



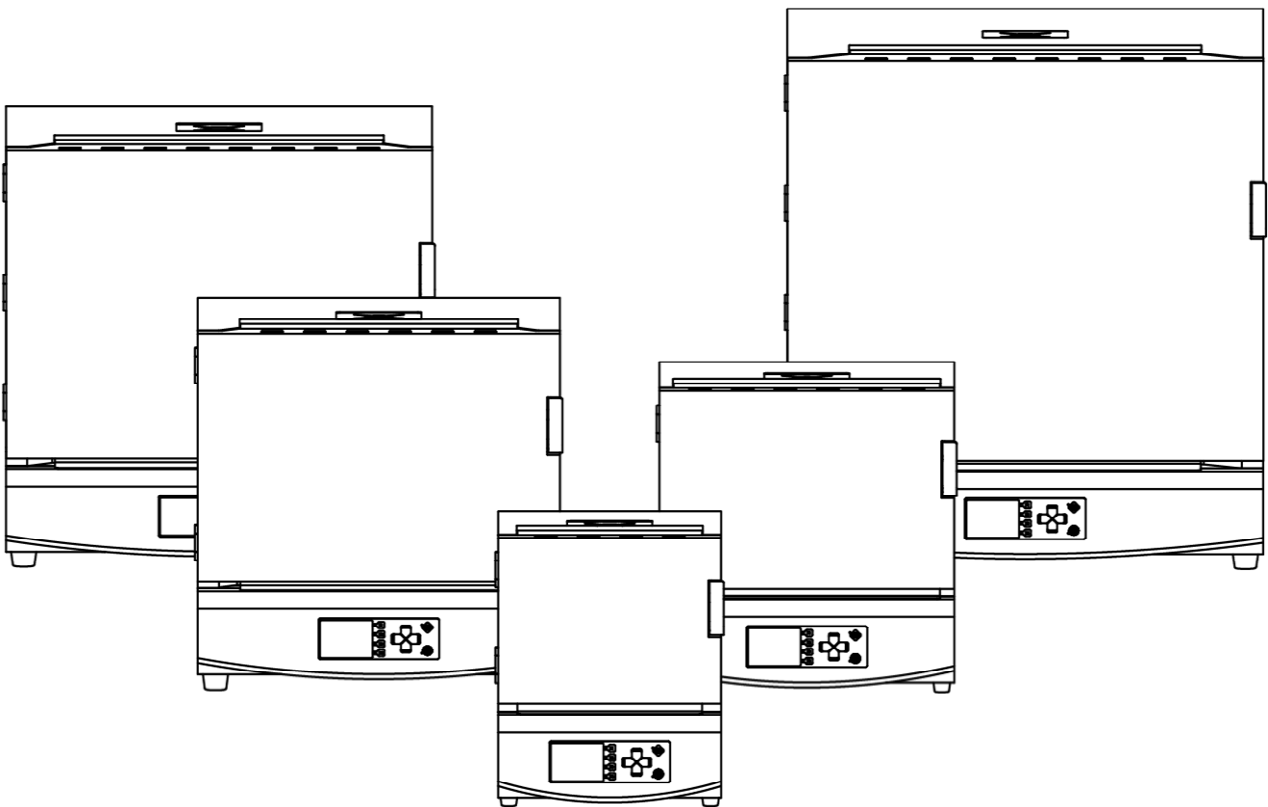
## Instuction Manual

# Electric furnace Plus series

300 500 1500 3000 5000-Plus

Thank you for purchasing KDF's Electric Furnace Plus series. Before using the unit, please read the manual thoroughly and understand the capabilities and proper usage for this machine.

Please keep this manual in an easily accessible location for future reference.



DENKEN-HIGHDENTAL Co., Ltd.



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# Safety Precautions

We recommend you to follow these instructions for proper use of the unit.

The safety precautions contained herein and the accompanying icons provided for the safe use of this machine and to prevent injuries and loss on material resources. Please read them carefully prior to your actual machine operation.



**WARNING**

Failure to follow or ignorance of the directions may cause severe injury or death.



**CAUTION**










Failure to follow or ignorance of the directions may cause injuries or damages to material properties.












This symbol indicates that the action is prohibited.



This symbol indicates the content that calls attention or compulsory matter.

 <b>WARNING</b>		<p>If any of the following situations occur, immediately turn off the power switch and breaker of this machine to cut off the power supply and contact your dealer. Continued use may cause fire or electric shock.</p> <ul style="list-style-type: none"> <li>● When an abnormality such as smoke, a strange odor, or a noise occurs.</li> <li>● If water gets inside.</li> <li>● When foreign matter enters the inside.</li> <li>● If the unit is dropped or the cabinet is damaged/deformed.</li> </ul>
		<ul style="list-style-type: none"> <li>● Do not disassemble except where indicated. It may cause electric shock or malfunction.</li> </ul>
		<ul style="list-style-type: none"> <li>● Perform wiring work safely and securely in accordance with the electrical equipment technical standards and the regulations of the electric power company. Also, do not use a power supply other than the specified voltage. It may cause a fire.</li> <li>● Ask a licensed electrician to perform power supply work. Unlicensed work is not only against the law, but also dangerous and may cause electric shock, fire and breakdown.</li> <li>● When connecting the power cord to this unit, be sure to perform ground work. It may cause electric shock.</li> </ul>
		<ul style="list-style-type: none"> <li>● Do not block the fan intake port on the back of this machine. The internal temperature will rise, which may cause a fire or malfunction.</li> </ul>
		<ul style="list-style-type: none"> <li>● Do not use the voltage other than the power voltage shown on the rating plate. It may cause fire or electric shock. This unit can only be used in Japan.</li> </ul>
		<ul style="list-style-type: none"> <li>● When installing this unit, keep it 100 cm above the ceiling and at least 30 cm away from walls and equipment in other cases. Also, do not place any objects on the top surface of this machine. It may cause fire or malfunction.</li> <li>● Do not install in a place where flammable materials may fall onto the projector or fly. It may cause a fire.</li> <li>● Do not install in places subject to rain or water. There is a risk of electric shock.</li> </ul>
		<ul style="list-style-type: none"> <li>● Do not place a heavy object on the power cord or the power cord under the unit. The cord may be scratched, resulting in fire or electric shock.</li> <li>● Do not damage, modify, forcibly bend, twist or pull the power cord. The cord may be damaged resulting in fire or electric shock.</li> <li>● Do not turn off the power supply by turning off the power switch or turning off the breaker while the cooling fan of this unit is operating. The external case of this machine may become hot and burn, which may cause a fire.</li> </ul>
		<ul style="list-style-type: none"> <li>● Do not process substances that generate explosive gas due to heat treatment with this machine. Explosion may result in death, injury or fire. Take measures beforehand to prevent the generation of explosive gases.</li> <li>● Be sure to follow the equipment, rating, and method described in the outlets and connection terminals on the back of this unit. Internal parts may burst or burn, which may cause a fire. The internal parts may burst or burn, which may cause a fire. It may also cause a malfunction of this unit and connected devices.</li> </ul>

 <b>CAUTION</b>		<ul style="list-style-type: none"> <li>● Be sure to turn off the breaker of this machine for safety when you do not use this machine for a long time.</li> </ul>
		<ul style="list-style-type: none"> <li>● Do not operate the machine with wet hands. It may cause electric shock.</li> <li>● Do not pull the power cord when unplugging the power plug. The cord may be damaged, causing fire or electric shock. Be sure to hold the plug and pull it out.</li> </ul>
		<ul style="list-style-type: none"> <li>● This machine is an industrial electric furnace. Do not use it for any other purpose.</li> </ul>
		<ul style="list-style-type: none"> <li>● When move it, turn off the breaker of the power supply source, disconnect the power cord from the outlet, or disconnect it from the power terminal of this machine. The cord may be damaged and cause a fire.</li> </ul>
		<ul style="list-style-type: none"> <li>● Do not open the furnace door when the temperature inside the furnace is high (600°C or higher). This may cause damage to the insulation, burns, or fire. Also, depending on the heat-treated product, there is a risk of explosion due to sudden air entry.</li> <li>● Do not raise the temperature with the furnace door of this machine open. It may cause burns or fire.</li> <li>● While the cooling fan of this unit is operating, be careful not to cut off the power supply by turning off the power switch or breaking the breaker. The case of this machine will not be cooled and may cause burns.</li> </ul>
		<ul style="list-style-type: none"> <li>● Fixed the wiring and piping connected to this machine so that they will not be caught. It may cause electric shock, fire or gas leak.</li> <li>● Keep paper, cloth, curtains, vinyl, hair spray, gasoline, benzine, thinner, alcohol, and other flammable materials away from this machine. Also, do not install this unit on a flammable object such as tatami mat, carpet, table cloth, etc. It may cause a fire.</li> </ul>
		<ul style="list-style-type: none"> <li>● Use the supplied power cord to supply power to this unit. If it is unavoidable to use another power cord, contact the manufacturer to see if the allowable current of the power cord is appropriate for this machine. If you use the wrong power cord, the power cord may overheat and cause a fire.</li> <li>● Connecting with the power plug conversion adapter may generate heat in the connection area and cause a fire. Please do not use.</li> <li>● When unplugging the power cord, do not pull it out. It may cause fire or electric shock. Hold the power plug and pull it out.</li> </ul>
		<ul style="list-style-type: none"> <li>● Please be careful not to touch the case as the cooling fan will stop during a power failure and the case may become hot. Also, please be careful not to touch the housing as the temperature may be high for a while after the power is restored.</li> </ul>

# Before you start using your furnace

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When you unpack the unit, we recommend you to make sure that the following standard accessories are included. In addition, check the unit for any damage or dent on the unit surface. Contact the dealer if there is any damage on the unit.

※The heat insulation material in the furnace may crack during delivery and during use, but this is not a defect. There is no problem with performance, so use it as is.

