No.SK00-8740-EI-002-00E

ULVAC

Qulee Series

Residual Gas Analyzer/Process Gas Monitor

Instruction Manual

This manual is for the following serial numbers 00001 and higher.
CGM-051:S/N00001 and higher
CGM-052:S/N00002 and higher
BGM-101:S/N00051 and higher
BGM-101L:S/N00001 and higher
BGM-102:S/N00001 and higher
BGM-201:S/N00001 and higher
BGM-202:S/N00001 and higher

Read this manual before using this instrument and keep it at hand for immediate reference.

Components Division,
ULVAC, Inc.
2500 Hagizono, Chigasaki, Kanagawa, 253-8543, Japan
http://www/ulvac.co.jp/

Before using This Instrument

Upon receipt of this instrument, make sure that it is the correct model you ordered and is not damaged in transit.

	Read this manual and thoroughly understand safety precautions, specifications and operating procedure before installation, operation, inspection or maintenance of this instrument.
	No part of this manual may be copied for use by a third party without consent by ULVAC in writing.

Safety Notations

	The following notations are used throughout this manual to all operator's attention to safety. The notations are classified as follows.

	Failure to comply with WARNING involves a possibility of impending loss of life or serious personal injury.
	Failure to comply with DANGER involves a possibility of loss of life or serious personal injury.
	Failure to comply with CAUTION can lead to a medium degree of personal injury or serious damage to the equipment. It involves a possibility of damaging equipment or impairing its normal action.

Safety Precautions

Before using the Qulee series residual gas analyzer/process gas monitor, read this manual and the following safety precautions. ULVAC is not liable for any accidents or injuries caused by negligence of these safety precautions.

	**Handle with care** Read the manual before replacing the ion source of the analyzer tube and the secondary electron multiplier tube (SEM). The ion source is very hot immediately after operation. Before handling it, make sure that the filament is turned off and the ion source has cooled down. If the analyzer tube or its part was used in an atmosphere that can be hazardous to the human body, dispose of it through a disposal company.
	**Caution against gas** The analyzer tube has a hot cathode (about 1400°C). If the gas to be introduced into the analyzer tube is combustible or inflammable, check its limit density and the amount of gas to feed before use.
	**Beware of high temperature** The ion source periphery is hot during operation because of the hot cathode. Before touching the ion source or its periphery for maintenance or other purposes, make sure that the temperature has lowered to a sufficiently low level. You may get burned if you touch it immediately after shutdown. Do not touch the envelope during operation immediately after shutdown because it may be heated to a high temperature by the hot cathode.
	**Don't disassemble** Do not disassemble the analyzer tube, sensor unit and cable.
	**Don't modify** Do not modify the analyzer tube, sensor unit and cable. If modified, its action is not guaranteed. Also it can be a cause of fire or electric shock.

	**Grounding** Connect the instrument to Class 1 ground to prevent electric leak.
	**Don't touch** For safety reason, do not touch the metal portion of a terminal, which may be energized with a voltage. Also contact with the metal part can cause electric shock.
	**Turn off power** When installing or removing a component or part, turn off the power to the sensor unit. Contact with a terminal when power is turned on can cause electric shock. The SEM terminal is energized with a voltage of –0.5 kV to -3 kV when the SEM is turned ON. You may receive electric shock on contact with the terminal.
	**Check line voltage** Before turning on power, make sure that the operating voltage and supply voltage are in agreement. If incorrect power is applied, damage or fire can result.
	**Turn off power** Whenever replacing a fuse, turn off the power. If a fuse is replaced with the power turned on, you may receive electric shock.
	**Use a rated fuse.** Do not use a fuse other than specified ones nor short the fuse holder. Damage or fire can result.
	**Turn off power** If the residual gas analyzer/process gas monitor fails, immediately turn off the power. If not, fire or electric shock can result. For repair, contact your local ULVAC representative or Components Division, ULVAC, Inc., Japan.

	**Turn off power** If the residual gas analyzer/process gas monitor is overheated or gives out smoke or unusual smell, immediately turn off the power. Otherwise, fire or electric shock can result. For repair, contact your local ULVAC representative or Components Division, ULVAC, Inc., Japan.
	**Check connection** If an EXT I/O connector is used, make sure that there is no error in wiring. If there is an error in wiring, components may be damaged.
	**Operating environment** Do not use this instrument in a place where it may be splashed with water. If it is wetted with water, failure, electric leak or fire can result.
	**Check connection** Before turning on power, make sure that the sensor unit and analyzer tube are correctly connected. If power is turned on without connecting the analyzer tube, components may be damaged.
	**Ensure ventilation** A discharge fan is provided at the top and a blow fan is provided on the side (opposite side of the LCD display) to cool the sensor unit interior. Provide a space of 100 mm or more for all panels. If the air vent is plugged, heat will be contained in the unit, which can be a cause of failure.
	**No vibration** Keep the instrument free from vibration or impact from the surrounding. It can damage the instrument.

	**Maintenance** Aluminum electrolytic capacitor is used for the electric circuit in the sensor unit. Generally, the life expectancy of the aluminum electrolytic capacity is limited and the higher the surrounding temperature, the shorter the life. It is recommended to replace the aluminum electrolytic capacitor once every three years or at the time or repair or overhaul to prevent components from being damaged.
	**Keep out foreign objects** If a foreign object like a metal or combustible object is admitted into the sensor unit, remove it. If the instrument is operated with a foreign object in it, it can be a cause of failure.
	**Operating conditions** Use this instrument within the scope of specifications.
	**No impact** Do not give an impact to the instrument.
	**Caution in repacking and shipping back** Repack the residual gas analyzer/process gas monitor as shipped from the factory. If it is shipped bare, it may be damaged.
	**Discarding** If the residual gas analyzer/process gas monitor is to be discarded, dispose of it according to your local government regulations. If the analyzer tube or parts were used in an environment that can affect the human body, dispose of them through a disposal company. Expenses for disposal are on the user's account.

	**Be careful in operating PC** If an unexpected shutdown of PC or trouble of communication should occur between the residual gas analyzer/process gas monitor and PC in which gas analysis software "QuleeQCS" series is installed, turn off the power to this instrument and reset it. When this instrument is controlled by PC, PC has control over all actions, so that the filament ON state and the state during measurement are held and filament burnout or other trouble can be caused by operation on the instrument.
	**Be careful in operating isolation valve** If the user's isolation valve for this instrument is used, turn off the filament and check the measurement stop. If the filament is kept on in vacuum for an extended time, the ion source and electrode in the analyzer tube may be contaminated or insulation failure may occur.

AC adapter

	**Don't disassemble** Do not disassemble the AC adapter.
	**Don't modify** Do not modify the AC adapter. If modified, its action is not guaranteed. Also it can be a cause of fire or electric shock.
	**Grounding** Connect the instrument to Class 1 ground to prevent electric leak.
	**Check line voltage**

	Before turning on power, make sure that the operating voltage and supply voltage are in agreement. If incorrect power is applied, damage or fire can result. K type; Korean Ver. 7A-250V GB type; China Ver. 10A-250V CEE7 type; German Ver. 10A-250V A type ; USA Ver. 15A-125V
	**Check line voltage** Use this instrument within the scope of specifications. Damage or fire can result.
	**Turn off power** If the AC adapter fails, immediately turn off the power. Otherwise, fire or electric shock can result. For safety, contact your local ULVAC representative or ULVAC, Inc., Japan for repair.
	**Turn off power** If the AC adapter is overheated or gives out smoke or unusual smell, immediately turn off the power. Otherwise, fire or electric shock can result. For safety, contact your local ULVAC representative or ULVAC, Inc., Japan for repair.
	**Operating environment** Do not use this instrument in a place where it may be splashed with water. If it is wetted with water, failure, electric leak or fire can result.
	**Check connection** Before turning on power, make sure that the AC adapter is correctly connected. Otherwise, components may be damaged.
	**No vibration** See to it that no vibration or impact is given to the AC adapter. If given, it may be damaged.
	**Operating conditions** Use this instrument within the scope of specifications.

	**Caution in repacking and shipping back** Repack the AC adapter as shipped from the factory. If it is shipped bare, it may be damaged.
	**Discarding** If the AC adapter and its parts are to be discarded, dispose of them according to your local government regulations. If the analyzer tube or parts were used in an environment that can affect the human body, dispose of them through a disposal company. Expenses for disposal are on the user's account.

Jacket Heater

	**Don't disassemble** Do not disassemble the Jacket heater.
	**Don't modify** Do not modify the Jacket heater. If modified, its action is not guaranteed. Also it can be a cause of fire or electric shock.
	**Check line voltage** Before turning on power, make sure that the operating voltage and supply voltage are in agreement. If incorrect power is applied, damage or fire can result.
	**Check line voltage** Use this instrument within the scope of specifications(AC100V,typeA). Damage or fire can result.
	**Turn off power** If the jacket heater fails, immediately turn off the power. Otherwise, fire or electric shock can result. For safety, contact your local ULVAC representative or ULVAC, Inc., Japan for repair.

	**Turn off power** If the jacket heater is overheated or gives out smoke or unusual smell, immediately turn off the power. Otherwise, fire or electric shock can result. (When the jacket heater is heated, it gives out a little smell.) For safety, contact your local ULVAC representative or ULVAC, Inc., Japan for repair.
	**Operating environment** Do not use this instrument in a place where it may be splashed with water. If it is wetted with water, failure, electric leak or fire can result.
	**Check connection** Before turning on power, make sure that the jacket heater is correctly connected. Otherwise, components may be damaged.
	**No vibration** See to it that no vibration or impact is given to the jacket heater. If given, it may be damaged.
	**Operating conditions** Use this instrument within the scope of specifications.
	**Caution in repacking and shipping back** Repack the jacket heater as shipped from the factory. If it is shipped bare, it may be damaged.
	**Discarding** If the jacket heater and its parts are to be discarded, dispose of them according to your local government regulations. If the analyzer tube or parts were used in an environment that can affect the human body, dispose of them through a disposal company. Expenses for disposal are on the user's account.

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1. Features of Qulee Series

The Qulee series residual gas analyzer/process monitors include the following models.

(1) Model CGM compact process gas monitor
Application: Process gas monitoring, leak test and residual gas analysis of sputtering system, vacuum evaporation system and others

(2) Model BGM basic process gas monitor
Application: Residual gas analysis and leak test of sputtering system, vacuum evaporation system, etc.

(3) Model RGM reactive process gas monitor
Application: Process gas monitoring, leak test and residual gas analysis of CVD system, etching system and others

Features of the "Qulee" series include the following.

- Transducer type that permits connection of the control power supply to the analyzer tube, which has realized reduction of space.
- Measurement results can be displayed by the control power supply with displaying function without connecting PC.
- Leak test and monitoring of impurities can be made by operating only two buttons.
- Connected to PC, the instrument permits detailed data analysis using the dedicated software Qulee QCS.
- Compatible with RoHS Directive.

(1) Model CGM compact process gas monitor

- Measurement can be made with high accuracy and high sensitivity under a high pressure (1 Pa or less) without using a differential pumping system.

(2) Model BGM basic process gas monitor

- Cost has been reduced while retaining the basic performance of the residual gas analyzer/process gas monitor.

(3) Model RGM reactive process gas monitor

- Employment of a closed ion source with magnet, which has realized long life even in an atmosphere of corrosive gas, such as in a CVD or etching system.
- Capability of measurement of a wide pressure range of cleaning, process and ultimate pressure with a compact valve.

* This manual describes the following models. Confirm the

specifications, which differ from one model to another.

- CGM Models CGM-051, CGM-052
- BGM Models BGM-101, BGM-101L,BGM-102, BGM-201, BGM-202
- RGM Models RGM-201, RGM-202

2. Specifications and Components

2.1 Key Specifications

Series	CGM		BGM[*1)]					RGM[*2)]	
Model	CGM-051	CGM-052	BGM-101	BGM-101L	GBM-102	BGM-201	BGM-201	RGM-201	RGM-202
Mass number range (amu)	1 – 50		1 – 100			2 – 200			
Resolution (M/ΔM)	M/ΔM = 1M (10% P.H.)								
Mass spectrometer	Quadrupole type								
Detector	FC	SEM	FC		SEM	FC	SEM	FC	SEM
Sensitivity (A/Pa)	1e-7 @0.4mA	1e-4 @0.4mA	1e-7		4[*3)]	1e-7	4[*3)]	1e-6 (orifice) 1e-7 (direct)	1e-2 (orifice) 1e-3 (direct)
Min. detectable partial pressure (Pa)	1e-8 range	1e-11 range	1e-8 range		1e-12 range	1e-8 range	1e-12 range	1e-8 range	1e-12 range
Max. operating pressure (Pa)	2[*4)]		1e-2						
Linearity (Pa)	1		-						
Ion source	B-A type with total pressure measuring function							Closed type with magnet	
Filament	Ir/Y_2O_3, 1 pc.		Ir/Y_2O_3, 2 pcs.					Ir/Y_2O_3, 1 pc.	
Ionizing voltage (eV)	40		50					20 to 70	
Emission current (mA)	0.1/0.4[*5)]		0.5					0.01	
Degas	Electron bombard 300 V, 5 mA		-		Electron bombard 300 V, 5 mA			-	
Voltage applied to SEM (kV)	-0.5 to –1.5		-1.0 to -3.0						
Max. baking temperature (when sensor unit is removed)	120°C								
Max. baking temperature (when sensor unit is connected)	250°C								
Power requirements	24 VDC ± 10%								
Power consumption	50 W								
Ripple & noise (Vp-p)	240 mV or less								
Rush current[*6)]	8.5 (room temperature 25°C at cold start)								
Power connector	MSTBV2.5/3-GF-5.08								

External input/output connector	D-sub 15 pin (M2.6 screw)
Serial communication connector	6 pole 6 wire modular connector (RJ-11)
External input/output signal *7)	Analog input (0 to 10 V) × 2 External interlock input × 1 (pressure protection) , Start input × 1 (measurement start), error output × 1 (FIL, SEM, RF fault), Partial pressure setpoint output × 2 (fault, alarm) Total pressure setpoint output × 1
Fuse	6.3 A
Weight (basic unit)	2.1 kg (sensor unit, less SEM)/2.2 kg (sensor unit: with SEM)
CE standard*8)	[Emission Test] Radiation field intensity measurement: EN55011 CLASS A [Immunity Test] Radiation electromagnetic field test: EN61000-4-312002; Al Static electricity test: EN61000-4-2 Transient burst test: EN61000-4-4 Lightening surge test: EN6100-4-5 Conduction test: EN61000-4-6 Commercial magnetic field test: EN61000-4-8
IP protection class	IP30 (sensor unit)
Operating temperature range*9)	10°C to 40°C
Operating humidity range*10)	15% to 80% (not condensing)
Serial communication specifications	RS232C/RS485 (when option is used)

*1) Model with differential pumping system is available. The specifications above are those of the analyzer tube and sensor unit only.

*2) Differential pumping system is included as standard. The specifications above are those of the analyzer tube and sensor unit only.

*3) Sensitivity when the SEM voltage is set at -3kV. Normally, use at 5 mA/Pa or less.

*4) Measurement can be made down to 2 Pa, but linearity (of the measurement data) is down to 1 Pa. Use SEM at a pressure of 1×10^{-2} Pa or less. If a current in excess of 1×10^{-7} A is measured continuously, the life will be extremely short.

*5) Use emission current 0.4 mA at a pressure of 1×10^{-2} Pa or lower.

*6) Power thermistor is used to prevent rush current. Wait until the sensor unit cools down before turning on power again.

*7) Analog inputs and partial pressure/total pressure setpoints are effective when dedicated software is used for connection. START input is effective in the local mode.

*8) If measurement is made in an environment where measurement data is subject

to electromagnetic interference at a frequency of about 170 MHz, measurement data is subject to variation.

*9) If the temperature and/or humidity change, resolution will change and the mass number will change. Adjust resolution and calibrate mass number when temperature and humidity are stable.

2.2. Standard Equipment Configuration

(Qulee CGM-051/052, BGM-101/101L/102/201/202R, BGM-102-QIP-IG)

Qulee sensor unit	CGM-051/052, BGM-101/101L/102/201/202	1 unit
Qulee sensor	CGM-AN01/02, BGM-AN01/02	1 pce
Envelope	CGM-TU01/02、BGM-TU01/02	1 pce
Software for gas analysis	After Qulee QCS Ver.2.X	1
Power supply connector	MSTBV2.5/3-GF-5.08(Phoenix)	1 pce
RS232C communication cable	3m	1 pce
Bolt/nut/washer	M6 size (Bolt length;35mm)	1 set in 6 pcs
Gasket	UFC070G	1 sheet

Standard Equipment Configuration (Qulee CGM-051/052-QIP-PG)

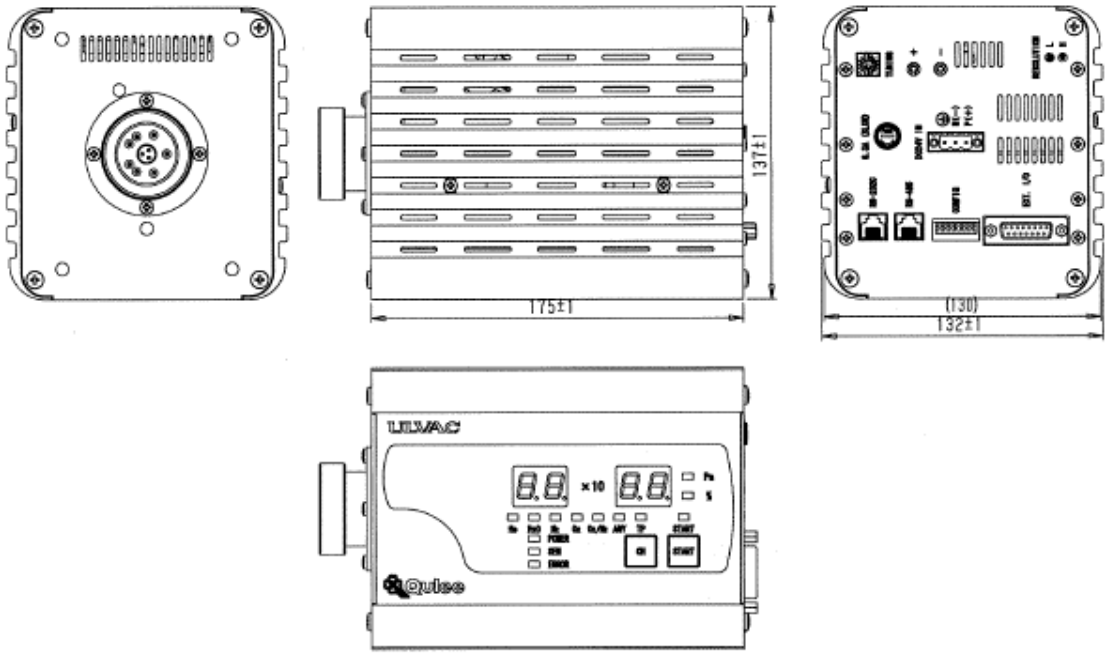
Qulee sensor unit	CGM-051/052	1 unit
Qulee sensor	CGM-AN01/02	1 pce
Envelope with PG port	-	1 pce
Pirani gauge	SP1(G-TRAN)	1
QIP cable	-	1 pce
Clamp/ center ring	KF(NW)16	1 set
Software for gas analysis	After Qulee QCS Ver.2.X	1
Power supply connector	MSTBV2.5/3-GF-5.08(Phoenix)	1 pce
RS232C communication cable	3m	1 pce
Bolt/nut/washer	M6 size (Bolt length; 35mm)	1 set in 6 pcs
Gasket	UFC070G	1 sheet
Operation manual	Qulee series operation manual (Clean paper)	1 copy
	Software Qulee QCS operation manual (Clean paper)	1 copy

2.3 Separate Goods Ordered

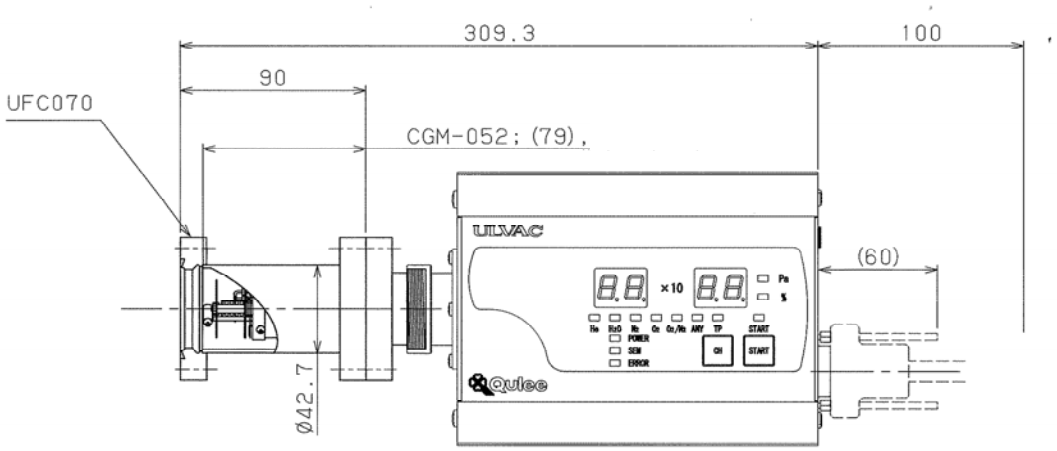
RS232C communication cable	5m,10m,15m
AC adaptor	PW-060A-01Y240(G)
AC adaptor power supply cords	Korea; AC250V 7A 2m Plug type K type China; AC250V 10A 2m Plug type GB type German; AC250V 10A 1.8m Plug type CCC7 type America;AC125V 15A 2m Plug type A type
Serial communication card	COM-1(CB)H
RS232C/485 converter	CD485/V-F
Transformer for RS232C/485 converter	Transformer M-100G, Adaptor plug set AP-7
RS485 branch connector and relay cable	NW081-666
EXT I/O connector	D-sub15 socket (M2.6 screw), clamp hood
Jacket heater	CGM-JH01、CGM-JH02、BGM-JH02
I type piping	C70-NW16 C70-NW25 C70-NW40
Carry case	CB-001
Acrylic case for transportation	For CGM-051/052, for BGM101/101L/201, for BGM102/202
Operation manual	Clean paper
Software operation manual	Clean paper
Inspection report	

