# Freeze Dryer

**Model**

# DC401

## Instruction Manual

- First Edition -

- **Thank you for choosing DC series freeze dryers from Yamato Scientific Co., Ltd.**
- **For proper equipment operation, please read this instruction manual thoroughly before use. Always keep equipment documentation safe and close at hand for convenient future reference.**

**⚠WARNING!:**
**Read instruction manual warnings and cautions carefully and completely before proceeding.**

**Yamato Scientific America Inc.**
**Santa Clara, CA**

Printed on recycled paper

# Contents

# 1. SAFETY PRECAUTIONS

## Explanation of Safety Symbols

### A Word Regarding Symbols

Various symbols are provided throughout this text and on equipment to ensure safe operation. Failure to comprehend the operational hazards and risks associated with these symbols may lead to adverse results as explained below. Become thoroughly familiar with all symbols and their meanings by carefully reading the following text regarding symbols before proceeding.

**Warning** Signifies a situation which may result in serious injury or death (Note 1)

**Caution** Signifies a situation which may result in minor injury (Note 2) and/or property damage (Note 3)

(Note 1) Serious injury is defined as bodily wounds, electrocution, bone breaks/fractures or poisoning, which may cause debilitation requiring extended hospitalization and/or outpatient treatment.

(Note 2) Minor injury is defined as bodily wounds or electrocution, which will not require extended hospitalization or outpatient treatment.

(Note 3) Property damage is defined as damage to facilities, equipment, buildings or other property. （Note 1） Serious injury is defined as bodily wounds,

### Symbol Meanings

Signifies warning or caution.
Specific explanation will follow symbol.

Signifies restriction.
Specific restrictions will follow symbol.

Signifies an action or actions which operator must undertake.
Specific instructions will follow symbol.

# 1. SAFETY PRECAUTIONS

## Symbol Glossary

### Warning


General Warning


Danger!: High Voltage


Danger!: Extremely Hot


Danger!: Moving Parts


Danger!: Blast Hazard

### Caution


General Caution


Caution: Shock Hazard!


Caution: Burn Hazard!


Caution: Do Not Heat Without Water!


Caution: May Leak Water!

Caution: Water Only


Caution: Toxic Chemicals

### Restriction


General Restriction


No Open Flame


Do Not Disassemble


Do Not Touch

### Action


General Action Required


Connect Ground Wire

Level Installation Required


Disconnect Power


Inspect Regularly

## WARNING!

### Never operate equipment near combustible gases/fumes.

Do not install or operate DC series unit near flammable or explosive gases/fumes. Unit is NOT fire or blast resistant. Negligent use could cause a fire/explosion. See “List of Hazardous Substances” (P.28).

### Always ground equipment.

Always ground this unit properly to avoid electric shock.

### DO NOT operate equipment when abnormalities are detected.

If smoke or unusual odors begin emitting from unit, or if any other abnormalities are detected, terminate operation immediately, turn off main power switch (Earth Leakage Breaker - “ELB”) and disconnect power cable. Continued operation under such conditions may result in fire or electric shock.

### DO NOT operate with bundled or tangled power cable.

Operating unit with the power cable bundled or otherwise tangled, may cause power cable to overheat and/or catch fire.

### DO NOT damage power cable.

Damaging the power cable by forcibly bending, pulling or twisting may cause fire or electric shock to the operator.

### DO NOT handle flammable substances without proper ventilation.

Be sure there is adequate ventilation when working with certain flammable substances (such as ethanol, etc.), which evaporate quickly at or below room temperature, and emit flammable fumes. Insufficient ventilation may cause a fire or explosion. See “List of Hazardous Substances” (P.28).

### DO NOT disassemble or modify equipment.

Attempting to dismantle or modify unit in any way, may cause malfunction, fire or electric shock.

## Warnings & Cautions

# ⚠CAUTION!

**DO NOT operate equipment during thunderstorms.**

In the event of a thunderstorm, terminate operation and turn off main power switch (ELB) immediately. A direct lightning strike may cause damage to equipment, or result in fire or electric shock.

**DO NOT touch ice in cold trap.**

Handling ice in the cold trap during or after operation with bare hands/fingers may result in severe frostbite.

**DO NOT touch cooling fins.**

Edges of cooling fins are very sharp. Do not contact with bare hands or skin. Laceration injuries may result.

# 2. PRE-OPERATION PROCEDURES

## Installation Precautions & Preparations

## ⚠WARNING!

### 1. Equipment MUST always be grounded properly.

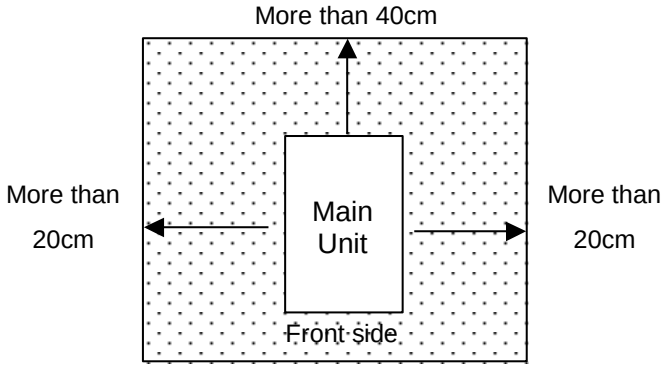
- Always connect power cable to a grounded outlet to prevent electric shock from power surges.
- Never connect ground wire to gas lines, water pipes, telephone grounding lines or lightening rods. Doing so may result in fire or electrical shock.
- Do not use branched outlets or extension cords, which may cause power cable to overheat and/or catch fire.

### 2. Choose an appropriate installation site.

●Do not install DC series unit:

- where flammable or corrosive gases/fumes will be generated.
- where external temperature will exceed 35ºC, will fall below 5ºC or will fluctuate.
- in excessively humid or dusty locations.
- where there is constant vibration.
- where power supply is erratic.
- in direct sunlight or outdoors

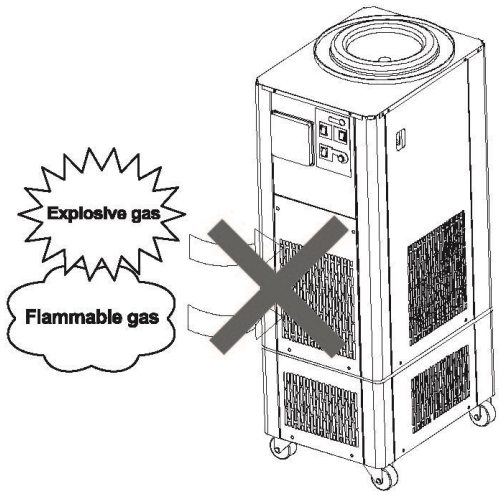
- Install DC unit in a location with sufficient space, and venilation as specified as below.




