221-40805
Jul. 2009

Gas Chromatograph
GC-2010 Plus
QUICK REFERENCE

This quick reference is a short summary of the instruction manual. For details refer to the instruction manual.

SHIMADZU CORPORATION
KYOTO JAPAN
ANALYTICAL & MEASURING INSTRUMENTS DIVISION

Precautions for Safety

The Gas Chromatograph GC-2010 Plus is a system for qualitative analysis and quantitative analysis. Strictly appreciate the following contents to use this system safely.

1. Never use the system for any purpose other than the purpose described above.
2. Follow the procedures described in the Instruction Manual.
3. Observe warnings and cautions.
4. Never disassemble or modify the system without our permission.
5. Contact our service representative to repair the inside of the system.
6. Contact your Shimadzu representative if product installation, adjustment, or re-installation (after the product is moved) is required.
7. Wear safety glasses during maintenance and/or inspection of the syringes, the glass liners, the columns and the detectors.

Warning Labels

In this reference, warning statements are stipulated as follows.

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.

Warning Labels on System

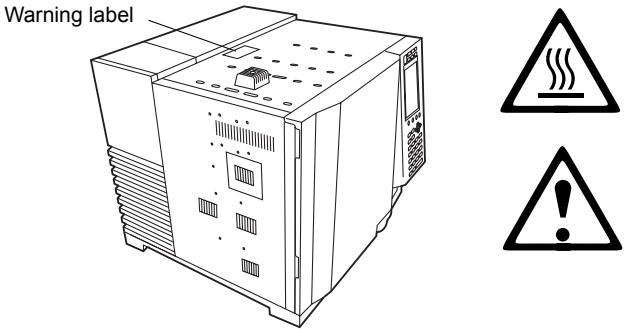
Warning

Do not touch

High temperature injection ports, detectors and upper cover.

Fire

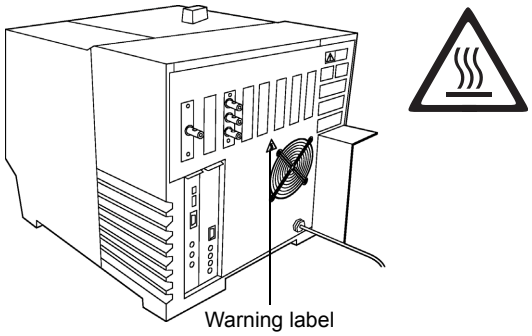
Danger of fire. Do not put anything on the top cover.



Warning

Do not touch

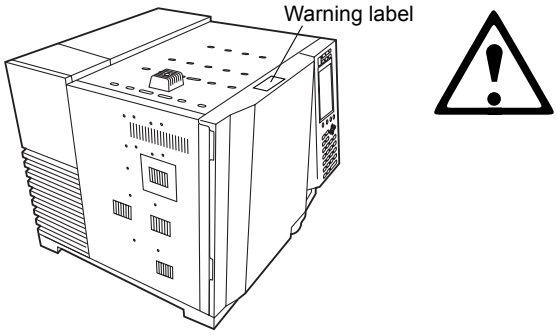
The rear panel may be hot and can cause burn.



Warning

Warning in using hydrogen

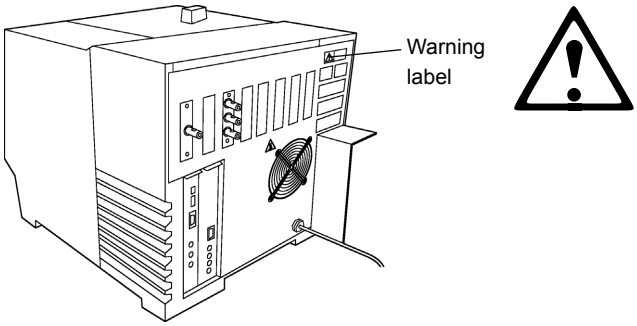
Shut off hydrogen and cap unused column fittings to prevent accumulation of hydrogen in oven and possible explosion.



Warning

Hot air exhaust

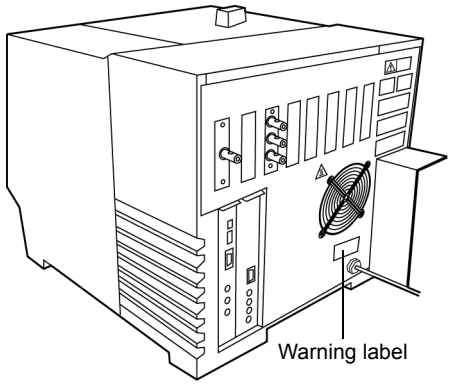
Keep temperature sensitive materials away from opening.



Warning

High voltage

Disconnect power cable before removing cover. Refer servicing to qualified service personnel.

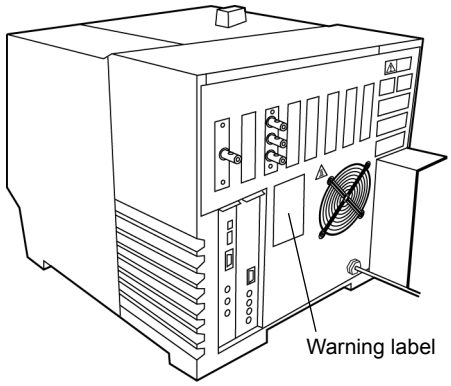


Warning

Warnings on using hydrogen

When hydrogen gas is in use, care should be exercised in order to prevent accidents.

1. Connect gas lines correctly. Do not connect the hydrogen line to the air inlet, or hydrogen will leak excessively.
   To prevent an improper connection, the GC-2010 Plus is equipped with a right-hand thread at the air inlet joint and a left-hand thread at the hydrogen inlet joint.
2. When the device is not in use, the main valve of the hydrogen gas cylinder or generator must be closed. Also, make sure that there is no gas leakage from the main valve of the supply.
3. The flow line for hydrogen gas should be checked for leakage whenever it is used.
4. To prevent buildup of explosive concentration in case the hydrogen gas leaks, the room in which the device is used should be well ventilated.
5. When analysis are completed, close the main valve of the hydrogen gas container immediately before performing other procedures.



Emergency Procedures

In emergency (when an abnormality is detected in the gas chromatograph GC-2010 Plus, for example), take the following action.

Before using the system again after an emergency, inspect the system. And contact our service personnel if necessary.

Emergency stop procedure

1. Turn off the power switch of the gas chromatograph GC-2010 Plus.
2. Turn off all power switches of peripheral units.
3. Close the main valve of the piping which supplies carrier gas, hydrogen, air and makeup gas.
4. Shut down the power supply.
   - If the power cable is attached to the power distribution board by screws, turn off the switch provided on the power distribution board.
   - If the power cable is connected by a plug, disconnect it.

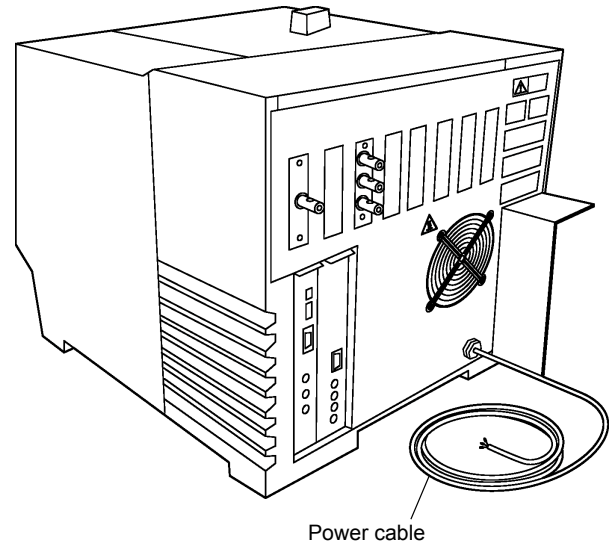


Figure Power switch and power cable

When Handling Insulation

Caution

Installation or removal of the GC-2010 Plus main unit or optional units (parts) generates insulation material particles and dust. Since these materials include ceramic fibers, be sure to observe the following precautions.

1. Inhaling ceramic fibers, either in large amounts or for extended periods, can damage the respiratory system.
2. Direct contact with ceramic fibers can cause temporary inflammation of the skin.

The insulation used in the GC-2010 Plus gas chromatograph contains refractory ceramic fibers (RCF). These fire-resistant fibers consist primarily of inorganic alumina (Al_2O_3) and silica (SiO_2). RCF is used as an insulating material due to its stability at temperatures of 1000 °C or higher, and is found around the column thermostatic chamber, the temperature-controlled portion of the INJ/DET unit, and on any GC accessories requiring heating or the maintenance of a constant temperature.
When working with the GC unit, if there is a possibility of contact with insulation containing RCF, avoid direct contact and observe the following precautions.

- Be sure to wear protective clothing, such as long sleeves, gloves, safety goggles, and a dust mask.
- Be sure to use a nearby ventilation system and/or dust filtration system.
- DO NOT smoke in the work area.
- After insulation-related work is finished, be sure to ventilate the work area.
- After insulation-related work is finished, be sure to gargle and wash your hands to remove any ceramic fibers.
- If any portion of insulation material must be cut off and stored, be sure to use an appropriate sealed container, such as a plastic bag at least 0.15 mm thick.

Shimadzu has measured the airborne mineral fiber levels of the GC-2010 Plus when used under normal operating conditions and confirmed that they are well below the concentrations allowed by Japanese dust level regulations.

Caution

Increasing the oven temperature immediately after installation may generate an odor. The odor is generated from the glue (material: corn starch etc.) contained in the insulation material. Although the odor dissipates after several hours, thoroughly ventilate the work area.

Action for Environment (WEEE)

Equipment Disposal:
Dispose of the GC unit using a qualified industrial waste management company, in compliance with the applicable laws in the country where it is used.

To all users of Shimadzu equipment in the European Union:

WEEE Mark

Equipment marked with this symbol indicates that it was sold on or after 13th August 2005, which means it should not be disposed of with general household waste. Note that our equipment is for industrial/professional use only.

Contact Shimadzu service representative when the equipment has reached the end of its life. They will advise you regarding the equipment take-back.

With your co-operation we are aiming to reduce contamination from waste electronic and electrical equipment and preserve natural resource through and recycling.
Do not hesitate to ask Shimadzu service representative, if you require further information.

Voltage Fluctuation

To all users of Shimadzu equipment in the European Union:

This equipment can only be connected to a supply with the impedance 0.1 ohm or lower. If necessary, determine the impedance in consultation with the supply authority.

Note

If the actual system impedance Z_{act} exceeds 0.1 ohm at the point of interface point on the user's premises, the supply authority may impose restrictions to connection on the use of the equipment.

Note

If the actual system impedance Z_{act} has been declared to, or measured by the user, the user can use the information to assess the equipment's suitability without reference to the supply authority.

Electromagnetic Compatibility

NOTE

Descriptions of this section are only applied to the following models:

221-73020-34	GC-2010 Plus AF
221-73022-34	GC-2010 Plus AT
221-73021-34	GC-2010 Plus ATF
221-73000-34	GC-2010 Plus AF/AOC
221-73002-34	GC-2010 Plus AT/AOC
221-73001-34	GC-2010 Plus ATF/AOC
221-73023-34	GC-2010 Plus A
221-73027-34	GC-2010 Plus AF/OCI
221-73029-34	GC-2010 Plus AMS
221-73030-34	GC-2010 Plus AMS

This instrument complies with European standard EN61326-1:2006, class A for electromagnetic interference (emission) and minimum requirement for electromagnetic susceptibility (immunity).

Electromagnetic Interference (Emission)

This instrument is a class A product, designed not for use in residential environment.

NOTE

When an electromagnetic disturbance occurs to the instruments being used close to this product, take an appropriate distance between the instruments and this product in order to eliminate the disturbance.

Electromagnetic Susceptibility (Immunity)

Compliance to the standard does not ensure that the instrument can work with any level of electromagnetic interference stronger than the level tested. Interference greater than the value specified in the standard may cause malfunction of the instrument.

NOTE

Take the following measures before installing and/or using the instrument especially in an industrial location:

- Install the instrument away from the device emitting strong electromagnetic noise.
- Supply power from a different power source from the one emitting strong electromagnetic noise.
- Take the following measures to prevent the occurrence of static electricity.
  - Before touching the instrument, discharge the static electricity charged in operator's body by touching metallic structure connected to the ground.
  - Do not touch the terminals and connectors unconnected with cables, while the instrument is operating.

Regulatory Information

For Europe:
The product complies with the following requirements.

EMC Directive 2004/108/EC
Low Voltage Directive 2006/95/EC

Product Name	: GAS CHROMATOGRAPH
Model Name	: GC-2010 Plus SERIES
Manufacturer	: SHIMADZU CORPORATION ANALYTICAL & MEASURING INSTRUMENTS DIVISION
Address	: 1, NISHINOKYO-KUWABARACHO, NAKAGYO-KU, KYOTO 604-8511, JAPAN
Authorized Representative in EU	: SHIMADZU EUROPA GmbH
Address	: Albert-Hahn-Strasse 6-10, 47269 Duisburg, F.R. Germany

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CONTENTS

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1 Specifications

1. Column oven

Range of temperature:	Room temperature + 4 °C to 450 °C
Accuracy of temperature:	±1 % (K) (Calibrated at 0.01 °C)
Range of linear temperature increase:	(in power voltage 115 VAC) 40 °C/min up to 200 °C 25 °C/min up to 250 °C 15 °C/min up to 380 °C 7 °C/min up to 450 °C (in power voltage 230 VAC) 70 °C/min up to 200 °C 50 °C/min up to 350 °C 35 °C/min up to 450 °C
Cooling speed:	It takes 3.4 minutes for cooling from 450 °C to 50 °C. (Ambient temperature: 22 °C)

2. Temperature program

Program ramps:	20 ramps in total (Heating and cooling available)
Setting:	0.1 °C increments
Program setting:	–250 to 250 °C/min, 0.01 °C/min increments
Total time of total program:	Up to 9999.99 minutes

3. Injection port

Range of temperature:	Up to 450 °C
Temperature setting:	0.1 °C increments
Injection unit:	Split/Splitless injection, Direct injection

4. Detector

- Hydrogen flame ionization detector (FID)

Range of temperature:	Up to 450 °C, 0.1 °C increments
Dynamic range :	10^7

- Temperature conductive detector (TCD)

Dynamic range:	10^5
Maximum temperature:	400 °C

5. Carrier gas flow control unit

- Split/splitless mode

Range:	0 to 970 kPa (The maximum pressure limit is the primary pressure minus 10 kPa.) 0.1 kPa increments
Program ramps :	7 ramps possible
Program rate:	–400 to 400 kPa/min, 0.01 kPa/min increments
Split rate setting:	0 to 9999.9, 0.1 increments

- Direct injection mode

  Pressure mode

  Range: 0 to 970 kPa (The maximum pressure limit is the primary pressure minus 10 kPa.)
  0.1 kPa increments

  Program ramps: 7 ramps possible

  Program rate: –400 to 400 kPa/min, 0.01 kPa/min increments

  Flow rate mode

  Range: 0 to 1,200 ml/min (When primary pressure is 980 kPa)

  Program ramps: 7 ramps possible

  Program rate: –400 to 400 ml/min, 0.1 ml/min/min increments

6. Power supply

Commended power voltage: 115 VAC ± 5 %
230 VAC ± 5 %
Frequency 50/60 Hz

Operating power voltage: 115 VAC ± 10 %
230 VAC ± 10 %
Frequency 50/60 Hz

Transient over voltage: Installation Category II (IEC)

Power supply capacity

Standard model with FID: 1,800 VA (115 V model)/2,600 VA (230 V model)

Optional temperature control block (INJ, etc.):
150 VA/pc

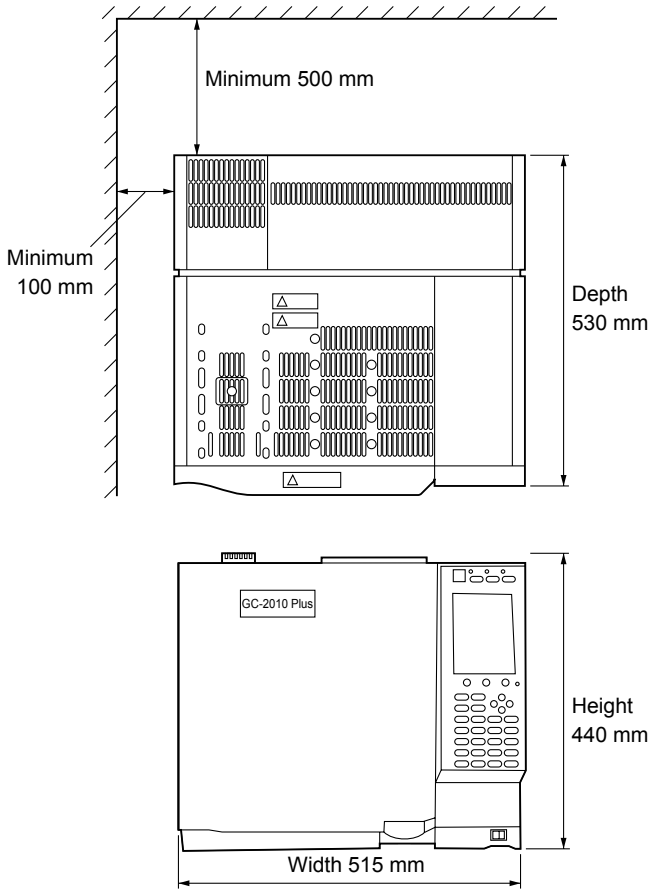
Maximum power is 2,600 VA (115 V model), 3,400 VA (230 V model)

The above-mentioned specification is an excerpt from Instruction manual.
Refer to "1 Specifications" in the Instruction manual for more details.

