Kalstein

Universal Lab High Temp Box Muffle Furnace

Model YR05281

Instruction Manual

Thank you very much for purchasing our Kalstein Universal Lab High Temp Box Muffle Furnace model YR05281

Please read the “Operating Instructions” and “Warranty” before operating this unit to assure proper operation. After reading these documents, be sure to store them securely together with the “Warranty” at a hand place for future reference.


Warning: Before operating the unit, be sure to read carefully and fully understand important warnings in the operating instructions.

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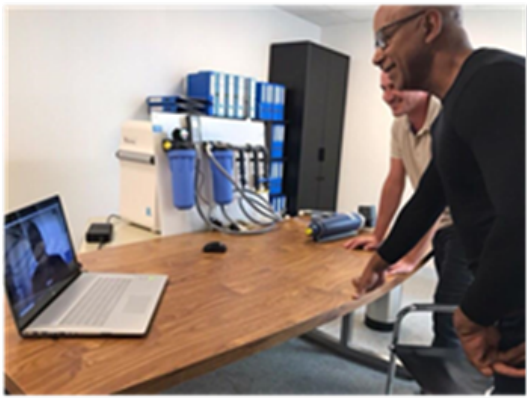

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Preface

Respected customers, sincerely thank you for being a user of Kalstein products. In order to ensure that you can use the equipment safely and efficiently, please read the following instructions carefully before using.

YR0 series box muffle furnaces (1200 C/1400 C/1700 C/1800.C) have the following characteristics:

- 30 segments intelligent temperature control regulator, PID control, temperature control accuracy (±1 degree).
- The upper temperature alarm can be set, and the main circuit can be automatically cut off when the temperature exceeds the upper limit.
- The high-purity alumina ceramic fiber is used as the furnace material, and the heat insulation effect is good.
- Different furnace sizes can be customized according to customer requirements.
- Simple air inlets, exhaust ports and observation windows can be added according to customer requirements.

Warning

Definitions of "danger" and "attention":

Since it is not operating as required,

It may cause serious damage to equipment or personal injury or death.

Since it is not operating as required,

It May cause moderate or minor injury or material loss.

Please read this manual carefully before installation and use. If you do not read the instructions carefully and violate the safety regulations, it may affect the normal use!

1.1 Installation

- Do not place it in an uneven or vibrating place, otherwise it may cause the equipment to be unstable and dump.
- Do not place flammable or explosive materials near the furnace, otherwise there is a danger of explosion.
- Do not drop metal objects such as screws or gaskets inside the device, as this may cause a short circuit or fire.
- Do not place it in a place where it is easy to splash water. If water enters the product body, it may cause fire or electric shock.

- The equipment should be installed in an environment free of conductive, dust-free, non-destructive insulation gas or steam.
- Place the place with air circulation, no vibration, no impact, no high dust.

1.2 Wiring

- Wiring must be carried out by qualified personnel, otherwise there is a risk of electric shock
- Make sure that the input power is completely disconnected before wiring work, otherwise there is a risk of electric shock.
- The equipment must be reliably grounded when it is connected to the power supply, otherwise there is a risk of electric shock.
- Do not drop metal objects such as screws or gaskets into the inside of the device. Otherwise, there is a danger of short circuit or fire.
- The equipment power supply must be connected to the corresponding air switch/Breaker.

1.3 Use

- The muffle furnace is used for the first time or not used for a long time. It should be used after baking for about 2 hours at 300.C to avoid cracking of the furnace.
- The furnace temperature must not exceed the rated temperature to avoid damage to the heating element and the furnace. It is forbidden to directly inject liquid or molten metal into the furnace, and often remove the metal and oxidation residue in the furnace to keep the furnace clean.
- Please lock the furnace door before heating. It is not recommended to open the furnace door when the temperature in the furnace is more than 400.C.
- Regularly check whether the electrical connection parts of the temperature control system are in good connection, especially the connection points of the heating elements;
- The heating rate is recommended to be 10.C/min,T <1000.C; 1000-1500.C does not exceed 5.C/min, and >1500 degrees does not exceed 2.C/min, otherwise the furnace and heating elements will be damaged.
- When the equipment is cooled, please use the program to cool down and set the cooling program. It is not recommended to directly stop the temperature. For the 1800-degree furnace, the cooling speed is recommended not to exceed 3.C/min, otherwise the chamber will be damaged. When the temperature of the device is above 500.C, please do not turn off the power of the device, to prevent safety problems.

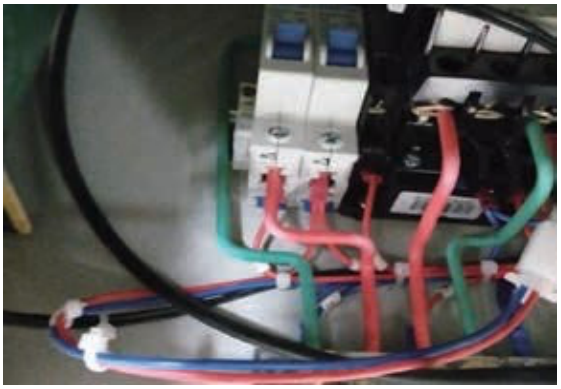
Note: The losses caused by the above operation errors are not covered by the company's warranty, and the company will charge the corresponding fees for after-sales maintenance.

1.4 Maintenance

- Power off before repair or inspection.
- If the product body is damaged, stop using it. If the product body is damaged and continues to be used, it may cause fire, electric shock, etc.
- Parts must be replaced by qualified personnel. It is strictly forbidden to leave the thread or metal objects in the equipment, otherwise there is a danger of explosion and fire.
- After replacing the instrument or circuit board, parameters must be adjusted and matched before operation, otherwise there is a danger of damage to property.
- The control circuit part of the equipment should be regularly inspected (checked once every half year) to tighten the line. If it is found that there is insulation on the line and the wiring is disconnected, it should be dealt with in time. Otherwise, the equipment may be short-circuited or a fire may occur.

Inspection Method:

Remove the rear cover



Check if the screws at the wiring point are looseness and tighten

1.5 safety warning

Danger

- If you ignore the warnings listed below, there is a risk of fire or personal injury.
- Do not touch the inside or outside of the furnace during use or for a period of time to prevent burns.
- Do not place vases, bonsai, cups, cosmetics, medicines, metal objects, etc. on the product body. If it falls, it may cause injury.
- Do not damage the power cord. If the power cord is damaged, it may cause fire, electric shock, etc.
- Do not arbitrarily change the power cord or bend, twist, or stretch the power cord. May cause fire and electric shock.
- When smoking, foreign objects or water enter the product body, please turn off the power switch and unplug the plug. Please entrust a professional to inspect and repair.
- Do not plug or unplug the power supply if the hand is wet. It may be an electric shock.
- Within one meter of the product, it is forbidden to place flammable or explosive materials to prevent fire.
- Do not let children touch this product. The temperature of the outer casing can cause burns.
- It is forbidden to decompose and reconstruct the body at will May cause injury, malfunction, or fire.
- The upper cover can be opened after the temperature in the furnace becomes normal temperature. At this time, the temperature of the furnace may still be high. Please wear high temperature gloves for operation.

