular pump	This vacuum pump maintains a high vacuum in the ion source and analyzer within the vacuum housing. Gas molecules collide with the moving rotor blades, directing the gas molecules in a certain direction. If the gas molecules collide with other gas molecules more often than the rotor, then the pump stops. Therefore, the turbo pump must be backed up by another type of pump, usually a rotary pump. See also Evacuation rate.
V	

Vespel ferrule	This is a ferrule made from polyamide resin that seals the capillary column interface.
W	
Wide bore capillary column	Designation for capillary columns of inner diameter 0.32 mm. Can be used in the standard GCMS-QP2050 configuration.

6.4 Using Hydrogen and Nitrogen Gas as Carrier Gases

6.4.1 Using Gases Other Than Helium

The maximum column flow rate at which data acquisition is possible is shown as below. If the internal diameter of the column is 0.53 mm, use a columns with a length of 25 m or longer.

Carrier gas type	GCMS-QP2050 TMP Pumping speed	
	255 L/sec class	60 L/sec class
Helium	10 mL/min	4 mL/min
Hydrogen	3 mL/min	Deprecated
Nitrogen	1.5 mL/min	Not supported

Using hydrogen gas is not recommended for TMP pumping speed 60 L/sec class model. Detector inside the MS unit and ion gauges (option) may wear out faster. Please note the following restrictions when using hydrogen gas.

- The column flow rate should be 1.3 mL/min or less.
- Use a column with a narrow inner diameter (0.18 mm or less). Alternatively, use a column with a length of 60 m, when using a column with an internal diameter of 0.25 mm.

■ Connecting the Gas Line to the Instrument

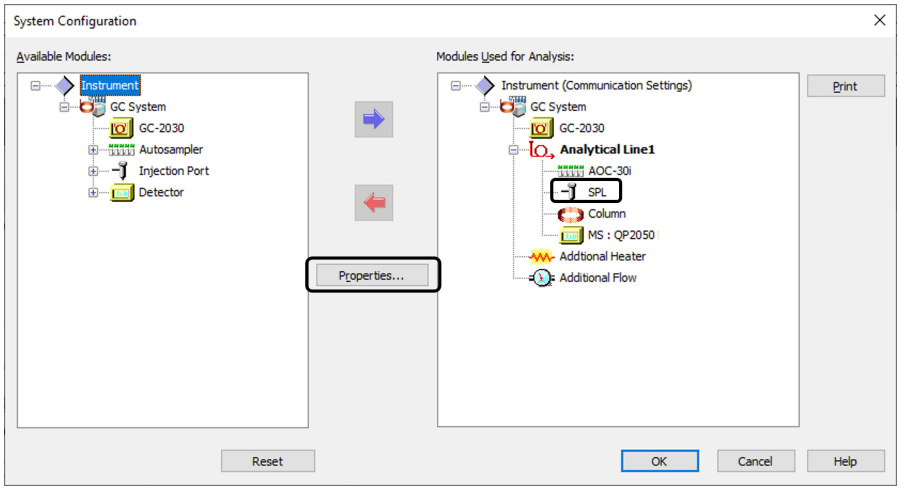
Remove the helium gas line and connect the hydrogen or nitrogen gas line.
See "2.2.1 Starting the Instrument".
Be sure that the hydrogen or nitrogen gas used is G1 grade (99.9999 % pure).
In addition, if a gas generator is used, the baseline is expected to be heightened. If necessary, use a gas purification filter.

■ Setting the Carrier Gas Used

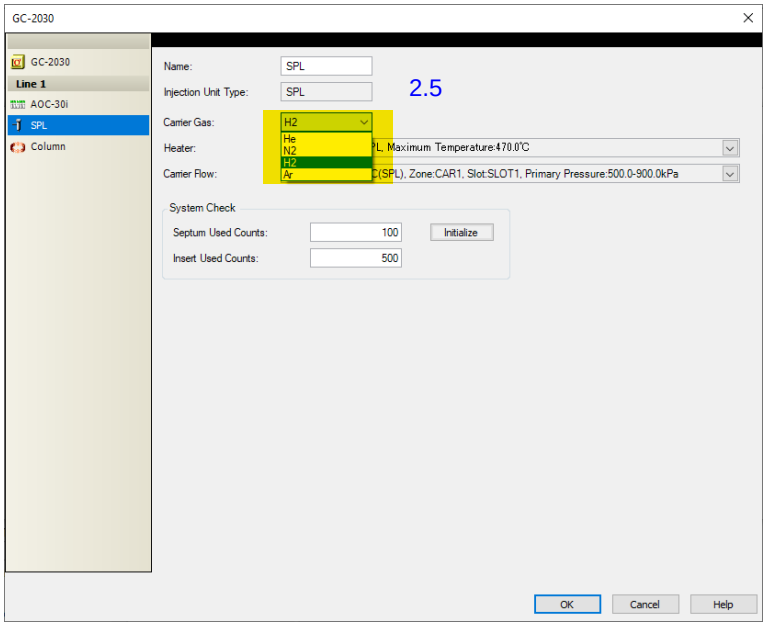
1 **Start the "GCMS Real Time Analysis" program and click the System Configuration icon  on the [Main] Assistant Bar.**

The [System Configuration] window is displayed.

