

# ACROSS INTERNATIONAL GCF CONTROLLED ATMOSPHERE MUFFLE FURNACE SERIES USER'S MANUAL



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## 1. SAFETY NOTES / ILLUSTRATED SYMBOLS

Thank you for choosing our GCF Controlled Atmosphere Muffle Furnace Series User's Manual. Please read this manual carefully before operating the unit. Keep this manual on-hand so it can be used by all operators of the unit. Across International is not responsible for any injury or damage caused by misuse.

Symbol	Explanation of Symbols / Explication des Symboles
	Watch out Important note
	Protective earth connection
	Caution Hot Surface
	Caution High Voltage
	Danger: Situation is dangerous and may result in death or serious injury
	Attention: Beware of rotating objects
	Attention: Wear protective gloves and goggles to prevent personal injury

## 2. PRECAUTIONS

### English

- ◆ **THIS IS NOT AN EXPLOSION PROOF FURNACE. THIS FURNACE IS NOT SUITABLE FOR USE IN CLASS I, II, OR III LOCATIONS, AS DEFINED BY THE NATIONAL ELECTRICAL CODE NFPA 70.**
- ◆ **NEVER LEAVE YOUR FURNACE UNATTENDED WHILE OPERATING.**
- ◆ Across International is not responsible for any loss of material inside of the unit.
- ◆ Never clean the unit with flammable cleaners. Assure that all cleaning agents are completely evaporated and dried before reconnecting the unit to the power supply.
- ◆ Do not try to heat combustible or explosive materials, or materials that may release corrosive/erosive gases.
- ◆ Keep the unit away from any electromagnetic interferences, vibrations, flammable materials, fire, or corrosive/erosive gases.
- ◆ Avoid vibration or any corrosive/erosive gases around the mantle
- ◆ Always wear thermal gloves and protective goggles during operation.
- ◆ Always make sure your unit is connected the correct power source (110/220/480V) and grounded properly. Always use the power cord that comes with the unit. Never modify the cable or power plug.
- ◆   Do not unplug the unit during normal operation.
- ◆ Do not position the equipment so that it is difficult to operate the disconnecting device.
- ◆ Consider conditions that may affect your furnace's ability to accurately control its temperatures. Examples include extreme heat from radiators, stoves, other mantles, autoclaves, etc. Avoid direct sun, fast-moving air currents, and heating/cooling ducts.
- ◆ To ensure proper air circulation around the furnace, allow a minimum of 12 inches between the unit and any walls or partitions.
- ◆ A separate circuit is strongly recommended to prevent possible loss of product due to overloading or failure of other equipment on a shared circuit.
- ◆ If the equipment is not used in a manner specified in this manual, the protection provided by the equipment may be impaired.
- ◆ Returning shipment: Save the shipping crate until you are sure your unit is consistently working properly. If for any reason you must return the unit, first contact AI for a return material authorization (RMA) number.

### 3. INTRODUCTION

GCF Controlled Atmosphere Muffle Furnaces feature a chamber with alumina fiber insulation or stainless-steel interior (DISCONTINUED). A double walled steel internal housing helps minimize heat loss to exterior surface. Furnace operation is controlled by Eurotherm 3204 digital controller with built-in RS485 digital communications port and USB adaptor, allowing the user to connect to a PC for remote control and monitoring of the furnace. You can also save or export test results. All our furnaces are CE compliant, UL/CSA (optional).

An atmosphere furnace provides the perfect environment for various procedures in many laboratories, providing the controlled temperature and atmosphere specific projects require. The controlled atmosphere is desired to complete tasks that require exact temperatures with no room for error. This is the best way to ensure the successful outcome of your project because it is sealed tightly to ensure the proper environment.

One of the main components of the atmosphere furnace is the correct mixture of gases. The precise measurement of each gas is essential to the success of your project. You can use a separate chamber to mix the gases, which are then pumped into the furnace chamber where the work will be completed when they are done mixing. It is essential that the separate chamber that holds the gases does not receive any outside air because it could throw off the gas mixture and render your project useless.