1.6 Warranty principle

One year limited warranty with lifetime support, excluding heating element, cooling fans, thermocouple and ceramic tube damaged by user. Attention: Any damages caused by the use of corrosive and acidic gases, and any damage from wrong operate and use are not under the coverage of One Year Limited Warranty.

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1.0 Muffle furnace Model and Specifications

Model	Max. temperature	Chamber size	Rated Power
YR05272	1200.C	100x100x100mm	220V/1kw
YR05273	1200.C	200x150x150mm	220V/2kw
YR05275	1200.C	300x200x200mm	220V/6kw
YR05276	1200.C	400x300x300mm	380V/9kw
YR05277	1400.C	100x100x100mm	220V/2kw
YR05278	1400.C	200x150x150mm	220V/4kw
YR05280	1400.C	400x300x300mm	380V/16kw
YR05281	1700.C	100x100x100mm	220V/2kw
YR05282	1700.C	200x150x150mm	220V/4kw
YR05283	1700.C	300x200x200mm	380V/9kw
YR05284	1700.C	400x300x300mm	380V/16kw

2.0 YR0 series high temperature sintering furnace working principle

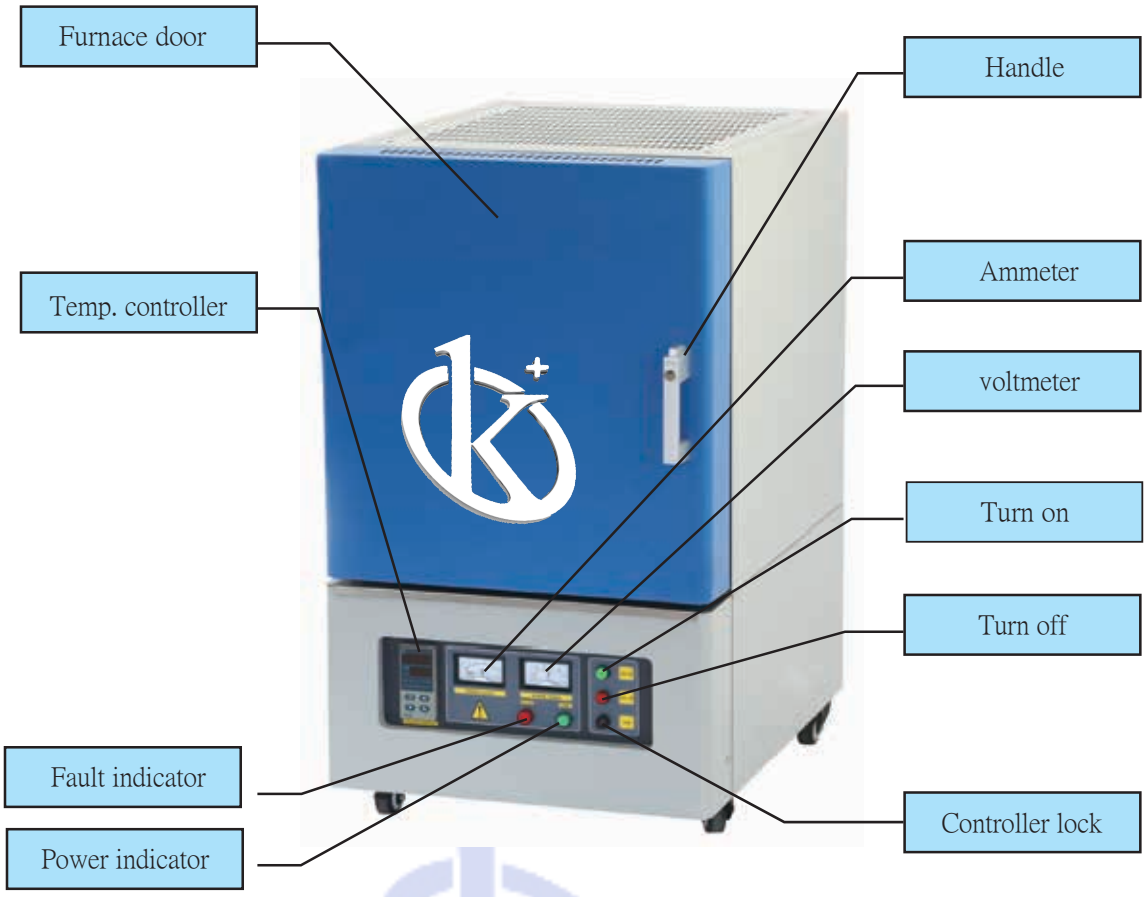
Working principle: after thermocouple changes temperature to signature voltage, it will connect to microcomputer temperature-control equipment. Temperature control equipment will compare the signature with programmed setting data then micro-computer will follow the data, positive and negative value also time calculating then produce a control signature which shows the furnace temperature changing. Using this signature to drive electrical elements

(like power model, solid power relay, exchange contactor, etc) to meet the purpose of control chamber temperature. The furnace uses high precise APID programmed to finish thorough auto-control, digital showing of temperature and process information.

Our high temperature furnaces follow the difference of heating element used, can catch respectively three temperature phases: 1200 ℃ ,1400 ℃ and 1700 ℃ 。 The heating element is Mo included resistance wire; and SiC heater for 1400℃ , MoSi2 heater for 1700℃ .

3.0 Structure introduction

YR0 series high temperature sintering furnace adopts a spring type furnace door, and the preloading force of the spring ensures the tight fitting of the furnace door. The stainless steel shield is used at the door of the furnace, which can be used for a long time without the phenomenon of paint fading. The furnace type is novel and beautiful, the surface has passed more than a dozen processes, fine workmanship, reasonable color matching, heat and corrosion resistance. The furnace is made of high-quality alumina ceramic fiber, which is processed by mature Japanese technology. It has high temperature stability and good heat preservation effect. The furnace body adopts double- layer forced air cooling structure, which has a fast cooling speed and a low surface temperature. The circuit design is advanced and reasonable, the module is controlled, and the double circuit protection ensures safe use. It adopts advanced intelligent temperature control regulator, 30~50 segment PID program control, temperature control accuracy reaches ±1° C, heating rate is fast, energyefficient.



4.0 Equipment installation wiring

1. Open the package, check if the equipment is in good condition, accessories are complete.
2. Remove them from furnace top and Chamber, if have foam and sponge. (Figure 1) (Figure 2) (Figure 3)

(Figure 1)

(Figure 2)

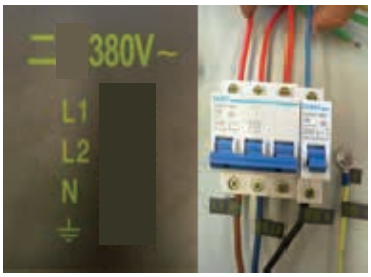
(Figure 3)

3. Equipment placement should choose the air circulation, no vibration, no inflammable, explosive gas and high dust place.