3. Outside Dimensional Drawing

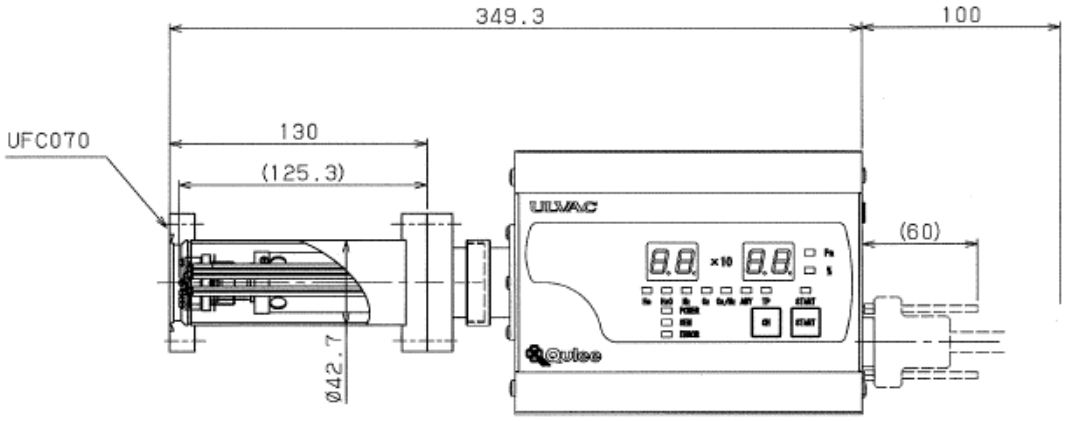
3.1 Sensor Unit



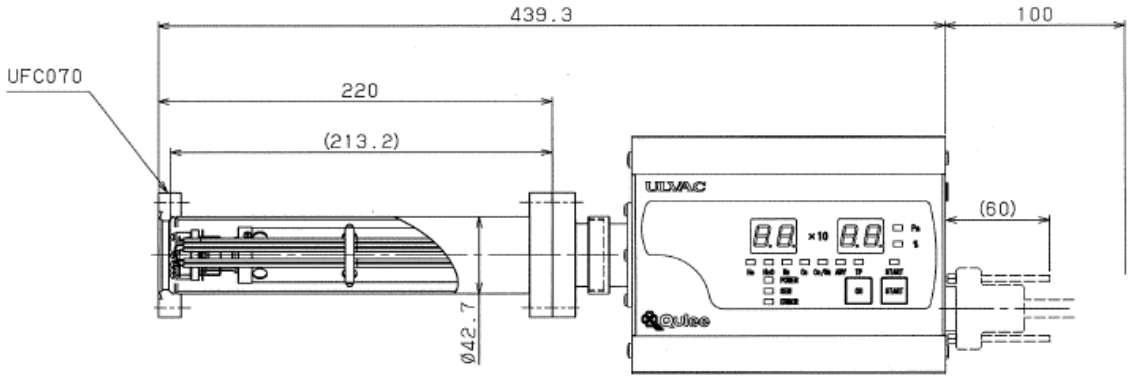
3.2 CGM-051/052



3.3 BGM-101/101L/201, RGM-201



3.4 BGM-102/202, RGM-202



4. Nomenclature and Functions of Components

4.1 Operation Switches and LEDs

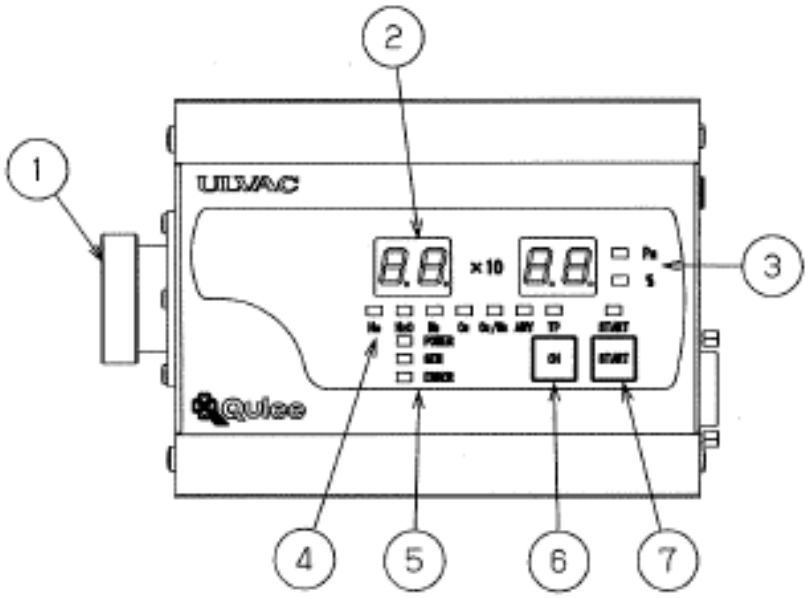


Fig. 4.1 Operation switches

No.	Name	Function
①	Analyzer tube connector	Connector that connects the analyzer tube.
②	Measurement value/fault display	Displays a measured partial pressure value. If any trouble occurs, this displays the symptom of the trouble.
③	Measurement value unit display LED	Displays the unit of measured partial pressure. If O2/N2 is selected, the display is switched over to %.
④	Gas specie/total pressure selection display LED	Displays the gas specie and total pressure being measured.
⑤	Power (POWER) SEM (SEM) Fault (ERROR) display LED	POWER LED (green) lights when power is applied. SEM LED (green) lights when SEM is used. ERROR LED (red) lights if a fault occurs.
⑥	Gas specie/total pressure selector switch (CH)	Selects a gas specie and total pressure to measure. Each press on the switch switches over the LED (orange).
⑦	Measurement start switch (START)	Each press on the switch lights the LED (orange) at the top and starts measurement.

4.2 Rear Panel

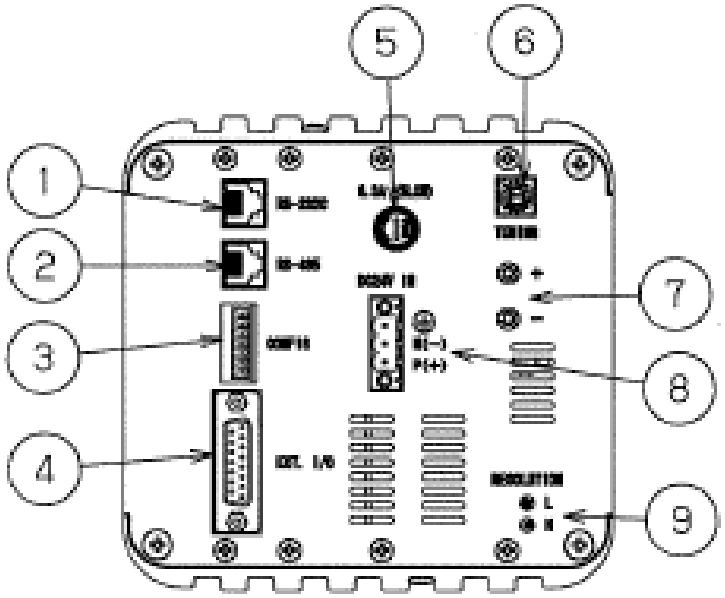
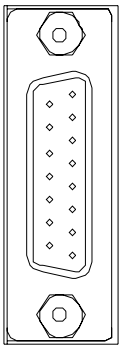


Fig. 4.2 Rear panel

No.	Name	Function
①	RS232C communication connector (RS232C)	Connector (6-pole, 6-wire) for connecting the RS-232C cable.
②	RS485 communication connector (RS485)	Connector to be connected in communication through RS-485. T-shaped connector is used for connecting multiple sensors.
③	Initial setting dip switch (CONFIG)	Dip switch for changing over RS232C/485, using SEM, address, and setting RS485 terminal resistor.
④	External input/output connector (EXT-I/O)	Signal I/O connector (D-sub 15-pin male).
⑤	Power fuse holder (FUSE)	Fuse for over-current protection of the entire instrument (rapid action type, 6.3 A).
⑥	Rotary switch for regulating tuning voltage (TUNING)	Rotary switch for regulating the tuning voltage with the analyzer tube.
⑦	Tuning voltage check terminal (+, －)	Terminal used for checking the tuning voltage with the analyzer tube.
⑧	Power inlet connector (POWER IN)	Connector for connecting the power cord (with grounding wire)
⑨	Resolution adjustment potentiometer (RESOLUTION L, H)	L: used when adjusting the resolution of low mass number. H: used when adjusting the resolution of high mass number.

4.3 EXT-I/O Connector

9 1



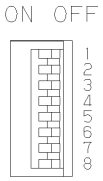
1 8

Fig. 4.3 I/O pin connector assignment

Terminal No.	Signal identification	Terminal No.	Signal identification
1	Analog input 1 (INPUT)	9	A-GND (INPUT)
2	Analog input 2 (INPUT)	10	A-GND (INPUT)
3		11	START input ON/OFF (INPUT)
4	Error output OK/NG (OUTPUT)	12	Interlock ON/OFF (INPUT)
5	Total pressure (TP) setpoint output ON/OFF (OUTPUT)	13	INPUT COM (INPUT)
6	Partial pressure abnormal output ON/OFF (OUTPUT)	14	
7	Partial pressure alarm output ON/OFF (OUTPUT)	15	
8	OUTPUT-COM (OUTPUT)		

- Digital output common is pin No. 8.
- Digital input common is pin No. 13.
- □ in the signal identification shows that the signal is LOW (short, negative logic).
- Total pressure setpoint output, partial pressure abnormal output and partial pressure alarm output of terminal Nos. 5 – 7 are effective only when software is connected.
- START input of terminal No. 11 is effective only in the local mode.

4.4 Dip Switch



(as viewed from
connector panel front)

Fig. 4.4 Dip switch

Name	Function	
Initial setting dip switch (CONFIG)	1	ON/OFF switch for the terminator of RS-485. Set the control unit of the last address at ON.
	2	Set at ON when SEM is selected and OFF when FC is selected. (can be operated when power is on. Operate it after turning OFF the START button.)
	3	Set at OFF when RS-232C is selected and ON when RS-485 is selected.
	4	Set it at ON when the LOCAL mode that enables only operation from the power supply main unit is selected. Set it at OFF when the REMOTE mode that enables only operation from PC is selected. (can be operated when power is on. Operate it after turning OFF the START button.)
	5	Sets the address for the sensor. The relationship between the address and switch is as shown on the table below.
	6	
	7	
	8	

(0; OFF 1: ON)

Address	S5	S6	S7	S8	Address	S5	S6	S7	S8
1	0	0	0	1	9	1	0	0	1
2	0	0	1	0	10	1	0	1	0
3	0	0	1	1	11	1	0	1	1
4	0	1	0	0	12	1	1	0	0
5	0	1	0	1	13	1	1	0	1
6	0	1	1	0	14	1	1	1	0
7	0	1	1	1	15	1	1	1	1
8	1	0	0	0					

The table below shows the settings before shipment from the factory. (except when shipped as the multi-sensor type)

① When SEM is provided

S1	S2	S3	S4	S5	S6	S7	S8
OFF	ON	OFF	OFF	OFF	OFF	OFF	ON

② When SEM is not provided

S1	S2	S3	S4	S5	S6	S7	S8
OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON

RS-485 terminator : OFF
LOCAL/REMOTE : REMOTE
RS-232C/485 changeover : RS-232C
Address : 1

5. Installation

 WARNING	Turn off power.

5.1 Preliminary Operation

(1) Unpack the instrument and check quantities (See 2.2 for the standard accessories.)

(2) Check if any component is damaged.

5.2 Installation

5.2.1 Installing the analyzer tube

 CAUTION	Beware of high temperature.
	Ensure ventilation.
	Keep out foreign object
	Beware of operating environment.
	Check connection.

(1) Measuring position

- To measure pressure, measure the static pressure in the position where the analyzer tube is connected.
  Be careful in selecting the measuring position because the measurement value is affected if there is a flow in the vacuum system, source of outgas or source of high intensity electrons or ions.
- Notice that correct pressure measurement cannot be made or the analyzer tube may fail if the analyzer tube is subject to vibration, heat radiation, high intensity electromagnetic field or high intensity radiation.

(2) Installing the analyzer tube

- Install the analyzer tube so that the plane of the opening to which the analyzer tube is installed is parallel to the flow of gas. Especially, see to it that gas is not introduced into the analyzer tube in a beam. Also ensure that a foreign object is not introduced by installing a mesh with its opening plane above when the analyzer tube is installed.
- Use a new gasket and do not handle it with bare hands. Before using it,

wipe it with a clean cloth wetted with alcohol. If it is touched with bare hand or if a contaminated gasket is used, it will be a cause of error. Use of a reused gasket can be a cause of leak.

- If the filament is subjected to strong lateral impact or vibration when it is slackened with heat, it may break or contact the grid electrode.

(3) Continuity and insulation check

- Check insulation and continuity between each terminal of the analyzer tube connector and the earth before installing the sensor unit. Fig. 5.1 shows the pin assignment of the analyzer tube connector.

① CGM

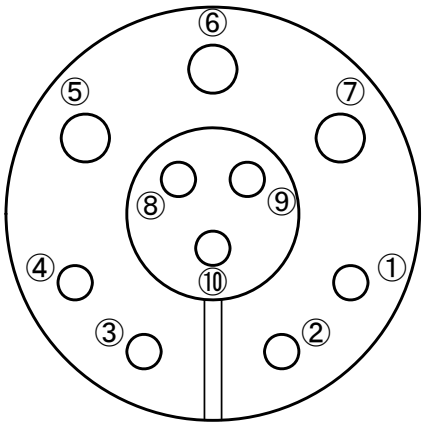
Insulation check	Between terminals, except HV terminal, and earth
Continuity check	FIL1 and FILC

② BGM

Insulation check	Between terminals, except HV terminal, and earth
Continuity check	FIL1 and 2 and FILC

* When the analyzer tube is equipped with SEM, the resistance between the HV terminal and earth is ① CGM 9 MΩ and ② BGM 17 MΩ.

To check filament continuity, measure the resistance between FIL. C and FIL. 1 and FIL.2 in the resistance range using a circuit tester. If the filament is open, the resistance is infinite and, if not open, it is about 1 Ω.



10pin Feedthroughs pin assign (outside view)

	CGM	BGM
①	Fil.1	Fil.1
②	Fil.COM	Grid
③	Grid	Fil.2
④	N.C.	Fil.COM
⑤	HV	RF
⑥	RF1	HV
⑦	RF2	RF
⑧	IC (SEM/FC)	IC (SEM/FC)
⑨	N.C.	IC (FC) * BGM-101/101L
⑩	TP	TP

Fig. 5.1 Pin assignment as viewed from atmospheric side

5.2.2 Installing the sensor unit

(1) Be careful that the sensor unit does not strike against other structures.

(2) Please insert a sensor unit into a sensor. When tightening a screw, please do so tightly by hand. Do not use tools like wrench to tighten a screw. Strongly tightened screw might damage a pin inside of a sensor unit to cause defects.

(3) Lay the RS-232C communication cable and EXT I/O cable away from power lines and others. Otherwise, they may be affected with noise.

	Be careful in repacking and shipment.

* Before shipping the instrument, remove the sensor unit. Also install a protective cap to protect the analyzer tube flange

5.2.3 Connecting the power connector

	Turn off power.

Fig. 5.2 shows the pin assignment of the power connector. Do not mistake the pin No. when supplying power. If power is fed to an incorrect pin, the internal circuit may be damaged. Also tighten screws securely so that the power connector does not come off. Connect it to Class 1 ground to prevent electric leak.

① Power +24V
Pin that supplies 24VDC power.

② Power GND
GND when +24VDC power is supplied

③ Frame GND
Frame ground. Connect it to the instrument frame.

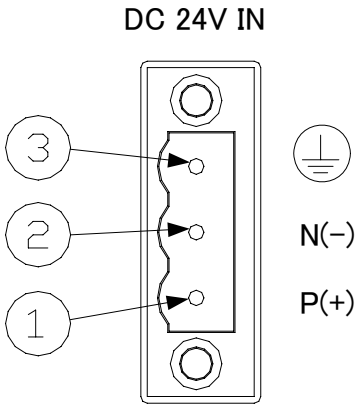


Fig. 5.2 Pin assignment on power connector

5.2.4 RS485 cable connection

CAUTION	Check connection.

To connect multiple sensors, select RS232C/485, set the address and RS485 terminator and connect the cable, as shown in Fig. 5.3 below, referring to 4.4 Dip Switch.

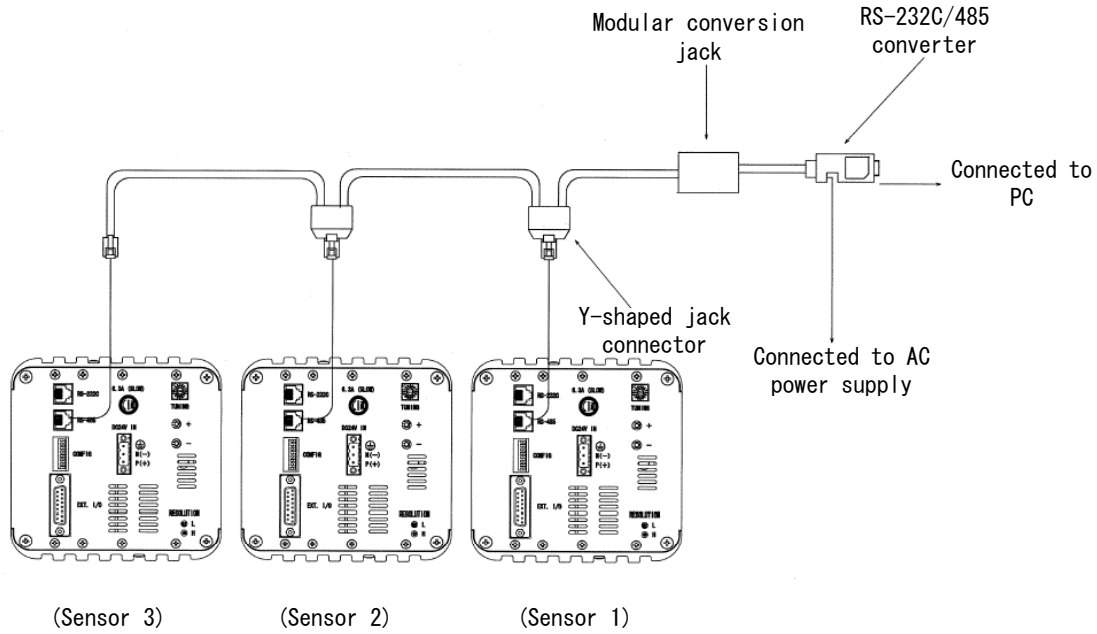
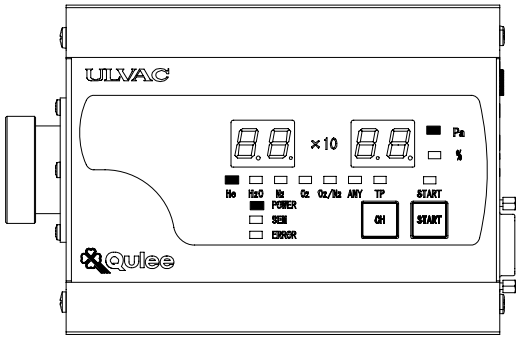


Fig. 5.3 Connection of RS485 cable

6. Starting up Basic Unit (supply of power)

CAUTION	Check connection.
	Check pressure.

Turning on the power displays POW-① and sets up the instrument.
For stable measurement, start measurement more than 30 minutes after supplying power.



POW-①

The POWER LED, measurement value display LED and Pa LED in the opposite figure light.
([0.00-0] is displayed in the segment.)

7. Before Measurement

Methods of measurement using Qulee Series include two: one by measurement using a computer (PC) in which the "QuleeQCS" gas analysis software is installed and the other by measurement while checking the pushbutton switch, indicating light and partial pressure display value on the basic Qulee Series sensor unit.

7.1 Measurement with Software (Remote)

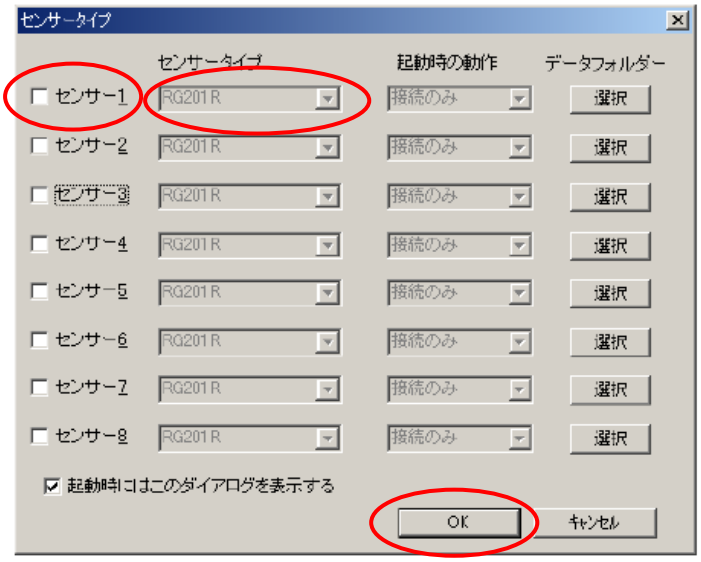
* Refer to the "Gas Analysis Software QuleeQCS Instruction Manual" for more information.
* Check 4.4 Dip Switch. (4 is OFF)
* Refer to the QuleeQCS manual and confirm the required PC specifications before measurement.

(1) Install the gas analysis software "QuleeQCS" (called "QuleeQCS" in this manual) in your PC.

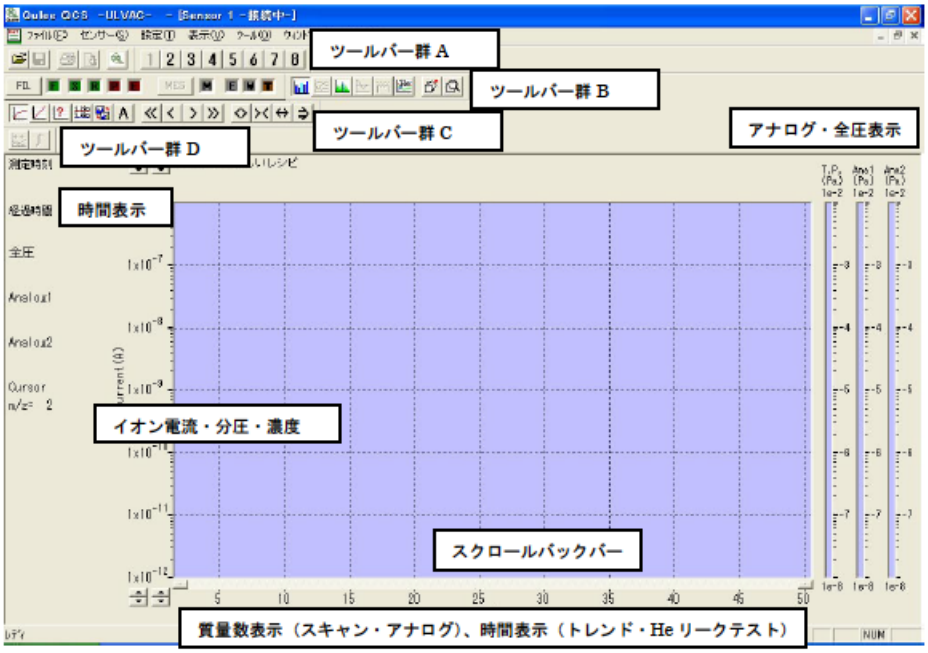
(2) Connect the communication port (RS232C port, D-SUB 9-pin male connector) of your PC and the RS232C communication connector of the Qulee sensor unit (refer to Fig. 4.2) by means of the RS232C communication cable.