### 3. Install in a location free of flammables and explosives.

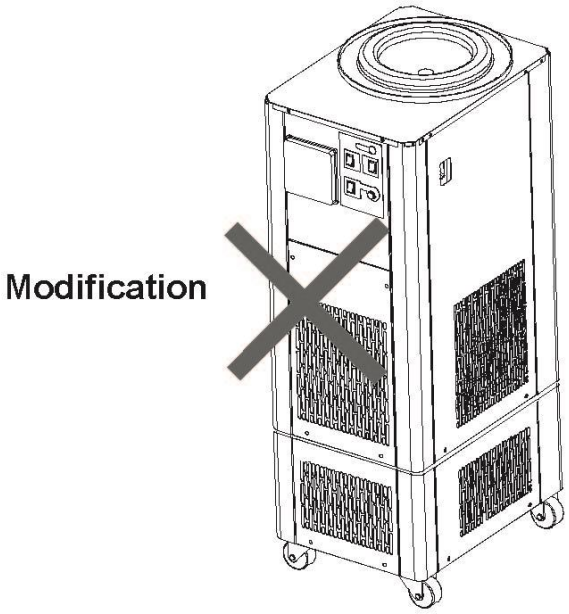
●Never install near flammables or explosives. This unit is NOT fire or blast resistant. Simply switching the main power switch (ELB) "ON" or "OFF" can produce a spark, which can relay during operation, causing a fire or explosion when near flammable or explosive fluids, chemicals or gases/fumes.

- See "List of Hazardous Substances" (P.28).



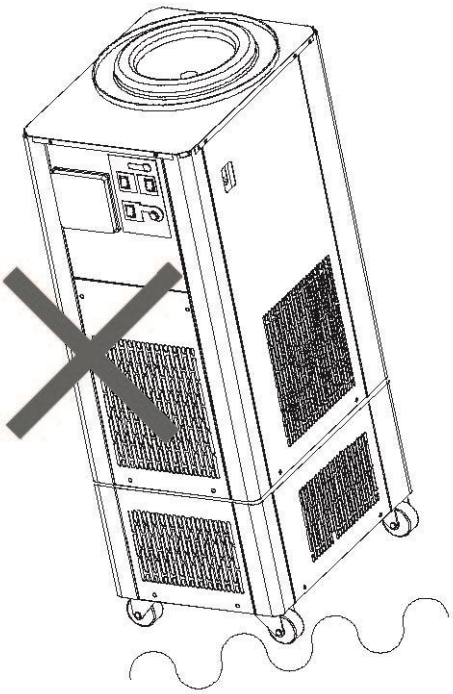
### 4. Never disassemble or modify.

- Attempting to disassemble or modifiy this unit in any way may result in malfunction, fire or electric shock.




### 5. Install on a level surface.

- Install unit on a level and even surface. Failure to do so may result in abnormal vibrations or noise and damage to the refrigeration system.



Approximate unit weight:
DC401: 47kg.
Handle with care. Transport and installation should always be performed by two or more people.

# ⚠CAUTION!

### 6. Connect to a proper power supply.

- Connect power cable to a suitable facility outlet or terminal, according to the following electrical requirements.

**Electrical requirements:** DC401: 115V AC, 50/60Hz, 5A (When used with pump & heater: 12A)

**NOTE)**

- Check the line voltage on outlet or terminal to be used and properly evaluate whether to utilize a line being shared by other equipment. If the unit is not activated by turning on the main power switch (ELB), take an appropriate course of action, such as connecting the unit to a dedicated power source.
- If multiple power cables are connected to a single outlet, input voltage to unit may drop, causing degraded cooling and temperature control performance.

### 7. Install in a safe location.

- In the event of an earthquake or other unforeseen incident, equipment may unexpectedly shift or fall, causing injury. Taking preventative steps to install unit in a safe location, away from room access doors and out of other danger is strongly recommended.

### 8. Handle power cable with care.

- Never operate unit with power cable bundled or tangled; and do not modify, bend, forcibly twist or pull on power cable. Doing so may cause fire and/or electrical shock.
- Do not risk damage to power cable by positioning it under desks or chairs, or by pinching it between objects. Doing so may cause fire and/or electrical shock.
- Do not place power cable near kerosene/electric heaters or other heat-generating devices. Doing so may cause power cable insulation to overheat, melt and/or catch fire, which may result in electric shock.
- Turn off main power switch (ELB) immediately and disconnect from facility terminal or outlet, if power cable becomes partially severed or damaged in any way. Failure to do so may result in fire or electric shock.
  Contact a local dealer or Yamato sales office for information about replacing power cable if it is damaged.
- Always connect power cable to appropriate facility outlet or terminal.

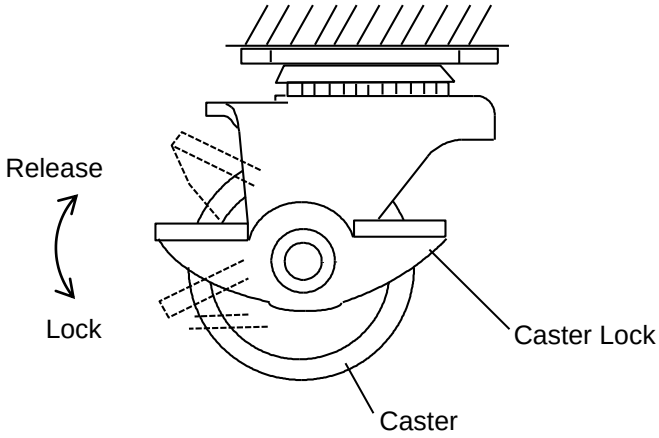
# 2. PRE-OPERATION PROCEDURES

## Installation Procedures

1. Unlock caster.
   Pull up on lever to release caster lock (only two front casters are equipped with locks).
2. Move unit in place for installation.

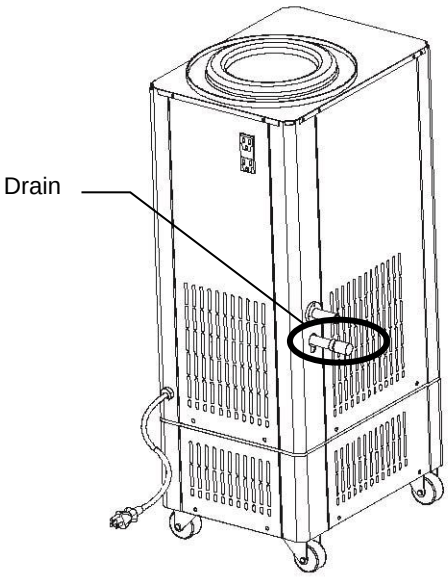
❖ Wheeling unit over large bumps or crevices may cause excessive shock to unit or damage to casters. Use care when moving unit and obtain assistance, when necessary, to lift unit over bumps and crevices.

3. When unit is in place, push down on lever to lock caster.




4. Check drain cap

- Check to make sure cap is installed on drain outlet hose.