## Accessories

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### Standard accessories

Exhaust guide	1pc	
Exhaust port plug	1pc	
Hearth plate	1pc	※ (One set of 2 for 5000Plus)
AC cord	1pc	※ (Except 300Plus)
500, 1500Plus	3m	
3000, 5000Plus	5m	
For cleaners and Exhaust gas devices		
Extension cable	1pc	※ (Only for 3000, 5000Plus)
Instruction Manual (This document)	1booklet	

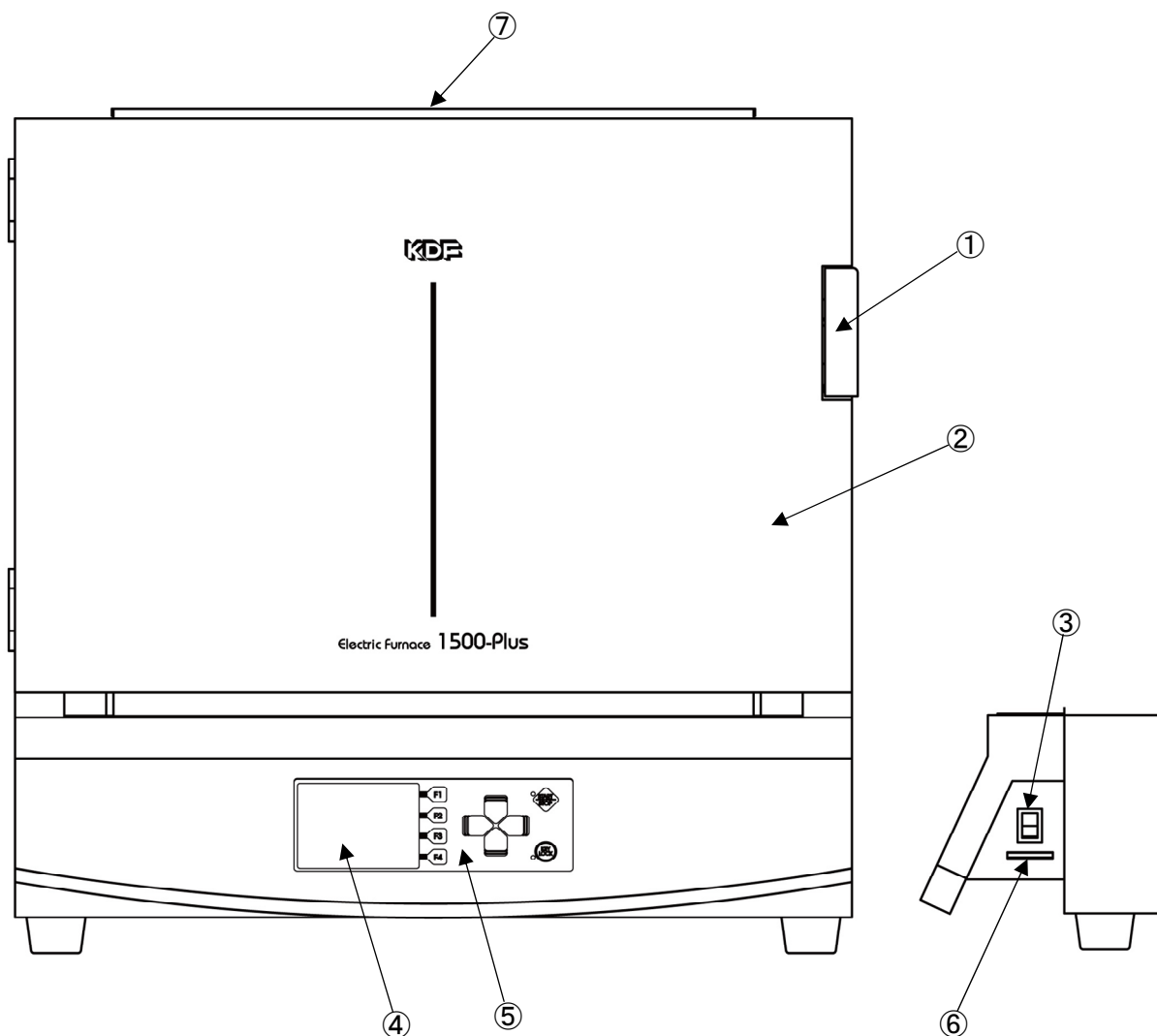
We recommend you to save the carton and all packing materials for future use when there is ever a need to ship or move your equipment



# Descriptions of Component Parts

## ■Furnace Front

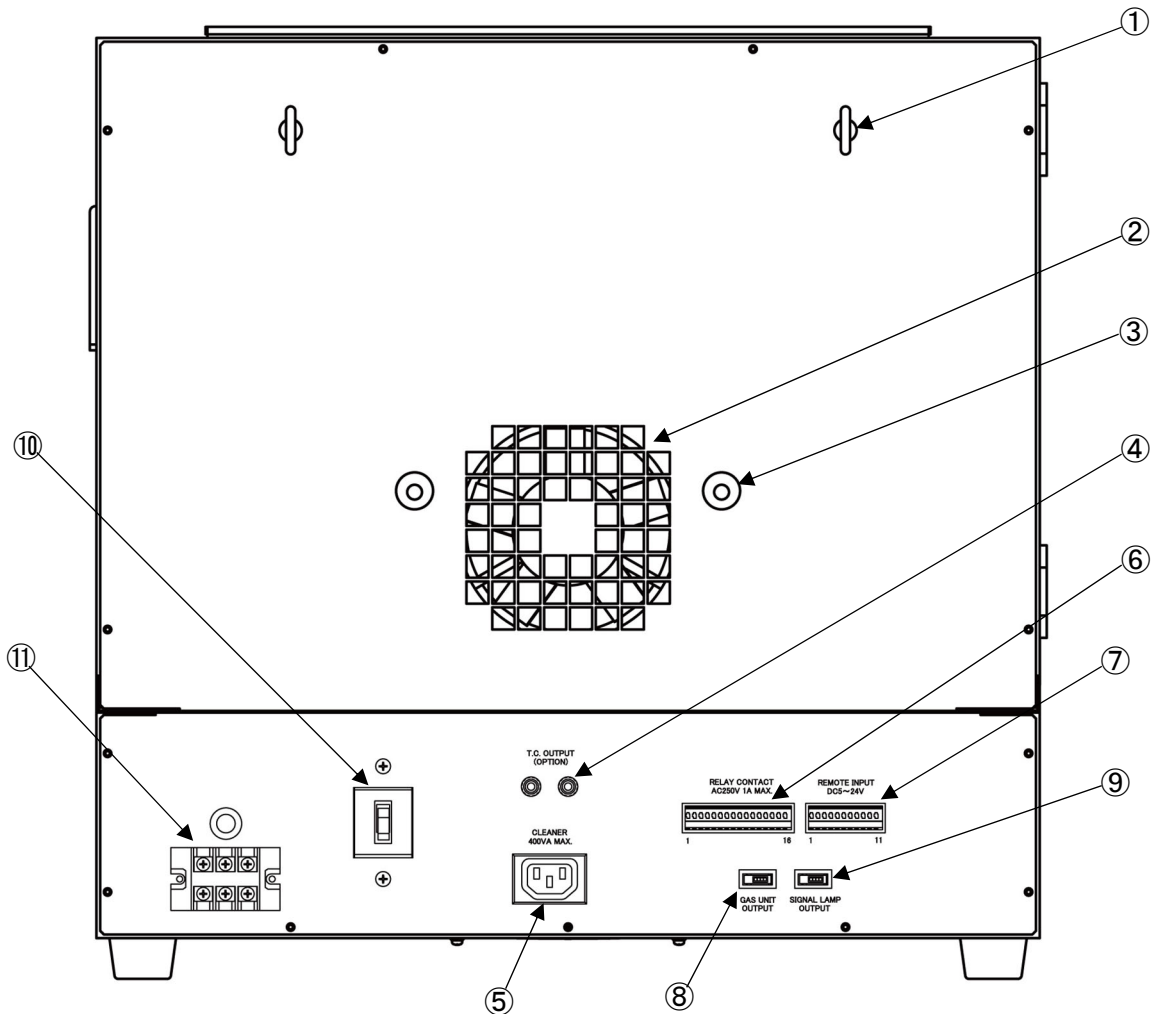
※The drawing below shows the 1500 Plus figure as a representative.



- |                       |  |
|-----------------------|--|
| ①Door Knob            | : Pull the knob to open the door and push to close.  |
| ②Furnace door         | : The door of the furnace body.  |
| ③Power switch (side)  | : To turn on the power.  |
| ④Liquid crystal panel | : Display part of the color liquid crystal.  |
| ⑤Operation panel      | : Program operation, Start processing  |
| ⑥SD card slot (side)  | : Use SD card to edit programs, update this unit, etc.   |
| ⑦Exhaust port         | : The exhaust port is open near the center of the furnace top surface.<br>Deodorizer and smoke exhaust when connecting, gas is exhausted from this hole. Usually, the exhaust port plug provided is packed and closed. |

## ■ Furnace Rear

※The drawing below shows the 1500 Plus figure as a representative.



- ①Eyebolt : Eyebolt for fixing this machine. Use wires to secure it to a sturdy structure such as a wall to prevent it from falling.
- ②Fan intake port : The intake port for the cooling fan.
- ③Gas pipe outlet : The outlet for the gas introduction pipe attached to the furnace body. Used when connecting the optional gas introduction unit.
- ④Temperature sensor signal output terminal : When an optional temperature sensor is attached, the temperature sensor signal can be output from this terminal. The red terminal is the positive pole. Options are K or Platinel thermocouples.
- ⑤Cleaner, smoke exhaust device output : Power outlet for optional cleaner and smoke exhaust device. The 3000 and 5000Plus are connected using the included extension cable. Do not connect anything other than our designated cleaner and smoke exhaust device.
- ⑥External output terminal : The terminal block that outputs information inside the main unit to the outside.
- ⑦Remote terminal : The connection terminal for remote control of the unit with a sequencer.
- ⑧Gas introduction unit terminal : The Terminal for connecting the optional gas introduction unit.
- ⑨Patlite terminal : The Terminal for connecting an optional patrol light.
- ⑩Overcurrent breaker : The main breaker of the main unit.
- ⑪Power supply terminal : The terminal to connect the power cord of this unit.  
 ※The power cord is directly attached to 300Plus (Only 300Plus)

# Precautions before use

## ■ About heat-treated products

When heat-treated in an electric furnace, the physical properties may change depending on the object, which may cause a danger to the surroundings and may adversely affect the electric furnace itself. Please read the following carefully.



### WARNING

Do not process substances that generate explosive gas by heat treatment with this machine. Explosion may result in death, injury or fire. Take treatment beforehand to prevent the generation of explosive gases.



### CAUTION

- A large amount of carbon is generated by heat treatment. Heat treat resin, etc. as little as possible. Also, if the inside of the furnace is black, carbon may be attached, so please be careful to muffle firing with unloaded at 800°C for about 1 hour. If the heat treatment is continued with the carbon still attached, the heater may break.
- The heat treatment may damage the furnace heat insulator, heater, hearth plate, sheet metal, and deodorizer due to the gas or liquid generated from the substance. When performing heat treatment, thoroughly check the material.
- If the processed material and the heat insulating material are in contact with each other, they may react with each other and fuse together, or the heater may break.

- If the product has not been used for a long time, the heat insulating material will absorb moisture, so it is recommended to bake it (800°C for about 1 hour) before use.