(3) After supplying power to the Qulee basic unit, double-click the "QuleeQCS" icon on the desktop of PC and execute "QuleeQCS".

(4) Enter the sensor number and sensor type in the sensor type dialog displayed first and press the "OK" button.



(5) When communication between PC and Qulee is established, QuleeQCS loads the default recipe or the recipe used last.



(6) Press the “FIL” button to turn on the filament of the Qulee analyzer tube. The “F” and “R” lights come on.

* Before pressing the START button, check the operating pressure on an ionization gauge or other.

(7) Turn on the “MES” button to start gas analysis. The “S” and “M” lights come on.

(Whether the F, R and S lights are on or off depends on the settings on the control panel.)

(8) To terminate gas analysis, press the "MES" button again.

(9) Turn off the "FIL" button and then turn off the Qulee analyzer tube filament.

(10) Exit the software when measurement is completed.

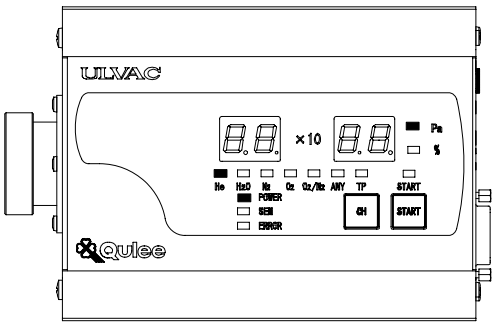
7.2 Measurement with the Qulee Control Unit (Local mode)

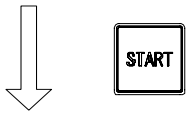
* Check 4.5 dip switch (4 is turned on.)

(1) Check the setting of the dip switch on the rear panel of the Qulee basic unit and set 4=ON.
Conduct gas analysis referring to 8. Front Panel Operation.

8. Front Panel Operation

8.1 Measurement Start and End

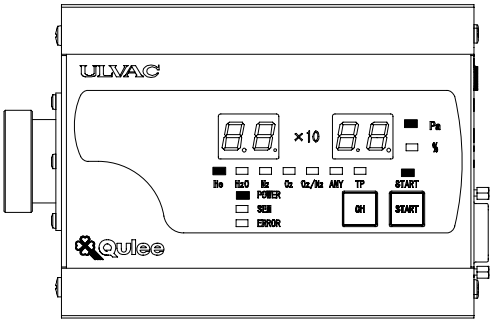


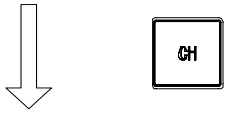


MES-①

A press on the START button sets up the filament measurement state (FIL, RF, and <SEM> are lit). A second press stops measurement.

* Before pressing the START button, check the operating pressure on an ion gauge or other.





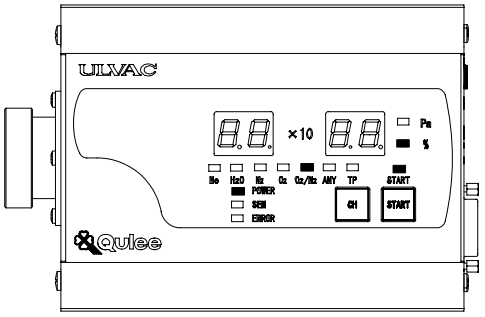
MESU-②

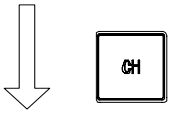
Partial pressure is displayed in the segment during measurement.

Pressing the CH button changes over the measurement gas specie from He to H2O to N2 to O2 to O2/N2 to ANY to TP to He to ….

MESU-③

When CH is changed over to O2/N2, the unit is changed over from Pa to %, displaying the ratio between O2 and N2.

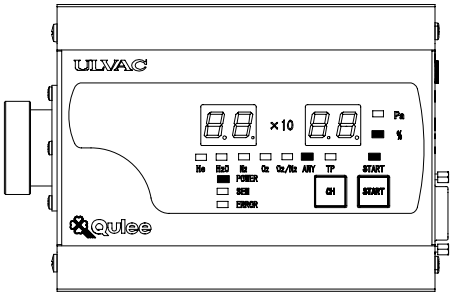


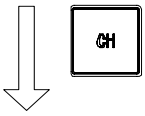


MESE-④

When CH is changed over to ANY, the partial pressure of the preset measurement gas specie is displayed.

* M/e has been set at 44 (CO2) before shipment from the factory. To change the setting, use the dedicated software.

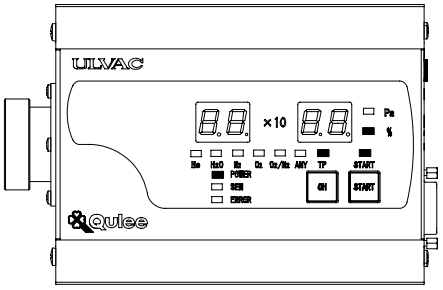




MESU-⑤

Total pressure is displayed when CH is changed over to TP.

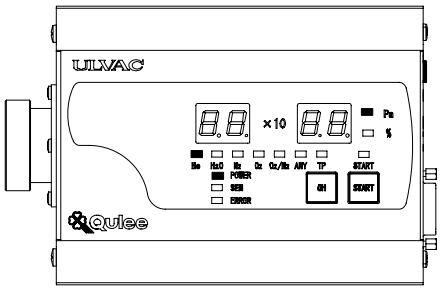
* Total pressure is displayed only by a model equipped with total pressure measuring function. If the model has not total pressure measuring function, [0.00 – 0] is displayed in the segment.



CAUTION

Before turning on the START button, make sure that the pressure is within the operating pressure range using an ion gauge or other. If the START button is turned ON at a pressure higher than the operating pressure range, the filament will burn out, the secondary electron multiplier tube will be deteriorated and the RF power supply will fail.

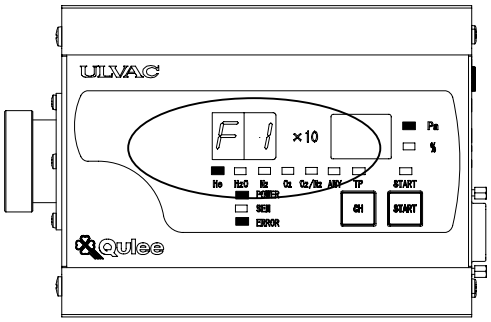
8.2 If Pressure is lower than Measurement Range



UNDER-①

When the START button is ON and the partial pressure and total pressure are below the measurable lower limit, [0.00 – 13] is displayed in the segment.

8.3 If Filament Fault has occurred

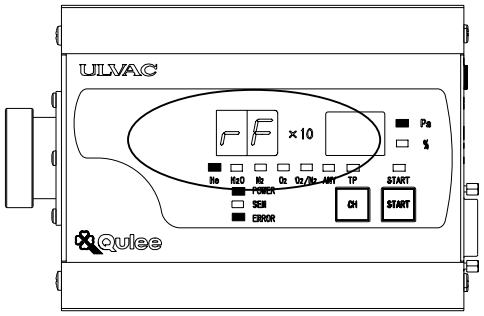


Err.-①

If any fault occurs with filament 1 when the START button is ON, the LED in the ellipse in the opposite figure comes on.

8.4 If RF Fault has occurred

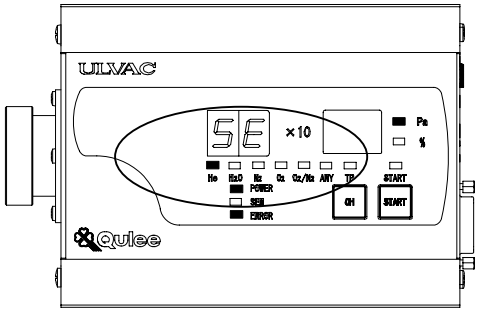
Err-①



If any fault occurs in RF when the START button is ON, the LED "rF" in the ellipse in the opposite figure comes on.

8.5 If SEM Fault has occurred

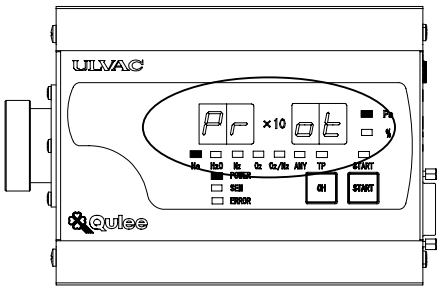
Err.-①



If any fault occurs in SEM when the START button is ON, the LED "SE" in the ellipse in the opposite figure comes on.

8.6 If Interlock Signal is input

Err.-①



If the interlock signal is entered when the START button is ON, the LED in the ellipse in the opposite figure comes on.

9. Detailed Description of External I/O

Signals are exchanged with outside through the EXT-I/O connector on the rear panel, except RS-232C.

9.1 Total Pressure Setpoint, Partial Pressure Fault, Partial Pressure Warning Output, Error Output

The operating states of the total pressure setpoint, partial pressure fault, partial pressure warning, and error output are output to outside with digital signals (negative logic).

The output format is the open collector output of emitter common. The capacity of the transistor is maximum 24V between the collector and emitter, the maximum current of the collector is 50 mA, and the rated loss power is 100 mW.

(Photocoupler: equivalent to TLP-523)

Fig. 9.1 shows the digital output internal circuit diagram for the output circuit.

Error output is Hi when any error of the filament, SEM and RF occurs or Lo in the normal state.

* The total pressure setpoint output, partial pressure abnormal output and partial pressure warning output are effective only when software is connected.

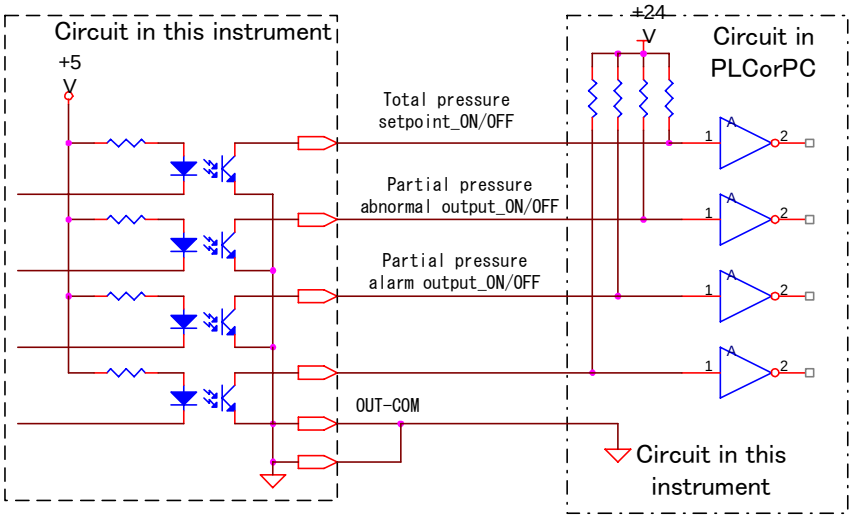


Fig. 9.1 Digital output internal circuit diagram

9.2 Interlock Input

Used for protecting the filament, SEM and RF power supply from outside.

Ground the interlock input terminal (pin 12) and INPUT-COM terminal (pin 13) with the relay contact or open collector, referring to Fig. 8.2.

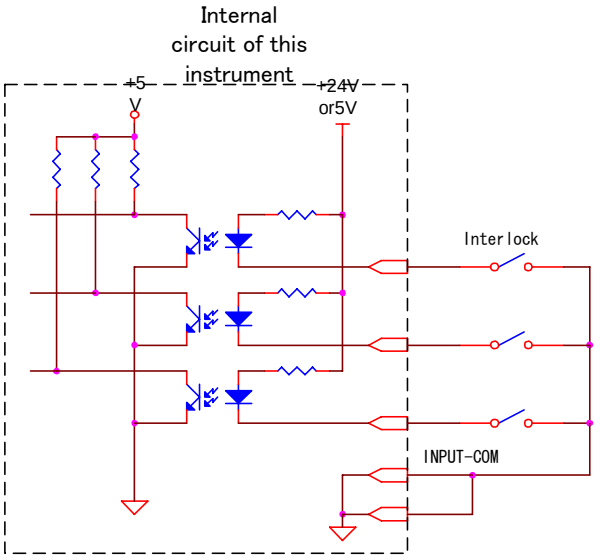


Fig. 9.2 Inputting interlock signal

9.3 Analog Input

Used when loading the pressure on the pressure gauge or temperature from outside.

CAUTION	Observe operating conditions.

Input a voltage of 0 to 10 V to the analog input terminal (pins 1 and 2) and A-GND (pins 9 and 10). The instrument may fail if a voltage of 10 V or more is applied.

The analog input specifications are as follows.

Insulation: Not insulated

Input range: 0 to 10 V

Input impedance: 50 kΩ

Input form: Differential
Resolution: 0.01 V

10. Cautions in Operation

10.1 Operating Pressure Range

(1) CGM

 CAUTION	Observe operating conditions.

Always use the instrument under a pressure of 2 Pa or lower. If the pressure is higher than 2 Pa, the filament will burn out. Use SEM under a pressure of 1×10^{-2} Pa or less. Otherwise, the filament life will be extremely short.

(2) BGM

Always use BGM under a pressure of 1×10^{-2} Pa or less. If the pressure is higher than 1×10^{-2} Pa, the filament will burn out and the life of SEM will be extremely short.

10.2 Degassing

 CAUTION	Observe operating conditions.
	Beware of high temperature.

This instrument uses the electron bombardment system for degassing. Electron bombardment is a method of applying a high voltage of 300X to the grid electrode to release the gas adsorbed to the grid and bombarding the grid surface with thermions from the filament to release the gas adsorbed to the grid.

This means that the electrode bombarded with thermions is heated to a temperature equivalent to the energy and the gas in the electrode is released.

Conduct degassing at a pressure of 1×10^{-4} Pa or less. If it is conducted in a higher pressure region, the sensor head will be contaminated, contrary to your expectation.

Total pressure cannot be measured during degassing. See to it that the pressure does not rise during degassing because filament protection from pressure rise is not activated. Or monitor the pressure using another

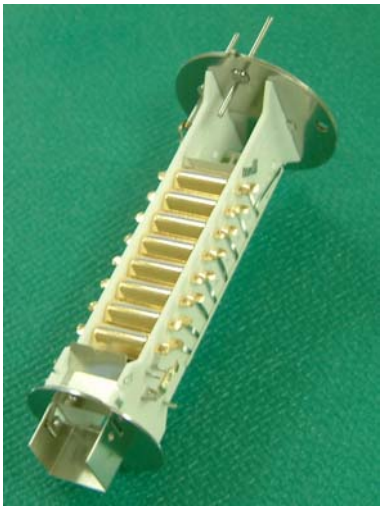
vacuum gauge and, if the pressure exceeds the measurement range, input an interlock signal.

Note that the envelope is heated to a high temperature during degassing.

10.3 Secondary Electron Multiplier Tube (SEM)

CAUTION	Observe operating conditions.

Ions that have passed through the quadrupole are incident on SEM. Ions are incident on the metal surface on the 1st stage through the ion entrance port in SEM, and secondary electrons are discharged. The secondary electrons are accelerated by electric field, impinge upon the diode on the next stage, and generates new secondary electron groups. As this step is repeated many times, the number of electrons increases from one to about 100 million when it reaches the dynode of the last stage. The electrons that have reached here are read out to outside.



Secondary electron multiplier tube

Take the following care in using SEM.

(1) Decrease the SEM voltage to -1 to -1.2 kV because gas has been adsorbed to the dynode surface immediately after evacuation.

(2) If the SEM voltage is increased excessively, the multiplying factor may increase and accelerating deterioration, increasing output drift and noise or may lower linearity.

(3) If an analyzer tube that has been vented to atmospheric pressure is used, the SEM sensitivity may rise, but this not a trouble because this is due to the SEM surface being cleaned.

(4) The amplification factor of SEM lowers with operation. It varies with operating hours, operating atmosphere (gas specie, contamination) and others. The life will be short if the SEM voltage is high and the measuring ion current value is high.

As rough indication, replace SEM if the sensitivity has become so low as to affect measurement when measured at the maximum voltage. Or decide it from the value calculated by the SEM amplification factor calculation method.

Determine the mass number to calculate amplification factor (for example, mass number of 18, 28 or other if peak is high). Set the detector at SEM on the "Qulee QCS" control panel and measure the ion current value of a desired mass number at the currently set SEM voltage value. Set the detector at FC and measure the ion current value of a desired mass number.

Calculate (ion current value at the time when SEM is set/ion current value at the time when FC is set) from the above measurement value to find amplification factor and check the condition of deterioration.

(Example) 9.71×10^{-6} A/6.12×10^{-11} A = 1.59×10^{5}

10.4 Baking

	Observe operating conditions.
	Handle with care.

If the analyzer tube is left under atmospheric pressure for an extended time and contaminated, conduct baking (heating) to remove contamination and reduce the outgas of the residual gas analyzer (background).

Baking can be conducted up to 120°C with the sensor unit connected or up to 200°C with the sensor unit removed.

Baking procedure

(1) Make sure that there is no leak.
(2) Turn off the Qulee power and remove the sensor unit. (If the cable is connected or removed with the power turned on, the sensor unit may fail.)
(3) Wrap the analyzer tube with aluminum foil to improve heat conduction.
(4) Wind the baking heater around the analyzer tube.
(5) Wind aluminum foil around the baking heater.
(6) Set baking temperature. Conduct baking at 150°C for 12 hours. Change the baking time and temperature according to the degree of contamination in the analyzer tube and adsorbed substance. For temperature control, measure temperature by using a thermocouple thermometer.
(7) Start baking.
(8) Baking involves a danger by high temperature. Put up a sign reading "Caution! High Temperature" in an easily noticeable place.
(9) Upon completion of baking, install the sensor unit after the analyzer tube has cooled down to room temperature.
(10) Make measurement and make sure that water content (M/e=17.18) and hydrocarbon type gas (M/e=27. 29, 39, 41, 43, 55, 56, 57, etc.) have decreased as compared with before baking.

* Conduct baking while evacuating the analyzer tube. Cover the analyzer tube with heater or aluminum foil so that temperature rises uniformly. If any part is at low temperature, it will adsorb gas, reducing the baking effect.

10.5 Cautions in Measurement

For accurate measurement, it is necessary to calibrate mass number and densitivity.

10.5.1 Mass number calibration

Mass number calibration means allocating mass numbers to the peak tops of an analog waveform. For the relationship between mass numbers and ions, refer to Appendix "Peaks of Major Residual Gases".

Mass numbers have been calibrated at ULVAC before shipment, but they are subject to some shift due to the measurement environment and others (electrical factors like ground and others). They may also shift if the analyzer tube is contaminated. In that event, conduct mass number calibration.

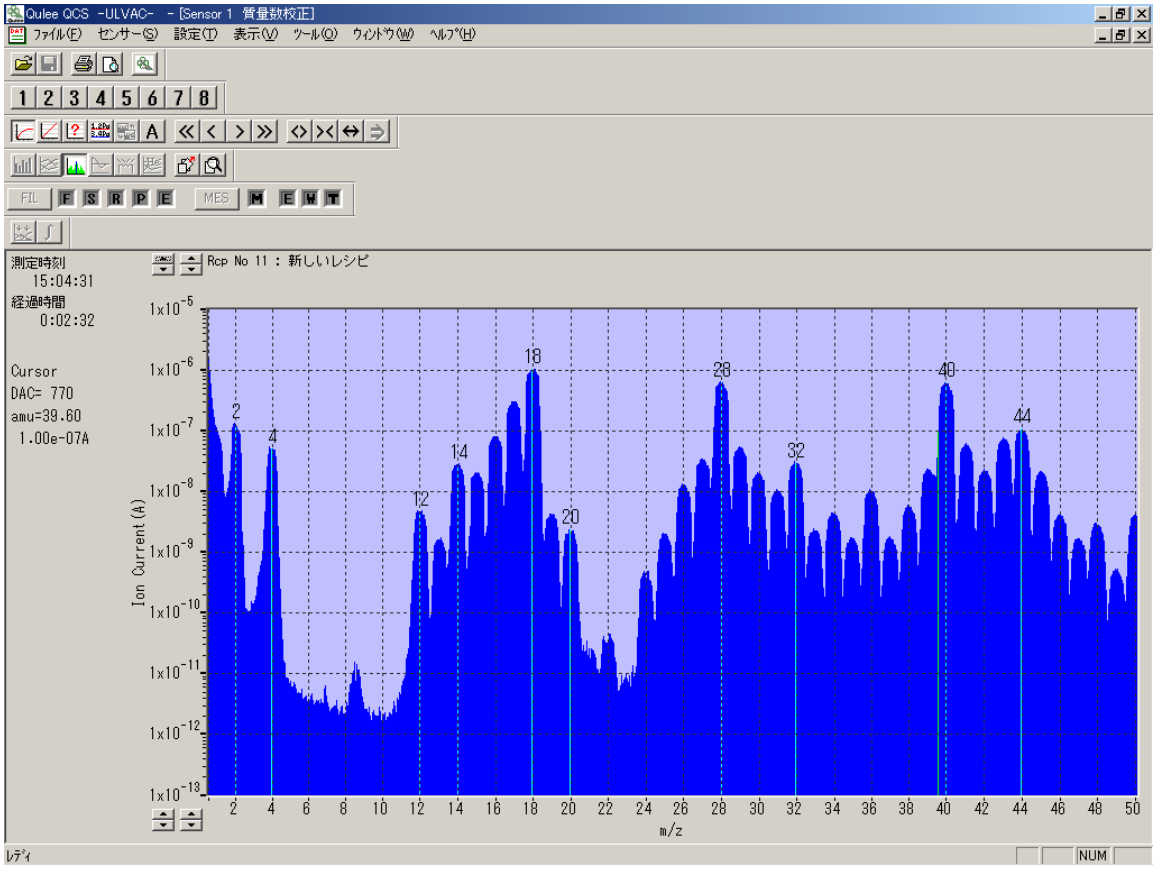


Figure 10.1 Mass number calibration window

10.5.2 Sensitivity calibration

The sensitivity of the mass spectrometer is determined by such factors as the ionizing efficiency of the ion source, transmittance of the quadruple, and amplification factor of SEM. Sensitivity will lower as the ion source and quadruple are contaminated and SEM is deteriorated.

Sensitivity calibration means increasing/decreasing the voltage applied to SEM so that the ion current value becomes constant.

Feed the gas to measure, nitrogen gas and argon gas and set the SEM voltage so that the ion current value becomes

Pressure 1×10^{-4} (Pa) x sensitivity 5×10^{-3} (A/Pa) = 5×10^{-7} (A)

However, regulate the SEM voltage regularly because sensitivity lowers, thereby measurement can be made while maintaining sensitivity constant.

* With a type equipped with a differential pumping system, feed gas so that the pressure in the system to be measured becomes constant and regulate the ion current value at this time to 5×10^{-7} A.

Use the following to feed gas to be used for sensitivity calibration.