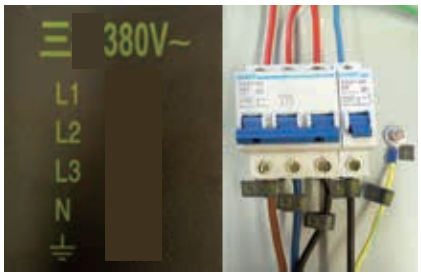
4. Please let professional personnel to carry out wiring work, otherwise there is danger of electric shock. Then match the right power supply for furnace, install the circuit breaker matched with the working current of the furnace, and connect the standard ground protection line. Do not introduce excessive voltage, so as not to cause damage to the instrument and control circuit, turn off the power when not in use. When wiring, please connect the wiring according to labels on power line and nameplate.

5. After the installation is complete, power up and test the furnace.

220V



380



380V

5.0 Equipment start operation

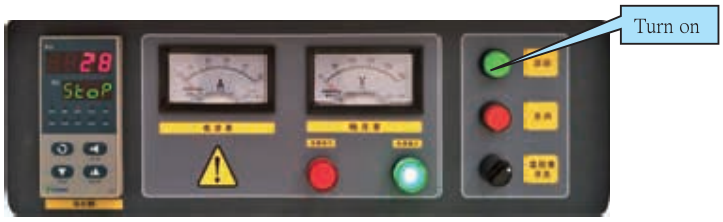
5.1 Before Use Muffle furnace, first place the door block.

5.2 Start furnace steps in the following:

5.2.1 Turn on the power, the power indicator light, while the furnace cooling fan to work. Turn on the temperature controller lock clockwise, and the controller is ready for operation.

5.2.2 Using temperature controller,input temperature control curve. The end of the curve must end by "t xx -121". (Refer the page 12-14 7.0 for detailed temperature control program settings)

5.2.3 Press the green start (Turn on) button and hear the "bang" sound, the main relay close up.



5.2.4 Press ⓥ button 2 seconds, SV display "RUN", the controller will go to auto control status according setting program.

5.3 Turn off the furnace

5.3.1 After program ends, SV display "STOP" and the controller will stay basis status.

If need to stop program, press ⓐ button 2 seconds, the controller will be in "STOP" status.

5.3.2 Press red Turn off button, Disconnect the control loop. 5.3.3Close the temperature control switch Counterclockwise. 5.3.4When the temperature is under 400.C, turn off the power.

Power indicator light off, the furnace fan will stop running, working end.

6.0 Introduction of intelligent temperature controller

6.1 Main feature:

(1) Using Advanced AI artificial intelligence adjustment algorithm, no overshoot, with self-tuning function, can achieve any slope of the rise, cooling control, with jump (cycle),run ,pause and stop etc... programmable / operational commands.

(2) Input and output using digital calibration system, accurate and stable measurement, can be extended using any number of sub-degree of non-linear sensor.

(3) Two stages digital filter function and watchdog circuit, in a strong interference environment can also maintain accurate measurement and stable work.

(4) Measurement accuracy: 0.2

(5) Alarm function: upper limit, input open circuit. (6)30/50 segment program control function.

(7) Power-down protection: Because using the EPROM chip, making the input data in the instrument power and interference can be reliably preserved.

(8) power supply: 100 ~ 240V AC 50/60Hz

(9)Power consumption: ≤5W

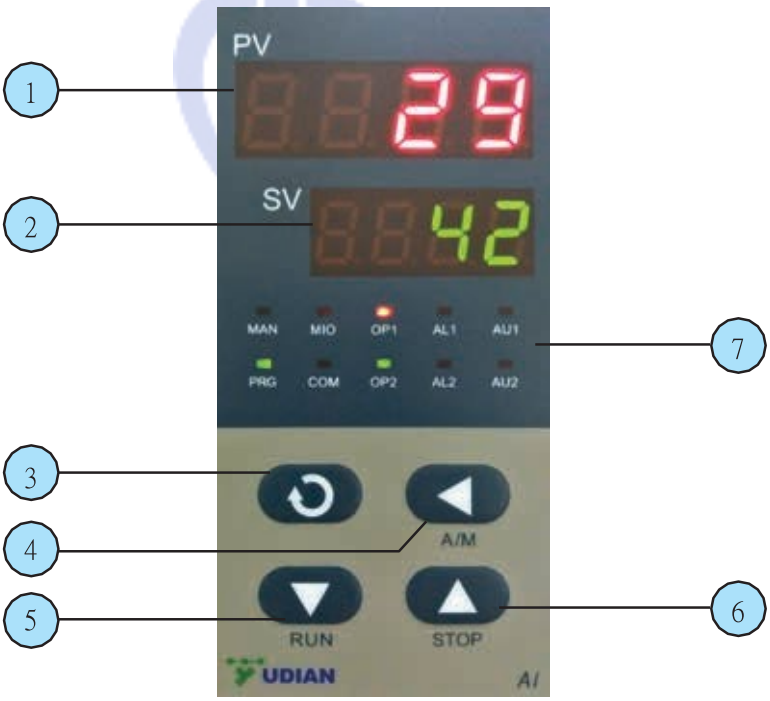
6.2 Basic state setting

When turn on the "Lock" ,the temperature controller will display the model and version, after several seconds, it will coming into the basis state, "PV" display testing temperature ,"SV" Flashing display Stop;"Stop" for in the stop state.

Model and version No.

Basic State

6.3 Panel Description



1. PV Testing Value 2. SV setting Value 3. Setting button (confirm button)

4. Data shift key (program setting enter key)

5. Data reduction key (program run/pause operation)

6. Data increase key (program stop operation) 7.Function indicator

6.4 Temperature Controller Wiring Diagram

7.0 Intelligent temperature control program settings

Temperature controller program curve is very important, that is the selection of the user to handling the sintering material, and rightly setting is successfully for material sintering!

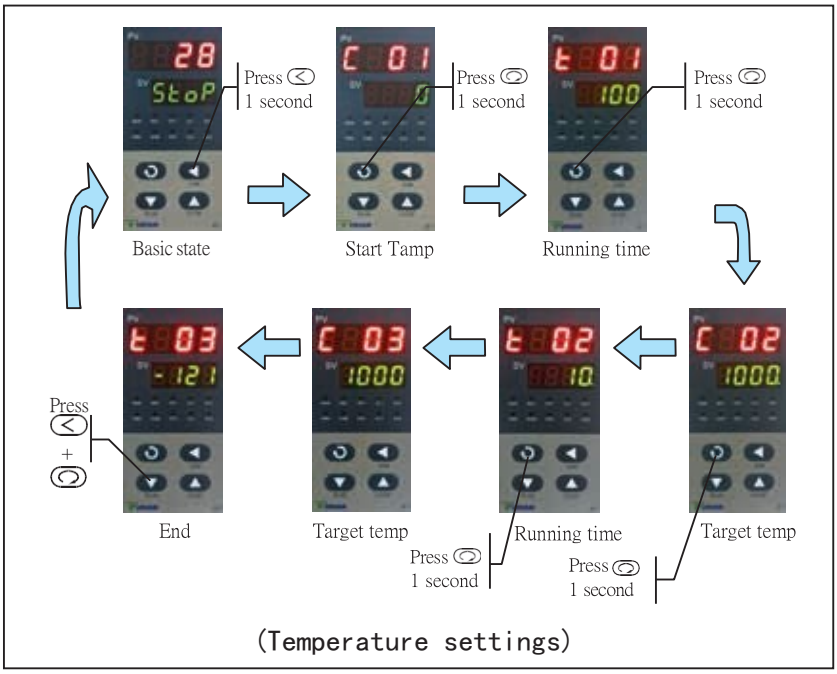
7.1 Temperature control program is set as follows:

7.11 At basis status , Press ＜ the key 1 second, The controller enters the temperature control program setting state.First displays the current running segment starting set value, and Press ＜ ∧ or ∨ three keys to modify the data.