## ■ Insulation material



### CAUTION

- The heat generator of this machine uses lightweight insulation to improve the thermal efficiency and temperature distribution. For this reason, if the processed product contacts the hot plate, it may be damaged, so be careful not to contact the left and right hot plates when putting in or taking out the processed product. Also, depending on the type of gas or liquid generated from the heat-treated material, damage to the heat insulating material or breakage of the heater may occur, so please check in advance.

(Reference)	Heater material	Al	6%
		Cr	23%
		Fe	71%
	Insulation material	Al <sub>2</sub> O <sub>3</sub>	48%
		SiO <sub>2</sub>	52%

- If the inside of the furnace is at a high temperature of 600°C or higher and the door is opened for rapid cooling, the insulation may be damaged.

- ※ There may be cracks on the surface of the heat insulation material of the furnace body at the time of purchase or after several temperature rises, but there is no problem with performance and quality.

## ■ Regular operating temperature and maximum operating temperature

- Regular operating temperature

It is specified as a temperature that can withstand long-term use when there is no corrosive gas from the heat-treated product. Therefore, if corrosive gas, liquid, etc. are generated by heat treatment, the furnace is damaged in a relatively short period of time even if it is used at a normal operating temperature or a lower temperature. It is possible that the heater will break or the furnace insulation will be adversely affected.

- Maximum operating temperature

For a relatively short time (several hours), the temperature is set so that it can be used in the absence of corrosive gas. Therefore, it is not suitable for long-term use.

## ■ Operating at low temperature

Generally, due to the structure of electric furnaces, temperature control and temperature distribution tend to worsen as the operating temperature decreases due to control methods. When used below 300°C, the lower the temperature, the greater the tendency. Therefore, adjust the set temperature according to the actual firing condition.

## ■ Heating element

The heating element used in our electric furnace is a heating element for high-temperature furnaces with a maximum operating temperature of 1400°C. In particular, this material has extremely good resistance to oxidation in the atmosphere, making it suitable for various electric furnaces as well as various high-temperature furnaces and electric heating equipment.

### • Effects of various atmospheric gases

#### a) Atmosphere/Nitrogen

It can be used without problems. Especially in the air above 800°C, a protective film consisting of  $AL_2O_3$  is formed on the heater surface, so it is recommended to regularly bake in air.

#### b) Carburizing atmosphere

The protective film of  $AL_2O_3$  formed on the surface of the heating element prevents carburization inside and shows good high temperature corrosion resistance. Before using the heating element in the carburizing atmosphere, preheat it in the air (at 800°C or higher for about 5 hours) and generate a protective film of  $AL_2O_3$  on its surface to prevent carburization inside the heating element Lengthen.

#### c) Other

Any substance that inhibits the formation of the  $AL_2O_3$  protective film formed on the surface of the heating element or that reacts with the protective film to lower the melting point is harmful to the heating element.



CAUTION

#### ● S (sulfur)

Use in an atmosphere containing  $H_2S$  or  $SO_2$  is not preferable because it reacts with S to lower the melting point.

#### ● Halogen/salt

Halogen elements such as Cl and F and salts of alkali metals such as Na and K are all harmful because they hinder the formation of protective film.

### • Operating at low temperature

When used in a temperature range of 500°C or lower, the heater may break due to the carbon that comes out of the heat-treated product adhering to the heater surface (shooting phenomenon). If the inside of the furnace is dark, carbon may be attached, so bake it at 800°C or higher for about 1 hour. A long burning life can be expected as the carbon burns and an oxidation protection film is also formed on the heater surface.

## ■ Structure of the furnace door

The furnace door of this machine has a structure in which the heat insulating material moves slightly back and forth. This is to ensure that there is no gap between the furnace lid and the furnace lid even after many years of use, and the furnace lid is pressed with a spring when the door is closed, so that the furnace lid is always in close contact. It is supposed to be. If you open the door and press the furnace lid (insulation part), it will dent in the back, but this is not a malfunction.

## ■ Transportation



CAUTION

When transporting this product for movement or repair, do not put the hearth plate, objects, etc. in the furnace. Also, remove the exhaust port plug and exhaust guide. It damages the furnace during transportation.

# Handling method

## Installation of this machine

### ■ Installation location / environment

- In order to operate the muffle furnace normally, please prepare the following power supply equipment according to the product.
  - 300Plus : AC100V 50/60Hz, current capacity 20A
  - 500Plus : Single-phase AC200V 50/60Hz, current capacity 20A
  - 1500Plus : Single-phase AC200V 50/60Hz, current capacity 30A
  - 3000Plus : Single-phase AC200V 50/60Hz, current capacity 40A
  - 5000Plus : Single-phase AC200V 50/60Hz, current capacity 50A
- Install in a place with little dust and near the power supply facility.
- Install this machine on a horizontal and sturdy table, and fix it to a sturdy structure with metal wires, etc., to prevent it from falling.
- Install the unit at a distance of 100 cm on the top and at least 30 cm away from walls and equipment. Also, do not place any objects on the top surface of this machine.

### ■ Wiring work

- For 300Plus :

The power cord comes out of the main unit. Connect it to the grounded outlet of the power circuit prepared for this unit alone. Do not use a plug adapter, etc. There is a risk of fire or electric shock.
- For other than 300Plus :

Connect the supplied power cord to the power terminal of this machine, and then connect it to the power equipment prepared exclusively for this machine. The green wire of the power cord becomes the ground wire.



※Be sure to connect the ground wire to a properly constructed ground terminal.

### ■ Installation of hearth plate

- Please lay the attached hearth plate on the bottom of the furnace.
  - ※For 5000Plus, lay two attached hearth plates on the bottom of the furnace.



#### CAUTION

- If you place the fired product directly on the hearth plate, the temperature may be lower than the furnace temperature, so adjust it with a spacer such as refractory so that it is placed in the center of the furnace as much as possible.
- The hearth plate is necessary to protect the heat insulating material inside the furnace. Never use without the hearth plate.
- Since the hearth plate and the fired product may react with each other and damage each other, put the fired product in a tray or crucible that does not react with the fired product (alumina, mullite, etc.) before placing it on the hearth plate.

### ■ Installation of exhaust guide and exhaust port plug

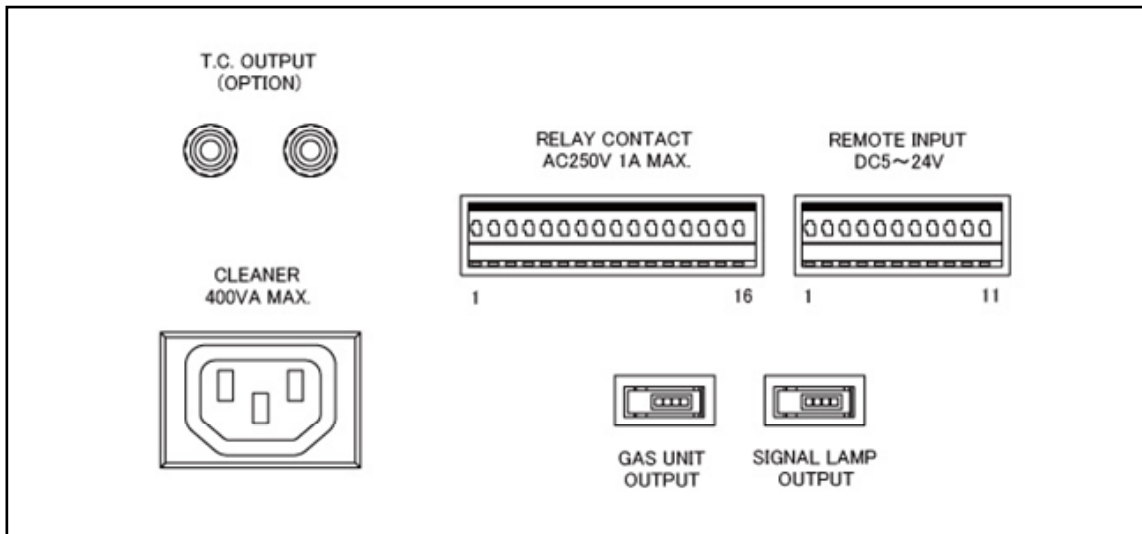
- Depending on the application, insert the attached exhaust guide or exhaust port plug into the hole near the center of the furnace top surface. Insert the thin outer shape through the hole.

Exhaust guide : When installing a deodorizer or smoke exhaust device, install an exhaust guide.

Exhaust plug : If you are not using a deodorizer, insert the exhaust plug into the hole to close it.

## ■ Connection of rear terminals

- There are terminals on the back of the main unit for exchanging signals with external devices. Please use if necessary.



### ◆ T.C. OUTPUT (OPTION) (optional thermocouple output)

- By installing an optional temperature sensor, you can monitor the furnace temperature with a recorder. The red terminal is the + pole and the black terminal is the -pole. Optional temperature sensors are K thermocouple and Platinel thermocouple (high durability).
  - ※ This cannot be used when the "Extra temperature rise sensor" option is installed.

### ◆ CLEANER (deodorizer, smoke exhaust device output)

- A power outlet to connect the optional deodorizing device and smoke exhausting device. The power supply capacity is 400VA MAX. The power supply voltage is always output during operation. The following options can be connected.
  - ※ The deodorizing device and smoke exhausting device cannot be used at the same time.

300Plus	:	"Deodorizing device ES71", "Smoke exhausting device VF71"
500Plus	:	"Deodorizing device ES72", "Smoke exhausting device VF72"
1500Plus	:	
3000Plus	:	
5000Plus	:	
	:	※ Use the extension cable included with 3000 and 5000Plus.

※ For connection of the deodorizer and smoke exhaust device, follow the instruction manual of the deodorizer and smoke exhaust device.

### ◆ RELAY CONTACT OUTPUT (contact output terminal)

- Event output and each operation status are output at the contact.



