Plasma Dry Cleaner

PDC610

Instruction Manual

First version

Thank you for your selecting Yamato Scientific's "plasma dry cleaner".
To ensure proper handling of the machine, please read this instruction manual and the warranty thoroughly. After reading the manual, please keep it together with the warranty in a safe place where it is available any time necessary.

⚠ WARNING: Prior to using the product, carefully read all warning instructions contained in the manual and understand them fully.

YAMATO SCIENTIFIC CO., LTD.

This paper has been printed on recycled paper.

Contents

1. Safety precautions

Description of Warning Symbols

About pictograms

A variety of pictograms are indicated in this operating instruction and on products for safe operation. Possible results from improper operation ignoring them are as follows.

Be sure to fully understand the descriptions below before proceeding to the text.

Warning Indicates a situation which may result in death or serious injury (Note 1.)

Caution Indicates a situation which may result in minor injury (Note 2) and property damages (Note 3.)

（Note 1）Serious injury means a wound, an electrical shock, a bone fracture or intoxication that may leave after effects or require hospitalization or outpatient visits for a long time.

（Note 2）Minor injury means a wound or an electrical shock that does not require hospitalization or outpatient visits for a long time.

（Note 3）Property damage means damage to facilities, devices and buildings or other properties.

Meanings of pictograms

This pictogram indicates a matter that encourages the user to adhere to warning (“caution” included).
Specific description of warning is indicated near this pictogram.

This pictogram indicates prohibitions
Specific prohibition is indicated near this pictogram.

This pictogram indicates matters that the user must perform
Specific instruction is indicated near this pictogram.

1. Safety precautions

A List of Symbols

Warning

General warnings

Danger!: High voltage

Danger!: High temperature

Danger!: Moving part

Danger!: Hazard of explosion

Caution

General cautions

Electrical shock!

Burning!

Prohibitions

General bans

Do not disassemble

Do not touch

Compulsions

General compulsions

Connect ground wire

Install levelly

Pull out the power plug

Periodical inspection

1. Safety precautions

Warning and Caution

⚠ Warning

1. Never use the machine in atmosphere containing ignitable and explosive gases.

Never use the machine in atmosphere containing ignitable and explosive gases. The machine is not of explosion-proof construction. Turning on and off the switches and operating the machine will produce sparks, which may become a cause of a fire or explosion. (See "List of Hazardous Substances.")

2. Never use explosive and flammable substances.

Never use explosive and flammable substances and substances containing such substances. The machine is not equipped with safety features against such substances. They are a cause of explosion and fire.

3. Never use the machine in abnormal conditions.

If you notice smoke, offensive odor or other problems, immediately turn off the circuit breaker of the machine and also turn off the power of the distribution panel on the building side. They are a cause of a fire and electric shock.

4. Never disassemble or modify the machine.

The machine must not be disassembled or modified by the user. Unauthorized disassembly and modification are a cause of failure, fire, electric shock and other accidents.

5. Handling of the power cords.

Do not use bundled power cords. Such a way of use may cause the cords to overheat to cause a fire.

Do not machine power cords or bend, twist or pull them by undue force. Hazard of a fire and electric shock.

Do not damage power cords by for example placing them under a desk or chair or clamping them by devices. Hazard of a fire and electric shock.

Do not bring power cords near heating devices such as a heater. The coating of the cords will be burnt to cause a fire or electric shock.

If a power cord is damaged (core wires exposed or broken), immediately turn off the power of the machine and also turn off the source power supply. Then request the dealer for replacement of the cord. If such damaged cords are used, a fire or electric shock may result.

Use only one power cord. Never join two or more power cords.

Depending on the connecting method, screws may be loosened and cause a fire or an electrical shock.

6. Be sure to use the specified reaction gas.

Be sure to use the specified processing gas (argon gas, oxygen optional). If other gas is used, the actual flow rate becomes different from the indicated flow rate. Also other problems such as damage to products and insufficient cleaning may happen.

2. Before operating the unit

Precautions for Installation

⚠ Warning

1. Be sure to connect the ground wire.

- To prevent electric shock accidents due to fault current, be sure to connect the ground wire to the ground terminal on the building side. This machine falls in the category of Class D Ground Work.
- Never connect the ground wire to a gas pipe, water pipe, ground wire of a telephone or lightning conductor. Hazard of a fire and electric shock.

2. Select a suitable installation site.

Do not install the machine in the following places:

- An unstable place.
- A place where flammable or corrosive gas is produced.
- A place where ambient temperature rises above 35℃.
- A place where temperature changes largely.
- A place filled with dust or a humid place.
- A place under direct sunlight.
- A place that is subjected to vibrations.

3. Install the machine on a level foundation.

Install the machine on a level foundation. If the machine is not in contact with the floor uniformly, vibration and noise may be produced. Also unexpected troubles or failures may occur.

4. Use a suitable distribution panel.

Use a distribution panel that is suitable for the electric rating of the machine.
Electric rating: 3-phase, 200 VAC (Differ depending on the region. See page 19.), 15 A, 50/60 Hz
If the capacity is insufficient or the machine is used on a line to which other equipment is connected, the machine may not function properly or the circuit breaker in the distribution panel may operate.

Applications

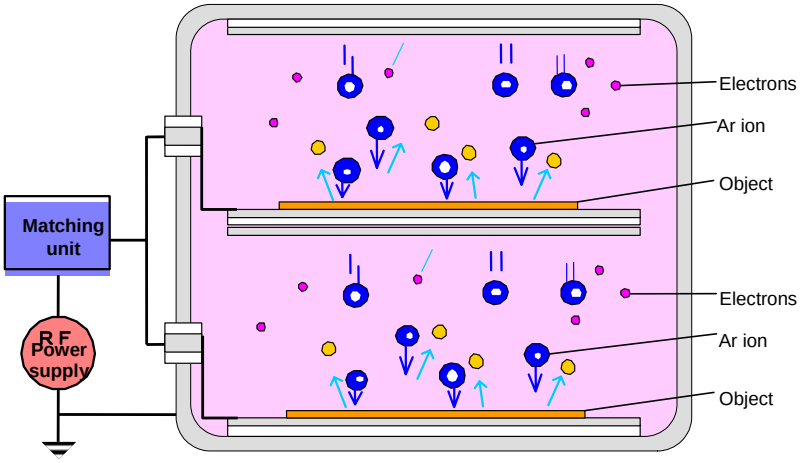
The unit is used to plasma-process work pieces to modify their surfaces or to clean them.
The unit has two modes (RIE and DP) to support various applications.

Application of the RIE mode

This mode is used to clean objects whose soil contains inorganic matters as well as organic ones, or to modify surfaces.
When Ar gas plasma process is performed in the RIE mode, the surface of a work piece put on the electrode surface will be cleaned with physical action caused by ions accelerated toward it and hit against it, which is the main feature of this mode. (Because the work piece on the electrode is processed with Ar ions hit from the above, only its top surface will be processed. The range in which Ar gas is accelerated is several millimeters above the electrode.)

＜Examples of applications＞

- Improving adhesiveness and surface modification of different materials
- Light etching process
- Preprocessing of implementation board bonding
- Preprocessing of plastic package
- Preprocessing of print board plating
- Processing of part for LED related markets
- Cleaning of electronic parts
- Cleaning of optical parts, dies, machine parts and other precision parts
- Modification of fluoride or other resin surfaces

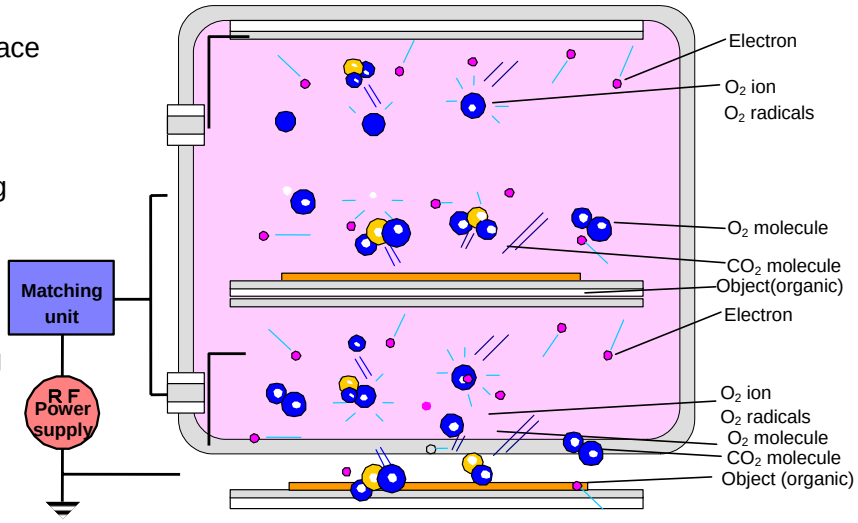


Application of the DP mode

This mode is used to clean objects whose soil contains organic ones, or to modify surfaces.
When O_2 gas plasma process is conducted in the DP mode, O_2 plasma acts to organic matters on the surface of the object, then those organic matters and O_2 radicals will be converted chemically in vacuum to clean the surface. Because O_2 ions and O_2 radicals in the plasma spread non-directionally between the electrodes in the DP mode, the whole surface of the work piece between the electrodes and that contacts the plasma will be processed.

＜Examples of applications＞

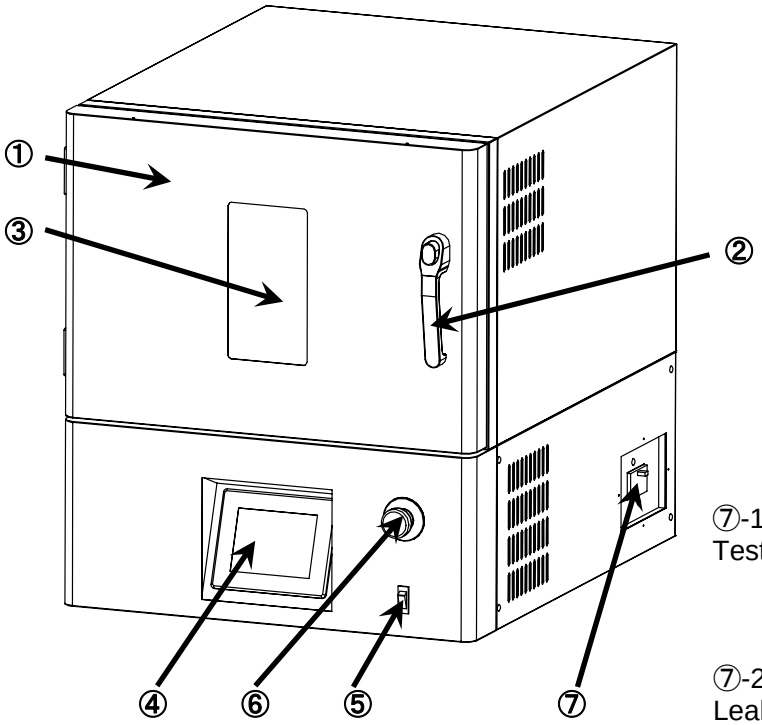
- Improving adhesiveness and surface modification of different materials
- Light ashing process
- Preprocessing of plastic package
- Preprocessing of print board plating
- Cleaning of electronic parts
- Cleaning of optical parts, dies, machine parts and other precision parts
- Peeling off of resists or removing residue after wetting process
- Modification of resin surfaces

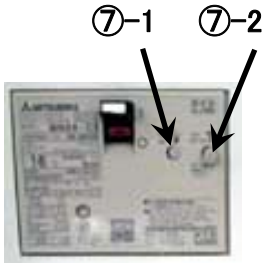


4. COMPONENTS AND FUNCTIONS

Main Unit

Front of the machine





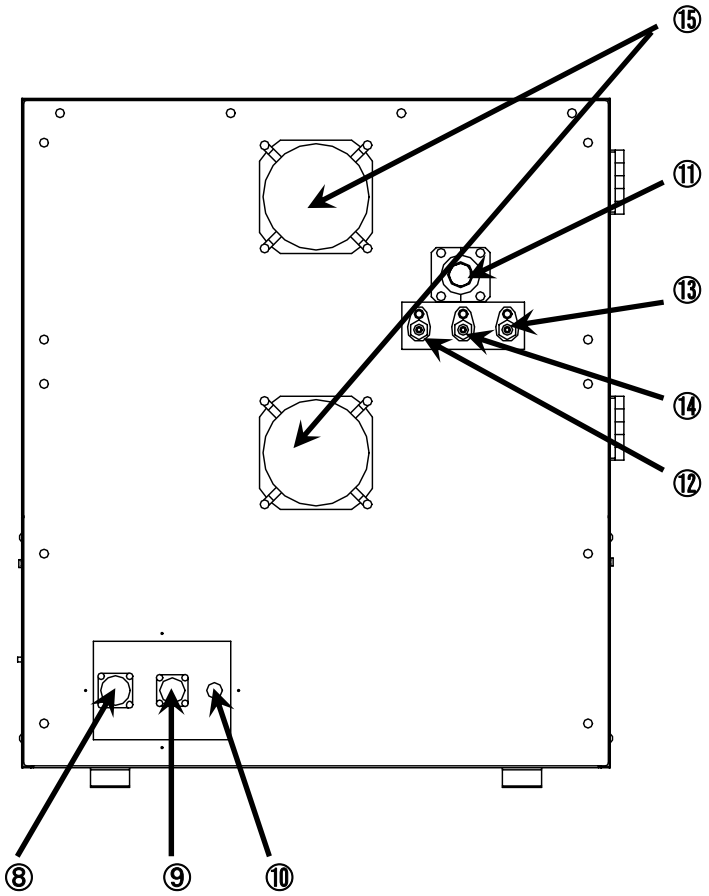
⑦-1 Test button : Use this during periodic inspections to check if the earth leakage breaker is functioning properly.

⑦-2 Leakage indicator : When leakage occurs, this button pops out.

①	Door	: This door is manually opened sideways.
②	Grip	: Used to open and close the door.
③	Check window	: This window is used to check plasma status.
④	Touch panel	: Used to operate various keys and show various information.
⑤	Operation power switch	: When this button is pressed, electricity is applied to the touch panel and other parts of the machine to set the machine ready to run.
⑥	Emergency stop switch	: Press this button when an emergency situation occurs. When this button is pressed, the RF power, vacuum pump and operation panel power are turned off. To reset the button, turn it in the arrow direction.
⑦	Earth leakage breaker	: When this breaker is turned on, electricity is applied to the machine. If leakage exceeding 30 mA or overcurrent exceeding 16 A flows, it cuts off the current to protect the machine.

4. COMPONENTS AND FUNCTIONS

Back of the main unit



⑧	Connector for power cord	:	Connect this to the distribution panel on the building side. (A 3-m cord is attached for connection.)
⑨	Connector for vacuum pump	:	Connect the cable from the vacuum pump.
⑩	Ground terminal	:	Use this to ground the machine by a line other than the attached power cord or to ground measuring instruments.
⑪	Vacuum nozzle	:	Connect the vacuum pump with the attached flexible tube.
⑫	Nitrogen（N_2）gas connector	:	Connect piping from the N_2 gas cylinder. Adjust the pressure to the range of 0.2 MPa to 0.3 MPa.
⑬	Argon (Ar) gas connector	:	Connect piping from the Ar gas cylinder. Adjust the pressure to the range of 0.15 MPa to 0.2 MPa.
⑭	Oxygen (O_2) gas connector	:	Connect piping from the O_2 gas cylinder. Adjust the pressure to the range of 0.15 MPa to 0.2 MPa
⑮	Cooling fan	:	Cools the inside of the enclosure. Provide a space of more than 10 cm around the enclosure so that the airflow will not be disturbed.

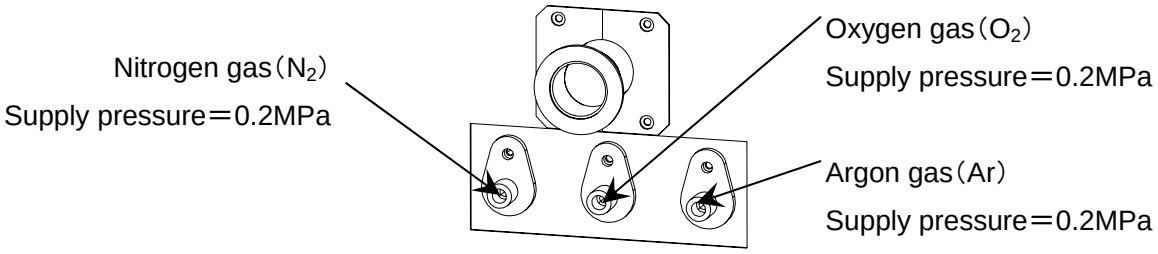
5. INSTALLATION METHOD

Required Equipment / Methods to Connect Cables and Tubes

1) Gas piping

Gas piping up to the machine must be provided by the user. Connect piping to the gas supply ports on the back of the machine and supply gases at the specified pressures. Use the included 1/4-inch flare-less joints (attached in the coupling portion on rear side) the to connect the machine and the piping and tighten them as described below.