Standard leak: Standard leaks for various types of gas such as He, H2, N2 and others, are commercially available. They are valuated with flow rate Pa·m^3/sec and permits measurement using a mass spectrometer in the same chamber.

Flow meter: Commonly called mass flow. Used mainly through a mass spectrometer and differential pumping system. The flow rate is kept constant and gas is fed as reference gas. Gases that are used commonly are He, N_2, Ar, etc.

10.5.3 Converting to partial pressure

Peaks of mass numbers that are measured by a mass spectrometer are detected as ion current values (A). Various methods are used to convert them into partial pressure.

"QuleeQCS" permits selection of the following three methods.

(1) When utilizing the correlation between the ion current set in the sensitivity calibration mode and the pressure.

If sensitivity is calibrated when the vacuum gauge for the system under measurement indicates 1×10^{-1} Pa and the ion current is set at 5×10^{-7} A, the partial pressure conversion factor is

$$1 \times 10^{-1} \text{ (Pa)} / 5 \times 10^{-7} \text{ (A)} = 2 \times 10^{5} \text{ (Pa/A)}$$

Convert it to a partial pressure (Pa) by multiplying the ion current value by this partial pressure conversion factor.

(2) When using the total pressure measuring function

Given that P_T (Pa) is the value measured by the total pressure measuring function and I_N (A) is the ion current value of each mass number and partial pressure is P_N (Pa), pressure is converted to partial pressure (Pa).

$$P_N = (I_N/\Sigma I_N) \times P_T$$

Since the ion current value of a mass number not measured is not calculated, however, the figures do not add up unless the mass number of a higher ion current value is measured. With a pumping system of 1×10^{-5} Pa or less, select method (1) or (3) because the total pressure measurement range of Qulee BGM is 1×10^{-2} to 1×10^{-5} Pa.

(3) Ion current can be converted into partial pressure P_N (Pa) by using the following equation, when P_T (Pa) is the vacuum gauge value acquired by analog input of Qulee and I_N (A) is the ion current of each mass number.

$$P_N = (I_N/\Sigma\ I_N) \times P_T$$

However, the figures do not add up unless the mass number of a higher ion current value is measured.

* This calculation does not take into consideration the difference in the sensitivity factor with gas specie, cracking pattern dissolved when gas molecules are ionized, and presence of isotope.

10.5.4 Operating environmental temperature and humidity

Resolution varies with operating environmental temperature and humidity. If resolution changes, adjust it when the temperature and humidity are constant.

Also the mass number changes with the operating temperature and humidity. In that event, calibrate the mass number when the temperature and humidity are constant.

10.6 Storage

If the instrument is not used for an extended time, store the analyzer tube in an inert gas atmosphere like nitrogen. If the analyzer tube is stored in a high humidity atmosphere, the SEM may be deteriorated.

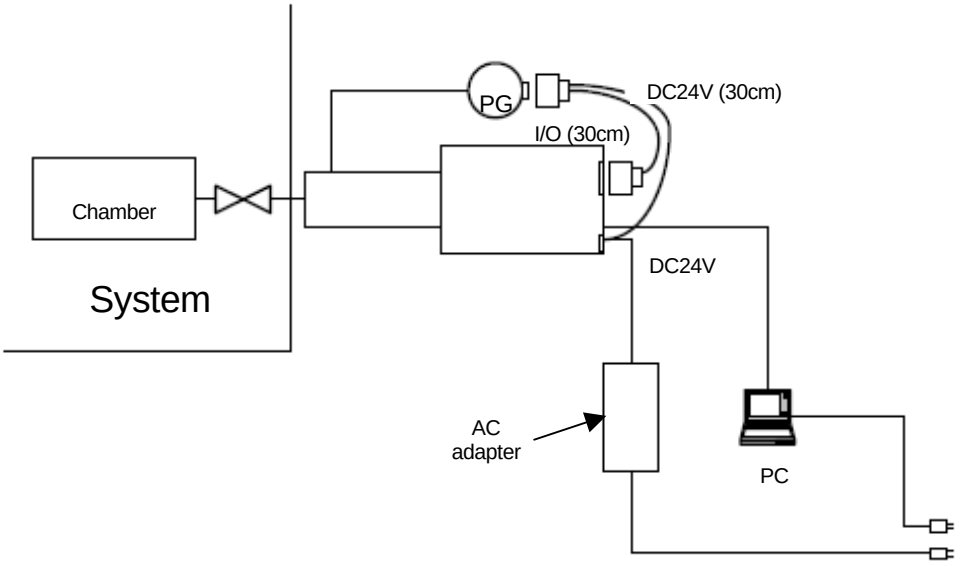
11.Description on the Qulee QIP (Quick Install Package) system

Two types of Qulee CGM-051/052 machines have the Auto measurement start/stop function using the analogue output (0-10V, nonlinear output) from the Pirani gauge (GTRAN series; SP1) and analogue output (0-10V, pseudo-logarithmic output) of the Ionization vacuum gauge (GTRAN series; BMR2, GI-M2) as well as the "Qulee QIP (Quick Install Package) system added with the interlock function to protect sensors using respective vacuum tube set point output.

Type: Qulee CGM-051-QIP-PG
Qulee CGM-052-QIP-PG

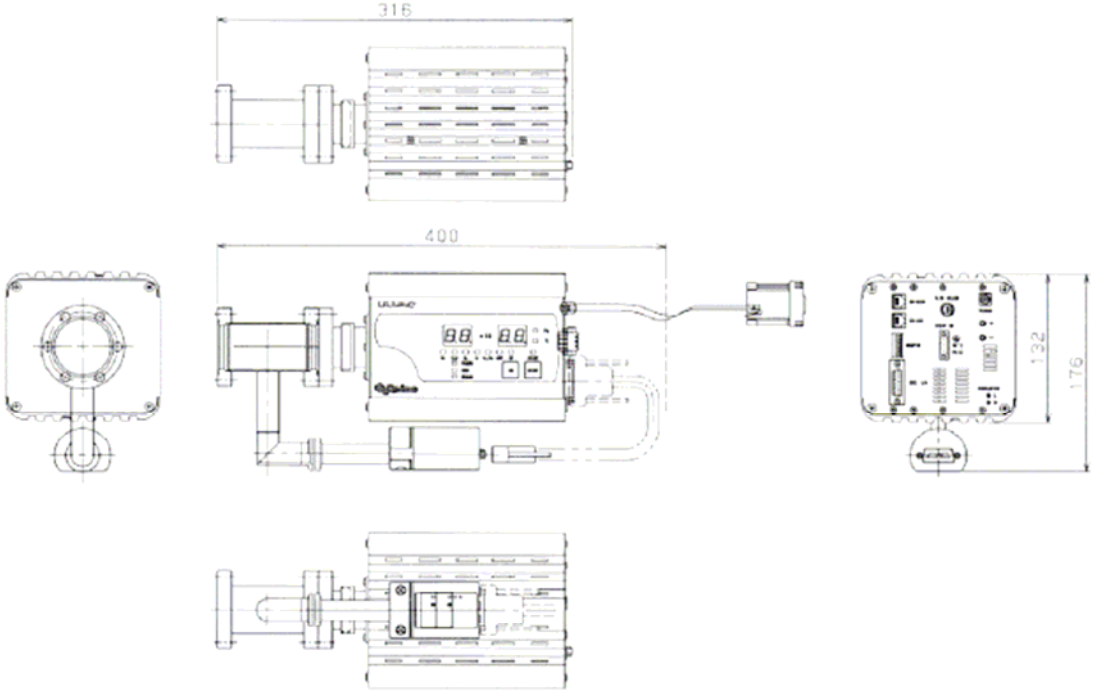
11-1. Qulee QIP system diagram

[Qulee CGM-051/052-QIP-PG]



11-2. Qulee QIP system external view

[Qulee CGM-051/052-QIP-PG]



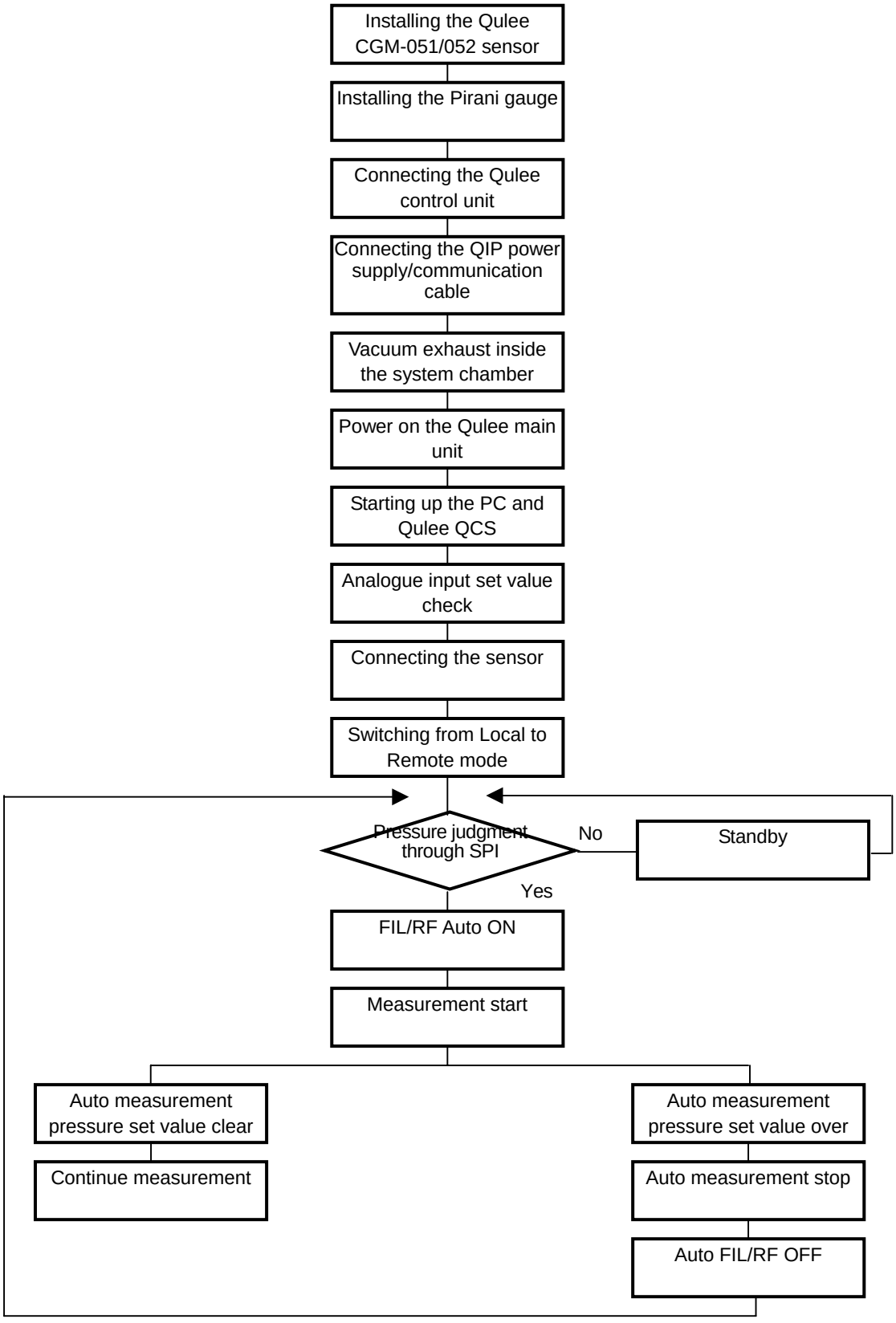
11-3. Auto measurement start/stop function/Interlock function

The Auto measurement start/stop function shall judge the CGM sensor pressure on inputting the analogue output (0-10V, nonlinear output) from the Pirani gauge in the Qulee external I/O analogue input pin, automatically light up the filament if it was lower than set pressure value and start measurement. It also automatically stops measurement if the pressure rose up higher than the auto measurement pressure value during measurement and puts off the filament.

The Interlock function shall, on inputting the set point output from the Pirani gauge in the Qulee external I/O analogue input pin and stop measurement to protect the filament when the CGM sensor internal pressure passes over the set point output set value and put off the filament.

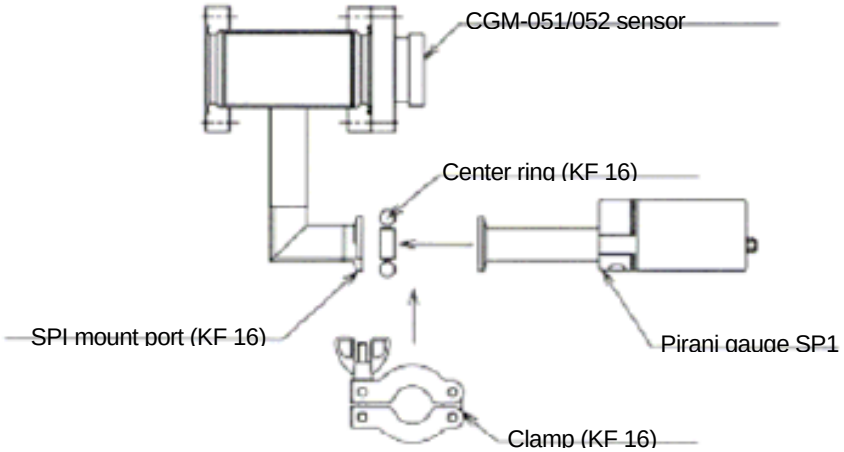
* Please refer to the attached “Pirani gauge SP1 Instruction Manual” as for the analogue output and set point output.
* Set point output setting value of the Pirani gauge at shipping shall be 2Pa.

[From the install to running the Qulee QIP-PG]

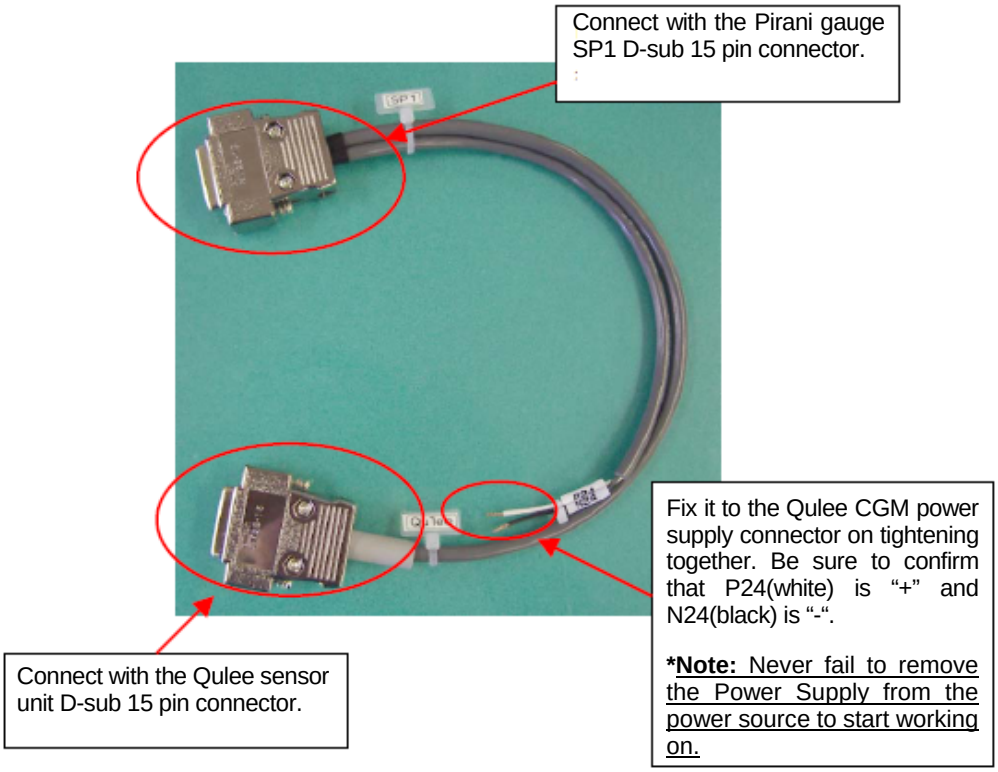


11-4. QIP system setup procedure

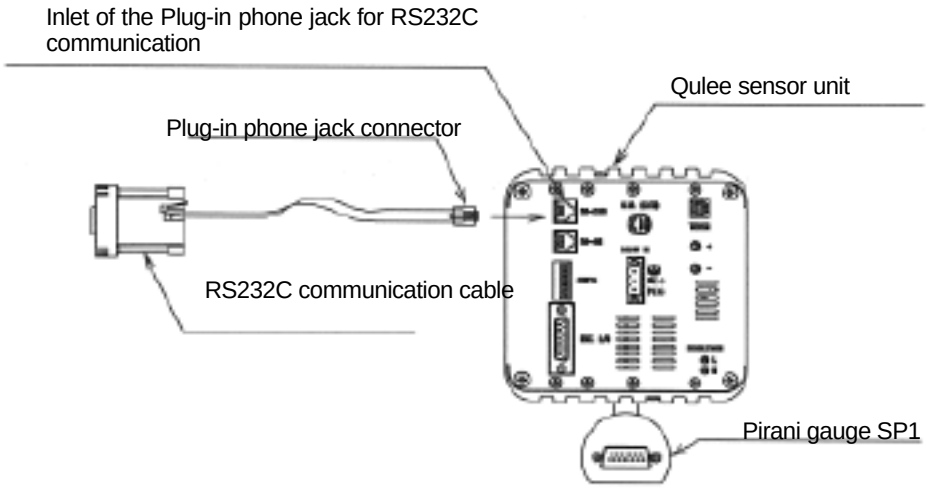
1) Please refer to the section 5. 3 of this document as for mounting the Analytical cube and Qulee sensor unit.
2) Envelope for the QIP-PG is equipped with the KF16 port to mount the Pirani gauge (AP1). Mount the SPI using the Clamp/center ring (KF16) included in accessories as illustrated below;



3) If it was the QIP-PG specification, connect the QIP cable to load the SP1 analogue output/set point output signal. If you are to apply the Ionization vacuum gauge GI-M2, BMR2 (QIP-IG specification), you are requested to prepare the QIP cable and execute wiring.

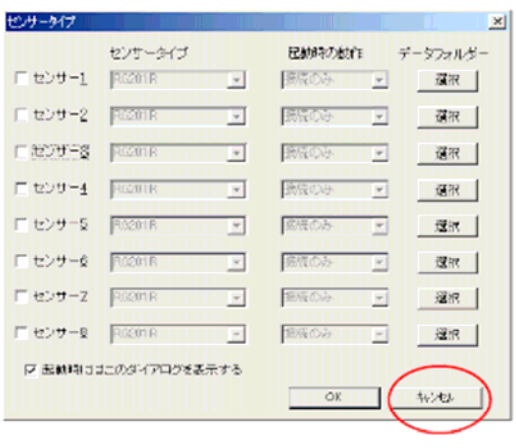


4) Connect the Qulee power supply connector referring to the item 5. 3. 3 of this document.
5) Connect the RS232C communication cable. Further, if you are to execute the multi sensor connection using plural Qulees, connect cables referring to the item 5. 3. 4 (RS232C/485 converter shall be separately required).

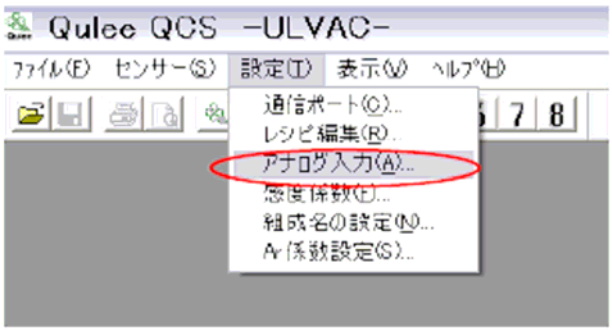


6) Execute vacuum exhaust inside the CGM-051/052 sensor through the exhaust system on your facility.
7) Turn Power ON the Qulee sensor unit (DC24V, 2A).
This time, the interlock shall work if the pressure inside the CGM-051/052 sensor was 2Pa or more. SET1 lamp on the SP1 front panel shall light up if the pressure inside the CGM-051/052 sensor went below 2Pa.
* Should the interlock worked, an LED “Prot” shall light up on the Qulee display panel as described on the section 8 of this document. You are requested to turn OFF once the Power Supply and turn ON it again to reset the interlock.
8) Start up the PC for gas analysis and start the software for gas analysis Qulee QCS.

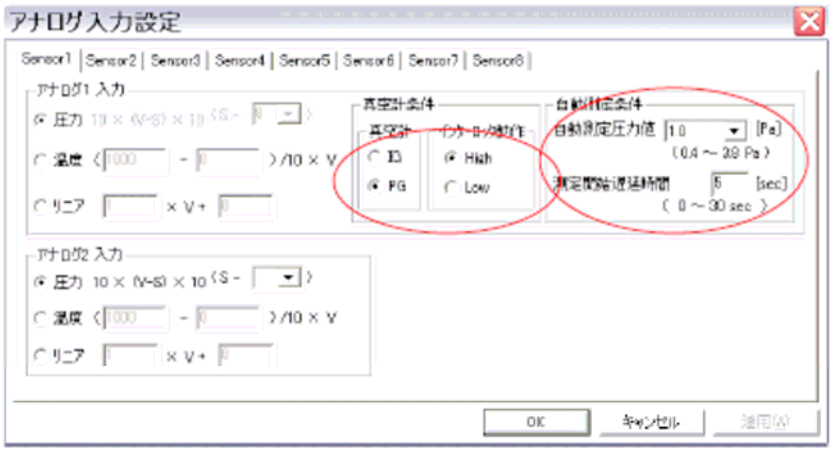
9) Press the [Cancel] button to close once the Sensor type dialog that appears first.



10) Open [Set] – [Analogue input] in the Software menu bar.



11) Then appears the Dialog box as illustrated below. Set and confirm the following and press [OK] button.



- Vacuum gauge condition : Select the type of vacuum gauge.
  Select [PG] for the QIP-PG and [IG] for the QIP-IG.

- Interlock operation : Select whether the set point output signal loading from the external vacuum cube was High or Low to make the interlockoperation work.
  Select [High] if selected vacuum gauge was PG and [Low] if it was IG.