■ **Installation clearances**

Warning

Hot air is exhausted from the back vent. Do not place flammable materials near the exhaust vent.



Rear clearance

Hot air is vented at the back of the unit when the column oven cools. Consider the following during installation:

- Do not place any flammable materials behind the unit.
- Allow a clearance of 50 cm* or more between the back cover and the wall.
- Reserve extra space for maintenance and inspection behind the unit.

* 25 cm with the exhaust duct (option, P/N 221-47748-41)

Left clearance

Allow a clearance of 10 cm or more on the left side. The vent on the left side is important to ensure that the outer wall of the column oven cools properly and improving the cooling efficiency of the column oven.

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2 Parts

This unit consists of the following parts.

1. GC-2010 Plus main body

2. Quick reference (P/N 221-40805)

3. Instruction Manual (CD-ROM) (P/N 221-40801-91).

4. Standard accessories

Type	Description	Part No.	Qty'
Tools	Wrench 6 × 8	086-03003	2
	Wrench 10 × 12	086-03011	2
	Wrench for glass insert nut	221-46977	1
Parts	Branch tube	221-72658-91	1
	Injection port column nut	221-16325-01	1
	Column nut	221-32705	1
	Ferrule adjuster (for SPL)	221-41532-91	1
	Chromatopac signal cable (115 V/230 V)	221-47251-41/-43	1
	Column hanger *	221-47159	1
	Injection port cover **	221-43597-01	1
	Partition plate ***	221-73257	1
	Screw, M4 × 8 ***	020-46547	2
	Cable tie (red) ****	072-60606-01	2
	G-type blank nut (with 2 pcs)	221-35566-92	1
Consumables	Silicon rubber septum (with 20 pcs)	201-35584	1
	Silica wool stuffing (with 2 g)	221-48600	1
	Graphite ferrule 0.5, for capillary (with 10 pcs)	221-32126-05	1
	Aluminum gaskets (with 100 pcs)	201-35183	1
	Glass insert, for split	221-41444-01	1
	Glass insert, for splitless	221-48335-01	1
	Fluoride rubber O ring, for glass insert (with 5 pcs)	036-11203-84	1

* The column hanger is inserted into the support slots in the oven interior.

** Attach the injection port cover to INJ/DET cover in case of manual injection. (Refer to "3.1 Component Description".)

*** The plate is attached to the back of the gas chromatograph at the time of installation. (Refer to "Rear view" in "3.1 Component Description".)

**** Attach the cable ties to the hydrogen gas line for making a distinction from other gas lines.

5. FID accessories (for FID model only)

Description	Part No.	Qty'
Ferrule adjuster (for FID)	221-41532-92	1

6. TCD accessories (for TCD model only)

Description	Part No.	Qty'
Ferrule adjuster (for TCD)	221-48610-01	1
Caution label TCD-2010 Plus	221-42741	1
Card case, A6	038-03055	1

Only one chromatopac signal cable is attached to GC-2010 Plus ATF in which one TCD and one FID an equipped.

Refer to the AOC-20 Instruction Manual for the parts list of auto injector AOC-20i.

3 Description of Unit

3.1 Component Description

Warning

High temperature
Danger of burns. Keep the column oven door closed, when the oven is at high temperature. Keep the injection port cover on when making manual injections.

■ **Front view**

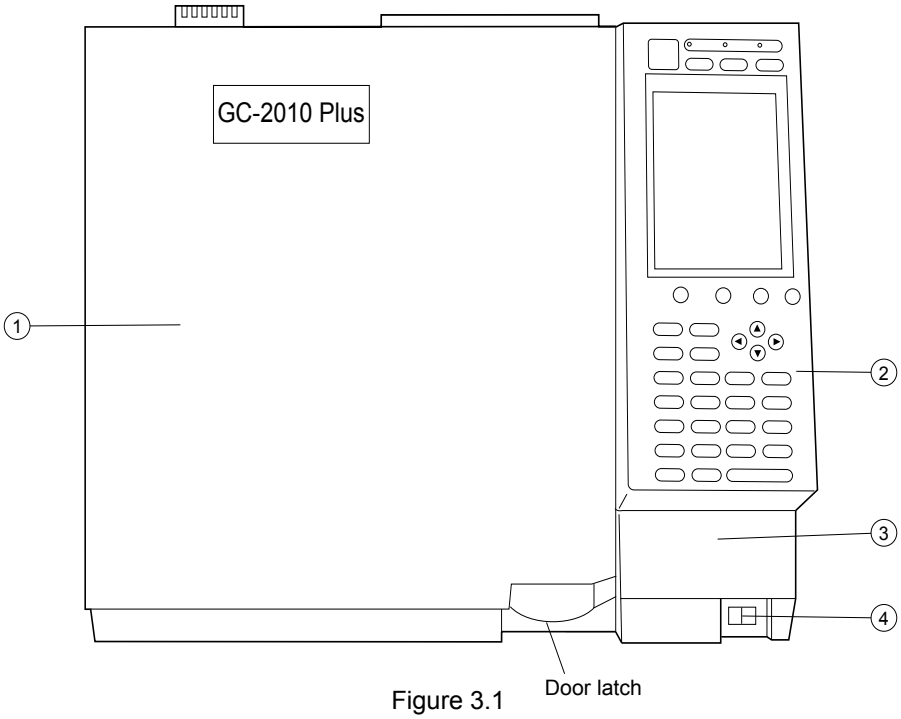
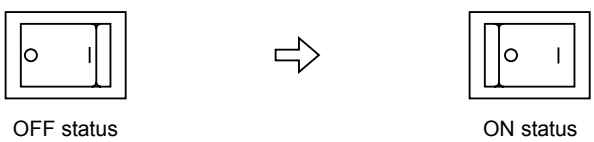


Figure 3.1

No.	Name	Description
1	Column oven door	Pull the latch at the lower right to open the door. Press the center of the door to close it.
2	Key/Display	Used for various input and displaying the status during operation.
3	Battery case for FPD fan	Houses the battery for the FPD cooling fan (option).
4	Power switch	Turns the power of the unit on and off.

■ **Symbol conventions**

~ : AC
○: Off, Open
| : On, Close



■ **Oven interior**

Warning

High temperature
Danger of burns. Never touch the connections or the internal surface of the oven when the injection port or detector temperature is high.

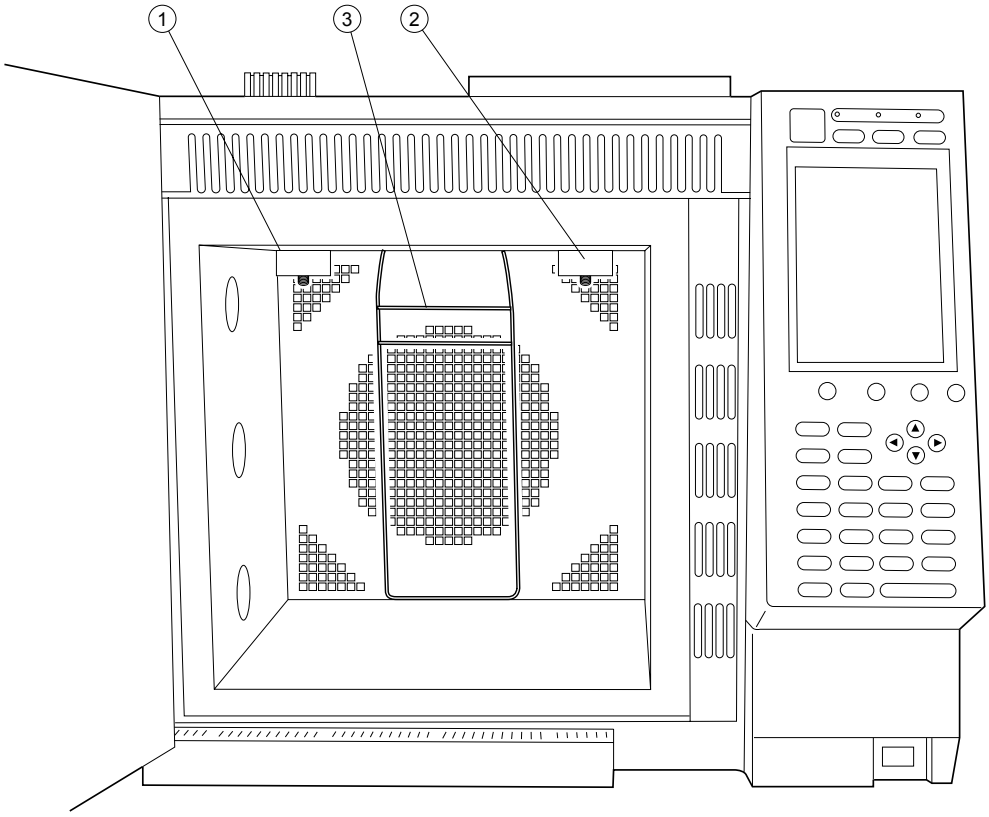


Figure 3.2

No.	Name	Description
1	Column connection (injection port side)	Attach the column to the injection port. (Close up ①)
2	Column connection (detector side)	Attach the column to the detector. (Close up ②)
3	Column hanger	Install the capillary column here. (Close up ③)

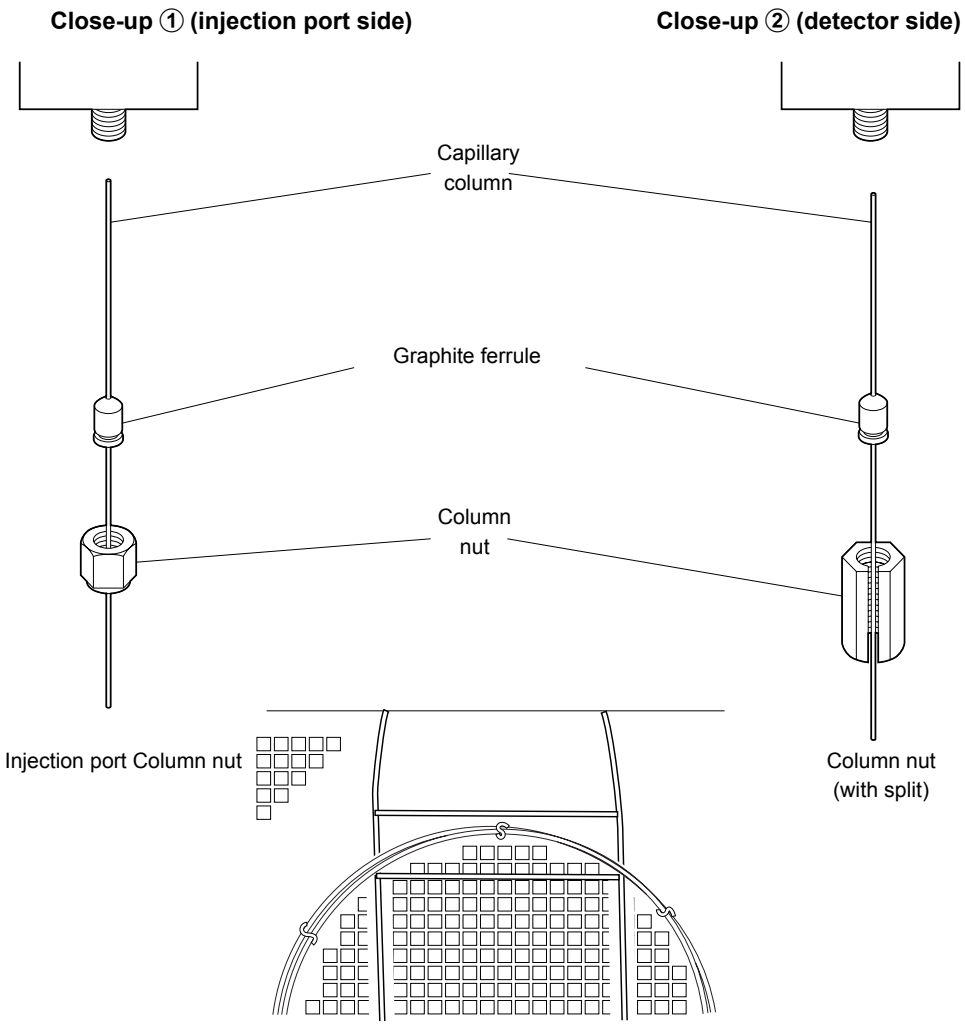

Close-up ① (injection port side)
Close-up ② (detector side)
Capillary column
Graphite ferrule
Column nut
Injection port Column nut
Column nut (with split)
Close-up ③ (column hanger)

Figure 3.3

■ **Rear view**

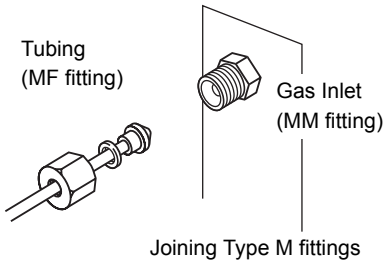
Warning

High voltage
Danger of electrical shock.
Only qualified service personnel may remove the rear cover.
Ensure that the power distribution board power is off before starting installation if the power cable will be connected directly to terminals on the power distribution board.
Ensure that the power supply is properly grounded.
Never place heavy objects on the power cable.

High voltage
Hot air is emitted from the back of the unit. Do not place flammable items behind the unit. Do not touch the back of the GC near the exhaust vent.

High pressure gas
Frequently check the gas flow lines for leaks.
In particular, accumulations of hydrogen gas can cause an explosion.

The connection of gas inlets are Type M fittings. These metal fittings contact directly (without gaskets). Use two 12 mm wrenches to tighten the joint.



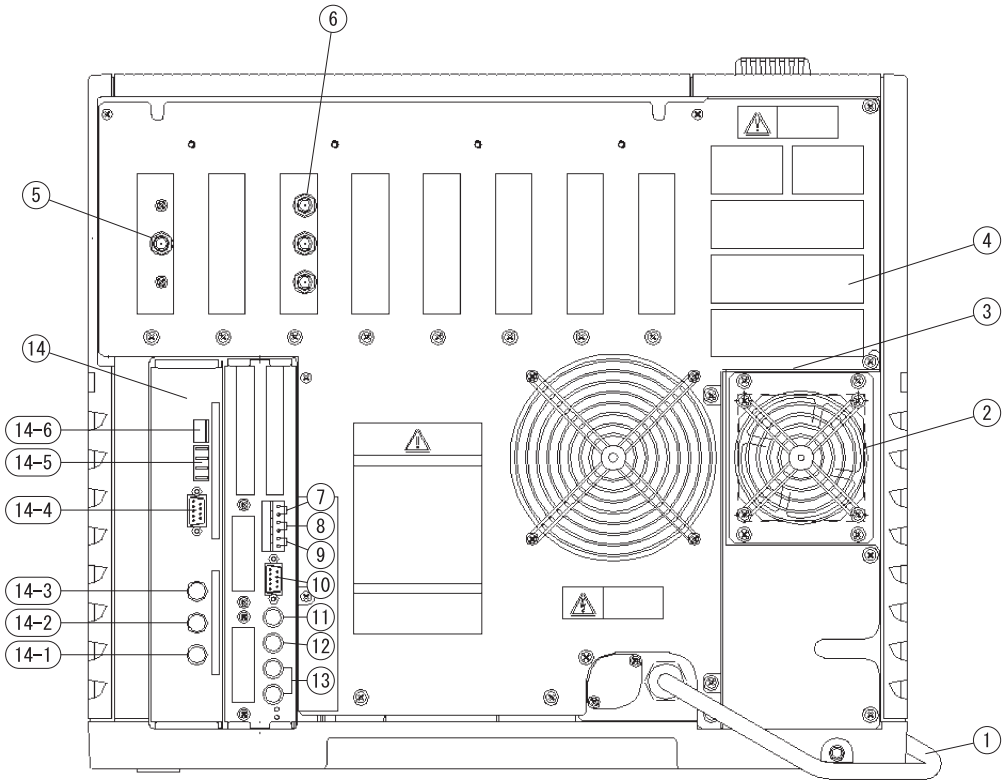


Figure 3.4

Caution

Do not touch the connectors or the terminal when the power is on. This could damage the circuits.