2 Select [SPL] at Modules Used for Analysis and click [Properties].

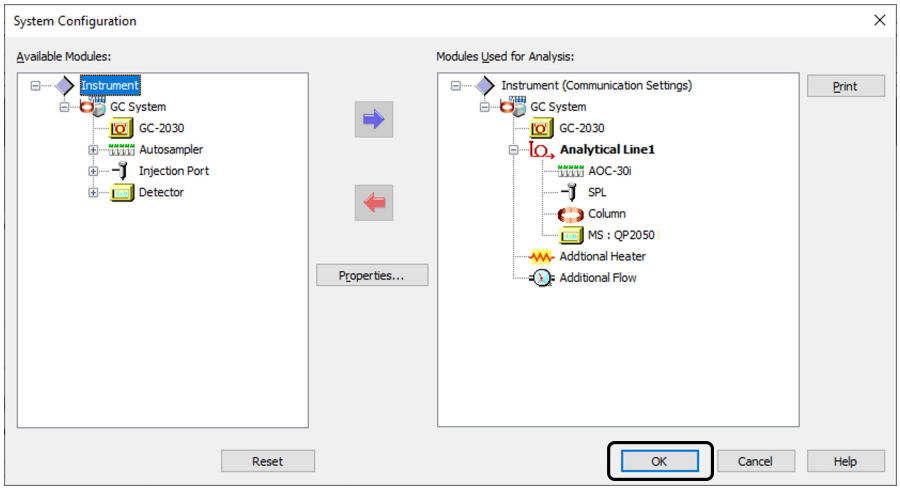


3 Select the carrier gas to be used at [Carrier Gas] and click [OK].



This returns to the [System Configuration] window.

4 **Click [OK].**

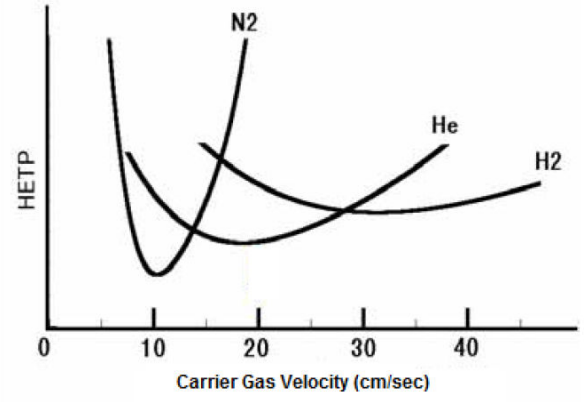


■ Analysis Procedures

The instrument can be used in the same way as when helium gas is used.
However, there may be restrictions depending on the gas used. Be sure to read "6.4.2 Cautions When Using Hydrogen and Nitrogen Gas".

6.4.2 Cautions When Using Hydrogen and Nitrogen Gas

- Hydrogen and nitrogen gas are cheaper than helium gas, but do not provide the same degree of sensitivity. The order of sensitivity is helium > hydrogen > nitrogen.
- A likely reason that the same degree of sensitivity as with helium gas is not obtained is an increase in the amount of gas flowing into the MS unit. The use of a column with a narrow internal diameter is recommended to reduce the amount of flow into the MS unit and lower the noise level.
- The degree of vacuum displayed on the Instrument Monitor in the [Analysis] program differs from when helium gas is used. Check the rise and fall with the gauge, indicated by the arrow.
- It is necessary to revise the analytical conditions used with helium gas. The relationship between the velocity and separation characteristics differs from that of helium gas. The figure below shows so-called HETP (Height equivalent to a theoretical plate) curves, which indicate the relationship between HETP as an index of the separation characteristics of a capillary column and the velocity. They show that the smaller the value, the better the separation performance of the column. Under the conditions in the figure below, with hydrogen gas, there is a tendency for separation performance to improve as the velocity increases. Conversely, with nitrogen gas, the separation performance improves as the velocity slows.



- Be aware of safety issues when using hydrogen gas. For details, refer to the separate document "Hydrogen Carrier Gas Safety".
- Long-life filament (S225-41730-91) cannot be used when hydrogen gas is used. Use standard filament (S225-10340-91).
- If nitrogen gas is used, air leakage checks cannot be performed using the peak monitor. Check for leaks using a leak detector.
  In addition, large peaks from the carrier gas are detected at *m/z* values of 50 and below, so set the measured m/z in the analysis method at 50 or higher.

  ▶▶ Reference Refer to Chapter 2.7 of the LabSolutions User's Guide.

- When the carrier gas is changed, be sure to perform autotuning.
- When using hydrogen or nitrogen gas, use a gas purification filter if necessary.
- When replacing the carrier gas, also replace the tubing and the filters. In addition, it takes time for the gas to be exchanged inside the instrument.

- When using hydrogen gas, do not use dichloromethane or carbon disulfide as solvents.
- When using hydrogen gas, the mass spectrum may differ from when helium gas is used.

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