7.12 Press ⬭ 1second, the next program value to be set will be displayed in order (current run time),each segment of temperature control is arranged in the order of C-X., t-X.;That is, the starting temperature of the segment → the running time of the segment → the target value, The target value of this segment is the starting temperature of the next segment. (Press ＜ ∧ or ∨ three keys to modify the data)

7.13 Pressing ＜ and holding for about 2 seconds will return to the previous parameter.

7.14 Pressing ＜ + ⬭ can exit from the parameter setting. If no key is Pressed within about 30 seconds, it will also exit setting condition.



(Temperature settings)

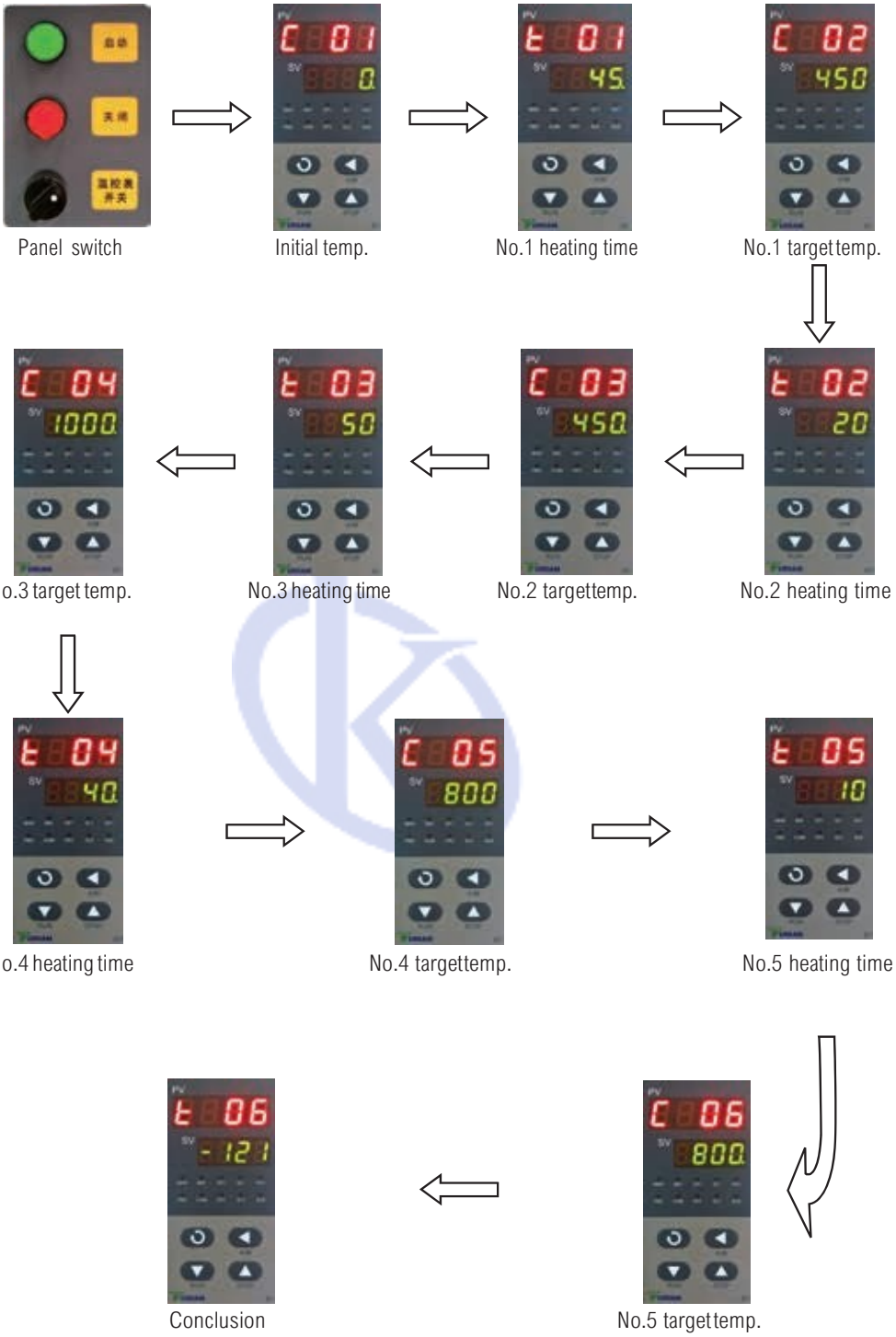
7.2 The program setting example

In order to clearly for the temperature controller setting, we strongly suggest refer to follow 6 segments with the Symbol meaning, use the 4 buttons, input the data and finish the setting!

	symbol	Input data	meaning
Starting at 0 degrees,45 minutes to 450 degrees	C01	0	Starting temperature (set 0 or less than the current temperature in the furnace)
	t01	45	First segment running time
	C02	450	The temperature value of the first Break point (the target value of the previous segment, the starting value of the next segment)
450 degree insulation 20 minutes	t02	20	Second running time
	C03	450	The temperature value of the second Break point (the target value of the previous segment, the starting value of the next segment)
From 450 heat up to 1000 degree in 50 minutes.	t03	50	Third running time
	C04	1000	The temperature value of the third Break point (the target value of the previous segment, the starting value of the next segment)
From 1000 reduce to 800 degree in 40 minutes.	t04	40	Fourth running time
	C05	800	The temperature value of the fourth Break point (the target value of the previous segment, the starting value of the next segment)
800 degree insulation 10 minutes	t05	10	Fifth running time
	C06	800	The temperature value of the fifth Break point (the target value of the previous segment, the starting value of the next segment)
program ending	t06	-121	The program finishes returning to the first stage and performs a Stop operation, which naturally cools down.

Please notice: must set: t××= -121.0 when heating program ends. the program should have continuity. During the running can modify the heating program, and the heating curve will be according to the modification program , Non professional operator not change any data unless totally understand, if have any modification mistake will caused the excessive temperature difference ,over load, if need modify, please stop the program then revise !

Note: The controller have one version update, PV display C01 will change into SP1..... C02 will be SP2..... ;SV display t 01 will change into t- 1, t 02 will be t- 2 and so on.