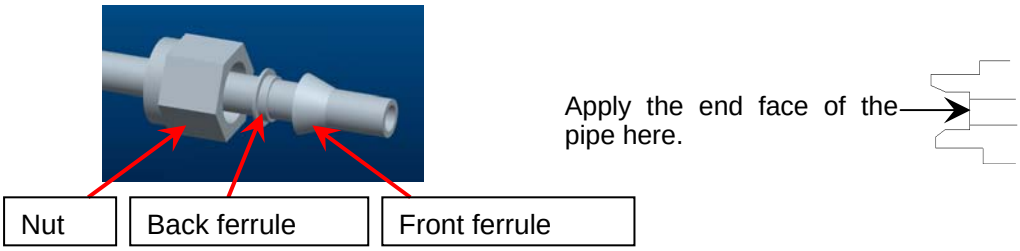
（1）Gas supply nozzle locations and supply pressures



（2）Flare-less joint tightening procedure

① Pass a nut, back ferrule and front ferrule(attached in the coupling portion on rear side) to the pipe.

② Insert the pipe to the joint to the specified depth.



③ Tighten the nut strongly with fingers.

Exercise care so that the pipe will not be bent to become resistance.

④ Using a wrench, tighten the nut one turn and a quarter from the finger-tightened point.

The left side figure shows the correctly tightened pipe.

2） Electricity connection and supply

The wiring from the building side distribution panel to the machine must be laid by the user. The machine requires an electric capacity of 3-phase, 200 VAC (differ depending on the region. See page 19), 15 A or more. Connect the red, white and black cables to the R, S and T phases respectively. **The green cable is for grounding. Connect it to the terminal of Class D Ground Work.**

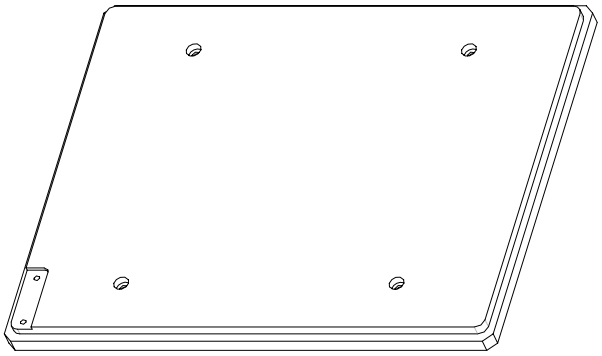
3） Vacuum pump

Install the vacuum pump by the following procedure:

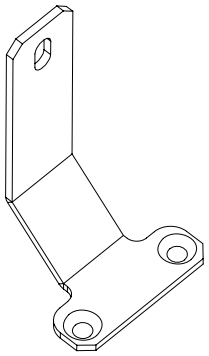
① Referring to the attached vacuum pump instruction manual, fill oil to the vacuum pump.
② Place the vacuum pump on a horizontal floor or sturdy table.
③ Connect the power cable for vacuum pump to the vacuum pump connector of the machine.
④ Install the oil mist filter on the vacuum pump using a clamp.
⑤ Cap the suction port of the vacuum pump and turn on the switch on the operation panel momentarily. When the cap is sucked, the pump is running in the correct direction. If the cap is blown out, it is running in a reverse direction.
⑥ If the pump runs in a reverse direction, exchange two out of three power cables connected to the distribution panel.
⑦ Connect the nozzle and the vacuum pump with the included flexible tube and NW25 clamp.

6. INSTALLING ELECTRODES

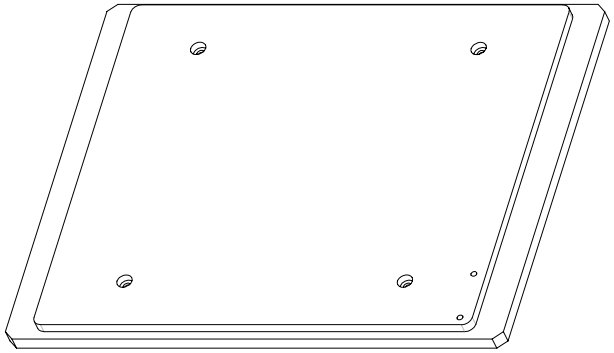
List of electrode related accessories



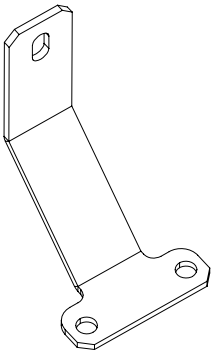
① Lower electrode x 1



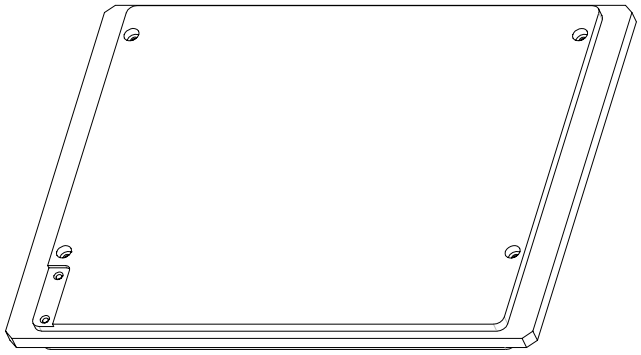
② Lower electrode fixing clamp



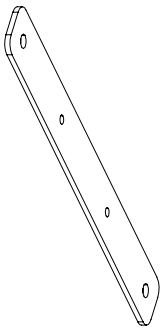
③ Upper electrode x 1



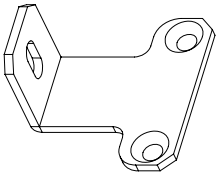
④ Upper electrode fixing clamp



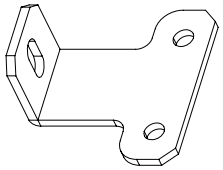
⑤ Shelf board electrode x 2



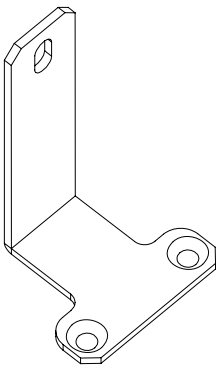
⑥ Feed through connecting plate
（used for three-stage configuration）



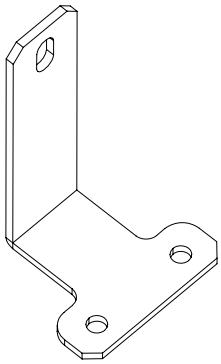
⑩ RIE fixing clamp for shelf board electrode (used for 3-stage configuration）



⑨ DP fixing clamp for shelf board electrode
(used for 3-stage configuration）



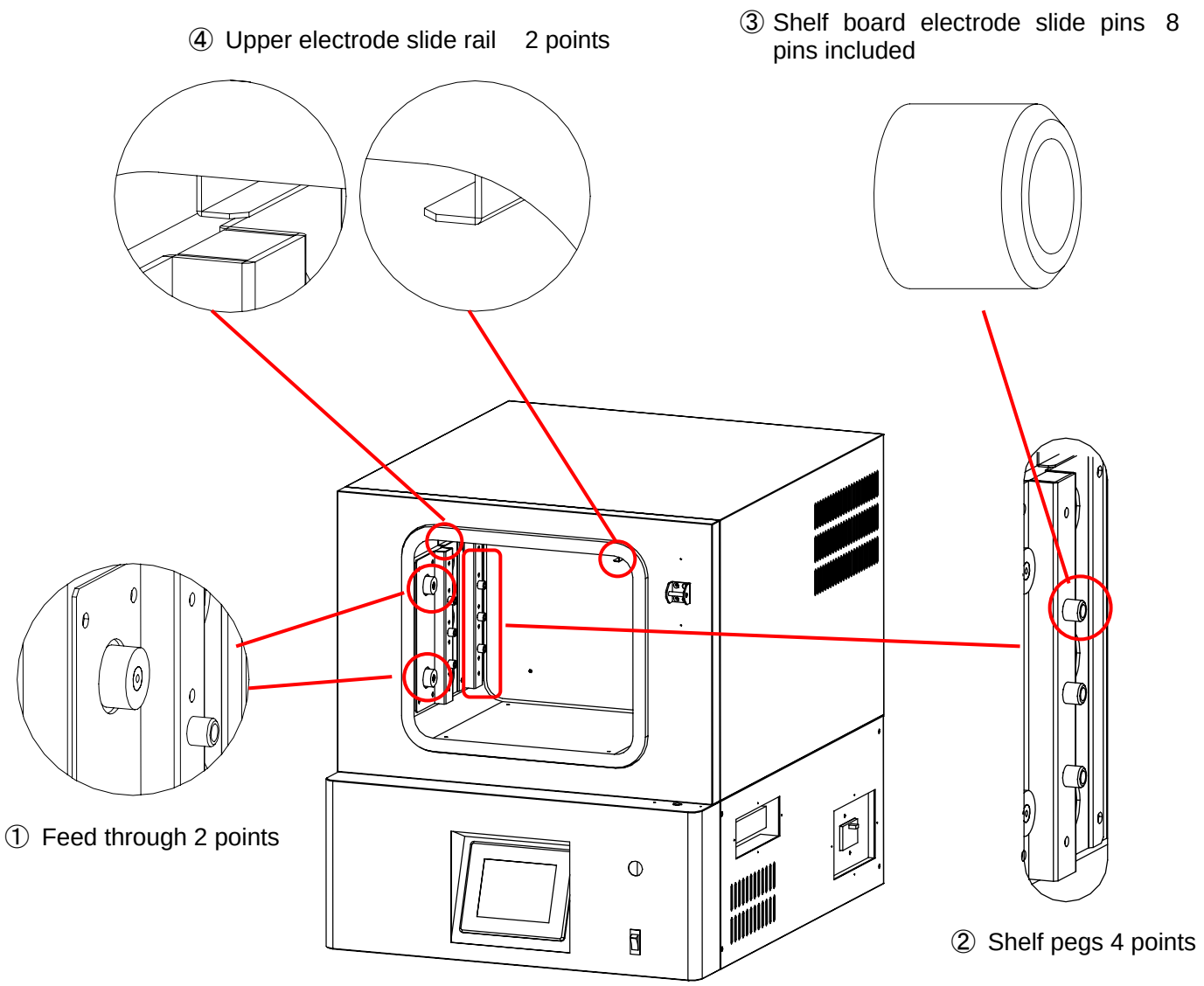
⑧ RIE fixing clamp for shelf board electrode (used for 2-stage configuration）



⑦ DP fixing clamp for shelf board electrode (used for 2-stage configuration）

6. INSTALLING ELECTRODES

Internal structure and of the chamber and parts names



①	Feed through	:	High frequency wave is supplied here.
②	Shelf peg	:	Cable from the vacuum pump is connected here.
③	Shelf board electrode slide pin	:	This is used when earthing from a source other than the included power cord or for earthing measuring devices.
④	Upper electrode slide rail	:	Connected to the vacuum pump with the included flexible tube.

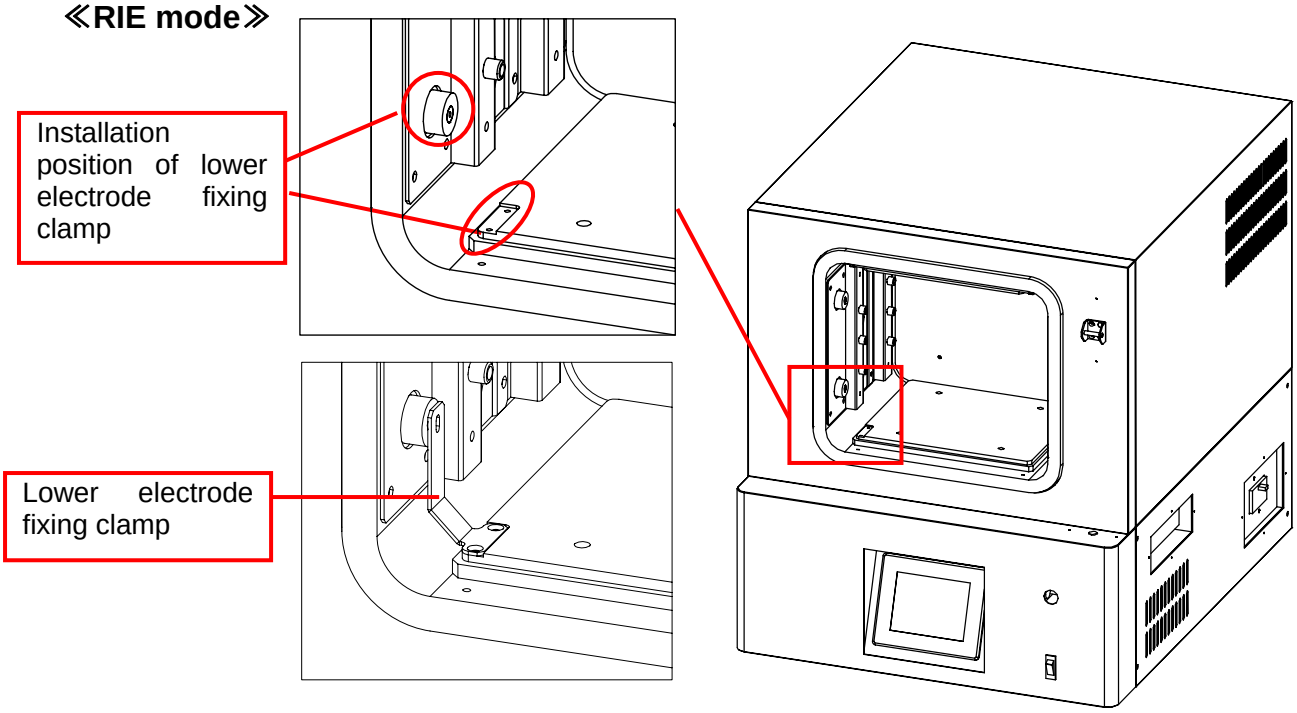
6. INSTALLING ELECTRODES

When one-stage electrode is used

Installing electrodes

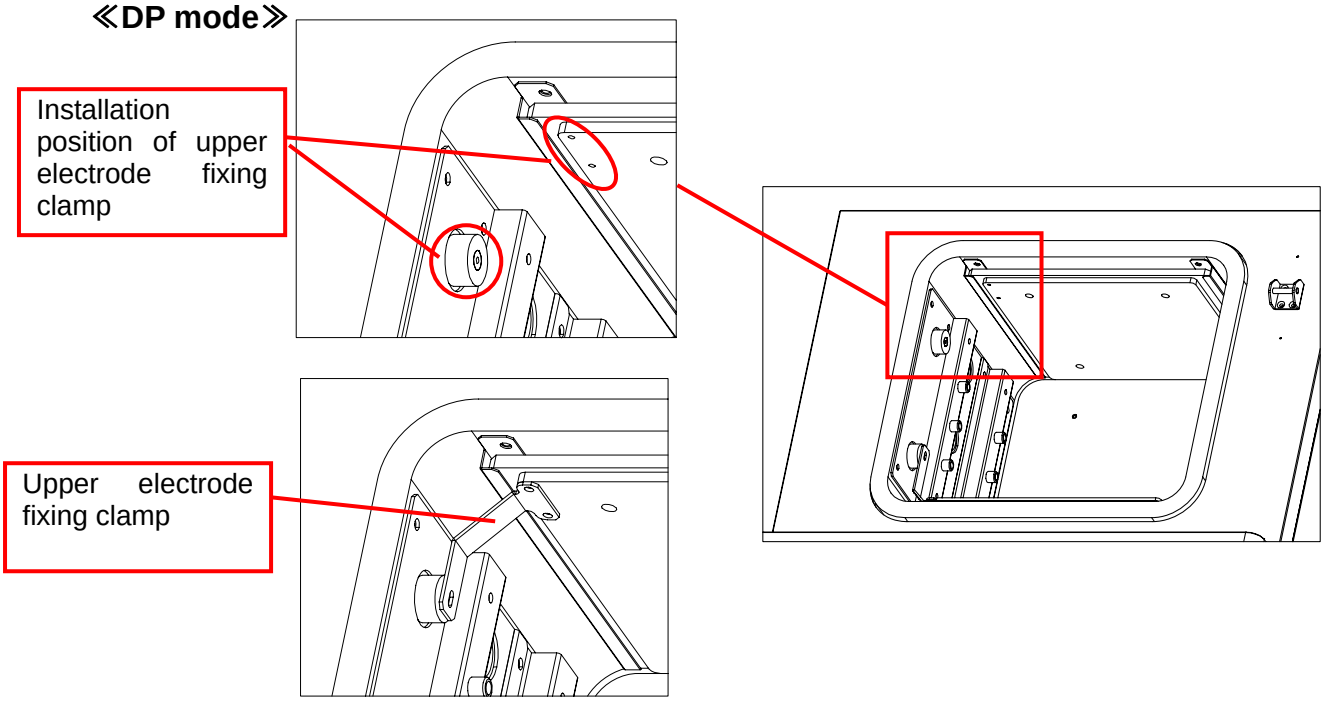
i) Insert the upper electrode into the slide rail.
ii) Install the lower electrode onto the bottom of the chamber.