No.	Name	Description
1	Power cable	Supplies power to the unit.
2	Air inlet fan	Sends air to the column oven to cool it down.
3	Partition plate	Prevents air from flowing back into the column oven.
4	Exhaust vent	This vents the column oven during cooling.
5	Carrier gas inlet	Supplies carrier gas.
6	Detector gas inlet	Supplies detector gas.
7	START signal input terminal	Connects the external device if any to this terminal to receive a start signal.
8	READY signal terminal	Outputs the READY signal to any external device (such as the auto injector).
9	START signal output terminal	Connects the external device if any to this terminal to output the start signal.
10	RS-232C connector	Connect the RS-232C cable (9 pin) to this connector. For I/O of digital signal.
11	Relay terminal	Relay terminal to switch at EVENT91 and 92.
12	AOC communication connector	Connects this connector to the RS-232C terminal in the power unit of AOC-20 i/s.
13	Detector signal output terminal (analog)	Outputs the detector signal to the analog input of a Chromatopac or other type of date processing unit. (ch1, ch2)
14	AOC power supply *	Connects the AOC-20i and AOC-20s (option).
14-1	INJECTOR 1 connector	Connects the auto injector. (in single mode) Connect the main auto injector in dual mode.
14-2	INJECTOR 2 connector	Connects the subordinate auto injector in dual mode here.
14-3	SAMPLER connector	Connects the auto sampler carousel.
14-4	RS-232C connector	Connects the external control.
14-5	Fiber optic cable connector	Don't connect a RS-232C and fiber optic cable simultaneously.
14-6	Start out/Ready in Connector	Outputs the READY signal from the gas chromatograph and inputs the START signal to the gas chromatograph.

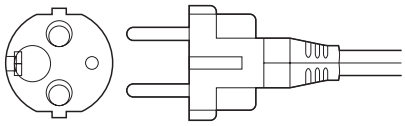
* Only for units with AOC-20i.

Note

The symbol ⏚ indicates the functional ground terminal.

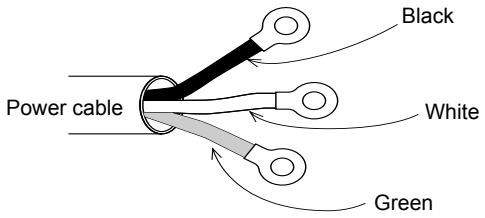
■ Connecting the power cable

The power cable of the 230 V model uses a plug.



Plug

The power cable for 115 V model is color-coded as follows.
Black... Connected to HOT of AC line.
White... Connected to NEUTRAL of AC line.
Green... Grounding (GROUND)



Power cable

Figure 3.5

■ Whole drawing

Warning

High voltage
Danger of electrical shock. Only qualified service personnel may remove the side covers.

High temperature
Danger of burns. Never touch the top cover, the injection ports and detectors-while they are hot.

Caution

All the GC unit covers (including the INJ/DET covers, carrier and detector gas controller covers) are essential to the optimal performance of the GC-2010 Plus. Ensure that these covers are in place when the GC is in use.

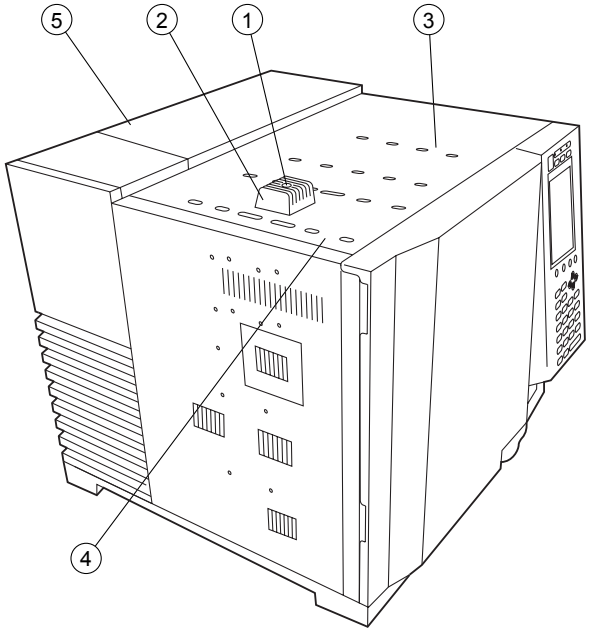


Figure 3.6

No.	Name	Description
1	Injection port	Samples are injected into this port, which can become extremely hot.
2	Injection port cover	This cover becomes extremely hot. It protects you from the heat of the injection port.
3	Detector	The detector is located under the INJ/DET cover. The detector can become extremely hot.
4	INJ/DET cover	Lift up this cover to remove it. Keep the cover closed during operation.
5	Carrier and detector gas controller cover	Houses AFC, APC and manual flow controller. Open and lift up this cover to remove it.

3.2 Keypad Description and Operation

The keypad functions control the unit, and displays the operational status.

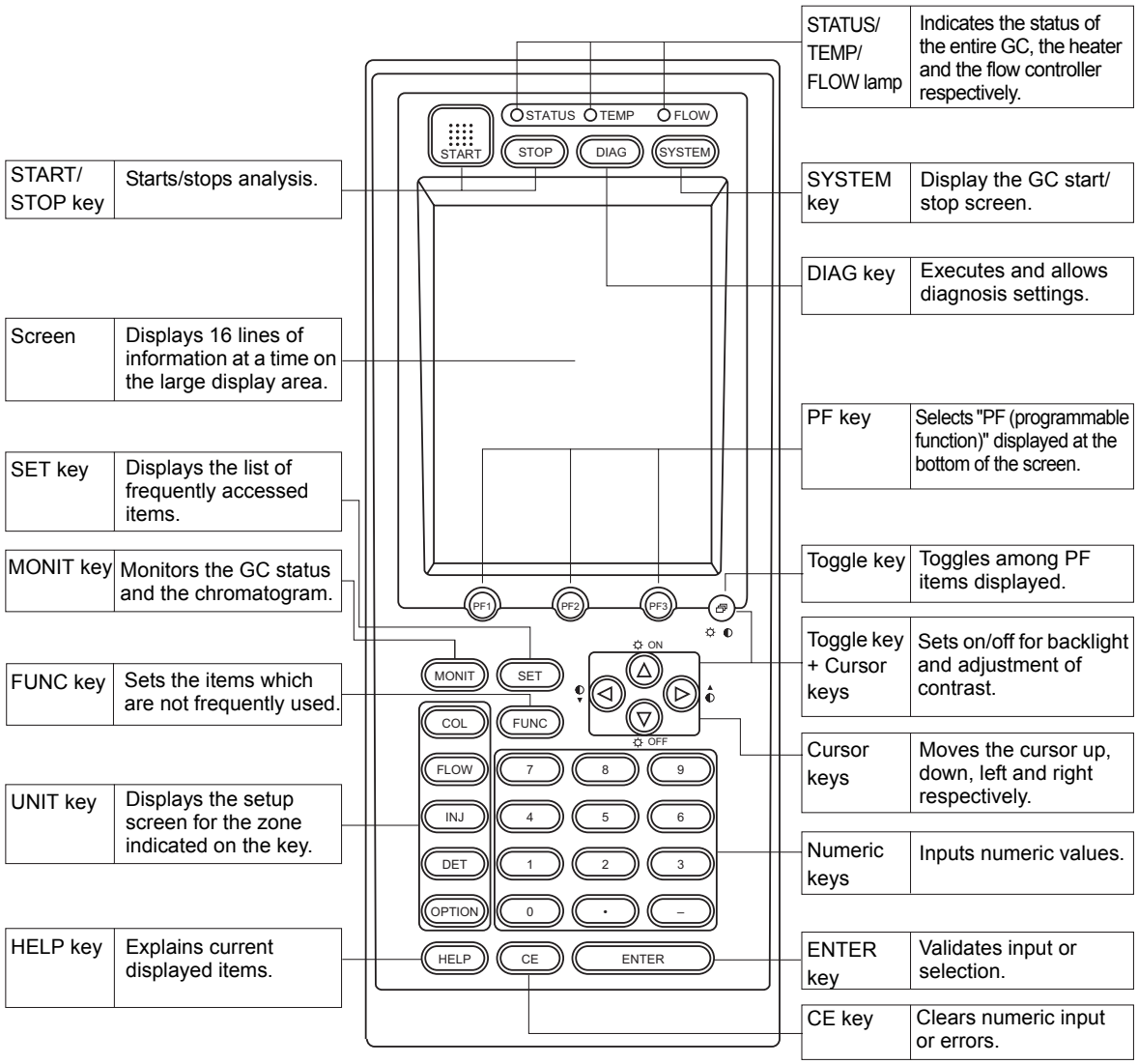


Figure 3.7

The table below shows the function of each key.

Name	Function
START key	Starts the temperature program, pressure/flow rate program and time program. If a Pre-Run program is set, the Pre-Run program starts.
STOP key	Stops the program.
DIAG key	Performs unit self-diagnosis. Also, used for maintenance function such as confirmation of various logs, part replacement status, and standard signal output.
SYSTEM key	Starts/stops the GC. Manages the analytical condition file.
PF key	Selects the PF menu displayed at the bottom of the screen. (PF = programmable function)
Toggle key	Toggles through the PF menu displayed at bottom of the screen.
MONIT key	Monitors the GC status and analysis status. Displays the GC temperature, pressure and flow rate status for each heated zone as well as chromatograms.
SET key	Access commonly-used items, such as temperature, pressure and flow rate for each component on one screen. Manages the analytical condition file like the [SYSTEM] key.
FUNC key	Access less frequently used items.
COL key	Sets the oven temperature program.
FLOW key	Sets the carrier gas flow rate parameters, such as pressure, flow rate and split ratio.
INJ key	Sets the temperature of the injection port (or temperature program for an OCI/PTV).
DET key	Sets the detector temperature, range and current or other detector-related parameters.
OPTION key	Sets the parameters for optional units, such as an auto injector or CRG.
HELP key	Describes the procedure and suggests valid parameter ranges. Jumps to a desired item using an index function.
Cursor key [△], [▽], [◁] and [▷]	Moves cursor up, down, left and right a blinking cursor indicates the location of parameter value entry. [◁] and [▷] keys may be used to change the selection.
Numeric keys [0] [9]	Inputs a numeric values.
Clear key	Clears the current numeric value.
[CE] key	Clears display and alarm during an error.
ENTER key	Validates parameter input or item selection.

Three status lights indicate the GC status regardless of the screen display. The STATUS, TEMP and FLOW lights indicate the GC status, the temperature control status and the gas control status, respectively. Light color and illumination are also used to indicate instrument parameter status.

■ STATUS indicator

Color	Status	Meaning
Off		Power is OFF.
Green	On	System is ready.
	Blinking	Program, like the temperature program, are executing.
Yellow	On	System is OFF. Alternatively, the system is ON, but is not ready.
	Blinking	Diagnosis, baking or flow controller calibration is being executed.
Red	On	An error has occurred in the system.

■ TEMP indicator

Color	Status	Meaning
Off		Temperature control is not performed.
Green	On	All temperature controlled zones are ready.
	Blinking	Temperature program is running. Alternatively, the column valve is closing. (COL CRG auto off)
Yellow	On	One of the temperature controlled zones is not ready.
	Blinking	Temperature program is finished, and system is being cooled.
Red	On	An error related to temperature control has occurred.

■ FLOW indicator

Color	Status	Meaning
Off		Gas control is not performed.
Green	On	All gas control lines are ready.
	Blinking	Pressure/flow rate program is running, it is sampling time, or high pressure injection is occurring.
Yellow	On	One of the gas control lines is not ready. Alternatively, the system is waiting for restoration. (Gas saver AOC link, Gas saver auto on or Splitless auto off)
	Blinking	Pressure/flow rate program is finished, and initial values are being set.
Red	On	An error related to gas control has occurred.

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4 Precautions for Handling Gas

For the type, the purity and the supply pressure of the gas used in the unit, refer to "2.6 Tubing of Supply Gas" in the Instruction Manual. This section describes handling of gas to which the most strict attention should be paid during use of the unit.

■ **High pressure gas cylinder precaution**

Warning

High pressure
Gas cylinders are under high pressure. When handling gas cylinders, the instructions and safety measures provided by the gas supplier must be strictly observed to prevent accidents.

General precautions are provided below.
Consult state and local regulations for specific precautions.

Keep gas cylinders away from the lab, preferably outdoors, but not exposed to direct sunlight. The area must be well-ventilated. Use tubing to bring the gases to the lab.
The temperature of gas cylinders must not exceed 40 °C. Flammable items must be kept at least 2 m from a gas cylinder.
When using high pressure gases, pay strict attention to ventilation, and perform daily leak checks. In particular, when using flammable gases (such as hydrogen), never smoke or allow open flame within 5 m of the equipment. Fire extinguishers must be present.
Secure gas cylinders firmly with cylinder clamps so they cannot fall over. Use pressure reducing valves and pipes that are free of contamination from impurities that lower the purity of the supply source. If the purity of the supply gas connected to the GC is low, the sensitivity or stability is not guaranteed even when a high purity gas cylinder is used.
Connect the gas filter right before connecting gases to the GC in order to remove any impurities. The filter's removal ability eventually wears off. The filter requires periodical maintenance service because a filter saturated with impurities contaminates the GC.
When finished with the gas, tighten the main valve of the cylinder immediately.

■ **Gas type and supply purity**
The following gases and associated purity valves are required to maintain optimal performance of the unit.
For detectors other than FID and TCD, refer to the instruction manual corresponding to each detector.

Carrier gas
Helium purity: 99.999 % or more
Nitrogen purity: 99.999 % or more

Makeup gas

FID

Nitrogen purity:	99.999 % or more
Helium purity:	99.999 % or more

TCD

Nitrogen purity:	99.999 % or more
Helium purity:	99.999 % or more
Argon purity:	99.999 % or more

Detector gas

FID

Hydrogen purity:	99.999 % or more
Air	Dry air cylinder (including total hydrocarbons of 1 ppm or less)

Note

If a gas that does not satisfy the purity described above is used even once, the instrument may not satisfy the minimum detection specification even after changing the gas to a high-purity one.
Gases with a purity of 99.995 %, dry air excluding organic substances, or air compressed using an oilless compressor and then dehumidified can be used when high sensitivity analysis is not necessary.

Gas supply pressures

Carrier gas:	300 - 980 kPa
Make-up gas:	300 - 980 kPa
Hydrogen:	300 - 500 kPa
Air:	300 - 500 kPa

■ Precautions for handling hydrogen gas

Warning

Hydrogen gas precautions

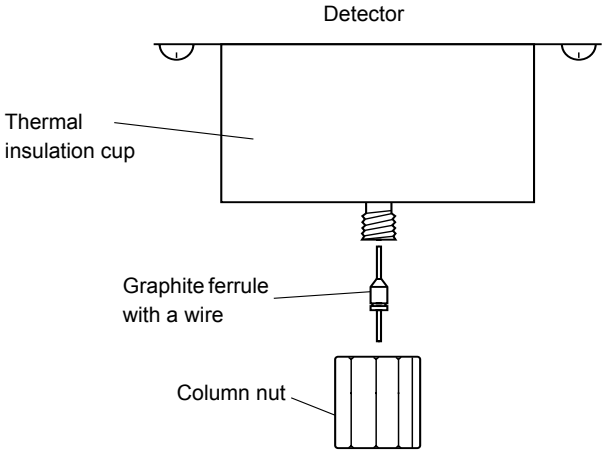
Hydrogen can explode if it is allowed to accumulate in a poorly ventilated area.