#### Features

- ◆ Multiple gas inlets and outlets with stainless steel ball valves. Flow meter to control inbound and outbound gas flows. Outlets can be ignited to burn off gas.
- ◆ Furnace chamber is welded, and oil leak tested to ensure air tightness. Furnace door is sealed with high temperature silicon gasket.
- ◆ Built-in stainless-steel water-cooling panel protects door sealing gasket when furnace is under heavy use.
- ◆ Microprocessor based self-tuning PID control provides optimum thermal process with minimal overshoot.
- ◆ Multiple atmosphere processes in a single cycle are possible (ex: binder burn out in air and parts sintering under rough vacuum or inert gas environment.)
- ◆ Built-in ammeter and dual voltmeters for easy monitoring and troubleshooting.
- ◆ Built-in computer interface.
- ◆ Overheat protection shuts down the furnace if temperature is outside of acceptable range.
- ◆ Power failure protection resumes furnace operation right after the point of failure when power is reestablished
- ◆ UL, CSA Certification (Optional)

## 4. SPECIFICATIONS

**Table 1: Model's Specification**

Model	Max Temp (°C)	Chamber Size. (LxWxH) (inches)	Voltage (V)	Current (A)	Frequency (Hz) / Phase (Ph)	Power (kW)	Maximum/ Constant working temp. (°C)	Max. Positive Pressure (PSI)	Thermo-couple	Heating Elements Type/QTY	Built in Circuit Breaker (A)	Shipping Dimensions (LxWxH) (inches)	Unit / Shipping Weight (lbs.)
GCF1100B	1100	11x9x9	220	23	50/60 single	5	1100/1000	3	K	Kanthal	32	40x30x40	300/400
GCF1200	1200	12x8x8	220	19	50/60 single	4.2	1200/1100	3	K	Kanthal	25	38x26x44	350/420
		16x12x12		42		9.24					60	40x30x48	400/470
		20x16x16		72		15.84					100	49x44x61	800/950
		40x24x24	480	60A		55					80	75x50x71	67x44x65
GCF1400	1400	6x6x6	220	14	50/60 single	3	1400/1300	3	S	(SiC) / 4	20	28x33x45	290/400
		12x8x8		45		9.9				(SiC) / 8	40	33x34x50	450/580
		16x12x12		53		11.6				(SiC) / 12	80	43x35x55	590/720
GCF1700	1700	6x6x6	220	17	50/60 single	3.7	1700/1600	3	B	MoSi2 / 4	20	33x30x51	430/510
		12x8x8		45		9.9				MoSi2 / 8	40	37x26x50	620/720
		16x12x12		80		17.6				MoSi2 / 12	80	34x29x60	880/1050
GCF1750	1750	16.12.12	220	60A	50/60 single	13	1750/1650	3	B	MoSi2 / 12	80	37x42x70	915/1131
GCF1750	1750	20X16X16	480	37A	50/60 3-phase	31.5	1750/1650	3	B	MoSi2/18	50	43 x 46 81	1179/1830