≪RIE mode≫



※ Connect the feed through and the lower electrode with the lower electrode fixing clamp.（Flat head screw M4×5, truss screws M4×6）
At this time, install M4×6 truss screws (included) to the screw points of the upper feed through that is not used.

≪DP mode≫



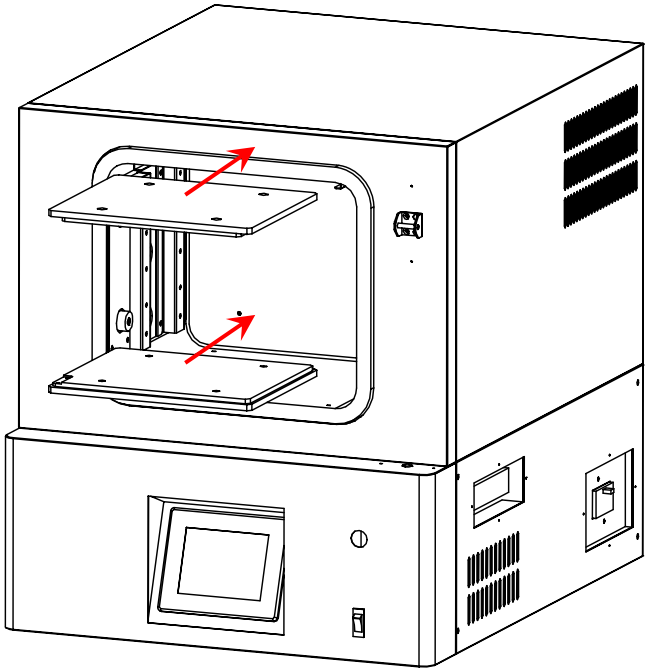
※ Connect the feed through and the upper electrode with the upper electrode fixing clamp.（Truss screw M4×6）
At this time, install M4×6 truss screws (included) to the screw points of the lower feed through that is not used.

6. INSTALLING ELECTRODES

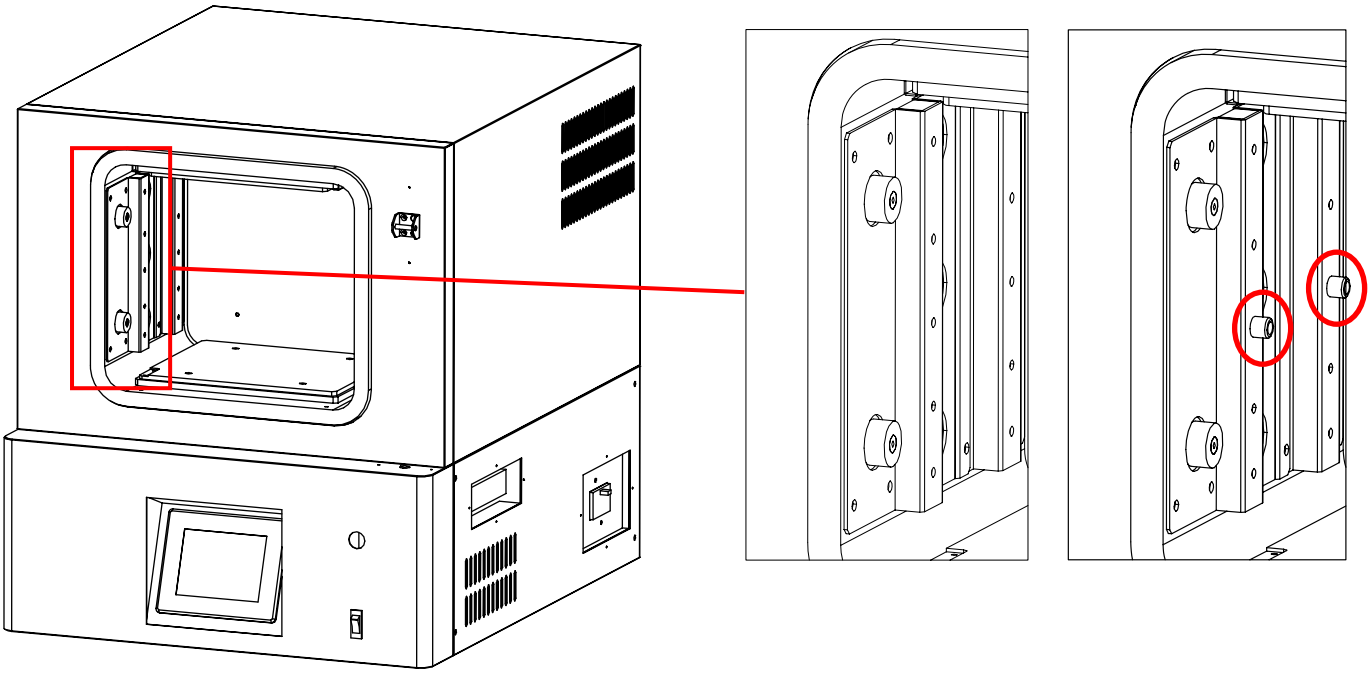
When 2-stage electrode is used（installation of electrodes）

ⅰ） Insert the upper electrode into the slide rail.

ⅱ） Install the lower electrode onto the bottom of the chamber.



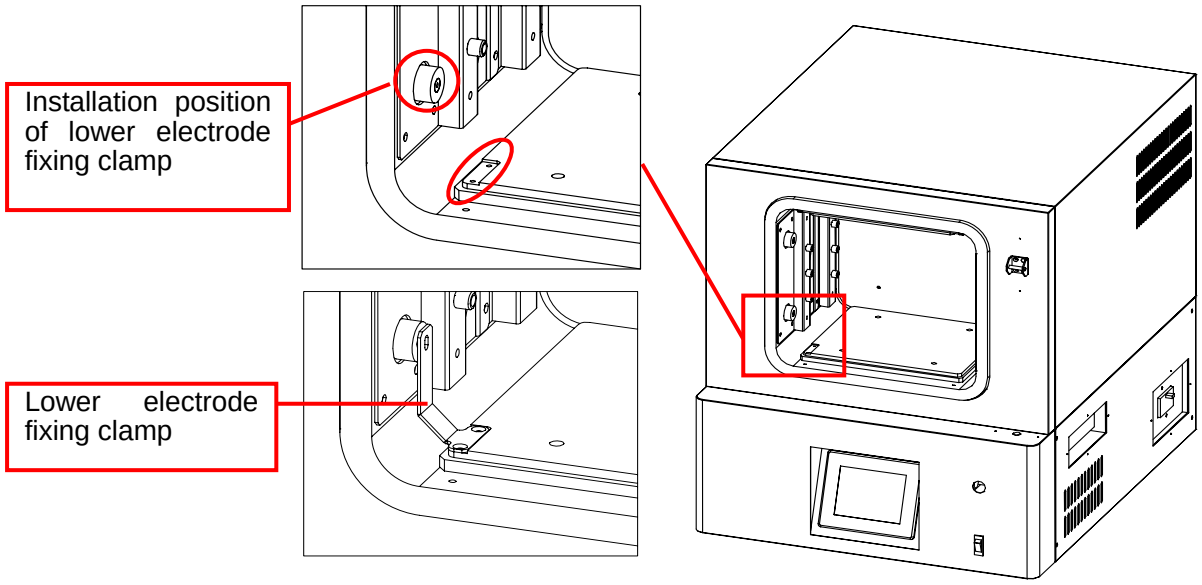
ⅲ） Install shelf board electrode slide pins into the screw holes in the middle of each of shelf pegs. (CAP bolts M4×10) （Right/left Four points in total）



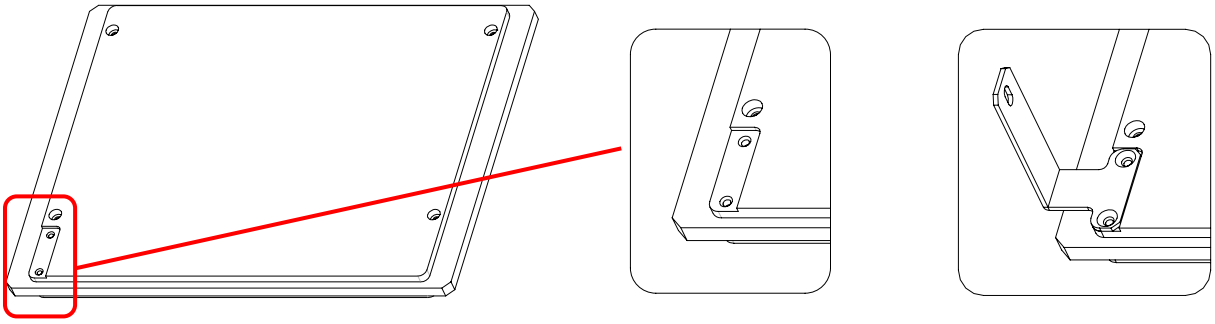
6. INSTALLING ELECTRODES

When 2-stage electrode is used（RIE mode）

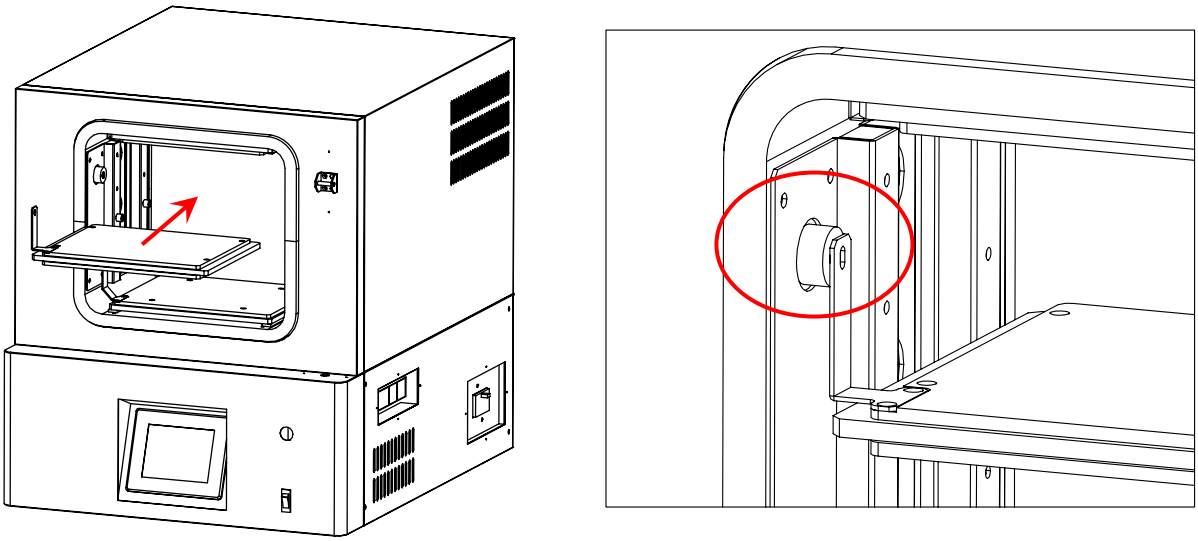
① Connect the feed through and the lower electrode with the lower electrode fixing clamp.（Flat head screws M4×5, truss screws M4×6）



② Install the RIE fixing clamp for shelf board electrode at the point of the shelf board electrode shown in the diagram below. (Flat head screw M4×5）



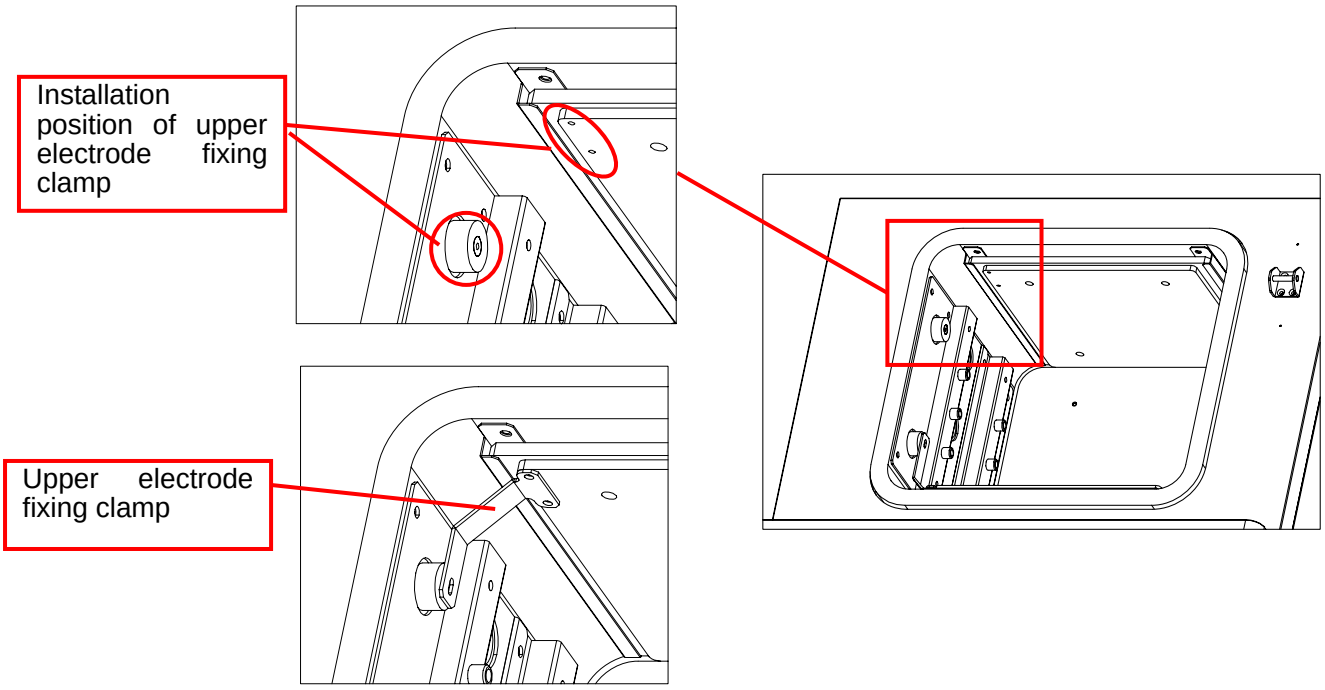
③ Insert the shelf board electrode into the chamber and connect the feed through and the RIE fixing clamp for the shelf board electrode. （Truss screw M4×6）