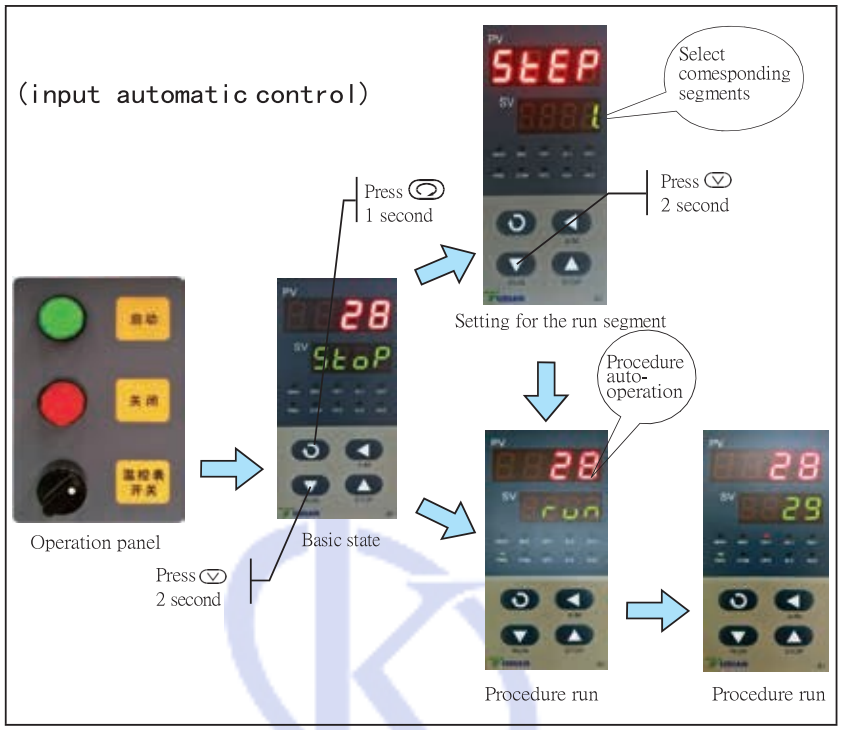


8.0 Intelligent temperature controller running

8.1 If controller is on basic state originally (programmed is on stop state, Display of SV flash to show "Stop") , press the button and hold for 1second , programmer will start to run (PV"STEP"、SV"××") , user can choose by himself which step he can start , Normally programmer will add or switch automatically by runs different steps , no need human interference. Sometimes for special factors , maybe we hope programmer run can start from one certain step, or jump directly to certain step, we can adjust "STEP" value to realize this. Then press the + button to return to basic state.

(Note that if you use the selected segment to run, please note that the temperature of the Selection segment need less than the current display value of PV)

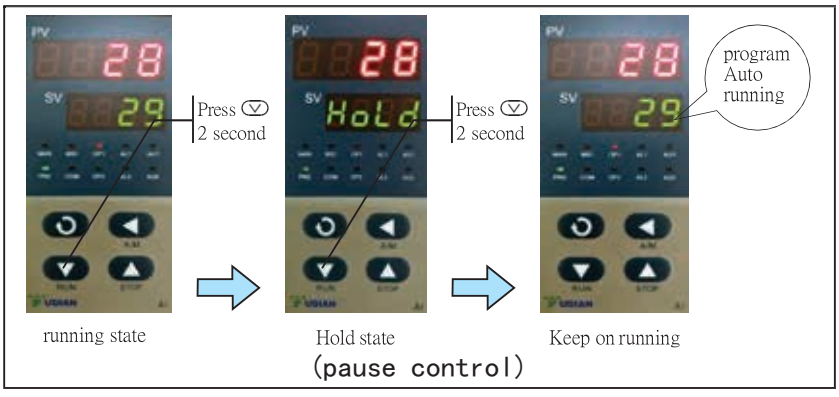
8.2 Press the button and hold for 2 seconds, Display of "SV" will show "RUN" , now the controller will get into auto-control state.



9.0 Intelligent temperature controller Hold state

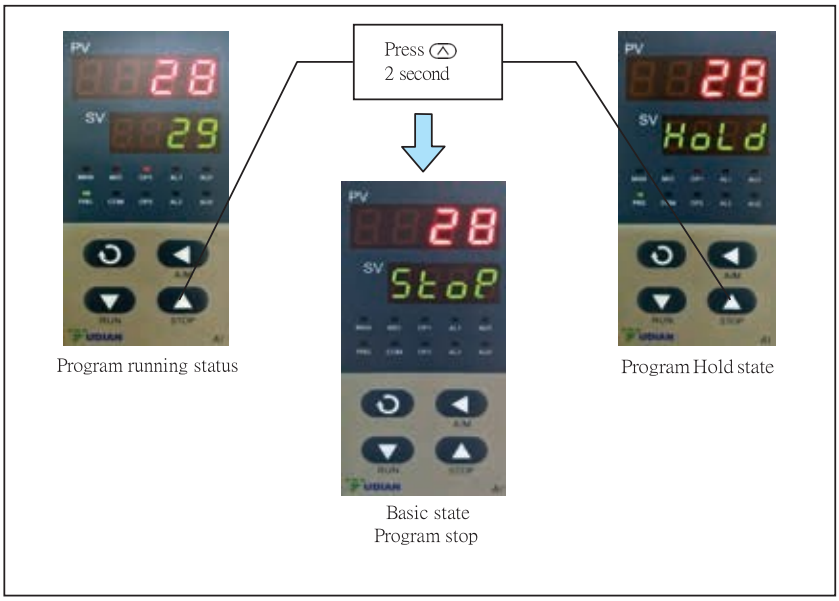
In running display state,Press and hold the key for about 2 seconds, Display of "SV", will show symbol "Hold",controller will get into hold state, controller will still execute control and keep the temperature on given value when it is hold state, but control time will stop increasing.

Under hold state, press the button and hold for 2 seconds, display of "SV" will show symbol "RUN" , controller will restart running.



10.0 Intelligent temperature controller stop State

In running or Hold status, Press and hold the ⌃ key for about 2 seconds,the lower display window displays the “STOP”, the program control is ended, the controller is in the basic state of the stop state, and the parameter "STEP" is automatically changed to "1". At this time, the PV display furnace temperature is "××××° C", and the SV display "STOP" flashes. Then Press the turn off button on the operation panel and the main circuit relay stops.