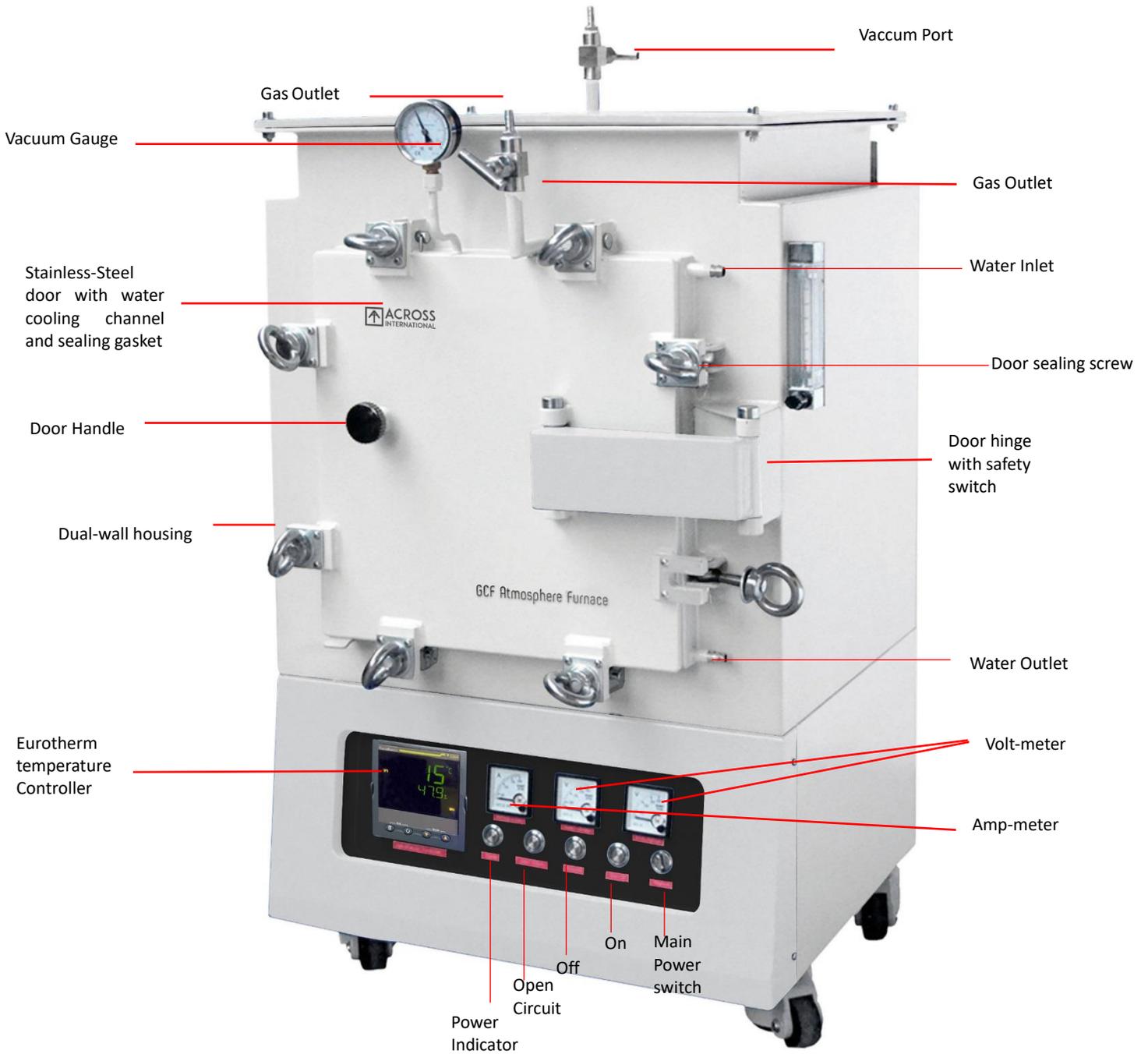
**Table 2: Below table applies to all models**

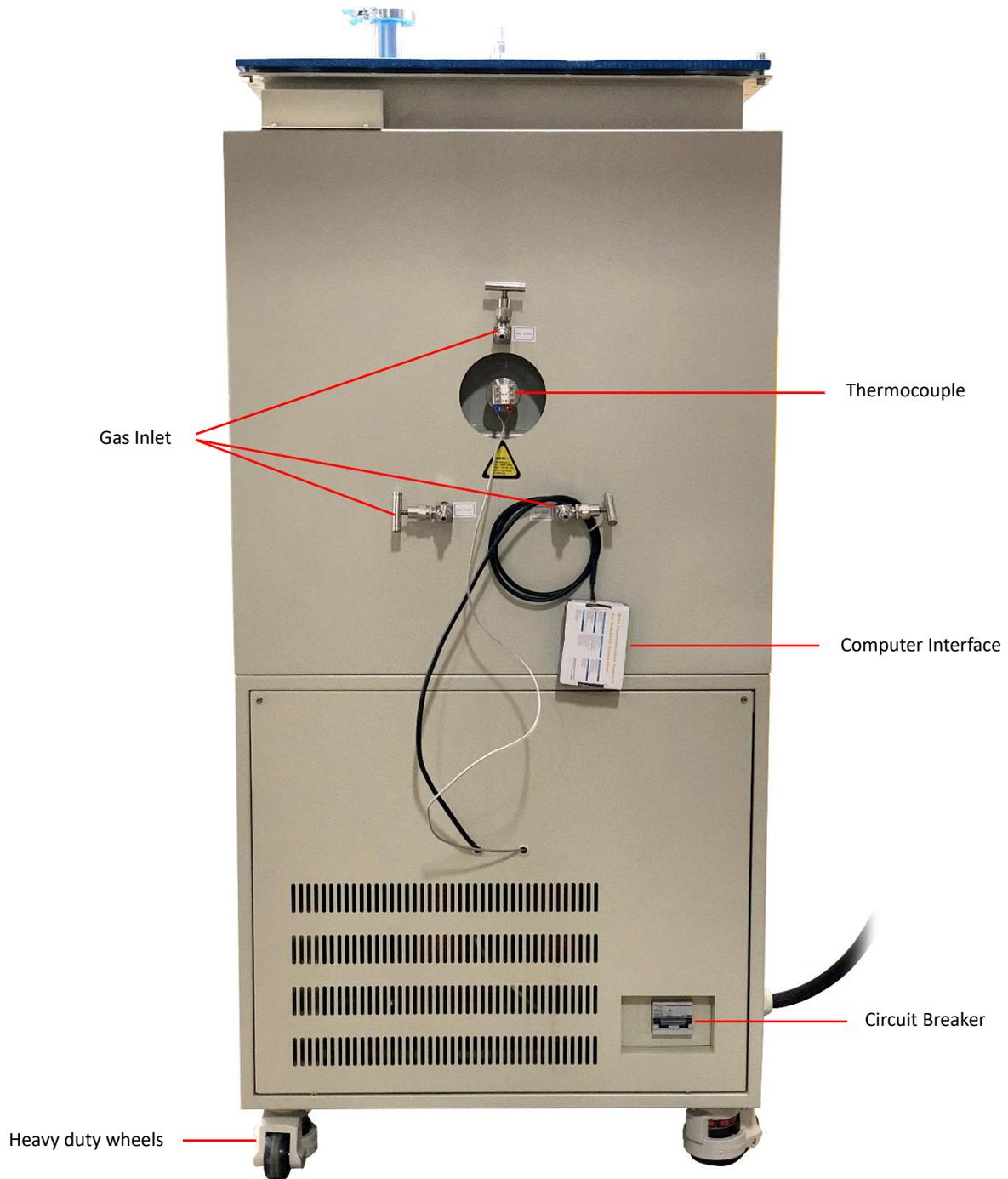
Minimum Temperature	300 °C
Temperature Controller	Eurotherm 3204
Temperature Controller Precision	±1
Heating Rate	5-15 °C
Gas Inlet/Outlet	1/4" hose barb with 1/4" BSPT (British Standard Pipe Thread)
Compliance	CE, UL/CSA (optional)