1. Connect gas lines correctly. Hydrogen is released into the room if the tubing is accidentally connected to the air inlet.
   To prevent an improper connection, the GC-2010 Plus is equipped with a right-hand thread at the air inlet joint and a left-hand thread at the hydrogen inlet joint.
2. When the unit is not in use, close the main valve of the hydrogen gas cylinder. Check for leaks at the main valve.
3. Every time the unit is used, check for leaks along the flow line from gas cylinder to the unit interior.
4. To prevent an explosion due to a hydrogen gas leak, the room in which the unit is used should be well ventilated. Prohibit the use of open flame in this room.
5. Close the main valve of the hydrogen cylinder immediately after completing the analyses. Then, turn OFF the unit and perform normal shut-down procedures.

Warning

Hydrogen gas handling precautions

The accumulation of hydrogen gas inside the column oven can cause an explosion. Close all hydrogen pressure regulator valves when not in use, and seal the column connection.



Capping the Detector Fitting.

Caution

Gas plumbing precaution

The pressure regulator valve will be damaged if pressure exceeding its specification is applied.

Set the gas inlet pressure within the permitted maximum pressure range.

Caution

Hydrogen gas supply precaution

Make sure that the supply pressure to the flow controller does not exceed 500 kPa. If the flow controller fails with a hydrogen gas supply pressure over 500 kPa, a dangerous situation exists. Large amounts of leaking hydrogen could cause the FID flame to expand out of the detector.

Hydrogen gas is lighter than air. If it leaks, it can accumulate near the ceiling. Pay strict attention to the ventilation so that leaking hydrogen is vented out of the room and cannot accumulate.

Caution

Supply pressure

When the GC shares gas supplies with other instrumentation, check all instrument specifications in order to provide adequate gas supply pressures for all the instruments.

Warning

Hydrogen carrier gas precautions

If a lot of hydrogen gas is released into a poorly ventilated room, it may cause an explosion.

1. In order to prevent hydrogen gas accumulate in the room, attach tubes to the split vent, purge vent, TCD vent and ECD vent. Discharge the gas to open air or a ventilation equipment (such as a draft chamber).
2. Install the GC in the well ventilated area. (Ex. in the draft chamber)
3. In order to measure hydrogen gas concentration, equip a hydrogen gas sensor in the room. Keep the hydrogen concentration low.

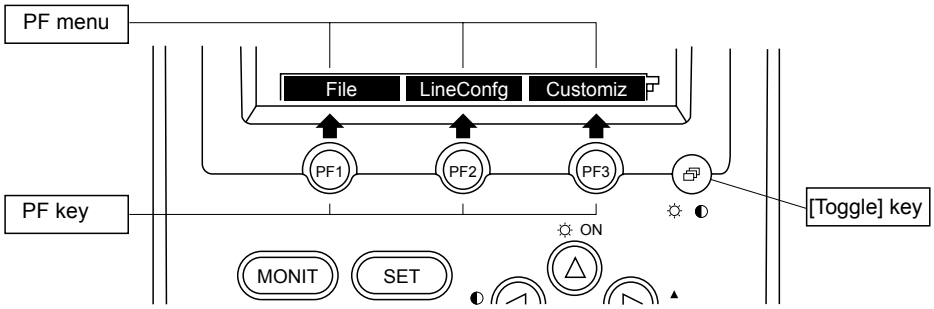
5 Description of Key/Display

5.1 Basic Key Operations

1. Screen display
Use the following 10 keys to display the parameter and status screens.
[DIAG], [SYSTEM], [MONIT], [SET], [FUNC], [COL], [FLOW], [INJ], [DET] and [OPTION].
Access the main function screens by pressing one of these keys, then the secondary screens by selecting a PF menu item displayed at the bottom of the screen. (Because the PF menu includes direct operations, some PF menu items do not have secondary selection screens.)

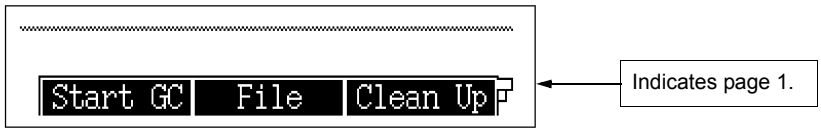
■ **PF menu item selection**

Select a desired PF menu item by pressing the PF keys ([PF1], [PF2] and [PF3]) underneath the screen which correspond to PF menu items.

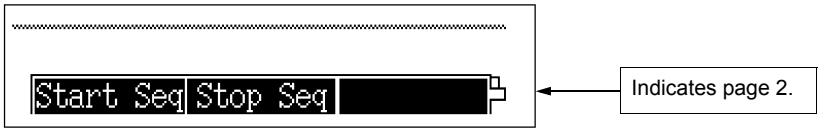


If the PF menu continues over two or more pages, press the [Toggle] key to display the desired PF menu, then press the [PF] key.

Example:
First page of PF menu



Press the [Toggle] key to display the 2nd page.

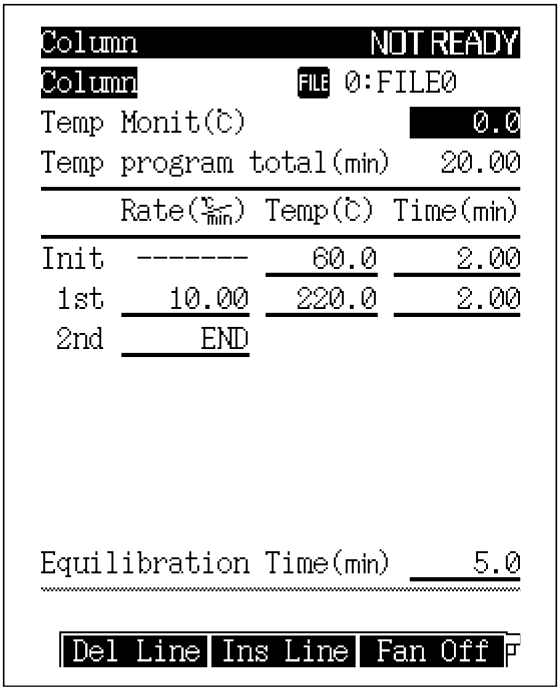


2. Moving the cursor

Use the four keys, [△], [▽], [◁] and [▷] to move the cursor to an item to be set. However for screens, with listed items, only the [△] and [▽] keys may be available to move the cursor. The [◁] and [▷] keys may perform a different function.

■ **Moving the cursor using the [△], [▽], [◁] and [▷] keys**

(Example) Main screen of the [COL] key



3. Entering numeric values

Enter a numeric value using the following procedure.

(1) Move the cursor to an item to be set.
(2) Use the numeric keys to enter a number.
(3) Press the [ENTER] key to validate the input.

Note

The input value becomes valid when the [ENTER] key is pressed.
If you move the cursor or display another screen before pressing the [ENTER] key. The value is deleted.
To clear a value before pressing the [ENTER] key, press the [CE] key.

4. Changing a selection

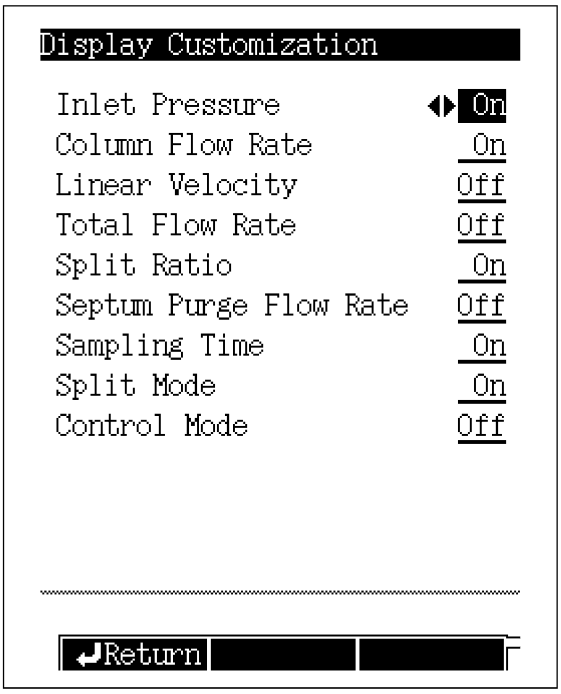
Parameters marked with "◁" and "▷" are changed by making another selection. Change the selection using the following procedure.

(1) Move the cursor to the item.
(2) Select the desired choice by pressing the [◁] and [▷] key.

(3) Press the [ENTER] key to validate the selection.

Note

The selection change becomes valid when the [ENTER] key is pressed.
If you move the cursor or display another screen before pressing the [ENTER] key, the change is not made.
To clear the selection before pressing the [ENTER] key, press the [CE] key.



Change the selection by pressing the [◁] and [▷] keys.
In this example, the selection is changed in the order "On → Off → On ..."

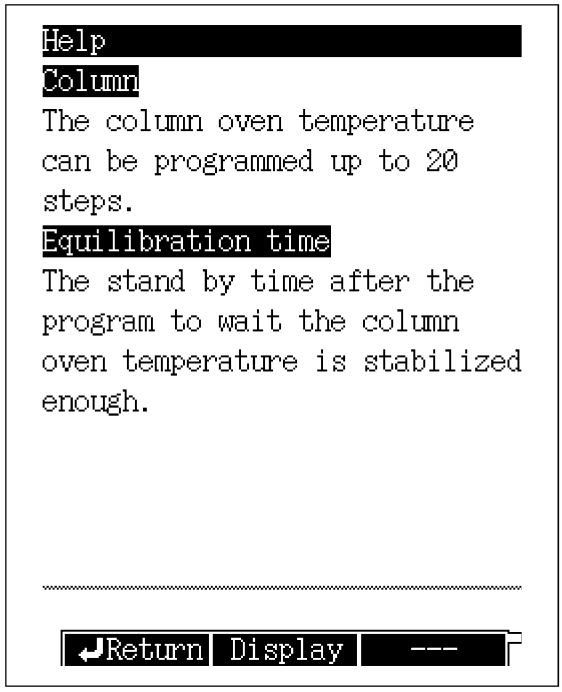
Press the [ENTER] key to validate the selection.

5.2 Getting Help

The Help function describes items on the setup screen.
Understanding the items helps you to quickly and efficiently set up analytical parameters and proceed to the operations.

1. Screen Help

If you do not know the meaning of an item on the screen, press the [HELP] key on the screen to display the item and its description.
Items which may be difficult to understand are linked to further descriptions. Access these underlined item descriptions by pressing [Display] (PF menu) with the cursor on the item.



6 Analysis Flow Chart

1. Preparation

Glass insert preparation

Confirm that the insert is appropriate for the injection mode, that the silica wool has not moved, and that the glass insert O-ring has not deteriorated.

↓

Septum preparation

Replace the septum after approximately 100 injections. (50 injections for a thick needle)

↓

Column preparation

Attach the column to the hanger and verify the proper position of the graphite ferrules.
Tighten the injection port and detector column nuts.

When the above preparations are complete, turn on the GC. (The power switch is in the lower right position of the unit main body)

2. Setting parameters

Set the column information and the flow rates

From the [Column] (PF menu) of the [FLOW] key screen, set the column inner diameter, the column length and the film thickness. From the [Purge] (PF menu) of the [FLOW] key screen, set the purge flow rate.
From the [FLOW] key screen, set the column inlet pressure, the injection mode, the split ratio, the sampling time, etc.
Changing the column temperature after the flow rate has been set may change the flow rate.

↓

Set the temperature of the detector and the injection port

From the [INJ] and [DET] key screens, set the temperatures.
If the detector is set to "Off", turn it "On". From [DET Gas] (PF menu), set hydrogen, air, makeup gas, etc.

↓

Set the COL temperature and the temperature program

From the [COL] key screen, set the column initial temperature and the temperature program. The column temperature settings must be within the permitted column range and must be less than detector temperature.

↓

Start GC control

Press the [SYSTEM] key to display the main screen.
Press [Start GC] (PF menu) to start GC control.
Press the [MONIT] key, and ensure that the temperature of each zone, the gas flow rate, the gas pressure, etc. are correct.

↓

Set the detector

From the [DET] key screen, set the range and the time filter constant.
Ensure that the temperature of the detector is rising, then ignite the FID or set the TCD current value.

↓

When all parameters reach the respective setup value, the STATUS indicator light becomes green and the system is ready for analysis.

The default zero parameter, "Zero at Ready" zeroes the detector signal when the GC is ready.

3. Analysis

Set the data processing unit

Perform the required settings for the data processing unit, such as specifying the processing parameters.

↓

Check the baseline

Press the [MONIT] key, and make sure that the baseline is stable.
When the baseline is stable, press [Zero Adj] (PF menu) to zero the detector output, and you can start analysis.

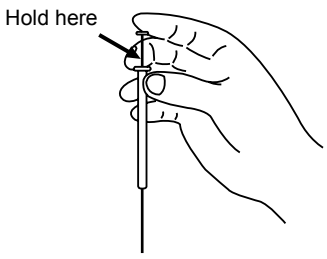
↓

Inject the sample

Aspirate the sample in the syringe, inject it into the GC injection port, and press [START] to analyze it.
For capillary column analysis, normally inject 1 μL or less liquid.
(1 - 2 μL available)

Warning

Wear protective goggles when using a syringe to inject samples.
The syringe plunger could be expelled due to injection port back pressure. Sample could get into the eyes.
By holding and supporting the plunger from the side with your middle finger, you can smoothly inject the sample and keep the plunger in the syringe.
Do not bend the plunger when holding the syringe in this position.



(example)
How to hold a syringe during injection

■ **Glass insert** (liner)

- There are two types of glass inserts, one for split analysis and the other for splitless/WBI analysis. Select the correct type based on the sample injection method.
- A glass insert for split analysis can be used for splitless analysis. However, when injecting thermo labile samples, or samples that are highly absorptive or of low concentration, use the (deactivated) splitless insert.
- The quantity and position of the silica wool in the insert directly affects the reproducibility of results. For the AOC-20i auto injector, the silica wool is normally positioned 25 mm from the upper end of the glass insert for split. On the other hand, the silica wool is positioned at bottom of the glass insert for splitless.

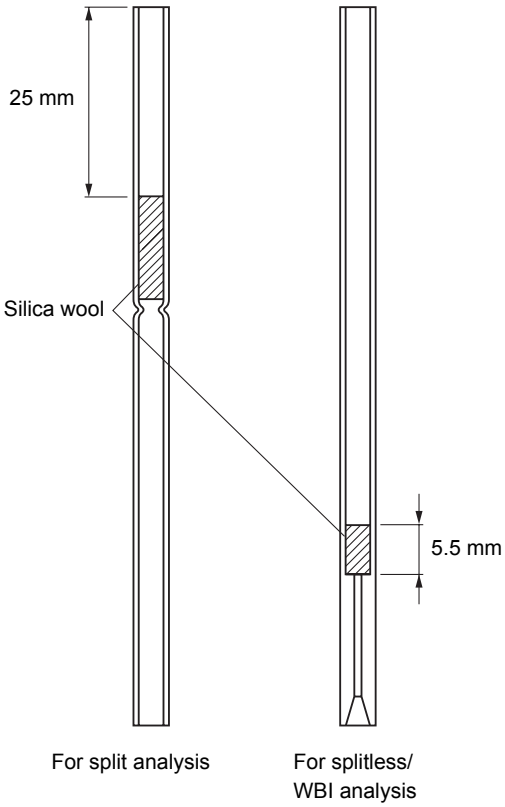


Figure 6.1 Correct placement of silica wool

- Samples come into direct contact with the inner surface of the glass insert and the silica wool. On these hot surfaces, unstable compounds may decompose or be adsorbed. If this occurs, use deactivated lines and silica wool.

■ **Analysis column**

- Verify that carrier gas is flowing for enough time to flush the air in the column before increasing the column oven temperature. Otherwise, the column liquid phase becomes oxidized, and cannot separate compounds properly. This is especially important for polar columns.
- Press the [SYSTEM] key, and set a start time. This ensures that carrier gas flows for the set time prior to temperature control of the heated zones.
- Selection of the analysis column is very important in GC analysis. In general, select a liquid phase whose polarity and chemical characteristics are similar to those of the analysis target compound to obtain good peak shape. However, highly polar columns require low temperatures and do not last long. Therefore, when analyzing an unknown sample, begin by analyzing it on a neutral column at higher temperatures. Switch to a more polar column if necessary.