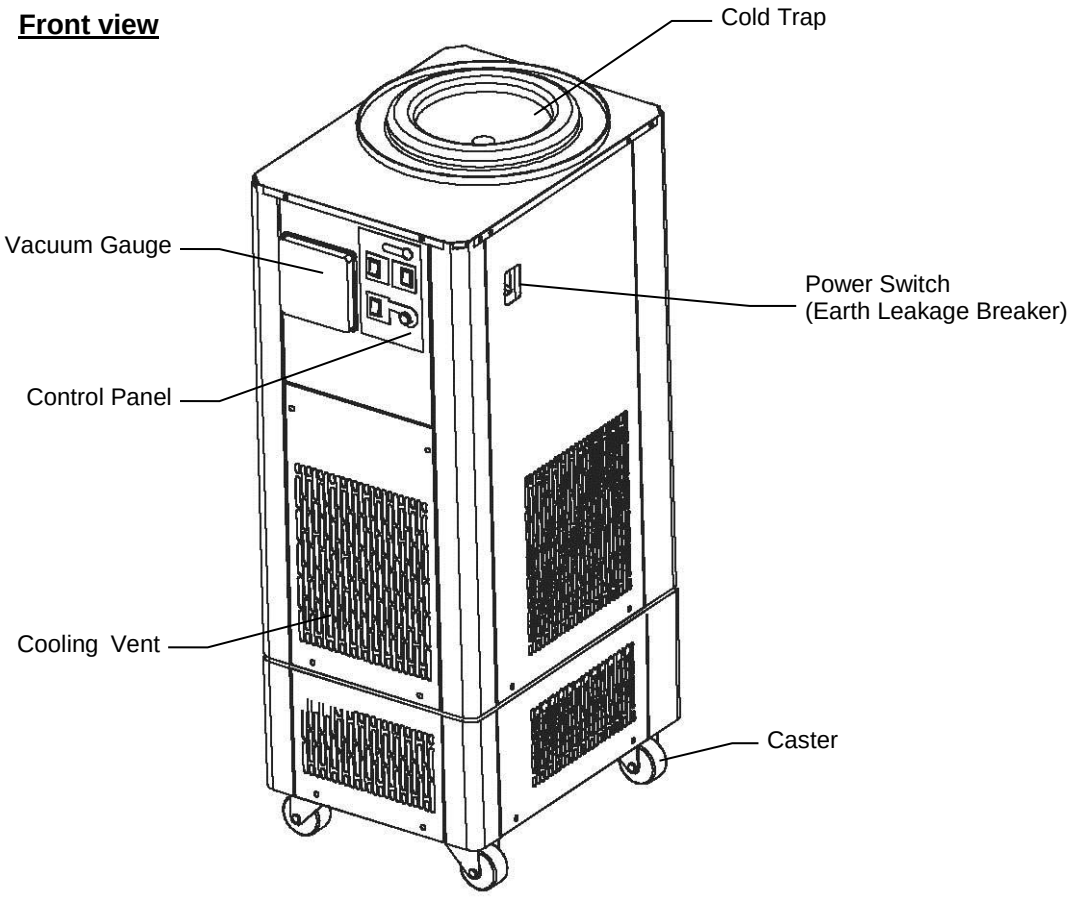



5. Connect power cable
   Be sure main power switch (ELB) is turned OFF. Connect power cable to grounded outlet.
6. Use a vacuum pump having a displacement of 50/min or more, maximum pressure of $1.0X10^{-1}$Pa and a check-valve.
7. Install vacuum valves on all valve openings in the flask mount vacuum chamber.
8. Be sure a freezer is available which can maintain samples sufficiently below their eutectic (solidification) point. Refer to P.11 for explanation on eutectic point.