**Table 3: Maximum Working Temperature**

Working Environment	Maximum Working Temperature (°C)		
	GCF1200/GCF1100B	GCF1400	GCF1700/GCF1750
Air	1200/1100	1400	1700
Helium (He), Neon (Ne), Argon (Ar)	1200/1100	1400	1650
Nitrogen (N2)	1200/1100	1270	1500
Hydrocarbon gas	1200/1100	1250	1550
Hydrogen (H2) up to 5%	1200/1100	1200	1500

## 5. COMPONENTS





## 6. INSTALLATION

Depending on what unit you bought, it is necessary for 2-3 people to assist in uncrating this unit. Crate can weigh between 400-1050 Lbs. and can be a little heavy for one person. Remember your safety is our concern so please use all the safety equipment to move the crate such as a pallet jack and good gloves. When uncrating the unit, remove the bottom screws of crate and pull the crate up, remembering that 2-3 people will need to help. Next remove all foam and any plastic bags that come with unit.



Unit must be installed 2 feet away from the wall for easy access of main power switch.



Unit must be installed on a horizontal and shock-proof platform away from any explosive gases and materials.



Remove the stuffing material from **GCF1400, GCF1700, and GCF1750 models ONLY**.



1. Unscrew and open the top panel (picture1).
2. Remove the stuffing material (picture2).
3. Put the top panel back and secure it (picture2).



Picture 1



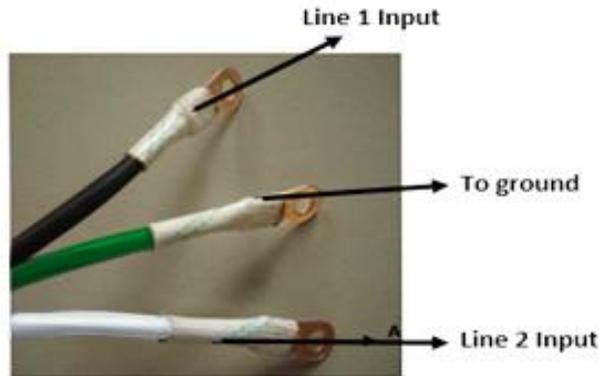
Picture 2



Picture 3-

## 6.1 Wiring Installation

6.1.1 Our furnaces come with a built-in circuit breaker. The brown and blue wires in picture should be the line inputs, while the black wire is ground.



6.1.2 The red wire in the thermocouple should be connected to the positive pole and the green wire to the negative pole.



## 6.2 Thermocouple

6.2.1 Insert thermocouple through the provided thermocouple nut (picture).

6.2.2 Thread the rubber sealing o-ring over the thermocouple and secure it to the nut (picture).

6.2.3 Insert the assembled thermocouple into the thermocouple hole in the back of the furnace (picture).

6.2.4 Tighten the nut (picture).



To test if you connected the wires correctly, turn the main power switch on and notice if the temperature controller powers on. If not, re-check your connection.