■ **Installing the analysis column**

Place one graphite ferrule at each end of the capillary column using the proper ferrule adjuster and nut.

Because graphite may be present on the column, the column must be clipped. The edge of the cut must be completely straight.

Use a small column nut on the injection port side. Use a column nut on the detector side. Do not forget to attach a column nut when setting the graphite ferrule on the injection port side. The column nut should be tightened by hand at first, then 1/2 turn further with a wrench.

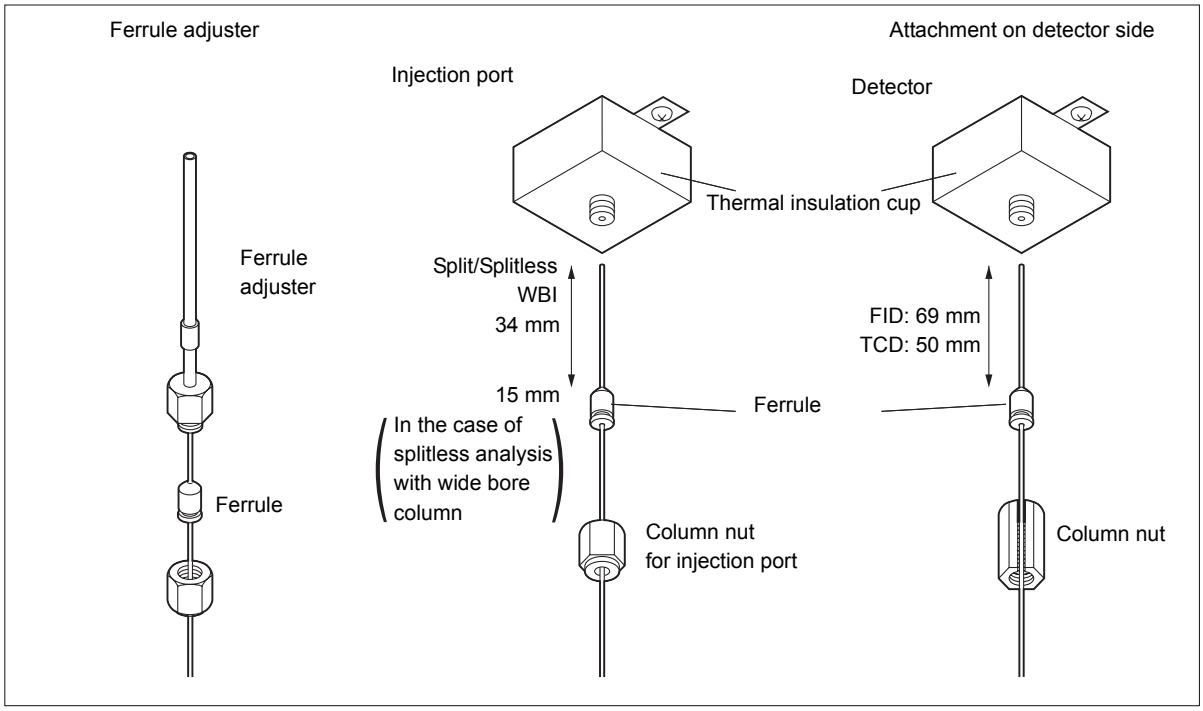


Figure 6.2

■ **Sample injection mode**

[Split injection]

In capillary columns, the inner diameter is small and the sample load capacity is low. Unlike packed columns, only a small (less than 0.1 µL) amount of sample can be injected at one time. The split injection mode only allows part of the injected sample to enter the column. This method is useful for samples of high concentration or about which nothing is known. Try to perform a split injection method first. Set the split ratio to approximately 1:50 for the narrow bore column (ex. 0.25 mm 2.0). If the target peak is too large, increase the split ratio. If the target peak is too small or cannot be detected, decrease the split ratio. In this way, specify the appropriate split ratio.

The standard to set the split ratio is [column flow rate + split ratio] ≥ 30 ml. The value varies depending on the columns' inner diameter and flow rate. It is recommended to start with the total flow rate of approximately 50 ml.

If the desired sensitivity cannot be achieved at [column flow rate + split ratio] < 20 ml, consider other injection methods.

[Splitless injection]
In the splitless injection method, almost all of the sample amount injected is introduced in the column by temporarily suspending the split flow.
This method is effective for analyzing a low concentration sample which cannot be easily detected by the split injection method.
To reduce band broadening and sharpen peaks by condensation and vaporization of the sample in the column, create a temperature ramp program. The column initial temperature is set to a temperature lower than the boiling point of the sample solvent.
The high pressure injection can reduce the volume of vaporized sample solution and improve the analysis repeatability.

[Direct injection]
In the direct injection method, almost the entire amount of injected sample is introduced into a wide bore column. Because the inner diameter of the wide bore column is 0.45 mm or more, separation is not as good as that of a column with smaller inner diameter. Since the peak shape is broad, the sensitivity may not always be sufficient.
For the direct injection method, the WBI (Wide Bore Injection) injection port should be used.

■ **Setting the heated zone temperature**
The temperature of the injection port, the column oven and the detector are set individually. Usually, the temperatures for the injection port and the detector are set higher than one for the column oven.
Temperature of the injection port varies according to the target substances. Set the temperature where an injected sample instantaneously evaporates. Always set the detector temperature higher than the column temperature.
Never set the column temperature higher than the detector because the detector could become contaminated.
When creating a temperature program, be careful not to set the final temperature higher than that of the detector temperature.

■ **Column temperature program**
Use a temperature program mainly in analyzing samples of a wide boiling point range. When developing the analytical conditions for an unknown sample or a sample which will generate an unpredictable chromatogram pattern, use an initial program with a low initial temperature (40 - 50 °C) and a temperature increase rate of approximately 10 °C /min. Based on the result, check the temperature range in which the peaks appear, then examine the analytical condition. This procedure facilitates time program development.

■ **Injection counter**
The injection port septum and the glass insert must be inspected and replaced periodically. The GC-2010 Plus provides a function which counts the number of injections. When the number of injections exceeds the limit, you are prompted to perform maintenance. (What is actually counted is the number of START times.)
Select the analysis counter on the [DIAG] key screen, to set and reset the counter limit. Set the limit to perform maintenance on a regular basis.
The septum/glass insert replacement cycle varies, depending on the analytical conditions and samples. If the glass insert is easily contaminated (when analyzing non-volatile compounds for example), set a low counter limit. On the other hand, when analyzing cleaner samples, the limit can be increased.

■ **Starting up the GC**

Turn on the power and/or press the [SYSTEM] key to display the GC startup screen. On this screen, specify the files used for instrument startup and instrument cleaning (column bake -out).

Press [Start GC] (PF menu) to start temperature control of each heated zone according to the parameters set in the file.

A start up method should be used to initialize the system once it has been turned on. Set the start up method to "auto" to start the file as soon as the power is on; this helps with instrument recovery after a power failure.

The initial step in the startup method should be turning on the carrier gas flow. After a set time, increase the injection port and detector temperatures. The column oven temperature can then be set to increase. The oven temperature increases last to protect the column from damage and the detector from contamination. The GC-2010 Plus controls the temperatures so that the column temperature never increases above the detector temperature, even if all temperatures are set to increase at the same time.

A clean up method uses higher oven temperatures than those used for the analysis. After set bake-out time, return the temperatures to their normal analytical parameter.

■ **Shutting down the GC**

When shutting down the GC, the heated zones are cooled, and then the carrier gas flow is turned off. To accomplish these in the correct sequence automatically, use a stop time (this stops temperature control at the set time) and flow off time (turns off carrier gas flow at the set time). Do not turn off the GC without first selecting [Stop GC] (PF menu). Because the carrier gas flow stops before the heated zones are cooled.

■ **Obtaining reproducible analysis results**

Follow these suggestions to obtain reproducible results:

- Use an AOC-20i auto injector.
- If more than one heated zone is dedicated as an injection port, but only one injection port is in use, do not increase the temperatures of the unused zones.
- If dual injections are normally performed, but single injections are being done, place the auto injectors on both injection ports.
- The GC is designed to perform optimally at room temperatures of 18 - 28 °C. Room temperatures above 28 °C will negatively impact reproducibility.

7 Maintenance and Inspection

7.1 Maintenance Parts

The following tables list maintenance parts and their part numbers (P/N). All parts, which are listed in the sections from "1." to "7." are consumables. Miscellaneous maintenance parts are listed in "8. Miscellaneous".

1. Septum

Parts name	P/N	Purpose
Silicon rubber septa (20 pcs)	201-35584	Injection port septa (Up to 350 °C)
Septa for high temperature (20 pcs)	221-48398-91	Injection port septa (above 350 °C)
LL long-life septa (20 pcs)	221-48972-91	Injection port septa (above 350 °C)
Thremogreen LB-2 (10 pcs)	221-35507-01	Injection port septa (Up to 350 °C)

The type of bleeding differs according to the type of septum and bleeding appears on a chromatogram in different patterns. For high sensitivity analysis, select a septum of which bleeding does not appear in positions that hinder the peaks of the subject compounds.

2. O-ring for glass insert

Parts name	P/N	Purpose
Fluoride rubber O-ring (5 pcs)	036-11203-84	Standard (Up to 450 °C)
Graphite O-ring (for splitless/ WBI) (4 pcs)	221-47222-91	For high temperature (350 °C to 450 °C)
Graphite O-ring (for split) (4 pcs)	221-48393-91	For high temperature (350 °C to 450 °C)
Fluoride rubber O-ring P4 (4 pcs)	036-11202-84	For residual solvent analysis kit

3. Glass insert

Parts name	P/N	Purpose
Glass insert (for split analysis)	221-41444-01	For split injection technique
Glass insert (for splitless analysis)	221-48335-01	For splitless injection technique
Deactivated glass insert (for splitless)	221-48876-03	5 pcs, with deactivated wool
Glass insert (for residual solvent analysis kit)	221-38107-01	
Silica wool (2 g)	221-48600	Packed in glass insert

4. Graphite ferrule

Parts name	P/N	Purpose
Graphite ferrule G0.5 (10 pcs)	221-32126-05	Capillary column installation
Graphite ferrule G0.8 (10 pcs)	221-32126-08	Wide bore column installation

5. Capillary column

To select a capillary column, refer to a column manufacturer's catalog.

6. Flow controller

Parts name	P/N	Purpose
Molecular sieve filter	221-34121-94	For removing contamination in carrier gas
Trap (SPLIT)	221-42559-92	Split flow line trap
Trap (PURGE)	221-42559-92	Septum purge flow line trap
Aluminum gaskets	201-35183	For tubing connections

7. Hydrogen flame ionization detector (FID)

Parts name	P/N	Purpose
Jet	221-48258-91	Jet for FID
Jet, ϕ0.8	221-49373-91	For water analysis 0.8 mm inner diameter
FID collector	221-72322-91	
Igniter	221-41847-93	Igniter for FID

8. Miscellaneous

Part	Name	P/N
FPD detector	Filter (S)	221-73354-01
	Filter (P)	221-73354-02
	Filter (Sn)	221-73354-03
	Quartz cylinder	221-46552
FTD detector	FTD collector ASSY	221-45586-91
	FTD-2010 collector repair kit	221-49079-91

7.2 Inspection and Maintenance Intervals

Warning

Danger of burns.
Do not perform injection port maintenance until the temperature of the injection on port has dropped below 50 °C.

Caution

Wait until the injection port has cooled to loosen screws and nuts to prevent them from binding.

Warning

Use a hood when cleaning the insert with reagents like organic solvent and acid.
Wear protective clothing, such as goggles, gloves, and a lab coat.
If reagents get on to the skin or in the eyes, flush with copious amounts of water and consult a medical professional.

Warning

Wear safety glasses when handling the capillary column, to prevent eye injuries.

Periodical inspection and maintenance are required to maintain the gas chromatograph in the good condition.
The recommended inspection interval for each part is described below. Refer to each section for details. The items "1) Glass insert" to "5) Capillary column" which you frequently inspect are described in detail in section 7.4 to 7.8.

1. Glass insert
   Inspect the glass insert before starting a series of analysis. Pay close attention to dirt and the position and quantity of the silica wool. An insert counter feature is available in the GC. Refer to the diagnosis item list in "14.1 Standard Diagnosis" in the Instruction Manual.
2. Septum
   Replace the septum periodically to avoid the carrier gas leakage. The guideline for replacement is every 100 injections (50 injections for thick needle). A septum counter feature is available in the GC. Refer to the diagnosis item list in "14.1 Standard Diagnosis" in the Instruction Manual.

3. O-ring for glass insert

Replace the O-ring when replacing the glass insert or if there is a carrier gas leak.

4. Graphite ferrule

Replace the graphite ferrule if a carrier gas leak is not stopped by tightening.
Replace the ferrule if it is completely compressed.

5. Capillary column

Condition the column if it has not been used for a long time, if ghost peaks are present, or if baseline noise is high.

6. Flow controller

Condition or replace the carrier gas molecular sieve filter if the baseline is unstable.
Every 6 months, check the split flow line and the septum purge flow line trap and replace any saturated trap.

7. Hydrogen flame ionization detector (FID)

Rinse or replace the igniter and the jet if ignition is not smooth, the flame often goes out during the analysis or no peaks are obtained.

8. Cleaning the unit

Clean stains on the surface of the equipment using a dry and soft cloth.
If the exterior surfaces become dirty, clean using a cloth with a neutral detergent.
Never use organic solvents. They may damage the surface.

7.3 Inspection and Maintenance

This section describes the preparation required before maintenance/inspection and the restart after maintenance/inspection.

1. Septum (Section 7.4), O-ring for glass insert (Section 7.5), Glass insert (Section 7.6)

■ **Preparing the gas chromatograph**

If the system is operating, press the [SYSTEM] key and select [Maint INJ] (PF menu). Then, the temperature of the injection port and the column oven automatically drops, and the carrier gas stops when the temperature falls below 51 °C. When the message "GC is ready for maintenance." appears on the screen, injection port inspection/maintenance can begin. Remove the auto injector if it exists. Lift up the INJ/DET cover, and remove it. Close the FID detector cover, which is fixed to the FID collector with the screw. Because the cover of the FID detector is hot when the flame is "On", use tweezers or pliers to handle the FID detector cover.

■ **Restarting the gas chromatograph after inspection and maintenance**

Open the FID detector cover using tweezers or pliers, and replace the INJ/DET cover. When starting up the GC again, select [Anal.] (PF menu). The GC automatically flows the carrier gas for 5 minutes, and then restores the temperatures set prior to maintenance. When the STATUS lights turns green and the base line becomes stable, you can start analysis.

2. Graphite ferrule (Section 7.7) and capillary column (Section 7.8)

■ **Preparing the gas chromatograph**

If the unit is operating, press the [SYSTEM] key and select [Stop GC] (PF menu). After the stop time, the temperature of the injection port, the column oven and detector automatically decreases. Press the [MONIT] key, and ensure that the temperature of the injection port, the detector and the column oven are below 50 °C. Press the [FLOW] key, and select [Off] (PF menu). The inspection/ maintenance can then begin.

■ **Restarting the gas chromatograph after inspection and maintenance**

When starting up the GC again, press the [FLOW] key, select [On] (PF menu), press the [SYSTEM] key, then select [Start GC] (PF menu).
When the STATUS indicator light turns green and the baseline becomes stable, you can start analysis.

7.4 Inspection and Maintenance : Septum

Repeated injections can deteriorate the septum, interfering with its sealing ability and causing carrier gas leaks. This can cause retention time shifts and poor producibility. In addition, septum fragments can fall into the glass insert, causing ghost peaks. Periodically inspect and replace the septum as described in this section.

1. Inspection/maintenance cycle

The guideline for inspection/maintenance is after every 100 injections.
Septum replacement is recommended every 100 injections.
(every 50 injections for thick needle: ex. gas tight syringes)
In addition, perform inspection and maintenance in the following cases.

- When the retention time and/or area reproducibility is poor
- When ghost peaks are detected

It ghost peaks are obtained although no septum fragments are found in the glass insert, ensure that the new-septa are conditioned properly.

2. Inspection/maintenance

■ **Conditioning the septum**

For high sensitivity analysis, impurities from the septum may be detected as ghost peaks. In such a case, condition the septum as describe below.