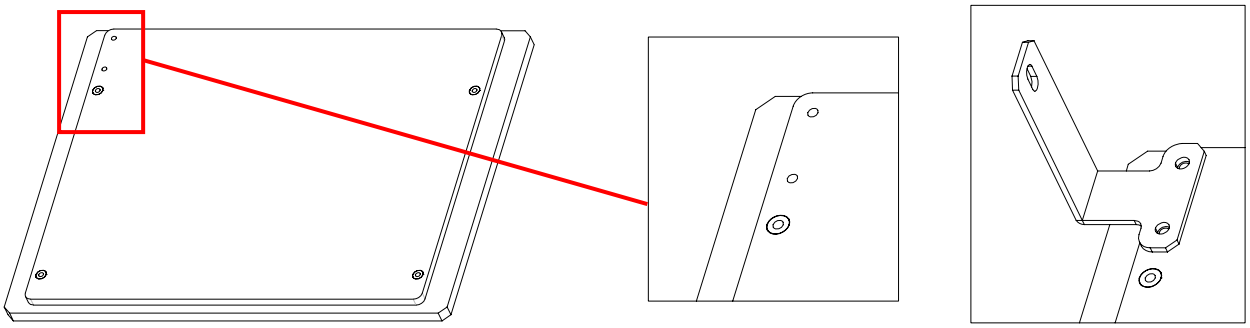
6. INSTALLING ELECTRODES

When 2-stage electrode is used（DP mode）

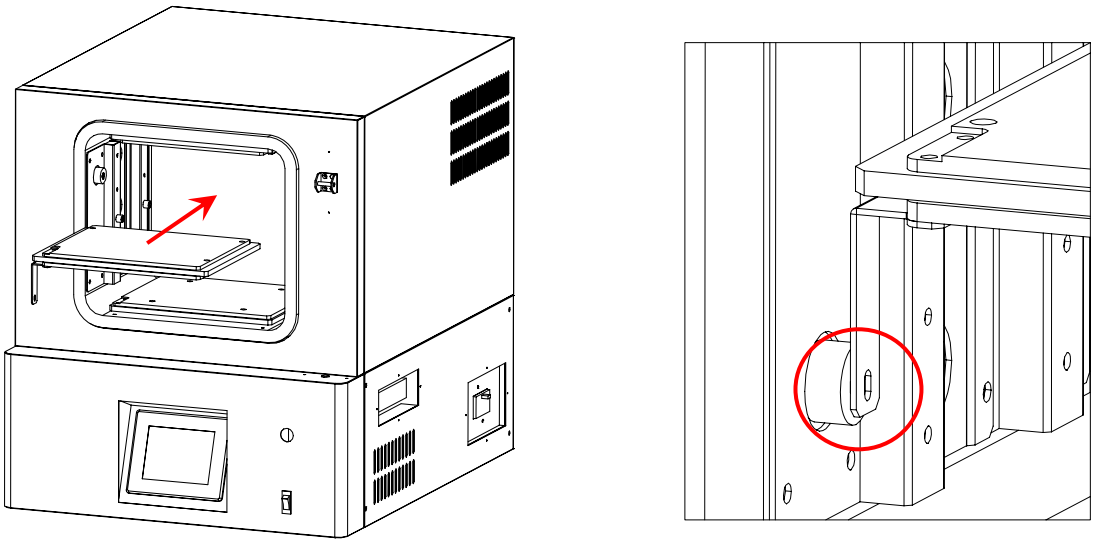
① Connect the feed through and the upper electrode with the upper electrode fixing clamp. (Truss screws M4 × 6)



② Install the DP fixing clamp for shelf board electrode at the point of the shelf board electrode shown in the diagram below. (Truss screw M4 × 6)



③ Insert the shelf board electrode into the chamber and connect the feed through and the RIE fixing clamp for the shelf board electrode. (Truss screws M4 × 6）

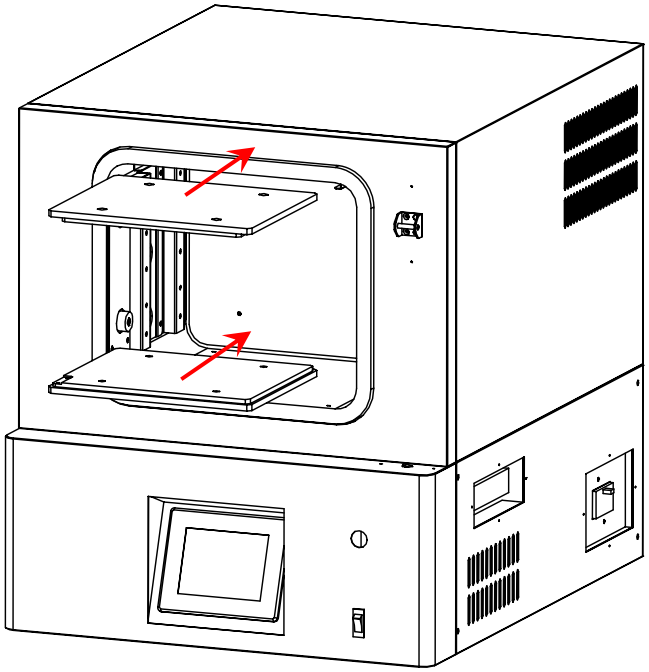


6. INSTALLING ELECTRODES

When 3-stage electrode is used（installation of electrodes）

ⅰ） Insert the upper electrode into the slide rail.

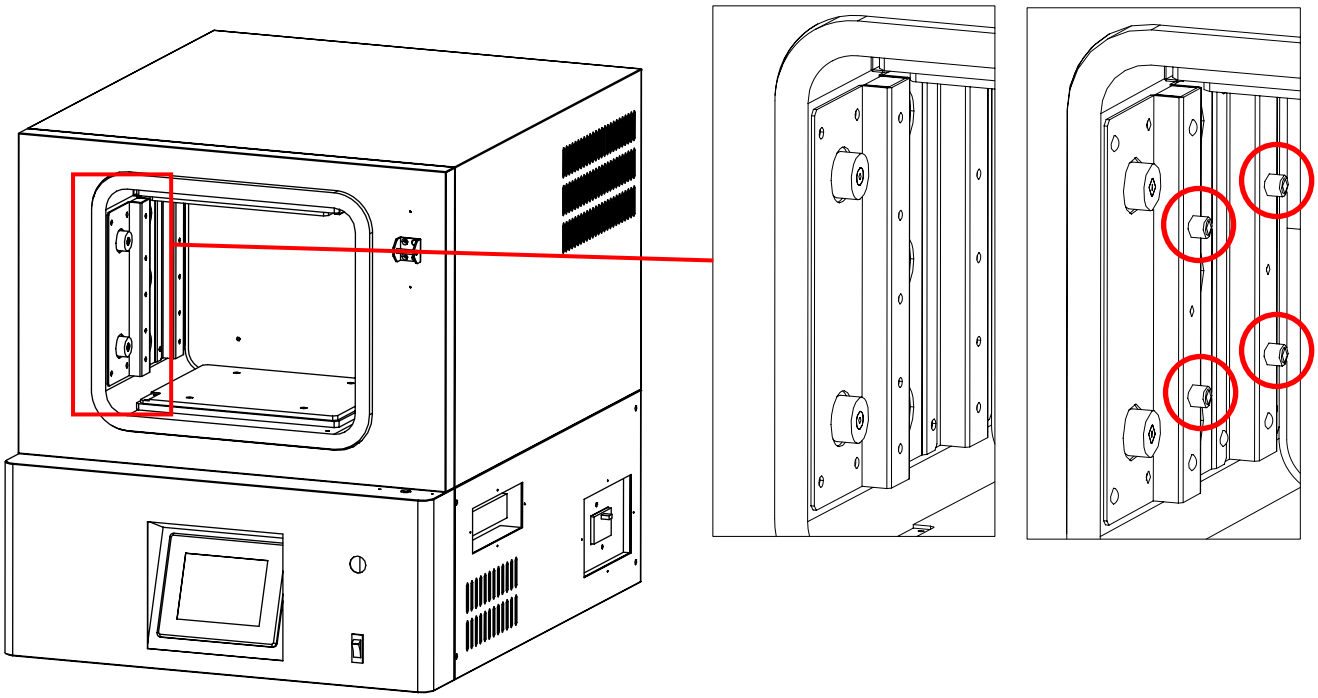
ⅱ） Install the lower electrode onto the bottom of the chamber.



ⅲ） Install shelf board electrode slide pins into upper and lower screw holes on each of shelf pegs.（CAP bolts M4×10）

At this time, install truss screws (M4×6) to those unused screw holes.

（Right/left Eight points in total）

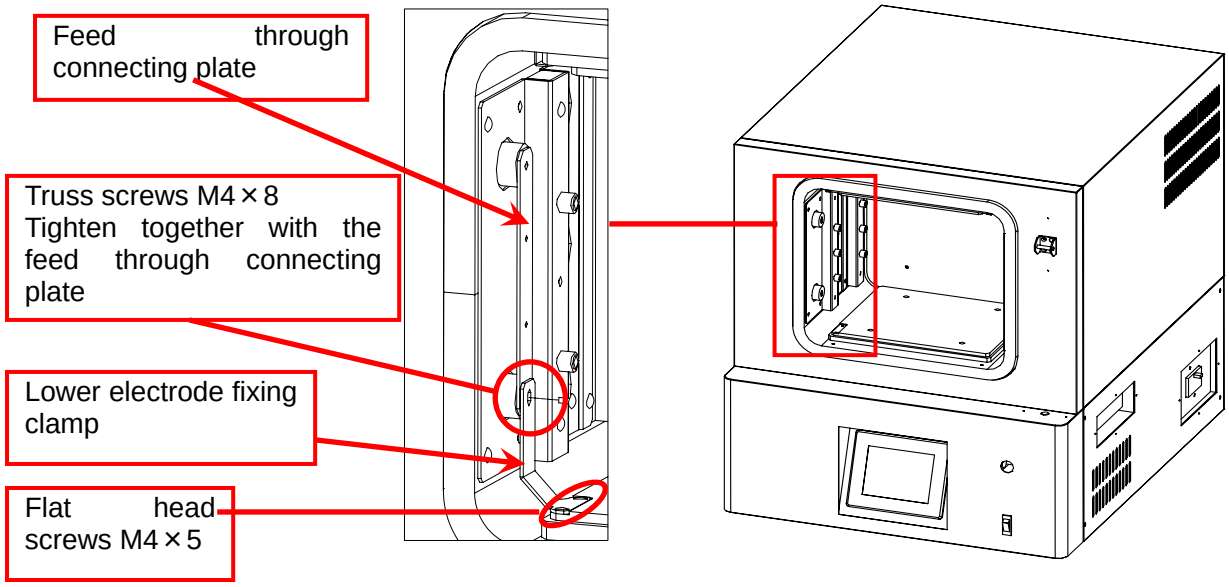


6. INSTALLING ELECTRODES

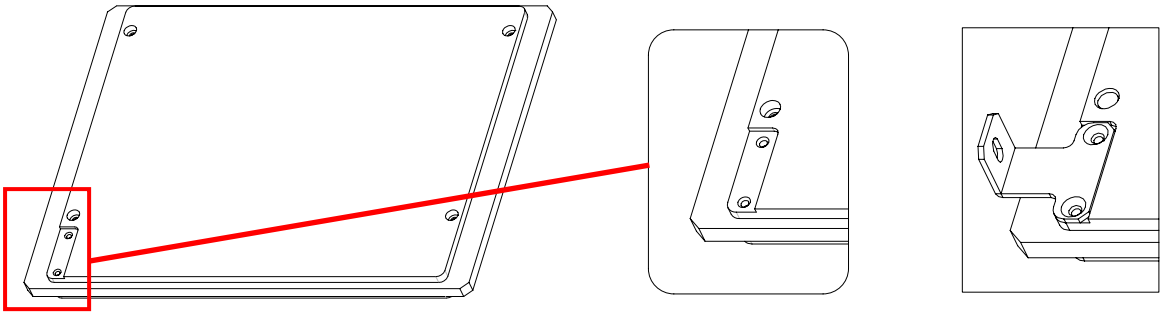
When 3-stage electrode is used（RIE mode）

≪RIE mode≫

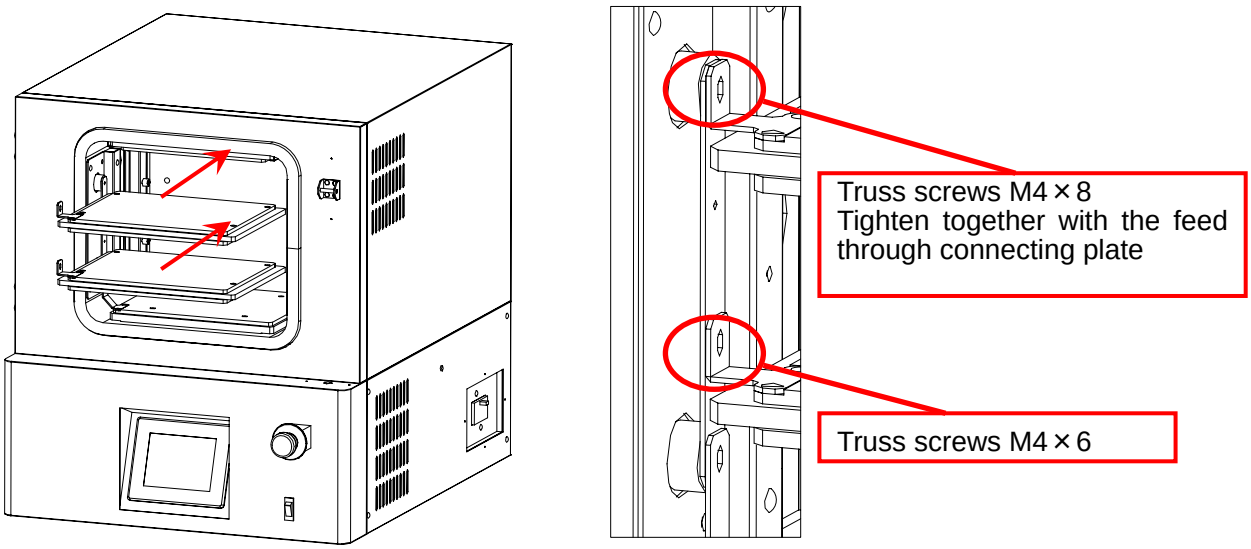
① Install the lower electrode fixing clamp to the lower electrode. (Flat head screws M4×5)
② Tighten the feed through connecting plate and the lower electrode fixing clamp altogether to the feed through.（Truss screws M4×8）



③ Install the RIE fixing clamp for shelf board electrode at the point of the shelf board electrode shown in the diagram below.



④ Insert the shelf board electrode into the chamber and connect it to the feed through. (Truss screws M4×6, M4×8）