## 6.3 Gas Filling

### 6.3.1 Check Furnace air tightness

- 6.3.1.1 Close furnace door, tighten all door screws and close all valves except one gas inlet
- 6.3.1.2 Fill the furnace with gas thru the gas inlet until pressure gauge reads 0.03MPa.
- 6.3.1.3 Hold this pressure for two hours and check if pressure gauge reading changes.
- 6.3.1.4 If pressure gauge reading drops, check and make sure all door screws are tightened properly and sealing gasket is clean and intact.

### 6.3.2 Outgas air in the chamber with inert gas

- 6.3.2.1 Inert gas should be filled into furnace before heating up
- 6.3.2.2 Inert gases can be filled into the furnace thru three gas inbound valves. Gas exhausting valves should be wide open during this operation to allow air to go out of the furnace quickly.
- 6.3.2.3 Generally, oxygen density will drop to 100ppm, if ten times of the volume of the furnace chamber inert gas is filled.
- 6.3.2.4 When oxygen density inside the furnace has reached the required level, close the gas exhausting valve to save inert gas.
- 6.3.2.5 During the furnace operation, a positive pressure must be maintained in the furnace chamber, to prevent air going into the furnace and allow gas to flow out. However, the positive pressure must be less than 3 PSI over 1ATM (pressure gauge reading 0 means 1 ATM).

### 6.3.3 Pre-vacuuming the furnace

- 6.3.3.1 Connect the pipe of the vacuum pump to any of the gas exhausting valves
- 6.3.3.2 Pre-vacuum the furnace chamber (to around -10 PSI)
- 6.3.3.3 Fill inert gas
- 6.3.3.4 Vacuum the furnace chamber again (to around -10 PSI)
- 6.3.3.5 Repeat this a few times until gas condition reach required level
- 6.3.3.6 However, the positive pressure must be less than 3 PSI over 1ATM (pressure gauge reading 0 means 1 ATM).

### 6.3.4 How to flow protection gas properly

After vacuum the chamber and fill in protection gas, try to keep chamber pressure slightly higher than ambient pressure. Gas should be filled from the inlet in the back and flow out from the valve on the top, to create a smooth gas flow. Try to keep chamber pressure within 0 to 0.04MPa, and do not let gas fill into the chamber too much that may create a dangerous high pressure. Try NOT to keep gas inside the furnace all the time but let gas flow in and out smoothly.

*For reference only:* to keep monitoring a smooth gas flow, open the gas outlet all the way and connect it to a hose and then place the hose into a bucket with water (the bucket should be placed outdoor if you use dangerous or poison gas). Use the flow meter to adjust flow speed and make sure you see bubble coming out from the hose (otherwise water or air may back flow into the furnace) in the bucket. Bubble speed will give you an idea how well gas flows and also keep the furnace chamber not in high pressure.

## 7. OPERATION

- 6.3.5 Make sure gas is flowing properly before turning on the furnace
- 6.3.6 DO NOT turn off gas flow until your furnace is cooled down, otherwise air may flow into the chamber causing oxidization even explosion.



**CAUTION!** Across International DOES NOT recommend the use of hydrogen or other dangerous gas, and we are not responsible for any damage or consequence damage caused by that.

### FOR REFERENCE ONLY

Hydrogen of 4% to 75% purity may cause explosion with air when heated. If you need to fill hydrogen, you need to have some fail-save device built in. Outgassing process is very important, and you also need to check the purity of hydrogen filled.

To test hydrogen purity, use a small test tube upside down and collect some hydrogen from the chamber, then cover it with your thumb. Move the test tube to an open flame and remove your thumb. If you hear a sharp explosion, the hydrogen is not pure. If you hear a slight explosion the hydrogen is pure. You can turn on the furnace if hydrogen is pure; otherwise you need to outgas the chamber a few more times.

## 7.1 Running the furnace

- 7.1.1 After connecting the power wires as in section 6.1, flip on the circuit breaker
- 7.1.2 Turn the main power switch on, the temperature controller display should turn on.
- 7.1.3 Place the alumina cushion block in the bottom of the chamber.



- 7.1.4 Place the sample material in the center of the furnace chamber
- 7.1.5 Place the door thermal block using the stainless-steel tongs (see picture)



- 7.1.6 Close the door and tighten all the screws.
- 7.1.7 Set the temperature controller (refer to section
- 7.1.8 Check the air tightness of the furnace (see section 6.3 Gas Filling)
- 7.1.9 Press "On" button, you should hear the AC contactor making a click sound.
- 7.1.10 Press and hold the "RUN/RST" for three seconds on the controller to start the controller program.