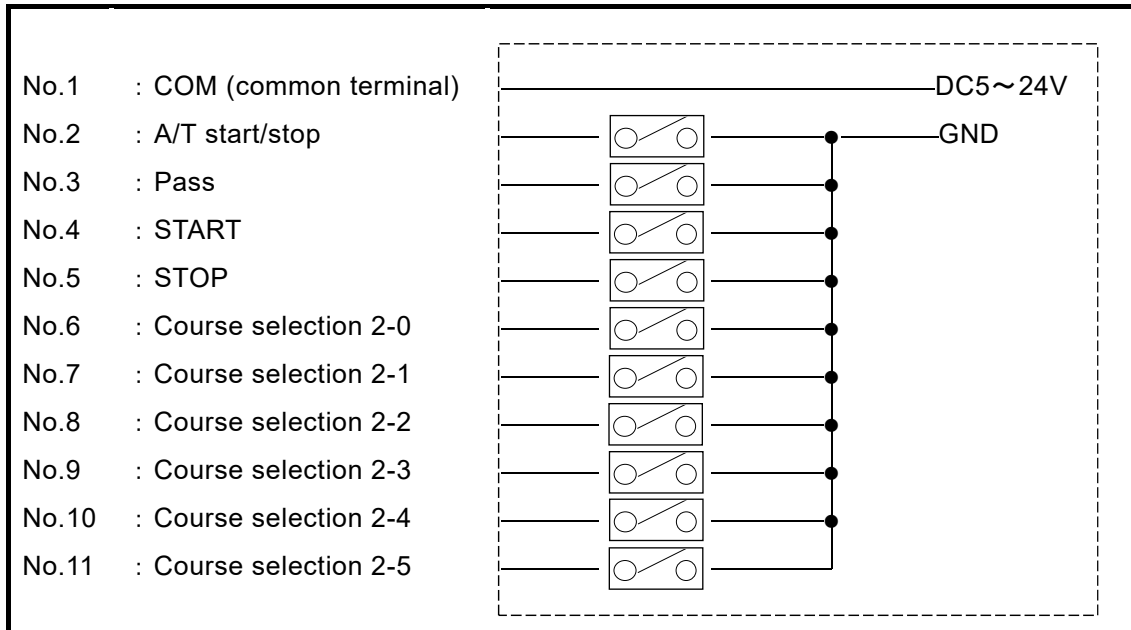
The contact rating is "AC250V 1A MAX."

Connecting a load that exceeds the capacity may cause fire or malfunction.

No. 1-2	:	EV1 output	} Turns on and off according to the settings of the program items (EV1 to EV4).
No. 3-4	:	EV2 output	
No. 5-6	:	EV3 output	
No. 7-8	:	EV4 output	
No. 9-10	:	A/T end output	Turns on for 1 second at the end of auto tuning.
No. 11-12	:	Alarm output	Turns on for 1 second when an error occurs.
No. 13-14	:	Operation start output	Turns on for 1 second at the start of operation.
No. 15-16	:	Operation end output	Turns on for 1 second at the end of operation.

### ◆ REMOTE INPUT (remote input terminal)

- Used for remote control of this unit with a sequencer, etc.  
For the ON input, apply 5 to 24 VDC between COM and each signal for 1 second or longer.  
The course is selected in binary, and each bit is turned ON/OFF.  
The operation is similar to the operation from the operation panel.



### ◆ GAS UNIT OUTPUT

- A connector for connecting the optional gas introduction unit.  
By connecting the gas introduction unit to this connector, the gas can be introduced as set in the program items gas 1 and gas 2.
- The following options can be connected.  
※For the connection method of the gas introduction unit, follow the instruction manual of the gas introduction unit.

300Plus	: KDG-300
500Plus	: KDG-300
1500Plus	: KDG-1500
3000Plus	: KDG-3000
5000Plus	: KDG-5000

### ◆ SIGNAL LAMP OUTPUT

- Connector for connecting optional 3-color signal lamp  
You can display three states: standby, running, and error occurrence.

Installation is complete when the rear terminals are connected.

## Turn on the power

- Turn on the overcurrent breaker on the back of this machine and turn the power switch on the right side upward.
- After displaying the following screen, it shifts to the standby mode.

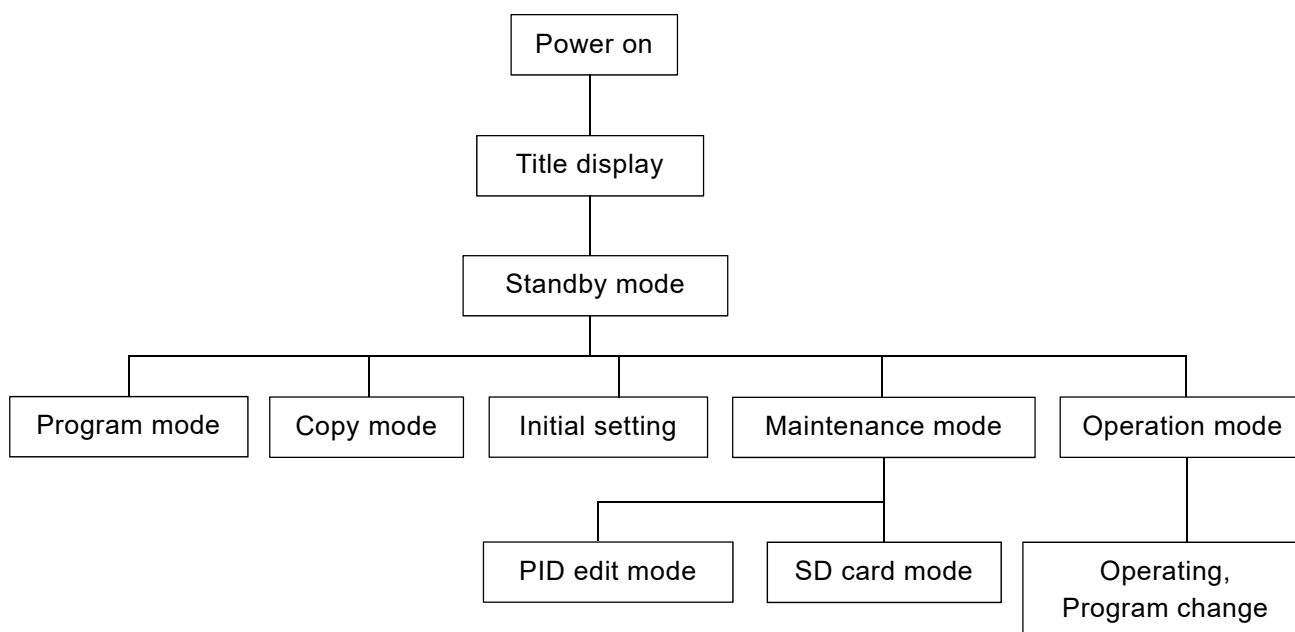


Screen data version    model display    control software version

## Program controller operation overview

The program controller can be operated automatically by programming the temperature control, each event and each condition value. The program can program up to 100 segments per pattern. There are 50 patterns, and it is easy to identify by entering the pattern name for each purpose. Now, we will explain each mode below.

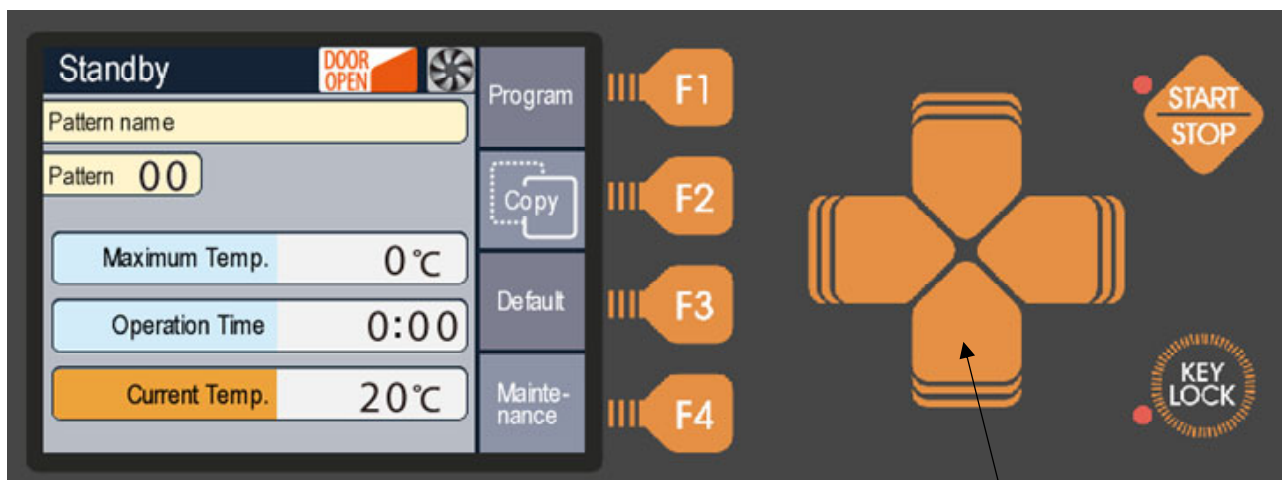
"Mode system diagram"







## Standby mode

- When the power is turned on, the title screen is displayed, then the following screen is displayed, and the unit enters standby mode. You can switch to each mode by operating in this mode.



Up/down/left/right direction Key

### ◆ Explanation of main display

- Pattern name : The name set for the selected pattern is displayed.
- Pattern : The pattern number being selected is displayed.  
There are 50 patterns from 00 to 49.
- Maximum Temp. : The maximum temperature among the temperatures programmed in the selected pattern is displayed.
- Operation Time : Displays the operation time of the selected pattern.
- Current Temp. : Displays the current temperature.
-  : Displayed when the furnace door is open. If you open the door during operation, the power to the heater will be cut off for safety.
-  : Displayed when the cooling fan is operating.  
It operates at a furnace temperature of 350°C or higher and stops at 300°C or lower. While this message is displayed, turn off the power switch or turn off the breaker to prevent the power supply from being interrupted. The fan will stop and the enclosure will become hot, which is dangerous.
- START/STOP Lamp : Lights during operation. Also, it flashes during each operation of the "auto tuning" and "soak stop"
- KEY LOCK Lamp : Lights during key lock.