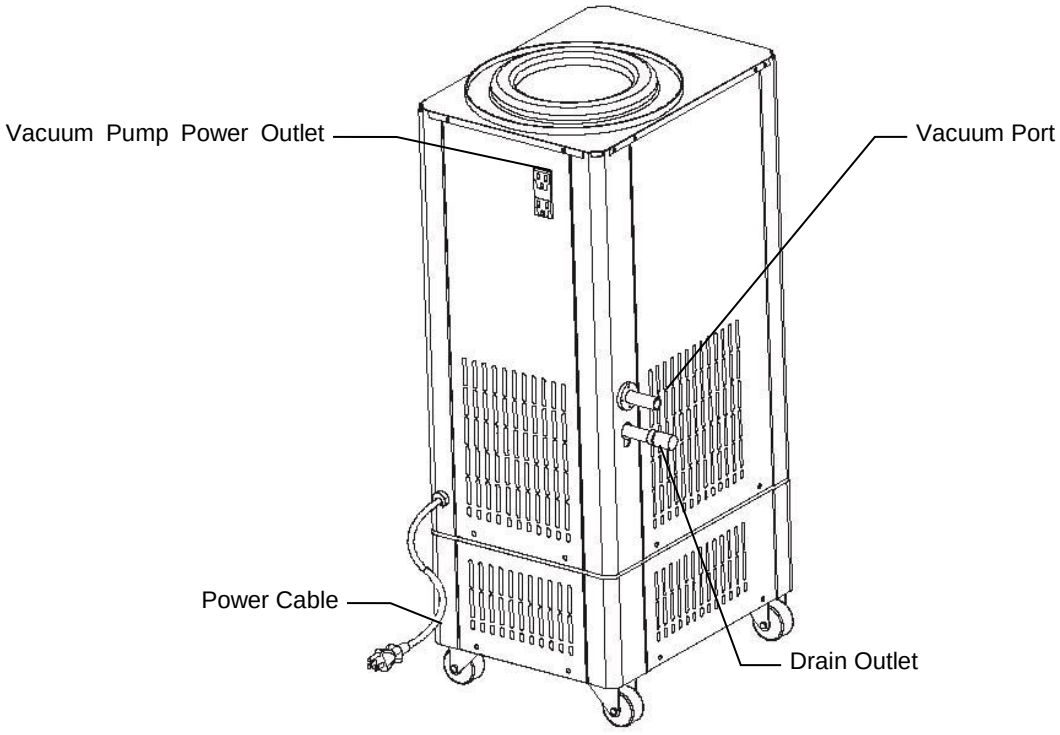
# 3. COMPONENT NAMES & FUNCTIONS

## Unit Overview

**Front view**

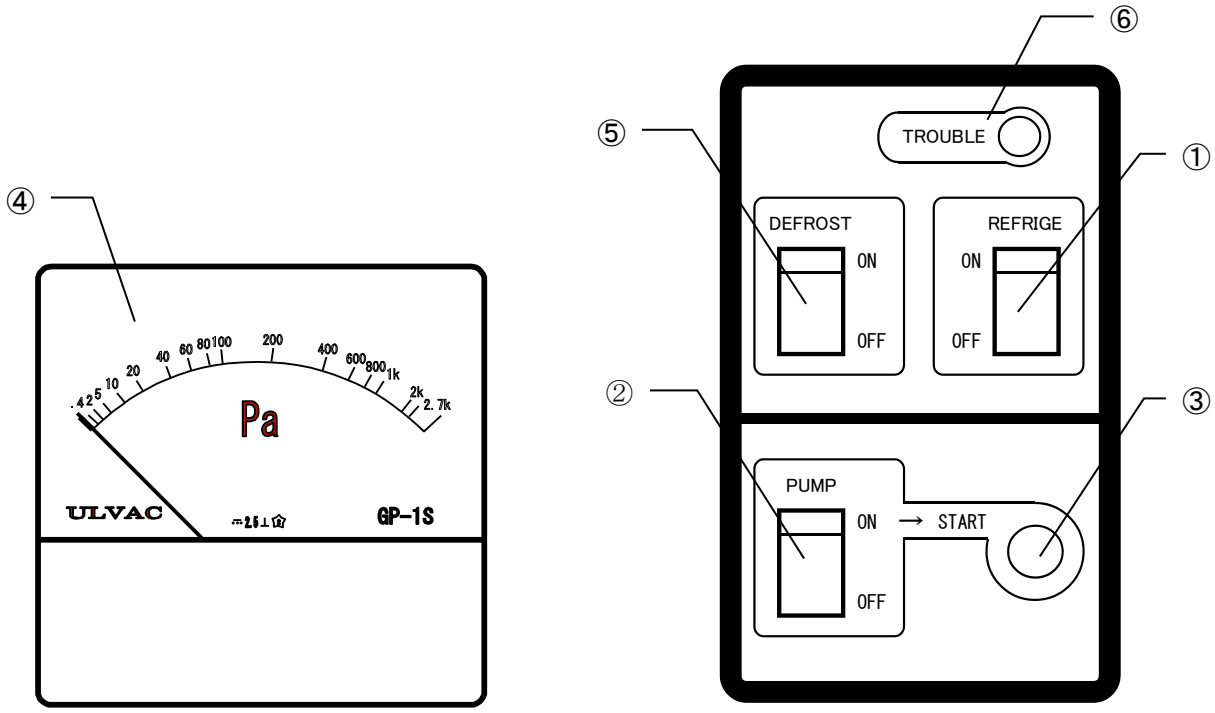



**Rear view**



# 3. COMPONENT NAMES & FUNCTIONS

## Control Panel




| Part Name | | Function |
|---|---|---|
| ① | Refrigeration Switch | Activates/deactivates refrigeration system. |
| ② | Vacuum Pump Switch | Enables/disables pump operation. |
| ③ | Pump Start Switch | Starts pump operation. |
| ④ | Pirani Vacuum Gauge | Decompression (vacuum) strength meter. |
| ⑤ | Defrost Switch | Loosens ice buildup in cold trap. |
| ⑥ | Refrigeration Error Lamp | Lights when refrigeration system is in overload. |

# 4. OPERATION PROCEDURES

## Pre-freezing

For the pre-freezing process, freeze samples quickly and completely through, at a temperature sufficiently lower than sample eutectic (solidification) point*. Freeze as thinly as possible so that sample will not have a chance to melt before the drying process can dry it. Likewise, external heat may influence and begin melting samples with a low eutectic table, if it is frozen too thickly in the container.

Be advised that if throughput is too high, or if the eutectic point of samples is low, melting may give way to sudden boiling (bumping) which may scatter samples.

- When installing containers during a freeze-dry process, following pre-freeze, wait 3-4 minutes (varies with container and sample types) before installing the next container and opening the next valve for the next process, and so on until the whole process for all containers is complete.

  Making intervals shorter between each individual container process or attempting to install all containers at once, will cause samples to melt before vacuum pressure is able build again to dry them.

**Eutectic (solidification) Point**

- If pure water freezes at 0 degree Celsius, a mixed solution of water and other fluids may not freeze immediately below 0 degrees Celsius, and may simply become soft ice, or not freeze at all, because of being mixed with fluid(s) having a freezing point below 0.
  If temperature continues to fall, the value at which the entire solution uniformly freezes solid is called the “eutectic point” of that solution.

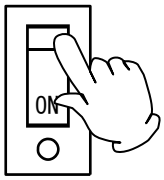
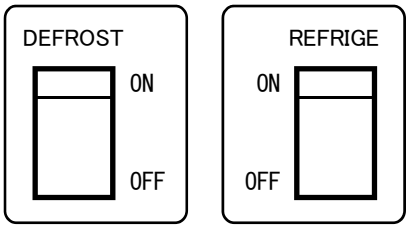
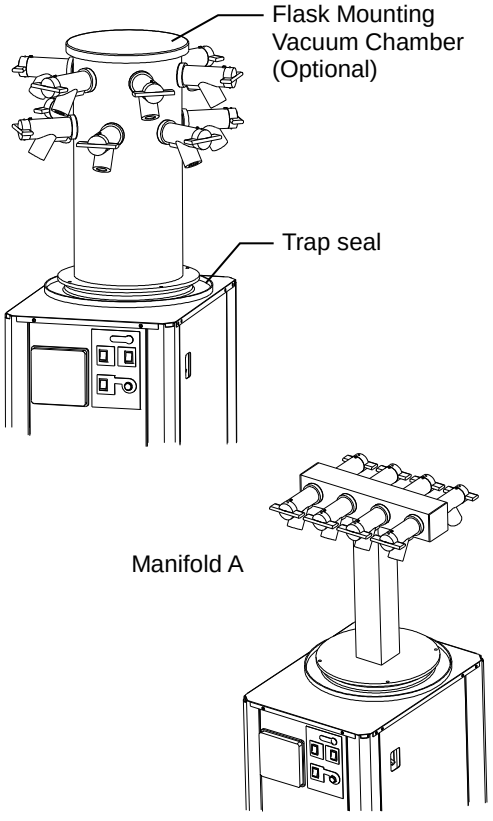
# 4. OPERATION PROCEDURES

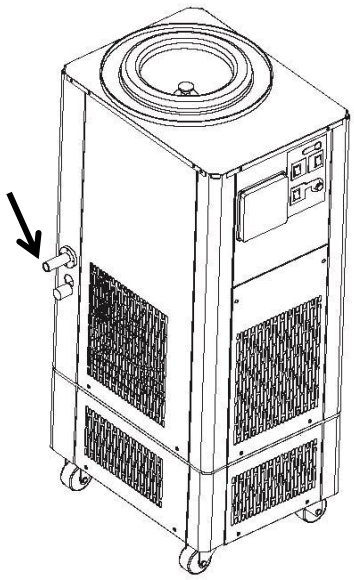
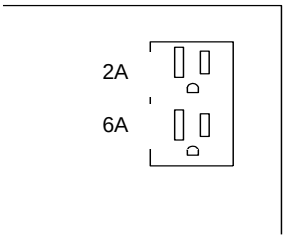
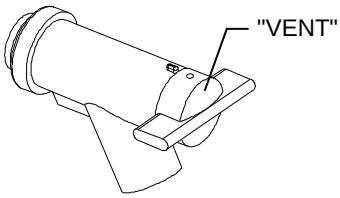
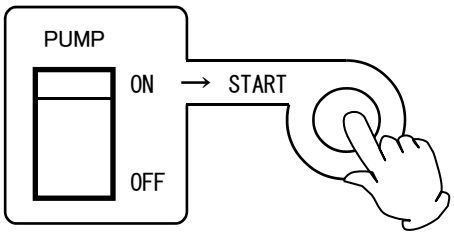
## Main Operation

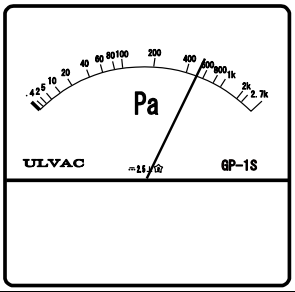
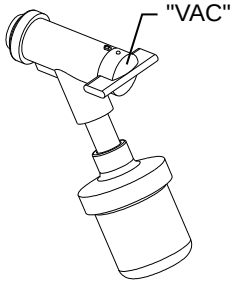
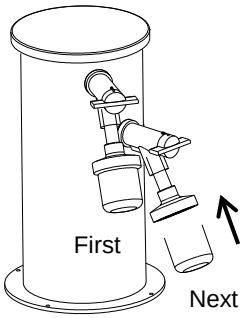
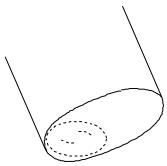
Prepare dryer manifold, vacuum pump, vacuum hose, tandem tube, and other equipment necessary to operation process.