- Auto measurement pressure :If the measurement was set as the Auto measurement mode, Value set the pressure value to automatically start or stop measurement.
  Selected vacuum gauge PG: 0.4 – 3.8 Pa
  Selected vacuum gauge IG: 1e-7 – 1.0 Pa

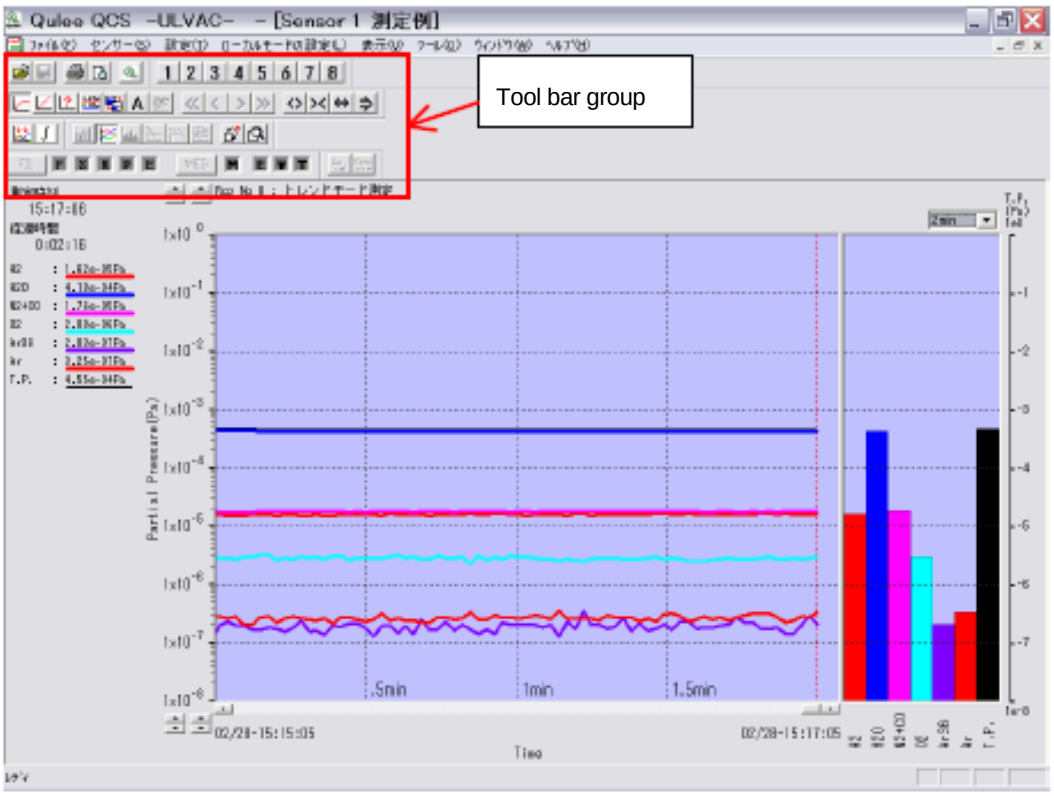
- Measurement start delay time : If the measurement was set as the Auto measurement mode,
  set a waiting time to actually start measurement when the pressure came to the Auto measurement pressure value.Setting range: 0-30 sec (default

value: 5 sec.)

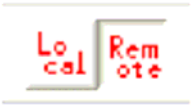
* As the Pirani gauge set point value is set to 2Pa at shipping, be sure to set the Auto measurement pressure value less than 2.0Pa. If set over 2.0Pa, the Auto measurement start/stop operation shall not work as the interlock function shall work.
* Please refer to the separate “Qulee QCS Instruction Manual” as for the detail of respective set item.

12) Open [Sensor] – [Connect Sensor] in the Software menu bar and execute connecting the Sensor on the CGM-051 or 052.

13) Upon the communication between the PC and Qulee main unit is established, "Qulee QCS" shall load the default recipe or the one used in the previous operation.



Upon completed the communication connection, the Local/Remove switch button is displayed in the Tool bar group.



Local mode :Manually light up FIL/RF, and start measurement.

Remote mode :Automatic measurement start/stop through judgment of the attached Pirani gauge (SPI) and external Ionization vacuum gauge.

14) Press the Remote button of the Local/Remote switch button. However, be sure to set the Trend/Scan measurement mode if it was set to the Analogue measurement mode as the Auto measurement start/stop function shall be applicable only under the Trend/Scan measurement mode.

15) After having pressed the Remote mode button, if the pressure inside the CGM-051/052 sensor was lower than the value set on the item 11), FIL button display shall automatically change to MES button ON display and the measurement shall start.

12. Option

12.1 AC Adapter

12.1.1 Standard Specifications

Model	PW-060A-01Y240(G)	
Input voltage	90 to 264 VAC	
Input current	2 A @ 90 VAC maximum	
Efficiency	75% @ maximum load, 115 VAC	
Frequency	47 to 63 Hz	
Output voltage	24 VDC	
Output current	2.5 A	
Power requirement	60 W	
Output variation	± 3%	
Ripple and noise (Vp-p)	240 mV	
Protection	Overvoltage and short-circuit protection	
Hold up time	<16msec under the condition of typical input with full loading	
Operating temperature	0～40℃	
Operating humidity	20～90%(non-condensing)	
Storage temperature	-10～70℃	
Storage humidity	20～90%(non-condensing)	
Reliability	MTBF 80,000 hoours min. at max.load for 25degree centigrade ambient temperature.	
Applicable standard	Safety standard: UL/CSA C22.2-No.60950/TUV/IEC60950,PSE	
	FCC classB,EN 55022 & EN55024 classB	
	Power cord（for Korea）	SZ04001-1006,SZ4001-1006
	Power cord（for China）	CH00717589-2001A,CH004442389-2000
	Power cord (for Germany)	N13389
	Power cord (for USA)	UL/CSA

Standard Accessories

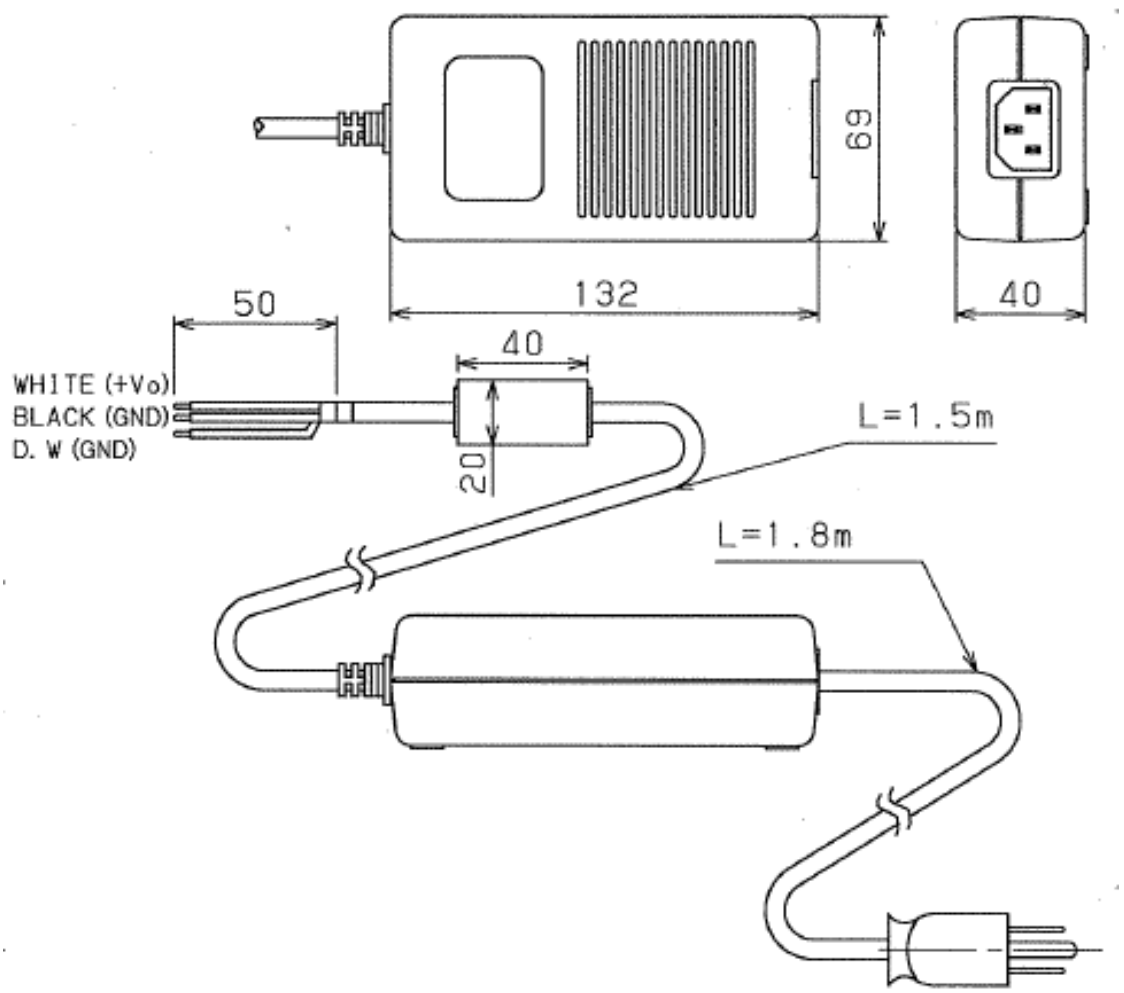
Power cord	125 VAC, 7 A, 1.8m long	1 pc.
Instruction manual (this manual)	clean paper	1 copy

Optional Accessories

Power cord（for Korea）	250VAC, 7 A, 2m long type K	1 pc.
Power cord（for China）	250VAC, 10 A, 2m long type GB	1 pc.
Power cord (for Germany)	250 VAC, 10A, 1.8m long type CCC7	1 pc.

Power cord(for USA)	125 VAC, 15A, 2m long type A	1 pc.

12.1.2 Dimensional Drawing



WHITE;P(+)
BLACK;N(-)
D.W.:FG

12.1.3. Installation

① Preliminary Operation

(1) Unpack the carton and check quantities.

(2) Make sure that the AC adapter is not damaged in transit.

② Installation

CAUTION	Check connection.
	Turn off power.
	Check line voltage.

The withstand voltage of the supplied power cord is 125 VAC and the receptacle shape is the A type. So do not use it on a voltage higher than 125 VAC. If it is to be used on a voltage around 200 VAC, use another power cord.

The pin assignment of the output cable is as shown on the dimensional drawing. Do not make mistake pin numbers. If power is supplied to an incorrect pin, the Qulee sensor unit may be damaged. Also tighten the screw securely so that the power connector does not come off.

Connect the socket plug. Always connect it to Class 1 ground.

① Power + 24 V (P(+))

Pin for supplying +24VDC power. Plug the white cable of the AC adapter to the power connector of the Qulee sensor unit accessory.

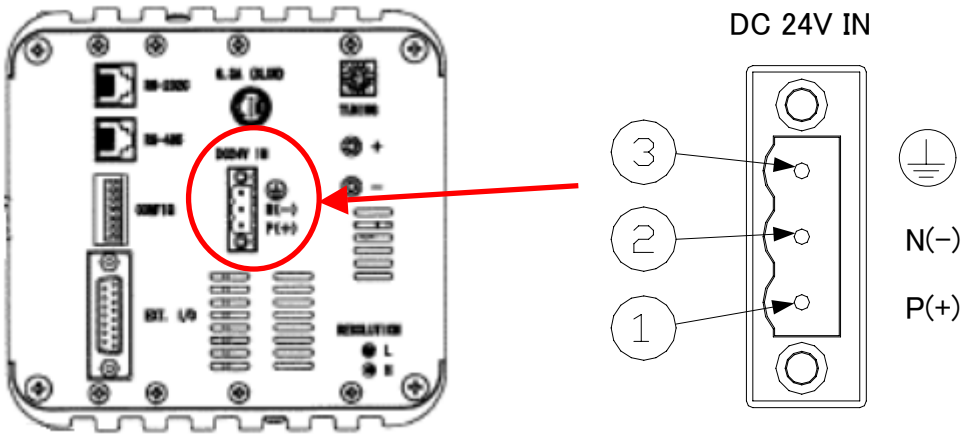
② Power GND (N (-))

Ground for supplying +24 VDC power. Plug the black cable of the AC adapter to the power connector of the Qulee sensor unit accessory.

③ Frame GND (⏚)

Frame ground. Plug the gray cable of the AC adapter to the power connector of the Qulee sensor unit accessory.

After plugging the wiring to the power connectors, firmly tighten the slotted screws on the connector using a slotted screwdriver.



Qulee sensor unit power supply connectors

12.1.4. Troubleshooting

For troubleshooting, refer to the following troubleshooting chart.
Turn off the power before troubleshooting.

 CAUTION	Turn off power.

○ POWER LED on the Qulee sensor unit does not come on when power is turned on.

Possible cause	Corrective action
Power connector is disconnected.	Check the power inlet connector for connection.
Power cord is not in continuity.	Check the wires of the power cord for continuity and insulation using a circuit tester or other.
Input power voltage is below the specified range.	Check the input power voltage using a circuit tester or other.
The AC adapter has failed.	Check the output voltage using a circuit tester or other. If output is not delivered, send the AC adapter to ULVAC for inspection and repair.

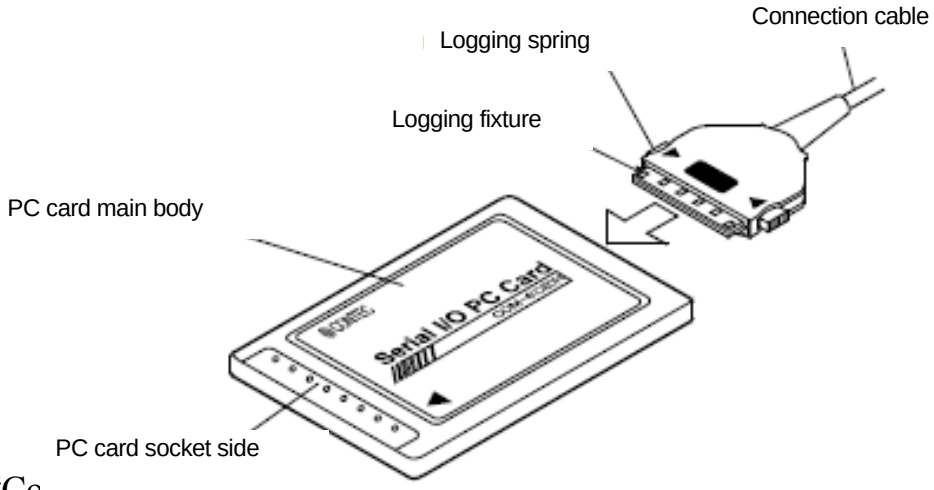
12.2 Serial communication card

When the RS232C communication D-sub9 pin connector is not attached as the interface on the PC for your used gas analysis, you are required to purchase the following RS232C serial communication card.

Name ;RS232C serial communication card
Model ;COM-1 (CB) H
Channel number ;1ch
Transmission method ;Asynchronous serial transmission
Baud rate ;2～921, 600bps
Responded card slot ;Responded for PC Card Standard conformance CardBus

Card form	;TYPE Ⅱ
Power consumption	;3.3VDC 100mA（Max.）
Used conditions	;0～50℃, 10～90％RH（No condensation）
Attached cable length	;250mm

“Schematic diagram”



“Co[illegible]

* As for the use method (Driver install method, connection method), refer to the product attached “COM-1(CB)H manual”.

12.3 Jacket Heater

12.3.1 Overview

The jacket heater for QuleeCGM/BGM series (Hereinafter referred to as this machine or the heater) is to do baking the analyzer tube evenly when using our company-made residual gas analyzer/process monitor "Qulee CGM051/052, BGM-102/202". This machine has two types of products depending on QuleeCGM specification (Standard specification (Hereinafter referred to as CGM-JH01) and QIP specification (Hereinafter referred to as CGM-JH02). Also there is one type of the product as (Hereinafter referred to as BGM-JH01) for QuleeBGM-102/202R.

12.3.2 Specification

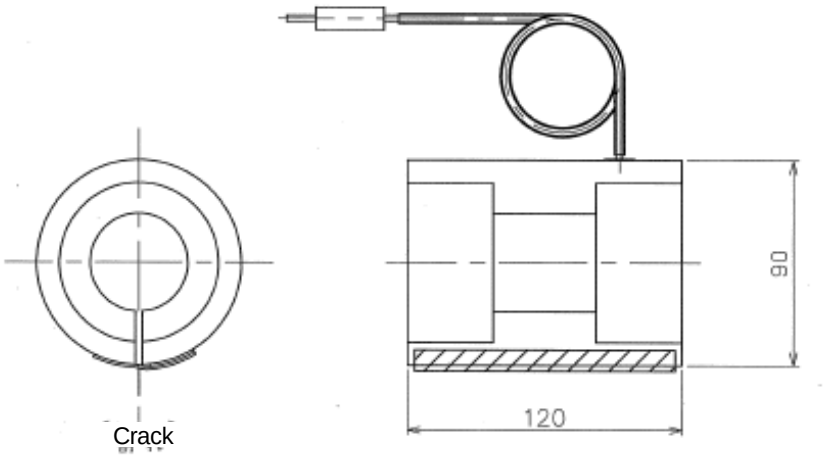
① Basic specification

Product name : Jacket heater for QuleeCGM/BGM series
Form : CGM-JH01（CGM standard）
CGM-JH02（QIP specification）
BGM-JH01（BGM-102/202 specification）
Used power supply : AC100V, 100W
Size (Rough dimension in mounting)
: Within ϕ 90 (Outer diameter) x 120（CGM length）/250（BGM length）
Quality of material : Outer material; Teflon clothBacking cloth; NH coat
Connection cable : 2-conductor, lagging cable, length 1m
Outlet form : Flat 2-conductor outlet plug
Sensor heating temperature (In even)
: 110℃±20℃ (Tolerance ±10℃ against the setting temperature)
Heater temperature adjustment
: Depending on the thermostat of the internal heater
Thermostat for over rise of temperature detection
: 200℃

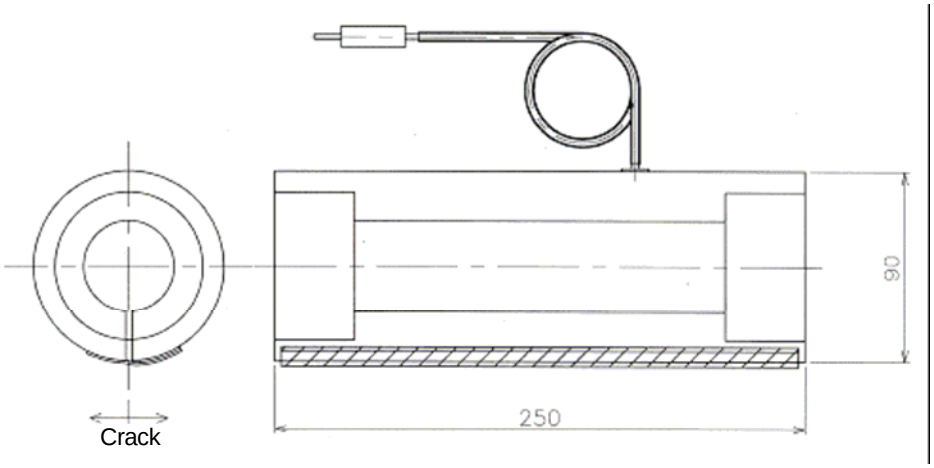
*In this machine, the earth leakage breaker is not included.

② Outside drawing (Outlined dimension)

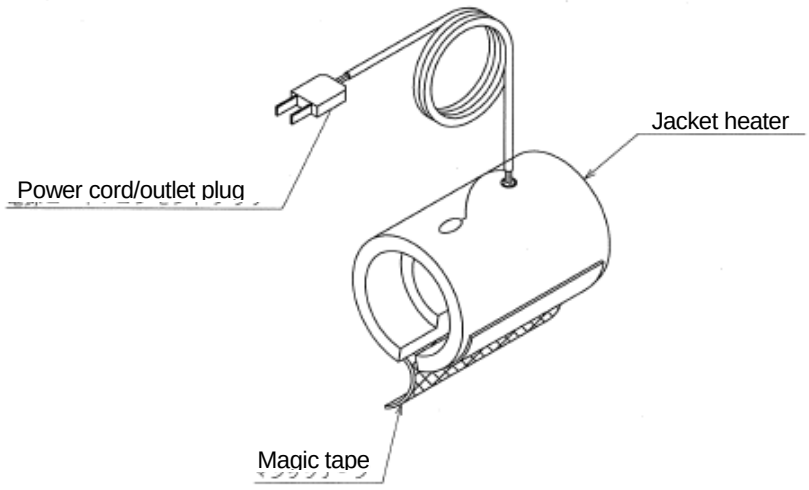
"CGM-JH01/JH02"



"BGM-JH01"



「Image drawing」



12.3.3 Use method

① Mounting

(1) Mount the sensor on the vacuum system in advance.
(2) Remove the magic tape part of the heater, and mount it to the sensor analysis tube with the heater being widened a little.
(3) Paste the magic tape part of the heater, and fix the sensor and the heater.

When mounting and removing the heater, do not widen the heater too much. (Widened guide: Sensor part piping diameter more or less)

② Energization

(1) Confirm that the vacuum system, which the sensor is being mounted, is being fully exhausted including the sensor part. (Recommended pressure in heating is 1e-4Pa or less)

When the pressure of the sensor part is higher condition than the above-mentioned recommended pressure, do not do baking. In baking with the pressure being high state, the stains occur inside the sensor, and it has a possibility that sensitivity deteriorates.

(2) Insert the outlet plug to AC100V power supply (Flat 2-conductor outlet socket) supplied from utility. However, do not connect to the outlet plug for the household.
(3) Heating inside the heater is started. When the heater rose to the sensor heating temperature, the internal thermostat functions, thus the sensor temperature is retained to 110℃±20℃.

When baking is not performed, turn OFF the heater removing the outlet. Do not forget with baking ON. Normally, in combination with baking for 12 hours or so and degassing of the sensor, you can reduce the residual gas of water

in the vacuum system and in the sensor.

CAUTION

During baking, the surface temperature is held to 60℃ or less, but caution should be taken not to touch the surface by bare hands.

③ Removal

(1) By removing the outlet plug, cut off energization to the heater.
(2) Peel off the magic tape fixing the heater, and then remove the heater.

Immediately after turning off the heater energization, since the inside may become considerably hot, remove it after a few minutes have passed.

(3) If the inside surface lowers up to the room temperature or less, store it in places where humidity/temperature are being held without dust.

12.3.4. Troubleshooting

Power shut down

Make reference for the following troubleshooting. Also, perform these works after shutting down the power supply.

● Even if applying the power, the jacket heater is not heated.

Causes	Measures
The power supply connector is disconnecting.	Confirm the connection of the power supply connector part.
The inside of the heater is broken.	Confirm resistance between cables of the heater output with the multimeter. In normal conditions, it is Ω. When fluctuations (Insulation or conduction resistance significantly becomes different) were confirmed from this resistance value, the repairs/inspection are required at ULVAC.

Does not rise temperature.	The thermostat for over rise of temperature detection is operating. After pressed the manual return button, if it is heated, the thermostat for temperature control is being broken down.
The input power supply voltage is the specification range or less.	Confirm the input power supply voltage with a tester.