### ◆ Explanation of operation keys

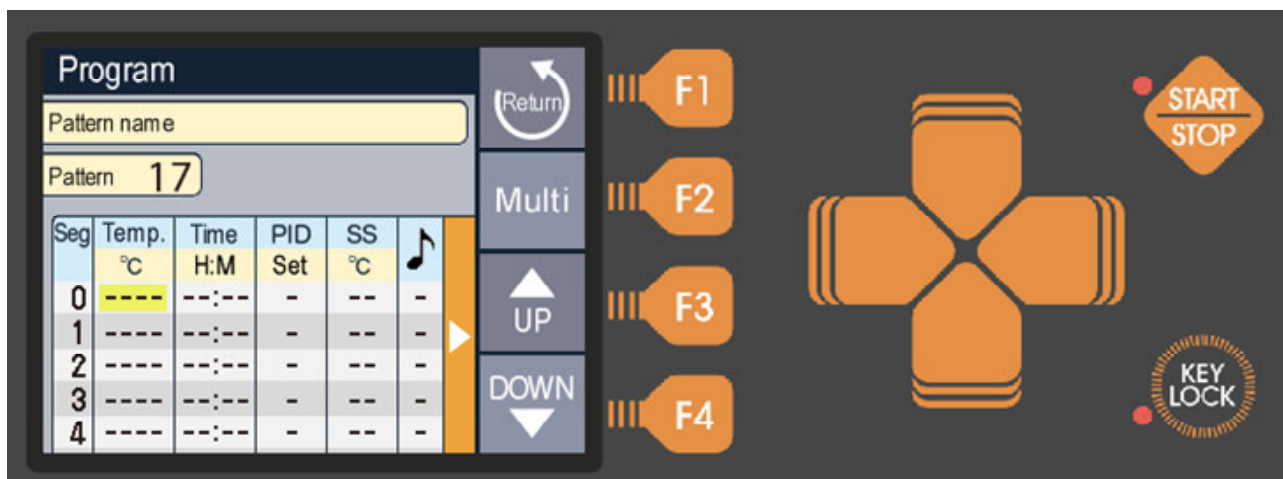
- F1~F4 : Function keys. The displayed on the screen operates.
  - F1 : Switch to program mode
  - F2 : Switch to copy mode
  - F3 : Switch to initial setting mode
  - F4 : Switch to maintenance mode
- Up/down/left/right direction : The pattern number can be changed with the up/down buttons.  
The left and right keys in this mode are invalid.
- START/STOP : Starts the operation of the selected pattern and shifts to the operation mode.  
If the pattern is not programmed, it will not be accepted.
- KEY LOCK : When pressed, the lamp lights up and keys other than the key lock are locked.  
Press it again to cancel. It works in any mode other than the standby mode.

#### ※About key buzzer sound

When the key is pressed, it will sound once with a low tone if it is enabled, and twice with a high tone if it is disabled. Also, in case of long-press or combination key, no sound will be heard when pressed and it will sound when enabled.

## Program mode

- Press the "F1" (program) key in standby mode to switch to this mode.  
In this mode, each operation can be programmed.



### ◆ Explanation of main display

- 「—」 display : Indicates the unprogrammed status.
- Yellow frame : The cursor position. You can change the values in this frame.

### ◆ Explanation of operation keys

- F1 (Return) : Return to standby mode.
- F2 (Multi) : Used in combination with the arrow keys when inserting, deleting, moving left and right pages, etc.
- F3 (UP) : Increases the set value. } Press and hold to change at high speed.
- F4 (DOWN) : Decrease the set value. }
- Up/down/left/right direction : Moves the cursor (yellow frame).
- START/STOP : Copies the segment contents on one line.

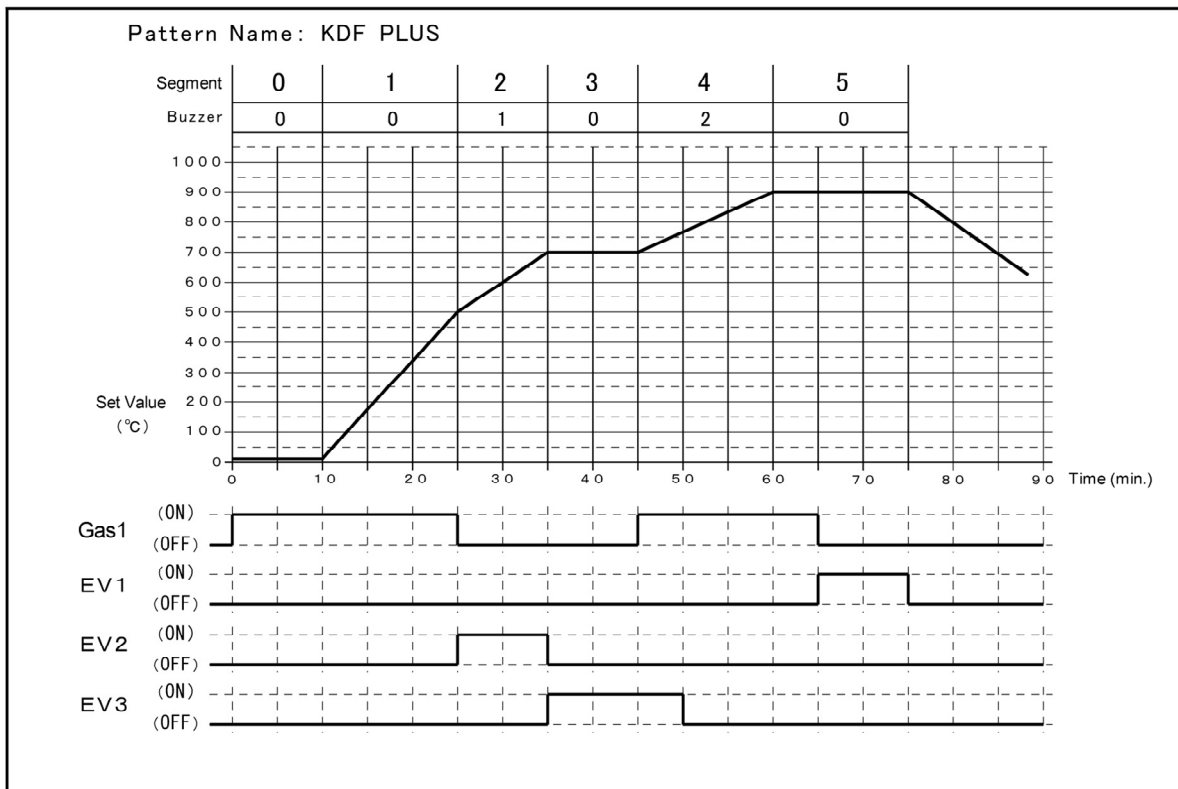
### ◆ Programmable value range and description of each item

Item name	Input range	Outline	Initial value
Pattern name	Character : English (uppercase) number Number of characters : 16 single-byte characters	Input the pattern name Enterable symbols [:] [=] [>] [<] [-] [.] [+] [/] [~]	Blank
Temp.	0 to 1150°C (other than 5000Plus) 0-1100°C (5000Plus)	Segment set temperature	0°C
Time	0:00 to 99:59 (hour:min.)	Segment set time	0 : 00
PID group	0-9, A	PID group selection, A is auto	A
SS	0-99°C 0 is no SS operation	Soak stop set temperature Set the temperature range when you want to give priority to temperature. Does not move to the next segment until the current temperature falls within this width.	0°C
♪ (Buzzer)	0 to 5 0 means no buzzer sound	Notification when moving to segment Buzzer Buzzer sound that sounds at the end of the segment can be set from 5 tones	0
Gas1, Gas2 EV1, EV2 EV3, EV4 (Each ON/OFF)	--:-- and 0:00-99:59 (hour:minute) ※--:-- is not set.	Each ON time and OFF time of gas 1,2 and EV1-4 ※An optional gas introduction unit is required to flow the gas.	--:--

## ■ Program operation overview

This machine can be operated automatically by pre-programming the temperature control, gas control and output control.

An example program is shown below, and pattern 17 will be programmed based on this.



Pattern Name : KDF PLUS

SEG	Temp. °C	Time	Buzzer	GAS1		EV1		EV2		EV3	
				ON	OFF	ON	OFF	ON	OFF	ON	OFF
0	20	0:10	0	0:00	--:--	--:--	--:--	--:--	--:--	--:--	--:--
1	500	0:15	0	--:--	--:--	--:--	--:--	--:--	--:--	--:--	--:--
2	700	0:10	1	--:--	0:00	--:--	--:--	0:00	--:--	--:--	--:--
3	700	0:10	0	--:--	--:--	--:--	--:--	--:--	0:00	0:00	--:--
4	900	0:15	2	0:00	--:--	--:--	--:--	--:--	--:--	--:--	0:05
5	900	0:15	0	--:--	0:05	--:--	--:--	--:--	--:--	--:--	--:--

※Items not programmed are omitted.

## ◆ Program example and Operation explanation

### 1. Segment 0 :

- The temperature of segment 0 is always held. In the example, the operation is maintained for 0:10 at 20°C.
- Gas 1-ON is set to 0:00, so it turns on immediately after segment 0 operation (after 0:00).

### 2. Segment 1 :

- Because the temperature is set to 500°C, the operation will increase from 20°C of the previous segment to 500°C in 0:15 of the time.

### 3. Segment 2 :

- Since the temperature is 700°C, which is the same as for segment 1, the temperature rises from 500°C in the previous segment to 700°C in 0:10 time.
- Since 1 is built in the buzzer, the buzzer sounds with the tone of 1 at the end of segment 2.
- Gas 1-OFF is set to 0:00, so it will be turned off immediately after shifting to segment 2 (after 0:00).
- EV2-ON is set to 0:00, so it will turn ON immediately after moving to segment 2 (after 0:00).

4. Segment 3 :
  - Since the temperature is set to 700°C, which is the same as the previous segment, the operation will be held at 700°C for 0:10 hours.
  - EV2-OFF is set to 0:00, so it will be turned off immediately after shifting to segment 3 (after 0:00).
  - Because EV3-ON is set to 0:00, it turns on immediately after moving to segment 3 (after 0:00).
5. Segment 4 :
  - Temperature, time, buzzer, gas 1 are the same as the previous explanation.
  - EV3-OFF is set to 0:05, so it will turn OFF 0:05 after moving to segment 4.
6. Segment 5 :
  - Temperature, time, and gas 1 are the same as described above.
  - EV0-ON is built in 0:05, so it will turn ON 0:05 after moving to segment 5.
7. End of operation :
  - The operation will end after the set time for segment 5 has elapsed.  
The temperature will be cooled naturally and all events will be turned off.

## ■ How to program

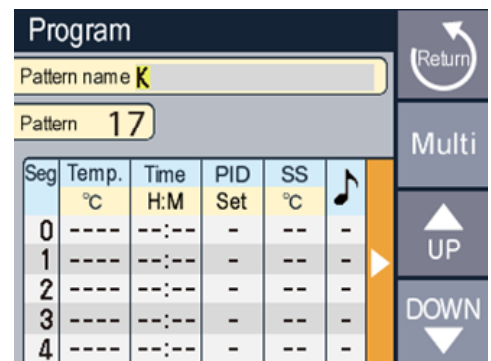
### ◆ Pattern selection

1. In standby mode, set the pattern display to 17 with the up and down arrow keys and press the F1 (program) key.

【Screen 1】

### ◆ Pattern name input

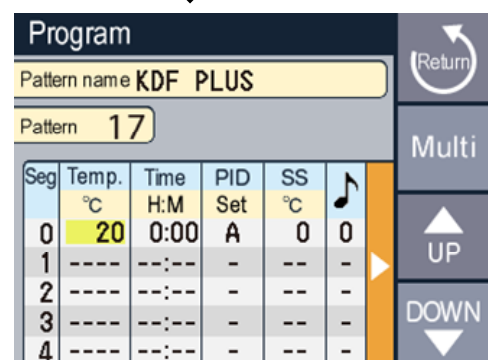
1. When the cursor is "Seg0", press the Up key to move the cursor to the pattern name.
2. Use the left/right keys to move to the place you want to input and press "UP" or "DOWN". Press the key to select the character (number, alphabet, symbol) you want to enter. In our example, we type KDF PLUS (Screen 1).
3. When input is complete, press the down key to return the cursor to "Seg0".