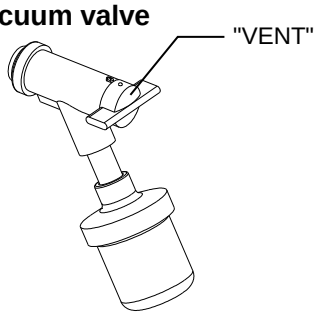
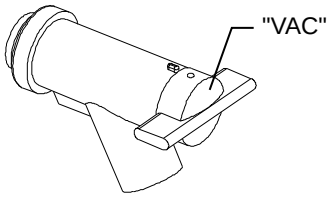
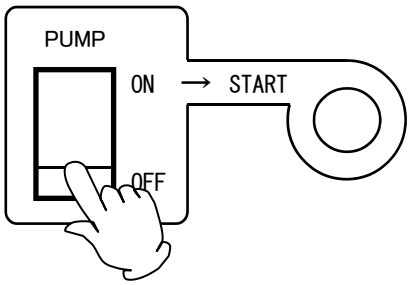
Example vacuum pump: PD52 (from YAMATO Scientific)

Displacement volume: 50/min, maximum vacuum pressure: $6.7 \times 10^{-2}$Pa,
inlet pipe diameter: 18mm (or equivalent)

| | |
|---|---|
| **1. Turn power ON**<br>  | • Turn "ON" main power switch (ELB). |
| **2. Start refrigeration**<br>  | • Turn "ON" refrigeration switch. Refrigeration system activates.<br>❖ In some cases, sound of the refrigeration unit may be higher or lower, depending on initial operation status and surrounding temperature. This phenomenon is not abnormal. |
| **3. Install vacuum chamber.**<br>  | 1. Be sure there is no dust or other contaminants on the trap seal or vacuum chamber before flask installation.<br>❖ Damage to or contaminants on chamber and seal weaken vacuum pressure.<br>2. Gently place flask mounting vacuum chamber on trap seal.<br>❖ If vacuum chamber does not sufficiently adhere to trap seal, a vacuum leak may result.<br>❖ The above holds true for Manifolds A & B, etc. as well |

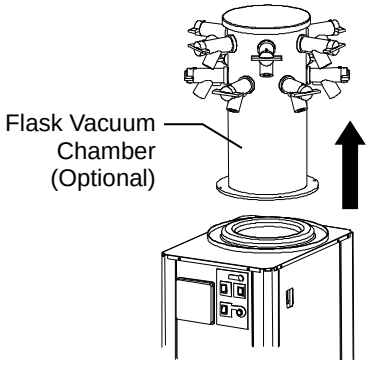
| | |
|---|---|
| **4. Connect vacuum pump**<br>  | • Connect vacuum hose from pump to the vacuum port on left side of unit.<br>(Exhaust port outer diameter: 17mm)<br>(Inside dia. of applicable vacuum hose: 12mm X outer diameter 30mm)<br>Connect the opposite end of the vacuum hose to vacuum pump inlet.<br>❖ Seal strength may be improved by applying vacuum seal grease (silicon grease compound manufactured by TORAY, H.V.G, etc) to the inside of vacuum hose opening. |
| **5. Connect vacuum pump to power outlet on back of unit**<br>  | • Connect vacuum pump power cable to the 6A power outlet on back of DC unit.<br>• Keep vacuum pump switch ON.<br>❖ Do not go above 8A total on 6A outlet. |
| **6. Close valves.**<br>  | • Turn all valves so that surface reading “VENT” is in the top position, closing chamber side path. |
| **7. Turn pump switch ON and press START**<br>  | • When the trap is sufficiently cooled (time required to reach minimum temp has passed), start the vacuum pump.<br>• Time required to minimum temperature:<br>(external temperature: 20°C, no load)<br>**DC401: 50min.**<br>This time is a guideline and may vary. (There will be condensation near the bottom of vacuum chamber when sufficient time has passed) |

| | |
|---|---|
| **8. Check vacuum gauge**<br>  | • Confirm by looking at the vacuum gauge, that vacuum chamber has sufficiently decompressed. (10Pa-20Pa) |
| **9. Install sample container and open valve**<br>  | • Install the pre-frozen sample container on the vacuum valve, turn the valve knob so that “VAC” is in the top position, opening the chamber side path.<br>Sample container is decompressed and drying process begins. |
| **10. Install the next container**<br>  | • When a vacuum valve is set from “VENT” to “VAC”, the chamber interior is pressurized. To process multiple samples, wait (approx. 3-4 min.) until the pressure has returned before turning the next vacuum valve from “VENT” to “VAC”.<br>❖ If multiple samples are processed at one time, decompression will decrease and pre-frozen samples will begin melting. |
| **11. End process**<br>  | • Process may be ended after confirming sample status and making sure process has finished normally. |

| | |
|---|---|
| **12. Close vacuum valve**<br>  | • When process has finished, turn valve from “VAC” to “VENT” (“VENT” in the top position) to normalize pressure in the sample container and remove the container.<br>Hold container securely when removing, so that it is not dropped. |
| **13. Normalize chamber pressure**<br>  | • When the drying process has completed for all samples, and all containers have been removed, turn one of the vacuum valves gradually until “VAC” is in the top position. This returns pressure inside the chamber to normal. |
| **14.Turn vacuum pump OFF**<br>  | • Turn the vacuum pump switch OFF, after chamber pressure has normalized. |

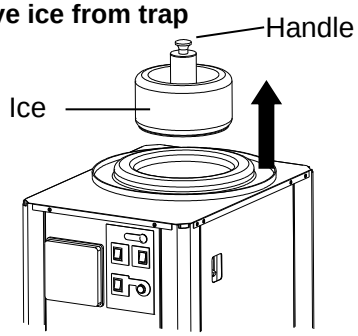
## Defrost

**1. Remove chamber**




- Remove the flask mounting vacuum chamber from the trap.
  If ice has formed on trap wall, turn ON the defrost switch.

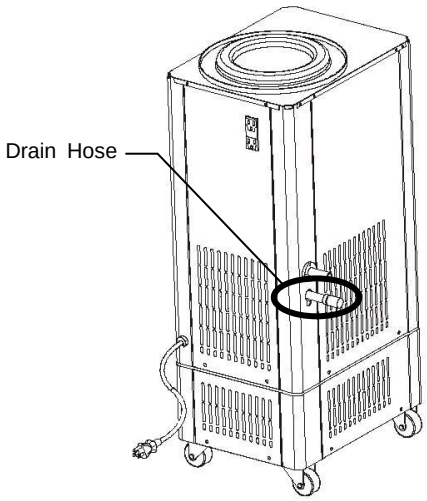
**2. Remove ice from trap**




- When ice has melted sufficiently to remove, do so by pulling up on handle and turn OFF the defrost switch.
- Defrost auto stop.
  DC401: Approx. 20min.

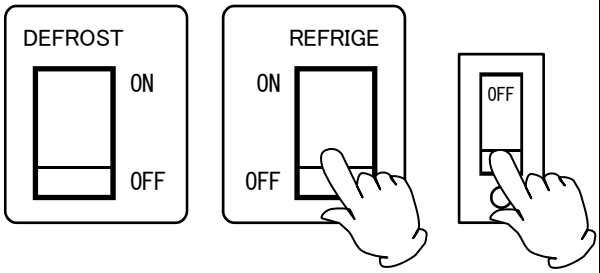
❖ Turn OFF defrost switch manually.

**3. Drain water**




- Remove the drain hose cap, and drain remaining water from the trap into a drain basin or other receptacle.