11.0 Heating elements replacement

11.1 If the heating element is damaged during use and needs to be replaced, the replacement method is as follows:

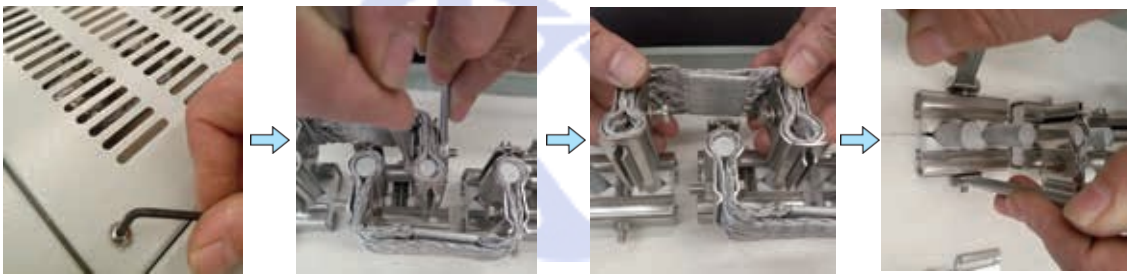


Figure.1 Figure.2 Figure.3 Figure.4

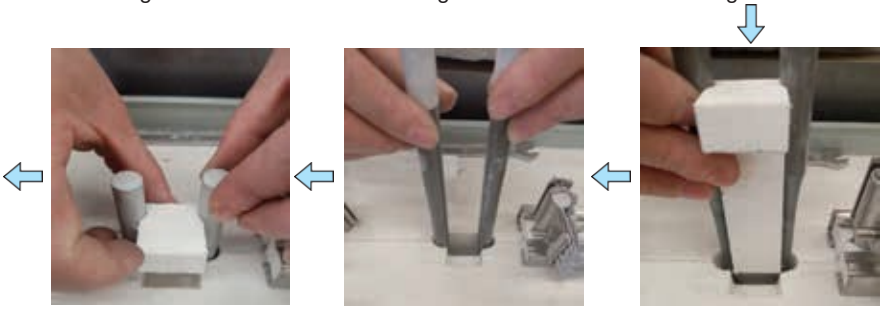


Figure.7 Figure.6 Figure.5

(1) Take off 4 screws on top of furnace, and then remove the cover, as (Fig.1);

(2) Take off the screw of clip for heating element, as (Fig.2). (it need to be careful when take off, the heating element is fragile character and easy to be broken)

(3) Take off Aluminum connection Strap between connections of heating element.(Fig.3).

(4) Loose the screws and remove of heater clamp/ clips as (Fig.4).

(5) Take off the L type ceramic block between rods of U type heating element, as (Fig.5).

(6) Take off the U type heating element which needs to be replaced, as (Fig.6).

(7) Replace a new heating element. Please put L type ceramic block together with the heating element, and make sure the ceramic block shall fit position as before, as (Fig.7).

(8) When tighten the screw of heater clamp/ clip for heating element, please make sure the bottom of U type heating element does not touch the bottom of furnace chamber. Usually the bottom of U type element shall rise 10mm high from the bottom of furnace chamber.

(9) Then follow the procedure (4)(3)(2)(1) to tighten screw and finish the exchange of heating element.

11.2 SiC heater replacement:

Figure.1

Figure.2

Figure.3

Figure.4

Figure.5

Figure.6

(1) Take off screws on top of furnace, and then remove the cover, as (Fig.1)

(2) Take off the heater clips for SiC heating element , as (Fig.2)

(3) Take off Aluminum connection Strap on heating element. as (Fig.3)

(4) Take off the ceramic block between rods of U type heating element, as (Fig.4).

(5) Take off the SiC heater which need replace. as (Fig.5).

(6) Replace a new heating element. Please put ceramic block together with the heating element.(Fig.6).

(7) Silicon carbide rod installation should install and maintain some distance with the side wall of chamber, avoid them to stick together in the heating process.

(8) Invert step 3,2,1, replacement is completed.

12.0 Electric furnace use and maintenance precautions

Note: After sending the power, you should hear the "beep" sound of the cooling fan. If there is no such sound, stop immediately and check the replacement fan. Fan specifications: axial fan AC220v/120×120mm.

First use /Long-term no use, or the working environment is wet, the electric furnace should be dried before use, to avoid splitting of the furnace and affect the heat preservation effect. The drying operation should be baked at 120 ℃ for 1 hour and 300 ℃ for 2 hours.

1. When the furnace is used, the input power shall not exceed the rated power, and the furnace temperature shall not

exceed the rated temperature to avoid damage to the heating element and the lining chamber. It is forbidden to directly inject various liquids and dissolved metals into the furnace tube to keep the inside of the furnace tube clean.

2. The rate of rise in each temperature range is not too big difference. When setting the heating rate, the physical and chemical properties of sintered material should be fully considered to avoid the phenomenon of spraying and polluting the furnace.

3. Regularly check that the electrical connection of the temperature control system is in good contact.

4. Working conditions of electric furnace:

(1) The ambient temperature is between -10 and 75 ℃.

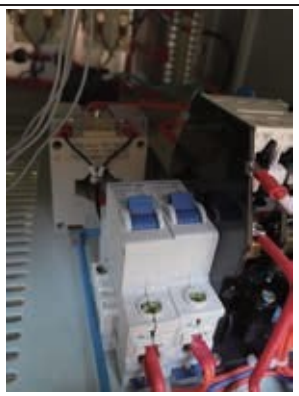
(2) The relative humidity of the surrounding environment does not exceed 85%.

(3) There is no conductive dust around the furnace, explosive gases and corrosive gases that seriously damage metals and insulating materials.

(4) There is no obvious tilt, vibration and bumps.

13.0 Common faults and troubleshooting

Problem	reason	solution
Connect the power, no power indication	The breaker of control line is off	Check if it is short circuited.If not, replace circuit breaker
Green Power indicator is off, but red Open circuit indicator is light	The breaker of main circuit is off	Check if it is short circuited.If not, Close circuit breaker
No current but with maximum voltage	Electric resistance broken	Find broken one and replace it
Controller SV Alternate display “OraL”	Thermocouple broken	Replace thermocouple
Controller SV Alternate display “HIAL”	Furnace temperature > Upper limit temp.	Cool down to safe temp., Controller recovery normal; Find the reason
Power and heating elements are well, but can not heating up	Controller circuit damage	Contact professional maintenance person



Built-breaker

External breaker

Under cover box

14.0 Option products

1. High temperature furnace bracket
2. Communication module and application software
3. Various sintering crucibles and heating elements

15.0 Instructions for Order

In order to improve the consistency of products, the company provides customers with standard high-temperature sintering furnaces, tube furnaces and their accessories. The following items must be specified when ordering:

1. The maximum operating temperature of the desired sintering furnace and the control functions that you want to achieve.
2. Furnace structure layout and furnace size.
3. The quantity that needs to be ordered.
4. If the customer needs us to provide non-standard products, please provide detailed technical requirements but the delivery period may be extended, please understand!