12.4 I Type Piping

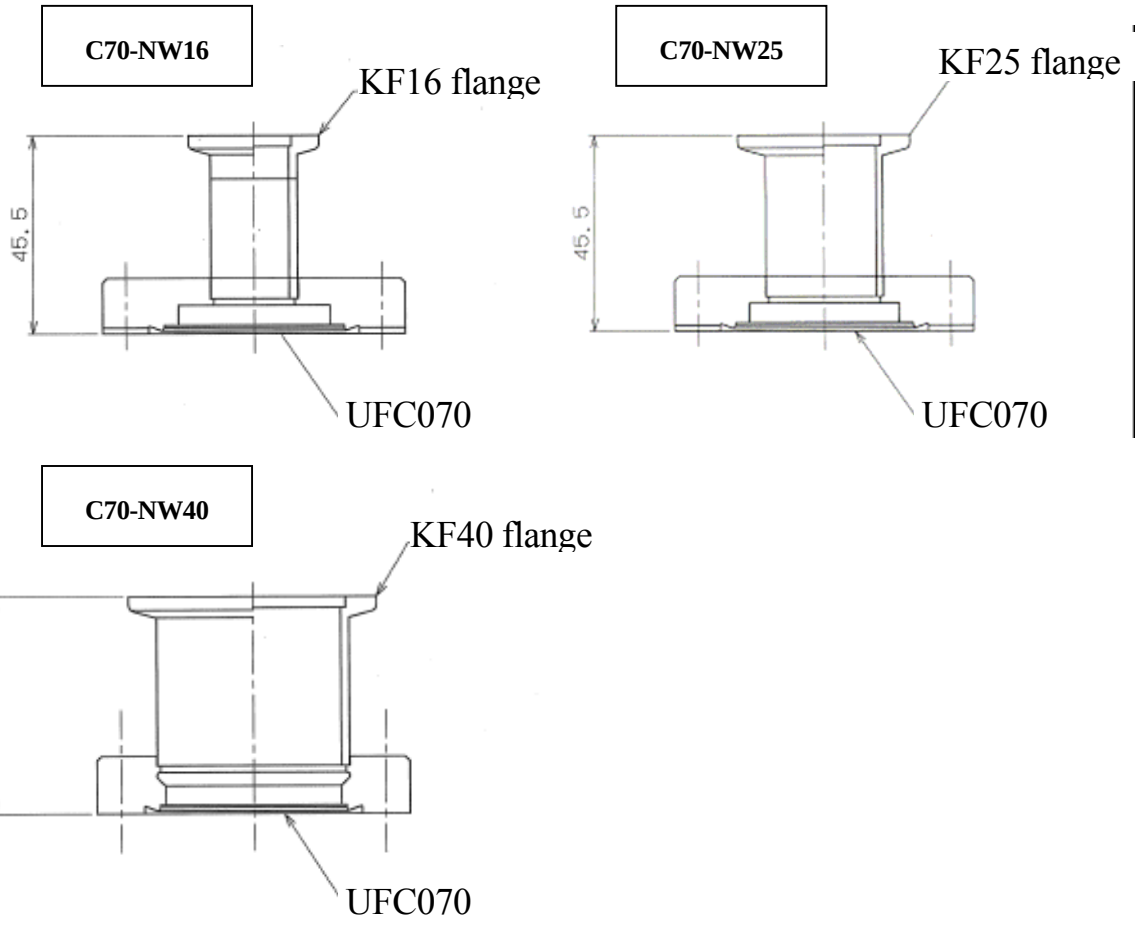
When the Qulee sensor mounting port is the KF (NW) flange, after purchasing three types of I type piping (Conversion piping), perform the mount work of the sensor to your equipment.

① Basic specification/configuration

Model; C70-NW16（UFC070-KF16 I type piping）
C70-NW25（UFC070-KF25 I type piping）
C70-NW40（UFC070-KF40 I type piping）

Accessories; Center ring （KF16/25/40） ×1
Clamp （KF16/25/40） ×1
Gasket（UFC070G） ×1 sheet

② Dimension drawing/ image drawing



③ **Mounting method**

(1) Since the tie-in flange of the Qulee series various models of sensors is "UFC070 flange", prepare for the bolts/nuts/washers (M6 x 35 – 6 pieces set) of the Qulee main body accessory.

(2) After preparing for either of the above-mentioned C70-NW16/25/40, pinch the attached gasket into between the Qulee sensor – I type piping, evenly tighten with hexagon head bolts/nuts/washers (M6 x 35 – 6 pieces set).

(3) Pinch the attached center ring in between the Qulee sensor having mounted the I type piping and the system mounting port (KF16/25/40), and tighten up strongly with a clamp.

(4) Lastly, after preparing for the He gas, start to measure by the Qulee QCS leak test mode or local mode (CH; He select), and then execute the He leak test.

12.5 Carry Case

It becomes the carry case capable of housing/carrying the Qulee main body (Sensor + Sensor unit) and accessories.

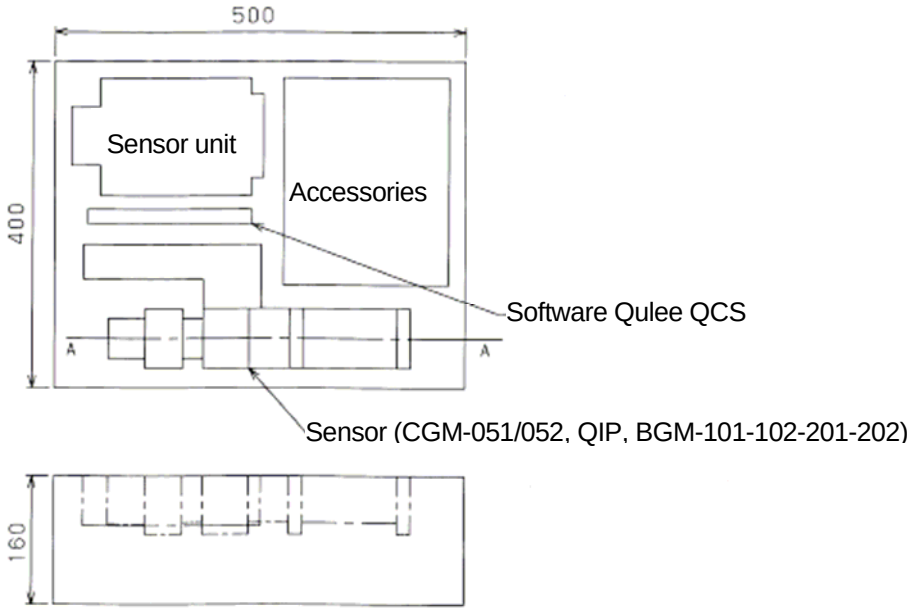
① **Basic specification**

Model	; CB-001
Dimension	; 500（W）×400（H）×160（D）mm
Quality of material	; Outer plate : Alpolic Inner packaging : Urethane Treatment : Alumite treatment
Storage possible item	; • CGM-051/052 main body • CGM-051/052-QIP-PG main body • BGM-101/101L/102/201/202 main body • Software Qulee QCS •Accessories(Communication cable, bolts/nuts/washer[M6], gaskets [UFC070G]) •Operation manual（Qulee series operation manual, Qulee QCS operation manual）

* The optional AC power supply adaptor is also accommodated in.

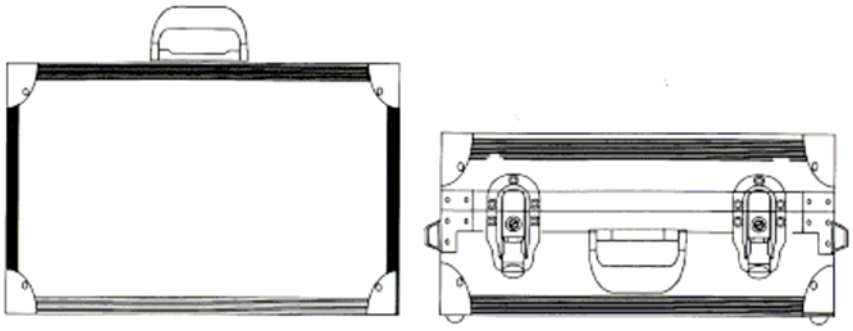
② Dimension drawing/ image drawing

"Dimension drawing"



A-A cross section

"Image drawing"



12.6 Acrylic Case

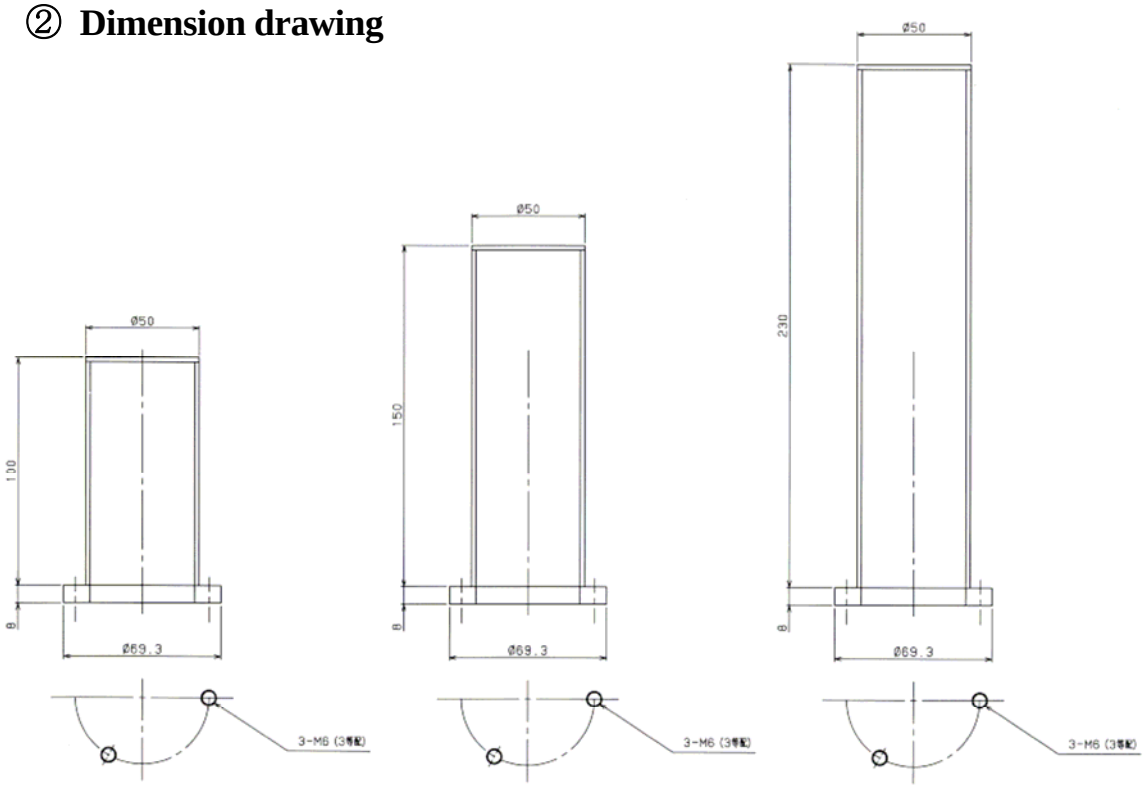
It becomes the acrylic case for the Qulee series (CGM-051/052, BGM-101/101L/102/201/202) various models sensor protection. Use it when purchasing/storing the single sensor or when transporting in the sensor overhauling.

① Basic specification

Model ;(Acrylic case for CGM-051/052)
(Acrylic case for BGM-101/101L/201)
(Acrylic case for BGM-102/202)

Accessories ;Hexagon head bolt (M6 size x 15) x 3
Washer (M6 size) x 3

② Dimension drawing



③ Mounting method

When removing the analyzer tube and mounting the acrylic case, prepare for gloves so that stains and dust are not attached.

(1) Prepare for the Qulee series (CGM-051/052、BGM-101/101L/102/201/202) various model sensors and the acrylic case.

(2) Cover the acrylic case to the analyzer tube (In the state of

removing the envelope).

(3) Tighten it with a spanner using the attached hexagon head bolts/washers (M6 size x 15).

13. Maintenance

13.1 Life Expectancy of Ion Source

	Maintenance

The life expectancy of the Model CGM-051 and Model CGM-052 ion sources, which can be used at a pressure of 0.1 Pa and higher, is shorter than that of other models.

Replace the ion source according to the following operating hours, as a rule.

Emission current (μA)	Measurement pressure (Pa)	Expected lifetime
400	1	700 hours (approx. 30 days)
400	0.1	7000 hours (approx. 300 days)
100	1	2800 hours (approx. 120 days)

* The life expectancy above is the length of time when air is fed and varies with the measurement atmosphere. Note that this time does not mean warranted lifetime.

13.2 Replacement of Ion Source

	Beware of high temperature
	Keep out foreign objects
	Operating environment
	Check connection

If “Filament Fault” occurs, filament burnout or contamination of the ion source is suspected. If FIL1 has burnt out in an instrument having two filaments, change over the filament to FIL2. If both filaments have burnt

out or if the ion source is severely contaminated, it is necessary to replace the ion source. Contact your local ULVAC representative for replacement.

* Before replacing the ion source or filament, wait for about 30 minutes after turning off the filament. Parts around the ion source are heated to a high temperature immediately after the filament is turned off and you may get burned on contact with the heated part.

(1) CGM

1)

Wear clean gloves and prepare a precision screwdriver (cleaned with alcohol) and remove all M2 screws in Figures ① to ③.

Fig. 1

Fig. 2

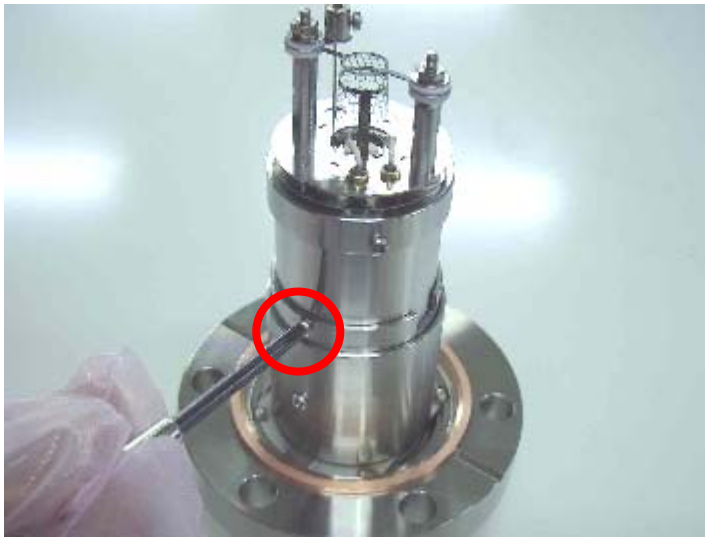


Fig. 3

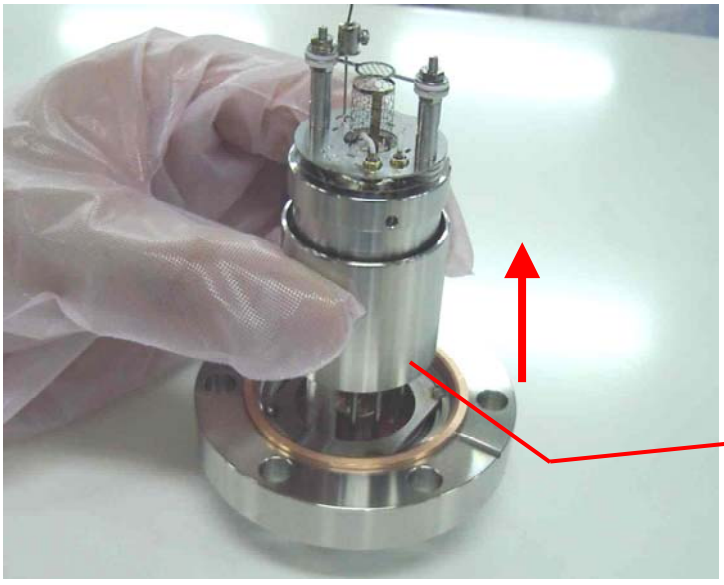


Fig. 4

Pull up the cylinder on the base flange side, as shown in Figure ④ and remove it, as shown in Fig. ⑤

Fig. 5

Fig. 6

Remove the M2 screw of the TP wiring at the top of the ion source, as shown in Fig. ⑥.

Fig. 7

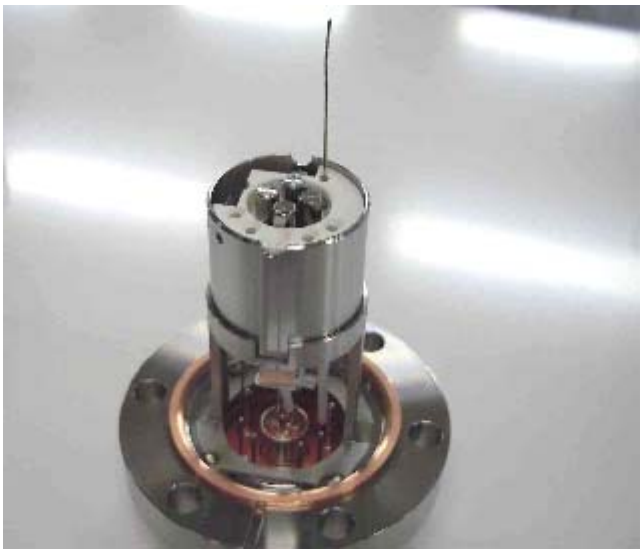


Fig. 8

Hold the ion source as shown in Fig. ⑦ and gently pull it up while holding the pin with a pair of tweezers or pliers.

* Clean the tweezers and pliers with alcohol before use.
* Be cautious when installing a new ion source, because multiple contact pins and TP wiring are to be installed at the same time.

Fig. ⑧ shows the ion source pulled up. This completes the removal of the ion source. When disassembling ion source, please do not remove electrodes except following ites listed below:

1. FIL.1
2. FIL. Com
3. Grid
4. N.C.

Removing electrodes other than ones listed above might cause defects of the unit.

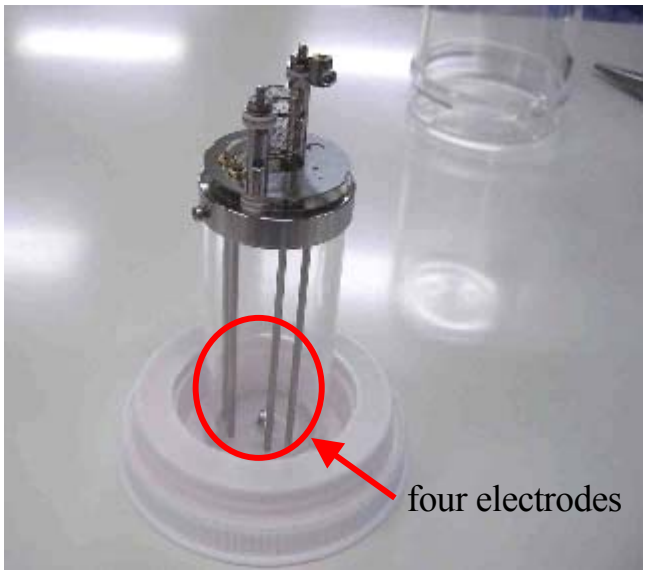
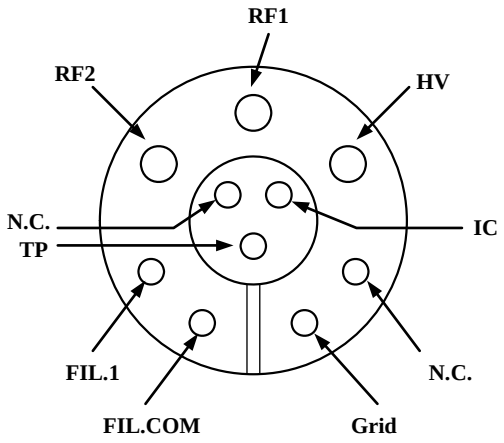


Fig. 9

A new ion source is supplied in a styrol bottle as shown in Fig. ⑨. Install it by reversing the steps above. When replacing to a new ion source, please make sure the following locations:

1. FIL.1
2. FIL. Com
3. Grid
4. N.C.

Please place each electrode to specific four places accordingly.

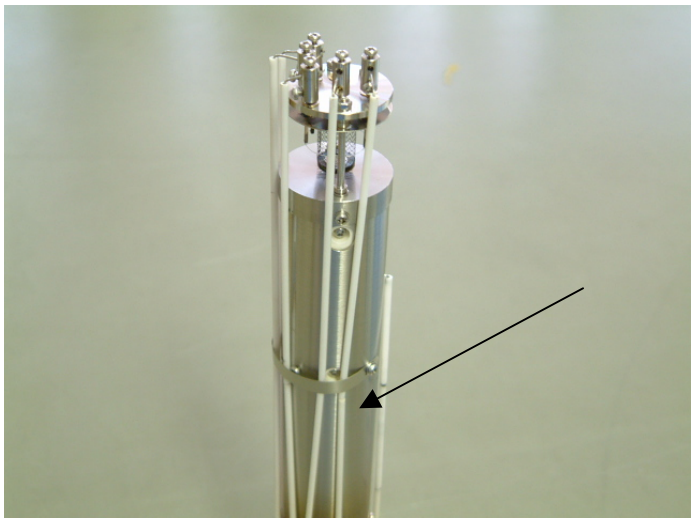


10pin Feedthroughs pin assign (inside view[The vacuum side])

Finally, check continuity and insulation according to the analyzer tube mounting procedure.

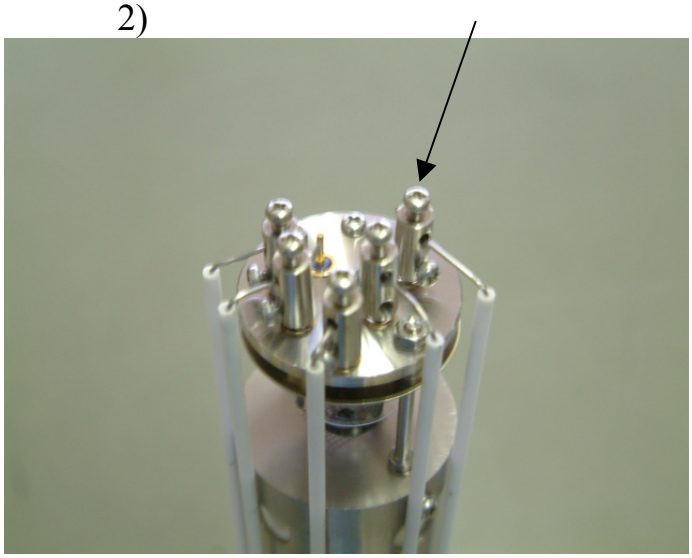
(2) BGM

1)

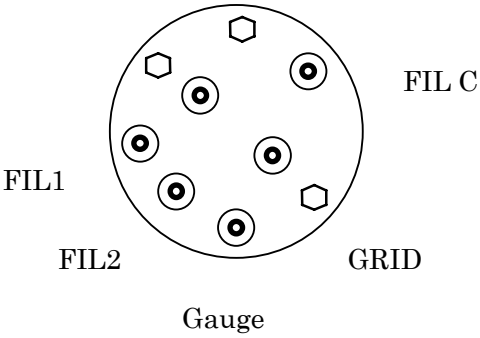


Loosen the M2 screw to remove the wiring clamp band of the Q pole.