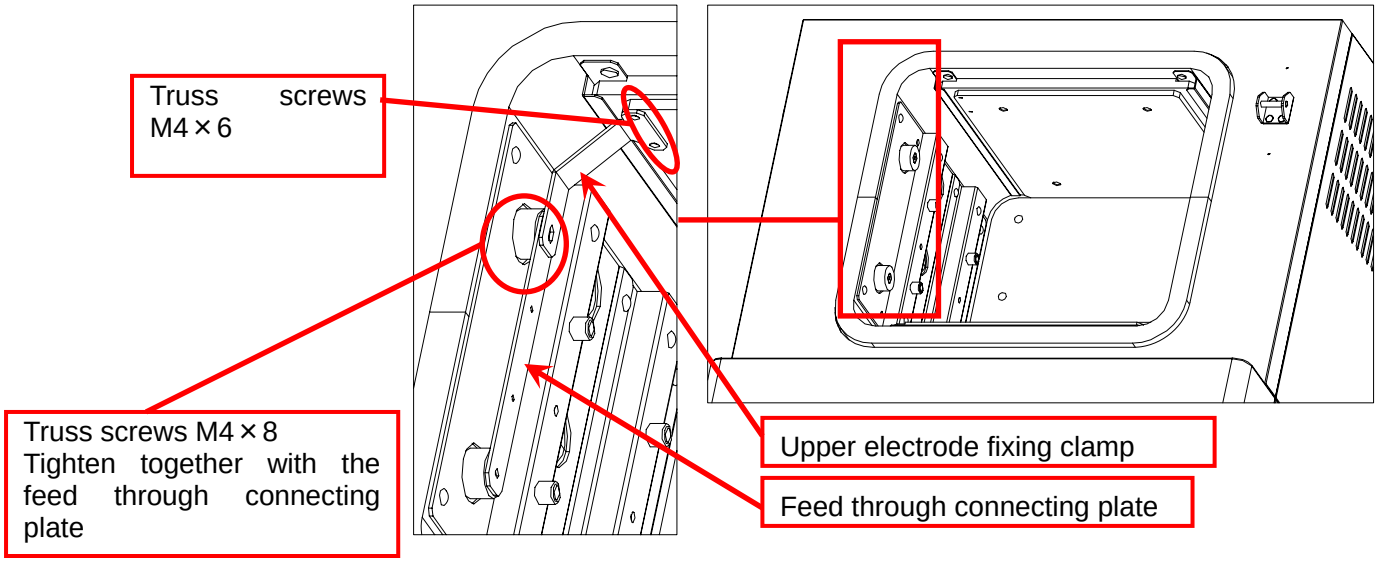


6. INSTALLING ELECTRODES

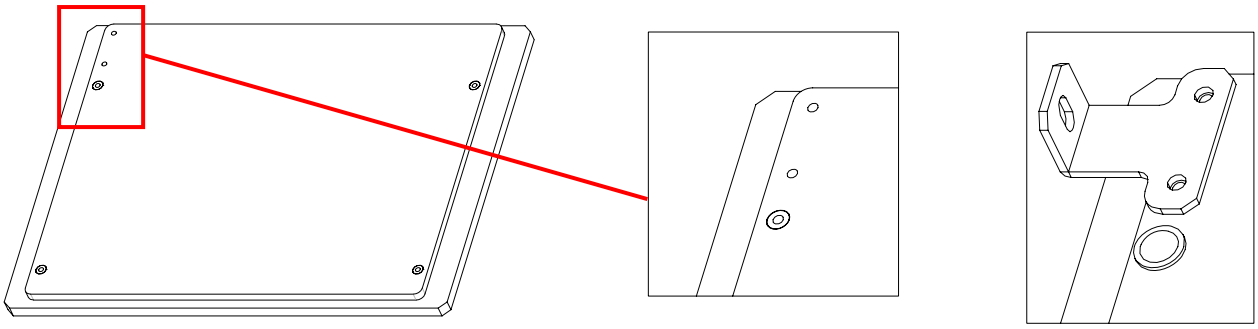
When 3-stage electrode is used（DP mode）

≪DP mode≫

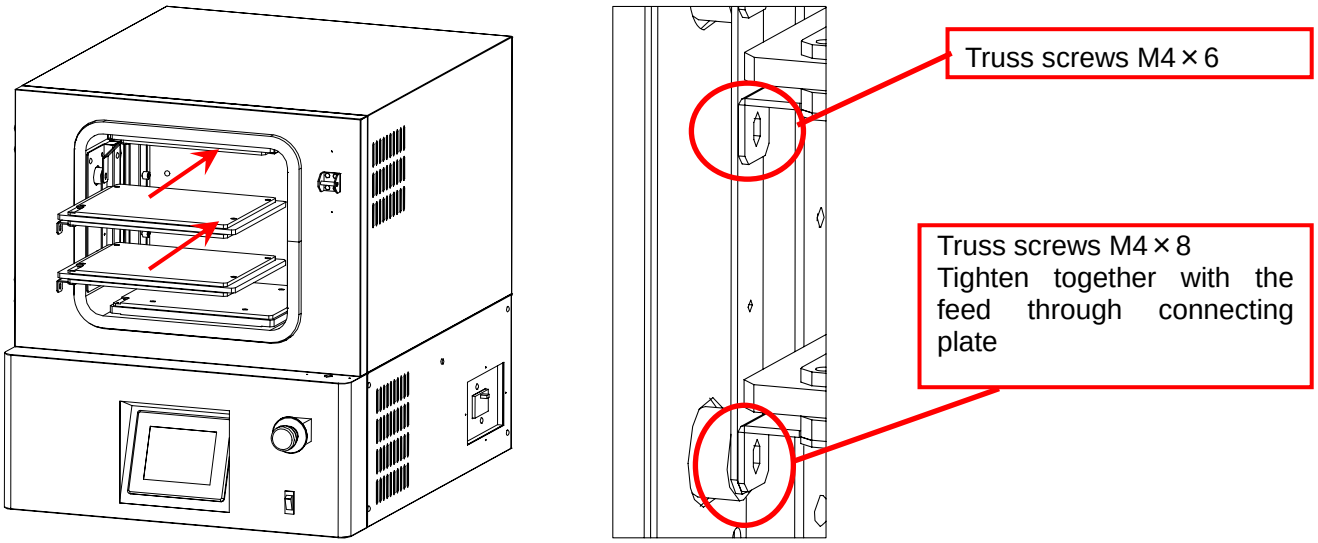
① Install the upper electrode fixing clamp to the upper electrode. (Truss screws M4 × 6)
② Tighten the feed through connecting plate and the upper electrode fixing clamp altogether to the feed through.（Truss screws M4 × 8）



③ Install the DP fixing clamp for shelf board electrode at the point of the shelf board electrode shown in the diagram below. (Truss screws M4 × 6)



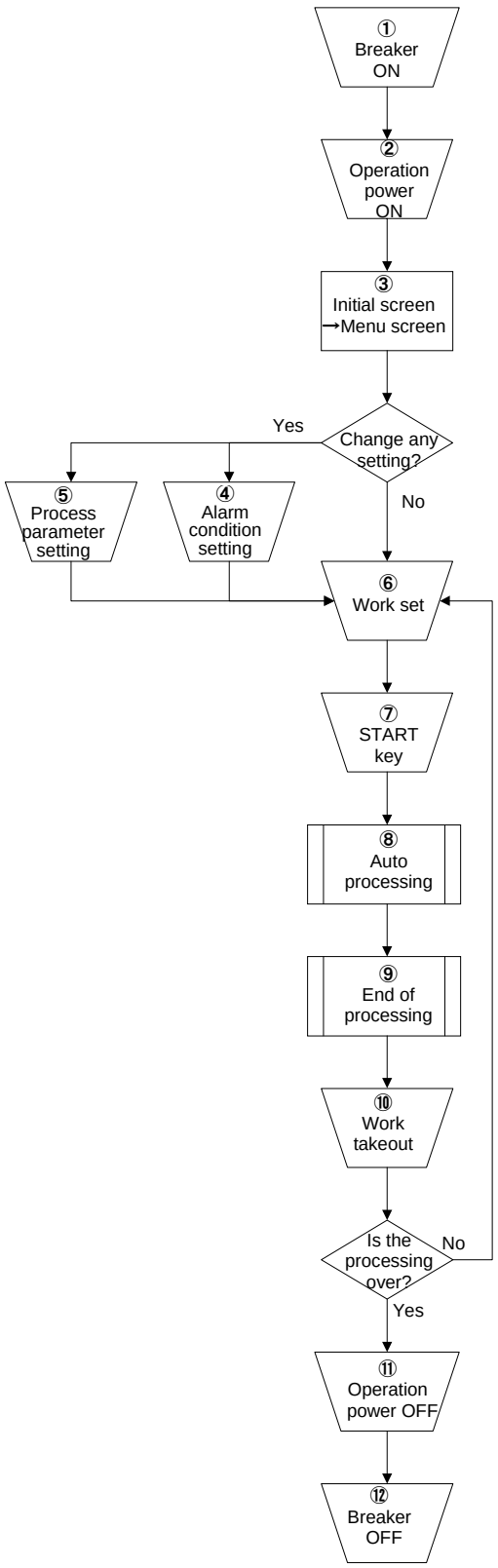
④ Insert the shelf board electrode into the chamber and connect it to the feed through.（Truss screws M4 × 6, M4 × 8）



7. RUNNING PROCEDURE

Operation in Auto Run

The operation and the setting items in the auto run are outlined below.



① Turn on the breaker to power on the machine.

② When the operation power is turned on, the operation panel and the pump are turned on to set the machine ready to run.

③ After the operation power was turned on, the initial screen will be shown for several seconds. During this period, the controller performs initial setting. When the initial setting is over, the processing screen will appear.

④ Set gas flow rates, RF power and RF processing time. If they need not be changed from the previous setting, they need not be set.

⑤ Set alarm conditions such as the RF power permissible fluctuation range and gas flow rate permissible fluctuation ranges. If they need not be changed from the previous setting, they need not be set.

⑥ Set the work in the chamber and close the door.

⑦ Press the START key.

⑧ The controller automatically performs the following processes according to the set parameters. Evacuating to set pressure → gas supply start → diffusion → RF on → processing time over → evacuating to set pressure → vacuum source valve close → N_2 purge → chamber to atmospheric pressure

⑨ When the processing is over, the end of process is displayed.

⑩ Take out the work. (To start the next process, set the work in the chamber and press the START key.)

⑪ Turn off the operation power.

⑫ Turn off the circuit breaker.

: indicates the actions by the operator.

7. RUNNING PROCEDURE

Running Procedure

1) How to start the machine

Start the machine by the following procedure:

① Supply 3-phase, 200 -230V VAC power to the machine.

First switch the power terminals

Make sure that the switches on the control assembly and the ELB are OFF and securely connect the power cord to a power supply meeting the specified voltage and current.

The standard specification for the power supply is AC200V. When you use this product at a place where AC208V or AC230V is used, switch the terminals inside unit before connecting the power supply. The terminal block can be found on the transformer inside the right side of the unit.

② Turn on the circuit breaker on the machine.

③ Turn on the operation power switch.

④ The touch panel shows the initial screen several seconds and then shows the process screen to set the machine ready to run.

2）Processing procedure and operating method

When the machine has been started, plasma-clean the work by the following procedure:

（1）When the processing parameters need not be set:

① Set the work in the chamber and close the door.

② Press the AUTO Screen key.

③ Press the START key.

④ The controller automatically performs the process according to the set parameters.

⑤ The end of process is displayed.

⑥ Open the door and take out the work.

※To prevent overlapped processing, the machine is designed to prevent the start of the next process before the door is opened.

⑦ Similarly, set the next work in the chamber and repeat the procedure.

（2）When the processing parameters need to be set:

① Press the PROCESS SETUP, SECRET NO INQUIRY, RECIPE keys on the SELECT screen to display the PROCESS SETUP screen.

② Set RE processing time, RF POWER, Ar GAS and O2 GAS.

③ Press the PROCESS??? key to return to the process screen.

④ To begin processing, follow the procedure in (1) above.。

（3）When the alarm conditions need to be set:

① Press the PROCESS SETUP, SECRET NO INQUIRY keys on the SETUP screen to display the ALARM SETUP screen.

② Set alarm conditions such as RF PERMISSIBLE LEVEL, GAS PERMISSIBLE LEVEL, etc.。

③ Press the FIRST WINDOW key to return to the process screen.

④ To begin processing, follow the procedure in (1).

7. RUNNING PROCEDURE

Running Procedure

3）Machine stopping procedure

Stop the machine by the following procedure:

⑤ Set the machine in the standby state.

⑥ Turn off the operation power.

⑦ Turn off the circuit breaker.

The power may be turned off in any state. The purpose of turning off the power in the standby state is to open the chamber to the atmospheric pressure to enable the door to be opened closed any time. To keep the chamber in the vacuum state, stop the machine in the order of PROCESS → START → vacuum reaches about 20 Pa → operation power off → circuit breaker off.

4）Motion when a power failure occurs

If the power fails, all motion stops and the status of motion is not stored. When the power is re-covered, the controller will display the initial screen for several seconds and the machine will enter the standby status. The following procedure is the same as the normal running procedure.

5）Motion when an alarm occurs

(The causes of alarms and corrective actions are listed on page 23.)

① If an abnormal situation occurs, the buzzer sounds and the alarm state is shown on the touch panel.

② Check the problem and take corrective actions.
(The buzzer can be stopped with the BUZZER OFF key.)

③ After the corrective actions, press the RESET key. The vacuum pump will run and the process screen will appear.

④ Follow the normal procedure.

6）Emergency stop

Use the emergency stop switch to stop the machine immediately when an emergency situation occurs. When the “emergency stop switch” installed on the operation panel is pressed, the power to the touch panel, RF and vacuum pump is turned off. To return the machine to the running status, use the following procedure:

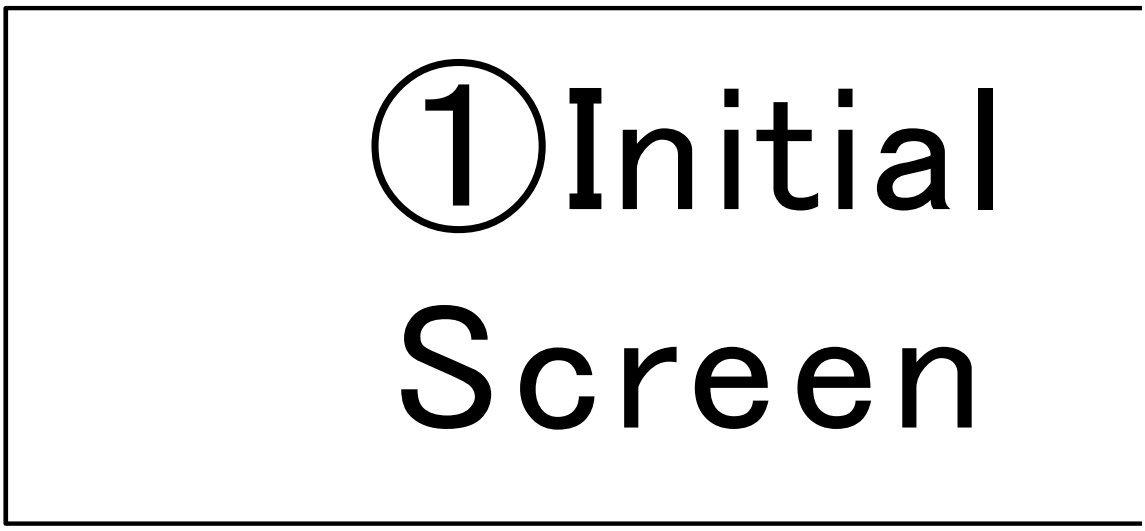
① Remove the cause of the emergency stop.

② Turn the emergency stop switch about 1/4 turn in the arrow direction (clockwise) to reset it.

③ The controller will display the initial screen for several seconds and the machine will enter the standby status. The following procedure is the same as the normal running procedure.

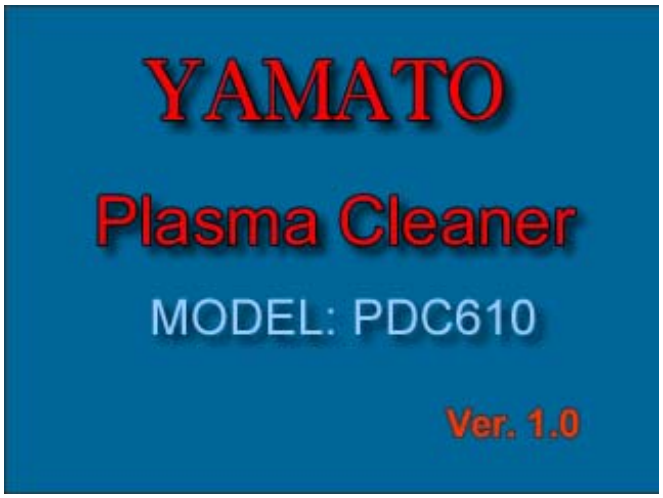
1）Configuration of screens

The operating screens are configured as follows. The arrow → indicates the lower-level screens.



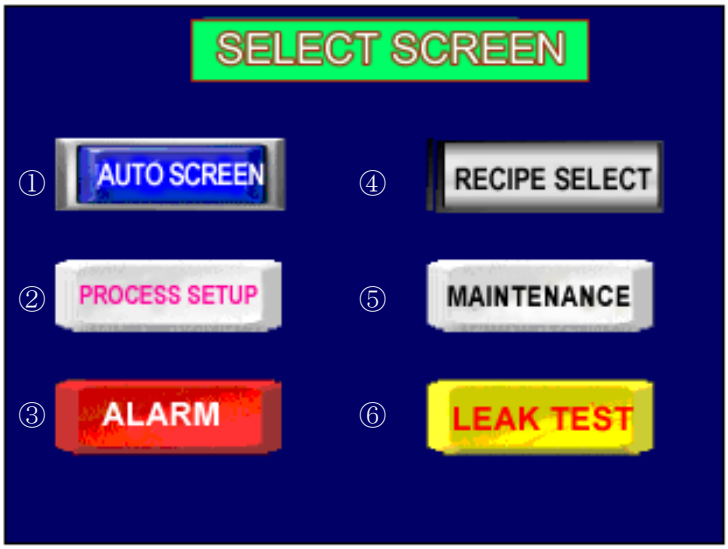
（1）Initial screen

This screen will appear automatically when the power is turned on. While this screen is being shown, the controller performs initial setting. There is nothing to be done by the operator.



（2）SELECT Screen

The SELECT screen is used to display the SETUP screen for the START and PROCESS SETUP.



① AUTO（MEAS screen）
Displays selected recipe conditions.

②When you enter the secret number in the SECRET NO INQUIRY screen, displays the SETUP screen.