**4. Stop refrigeration system**




1. Turn "OFF" the refrigeration switch.
2. Turn "OFF" the main power switch (ELB).

# 5. HANDLING PRECAUTIONS

## WARNING!

**DO NOT operate equipment when abnormalities are detected.**

If unit begins emitting smoke or abnormal odors for reasons unknown, turn off main power (ELB) immediately, disconnect power cable from power supply, and contact a local dealer or Yamato sales office for assistance. Continuing to operate without addressing abnormalities may cause fire or electric shock, resulting in serious injury or death. Never attempt to disassemble or repair unit. Repairs should be always be performed by a certified technician.

**DO NOT handle flammable substances without proper ventilation.**

Be sure there is adequate ventilation when working with certain flammable substances (such as ethanol, etc.), which evaporate quickly at or below room temperature, and emit flammable fumes. Little or no ventilation may cause a fire or explosion resulting in serious injury or death.

## CAUTION!

**Trap capacity.**

Maximum cold trap capacity for DC401 is approx. 0.6ℓ /1.0ℓ respectively. Exceeding this capacity may severely degrade performance.

**DO NOT climb on equipment.**

Do not attempt to climb onto unit or substitute it for a proper step ladder. Units are not designed to support bodily weight and damage may result. In addition, unit may become unstable and tip over or fall resulting in equipment damage, serious injury or death.

**DO NOT place objects on equipment.**

Do not place any objects on unit. Doing so may cause unit to become unstable and tip over, resulting in possible equipment damage, injury or death.

**DO NOT operate equipment during thunderstorms.**

In the event of a thunderstorm, turn off main power switch (ELB), and disconnect power cable immediately. A direct lightning strike may cause equipment damage fire or electric shock, resulting in serious injury or death.

**Overnight and extended storage.**

Whenever unit is not in operation, stored overnight or placed in storage, always turn off main power switch and disconnect power cable. Drain any fluid collected in the cold trap.

**Power supply voltage.**

Power supply voltage must be within +/-10% of the rated voltage.

**DO NOT use solvents.**

The seals contained in DC series units are made from chloroprene rubber and may be damaged by acids, halogens, aromatics, esters, and oxo solvents. Do not use these compounds with unit.

**Restarting**

To restart, wait more than 5 minutes after unit has been turned off before turning back on.

# 5. HANDLING PRECAUTIONS

**Upper limit of inside bath temperature.**

Do not run successive operations when cold trap temperature is above -20°C.

**Vacuum grease application.**

Vacuum pressure is weakened and vacuum leaks may occur if any contaminants are allowed to build up on vacuum connection components. If contaminant buildup is found in any vacuum connection joints, clean and reapply vacuum grease as needed.
If vacuum valve stem tubes become difficult to rotate, remove the stem tube, apply vacuum grease, and reinstall.

**Normalizing pressure.**

Before turning OFF the vacuum pump, following an operation run, confirm that pressure in the vacuum chamber has returned to normal. If vacuum pump is turned OFF while chamber is decompressed, oil from the pump may back up into the chamber. Refer to P.15 for pressure normalization procedure.

**Ampule neck size.**

Ampule adapter inner diameter is 7mm. Use ampules with a connection neck size of 7-9mm.

**Teardrop flask.**

Use TS29 for teardrop flask fitting.

# 6. MAINTENANCE PROCEDURES

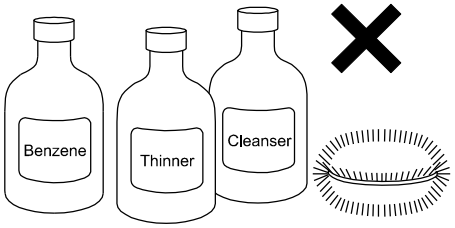
## Inspection & Maintenance

## ⚠WARNING!

- Always disconnect the power cable when performing inspection or maintenance, unless otherwise necessary.
- Perform daily inspection and maintenance after unit temperature has returned to normal (room temp).
- Do not disassemble unit.
- Do not touch cooling fins with bare hands or fingers.

## ⚠CAUTION!

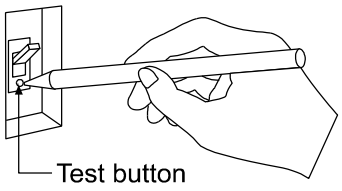
- Clean with a soft, damp cloth. Never use benzene, paint thinner, scouring powder, scrubbing brushes or other abrasives and solvents to clean unit. Superficial damage and/or discoloration, as well as deformity to some components may result.




### Monthly maintenance

**Inspect main power switch (ELB) ON and OFF function.**

- Prepare unit for inspection by connecting power cable to a facility outlet or terminal.
- Confirm that main switch (ELB) is “OFF” then, turn main switch (ELB) back “ON”.
- With the main switch “ON”, depress the test button on the main switch (ELB) using a ball-point pen or other fine-tipped object. If main switch (ELB) shuts off, it is functioning normally.




### Cleaning cooling fins

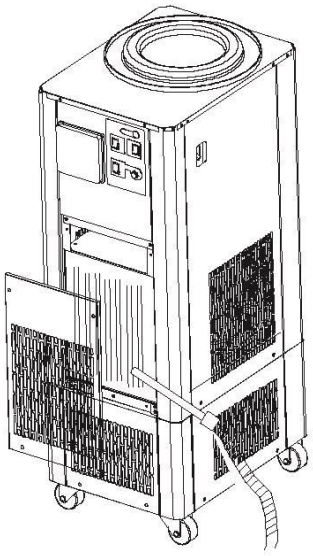
- If cooling fins are allowed to become clogged with dust, degraded performance and refrigeration system malfunction may result. Inspect and clean cooling fins periodically.

❖ Loosen (4) vent cover mounting screws and remove. Clean dust from cover/filter using a vacuum cleaner.

❖ After cleaning the cooling fins in the same way, reinstall vent cover.

⚠ Be careful not to bend or crush the fins while cleaning.

⚠ Do not contact cooling fins with bare hands or fingers.



**Contact a local dealer, or Yamato sales office for further assistance.**

## ⚠CAUTION!

**Extended storage**

- Turn off power switch and disconnect power cable before putting unit in storage or out of service.
- Drain all fluid and wipe remaining remnants from cold trap.

## ⚠WARNING!

**Disposal**

- Place out of reach of children.
- Dispose of main unit and cold trap as bulky or industrial waste.
- Refrigeration unit utilizes flammable refrigerant. Dispose of refrigerant by draining in small amounts at a time in a well-ventilated area, away from flames.

## Disposal Considerations

Dispose of or recycle this unit in a responsible and environmentally friendly manner.

Yamato Scientific Co., Ltd. strongly recommends disassembling unit, as far as is possible, in order to separate parts and recycle them in contribution to preserving the global environment.