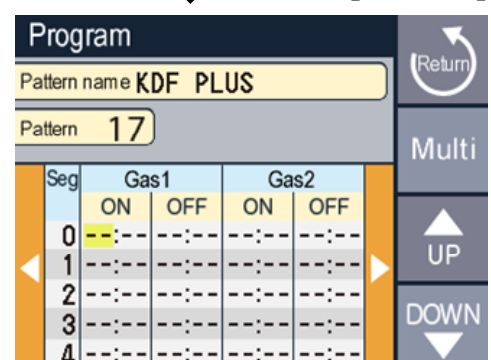
【Screen 2】

### ◆ Input of other items

1. Use the up/down/left/right direction keys to move the cursor to "Seg0", "Temperature", and use the "UP" and "DOWN" keys to set {20}.  
※ If you set the temperature, the initial values will be displayed for items other than temperature, and you can enter them (Screen 2).
2. Press the right arrow key and move the cursor to "M" of "Time" and set it to {10}.
3. When the right direction key is pressed further and the cursor moves over the "buzzer", the next screen is displayed and gas 1 can be set (screen 3).  
Set {0} for "H" and {00} for "M" of "Gas 1-ON".
4. You can move to the next segment with the down arrow key. Program the rest of the contents in the same way.
5. When all the programs are completed, press the return key to memorize the settings and shift to the standby mode.



【Screen 3】



## ■ Program one point

### ◆ Delete segment

- If "----" is set for the temperature setting, the segment for which "----" is set and subsequent segments will be erased when returning to the standby mode with the return key.

### ◆ Segment insertion and deletion

- Pressing the Up key while holding down the Multi key inserts a new segment at the cursor position. If you press the down key while holding down the Multi key, the segment at the cursor position will be deleted.

### ◆ Erase pattern

- If you move the cursor to segment 0 and insert a segment, segment 0 will be in the initial state ("----" is displayed). If you press the return key in that state to return to the standby mode, all the patterns will be erased.

Note) Even if the temperature setting of segment 0 is set to "----", it will be deleted in the same way.

### ◆ Set item screen page move

- By pressing the left/right direction key while holding down the Multi key, you can move to the next page of setting items.

### ◆ Copying segment

- Press the START/STOP key to copy the contents of the segment above the cursor position to the segment at the cursor position.

### ◆ PID group setting

The controller of this machine has one set of auto PID and 10 sets of manual PID. Optimal temperature control can be achieved by assigning appropriate constants to each segment. In the initial state, "A" (auto) is set, and the constant that matches the program temperature is automatically selected.

If you want to switch to manual, change the PID setting to 0-9. If set to Manual, the set PID set constants are used.

- For the setting method, set the value of "0-9" or "A" in the "PID" item of the program mode.

### ◆ Soak stop setting

The controller of this machine progresses with priority on time. Therefore, even if the set temperature is not reached, it will move to the next segment when the set time for that segment elapses. If the set time of the event elapses, it will move to the next segment. If you program the temperature rise and fall above the furnace performance, it will move to the next segment before reaching the set temperature, so the function to prevent this is the soak stop operation. The soak stop works for the temperature of the set segment. If the temperature does not reach the "set temperature  $\pm$  soak stop temperature" after the set time of the segment, the START/STOP lamp starts blinking and does not move to the next segment until it enters the range. If the setting is 0°C, the soak stop operation will not be performed.

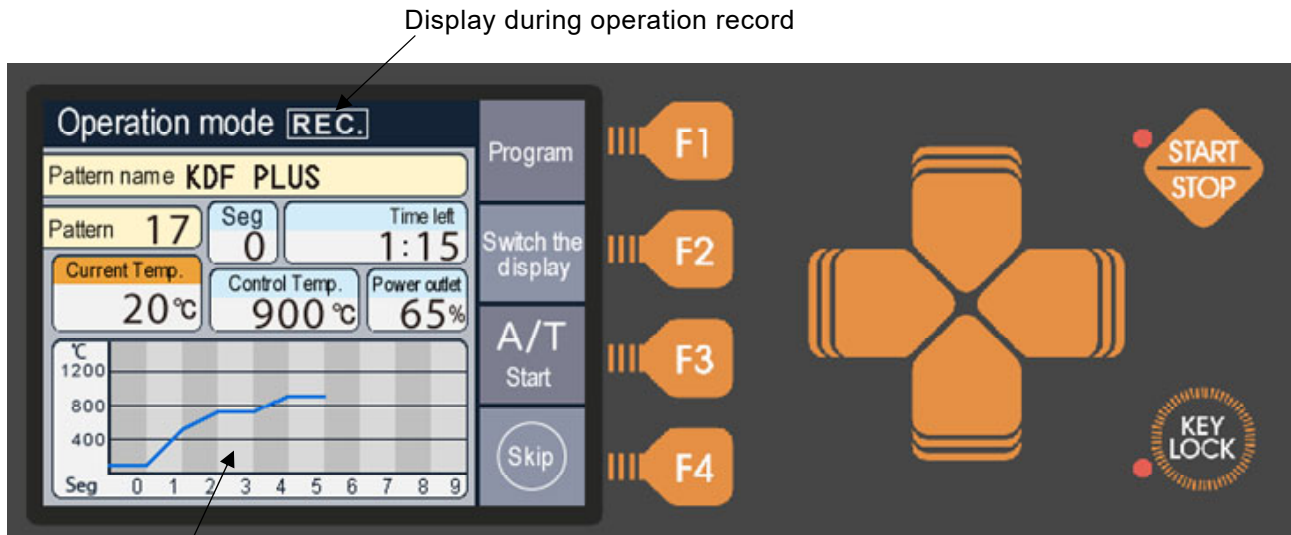
- For the setting method, set the value of "0 to 99" in the "SS" item of the program mode.

## Copy mode

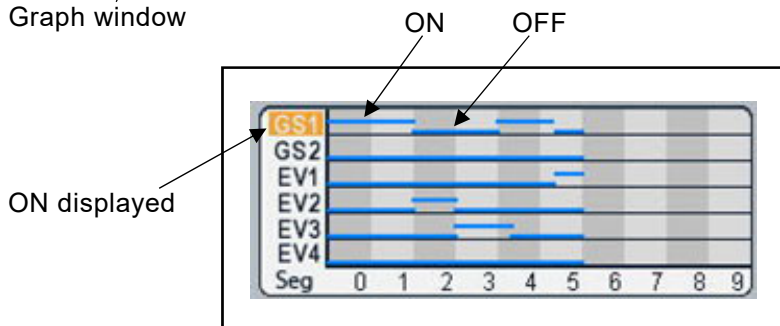
- Press the "F2" (copy) key in standby mode to switch to this mode.
- The copy source pattern will be the pattern selected in standby mode.
- The copy destination pattern can be changed with the UP and DOWN keys.
- After selecting the copy destination pattern, press the execute key. You can continue to copy to other patterns with the same operation.
- When copying is completed, press the return key to switch to standby mode.

## Operation mode

- Press the START/STOP key in standby mode to switch to this mode.  
When this mode is entered, the operation of the pattern selected in standby mode starts.
- If you insert an SD card before starting operation, the operation contents will be recorded automatically on the SD card.  
※If the SD card is properly inserted, it will be recorded automatically. If there is an abnormality, the operation will start without recording. If the SD card error display is required, set "SD error" in the initial setting mode to "Yes".



Graph window



[Event display]  
ON events are displayed in orange.

### ◆ Explanation of main display

- Seg : Displays the segment number currently in progress.
- TOTAL Time left : Displays the remaining time of operation. You can switch between TOTAL time and remaining time in Seg units.
- Control Temp. : The temperature is controlled so that the current temperature matches this temperature.
- Power outlet : Displays the heater power output in %.
- Display during operation record : Displayed during operation record to the SD card.
- Graph window : The programmed temperature gradient is drawn in segment units.  
You can switch between event display with the up and down arrow keys.  
The finished segment is drawn in orange.

## ◆ Explanation of operation keys

- F1 (Program) : Switches to the program change mode during operation.
- F2 (Switch the display) : Switches between remaining time display TOTAL (total operation time) and Seg unit.
- F3 (A/T start) : Starts PID constant auto-tuning.  
Press during auto tuning to cancel.
- F4 (Skip) : Set the path of the segment. The operation is long press to prevent erroneous operation.
- Up and down direction : Switch the graph window.
- Left and right direction : You can switch the page of the segment number displayed in the graph window in units of 10.  
Use the right arrow to increase and the left arrow to decrease
- START/STOP : Cancels the operation. The operation is long press to prevent erroneous operation.

## ■ Operation during driving

### ◆ Check and change program contents

- Press the program key to switch to the program mode and check and change the program contents.  
For the operation method, refer to the section on program mode.  
Note) You cannot change the course name before the current segment.  
Note) The changes will be reflected in the current operation, but will not be stored in memory.  
Note) If the segment moves during the change, the buzzer sounds when the mode is returned to and the changes are discarded. Please perform the change operation again.
- If you want to edit a pattern other than during operation, hold down the UP ARROW key and press the PROGRAM key. The pattern selection screen is displayed. Select the pattern you want to edit and press the enter key.  
Changes made to patterns other than those during operation are stored in memory.

### ◆ PID auto tuning operation

- If the amount of the burned material changes, temperature control may be uneven, so perform the PID auto-tuning operation if necessary.  
※Normally, there is no problem with the constants initially set.
1. Put the actual fired product in the furnace, set a program to maintain the temperature at which you want to perform auto tuning, and start the operation.
  2. If the current temperature is almost stable, press the A/T start button.  
When the auto tuning operation starts, the START/STOP lamp blinks.
  3. If you want to cancel the auto tuning, press the A/T cancel button.
  4. When the auto tuning is finished, the START/STOP lamp changes to lights up and the buzzer sounds.  
※The auto tuning will calculate for the control temperature at the start.  
Note) If the PID group setting is "A" (auto), the constants near the control temperature will be rewritten.  
If the value is other than "A", the programmed PID group number constant will be overwritten.

## ■ About SD card operation record

- If the SD card is properly inserted at the start of operation, the operation details will be recorded automatically.
- If you want to detect the SD card error at the start of operation, set "SD error" to "Yes" in the initial setting mode.
- If you remove the SD card during recording, it will not be recorded properly.
- During operation recording, (REC.) is displayed, so you can check whether it is recorded.