(1) Soak the septum in hexane, and leave it for 10 to 15 hours.
The septum will absorb hexane and swell to approximately twice its size. Therefore, use a container with a wide opening and a lid.

(2) Take out the septum, and put it into a rinse container.
Take particular care when handling the septum swollen with hexane because it can easily crumble.

(3) Let the septum air dry in clean surroundings.

(4) After drying, bake the septum at 130 to 150 °C for approximately 2 hours.

Note

Store the septum in a clean, sealed container to prevent contamination.

■ **Inspection**

When inspecting only the septum, remove the septum nut above the septum, take out the septum, then condition it or replace it with a new one.

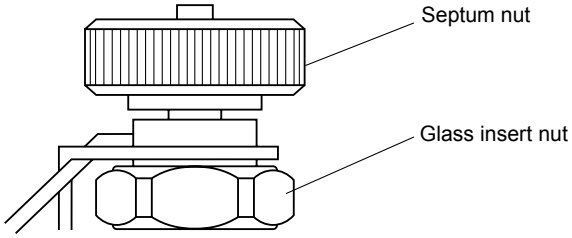
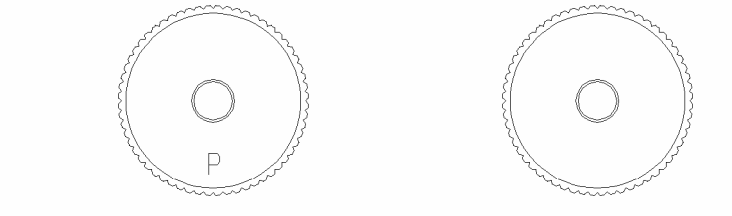


Figure 7.1

Note

Septum nut for the SPL of the GC-2010 Plus has a "P" mark. Do not mix up the nut with the septum nut for the WBI-2010 Plus or the injection port of the GC-2010.



Septum nut for SPL　　Septum nut for others

■ **Septum installation**

Install the conditioned septum or a new septum using the following procedure. When using an autosampler, tighten the septum nut by hand until it touches the nut below the screw, then loosen a half turn.

When performing manual injection, you can extend the life of the septum and prevent carrier gas leakage by tightening the septum nut by one thread after approximately 10 of injections. When the injection port is hot, the septum nut is also hot. When tightening the septum nut, wear gloves to prevent burns.

7.5 Inspection and Maintenance : O-ring for Glass Insert

1. Inspection/maintenance cycle

Two types of O-rings are available for the glass insert and the fluoride rubber type is usually used. But when the fluoride rubber type is used for long periods at the injection port temperature more than 350 °C, its ability to remain leak-tight is reduced and it should be checked for leakage every week.

When operating the system for long hours at more than 350 °C, the graphite type is recommended. But the graphite type has a little less sealing effect than the fluoride rubber type. The fluoride rubber type can be used for several glass insert replacements, but the graphite type can be used only once. However, replacing the O-ring when replacing the glass insert is recommended.

Perform inspection and maintenance of the O-ring when the carrier gas leaks.

To stop leaks, tighten the glass insert nut. If the leak continues, inspect the O-ring and replace it if necessary.

2. Inspection/maintenance

■ **Troubleshooting**

It is recommended to replace the O-ring when replacing the glass insert in order to prevent gas leakage.

Caution

Handle graphite O-rings with care to prevent leakage.

■ **Replacing the O-ring**

Take out the glass insert, remove the O-ring, and install a new O-ring.

Note

For the glass insert removal/attachment procedure, refer to "Inspection and maintenance of glass insert".

(1) Fluoride rubber O-ring

Place the fluoride rubber O-ring approximately 4 mm from the lop of the glass insert. When inserting the glass insert in the injection port, push the glass insert in until the glass insert touches the bottom of the injection port. This correctly positions the O-ring 3 mm from the top of the glass insert glass insert nut.

(2) Graphite O-ring

Insert the glass insert without O-ring in the injection port, place a graphite O-ring on it, and then tighten the glass insert nut.

Note

Use the correct graphite O-ring for the glass insert type.

■ **Leak check**

A leak will affect reproducibility and carrier gas will be wasted.
Confirm whether there is a leak or not according to the following procedure:
(As for the following procedure, there could be cases in which the error message "purge leaks" etc. appears. However, it does not matter for the test. Then, select "Ignore Error".)

(1) Set the "Flow Control" to "Cont" on the screen after pressing the [SYSTEM] key.
(2) Push the [Stop GC] (PF menu), and the system stops.
(3) Wait until the oven temperature, injection port temperature and detector temperature are all below 40 degrees on the screen after pressing the [MONIT] key.
(4) Push the [On/Off] (PF menu) on the screen after pressing the [FLOW] key, and the control of the AFC stops.
Set the purge flow rate to "0 ml/min".
(5) Remove the capillary column from injection port, and blank off with a column nut and the graphite ferrule with a wire.
(6) Install the blind (G-type blank nut) to the split vent and purge the vent port.
(7) Make sure that the supply pressure to the carrier gas (the pressure from a gas cylinder) is above 300 kPa.
(8) Set the "Split mode" to "DIRECT" and "Control mode" to "PRESS" on the screen after pressing the [FLOW] key.
(9) Set the inlet pressure to 150 kPa. Push the [On/Off] (PF menu), and the control of AFC starts.
(10) Wait for five minutes. Confirm that the inlet pressure is 125 - 175 kPa. If the inlet pressure is above 175 kPa, unfasten the column nut a little and release the pressure.
If the inlet pressure is below 125 kPa, raise the supply pressure a little.
(11) Confirm that the total flow is below 2 ml/min. If the total flow is above 2 ml/min, then there is a leak somewhere.
(12) Push the [On/Off] (PF menu) on the screen of the [FLOW] key, and the control of AFC starts.
(13) When using a fluoride rubber O-ring, confirm that the pressure does not drop more than 15 kPa per hour or 2.5 kPa in 10 minutes.
When using a graphite O-ring, confirm that the pressure does not drop more than 21 kPa per hour or 3.5 kPa in 10 minutes.
If the pressure has dropped more than the above values, there is a leak somewhere.
(14) When the leak check has been passed, set the system back into operating status.

■ **Possible leak positions**

In case the leak check conditions has failed, check the following items on the GC for possible leaks:

septum injection inlet, around the injection port, the connection of piping, split vent (around the blind plug), purge vent (around the blind plug) and the connection of column with a leak detector or snoop.

If you have located a leak in one of the above positions, perform the following according to the location of the leak.

- Septum injection inlet : replace septum.
- Around the injection port : replace O-ring of glass insert.
- Split vent : replace blind plug seal.
- Purge bent : replace blind plug seal.
- Connection of column : replace graphite ferrules and column nut.

Caution

Do not use leak detecting fluid nor soapy water for gas leak check on the connections above the carrier and detector gas controllers (AFC/APC).
The drips may damage the controller.

Note

When you use snoop liquid etc., take care that the liquid is not splashed to the electric wiring and detector. There is a risk to get an electrical shock.
When using snoop liquid for detecting leaks there is always a possibility that a part of the liquid creeps into the pipings which in case of trace analysis can give ghost peaks which may interfere your peaks of interest. Then it is recommended to use a leak detector instead.

7.6 Inspection and Maintenance : Glass Insert

Note

For details on handling the glass insert, refer to "12. Injection Port" in the Instruction Manual.

1. Inspection/maintenance cycle

Inspect the glass insert before starting a series of analysis.

In addition, inspect and maintain the glass insert when the following problems occurs.

- If the retention time shifts or reproducibility is poor.
- If ghost peaks are detected.

When the problem above occurs, the silica wool may have moved, or become dirty, or the glass insert could be dirty.

2. Inspection/maintenance

■ **Removing the glass insert**

Remove the glass insert using the following procedure.

(1) Loosen and remove the glass insert nut while holding the septum nut. Remove the septum nut assembly by lifting it straight up and moving it to the side.

The glass insert could break if the septum nut assembly is not lifted straight up.

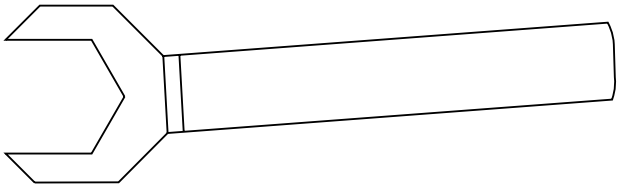


Figure 7.2 Tool: Glass insert wrench, standard accessory Part No. 221-46977

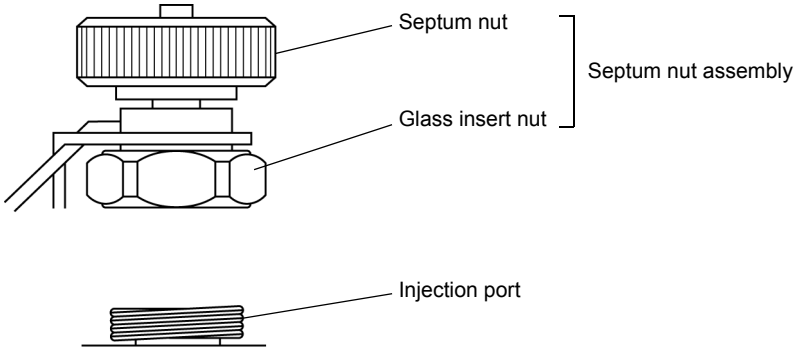


Figure 7.3

(2) Use tweezers to lift the glass insert out of the injection port.

Note

If the O-ring has become fixed, turn the O-ring using tweezers and then lift the glass insert. Do not forcibly lift the glass insert with the O-ring fixed because it may break the glass.

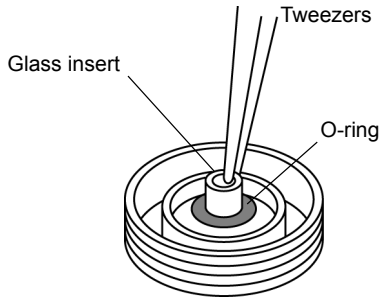


Figure 7.4

■ **Cleaning the glass insert**

Note

Remove the O-ring before rinsing the glass insert with solvent. After cleaning, use a new O-ring.

(1) Removing the silica wool
Septum fragments and other contaminants on the silica wool affect reproducibility. Ghost peaks may also be present.
Push silica wool out using a thin, long wire.

(2) Removing particles from the glass insert
After removing the silica wool, rinse the interior of the insert by wiping with gauze soaked in solvent (such as acetone), etc. or soak the insert in organic solvent and clean with an ultrasonic cleaning unit.

(3) If the glass insert is extremely dirty
If particles and stains cannot be removed, soak the glass insert in an aqueous solution of alkaline detergent for glass for approximately 1 day; rinse the insert with large amounts of water, then, rinse it with organic solvent such as acetone, and let it air dry.
If the glass insert still cannot be cleaned, you can soak it in an aqueous solution of 1N nitric acid for 7 to 8 hours, then wash, rinse and air dry as described above.

■ **Silica wool packing**

(1) Quantity of silica wool
Pack the following standard amount of glass wool.
- For Split: Approx. 10 mg
- For Splitless: Approx. 2 mg

Note

For special samples, better results may be obtain by varying the amount of silica wool in the insert.
- Reduce the amount of silica wool for highly absorptive samples, such as agricultural samples.
- Increase the amount of silica wool when injecting solvents with a high latent heat of vaporization, such as water.

(2) Position of silica wool
Place the silica wool 1-2 mm below the lowest position of the needle at injection. If the silica wool is too close or too far away from the needle good reproducibility of results may not be obtained. Refer to "6 Analysis Flow Chart" for silica wool location.

(3) Packing silica wool
Pack silica wool flat and evenly without making it too densely packed or too fluffy.

■ **Cautions setting the glass insert**

Attach the O-ring and set the glass insert, referring to "7.5 Inspection and Maintenance : O-ring for Glass Insert".

7.7 Inspection and Maintenance : Graphite Ferrule

> **Note**
>
> For details on handling the graphite ferrule, refer to "4. Installing the Column" in the Instruction Manual.

The graphite ferrule is used in both ends of the capillary column.

1. Inspection/maintenance cycle

In the following situation, inspect or maintain the graphite ferrule.

- When a new graphite ferrule is being installed.
- When ghost peaks are detected during temperature increase.
- When the baseline drifts significantly during temperature increase.

2. Inspection/maintenance

■ **Troubleshooting**

(1) Check for carrier gas leaks

Deterioration of ferrules can cause carrier gas leaks and poor reproducibility. Check the gap between the back ring and side ring of the graphite ferrule. If it is in poor condition, replace it with a new graphite ferrule.

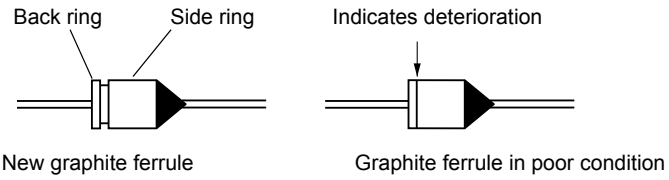


Figure 7.5

(2) Check for the source of contamination

Ghost peaks can be caused by a poorly made column inlet connection. Baseline drift can be caused by a poor connection at the column outlet (provided the column has been sufficiently conditioned).

If a contaminated graphite ferrule is causing problems, condition the graphite ferrule using the procedure described below.

■ **Conditioning the graphite ferrule**

If a contaminated graphite ferrule is causing problems, condition the graphite ferrule using a procedure below.

Condition the graphite ferrule just before using the system if possible. Otherwise, the ferrule may become re-contaminated.

Hold the graphite ferrule in the blue flame of a gas burner for 1 to 2 seconds until it becomes red hot.

Caution

Do not get burned when holding the graphite ferrule.

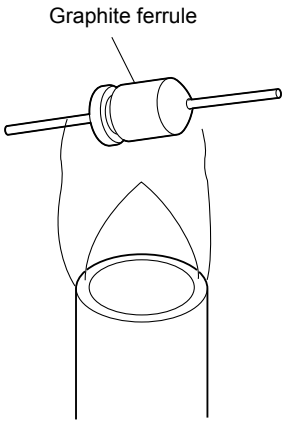


Figure 7.6 Conditioning the graphite ferrule

7.8 Inspection and Maintenance : Capillary Column

> **Note**
>
> For details on removing the capillary column, refer to "4. Installing the column" in the Instruction Manual.

1. Inspection/maintenance cycle

In the following situation, inspect and/or maintain the capillary column.

- When using a new column or a column which has not been used for a long time
- When ghost peaks are detected
- When the baseline is unstable
- When the baseline noise is high

2. Inspection/maintenance

■ **Troubleshooting**

Check whether the base line is unstable or ghost peaks are present.
A contaminated column can cause an unstable baseline on ghost peaks. If these problems occur, the column should be conditioned.

> **Note**
>
> For details on handling the capillary column, refer to "4. Installing the column" in the Instruction Manual.

■ **Conditioning the capillary column**

Condition the capillary column using the following procedure.

(1) Setting the carrier gas
To condition the column, use an analysis flow rate. However, reduce the split ratio, to conserve carrier gas.

(2) Setting the column oven temperature
Set the column oven to a temperature approximately 30 °C higher than the column operating temperature during analysis.
Do not exceed the maximum column temperature limit.

(3) Setting the injection port temperature and the detector temperature
Set the same injection port temperature normally set for analysis.
Set the detector to a temperature approximately 30 °C higher than the column operating temperature.

(4) Conditioning time
As a general rule, condition the column for 2 to 3 hours.
If the column is considerably contaminated increase the condition time.
The condition time should be less than 24 hours to avoid unnecessary damage to the column.

Note

Some column liquid phases can be easily damaged.
Verify the maximum column temperatures limit before use and conditioning. High temperatures can damage the column, particularly if oxygen is present in the column. Use of an oxygen trap is recommended.
Avoid rapid temperature increases, especially for polar columns.

7.9 Others

Further, flow controllers and detectors should be maintained. However, the maintenance procedures for them are omitted in this chapter because of long maintenance cycle. For more details, refer to "18.8 Maintenance of inspection of flow controller", "18.9 Maintenance of inspection of FID" in the Instruction Manual and the Instruction Manual of each detector.

Warning

Check the following items before starting inspection/maintenance of the FID.
1. Stop supply of hydrogen gas, and extinguish the hydrogen flame.
2. Set the detector temperature to 50 °C or less.
3. Turn off the power of the FID.
4. Remove the capillary column from the FID.

Risk of burns. Do not perform maintenance until the temperature has dropped below 50 °C.