Major components and materials, comprising DC series units are listed in the table below:

| Component | Material/Compound |
|---|---|
| **Main** | |
| Casing | Galvanized steel with baked-on melamine resin coating |
| Inner trap, Cover | Stainless steel SUS304, Acrylic |
| Name plate | Polyester (PET) resin film |
| Corner protectors | Alkylbenzenesulfied (ABS) resin |
| Trap seal | Silicon rubber |
| **Electrical** | |
| Switches, Relays | Composite of resin and other |
| Power cable, wiring materials and other | Composite of synthetic rubber, copper, nickel and other |
| **Refrigeration System** | |
| Refrigeration unit | Iron, Synthetic oil and other |
| Cooling fins | Aluminum, Copper |
| **Parts of Piping** | |
| Drain hose | Natural rubber |
| Drain tap | Polyacetal resin |
| Drain tap holder | Galvanized steel with baked-on melamine resin coating |
| Pipe cover | Polyurethane sponge |
| Pipe | Copper |
| **Sealed Cooling Medium for Refrigerator** | |
| Coolant | DC401: R404A,225g |

# 8. TROUBLESHOOTING

## Troubleshooting Guide

| Symptom | Possible Causes/Solutions |
|---|---|
| Unit will not power on. | • Power cable is not connected properly or securely.<br>• Power failure in progress.<br>• Main power switch (ELB) is “OFF” |
| Temperature does not fall. | • Cooling fins are clogged with dust or debris.<br>• Too many samples are being processed at once.<br>• External temperature exceeds 30°C.<br>• Cooling vent(s) are obstructed. |

### Error lamps

| Error symptom | Cause | Remedy |
|---|---|---|
| Refrigeration error lamp on | Refrigeration system overload | • Turn power off immediately, eliminate error source (refer to "Trouble Shooting" – “temperature does not fall”, above) and restart after 5 minutes.<br>• If lamp stays lit after restart, call for service. |

If problem persists, turn off power immediately, disconnect power cable and call for service.

# 9. SERVICE & REPAIR

## Requests for Repair

When a problem occurs, terminate operation immediately, turn off main power switch (ELB) and disconnect power cable.
Contact a local dealer or Yamato sales office for assistance.

The following information is required for all repairs.

- Model name
- Serial Number
- Date (year/month/day) of purchase
- Description of problem in as much detail as possible

Refer to serial no. and rating sticker on unit.

## Guaranteed Supply Period for Repair Parts

Guaranteed maximum supply period for repair parts is 7 (seven) years from date of discontinuation for DC401 freeze dryer models. “Repair parts” is defined as components which, when installed, allow for continued unit operation.

# 10. SPECIFICATIONS

## Main Unit

| | | |
|---|---|---|
| Model | | DC401 |
| Method | | Cooled container system |
| Performance | Drying capacity | Max. 0.6kg |
| | Minimum temperature ※ | -45°C |
| | Time required to reach minimum temperature ※ | 50min. (20°C to -45°C) |
| Configuration | Refrigeration | Air cooling, 400W |
| | Coolant | R404a |
| | Pressure meter | Pirani gauge |
| | Vacuum port | $\phi$17mm |
| | Chamber material | SUS304, Cylindrical |
| | Dimensions of chamber | $\phi$153×H235mm |
| | Capacity | Approx. 4L |
| | Usable external temperature | 5 to 30°C |
| Standard measurements | External dimensions | W340×D450×H920 mm |
| | Weight | Approx. 47Kg |
| | Power requirements | 115V AC, 50/60Hz, 5A |
| Included items | | Vacuum silicon grease (TORAY H.V.G), Vacuum hose ($\phi$12×$\phi$30×1.5m), DC401 instruction manual, Pirani gauge instruction manual |

※Performance based on operation room temperature (20°C), no load

# 10. SPECIFICATIONS

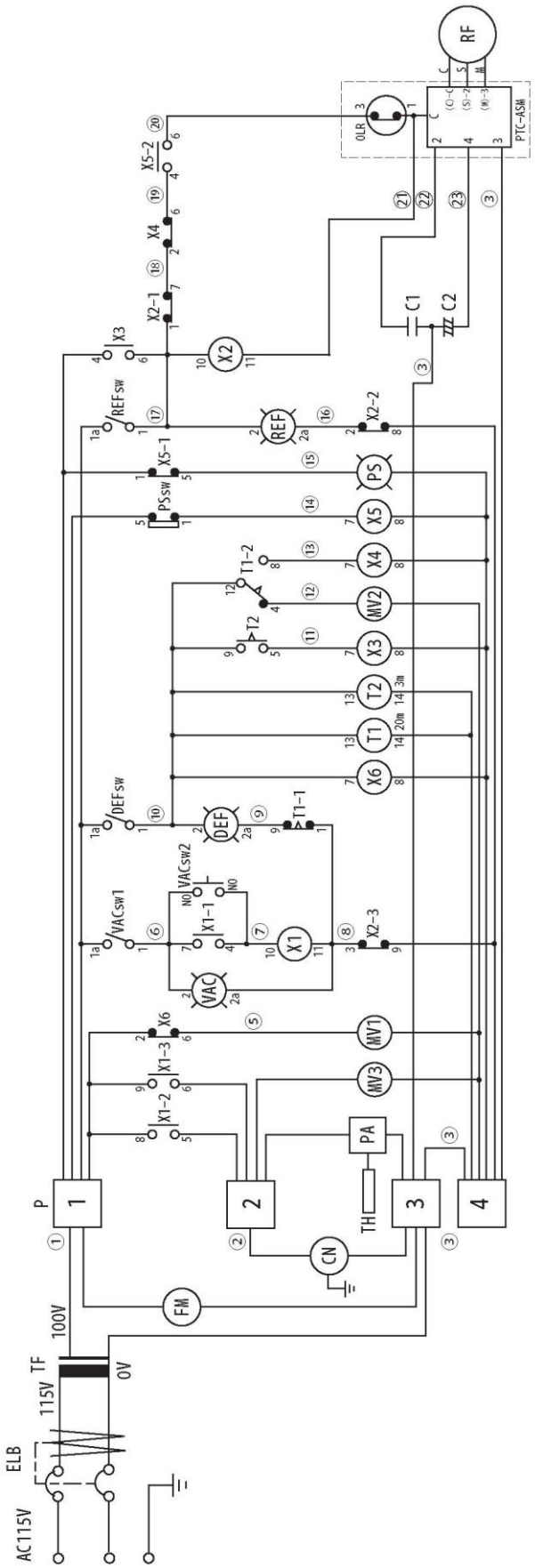
## Optional Accessories

| Name | Specification | | Product code |
|---|---|---|---|
| Flask Mounting Vacuum Chamber | Mounting valve | Inner dia.: 18.5mm | 212560 |
| | Mounting valve pitch | 96mm | |
| | Number of ports | 12 | |
| | Dimensions | ϕ195×H303 mm | |
| Manifold A | Mounting valve | Inner dia.: 18.5mm | 212561 |
| | Mounting valve pitch | 80mm | |
| | Number of ports | 8 | |
| | Dimensions | W304×D60×H263 mm | |
| Manifold B | Mounting valve | Inner dia.: 18.5mm | 212562 |
| | Mounting valve pitch | 80mm | |
| | Number of ports | 16 | |
| | Dimensions | W624×D60×H263 mm | |
| Dry chamber | Number of shelves | 1 | 212563 |
| | No. of 60mm petri dishes supplied | 7 | |
| | Temperature adjustment | 30°C±2°C ※ | |
| | Dimensions | ϕ252×H240 mm | |
| Stopper plug type dry chamber | Number of shelves | 1 | 212564 |
| | No. of 60mm petri dishes supplied | 7 | |
| | Temperature adjustment | 30°C±2°C ※ | |
| | Dimensions | ϕ252×H425 mm | |
| Dry flask | 120mℓ ・5 pcs. | | 212820 |
| | 250mℓ ・5 pcs. | | 212821 |
| Dry flask cap (with glass joint) | Straight・5 pcs. | | 212570 |
| | 45° bent・5 pcs. | | 212571 |
| Serum bottle (Vial) | 50mℓ ・10 pcs. | | 212814 |
| | 30mℓ ・10 pcs. | | 212815 |
| | 10mℓ ・10 pcs. | | 212816 |
| Ampule adapter | Single・5 pcs. | | 212572 |
| | Double・5 pcs. | | 212573 |
| | Triple・5 pcs. | | 212574 |
| Test tube adapter (with glass joint) | Straight | | 212590 |
| | Angled 45° | | 212591 |
| Teardrop flask adapter (female) | TS29 fitting or equivalent | | 212569 |
| Teardrop flask adapter (male) | TS29 grinding | | 212597 |
| Glass joint | Straight | | 212598 |
| | Angled 45° | | 212599 |
| Micro tube holder | 1.5mℓ ×16 pcs. mountable | | 212580 |