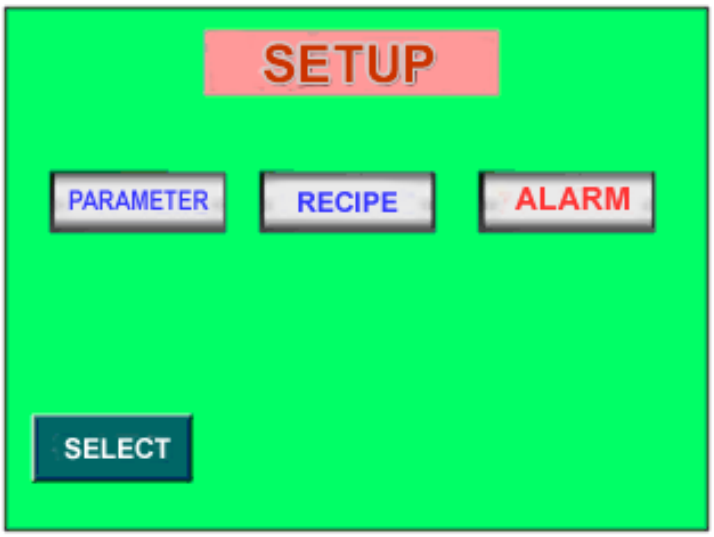
③ALARM
Displays the ALARM screen.

④RECIPE
Displays the RECIPE screen.

⑤MAINTENANCE screen
Displays the MAINTENANCE screen.

⑥LEAK TEST
Displays the LEAK TEST screen.

（3）PROCESS SETUP screen



① PARAMETER
Displays the PARAM screen.

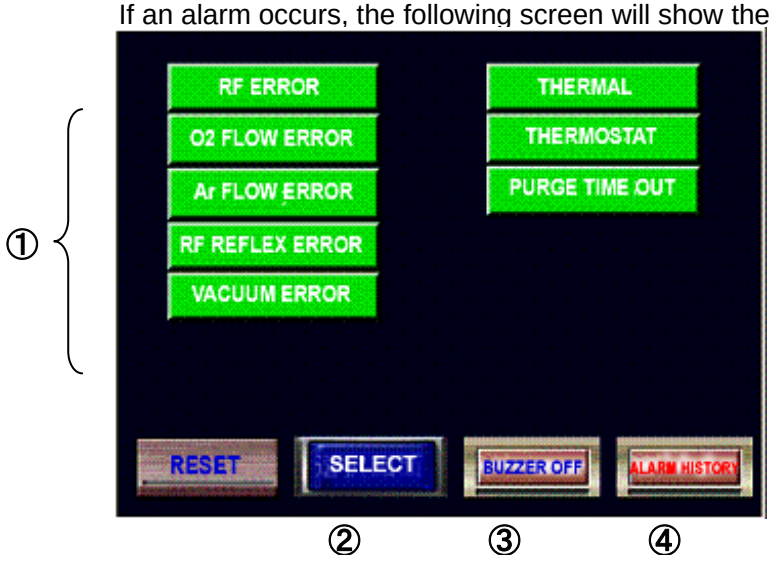
② RECIPE
Displays the PROCESS SETUP screen.

③ ALARM
Displays the ALARM screen.

④ SELECT
Displays the SELECT screen.

（4）ALARM screen

If an alarm occurs, the following screen will show the contents of the alarm..



① Shows the cause of the alarm.
② When this key is pressed after removing the cause of the alarm, the initial screen will appear.
③ Stops the buzzer.
④ Shows alarm history

（5）Process parameter setting screen

Set process parameters on this screen.

（Numeric keys）

（For recipe name）

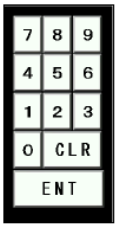
① Using the numeric keys, enter a value to a place where the cursor is blinking.
② After entering a value, press the ENT key. If the ENT key is not pressed, the previous value re-mains unchanged. When the ENT key is pressed, the cursor moves to the next item. Enter a value similarly. If a wrong value has been entered, press the CLR key to clear it.
③ After the entry, press the WRITE key to return to the process screen.
④ Press the READ key after setting a recipe No to load the settings.

※ Enter eight alphanumeric characters for a recipe name.
After entering a name, press the “ENT” key.

（6）ALARM HISTORY

① Returns to the ALARM screen.
② Clears alarm history.

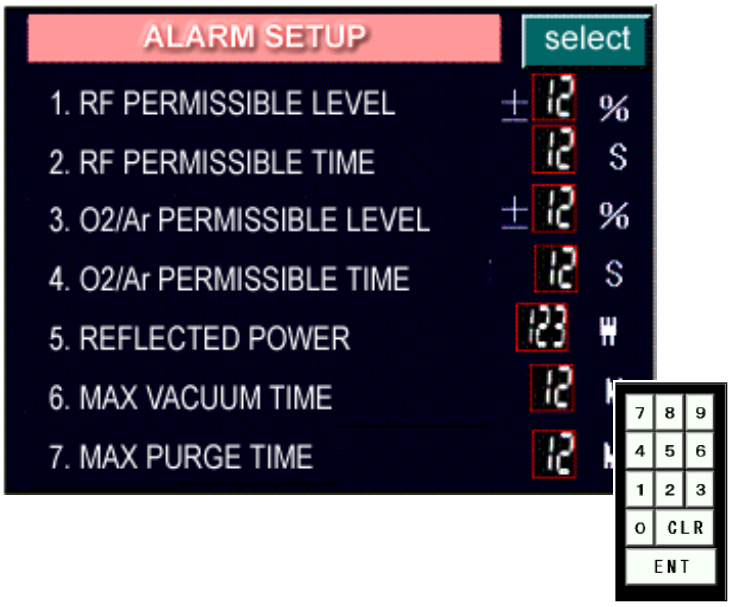
（7）RECIPE SELECT



Touching the RECIPE. No ☐, displays the ten keyboard.
After entering a value using 1～10 numbers, press the READ key.
The data will not loaded unless you press the READ key.

(8) Alarm condition setting screen

Set conditions to issue alarms on this screen.



① Using the numeric keys, enter a value to a place where the cursor is blinking.

② After entering a value, press the ENT key. If the ENT key is not pressed, the previous value re-mains unchanged. When the ENT key is pressed, the cursor moves to the next item. Enter a value similarly. If a wrong value has been entered, press the CLR key to clear it.

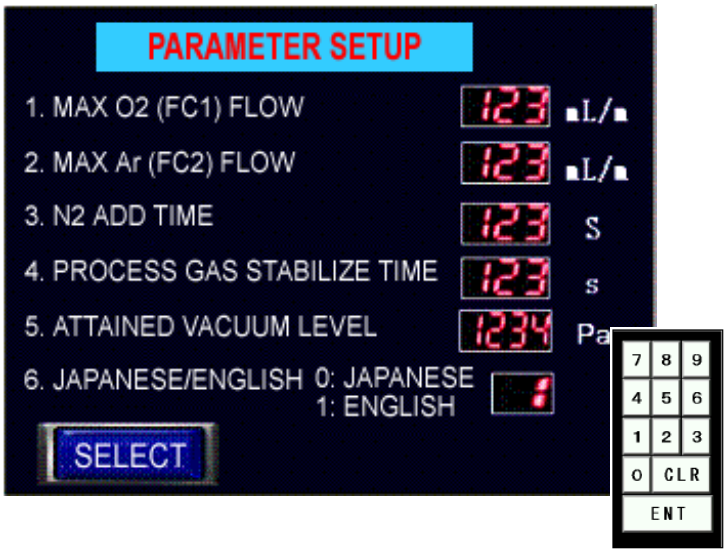
③ After the entry, press the SELECT key to return to the SELECT screen.

④ The default values and **input ranges are as follows.**

Param. No.	1	2	3	4	5	6	7
Default value	20	10	20	10	20	3	2
Input range	1～50	1～60	1～50	1～60	1～100	1～30	1～10

(9) Parameter setting screen

Set the maximum flow rates of the mass flow controller, ultimate vacuum when filling gas, time to add N2 gas after operation of the pressure switch for purge (an operation to ensure that the chamber is returned to atmospheric pressure which may be under negative pressure when the pressure switch operates) and processing gas stability time. Once they have been set, they need not be set again for normal run.



① Using the numeric keys, enter a value to a place where the cursor is blinking.

② After entering a value, press the ENT key. If the ENT key is not pressed, the previous value re-mains unchanged. When the ENT key is pressed, the cursor moves to the next item. Enter a value similarly. If a wrong value has been entered, press the CLR key to clear it.

③ After the entry, press the SELECT key to return to the SELECT screen.

④ The default values are as follows.

Item	O_2 gas	Ar gas	N_2 add time	Stable time	Attained vacuum level	Japanese/English
Default	200	100	5	30	10	0

(10) AUTO screen

This screen shows the time that has elapsed after the start of processing, gas flow rates, RF power, degree of vacuum, etc. Use this screen to check these conditions during processing.

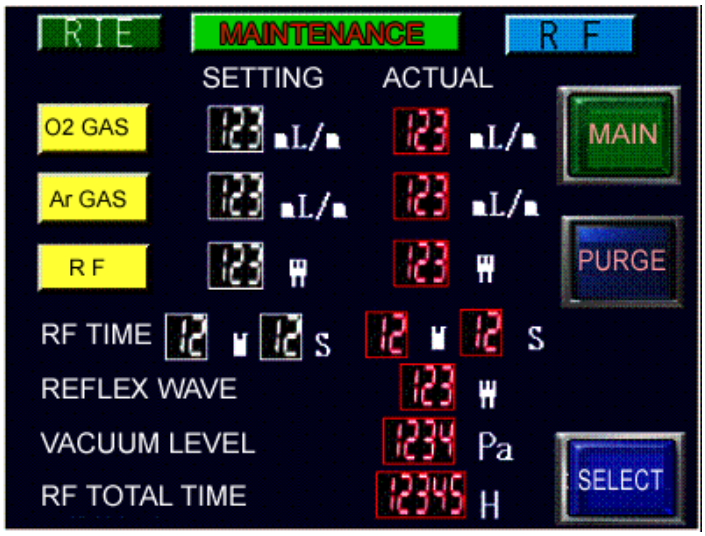
① ② ③ ④

① Returns to the SELECT screen.
② Starts processing.
③ Stops processing.
④ According to the current status, standby, processing or end of process is displayed.

Note 1: Only the blue keys may be operated.
Note 2: After the process has been ended, the START key will not be accepted before the door is opened.
Note 3: The process cannot be started if the door is open. 3.

(11) Maintenance screen

Use this screen to operate the units independently during maintenance.

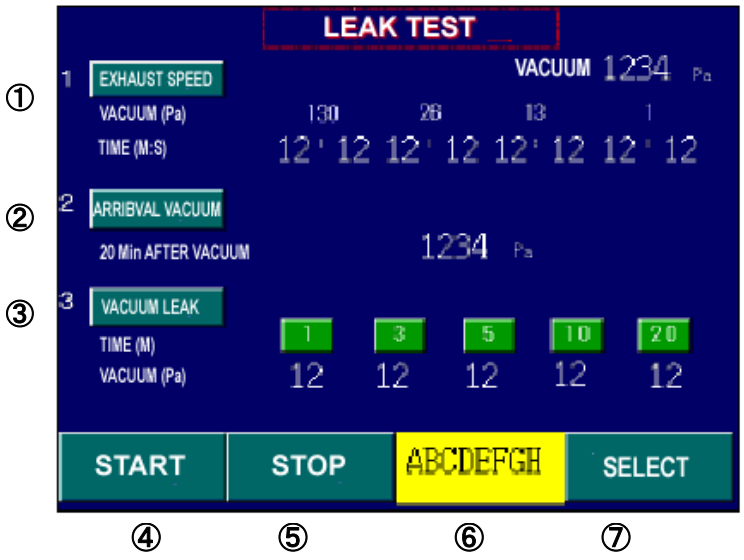


Note 1: If the main valve is not on, the O2 GAS, Ar GAS and RF keys are not accepted.。

① Using the numeric keys, enter a value to a place where the cursor is blinking.
② After entering a value, press the ENT key. If the ENT key is not pressed, the previous value re-mains unchanged. When the ENT key is pressed, the cursor moves to the next item. Enter a value similarly.
③ If a wrong value has been entered, press the CLR key to clear it.
④ Each time the O_2 GAS key is pressed, the supply of O_2 gas is turned on and off.
⑤ Each time the Ar GAS key is pressed, the supply of Ar gas is turned on and off.
⑥ Each time the RF key is pressed, the RF is turned on and off.
⑦ Each time the MAIN key is pressed, evacuating is turned on and off.
⑧ When the PURGE key is pressed, N_2 gas is filled to the chamber. When the chamber has been returned to the atmospheric pressure, the purge is automatically turned off.
⑨ When the SELECT key is pressed, the SELECT screen will appear.
⑩ When the door is open, DOOR OPEN will appear. Close the door

（12） Leak test

Use this screen to check leak of the vacuum system and verify the performance of the vacuum pump during the periodic maintenance, etc.



① Shows the time to reach the required vacuum. If the chamber has been left in highly humid atmosphere, 2 to 3 minutes may be required to reach 13 Pa. If 1 Pa cannot be reached, “0:00” will be shown, but it is no problem.

② Shows the ultimate vacuum after 20 minutes. OK when below 10 Pa.

③ The valve of the evacuating line is closed and the chamber is closed completely 20 minutes after the start of evacuating. Leak is detected by a change in the degree of vacuum. When a pressure rise is 60 Pa or be-low after 20 minutes, there is no problem in the cleaning performance.

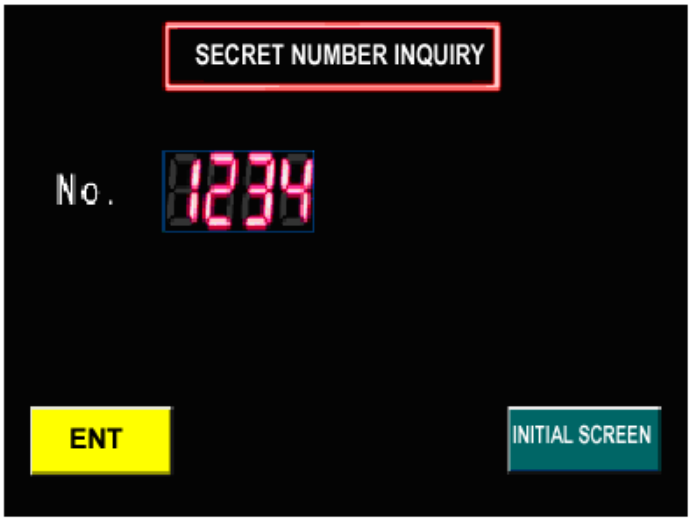
④ Starts the leak test. A series of exhausting to the vacuum leak is carried out automatically. The required time is 40 minutes.

⑤ Stops the test.

⑥ According to the current status, standby, testing or end is shown.

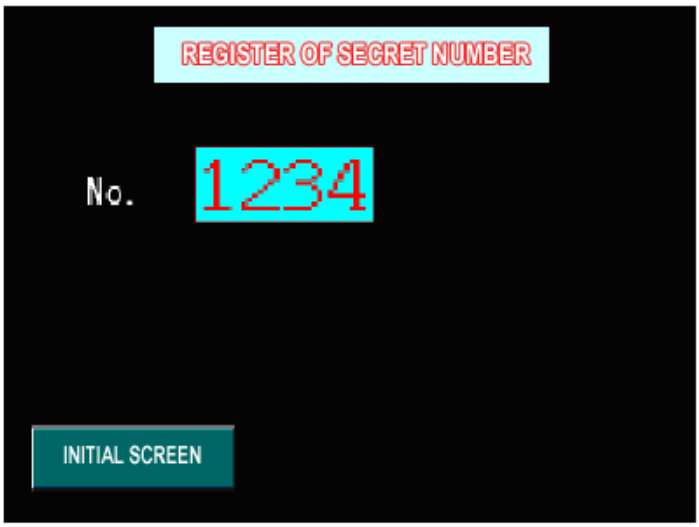
⑦ Returns to the SELECT screen.

(13) SECRET NO INQUIRY



This is a screen for inquiry of the secret number.
After entering the secret number, press the ENT key.

(14) SECRET NO REGISTER



The screen is used to register a secret number.
Enter a four-digit secret number.

8. PRECAUTIONS FOR HANDLING

⚠ Warning and Caution

1. Substances that must not be used

Do not use explosive substances, flammable substances and other substances containing such substances with this machine. They are a cause of explosion and fire. (See 17. “List of Hazardous Substances”)

2. Prohibition of use and corrective actions in the event of abnormal situations

This machine incorporates a high-frequency power supply. If you notice smoke or offensive odor or other abnormalities, immediately turn off the machine power and the distribution panel power and request the dealer or Yamato Scientific sales office for inspection. If the machine is left as it is, a fire or electric shock may occur. Never try to repair the machine by yourself. It is a very dangerous practice.