■ **Warning Messages for Maintenance**

GC-2010 Plus has the function of warning of the typical time for replacement of the following parts.

- Column oven fan motor
- LCD backlight
- Temperature sensors at the column oven, injection units, detectors and other heater units

One of the following warning messages appears when the use time has reached the time set for replacement. Contact your Shimadzu representative for replacement of the relevant part.

The GC unit may be used tentatively without part replacement; the warning message will appear every 24 hours.

[Warning messages]

Fan use time is over	LCD backlight use time is over
COL sensor use time is over	INJ1 sensor use time is over
DET1 sensor use time is over	INJ2 sensor use time is over
DET2 sensor use time is over	AUX3 sensor use time is over
AUX4 sensor use time is over	AUX5 sensor use time is over

The units connected to INJ1 to AUX5 are shown at "1. Installation (Position)" and "2. Installation (Piping)" under "7. Service and maintenance", which is displayed by pressing the FUNC key.

Note

Do not change the set values on this screen. If any value is changed, the GC unit may not work correctly.

For details, refer to "16.7 Service and Maintenance" in the instruction manual.

[Use time (Replacement time)]

Fan: 61320 hours (based on 8 hours per day: approx. 21 years, 24 hours: approx. 7 years)

Backlight: 46380 hours (based on 8 hours per day: approx. 16 years, 24 hours: approx. 5 years)

Sensor: 26280 hours (based on 8 hours per day: approx. 9 years, 24 hours: approx. 3 years; at 300 °C)

Note

The replacement time shows the number of years at which a replacement is recommended. Note that this is not the guaranteed service life of each part.
If a warning message is displayed for the sensor of a unit, consider that the other units that you started to use at the same time are also close to the replacement time.
It is recommended that these parts should be replaced at the same time even if their warning messages are not displayed.

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8 Troubleshooting

This section describes possible problems, causes and solutions. They are divided by analytical procedure. If the problem is not solved by following the recommended solutions, or if other problem occur, contact your Shimadzu representative.

1. Gas and pressure settings

(1) When the pressure/flow rate cannot be set or does not become the set value

(2) Continual gas leaks

2. Temperature control

(1) When the temperature does not increase or reach the set value

3. Detector

(1) FID

The FID flame does not ignited properly

The FID baseline is fluctuating

Baseline noise is high

(2) TCD

The detector can not be zeroed

Fluctuating baseline

Baseline noise is high

4. Chromatogram and data

(1) No peaks or extremely small peaks

(2) Presence of ghost peaks

(3) Abnormal peak shape

(4) Poor retention time reproducibility

(5) Poor peak area reproducibility

1. Gas and pressure settings

(1) When the pressure/flow rate cannot be set or does not reach the set value

Possible Cause	Solution
No gas is supplied.	Open gas cylinder main valve to supply gas.
Supply pressure is low.	Set carrier gas supply pressure to 300 to 980 kPa. Hydrogen: 300 to 500 kPa Air: 300 to 500 kPa Makeup gas: 300 to 980 kPa
Gas leaks.	Check for gas leaks, and tighten leaking connections. Replace gasket or septum. (Refer to "2.6 Gas supply plumbing" in the Instruction Manual.)
AFC/APC : Incorrect value set. Set value is outside controllable range.	Set pressure to proper value. (Refer to "3. AFC and APC" in the Instruction Manual.)
Carrier gas type, column length, inner diameter and film thickness are incorrect.	Set carrier gas type, column length, inner diameter and film thickness correctly. (Refer to "12.5.2" "12.6.2 Setting the flow note" and "12.5.3 Setting column parameters" in the Instruction Manual.)
Total flow rate is set to too low, and pressure cannot increase. (In this case, measured flow rate of split vent is extremely low.)	Increase total flow rate. (Refer to "3. AFC and APC" in the Instruction Manual.)
Split vent trap is clogged. (Even if total flow rate is set high, the measured flow rate from split vent is low and the pressure is high.)	Replace trap. (Refer to "18.8 Inspection and Maintenance : Flow Controller" in the Instruction Manual.)

(2) Continual gas leaks

Possible Cause	Solution
Part is incorrectly installed.	Install part correctly. (Refer to "2.6 Gas supply plumbing" in the Instruction Manual.)
Graphite ferrule or other seal is damaged.	Replace damaged gasket part with a new one.

If tubing on connection are damaged, the qualified service personnel should replace them. Contact your shimadzu representative.

2. Temperature control

(1) When the temperature does not increase or reach the setup value

Possible Cause	Solution
GC has not started yet.(Press [SYSTEM] key to display GC startup procedure screen.)	Press [SYSTEM] key, and press [Start GC] (PF menu).
Heater control is set to "Off".	Set control to "On" on COL/INJ/DET setup screen.
Because start time is set to a high value, heating has not started yet.	Set start time to a lower value. (Note: Immediately after this setup value is changed, new value is in effect.)
Heat loss is being caused by an open oven door or insulation out of place.	Close oven door. Replace the insulation.
Because maximum temperature is set to very low a value, an overheat error has occurred.	Increase the maximum temperature setting.
Because DET actual temperature is lower than the set value of COL temperature. (According to keep the detector clean, column oven temperature can not exceed DET actual temperature.)	Set DET temperature larger than COL temperature.

Only an oven with the CRG option can attain a temperature below room temperature. The lower temperature setting may cause an error if the CRG option is removed or turned off. Change the temperature setting.

3. Detector

(1) FID

The FID flame does not ignite properly

Possible Cause	Solution
Column is not connected.	Connect column.
Hydrogen gas is not supplied or its flow rate is incorrect.	Supply hydrogen gas, or set its flow rate to a proper value.
Hydrogen gas has not been flowing long enough to replace the air in the tubing.	Wait for 30 to 60 minutes to allow the air to be completely replace with hydrogen.
Air is not supplied or its flow rate is incorrect.	Supply air, or set its flow rate to a proper value.

Refer to "18. Inspection and Maintenance of FID" in the Instruction Manual, and inspect the FID. If a jet is clogged, clean or replace it. A defective ignitor filament must be replaced. Contact your shimadzu representative.

Warning

If the FID ignition has failed, shut off the hydrogen gas supply immediately and inspect the FID.

The FID baseline is fluctuating

Possible Cause	Solution
Carrier gas leaks.	Tighten leaking connections. Replace tubing or septum. (Refer to "2.6 Gas supply plumbing" in the Instruction Manual.)
Carrier gas (or makeup gas) quality is poor.	Replace gas with higher purity gas. Provide a molecular sieve filter in the gas flow line.
Molecular sieve filter is saturated.	Recondition the molecular sieve filter.
Injection port is contaminated.	Inspect the glass insert. Clean or replace the glass insert. (Refer to "18.5 Inspection and Maintenance : Glass Insert" in the Instruction Manual.)
Compressed are is contaminated. (The baseline fluctuates according to the compressor pressure.)	Install the silica gel trap on either end of the pressure regulator. Use air from a gas cylinder instead (with the FID on).
Hydrogen gas has not been flowing long enough to replace the air in the tubing.	Wait for 30 to 60 minutes to allow the air to be completely replace with hydrogen.
Room temperature is not within the recommended range and/or is fluctuating considerably.	Keep the room temperature within the recommended range and move the system away from heat on Air conditioner vent, etc.

Baseline noise is high

Possible Cause	Solution
Carrier gas quality is poor.	Replace carrier gas with higher purity gas. Provide a molecular sieve filter in the carrier gas flow line.
Hydrogen gas quality is poor.	Replace hydrogen gas with higher purity gas.
Gas leaks.	Check for leak in injection port and column connection area. Tighten leaking connectors.
The quartz jet is dirty.	Remove dusts with blowing air.

If the jet is damaged, replaced it. If the collector is coated with white powder, contact your Shimadzu representative for replacement.

(2) TCD

The detector cannot be zeroed

Possible Cause	Solution
Data processing unit is not connected properly.	Connect them properly.
Current is "Off".	Turn the current on.
Current value is too high.	Set current to a lower value.

Turning on the TCD current when oxygen is present in the cell can oxidize or blow out the filament, making it impossible to zero the detector.
If the filament blows out, the cell must be replaced. Contact your Shimadzu representative.

Fluctuating baseline

Possible Cause	Solution
Carrier gas or makeup gas leaks.	Tighten leaking connections. Replace tubing or septum. (Refer to "2.6 Gas supply plumbing" in the Instruction Manual.)
Carrier gas quality or makeup gas quality is poor.	Replace gas with higher purity gas. Provide a molecular sieve filter in the gas flow line.
Molecular sieve filter is saturated.	Recondition the molecular sieve filter.
Current value is too high.	Reduce the current.
Injection port (glass insert or silica wool) or column is dirty.	Clean or replace glass insert. Condition column.
Cell is dirty.	Condition cell.* Make several solvent injections.
Room temperature is not within the recommended range and/or is fluctuating considerably.	Keep the room temperature within the recommended range and move the system away from heat on air conditioner vents etc.

*Cell conditioning procedure

1. Remove the column and seal the detector by installing a new graphite ferrule (with its wire) in the column nut.
2. Set the current value to "0 mA".
3. Begin makeup gas flow (at the flow rate used in analysis).
4. Set the detector temperature 30 °C higher than the analysis temperature.
   (However, the detector temperature cannot exceed 400 °C, the maximum operating temperature.)

The conditioning time varies depending on the degree of contamination, but is approximately 1 to 12 hours.
The baseline may fluctuate because the temperature of a heated zone or the flow rate is not stable. Check the monitor display. If such problem occurs, contact your Shimadzu representative.

Baseline noise is high

Possible Cause	Solution
Carrier gas or makeup gas is contaminated.	Sufficiently purge air inside flow lines. Replace tubing. Use higher purity gas. Provide a molecular sieve filter in the gas flow line.
Gas leaks.	Check for leak in injection port and column connection area. Tighten leaking connectors.
Current value is too high.	Reduce the current.
Makeup gas flow rate is too how.	Increase flow rate.

Excessively high current can damage the filament and cause significant noise. Contact your shimadzu representative for cell replacement.

4. Chromatogram and data

(1) No peaks or extremely small peaks
Peaks may not be able to be detected because of high noise. Refer to "3.2.3 Baseline noise is high".

FID detector

Possible Cause	Solution
Carrier gas is not flowing.	Start carrier gas flow.
Carrier gas leaks.	Tighten leaking connectors.
Split ratio is too high (for split analysis).	Reduce split ratio.
Sample concentration is low. Or injection volume is too low.	Increase sample concentration or injection volume.
Wrong column is used.	Replace existing column with one appropriate for the compounds analyzed (more polar, less polar etc.)
Column temperature is too low.	Increase column temperature.
Signal cable of detector is connected incorrectly.	Connect signal cable correctly.
Detector is set to "Off".	Set detector to "On".
Detector parameters have been set incorrectly.	Increase range and attenuation sensitivity.
Hydrogen flame is extinguished.	Check hydrogen/air flow rate, then ignite.
Zero level is far below "0".	Press "MONIT" key then press "ZERO Adj" (PF menu) to execute zero point adjustment.

If the jet or the cable is damaged, contact your Shimadzu representative for replacement.

TCD detector

Possible Cause	Solution
Range is not "×1".	Set range to "×1".
Current set value is too low.	Increase current setting. (Decrease TCD thermostatic oven temperature, and increase maximum working current.)
Makeup gas flow rate is too high.	Set it to the proper value. He: Approx. 7.5 mL/min N_2: Approx. 8.0 mL/min
Split ratio is too high (for split analysis).	Decrease split ratio.
Carrier gas leaks.	Check for injection port and column connection leaks. Tighten leaking connectors.
Capillary column is installed incorrectly.	Install column correctly.
Column is contaminated.	Condition column.
Sample concentration is low. Or injection volume is too low.	Increase sample concentration or injection volume.
Wrong column is used.	Replace existing column with one appropriate for the compounds analyzed (more polar, less polar etc.)
Another analytical condition, such as temperature or column flow rate is incorrect.	Change the analytical conditions.

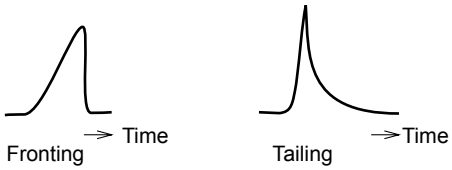
(2) Presence of ghost peaks

Possible Cause	Solution
Septum purge is not flowing.	Flow septum purge.
Peak which did not elute during previous analysis is detected.	Increase column oven temperature to maximum temperature in analysis to eliminate sample remaining inside column.
Sample is contaminated.	Prepare sample newly.
Micro syringe is dirty.	Clean micro syringe. Or replace it with a new one.
Carrier gas purity is low.	Replace carrier gas with one of higher purity. Provide molecular sieve filter in carrier gas flow line.
Substances of high boiling point accumulated at column inlet end are flowing out.	Condition column. Clip the injection port end of the column.
Injection port is dirty.	Clean or replace glass insert. (Refer to "18.5 Inspection and Maintenance : Glass Insert" in the Instruction Manual.)
Tubing, pressure regulator, etc. are contaminated with oil, etc.	Replace tubing, pressure regulator, etc. with clean ones.
Septum fragments are present inside glass insert or column.	Clean or replace glass insert. Clip the injection port end of the column.

(3) Abnormal peak shape

Fronting (Leading): A peak increase slowly. The first half peak area is higher.

Tailing: Once the peak has eluted, the baseline does not immediately return to its zero level. The second half peak area is high.



Possible Cause	Solution
<Fronting> Column is overloaded.	Dilute sample. Decrease injection volume, or increase split ratio. Use a column with a greater film thickness.
Peaks are co-eluting.	Change an analysis condition. Replace column to obtain better separation.
<Tailing, Fronting> Injection port temperature is low.	Increase injection port temperature.
<Tailing> Column is contaminated.	Condition column. (Refer to "18.7 Inspection and Maintenance : Capillary Column" in the Instruction Manual.)
<Tailing> Glass insert is damaged.	Replace glass insert. (Refer to "18.5 Inspection Maintenance : Glass Insert" in the Instruction Manual.)
<Tailing> Septum purge is not flowing or is too low.	Verity septum purge flow. Increase septum purge flow rate. (Refer to "3. AFC and APC" in the Instruction Manual.)
<Tailing> Septum fragments are present inside glass insert or column.	Clean or replace glass insert. Clip the injection port end of the column.

(4) Poor retention time reproducibility

Possible Cause	Solution
The carrier gas cylinder is almost empty.	Replace the gas cylinder with one of at least 3 MPa pressure.
Carrier gas flow rate is fluctuating due to a gas leak.	Tighten leaking connections. Replace tubing or septum.
Column is overloaded.	Decrease sample size. Dilute sample. Increase split ratio. Use a column with a thicker film.
Room temperature is not within the recommended range or is considerably fluctuating.	Keep the room temperature by within the recommended range or reduce temperature fluctuations.
Syringe tip is clogged, and sample is not properly injected straight.	Clean or replace syringe.

If the gas supply pressure is fluctuating due to failure of the gas cylinder pressure regulator, repair or replace it. Contact your Shimadzu representative.

(5) Poor peak area reproducibility

Possible Cause	Solution
The carrier gas cylinder is almost empty.	Replace the gas cylinder with one of at least 3 MPa pressure.
Carrier gas flow rate is fluctuating due to a gas leak.	Tighten leaking connections. Replace tubing or septum.
Sample is not injected completely.	Perform injection accurately. Replace the syringe with a new one.
Column is overloaded.	Decrease sample size. Dilute sample. Increase split ratio. Use a column with a thicker film.
Room temperature is not within the recommended range or is considerably fluctuating.	Keep the room temperature within the recommended range or reduce temperature fluctuations.
Syringe tip is clogged, and sample cannot be aspirated well.	Clean or replace syringe.
Syringe tip is clogged, and sample is not properly injected.	Clean or replace syringe.
Syringe plunger is stiff, and does not move smoothly.	Clean syringe barrel and plunger. Clean or replace syringe.
Silica wool inside glass insert is packed incorrectly.	Repack the silica wool.

If the gas supply pressure is fluctuating due to failure of the gas cylinder pressure regulator, repair or replace it. Contact your Shimadzu representative.

Appendix Error Message

Refer to Instruction Manual (CD-ROM) for the error messages which have not been described as follows.

1. System errors

<Room temperature sensor/atmospheric pressure sensor error>

Room temperature is out of range.
Atm. pressure is out of range.