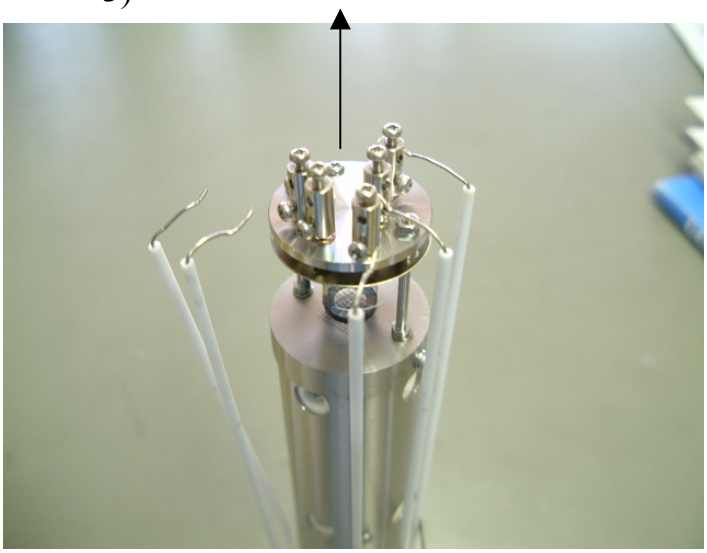
2)



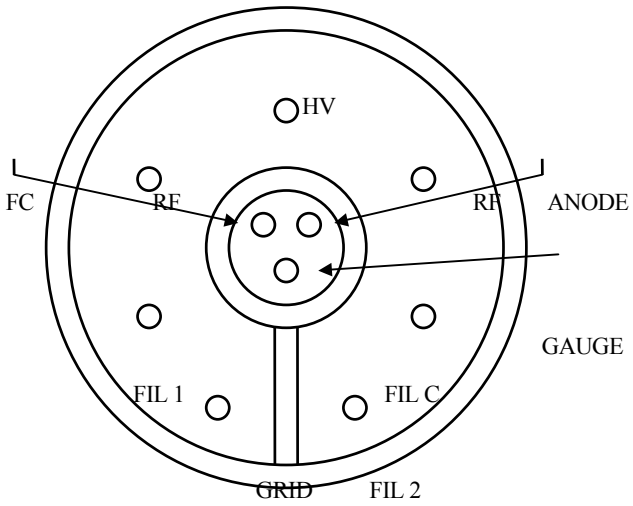
Loosen the M2 screw on top of the ion source to remove the FIL1, FIL2, FIL C, GAUGE and GRID wiring.



3) Loosen the M2 screw to remove the ion source



4) Install a new ion source and fix it to the Q pole using the M2 screw.
5) Fix the FIL 1, FIL 2, FIL C, GAUGE and GRID wiring with M2 screw.



Analyzer tube pin assignment (as viewed from vacuum side)

HV	:	High voltage for EM
RF	:	RF
FIL1	:	Filament 1

FIL2	:	Filament 2
FILC	:	Filament Common
GRID	:	Grid
FC	:	Faraday cup
ANODE	:	Anode
GAUGE	:	Total pressure

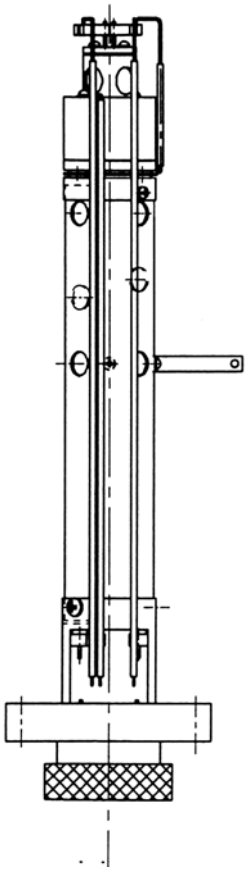
6) Fix the wiring using the wiring fixing band.
7) Check continuity and insulation according to the analyzer tube mounting procedure in 5.2.1.

③ RGM-201/202

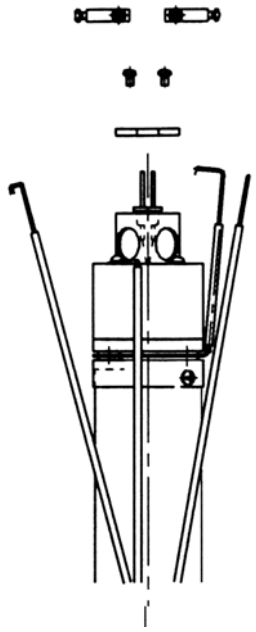
Changing the filament

(1) Remove the UFC070 flange to which the sensor unit is attached, remove the analyzer tube, and place it on a table or desk. At this time, the Teflon tube for gas feed may come with the analyzer tube. Do not lose it.

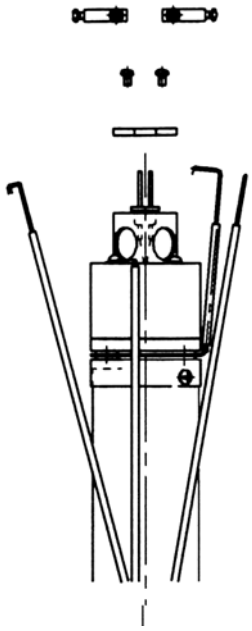
(2) Remove the wiring clamp band.



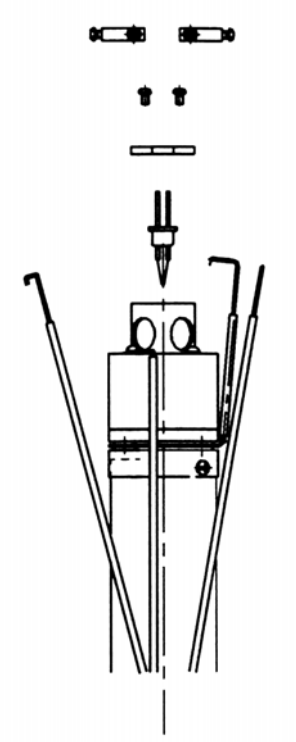
(3) Remove the jig that connects the filament and wiring and the screws. Here, tools may be attracted by the magnet used for the ion source. So be careful in disassembling.



(4) Remove the jigs and screws that fix the filament.

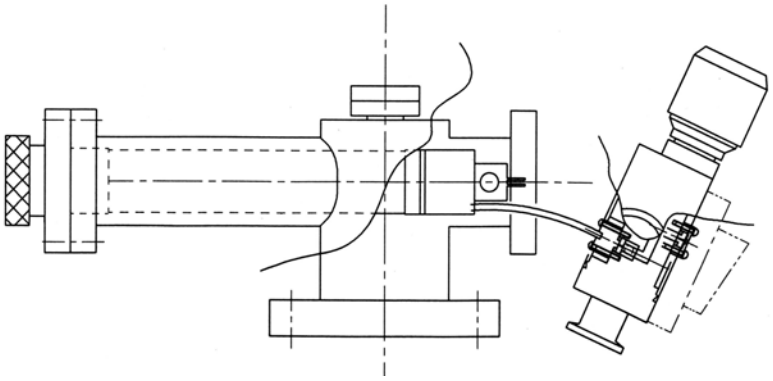


(5) Take out the used filament using a pair of tweezers.



(6) Take out a new filament and mount it on the ion source. Be careful that the filament does not come into contact with the ion source.
(7) Reassemble the analyzer tube by reversing the removing procedure (6), (5), (4) and (3).
(8) Remove the gas inlet valve. At this time, the gas feed Teflon tube may come out with the analyzer tube. Do not lose it.
(9) Mount the analyzer tube on the pumping system manifold. At this time, do not mount the analyzer tube upside down. The side on which there are 3 thick pins of the base flange is the upside. Also replace the gasket with a new one.

(10) Look into the analyzer tube from the gas inlet valve side and insert the Teflon tube into the hole in the bottom of the ion source.



(11) Place a new gasket on the gas inlet valve and insert the Teflon tube into the Teflon tube insert hole in the top of the valve, bring it closer to the Teflon tube while inclining the valve, and fix the gas inlet valve. Be cautious in installation so that the tube is inserted properly without being bent.

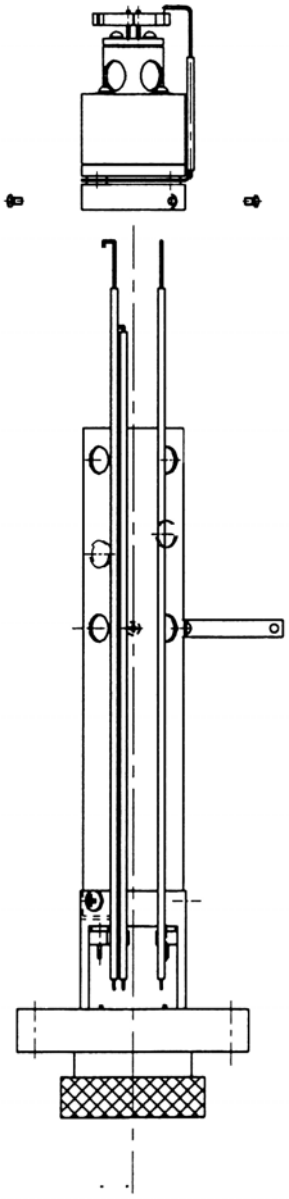
(12) Tighten the flanges securely so that no leakage occurs.

13.3 Replacement of ion source

(1) Remove the wiring from the analyzer tube according to steps (1) to (3) of "Replacement of Filament".

(2) Remove the ion source fixing screw to remove the ion source.

(3) Install a new ion source. At this time, make sure that the ion source is securely fixed with the fixing screw with no inclination or other problem.



(4) Connect the original wiring in the same position as before replacement.
(5) Install the analyzer tube and gas inlet valve according to steps (9) to (13) of "Change of Filament".

 CAUTION	Be careful that the wiring comes into contact with the earth (particularly, flange side). Also see to it that the wiring does not come into contact with other wiring.

13.4 Adjusting the Tuning Voltage

RF error may arise if the analyzer tube is contaminated. In that event, it is necessary to make readjustment of the tuning voltage.

(1) Create a trend mode recipe of only one channel of M/e=25 in the case of CGM-051 or 052 or M/e=50 in the case of BGM-101/101L/ or 102 or M/e=100 in the case of BGM-201 or 202 using "QueleeQCS". It is not necessary to save the data.
(2) Display the control panel dialog with [Sensor] → [Control Panel] and remove the check mark from [FIL].
(3) Start measurement with the [MES] button. Here, the "R" and "S" lights are lit.
(4) Insert the circuit tester probe into the tuning voltage adjustment terminal (refer to 4.2 Rear Panel) on the side of the sensor unit and measure voltage.
(5) Turn the rotary switch for adjusting the tuning voltage on the side of the sensor unit (refer to 4.2 Rear Panel) clockwise and counterclockwise to adjust the voltage to a minimum.

13.5 Adjustment of Resolution

Resolution (*) may change with contamination of the analyzer tube and change of environment temperature. In this case, adjust the resolution of low mass number (M/e=1 - 50) with the (L) potentiometer in ⑨ "RESOLUTION" in Fig. 10.1 and that of high mass number (M/e=50 and higher) with the (H) potentiometer. Turning the potentiometer counterclockwise improves resolution (narrows peak width) and turning it clockwise lowers resolution (increases peak width). Too high resolution and too low resolution adversely affect the measurement data. If there is an evident variation of the measurement value, it is

recommended to conduct “mass number calibration” using the dedicated software and make sure that the waveform is normal and that the mass number is in the correct position.

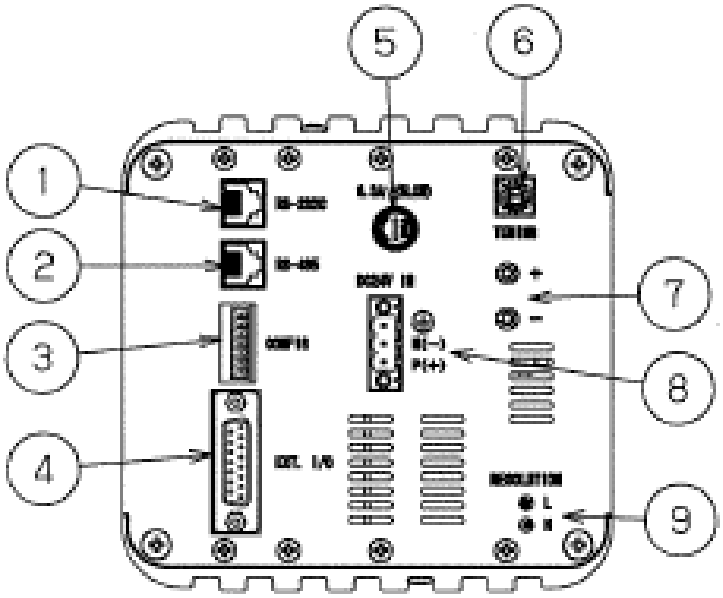


Fig. 13.1 Resolution adjustment potentiometer

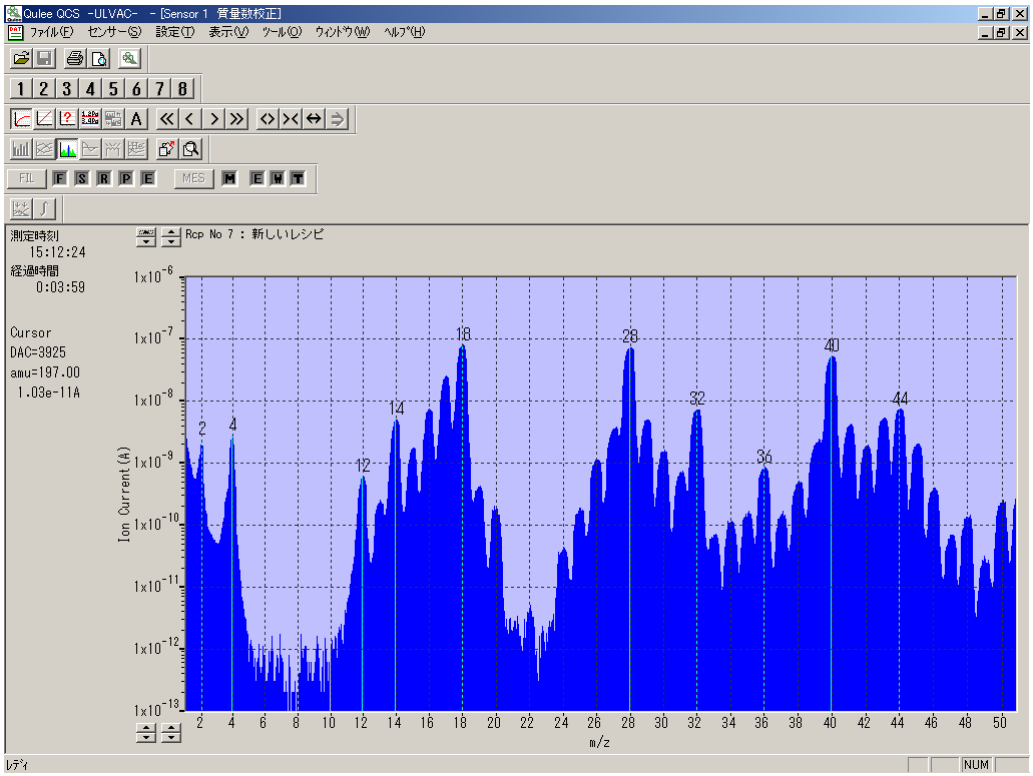


Fig. 13.2 Data subjected to resolution adjustment (low mass number side)

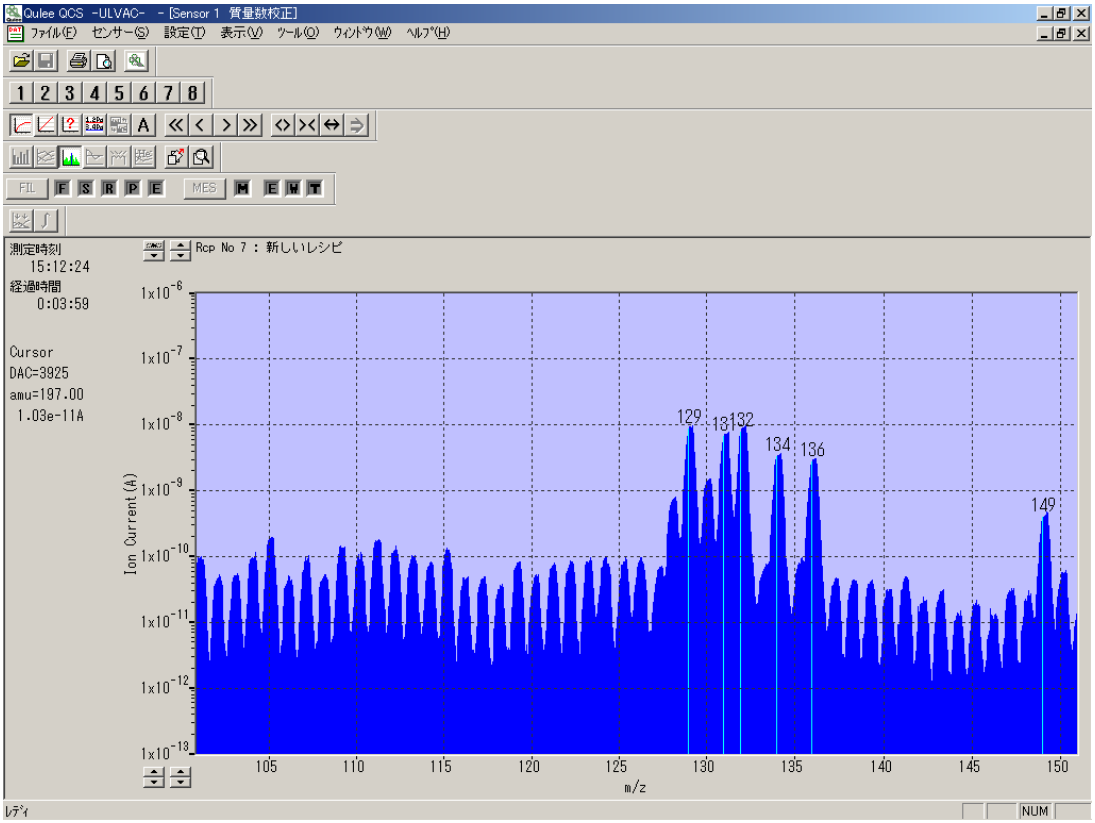
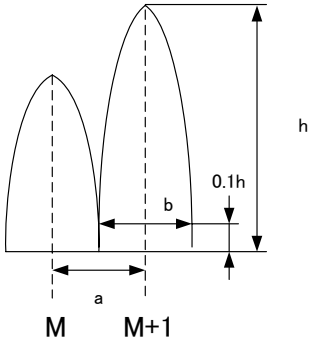


Fig. 13.3 Data subjected to resolution adjustment (high mass number side)

* "Resolution" represents the degree of separation of neighboring peaks of mass numbers. With the Qulee series, M/e=M and M+1 can be discriminated because ΔM=1 (10% P. H.).



$$M/\Delta M = M/(b/a)$$

$$= M(10\%P.H.)$$

$$\Delta M = b/a = 1$$

Fig. 10.4 Resolution

13.6 Replacement of Secondary Electron Multiplier (SEM) Tube

For replacement of the SEM tube, contact your local ULVAC representative or Components Division, ULVAC, Inc., Japan.

13.7 Consumable Parts List

Model	Component	Model	Maker	Corrective action
BMG-101/ 102/201/202	Ion source	BGM-IS01	ULVAC	Replace if filament has burnt out, is severely contaminated or sensitivity has lowered.
BGM-101/101L//202	Secondary electron multiple tube	BGM-EM01	ULVAC	Replace if sensitivity has lowered
BGM-101/101L//201	Analyzer tube	BGM-AN101/201	ULVAC	Replace if severely contaminated or sensitivity has lowered or waveform is abnormal.
BGM-102/202	Analyzer tube	BGM-AN102/202	ULVAC	Replace if severely contaminated or sensitivity has lowered or waveform is abnormal.
CGM-051/052	Ion source	CGM-ISO01	ULVAC	Replace if filament has burnt out, is severely contaminated or sensitivity has lowered
CGM-052	Secondary electron multiplier tube	CGM-EM01	ULVAC	Replace if filament has burnt out.
CGM-051	Analyzer tube	CGM-AN51	ULVAC	Replace if severely contaminated or sensitivity has lowered or waveform is abnormal.
CGM-052	Analyzer tube	CGM-AN52	ULVAC	Replace if severely contaminated or sensitivity has lowered or waveform is abnormal.
RGM-201/202	Filament	RGM-FIL01	ULVAC	Replace filament if it has burnt out
RGM-201/202	Ion source	RGM-IS01	ULVAC	Replace if filament has burnt out, is severely contaminated or if sensitivity has lowered.

Model	Component	Model	Maker	Corrective action
RGM-202	Secondary electron multiplier tube	RGM-EM01	ULVAC	Replace if sensitivity has lowered
RGM-201	Analyzer tube	RGM-AN201	ULVAC	Replace if severely contaminated or sensitivity has lowered or waveform is abnormal.
RGM-202	Analyzer tube	RGM-AN202	ULVAC	Replace if severely contaminated or sensitivity has lowered or waveform is abnormal.
Others	Gasket	UPC-070G	ULVAC	Replace once used

14. Troubleshooting

Refer to the following tables for troubleshooting.
Turn off power before troubleshooting.

 CAUTION	Turn off power.

• POWER LED does not light when power is turned on.

Possible Cause	Corrective Action
Power connector is disconnected.	Check connection of the power inlet connector.
Power cord has broken.	Check the power cord lines for continuity and insulation using a circuit tester or other.
Line voltage is out of specification.	Check line voltage using a circuit tester or other (line voltage: 24V DC ± 10%).
Switch on the optional power adapter is not turned on.	Turn on the switch on the power adapter.
Fuse in the rear panel is open.	Turn the fuse box with a Philips screwdriver, take out the fuse and check continuity using a circuit tester. If the fuse has blown out and its cause is a momentary over-current, replacement of the fuse will resolve the problem, but if other cause is responsible for the over-current, the fuse will burn out again. Locate the real cause from other items.

Possible Cause	Corrective Action
The power line in the sensor unit is open.	Open power line in the controller (inline filter, wiring, power switch, transformer, switching power supply, etc.) or short-circuit. To be inspected/repaired by ULVAC

• Measurement cannot be started by pressing the START button (FIL is lit)

Possible Cause	Corrective Action
Filament is open.	Check continuity between filament electrodes using a circuit tester or other. If the filament is open, change it over the other one. However, if the filament has burnt out due to operation above the measurement pressure range for an extended time, the sensor head interior may be contaminated. In this case, the emission current may not be normal even if the other filament is intact. In that event, replace the ion source.
Poor insulation between electrodes of the analyzer tube	Check insulation between electrodes and outside wall of the analyzer tube with a Megger. The indication should be infinite or more. If insulation failure is confirmed, overhaul the analyzer tube.
Pressure is high.	Check pressure by a vacuum gauge.
Insufficient power capacity	Use 24 VDC 2A power or more.
Contamination of the analyzer tube or filament worn out	Overhaul the analyzer tube.