## ◆ Operation record data

- Record file name :

PAT05\_8.csv (It will be a csv format file)

"05" is the pattern number of the operation and "\_8" is the serial number of pattern 05. The serial number is incremented each time the operation of pattern 05 is started and recorded with that file name.

- Record file date and time :

This unit does not have a clock, so the dates and times of files are as follows.

2014/04/01 0:00

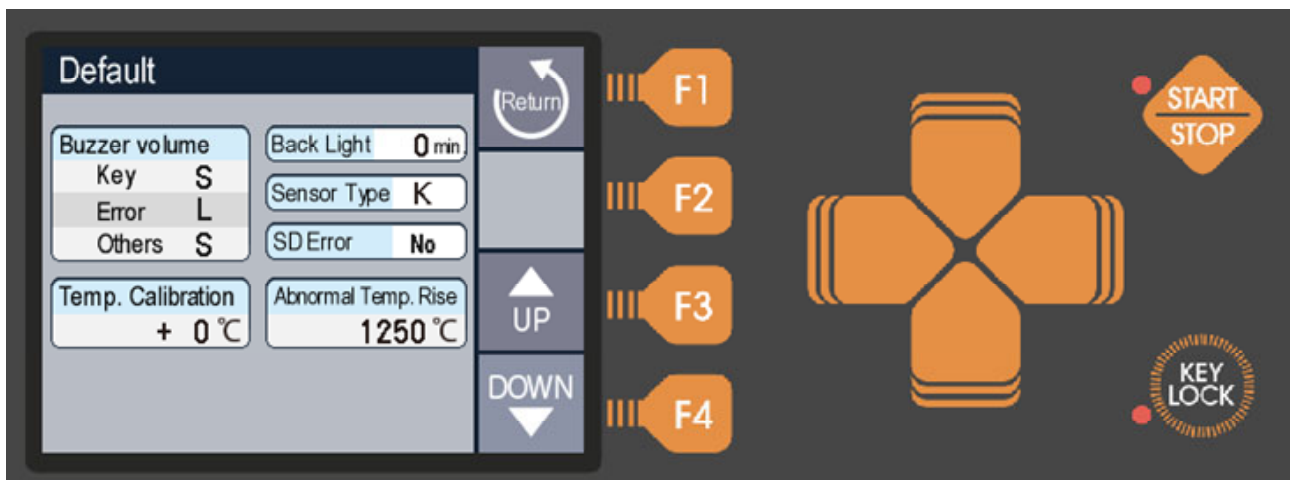
- Record contents

- At the beginning of the file, record the program content of the pattern that was operated.
- After that, every 5 seconds, record the status of "Running segment number, current temperature, gas output, event, AT, SS". When the operation is stopped, the contents up to the stop are recorded.

※For gas output, event, AT and SS, "1" is recorded during operation and "0" is recorded during stop.

## Initial Setting Mode

- In standby mode, press the "F3" (initial setting) key to switch to this mode. The following settings can be made in this mode.



※UP/DOWN keys are used to change the value, and up/down keys are used to move the items.

### ◆ "Buzzer volume" setting

- You can set 4 levels: mute, small, medium, and large.

- Key : Key operation sound Initial value : Small
- Error : Error sound Initial value : Large
- Others : Other than the above (end sound, power-on sound, etc.) Initial value : Small

### ◆ "Temp. Calibration" setting

- The gain of furnace temperature can be corrected for 1000°C.

For example, if you want to increase 20°C at 1000°C, set +20°C.

In that case, at 500°C, "20°C × 500°C / 1000°C" will be a correction of approximately +10°C.

Setting range : -50 to +50°C Initial value : + 0°C



### ◆ "Back Light" setting

- Set the LCD backlight off time. If no key is operated for the set time, the backlight turns off. Also, if you press any key while the light is off, it will return. If you set 0 minutes, it will not go out.

Setting range : 0 to 120 minutes      Initial value : 0 minutes

### ◆ "Sensor Type" setting

- Change to "P" when the optional high temperature sensor (platinel thermocouple) is attached. Since the standard is equipped with a K thermocouple, the initial value is "K".

### ◆ "SD Error" setting

- This unit can record the operation contents on the SD card, but if the SD card is not inserted at the start of operation, it will start operation without recording. If you want to detect the SD card error at the start of operation, set it in this section.

Setting value : No (initial value) "SD card error detection is not performed at the start of operation"  
Yes "If there is an error at the start of operation, a confirmation screen will be displayed."

※Either this setting is set, recording will be performed if the SD card is properly inserted.

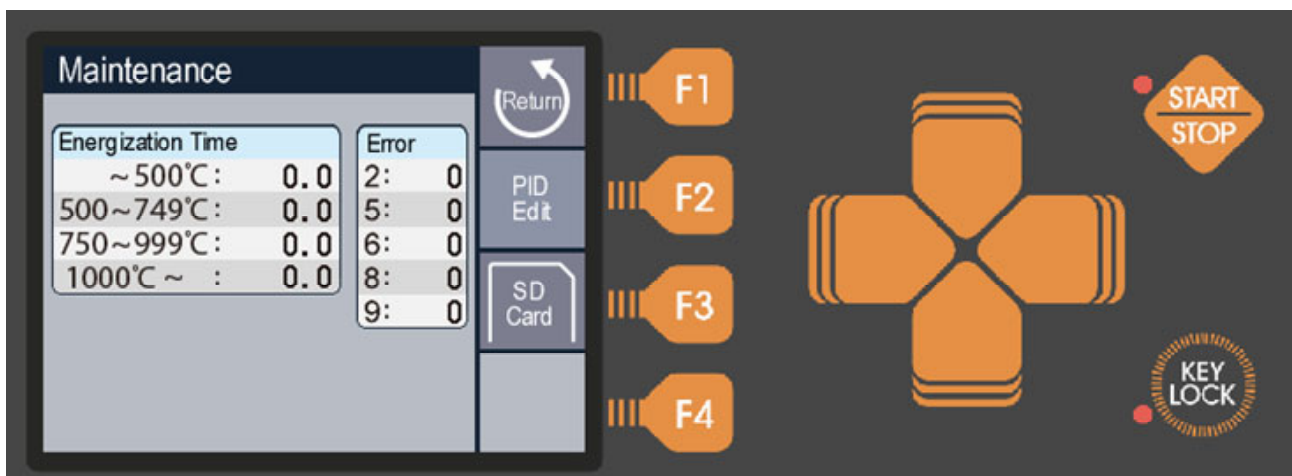
### ◆ "Abnormal Temp. Rise" setting

- Set the operating temperature of the excessive temperature rise abnormality detection circuit of this machine. Normally, it is not necessary to change the value for the purpose of protecting this machine at the time of failure and fire prevention, but change the value if you want to regulate the upper temperature limit to protect the burned material.
- There is an error of about  $\pm 30^{\circ}\text{C}$  in the set value, so consider the error and set it higher by 50 to  $100^{\circ}\text{C}$ .

Setting range :  $300$  to  $1250^{\circ}\text{C}$  ( $50^{\circ}\text{C}$  unit)

## Maintenance mode

- Press the "F4" (Maintenance) key in standby mode to switch to this mode. In this mode, you can check energization time, error count, SD card operation, and PID constant editing.

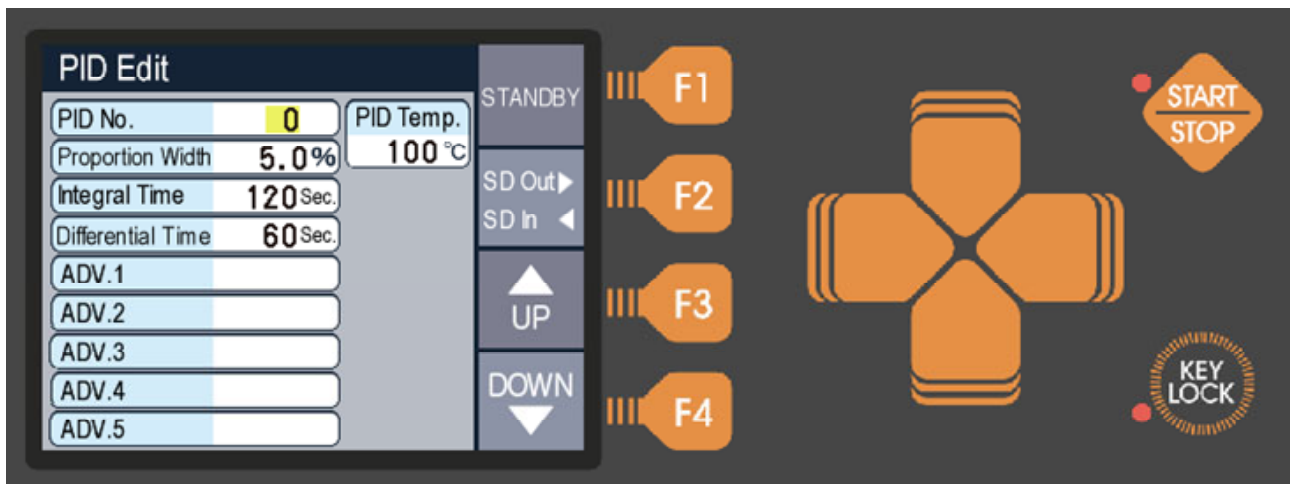


## ◆ Explanation of main display

- Energization time : The energization time at the temperature displayed on the screen is displayed in units of 0.1 hours.
- Error : Displays the number of occurrences of each error number.

## ■ PID edit mode

- Press the "F2" (PID edit) key in the maintenance mode to switch to this mode.  
In this mode, PID constants can be edited for each PID number, and the constants can be written to and read from the SD card.  
Normally, it is not necessary to change the constants, but if you want to suppress overshoot more, or if you want to reach the reached temperature quickly even after overshooting, those with knowledge of PID control should make frequent changes. You can change it.



## ◆ Explanation of main display

- PID No. : 0 to 9 correspond to the setting number at the time of programming.  
10 to 19 are constants for auto setting.  
It can be changed with the UP and DOWN keys.
- PID temperature : The temperature at which the constant of the current PID group No. is auto-tuned is displayed. It cannot be changed by any operation other than auto tuning.
- Proportion Width : The proportional band of proportional control is displayed in %.  
Full span is % for 1200°C.  
Setting range : 0.0-1000.0
- Integral time : It becomes integral control time. Controls to correct the offset of proportional control.  
Set time : 0 to 3600 seconds
- Differential time : It is the differential control time. Controls to quickly return to the target temperature when a disturbance occurs.  
Set time : 0 to 3600 seconds
- ADV.1~5 : Display with auto number 10 to 19.  
It becomes an auxiliary constant for PID control.  
Normally you do not need to change.