The room temperature or the atmospheric pressure is out of the performance range. If this error occurs although the actual room temperature/atmospheric pressure is within the range, the sensors may have failed. The system cannot be used. Turn off the system, and contact your Shimadzu representative.

2. Operation errors

<value outside of range was entered>

Input parameter out of range

The numeric value entered is out of the valid range. Enter a valid number errors.

<File operation errors>

Invalid file no.
This file is now used.
File initialize failure.
File can't be copied.

These messages appears when an incorrect file operation was attempted.
Press another key, and continue operation.

<Overflow of calculated pressure or flow rate value>

CARx calc. press is out of range.	
CARx calc. flow is out of range.	x=1-3

The carrier gas pressure (flow rate) calculated from the linear velocity, the flow rate (gas pressure) or the split ratio. You have input is out of the set range. Change the condition so that the pressure is within the set range, and enter the new value.

MUPn calc. press out of range	
HGNn calc. press out of range	
AIRn calc. press out of range	n=1-4
APCy calc. press out of range	y=1-18
PURx calc. press out of range	x=1-4

The pressure calculated from the flow rate you have input or is outside the set range. Change the condition, and enter a new value.

3. Communication errors

<External device communication error (i. e. : Chromatopac)>

TRS time out
TRS parity error
Message is not accepted
TRS data is invalid
Command is invalid
Param by TRS is out of range
TRS port is shut down
TRS file error

One of these messages appears during a link failure or communication failure (When a communication error occurs, the link is automatically disconnected.) when one of these messages appears, check the connection status, and reset the link.

4. Detector error

<Over current>

DET#n TCD cell error. DET#n FTD current error.

(n=1 - 4)

Abnormal detector current. If the resistance of the filament becomes abnormally high when the TCD or the FTD is in use, the protection circuit is actuated to prevent damages to the filament, and an alarm sounds. If ether error has occurred, turn off the system.

Possible reasons for the protection circuit to be activated are described below.

The set current value exceeds the maximum operating current.

The makeup gas is not flowing.

A Gas leak has occurred.

A significant amount of air is present in the flow line (for TCD).

Remove the cause of error, then turn on the system. If the system does not recover after several retries, or the reason for the error cannot be located, contact your Shimadzu representative.

<Detector flame error>

DET#n flame is out.

(n=1 - 4)

The detector flame (FID) has been extinguished. Check the gas supply, and ignite the detector again. If the flame error occurs repeatedly, the hardware has failed. The system cannot be used. Turn off the system, and contact your Shimadzu representative.

<TCD errors>

TCD signal is out of range. TCD signal zero error

The difference in filament resistance is high between the TCD cells, and the detector cannot be zeroed. The detector control unit may have failed. The system cannot be used. Turn off the system, and contact your shimadzu representative.

<Detector ignition errors>

DET#n ignition failed.

(n=1 - 4)

This message appears when the FID does not ignite within a certain time. When the message appears, hydrogen gas does not stop automatically for manual flow control. Shut off the hydrogen gas first for safety, then check the following items.

(1) The column is connected
(2) Hydrogen is supplied at proper flow rate
(3) Air is supplied at proper flow rate
(4) Filament in igniter is intact
(5) The jet in the FID is not clogged
(6) Unused FID is not set to ON

H2, AIR, APC are not ready.

This message appears when the APC for hydrogen or air is not Ready at the time of ignition. Check whether the gas supply pressure is stable and whether gas does not leak. If there is not problem with the gas supply, the hardware has failed. Turn off the system, and contact your Shimadzu representative.

5. Other errors

Settings were changed.

This message appears when a set value was changed while the program is running. If the parameter or event has not yet been executed, the new value is used for the analysis.

Program time error Clean up program time error Pre-run prog. time error

These massages appears when the program execution time exceeds the maximum permitted value (9999.99 min). Change the program so that its total execution time does not exceed "9999.99 min". The program continues running after this error occurs, and stops at 9999.99 min.

<Temperature control errors>

Heat is escaping.

This message appears when large heat loss is occurring. The oven door may be open, or the insulation may not be in place. If the column oven door is open, close it and select "Reset Error". If the insulation has been disturbed, replace the insulation and then restart the system.

xxx temp exceeds the limit.

xxx = COL, INJ1, DET1, INJ2, DET2, AUX3, AUX4, AUX5

This message appears when the maximum temperature limit has been exceeded. Change the maximum limit temperature if necessary.

<Unstable temperature with CRG>

COL CRG is out of control INJ2 CRG is out of control

This messages appears when the column oven or the INJ2 cannot be cooled down because the column oven door remains open or insufficient coolant (also for INJ2) is preventing the oven CRG from cooling.
If the column oven door is open, close it and select "Reset Error".
Turn off the system, replace the coolant, then restart the system.

<Pressure/flow rate control errors>

xxx leaks.

This message appears when the pressure can not reach the set value. Check whether gas is supplied and whether gas is leaking from connections.

Note

Gas leaks may be occurring in several locations.
(Example) If the purge flow rate is too low, the message "Purge leaks" may appear. If the carrier gas is also leaking the ESC a TFC error message may not be displayed first.

<Abnormal component operation>

xxx is out of control. CARx prim is out of range.

(x= 1 - 3)

Verify whether continuous supply of gas is available at the required pressure. If there is no problem in the gas supply, the control system, such as the APC, may have failed. Turn off the system, and contact your Shimadzu representative.

6. Warning messages

COL CRG use time warning INJ2 CRG use time warning CARx septum counter warning CARx insert counter warning

These massages appears when the time or the count exceeds the set value, but does not indicate any error. Refer to "14. Diagnosis" in the Instruction Manual, and clear the message.

System is not ready

This message appears when the analysis was started before it was ready. Normally, do not start the analysis until the system is ready. If this message appears when all parameters are ready, check the ready setting for unused components and check the equilibration time.

Ignition finished (retried)

Ignition sequence was re-attempted, because the ignition failed initially. This does not affect the analysis.

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9 How to Use CD-ROM

1. Installing the Adobe Reader 9.1

When using the CD-ROM, install the "Adobe Reader 9.1" saved in the CD-ROM. Install it using the following procedure.

(1) Set the CD-ROM.

(2) Double-click the "My computer" icon on the desk top, then double-click the "CD-ROM" icon.

(3) Double-click the file "CD-ROM drive \Adobe\En\AdbeRdr910_en_US.exe".

(4) After that, perform setting in accordance with instructions displayed on the screen to complete installation.

(5) After installation is completed, you can see the PDF files saved in the CD-ROM.

Reference: "Adobe" home page and latest information: http://www.adobe.com

2. Configuration of CD-ROM

CD-ROM

<manual_ jp>	: Saves the Instruction Manual in Japanese.
<manual_en>	: Saves the Instruction Manual in English.
<Adobe>	: Used to install the "Adobe Reader 9.1".
readmej.txt	: Describes the CD-ROM in Japanese. Read this file when using the CD-ROM for the first time.
readme.txt	: Describes the CD-ROM in English. Read this file when using the CD-ROM for the first time.

3. Using the Instruction Manual in CD-ROM

(1) Set the CD-ROM.

(2) Double-click the "My computer" icon on the Desk Top, then double-click the "CD-ROM" icon.

(3) Double-click the folder "manual_en".

(4) Double-click the file "GC-2010 Plus en.pdf".

(5) In the contents and the index of each displayed Instruction Manual, search and find an item you would like to read, and put the cursor on the item. When the cursor shape changes, click it to display the desired item. If the cursor shape does not change, the software does not jump to the item.

Note

The PDF files of the GC-2010 Plus include blank pages.
These pages are offered so that the beginning of each section becomes a front page in both-side print.

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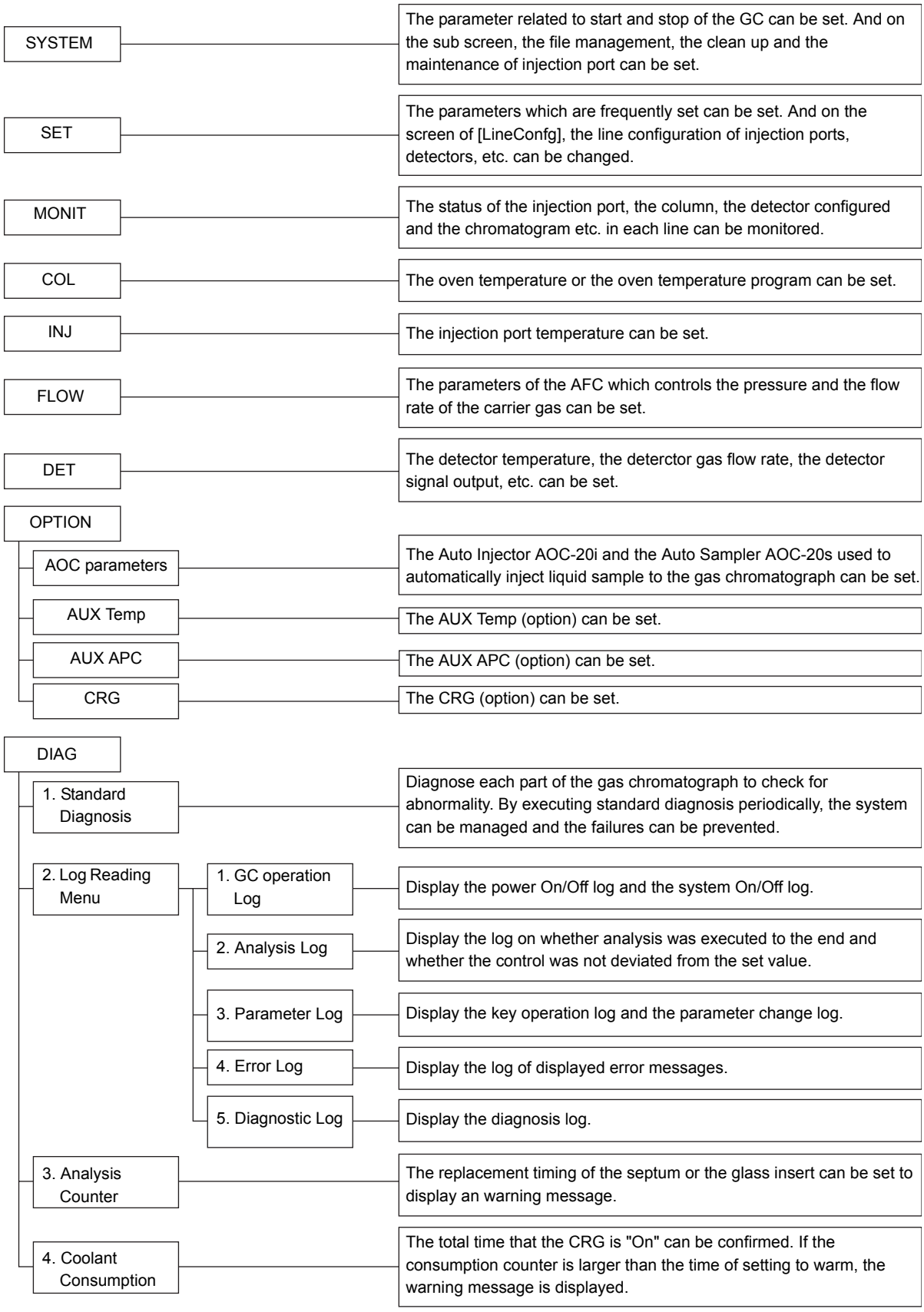
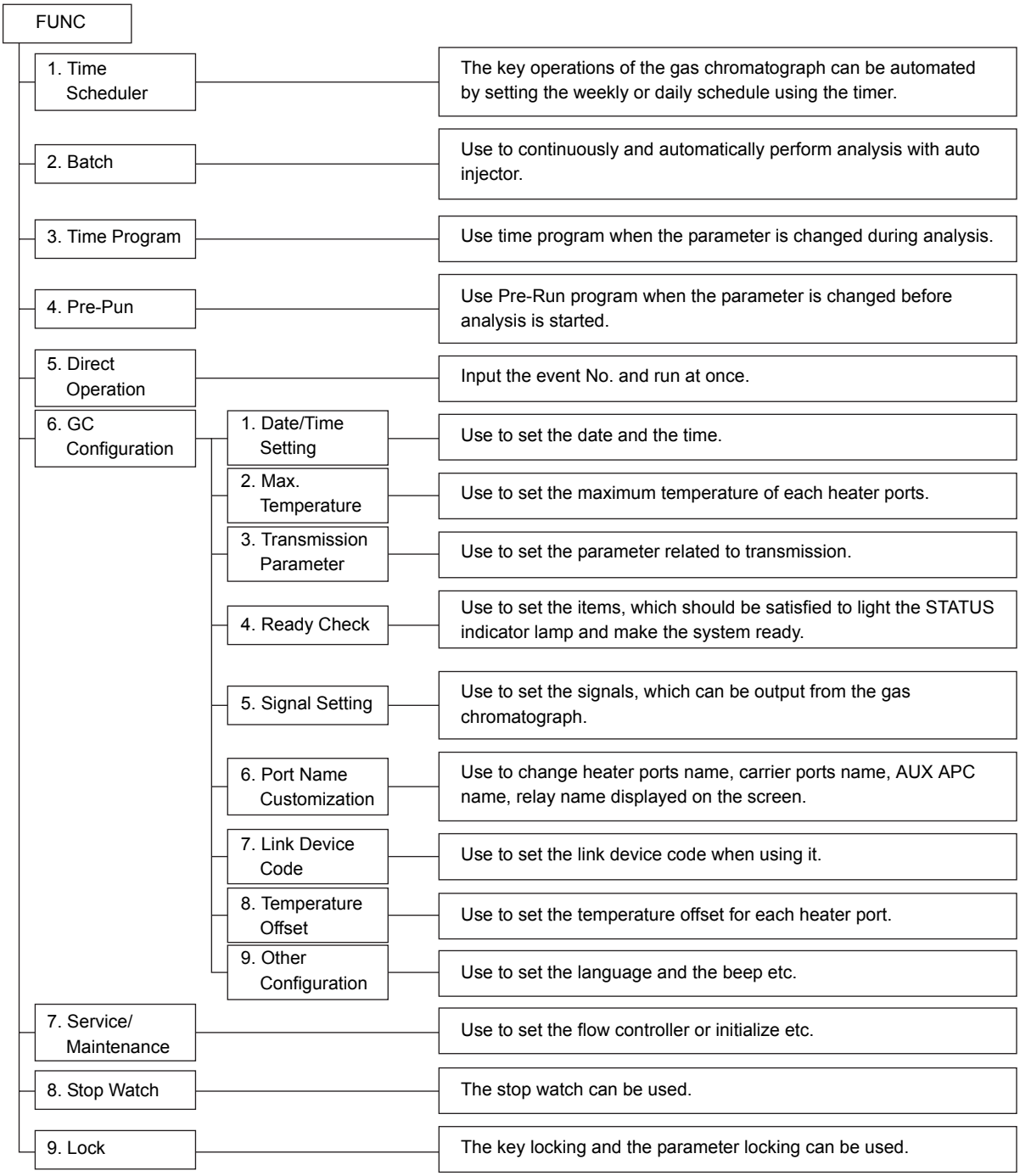
10 Appendix

Key Function List




FUNC
1. Time Scheduler
The key operations of the gas chromatograph can be automated by setting the weekly or daily schedule using the timer.
2. Batch
Use to continuously and automatically perform analysis with auto injector.
3. Time Program
Use time program when the parameter is changed during analysis.
4. Pre-Pun
Use Pre-Run program when the parameter is changed before analysis is started.
5. Direct Operation
Input the event No. and run at once.
6. GC Configuration
1. Date/Time Setting
Use to set the date and the time.
2. Max. Temperature
Use to set the maximum temperature of each heater ports.
3. Transmission Parameter
Use to set the parameter related to transmission.
4. Ready Check
Use to set the items, which should be satisfied to light the STATUS indicator lamp and make the system ready.
5. Signal Setting
Use to set the signals, which can be output from the gas chromatograph.
6. Port Name Customization
Use to change heater ports name, carrier ports name, AUX APC name, relay name displayed on the screen.
7. Link Device Code
Use to set the link device code when using it.
8. Temperature Offset
Use to set the temperature offset for each heater port.
9. Other Configuration
Use to set the language and the beep etc.
7. Service/ Maintenance
Use to set the flow controller or initialize etc.
8. Stop Watch
The stop watch can be used.
9. Lock
The key locking and the parameter locking can be used.