Packing list

No.	Item Name:	Unit	Qty	Remarks
1	YR0 Series box type high temperature sintering furnace	set	1	
2	User Manual	book	1	
3	Alumina heater's plug (except 1200. C type)	pc	2	Free
4	Alumina door block	pc	1	
6	Crucible tongs	pc	1	free
7	Temperature-resistant gloves	pair	1	free
8				
9				
10				

Product Receipt

Client Name:				Purchase Date:	
Address:				Post code	
Tel/Fax:			Mobile:		
Furnace details:					
Item No.:		Continuous working temperature		Specifications:	
Chamber Size:		Rated Voltage:		Rated Power:	
Instrument Model		Heating elements & Size:		Heating elements connection mode	
Fuse		Breaker		AC contactor	
transformer		thermocouple		Operating temp.	
Voltmeter		Ammeter		Button	
Trigger		Fan			
Instrument parameter memorandum					
M5		P		T	
Ctrl		oPL		oPH	
Loc					
Remarks:					

Appendix :

I. General knowledge of double platinum rhodium (platinum rhodium 30-platinum

rhodium 6) thermocouples

The thermocouple has a very small thermoelectromotive force at room temperature (-2μV at 25 ⁰ C and 3μV at 50° C), so compensation wires are generally used for measurement.

The effect of temperature changes at the reference end can be ignored. It has a long-term use temperature of 1600 ⁰ C and a short-term use temperature of 1800 ⁰ C. The platinum ruthenium 6 alloy has a melting point of 1820 ⁰ C, which limits its upper temperature limit. The double platinum rhodium thermocouple has a small electromotive force rate, so it is necessary to equip the display instrument with higher sensitivity.

Type B thermocouples are suitable for use in oxidizing or neutral atmospheres, and can be used for a short period of time in a vacuum environment. Even in a reducing atmosphere, the life is 10 to 20 times that of R and S type thermocouples.

Due to the high temperature of R and S type thermocouples, the phenomenon that the platinum ruthenium positive electrode diffuses to the negative electrode will occur, causing the thermocouple to deteriorate. In order to prevent the above phenomenon, the addition of lanthanum to platinum to form a platinum ruthenium alloy can not only improve heat resistance Performance, and can increase the thermoelectric power of the alloy to platinum.

When the rhodium content is less than 20%, the platinum-germanium alloy has a sharp increase in the thermoelectromotive force of platinum, but after exceeding this value, as the rhodium content increases, the change is not large, and it hardens significantly, and processing is difficult.

Therefore, the content of rhodium in such alloys should not exceed 40% by weight.

The grain length of Pt-Rh alloy tends to be smaller than that of pure Pt, and decreases with the increase of Rh content, which can make the thermoelectric properties more stable and the mechanical strength higher. Therefore, the double platinum rhodium thermocouple has been widely used in the high temperature measurement at 1800C. The index number of the double platinum rhodium thermocouple is previously LL-2, now B.

Pt-Rh 30-Pt-Rh 6 thermocouple scale (scale number: B)

(Reference terminal temperature: 0 degrees Celsius) Thermal electromotive force mv

	0°C	10°C	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
		-0.002	-0.003	-0.002	0	0.002	0.006	0.011	0.017	0.025
100°C	0.033	0.043	0.053	0.065	0.078	0.092	0.107	0.123	0.14	0.159
200°C	0.178	0.199	0.22	0.243	0.266	0.291	0.317	0.344	0.372	0.401
300°C	0.431	0.462	0.494	0.527	0.561	0.596	0.632	0.669	0.707	0.746
400°C	0.786	0.827	0.87	0.913	0.975	1.002	1.048	1.095	1.143	1.192
500°C	1.241	1.292	1.344	1.397	1.45	1.505	1.56	1.617	1.674	1.732
600°C	1.791	1.851	1.912	1.974	2.036	2.1	2.164	2.23	2.296	2.363
700°C	2.43	2.499	2.569	2.639	2.71	2.782	2.855	2.928	3.003	3.078
800°C	3.154	3.231	3.308	3.387	3.466	3.546	3.626	3.708	3.79	3.873
900°C	3.957	4.041	4.126	4.212	4.298	4.386	4.474	4.562	4.652	4.742
1000°C	4.833	4.924	5.016	5.109	5.202	5.297	5.391	5.487	5.583	5.68
1100°C	5.777	5.875	5.973	6.073	6.172	6.273	6.374	6.475	6.577	6.68
1200°C	6.783	6.887	6.991	7.096	7.202	7.308	7.414	7.521	7.628	7.736
1300°C	7.845	7.953	8.063	8.192	8.283	8.393	8.504	8.616	8.727	8.839
1400°C	8.952	9.065	9.178	9.291	9.405	9.519	9.634	9.748	9.863	9.979
1500°C	10.094	10.21	10.325	10.441	10.558	10.674	10.79	10.907	11.024	11.141
1600°C	11.257	11.374	11.491	11.608	11.725	11.842	11.959	12.076	12.193	12.31
1700°C	12.426	12.543	12.659	12.776	12.892	13.008	13.124	13.239	13.354	13.47
1800°C	13.585	13.699	13.814	--	--	--	--	--	--	--

2. General knowledge of platinum-rhodium (platinum-rhodium 10-platinum) thermocouples

The characteristics of the thermocouple are stable in thermoelectric performance and strong in oxidation resistance, and should be continuously used in an oxidizing and inert atmosphere. The long-term use temperature is 1400 ℃. Above this temperature, pure platinum wire will cause coarse grains due to recrystallization even in air. Therefore, the long-term use temperature is limited to 1400 ℃, and the short-term use temperature is 1600 ℃. Among all thermocouples, it has the highest level of accuracy and is commonly used as a standard or as a thermocouple for measuring high temperatures. It has a wide temperature range, homogeneity and interchangeability.

Single platinum rhodium (platinum rhodium 10-platinum) thermocouple indexing table (index Number: S)

(Reference terminal temperature: 0 degrees Celsius) Thermal electromotive force mv

	0℃	10℃	20℃	30℃	40℃	50℃	60℃	70℃	80℃	90℃
	0.0	0.055	0.113	0.173	0.235	0.299	0.365	0.432	0.502	0.573
100℃	0.645	0.719	0.795	0.872	0.951	1.029	1.109	1.19	1.273	1.356
200℃	1.44	1.525	1.611	1.698	1.785	1.873	1.962	2.051	2.141	2.232
300℃	2.323	2.414	2.506	2.599	2.692	2.786	2.88	2.974	3.069	3.146
400℃	3.26	3.356	3.452	3.549	3.645	3.743	3.84	3.938	4.036	4.135
500℃	4.234	4.333	4.432	4.532	4.632	4.732	4.832	4.933	5.034	5.136
600℃	5.237	5.339	5.442	5.544	5.648	5.751	5.855	5.96	6.064	6.169
700℃	6.274	6.38	6.486	6.592	6.699	6.805	6.913	7.02	7.128	7.236
800℃	7.345	7.545	7.563	7.672	7.782	7.892	8.003	8.114	8.225	8.336
900℃	8.448	8.56	8.673	8.786	8.899	9.012	9.126	9.24	9.355	9.47
1000℃	9.585	9.7	9.816	9.932	10.048	10.165	10.282	10.4	10.517	10.635
1100℃	10.754	10.872	10.991	11.11	11.229	11.348	11.467	11.587	11.707	11.827
1200℃	11.947	12.067	12.188	12.308	12.429	12.55	12.671	12.792	12.913	13.034
1300℃	13.155	13.276	13.397	13.519	13.64	13.761	13.883	14.004	14.125	14.247
1400℃	14.368	14.489	14.61	14.731	14.852	14.973	15.094	15.215	15.336	15.456
1500℃	15.576	15.697	15.817	15.937	16.057	16.176	16.296	16.415	16.534	16.653
1600℃	16.771	16.89	17.008	17.125	17.243	17.36	17.477	17.594	17.771	17.826
1700℃	17.942	18.056	18.17	18.282	18.394	18.504	18.612	––	––	––