**GCF 1700, and 1750 ONLY:** if the amp-meter reads over 200A for longer than one minute after "RUN/RST" is pressed and hold for three seconds, shut down the furnace immediate to avoid damage to the transformer and the heating element. This only happens in a short period of time after the furnace is

## 8. ADVANCED SETTING

started (within 250°C).

### Solutions:

- Set a value (prompt 306) to a lower number for the amp restriction trigger.
- Turn down the O-H value of PID used in this temperature range after turn-off (see Picture 44)
- Select No.1 PID for such temperature range as its O-H value has been set before delivery from the factory.

For detailed instructions of temperature controller operations, please refer to the instruction of the Eurotherm 3204 temperature controller, the instructions here is only used to explain those commonly used or difficult operations for convenient use by the users.

### 8.1 Controller Program Setting:

There are five programs, and each program consists of 8 steps or segments. Three parameters are required for each sequence of program in setting:

- Heating rate
- End temperature

- Enable or disable dwell function

A Program is an eight-segment programmer consisting of four ramp/dwell pairs. Each ramp consists of a controlled rate of change of setpoint to a target level. Each ramp is followed by a dwell at that level. The ramp rate, target level and dwell time can also be set by the user

The controller can put in Auto, manual or off mode. For the muffle furnace, we will only use "Auto" mode.

- **Auto mode** is the normal operation where the output is adjusted automatically by the controller in response to changes in the measured temperature. In Auto mode all the alarms and the special functions (auto tuning, soft start, timer and programmer) are operative
- **Manual mode** means that the controller output power is manually set by the operator. The input sensor is still connected and reading the temperature, but the control loop is 'open'.
- **Off mode** means that the heating and cooling outputs are turned off. The process alarm and analogue retransmission outputs will, however, still be active while Band and deviation alarm will be OFF.

### To select Auto, Manual or Off Mode"

1. Press and hold  and  arrows together for more than 1 second on the home display.
2. "Auto" is shown in the upper display. After 5 seconds, the lower display will scroll the longer description of this parameter "LOOP MODE – AUTO MANUAL OFF".
3. Press  to select "Auto".
4. When the desired mode is selected, do not push any other button. After 2 seconds the controller will return to the home display.

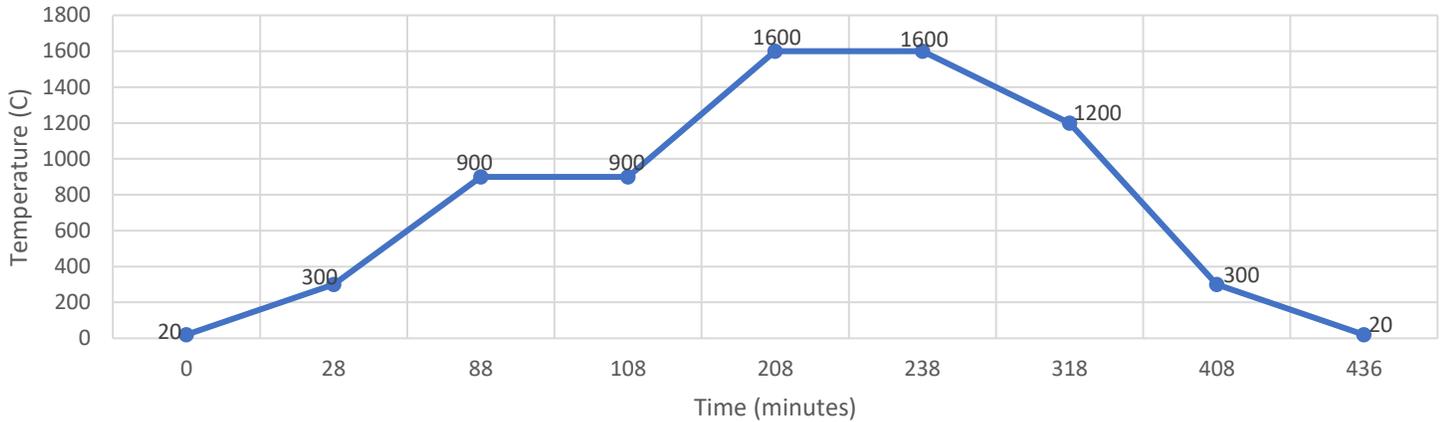
### To Operate the Program

Operation	Action	Indication
To run a program	Press and quickly release	Beacon -- RUN = On Scrolling display - TIMER RUNNING
To hold a program	Press and quickly release	Beacon -- RUN = Flashing Scrolling display - TIMER HOLD
To reset a program	Press and hold for more than one second	Beacon -- RUN = Off If End Type = Off then OFF will be displayed at the end of the program
	Program ended	Beacon -- RUN = Off SPX = On if End Type = SP2 Scrolling display - TIMER END

## 8.2 Temperature profile program

Below are the procedures for setting the following curve program. Below graph is for 1700C unit.