※Performance based on operation at 20°C, no load

# 11. WIRING DIAGRAM

## DC401




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ELB | Earth leakage breaker | X3 | Relay (refrigeration) | PAsw | Switch (vacuum gauge) | CN | Power receptacle |
| P | Terminal block | X4 | Relay (refrigeration stop) | PSsw | Pressure switch | T1 | Timer (auto defrost) |
| FM | Fan motor (refrigeration) | X5 | Relay (pressure error) | VAC | Lamp (VACsw built-in) | T2 | Timer |
| MV1 | Solenoid valve (refrigeration) | X6 | Relay (solenoid valve) | DEF | Lamp (DEFsw built-in) | PTC-ASM | Start relay |
| Mv2 | Solenoid valve (defrost) | VACsw1 | Switch (pump) | REF | Lamp (REFsw built-in) | OVR | Overload relay |
| Mv3 | Solenoid valve (VAC) | VACsw2 | Switch (pump start) | PS | Lamp (pressure) | C1 | Operation condenser |
| X1 | Relay (VAC) | DEFsw | Switch (defrost) | PA | Pirani gauge | C2 | Start condenser |
| X2 | Relay (refrigeration, pump stop) | REFsw | Switch (refrigeration) | TH | Sensor (vacuum gauge) | RF | Refrigeration unit |

# 12. REPLACEMENT PARTS

**DC401**

| Symbol | Part Name | Specification | Manufacturer | Code No. |
|---|---|---|---|---|
| MV1 | Solenoid valve (refrigeration) | NEV-603DXF | Saginomiya | 3020060004 |
| MV2 | Solenoid valve (defrost) | SEV-502DXF | Saginomiya | 3020060003 |
| MV3 | Solenoid valve (VAC) | AG33022 AC100V | CKD | 3200010018 |
| ELB | Earth leakage breaker | BJS2032N 20A | Panasonic | 2060050002 |
| X3, 4, 6 | Relay | LY1F AC100V | OMRON | LT00000992 |
| X1, 2 | Relay | LY3F AC100V | OMRON | LT00000993 |
| T2, 3 | Timer (auto defrost) | ADX11134 | Matsushita | 2050000053 |
| T1 | Timer | ADX11184 | Matsushita | LT00000994 |
| DEFsw<br>PEFsw | Switch | CW-SB21NMKZMEF | Nihon Kaiheiki | 2550000011 |
| VACsw2 | Switch | CW-SB21NYKZYEF | Nihon Kaiheiki | 2550000017 |
| VACsw1 | Switch | A3CT-90A0-Y | OMRON | LT00000995 |
| PS | Lamp (pressure) | BN5665L AC100V | Satoh Parts | LT00021961 |
| CN | Receptacle | AC-R02MB12 | ECHO | LT00033205 |
| PA | Pirani gauge | GP-1 (WP-02 with sensor) | ULVAC | LT00001004 |
| PSsw | Pressure switch | VHP-F | Fuji Kohki | 3180000006 |
| RF | Compressor | RL4075HA | Hitachi | LT00028782 |
| FM | Fan motor | SE4-C041NP | Sanyo C&C | 3010060006 |
| P | Terminal block | MKH-250ABC-4P | Terminal | LT00035672 |
| X5 | Relay | LY2F AC100V | OMRON | 2050000035 |
| TF | Transformer | UD11-02KB | Toyozumi | LT00033685 |

# 13. LIST OF HAZARDOUS SUBSTANCES

Never process any explosive, flammable samples and also samples contained with those substances.

| | |
|---|---|
| Explosive Substance | ①Nitroglycol, Glycerine trinitrate, Cellulose Nitrate and other explosive nitrate esters |
| | ②Trinitrobenzen, Trinitrotoluene, Picric Acid and other explosive nitro compounds |
| | ③Acetyl Hydroperoxide, Methyl Ethyl Ketone Peroxide, Benzoyl Peroxide and other organic peroxides |
| | ④Metallic Azide, including Sodium Azide, etc. |
| ExplosiveSsubstances | ①Metal “Lithium” ②Metal “Potassium” ③Metal “Natrium” ④Yellow Phosphorus<br>⑤Phosphorus Sulfide ⑥Red Phosphorus⑦Phosphorus Sulfide<br>⑧Celluloids, Calcium Carbide (a.k.a, Carbide)⑨Lime Phosphide⑩Magnesium Powder<br>⑪Aluminum Powder ⑫Metal Powder other than Magnesium and Aluminum Powder<br>⑬Sodium Dithionous Acid (a.k.a., Hydrosulphite) |
| Oxidizing Substances | ①Potassium Chlorate, Sodium Chlorate, Ammonium Chlorate, and other chlorates |
| | ②Potassium Perchlorate, Sodium Perchlorate, Ammonium Perchlorate, and other perchlorates |
| | ③Potassium Peroxide, Sodium Peroxide, Barium Peroxide, and other inorganic peroxides |
| | ④Potassium Nitrate, Sodium Nitrate, Ammonium Nitrate, and other nitrates |
| | ⑤Sodium Chlorite and other chlorites |
| | ⑥Calcium Hypochlorite and other hypochlorites |
| Flammable Substances | ① Ethyl Ether, Gasoline, Acetaldehyde, Propylene Chloride, Carbon Disulfide, and other substances with ignition point at a degree 30 or more degrees below zero. |
| | ②n-hexane, Ethylene Oxide, Acetone, Benzene, Methyl Ethyl Ketone and other substances with ignition point between 30 degrees below zero and less than zero. |
| | ③Methanol, Ethanol, Xylene, Pentyl n-acetate, (a.k.a.amyl n-acetate) and other substances with ignition point between zero and less than 30 degrees. |
| | ④Kerosene, Light Oil, Terebinth Oil, Isopenthyl Alcohol(a.k.a. Isoamyl Alcohol), Acetic Acid and other substances with ignition point between 30 degrees and less than 65 degrees. |
| Combustible Gas | Hydrogen, Acetylene, Ethylene, Methane, Ethane, Propane, Butane and other gases combustible at 15℃ at one air pressure. |

(Source: Appendix Table 1 of Article 6 of the Industrial Safety and Health Order, Japan)

## Limited Liability

**Always operate equipment in strict compliance to the handling and operation procedures set forth by this instruction manual.**
**Yamato Scientific Co., Ltd. assumes no responsibility for malfunction, damage, injury or death, resulting from negligent equipment use.**
**Never attempt to disassemble, repair or perform any procedure on DC401 units which are not expressly mandated by this manual. Doing so may result in equipment malfunction, serious personal injury or death.**

### Note

- **Instruction manual descriptions and specifications are subject to change without notice.**
- **Yamato Scientific Co., Ltd. will replace flawed instruction manuals (pages missing, pages out of order, etc.) upon request.**

Instruction Manual
**Freeze Dryer**
**Model DC401**
First Edition June 7, 2017
Revision

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