## ◆ Explanation of operation keys

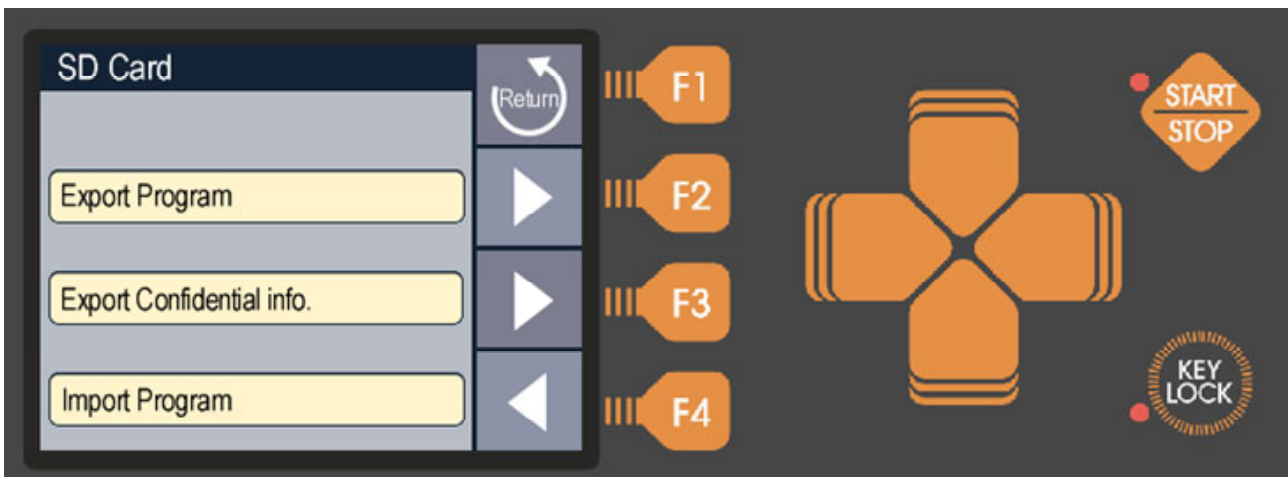
- F1 (Standby) : Memorize the setting contents and shift to the standby mode.
- F2 (SD output, input) : PID constants can be output and input to the SD card.  
While holding down this key, use the right direction key to output and the left direction key to input. The data will be written to the root of the SD card with the following file name. It can be edited as a CSV file with software such as Excel. If you want to save after editing, please save in CSV format.

Output file name : EFP\_PID.CSV

- F3 (UP) : Change (increase) each value.
- F4 (DOWN) : Change (decrease) each value.
- Up and down direction : Moves each item.
- Left/right direction : Performs input/output processing to the SD card in combination with the F2 key.

## ■ SD card mode

- In the maintenance mode, press the "F3" (SD card) key to switch to this mode.  
In this mode, you can read and write the program contents and write the maintenance information contents to the SD card.  
When you want to edit the program contents on the PC, back up the program contents, or when there is a failure please use it when you send us the usage data.



## ◆ Program contents Export/Import

- Insert the SD card into the slot and press the F2 key for writing and the F4 key for reading.  
The output file is written in the root of the SD card as one file for each program pattern. It will be.  
When you export, 50 files from pattern 0 to 49 are created.

Output file name : EF\_PRG0.CSV ~ EF\_PRG49.CSV

- When editing data with software such as Excel, edit the time "--:--" setting with "9999".  
Also, the pattern name can be up to 16 single-byte characters consisting of uppercase letters, numbers, and symbols (see program mode).  
When you want to save after editing, save it in CSV format.
- If you leave only the file of the pattern you want to read in the SD card when reading, only that pattern can be read.

## ◆ Export Confidential information

- If an error occurs, please send the exported file to us and we will let you know the details of the error and your usage. Since you can see the usage situation, you can respond more accurately.
- Insert the SD card into the slot and press the F3 key.  
Data is output with the following file name.

Output file name : EFP\_MNT.CSV

# Error Messages

## Warning display

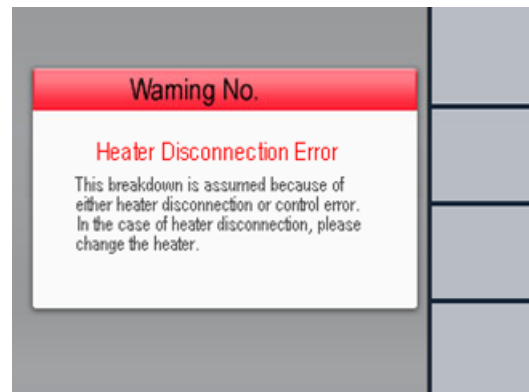
If an error occurs, the warning screen shown below will be displayed. Follow the instructions on the warning screen and take appropriate measures. Please contact us with the warning number displayed on the screen for consultation.

Even if the unit is normal, these warnings may occur only once due to excessive noise from the outside. Please try turning it off if you turn it off and back on again.

Note) Even if the power is turned off and then on again, the contents of the program and initial values may be erased or the values may have changed.

The following are possible sources of excessive noise.

- Nearby lightning, lightning
- High frequency, arc welding, casting equipment
- Wireless
- Electrical equipment



[Warning screen]

## ■ Warning content

### ● Warning No.2 : Controller error

- Displayed when the controller operates abnormally due to the influence of noise.
- Almost always recovers when the power is turned on again, but if it occurs frequently, repair is required.

### ● Warning No.5 : Heater disconnection error

- The heater may be broken. Needs repair

### ● Warning No.6 : Temperature sensor error

- The temperature sensor may be broken or defective. Replace the temperature sensor.
- When the temperature sensor is normal, it is also displayed when the heater is broken or the heater control system fails. Please contact the distributor for details.

### ● Warning No.8 : Memory error

- The stored data may have been damaged by the influence of noise. Turn the power off and then on again, and check the program contents and reset. If it occurs frequently, repair is required.

### ● Warning No.9 : Abnormal temperature rise

- Displayed when the current temperature exceeds the temperature set in "Excessive temperature rise" in the initial setting mode. After the inside of the furnace has cooled down, turn on the power again and check that the set value is 100°C or more higher than the maximum temperature of the program used. If there is no problem, it may be due to a failure. Please contact the distributor for details.

# Specifications

External dimensions / weight	300Plus	: 314 (W) × 396 (H) × 468 (D) mm	22kg
	500Plus	: 415 (W) × 441 (H) × 503 (D) mm	33kg
	1500Plus	: 510 (W) × 520 (H) × 608 (D) mm	49kg
	3000Plus	: 600 (W) × 604 (H) × 748 (D) mm	82kg
	5000Plus	: 670 (W) × 734 (H) × 883 (D) mm	118kg
Effective size in furnace / Furnace internal volume	300Plus	: 120 (W) × 110 (H) × 222 (D) mm	2.9L
	500 Plus	: 160 (W) × 130 (H) × 240 (D) mm	5.0L
	1500Plus	: 230 (W) × 200 (H) × 300 (D) mm	13.8L
	3000Plus	: 300 (W) × 244 (H) × 400 (D) mm	29.2L
	5000Plus	: 350 (W) × 300 (H) × 500 (D) mm	52.5L
Power supply voltage / Power consumption	300Plus	: AC100V 50/60Hz	1.2kVA
	500Plus	: AC200V Single phase 50/60Hz	1.8kVA
	1500Plus	: AC200V Single phase 50/60Hz	3.6kVA
	3000Plus	: AC200V Single phase 50/60Hz	5.5kVA
	5000Plus	: AC200V Single phase 50/60Hz	8.0kVA
Maximum operating temperature	1150°C ※5000 Plus only 1100°C		
Regular use temperature	1000°C		
Operating temperature range	100°C ~ Maximum operating temperature Note) Temperature distribution and control performance deteriorate as the temperature decreases from around 300°C.		
Temperature control unit	0.5°C		
Temperature control method	PID control (20 sets of PID constants, 10 of which are automatic) with auto tuning		
Furnace material	ceramic fiber-vacuum molding		
Temperature sensor	JIS K thermocouple ※Optional high temperature compatible platinum pin thermocouple		
Heating element	Iron chrome wire		
Exhaust hole diameter	φ 23.5		
Maximum heating rate	From normal temperature to maximum operating temperature 300Plus : About 40 minutes 500Plus : About 28 minutes 1500Plus : About 25 minutes 3000Plus : About 28 minutes 5000Plus : About 49 minutes		
Number of programs	50 patterns / 100 segments		

External input	Remote control input (Pattern selection, start, stop, pass, AT start/stop)
External output	Recorder thermocouple output, gas output, event contact output 4 types, Deodorizer/Smoke exhaust device output, Running/End/Alarm contact output, 3-color patrol light output, SD card slot
Safety functions	Overcurrent breaker, furnace temperature sensitive cooling fan, overheat detector, door open/close sensor, key lock function
Program controller	Detection abnormality controller abnormality, heater disconnection abnormality, temperature sensor abnormality, Memory error, over temperature error

### ◆Main options

Gas introduction unit 1 system	Model : KDG-300	
	Applicable models	300Plus, 500Plus
	Flowmeter	Nitrogen 2L/min (Oxygen, argon possible)
		1 inlet
Model : KDG-1500	Applicable model	1500 Plus
	Flowmeter	Nitrogen 5L/min (Oxygen, argon possible)
		2 inlets
	Model : KDG-3000	
Applicable model	3000 Plus	
	Flowmeter	Nitrogen 10L/min (Oxygen, argon possible)
		2 inlets
	Model : KDG-5000	
Applicable model	5000 Plus	
	Flowmeter	Nitrogen 20L/min (Oxygen, argon possible)
		2 inlets

※Please contact us regarding two gas introduction units.

Deodorizer	Model : KDF-ES71	
	Applicable model	300Plus
	Power supply	AC100V 300VA
	Model : KDF-ES72	
Applicable models	500Plus, 1500Plus, 3000Plus, 5000Plus	
	Power supply	AC200V 300VA

Smoke exhaust device

Model	: KDF-VF71
Applicable model	300Plus
Power supply	AC100V 34VA/50Hz 37VA/60Hz
Accessories	φ 75 heat-resistant duct 2.5m (when extended) Duct clamp
Model	: KDF-VF72
Applicable models	500Plus, 1500Plus, 3000Plus, 5000Plus
Power supply	AC200V 34VA/50Hz 37VA/60Hz
Accessories	φ 75 heat-resistant duct 2.5m (when extended) Duct clamp

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