Temperature Profile



Parameter	Action	Indication	Notes
WRK.OP	Press  to select "WRK.OP"		Working Output – is the output from the controller expressed as a percentage of full output. It appears when the controller is in Auto mode
PROG	Press  to select "PROG"		Program – the controller can save up to 5 programs. In this example, we will use program 1
RAMP.U	Press  to select "RAMP.U" Press  or  to adjust		Setpoint ramp units - to set the units of the ramp rate min – minutes, Hour- Hours, SEC- seconds In this example, we will use minutes as ramp rate units.
DWEL.U	Press  to select "DWEL.U" Press  or  to adjust		Set dwell duration - to set the units of the dwell time Min - 0:00 to 99:59 mm:ss, Hour - 0:00 to 99:59 hh:mm In this example, we will use minutes as dwell time units.
RMP.1	Press  to select "RMP.1" Press  or  to adjust		First ramp rate - OFF, 0:01 to 3000 units per min or hour as set by "RAMP.U" In this example the setpoint will ramp to 300C at 10.0 units per minute
T.SP1	Press  to select "T.SP1" Press  or  to adjust		Target set point 1- to set the target value for the first setpoint In this example the setpoint will ramp from room temperature to the first target
RMP1.E	Press  to select "RMP1.E" Press  or  to adjust		Ramp event 1 – to enable to disable the ramp rate set by "RMP.1" In this example the ramp event 1 will be set to "ON"
DWEL.1	Press  to select "DWEL.1" Press  or  to adjust		First dwell - to set the period of the first dwell. OFF, 0:01 to 99:59 hh:mm or mm:ss as set by "DWEL.U" For dwell periods greater than 1 hour, the 'Resolution' value above must be set in Hours. If it is set in minutes, it cannot display more than 60 minutes. In this example the setpoint will not dwell at "TSP.1"
			Resolution set in Hour 1 hour = 1:00 10 hours = 10:00 1 min = 0:01 1 sec = OFF

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DWL1.E	Press  to select "DWL1.E" Press  or  to adjust		Dwell event 1 – to enable to disable the dwell set by "DWEL.1"  In this example the ramp event will be set to "OFF" as we are not dwelling at the first set point
RMP.2	Press  to select "RMP.2" Press  or  to adjust		In this example the setpoint will ramp from 300C to 900C at 10.0 units per minute
T.SP2	Press  to select "T.SP2" Press  or  to adjust		In this example the setpoint will ramp from 300C to 900C
RAMP2.E	Press  to select "RAMP2.E" Press  or  to adjust		In this example the ramp event 2 will be set to "ON"
DWEL.2	Press  to select "DWEL.2" Press  or  to adjust		In this example the dwell time will be set to "20:00" as we are dwelling at "T.SP2" 900C for 20 minutes
DWL2.E	Press  to select "DWL2.E" Press  or  to adjust		In this example the dwell event 2 will be set to "ON"
RMP.3	Press  to select "RMP.3" Press  or  to adjust		In this example the setpoint will ramp from 900C to 1600C at 5.0 units per minute
T.SP3	Press  to select "T.SP3" Press  or  to adjust		In this example the setpoint will ramp from 900C to 1600C
RMP3.E	Press  to select "RMP3.E" Press  or  to adjust		In this example the ramp event 3 will be set to "ON"
DWEL.3	Press  to select "DWEL.3" Press  or  to adjust		In this example the dwell time will be set to "30:00" as we are dwelling at "T.SP3" 1600C for 30 minutes
DWL3.E	Press  to select "DWL3.E" Press  or  to adjust		In this example the dwell event 3 will be set to "ON"
RMP.4	Press  to select "RMP.4" Press  or  to adjust		In this example the setpoint will ramp from 1600C to 1200C at 5.0 units per minute
T.SP4	Press  to select "T.SP4" Press  or  to adjust		In this example the setpoint will ramp from 1600C to 1200C
RAMP4.E	Press  to select "RAMP4.E" Press  or  to adjust		In this example the ramp event 4 will be set to "ON"