· Measurement cannot be made by pressing the START button. (SEM is lit)

Possible cause	Corrective action
SEM is in contact with earth or other electrode.	Check continuity between electrodes using a circuit tester or other. If there is continuity, remove the analyzer tube and eliminate the cause of contact.
Power capacity is too small.	Use 24 VDC 2A power or more.

• Measurement cannot be made by pressing the START button. (RF is lit.)

Possible cause	Corrective Action
RF is in contact with earth or other electrode. RF terminal is off.	Check continuity between electrodes using a circuit tester or other. If there is continuity, remove the analyzer tube and eliminate the cause of contact.
Tuning voltage is extremely off.	Regulate tuning voltage.
Insufficient power capacity	Use power of 24VDC 2A or more.

• Pressing the START button does not display any value.

Possible cause	Corrective action
SEM voltage is too low.	Increase SEM voltage with "QuleeQCS".
Mass number is not calibrated correctly.	Calibrate mass again with "QuleeQCS".
Protected by external interlock.	Reset the interlock.
Power capacity is insufficient.	Use power of 24V DC 2A or more.

• Sensitivity is low.

Possible Cause	Corrective Action
Sensitivity is not correctly calibrated.	Calibrate sensitivity with "QuleeQCS".
SEM voltage is too low.	Increase SEM voltage with "QuleeQCS".
Amplification factor of SEM has lowered.	Replace SEM.
Ion source is contaminated.	Remove the analyzer tube and check if the ion source is contaminated. If it is severely contaminated, replace it.

• RS-232C and -485 communication cannot be established.

Possible cause	Corrective action
Incorrect connection of cable	Reconnect cables referring to 4.2 Rear Panel and 5.2.4 Connection of RS485 cable.
Parameters (conditions) are not set correctly.	Check if RS-232C/485 is changed over and the baud rate, address, terminator and if REMOTE/LOCAL is correctly set.
Communication setting of PC is not correct.	① Check the setting of communication port of PC and Windows. Check if the set value of PC communication port (COM port) is the same as that of the COM port of "QuleeQCS".

Possible Cause	Corrective Action
	② Set the communication buffer at the minimum value on the buffer capacity toolbar displayed by detailed setting of property of COM port. ③ Communication error may occur depending on the type of PC. With some models, communication may be unstable if the extension port is used in operation. Check functions using other PC. ④ Reset PC and check again. ⑤ Check after disabling use of infrared light.

• Measurement value fluctuates.

Possible Cause	Corrective Action
Contaminated analyzer tube or extremely low sensitivity	Change the sensor head with another one and check symptom. If OK with the sensor head, the problem is in the sensor head.
Line voltage is fluctuating.	Check line voltage using a circuit tester or other. (line voltage: 24VDC ±10%)
Ground potential is fluctuating.	Check the sensor unit ground and the ground where the analyzer tube is installed using a circuit tester or an oscilloscope. Take corrective actions by reinforcing the ground wire or installing either the control or analyzer tube in a floating condition.

Possible Cause	Corrective Action
Leakage current is generated because of poor insulation between electrodes of the analyzer tube.	Check insulation between the electrodes and the outside wall using a Megger (indication should be infinite or more.) If poor insulation is confirmed, overhaul the analyzer tube.
Operating environment temperature is varying.	Measure at a constant temperature.
Tuning voltage is deviated.	Regulate tuning voltage.
High intensity magnetic field is generated by equipment in the vicinity.	The orbit of thermoions generated from the filament is affected by intense magnetic field around the ion source, causing the emission current to fluctuate. So eliminate the intense magnetic field environment.
Mass number calibration is not correct.	Recalibrate mass number using dedicated software.

• Setpoint signal is not output.

Possible Cause	Corrective Action
In the LOCAL mode, setpoint is not output.	Actuate the setpoint with “QuleeQCS”.
Erroneous wiring or open circuit of EXT-I/O connector	Correct the wiring and check continuity using a circuit tester or other.
Failure of output circuit	To be inspected and repaired by ULVAC.

• Interlock signal is not output.

Possible Cause	Corrective Action
Erroneous wiring or disconnection of EXT I/O connector	Correct the wiring and check continuity using a circuit tester or other.
Photocoupler current is too low or cannot be fed.	Current of 10 mA is fed to the photocoupler inside. If an external power supply is used, check if the current capacity is sufficient and if the wiring resistance of the wiring is high. If it is turned ON/OFF with a relay, make sure that the minimum actuating current of the relay is 10 mA or less.
Failure of input circuit	To be inspected and repaired by ULVAC.

• Display differs from PC display.

Possible Cause	Corrective Action
Sensitivity is not calibrated correctly.	Calibrate sensitivity with “QuleeQCS”.

15. APPENDIX

15.1 Theory of Operation

Fig. 15.1 shows the analyzer tube of the quadrupole spectrometer. It consists of the ion source section, filter section, and detector section. The mass of ions generated by the ion source is analyzed in the filter section and the ion current is measured by the detector section.

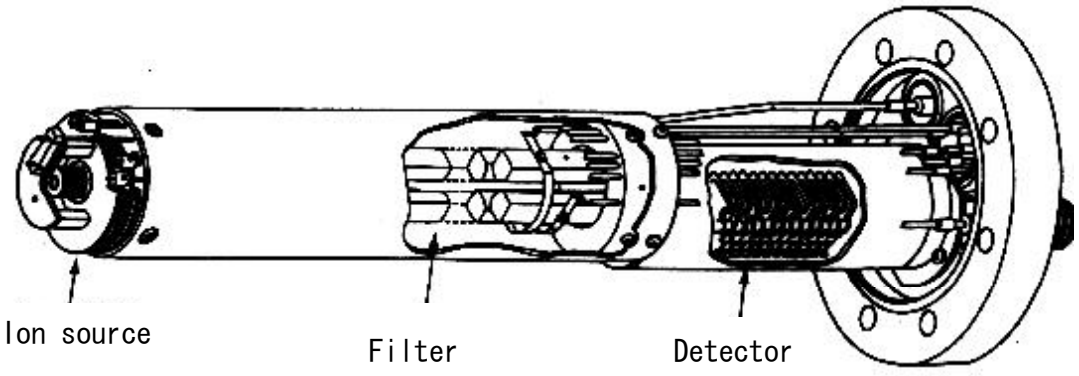


Fig. 15. 1 Structure of quadrupole spectrometer analyzer tube

Fig. 15.2 shows an example of spectrum. It shows data up to mass/electric charge ratio (M/e) = 1 to 40 and the mass number is small on the left side of the graph. A waveform with equal intervals is obtained for one mass. Gas composition can be known from the peak position and gas amount can be known from the peak height, for example, H_2 in the position of mass number 2, H_2O in the position of 18, N_2 in the position of mass number 28 and Ar in the position of mass number 40.

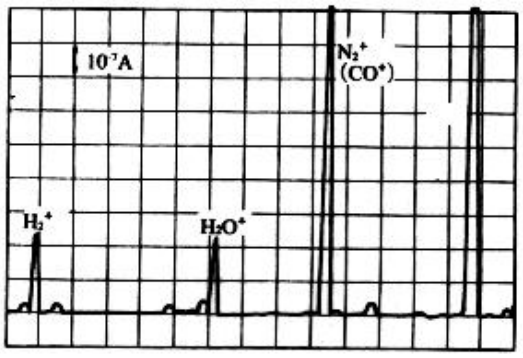


Fig. 15.2 Spectrum of quadrupole spectrometer

15.2 Principles of operation

(1) Ion source section

The structure of the ion source is identical with that of the hot cathode type ionization vacuum gauge, in which thermions emitted from the filament are accelerated, and gas molecules are ionized. In the ionization vacuum gauge, ions are collected into the collector, but the quadrupole spectrometer uses electric field to feed them to the filter section with an energy of about 10 eV.

(2) Filter section

In the filter section, four columnar electrodes are arranged parallel to each other. This is why the filter is called quadrupole and is referred to as mass filter.

As shown in Fig. 15.3, these opposing electrodes are connected with each other and dc and ac voltages of (U + Vcoswt) overlapped are applied with reverse polarity respectively. Here, the equation of motion of the ions incident on the filter section are expressed by Eq. (1) with respect to the x, y and z axes shown in Fig. 15.3.

$$\left.\begin{aligned} m\frac{d^2x}{dt^2} + 2e(U + V\cos\omega t)\frac{x}{r_0^2} &= 0 \\ m\frac{d^2y}{dt^2} - 2e(U + V\cos\omega t)\frac{y}{r_0^2} &= 0 \\ m\frac{d^2z}{dt^2} &= 0 \end{aligned}\right\} \quad (1)$$

As shown by Eq. (1), ions incident on the filter section are subjected to periodic force in the x-axis direction and y-axis direction and oscillate.

Substituting Eq. (1) as shown in Eq. (2), we obtain Maschew's equation.

$$\omega t = 2\xi$$

$$a = \frac{8eU}{mr_0^2\omega^2}$$

$$q = \frac{4eV}{mr_0^2\omega^2} \qquad (2)$$

$$\frac{d^2x}{d\xi^2} + (a + 2q\cos 2\xi)x = 0$$

$$\frac{d^2y}{d\xi^2} + (a + 2q\cos 2\xi)y = 0 \qquad (3)$$

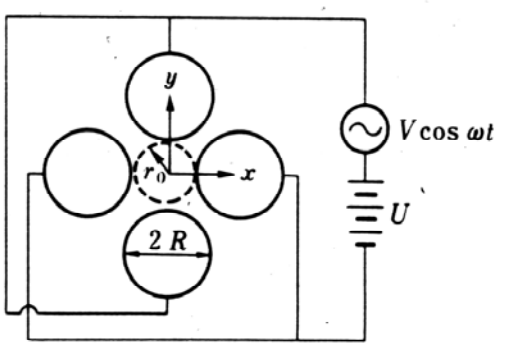


Fig. 15.3 Voltage applied to electrode

Equation (2) can be divided into stability analysis in which ions do not exceed a certain amplitude for an indefinite time and instability analysis in which amplitude increases with time. Whether Maschew's equation is stable or unstable is a function of a and q only, and it can be seen from Eq. (2) that the mass/charge ratio of ions with which stable oscillation can be performed for U and V voltage values.

When Eq. (3) is expressed on (U, V) plane as shown in Fig. 15.3, both the x axis and y axis show stable regions in which both axes x and y are stable, and only ions with a mass/charge ratio that falls in this area can pass through the filter section.

In order that the U/V ratio constant is constant, a/q is also constant from Eq. (2) and a straight line that passes through the origin can be drawn, as shown in Fig. 15.3. Under certain conditions of U/V, all ions of mass/charge ratio are arranged on this straight line in order of mass number, that is, they pass through the filter section. As the U/V ratio is increased further, the straight line comes close to the apex of the stability region and only ions of certain mass numbers can dwell in the stability region. In other words, the resolution of spectrum becomes high.

This can be summarized as follows: "Apply the voltage in Fig. 15.2 and sweep voltage while maintaining the U/V ratio at a ratio with which appropriate resolution can be obtained"

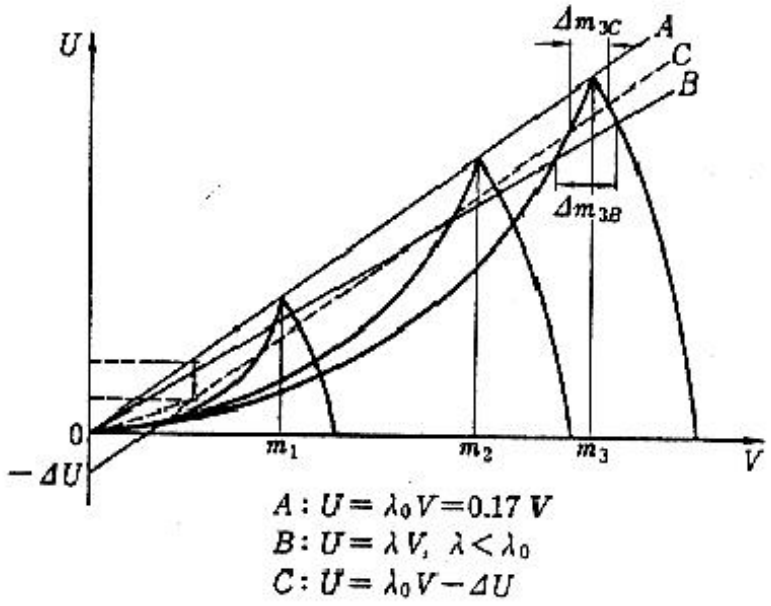


Fig. 15.4 Stability diagram of (U, V) plane and mass scan lines

(3) Detector section

The detector section collects and amplifies the ions that have passed through the filter section. Some simplified analyzers can directly catch ions with the Faraday cup alone to measure the ion current value. Normally, a secondary electron multiplier tube, channeltron, ceratron, or other are used to convert the incident ions into electrons, amplifies them by a factor of 5 to 6 , and send them to the DC amplifier of the controller.

For electronic amplification, a high voltage of about -2kV is applied to the incident end of the amplifier. The detector unit is arranged in the OFF-AXIS position with respect to the center axis of the filter section to inhibit incidence of soft X-rays generated from the ion source section and in the filter.

15.3 Handling of quadrupole spectrometer

(1) Measurement pressure range

Normally, the operating range is 0.01 Pa or less. If the spectrometer is used at a higher pressure, the ion source filament is oxidized or burns out, causing deterioration of the secondary electron multiplier tube. In the 10^{-3} Pa range, linearity is lost and sensitivity may lower.

To measure a high pressure gas, pump the analyzer tube section differentially using a turbomolecular pump, and measurement can be made by feeding gas from the system to be measured while controlling it.

(2) Deterioration

It is necessary to overhaul the analyzer tube if sensitivity has lowered by a factor of 3 or more as compared with the initial period or if the waveform becomes sharp and noise becomes noticeable. Normally, spare filaments are provided with the instrument, but it would be more effective to disassemble/clean or replace the ion source section rather than overhauling the analyzer tube.

If overhaul of the ion source section is not effective, it is necessary to replace the secondary electron multiplier tube. Since the amplification factor of this tube is subject to gradual decrease, it is desirable to measure sensitivity (amplification factor) periodically.

15.4 Interpretation of measurement value

Gas composition is judged from the mass number of the spectrum and is quantitatively decided with the ion current value of the peak top of the spectrum. Since the ion current value (A) cannot be converted directly to partial pressure (Pa), it is necessary to find sensitivity (A/Pa) by making calibration with an ionization gauge using nitrogen gas in order to obtain information about the pressure value.

(1) Sensitivity factor

The sensitivity of a quadrupole spectrometer varies with gas specie. Principal reasons are as follows.

1) The ionization probability in the ion source varies with the type of gas as with the ionization gauge.
2) The higher the mass number, the lower the transmitting efficiency of the quadruple section.
3) The amplification factor of the secondary electron multiplier tube varies with the ion specie.

To read the spectrum value of each gas as the amount of gas, it is necessary to feed mixture gas of which volume ratio has been valued and find the sensitivity factor for each gas.

(2) Cracking pattern

1) Ions dissociated in ionization

2) Divalent ion

3) Isotope, etc.

Cracking patterns appear when multiple spectra appear with one type of gas, and this occurs with most types of gases. The mass number of residual gas in an ordinary vacuum system is 50 or less and the number of cracking patterns is small, so that it is relatively easy to analyze them, but if organic gas is mixed, it is difficult to analyze the cracking pattern.

(3) Overlapping peaks

Since a gas specie is identified with mass number, it is difficult to separate gases with the same mass number. For example, N2 and CO that are present as residual gas have cracking patterns at mass numbers 14 and 12 respectively, it is possible to judge them to some extent, but it is not easy to find the ratio and partial pressure accurately because the peaks of CO2, CH4, etc. are overlapped in this position.

Recently, high resolution type quadrupole spectrometers have been developed, and D2 and He can be resolved.

15.6 Peaks of Major Residual Gases

M/e	Ion	Residual gas molecule	Remarks
1	H^+	H_2, vapor, hydrocarbon	
2	H_2^+	H2, vapor, hydrocarbon	H dissociated from various molecules are recombined.
12	C^+	CO, CO_2, hydrocarbon	
14	N_2^{++}, CO^{++} CH_2^+	N_2, CO, hydrocarbon	
15	CH_3^+	Hydrocarbon having methyl base	
16	O_2^{++}, O^+, CH_4^+	CH_4, O_2, oxgen compound	
17 18	OH^+ H_2O^+		With H_2O 16:17:18=1:5:20
20	Ar^{++},(H_2O)		H_2O (20) with O18 abundance ratio of about 0.2% is present.
22	CO_2^{++}		
27	$C_2H_3^+$	Hydrocarbon	
28	CO^+, (N_2^+), $(CO)^+$		Hydrocarbon (28) is 5 to 10 times hydrocarbon (27). When CO_2 (44) is high, CO (28) is also high.
29	$C_2H_3^+$, (N_2^+), $(CO)^+$		Abundance ratio of N13 is 0.3%. Abundance ratio of C13 is 1.1%.
30	NO^+		Appears immediately after evacuation of a contaminated vacuum system.
32	O_2^+		Air leak when 28:32=4:1.
35	C_1^+	Halogen type detergent	
37	$(C_1)^+$	Halogen type detergent	
39	$C_3H_3^+$	Hydrocarbon	
40	Ar^+, $C_3H_4^+$	Hydrocarbon, Ar	Abundance ratio of Ar in air is about 1%.
41 42	$C_3H_5^+$ $C_3H_6^+$	Hydrocarbon Hydrocarbon	C_3 type hydrocarbon appears at 36 to 44, especially much at 39, 41 and 43.
43	$C_3H_7^+$	Hydrocarbon	
44	CO_2^+	Hydrocarbon, CO_2	Some CO_2 peaks of C_{13} and O_{18} appear at 45 and 46
50	$C_4H_2^+$	Hydrocarbon, especially aromatic group	
51	$C_4H_3^+$	Hydrocarbon, especially aromatic group	
55 56 57	$C_4H_7^+$ $C_4H_7^+$ $C_4H_7^+$	Hydrocarbon Hydrocarbon Hydrocarbon	C_4 type hydrocarbon contains much 55 and 57.

15.7 Converting the Unit of Pressure

Pa (N/m^2)	bar (mmHg)	kg/cm^2	psi b/in^2	atm	Water column m(15°C)
1	10^{-5}	$1.01972\ 10^{-5}$	$1.45038\ 10^{-4}$	$9.86923\ 10^{-6}$	$1.02064\ 10^{-4}$
10^{+5}	1	1.01972	14.5038	0.986923	10.2064
$9.80665\ 10^{+4}$	0.980665	1	14.2233	0.967841	10.0090
$6.89476\ 10^{+3}$	$6.89476\ 10^{-2}$	$7.03070\ 10^{-2}$	1	$6.80460\ 10^{-2}$	0.703704
$1.01325\ 10^{+5}$	1.01325	1.03323	14.6959	1	10.3416
$9.79781\ 10^{+3}$	$9.79781\ 10^{-2}$	$9.99099\ 10^{-2}$	1.42105	$9.66969\ 10^{-2}$	1

15.8 Expression of pressure

Pressure value (Pa)	10^5	10^{-2}	10^{-1}	10^{-5}	10^{-8}
		Low vacuum LV	Medimum vacuum MV	High vacuum HV	Ultimate vacuum UHV	Extra high vacuum XHV
	Air	Viscous flow region	Medium flow region	Molecular flow region		
Pressure is ….	◎	High ←			→ Low	
	△	Poor ←			→ Good	
Vacuum level is …	×	Low ←			→ High	
	×	Poor ←			→ Good	

15.9 Supplementary Description of Unit of Current

The units of current, such as ion current and emission current, are important for a residual gas analyzer/process gas monitor. The units of current are briefly described below.

Current value (A)	Exponent	Expression	Unit
1	1×10^{0}	1 A	Ampere
0.001	1×10^{-3}	1 mA	Milliampere
0.000001	1×10^{-6}	1 μA	Microampere
0.000000001	1×10^{-9}	1 nA	Nanoampere
0.000000000001	1×10^{-12}	1 pA	Picoampere
0.000000000000001	1×10^{-15}	1 fA	Femtoampere

The residual gas analyzer/process gas monitor measure ion current on order of 0.1 μA to 0.1 pA. If the insulation resistance between the grid electrode (150 V) and the ion collector electrode (0 V) is 200 MΩ, the insulation may be held acceptable in normal sense, but in a micro-current measurement such as by an ionization gauge, a leakage current of 0.75 μA would flow from the grid electrode. Furthermore, ion current cannot be detected unless it is 1 μA or more because the direction is reverse to that of ion current.

Warranty

This instrument has been shipped after rigorous inspection at the factory, but if any trouble imputable to defects should occur, contact your local ULVAC representative or Components Division, ULVAC, Inc., Japan.

Troubles imputable to defects in material or workmanship within the warranty period will be corrected free of charge either by replacement or repair of defective parts.

- Warranty Period
  Twelve (12) months from the date of acceptance
- Scope of Warranty

(1) Products found defective on delivery (except those covered by insurance)

(2) Products that are used according to the standard specifications, such as measurement pressure, operating temperature range, operating power, etc. but do not meet key specifications

- Out of Warranty

(1) Products of which warranty period has expired

(2) Failures and troubles caused by natural disaster or force majeure, such as fire, earthquake, flood, etc.

(3) Failures and troubles caused by misuse, abuse or carelessness in operation

(4) Failures and troubles caused by unusual environment, such as high intensity electromagnetic field, radiation environment, high temperature, high humidity, etc.

(5) Failures and troubles caused by noise.

(6) Loss attributed to secondary troubles and indemnification against infringement on right

History of Revision

Date	Reason of revision
Sep 17, 2008	1st version

ULVAC Component Contamination Certificate

This form is a contamination certificate to be presented to ULVAC before requesting ULVAC to make repair/inspection of ULVAC components.
Please fill in this certificate and forward it to your local ULVAC representative along with component(s)when requesting repair or others.
Regarding components used in toxic gas or components deposited with reactive products, contact your local ULVAC representative before shipping component(s).

Name of product:
Model name :
Serial No. :
Application :
Request to ULVAC _____
Trouble symptom _____
Note _____

Contaminant (Check ☐ whichever applicable)

☐ We certify that the product above is not contaminated with toxic substance(s).

☐ The product above is contaminated with the following toxic substance(s).

	Name of contaminant (molecular form)	Characteristics
1		
2		
3		
4		
5		

To: ULVAC, Inc. ____,_____
Name of personnel in charge: _____
Division : _____
Name of your company : _____
Phone : _____
Fax : _____
E-mail : _____

* The responsibility for accidents that may be caused by contaminant in transit to ULVAC lies with the user (shipper). So be careful in packing. ULVAC may decline your request for repair depending on the type of contaminant and degree of contamination and return it to you.

By ULVAC, Inc. MSDS request: yes/no	Signed by	
ULVAC job No.		