3. Dry the work

If the work is wet, a very long evacuating time is required, which may cause the evacuation alarm. Also water may deposit in the vacuum pump to deteriorate the evacuating performance. Be sure to dry the work prior to plasma cleaning.

4. Do not bring the work in contact with the chamber

The work in contact with the chamber causes a short circuit between the electrode and the chamber, which may damage the work and the machine. Place the work above the electrode and provide a clearance of more than 20 mm between the chamber and the work.

5. Attention to high temperature when taking out work

When taking out the work from the chamber, be careful not to touch the chamber and elec-trode because the inside of the chamber may be very hot.

9. MAINTENANCE

Daily Inspection

Conduct the daily inspection at least once a day according to the following table.

Daily Inspection Table					
No.	Place	Item	Criteria	Result	Remarks
1	Cooling fan	Noise	Smooth rotation with no abnormal noise.		
		Vibration	No abnormal vibration.		
		Odor	No offensive odor.		
2	Chamber door	Opening/ closing	Smooth movement.		
		Tightness	No gap between the chamber and the door.		
3	Supply gases	Pressure	Process gas ＝ 0.15 to 0.2 MPa		
			Purge gas ＝ 0.2 to 0.3 MPa		
4	Gas connect port	Gas leak	No gas leak.		
5	Vacuum exhaust connect port	Tightness	Not loose.		
6	Commercial in-put line	Connection	No loose connectors.		
			No abnormal temperature rise of connectors.		
7	Vacuum pump	Oil level	Within the level lines.		
		Oil color	Not contaminated.		
		Noise	No abnormal noise.		
		Vibration	No abnormal vibration.		
		Oil leak	No leak.		
		Connection wires	No loose connections.		

- Prior to the inspections and maintenance, turn off the power switch on the distribution panel for safety.
- Wait until the machine has returned to the normal temperature before maintenance.
- Never disassemble the machine.

9. MAINTENANCE

Periodic Inspection

Conduct the periodic inspections according to the following tables.

Every Month

Date: Temperature: ℃ Humidity: % Inspected by:

No.	Place	Method	Criteria	Result	Remarks
1	Exhaust speed test	Conduct test under nor-mal operating conditions.	3 minutes max. from atmospheric pressure to 13 Pa.		If the criteria are not met or the oil is contaminated , the oil must be replaced.
2	Ultimate vacuum test	Conduct test under nor-mal operating conditions.	10 Pa or below. after 20 minutes of evacuation.		
3	Vacuum leak test	Conduct test under nor-mal operating conditions.	+20 Pa max. 20 minutes after start from the ultimate vacuum.		If over 20 Pa, vacuum may be leaking.

Note: If the first test did not meet the criteria, a possible cause may be adsorption of water. If the criteria are not met, conduct the leak test again immediately after the first test.

Every Year

Date: Temperature: ℃ Humidity: % Inspected by:

No.	Place	Method	Criteria	Result	Remarks
1	Retighten connection screws	All motion at a stop.	Not loose.		
2	Retighten piping joints	All motion at a stop.	Not loose.		
3	Replace O-rings	All motion at a stop.	No damage or adhesion of foreign matter.		
4	Earth leakage breaker	Under the normal operating conditions.	Turned off when the breaker's red button is pressed.		
5	Emergency stop button	Under the normal operating conditions.	The pump and operation panel power is turned off.		

Every 4 Years

Date: Temperature: ℃ Humidity: % Inspected by:

No.	Place	Installed on	Criteria	Result	Remarks
1	Battery	Programmable controller			Replace every 4 years.
		Programmable terminal			
2	Backlight	Touch panel	Correct brightness.		Replace every 40,000 hours.

- ◆ The intervals of replacing the oil in the vacuum pump largely depend on the conditions of use, but usually it must be replaced every three to six months.
- ◆ The recommended intervals of parts replacement as a result of the inspections are for reference. Parts may be replaced earlier depending on the frequency of use.
- ◆ If you have any questions, please contact the dealer or Yamato Scientific.

10. ALARMS AND CORRECTIVE ACTIONS

Alarms and Corrective Actions

Alarm	Probable Cause	Corrective Action	Reference page
RF error	The alarm condition, RF PERMIS-SIBLE LEVEL, is too low.	Increase the level. (Set this based on the default value 10%)	P27
	The electrode and the chamber are shorted by the work, etc. to disable the set power due to a matching error.	Place the work above the chamber so that it does not contact the chamber.	
	Plasma is not produced because the vacuum is too high or low.	Supply the process gas to ensure the vacuum in the chamber is in the range of 100 Pa to 1 Pa.	P28
Ar gas flow rate error O_2 gas flow rate error	The alarm condition, O_2, Ar PER-MISSIBLE LEVEL, is too low or PERMISSIBLE TIME is too short.	Increase the level or time. (Set this based on the default values 20% and 30 seconds)	P27
	The source valve of the gas is closed or the gas cylinder is empty.	Open the source valve of the gas. Replace the gas cylinder.	
Reflected wave large	The alarm condition, REFLEX WAVE, is too small.	Increase the value. (Set this based on the default value 20 W)	P27
	The electrode and the chamber are shorted by the work, etc. to disable matching.	Place the work above the chamber so that it does not contact the chamber.	
	Plasma is not produced because the vacuum is too high or low.	Supply the process gas to ensure the vacuum in the chamber is in the range of 100 Pa to 1 Pa.	P28
Evacuating time over	Plasma is not produced because the vacuum is too high or low.	Supply the process gas to ensure the vacuum in the chamber is in the range of 100 Pa to 1 Pa.	P27
	The alarm condition, VACUUM TIME, is too short.	Increase the value. (Set this based on the default value 3 min.)	
	The evacuating time becomes longer because of wet work.	Dry the work before plasma-cleaning.	
	Vacuum is leaking because of such problems as foreign matter caught by the door, damaged O-ring and loose piping joint.	Conduct the leak test. If leak is detected, take necessary actions such as replacing the defective O-ring and re-tightening the loose piping joint.	
Purge time over	The alarm condition, SUBSTITU-TION TIME, is too short.	Increase the time. (Set this based on the default value 3 min.)	P27
	The source valve of the gas is closed or the gas cylinder is empty.	Open the source valve of the gas. Replace the gas cylinder.	
Vacuum pump failure	The oil in the vacuum pump has deteriorated to overload the motor.	Replace the oil.	
Chamber temperatur e high	The chamber temperature has risen above 90℃ because of a long time of plasma radiation.	Stop using the machine until the chamber cools down. (Even if one process is finished within the limit time, if operation intervals are short, the limit value may be exceeded.)	

If any problem not listed above has occurred, please contact the dealer or Yamato Scientific.

10. WHEN ALARM OCCURS

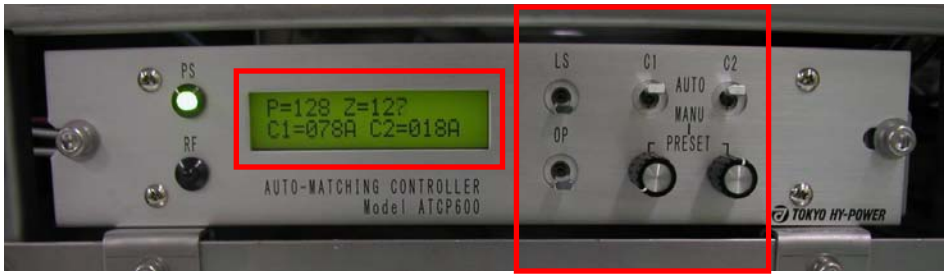
Operating Procedures for Auto Tuning Adjusting Switch

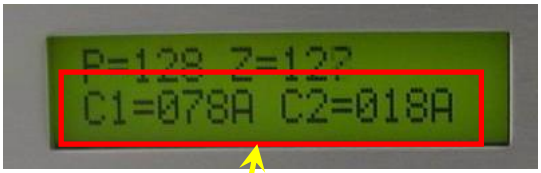
⚠**This operation is used when proper matching cannot be obtained or load in the chamber will not go into the matching range after switch the plasma mode（RIE⇔DP）.**

High frequency wave output must be matched with load. If not, reflective wave will be larger and preventing effective transmission of output to the load and may cause a malfunction of the high frequency wave power supply.

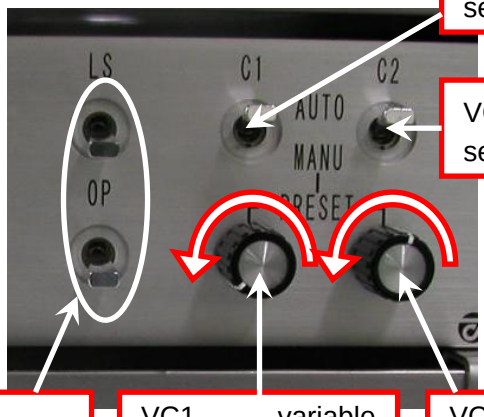
The auto tuning adjustment switch is located in the right panel.

（1）Remove the right panel.
※Make sure that RF is OFF before removing the panel.





Position of the variable condenser



VC1 AUTO/MANUAL selector switch

VC2 AUTO/MANUAL selector switch

※Never attempt to touch.
（Set at down at the default setting.）

VC1 variable condenser MANUAL position adjustment

VC2 variable condenser MANUAL position adjustment

（2）Set the “AUTO/MANUAL selector switch（VC1 and VC2）” to the MANU side.
（3）Turn the “MANUAL position adjustment（VC1 and VC2）” counterclockwise.
（4）Turn the value on the “Variable condenser position display（VC1 and VC2）” is 0.
（5）Set the “AUTO/MANUAL selector switch（VC1 and VC2）” to the AUTO side.
（6）Replace the right panel to the original position.
（7）Make sure whether matching will be made properly.

11. AFTER-SALE SERVICE AND WARRANTY

Request for Repair

Request for repair

If any problem occurs, stop the machine immediately and turn off the circuit breaker on the machine and the circuit breaker on the distribution panel. Then contact the dealer or Yamato Scientific.
Required information:

- Model of the product
- Serial No.
- Date of purchase
- Description of the problem (as detailed as possible)

When the service staff arrives at your factory, please present the warranty.

Warranty (Delivered separately)

- The warranty is delivered by the dealer or Yamato Scientific. Please confirm that the name of the dealer, date of purchase and other information are described correctly and keep the warranty in a safe place.
- The warranty period is one year from the date of purchase. During this period, failures will be re-paired free of charge pursuant to the terms and conditions stipulated in the warranty.
- As for repair of failures which may occur after the warranty period has expired, please contact the dealer or Yamato Scientific. Where the function can be maintained by repair, such failure will be repaired with charge if such repair is requested by the customer.

Minimum retention period of repair parts

The minimum retention period of repair parts of the machine is seven years after the discontinuation of production.
The repair parts are those parts that are required to maintain the performance of the product.