3. Introduction of Silicon Carbon Bars

Silicon carbide (SiC) electric heating element is a rod-shaped non-metal high-temperature electric heating element which is made of green high-purity hexagonal silicon carbide as the main raw material, processed and preformed, high-temperature silicidation, and recrystallized at a high temperature of 2200℃ . Normal use temperature can reach 1450 ℃ , under reasonable use conditions,

Continuous use for more than 2000 hours, used in air, does not require any protective atmosphere. Compared with metal electric heating elements, this component has the characteristics of high temperature, oxidation resistance, corrosion resistance, long life, slight deformation, convenient installation and maintenance.

Therefore, it is widely used in a variety of high temperature electric furnaces and other heating equipment in industries such as electronics, magnetic materials, powder metallurgy, ceramics, glass, metallurgy and machinery.

The service life of the silicon carbide rod heating element has been affected by the difference in the intrinsic quality of the vision. It is also affected by the operating temperature of the component, the surface load of the component heating part, the ambient atmosphere, the hazardous substances, the power supply mode (intermittent and continuous

use), and the components in use. The influence of factors such as the series-parallel method in the process, the load of the components at each temperature.

I. Silicon carbon rod (SiC) performance

The material is hard and brittle, has small expansion coefficient, can withstand rapid cooling and heat, is not easy to be deformed, has good chemical stability, has strong acid resistance, does not react with strong acid, has poor alkali resistance, and can corrode decomposition rod at high temperature. body. Chlorine gas can decompose components, and hydrogen and nitrogen have different degrees of erosion. If used in air and water vapor for a long time, the components will slowly age, the silica content will increase, and the resistance will increase. The following reactions occur:

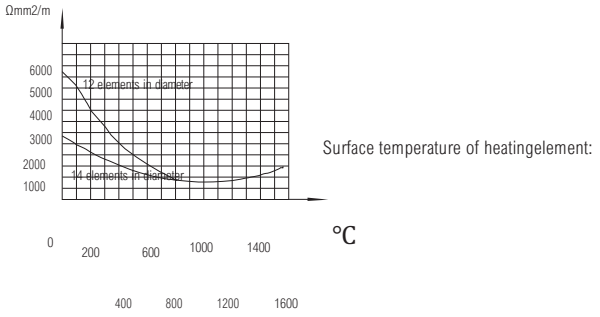
$SiC+2O_2=SiO_2+CO_2$

$SiC+4H_2O=SiO_2+4H_2+CO_2$

The resistance value of a silicon carbon rod varies with the temperature of the element because the element is a nonlinear type resistor. From room temperature to 850 ± 50 ℃ , the resistance is changed from large to small, and from 850 ± 50℃ or more from small to large. That is to say: the temperature coefficient of resistance of the component has a negative phase and a positive phase. The standard resistance is measured at 1050±50℃ according to the ministry standard, which is convenient for installation. The surface load density of the component is closely related to the temperature of the furnace and can be arbitrarily adjusted as needed.

When the furnace temperature is high, the load density is increased, and vice versa. The so-called "tuning power."

II. Resistance Temperature Characteristic Curve of Silicon Carbon Bar (SiC)



Resistance-Temperature Characteristic Curve of Silicon Carbon Bar

It can be seen from the diagram that the resistance of the heater is concave and curved. When the temperature is about 850 + 50 C, the resistivity is the minimum. After this temperature point, the resistivity increases with the increase of temperature. When the temperature exceeds 1500 ℃ , the aging rate increases and the components are burned down rapidly.

4. Brief Introduction of Silicon-Molybdenum Bars

The 1800 type silicon molybdenum rod is a kind of resistance heating element based on molybdenum disilicide. The highest surface temperature of the element is 1800.C. It is used at high temperature in an oxidizing atmosphere, and the surface is vitrified to form a bright and dense melting point of 1710.C quartz (SiO_2) glass film can protect the silicon molybdenum rod from oxidation, so the silicon molybdenum rod element has unique high temperature oxidation resistance. When the component use temperature is greater than 1700.C, the SiO_2 protective layer on the heating element is melted, and due to the surface tension, SiO_2 is melted into droplets, and the protection is lost. The SiO_2 protective layer is regenerated when the component is used in an oxidizing atmosphere. It must be pointed out that the silicon molybdenum rod electric heating element should not be in the 400-700.C range long-term use. Otherwise the component will be pulverized by the strong oxidation of low temperature.

I. Performance of Silicon-Molybdenum Bar ($MoSi_2$) :

1. Recrystallization temperature 1800 .C
2. At room temperature: high hardness, high brittleness, high temperature resistance
3. Deformation occurs at high temperature, and should be installed vertically
4. Good resistance to temperature sudden change (resistant to rapid changes)
5. Stable chemical properties, no reaction with acidic materials
6. But at high temperatures, it reacts with alkaline earth metals or low melting point salts.
7. At the heating element lead-out port, generally sealed to reduce heat loss
8. The shape is "U" shape, so there is enough expansion space at the bottom when considering the installation.

II. Influence under the condition of atmosphere protection

A. Used in NO2, CO2, O2, air, the temperature should be less than 1700 ℃

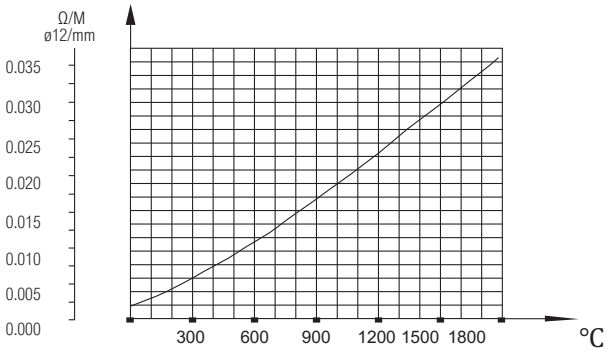
B. Used in He, Ar, Ne, the temperature should be less than 1650 ℃

C. When used in SO2, the temperature should be less than 1600 ℃

D. In CO and N2, the temperature should be less than 1500 ℃

E. In wet H2, the temperature should be less than 1400 ℃ , in dry H2, the temperature should be less than 1350 ℃

II. Resistance temperature characteristic curve of silicon molybdenum rod (MoSi2)



Silicon molybdenum rod resistance - temperature characteristic curve

The resistivity of the molybdenum disilicide electrothermal assembly increases rapidly with increasing temperature. Under normal operating conditions, the component resistance generally does not vary with the length of time of use. In general,new and old components can be mixed. But strictly speaking, it is recommended to use the same batch news ones, and use old ones with old ones.