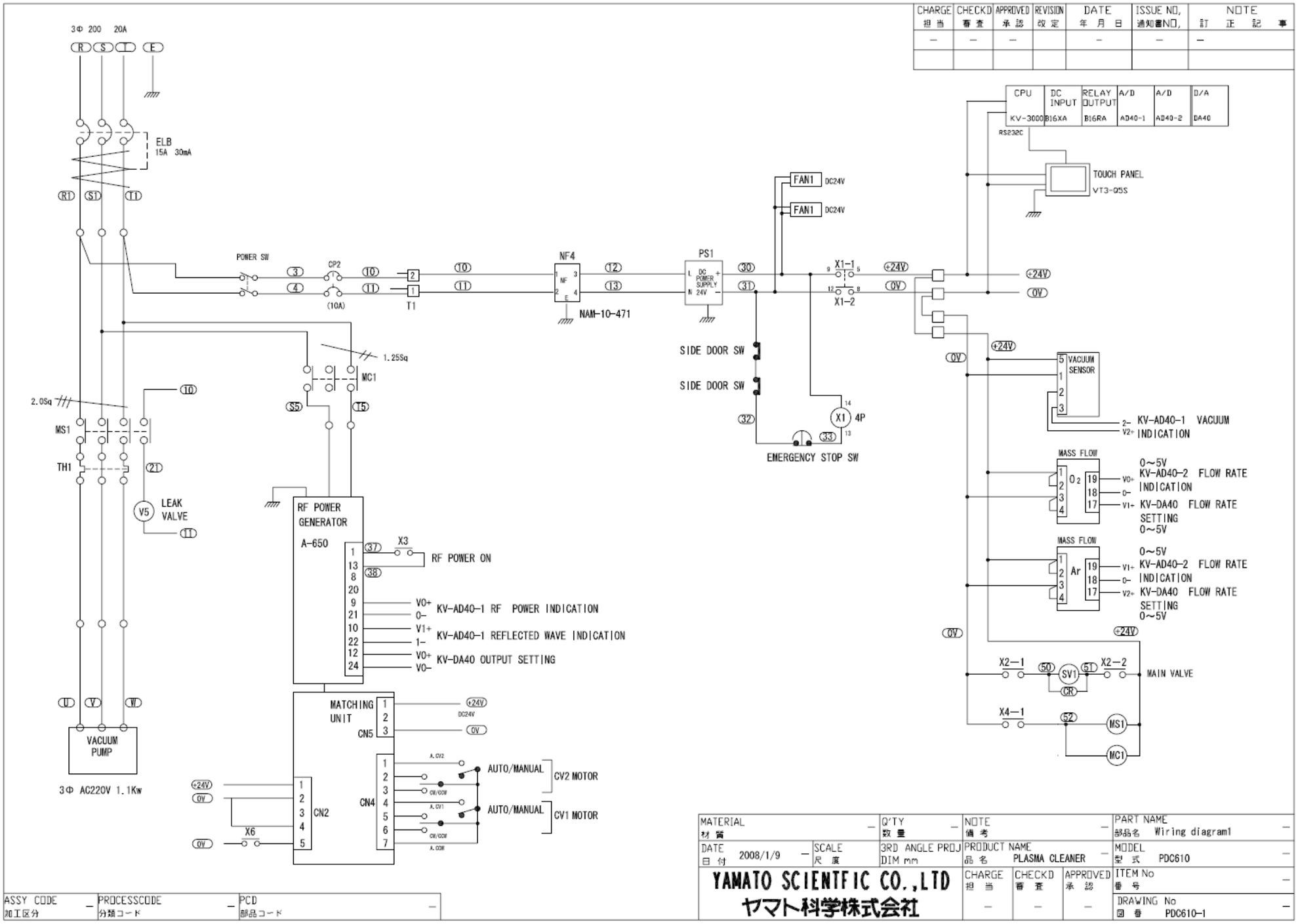
12. SPECIFICATIONS

SPECIFICATIONS

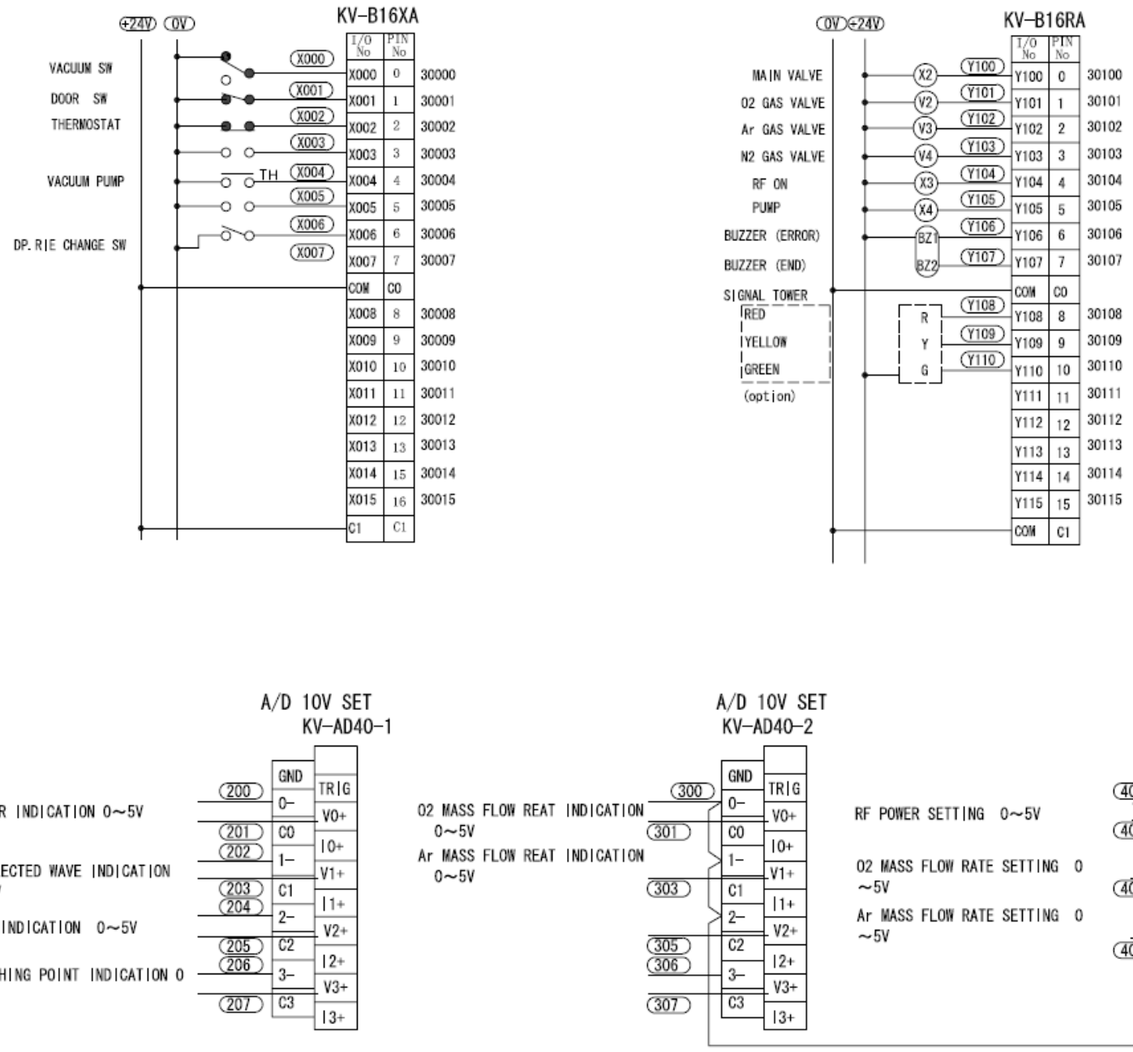
Model		PDC610
Main unit	Power supply	200 - 230 VAC 15A 50/60 Hz (Vacuum pump included)
	Internal dimensions of chamber	(Width) 350 × (depth) 270 × (height) 300 mm
	Electrode structure	Parallel flat type (Plasma mode: RIE/DP change-over type)
	Electrode dimensions	(Width) 250 ×(depth) 220 mm three stages
	Plasma method	RIE／DP change-over type
	Vacuum meter	Capacitance manometer
	Control device	Sequencer
	Operation/display unit	5 inch STN color LCD touch panel
High-frequency power supply	High-frequency output power	100 – 600W
	Reference oscillator	Quartz oscillator
	Oscillation frequency	13.56 MHz
	Output setting method	Manual setting on the touch panel
	Matching method	Auto tuning
Vacuum pump	Model	Alcatel T2021
	Effective exhaust speed	345 L/min（50 Hz）
	Suction port shape	NW25
	Exhaust port shape	NW25
	Motor rated output	450 W（50 Hz）
Gas system	Purge gas	N_2 1/4-inch flare-less joint
	Reaction gas	Ar gas Mass flow controller 100 SCCM 1/4-inch flare-less joint
		O_2 gas Mass flow controller 100 SC 1/4-inch flare-less joint

Accessory list

No	Part name	Qty	No	Part name	Qty
1	Main unit(PDC610)	1	18	Lower electrode	1SET
2	Operation manual（plain paper）	1 copy	19	Upper electrode	1SET
3	Operation manual（dust-free paper）	1 copy	20	Shelf board electrode	2SET
4	Operation manual of vacuum pump	1 copy	21	Lower electrode fixing clamp	1
5	Operation manual for capacitance manometer	1 copy	22	Upper electrode fixing clamp	1
6	Operation manual for vacuum pump	1 copy	23	Feed through connecting plate（used for 3-stage configuration）	1
7	Operation manual for mass flow controller	1 copy	24	Shelf board electrode RIE fixing clamp（used for 2-stage configuration）	1
8	Warranty card	1 copy	25	Shelf board electrode DP fixing clamp（used for 2-stage configuration）	1
9	Use of high frequency wave	1 copy	26	Shelf board electrode RIE fixing clamp（used for 3-stage configuration）	2
10	High frequency wave	1 copy	27	Shelf board electrode DP fixing clamp（used for 3-stage configuration）	2
11	High frequency wave	1 copy			
			28	Truss screw（M4×6）	15
12	Power cord（for vacuum pump）	1	29	Truss screw（M4×8）	5
13	Vacuum pump（T2021SD）	1	30	Flat head screw（M4×5）	10
14	Oil mist eliminator	1			
15	Clamp	3			
16	Center ring	3			
17	Flexible tube	1			

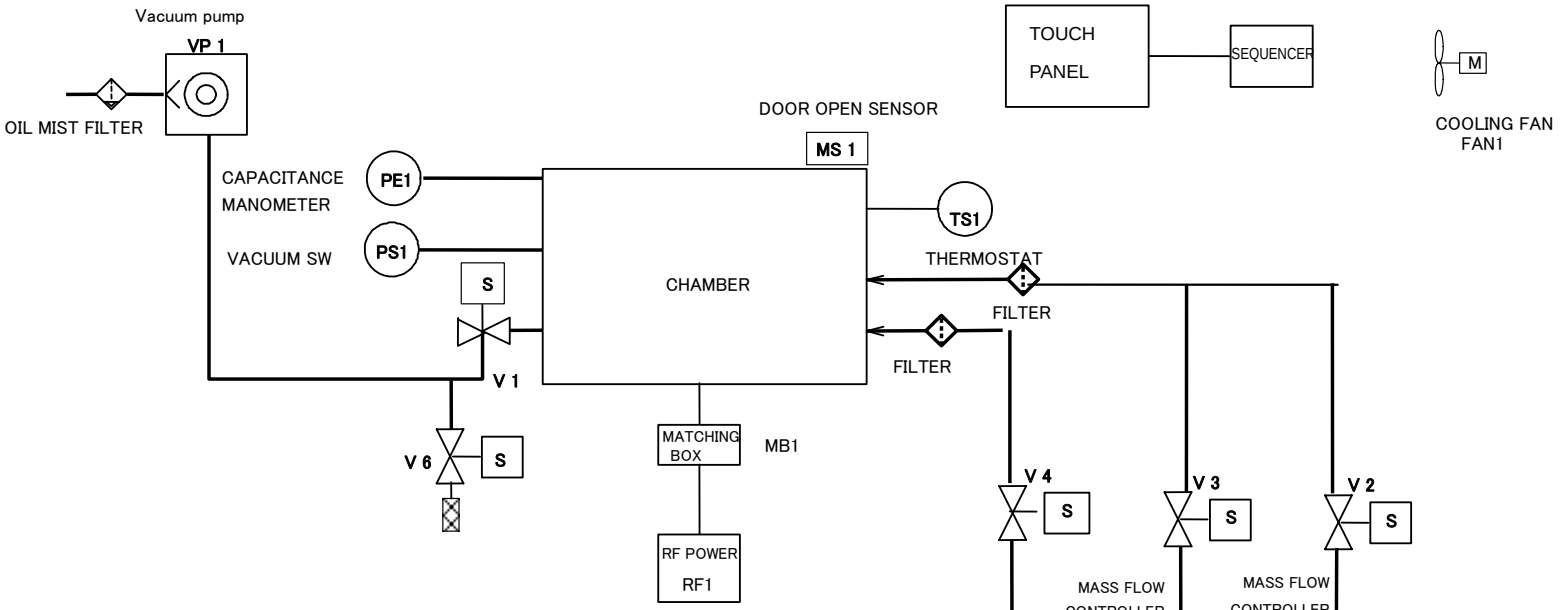

CHARGE 担当 – | CHECKD 審査 – | APPROVED 承認 – | REVISION 改定 | DATE 年月日 – | ISSUE NO, 通知書NO, – | NOTE 訂正記事 –
3Φ 200 20A
R S T E
ELB 15A 30mA
R1 S1 T1
POWER SW
3 4
CP2 (10A)
10 11
2 1 T1
10 11
NF4 NAM-10-471
12 13
PS1 DC POWER SUPPLY
30 31
FAN1 DC24V
FAN1 DC24V
X1-1 X1-2
+24V 0V
SIDE DOOR SW
SIDE DOOR SW
32
X1 4P
33
EMERGENCY STOP SW
CPU KV-3000
DC INPUT B16XA
RELAY OUTPUT B16RA
A/D AD40-1
A/D AD40-2
D/A DA40
RS232C
TOUCH PANEL VT3-Q5S
VACUUM SENSOR
KV-AD40-1 VACUUM INDICATION
MASS FLOW O2
0~5V KV-AD40-2 FLOW RATE INDICATION
KV-DA40 FLOW RATE SETTING 0~5V
MASS FLOW Ar
0~5V KV-AD40-2 FLOW RATE INDICATION
KV-DA40 FLOW RATE SETTING 0~5V
X2-1 50 SV1 CR 51 X2-2
MAIN VALVE
X4-1 52 MS1 MC1
1.25Sq
2.0Sq
MC1
10
S5 T5
MS1
TH1
21
V5 LEAK VALVE
11
U V W
VACUUM PUMP
3Φ AC220V 1.1Kw
RF POWER GENERATOR A-650
X3
37 38
RF POWER ON
VO+ KV-AD40-1 RF POWER INDICATION
0–
V1+ KV-AD40-1 REFLECTED WAVE INDICATION
1–
VO+ KV-DA40 OUTPUT SETTING
VO–
MATCHING UNIT CN5
+24V DC24V
0V
CN2
X6
CN4
AUTO/MANUAL CV2 MOTOR
AUTO/MANUAL CV1 MOTOR
MATERIAL 材質 –
Q'TY 数量 –
NOTE 備考 –
PART NAME 部品名 Wiring diagram1 –
DATE 日付 2008/1/9 –
SCALE 尺度
3RD ANGLE PROJ DIM mm
PRODUCT NAME 品名 PLASMA CLEANER –
MODEL 型式 PDC610 –
YAMATO SCIENTFIC CO.,LTD
ヤマト科学株式会社
CHARGE 担当 – | CHECKD 審査 – | APPROVED 承認 –
ITEM No 番号 –
DRAWING No 図番 PDC610-1 –
ASSY CODE 加工区分 – | PROCESSCODE 分類コード – | PCD 部品コード –

CHARGE 担当	CHECKED 審査	APPROVED 承認	REVISION 改定	DATE 年月日	ISSUE No. 通知書No.	LOT No. 実施ロットNo.	NOTES 訂正記事



MATERIAL 材質	FINISH 処理	NOTES 備考	Q'TY 数量	DRAWING TITLE 部品名 Wiring diagram2
DATE 年月日 2008/1/09	SCALE 尺度 Free	3RD ANGLE PROJ DIM mm	TITLE 品名 PLASMA CLEANER	MODEL 型式 PDC610
YAMATO SCIENTFIC CO.,LTD ヤマト科学株式会社	DRAWN 作成 matsumoto	CHECKED 審査 akiyama	APPROVED 承認 ookawa	ITEM No. 部品番号 / DRAWING No. 図番 PDC610—2

14.Piping Diagram



V 1	VACUUM MAIN VALVE
V 2	O_2GAS SOLENOID VALVE
V 3	Ar GAS SOLENOID VALVE
V 4	N_2 GAS SOLENOID VALVE
V 5	NEEDLE VALVE
V 6	LEAK VALVE

PIPING SYSTEM DIAGRAM

15.Parts List

Part name	Parts code	Material	Manufacturer
Fixed electrode（RIE）	LT00028332	Aluminum	YAMATO
Fixed electrode insulating plate (RIE)	LT00028334	Ceramics	YAMATO
Fixed electrode（DP）	LT00028331	Aluminum	YAMATO
Fixed electrode insulating plate (DP)	LT00028333	Ceramics	YAMATO
Shelf board electrode(RIE)	LT00028363	Aluminum	YAMATO
Shelf board electrode(DP)	LT00028362	Aluminum	YAMATO
Shelf board electrode insulating board	LT00028368	Ceramics	YAMATO
Insulating collar 1	LT00028350	Ceramics	YAMATO
Insulating collar 2	LT00028351	Teflon	YAMATO
Electrode SFT	LT00028386	Aluminum	YAMATO
Inner cover（lower on the back）	LT00028239	Aluminum	YAMATO
Inner cover（upper on the back）	LT00028240	Aluminum	YAMATO
Inner cover（door）	LT00028241	Aluminum	YAMATO
Shelf board holder BKT-FL	LT00028359	Aluminum	YAMATO
Shelf board holder BKT-RL	LT00028358	Aluminum	YAMATO
Shelf board holder BKT-FR	LT00028360	Aluminum	YAMATO
Shelf board holder BKT-RR	LT00028361	Aluminum	YAMATO
O-ring for electrode SFT	LT00028224,LT00028223	Viton	YAMATO
O-ring for observation window	LT00028225	Viton	YAMATO
O-ring for door/back plate	LT00028222	Viton	YAMATO

16. DISPOSAL

Precautions for Disposal

For protection of the global environment:

In order to protect the environment, it is requested that when disposing of the machine, break down the machine to as smallest pieces as possible and dispose of them by materials or recycle them wherever possible. The major components of the machine and their materials are as follows.

Major Component	Material
Major components of the main unit	
Enclosure	Stainless steel (SUS304)
Chamber, door	Aluminum (A5052)
Insulating plate	Ceramics
Check window	Heat-resistant reinforced glass (Pilex)
Piping, piping joint	SUS304、SUS316
Suction/exhaust valve	Aluminum A6063、SUS316
Major components of the electrical system	
Switch, relay	Resin, copper and other composite materials
PC board	Glass fiber and other composite materials
Power cord	Synthetic rubber coating, copper, nickel and other composite materials
Wiring	Glass fiber, flame retardant vinyl, copper, nickel and other composite materials
Seal	Resin-based materials

17. LIST OF HAZARDOUS SUBSTANCES

Never use explosive substances, flammable substances and other substances containing these substances with this machine.

Explosive substances	Explosive	①Nitroglycol, nitroglycerine, nitrocellulose, and other explosive nitric esters
		②Trinitrobenzen, trinitrotoluene, picric acid, and other explosive nitro compounds
		③Peracetic acid, methyl ethyl ketone peroxide, benzoyl peroxide, and other organic peroxides
Combustible substances	Ignitable	Metal “litium”, metal “potassium”, metal “sodium”, yellow phosphorous, phosphorus sul-fide, red phosphorous, celluloid, calcium carbide (alias, carbide), lime phosphide, magnesium powder, aluminum powder, metallic powder other than magnesium powder and aluminum powder, sodium dithionite (alias, sodium hydrosulfite)
	Oxidizing	①Potassium chlorate, sodium chlorate, ammonium chlorate, and other chlorates
		②Potassium perchlorate, sodium perchlorate, ammonium perchlorate, and other per-chlorates
		③ Potassium peroxide, sodium peroxide, barium peroxide, and other inorganic perox-ides
		④Potassium nitrate, sodium nitrate, ammonium nitrate, and other nitrates
		⑤Sodium chlorite, and other chlorites
		⑥Calcium hypochlorite, and other hypochlorites
	Flammable	①Ethyl ether, gasoline, acetaldehyde, propylene chloride, carbon disulfide, and other substances whose flash point is below minus 30℃
		②Normal hexane, ethylene oxide, acetone, benzene, methyl ethyl ketone, and other substances whose flash point is or is above minus 30℃ and below 0℃
		③ Methanol, ethanol, xylene, pentyl acetate (alias, amyl acetate), and other substances whose flash point is or is above 0℃ and below 30℃
		④Kerosene, light oil, turpentine oil, isopenthyl alcohol (alias, isoamyl alcohol), and other substances whose flash point is or is above 30℃ and below 65℃
	Combustible	Hydrogen, acetylene, ethylene, methane, ethane, propane, butane, and other combus-tible substances that are in the gaseous state at a temperature of 15℃ and a pressure of 1 atm.

(Source: Attached Table No. 1, Article 6, Labor Safety and Health Enforcement Regulations)

Scope of Warranty

Be sure to comply with the handling instructions described in this manual when using the machine.

Yamato Scientific shall not be liable whatsoever for accidents or failures which may result from using the machine in manners not authorized in this manual.

Never attempt operations or actions which are prohibited in this manual.

Such a practice may become a cause of unexpected accidents and failures.

Notice

- This instruction manual is subject to change without notice in the future.
- If you notice the manual is missing pages or not in order, please inform us.

Instruction Manual

Plasma Cleaner
First Version August 8, 2008
Revision June. 6, 2012

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