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DWEL.4	Press  to select "DWEL.4" Press  or  to adjust		In this example the dwell time will be set to "OFF" as we are not dwelling at "T.SP4" 1200C
DWL4.E	Press  to select "DWL4.E" Press  or  to adjust		In this example the dwell event 4 will be set to "OFF"
RMP.5	Press  to select "RMP.5" Press  or  to adjust		In this example the setpoint will ramp from 1200C to 20C at 10.0 units per minute
T.SP5	Press  to select "T.SP5" Press  or  to adjust		In this example the setpoint will ramp from 1200C to 20
RMP5.E	Press  to select "RMP5.E" Press  or  to adjust		In this example the ramp event 5 will be set to "ON"
DWEL.5	Press  to select "DWEL.5" Press  or  to adjust		In this example the dwell time will be set to "OFF" as we are not dwelling at "T.SP5" 20C
DWL5.E	Press  to select "DWL5.E" Press  or  to adjust		In this example the dwell event 5 will be set to "OFF"



**Caution:**

(Important! Only for furnaces with max. temp of 1600°C and up) If the amp reading is over 200A for longer than one minute after RUN is pressed for three seconds, shut down the furnace immediately to avoid damage to the transformer and heating elements. This only happens in a short time period after the furnace is started (within 250°C).

## 9. TROUBLESHOOTING

<b>Problem</b>	<b>Reason</b>	<b>Solution</b>
Turn off light is not on after release the power lock	FU1 fuse out	Replace fuse after making sure there is no short circuit.
Circuit Open light is on	FU2 fuse out	Replace fuse after making sure there is no short circuit.
PV temperature display decreasing instead of increasing when furnace is heating up	Positive and negative are reversed.	Reverse the positive and negative wires.
Ammeter has not reading but voltmeter has voltage reading	Heating elements broken	Change heating elements.
All power is normal but the furnace is not working.	Parameter setting error.	Change parameters.
All meters and power are normal, but temperature is not rising.	Wiring problem.	Call Ai Service Department

## 10. MAINTENANCE AND INSPECTION



### 10.1 Maintenance and cautions of the furnace

Please take the time to review all aspects of the unit and possible wear and tear items that are not listed below.

- 10.1.1 It is incumbent for you as a customer to have someone competent to maintain and service your equipment in a safe manner. No certification or special licenses are needed to maintain this unit, however, due to ever increasing of Safety regulations and OSHA, some level or Risk Management is needed for you to safely maintain this unit.
- 10.1.2 Power Cord and Plug – Do not modify or change the power cord or plug. A dedicated circuit should be established power output
- 10.1.3 The furnace should be baked when it is operated for the first time or after a long time.
- 10.1.4 Baking time: ambient temperature to 200°C in two hours, 200°C to 600°C in four hour and hold for two hours. Bake the furnace before conducting any sintering experiment to prevent the furnace cavity from cracking.
- 10.1.5 Clean the furnace frequently; check at regular interval to see if the furnace wires are in good connection.
- 10.1.6 The furnace temperature should not exceed the rated temperature during the operation to prevent any damage on the heating element; no flammable fluid and melted metal should be put into the furnace.
- 10.1.7 The temperature is generally controlled under 300°C in the operation, and the temperature should not be raised at a faster speed as the furnace cavity is cold and needs to absorb a large number of heats in the beginning.
- 10.1.8 Try to take down the temperature as slow as possible (lower than 10°C/Min) to protect the insulation of the furnace chamber.

### 10.2 Maintenance and cautions of MoSi<sub>2</sub> heating elements

- 10.2.1 Be very careful to install and uninstall the MoSi<sub>2</sub> heating element as it is hard and brittle.
- 10.2.2 The MoSi<sub>2</sub> heating element should be stored in dry place to prevent its aluminized ends being moisturized and deteriorating.
- 10.2.3 The connection of the MoSi<sub>2</sub> heating element should be closely attached to the white aluminum head of the cold end of the heating element.
- 10.2.4 The MoSi<sub>2</sub> furnace should not be operated under a constant temperature of 400-700°C as it tends to react with the oxygen and vapor in the air and become pulverized under such constant temperature.
- 10.2.5 The current should be limited for MoSi<sub>2</sub> element when operated under 250°C, as the resistance of the MoSi<sub>2</sub>, which increases with the temperature, is very low at low temperature and the current through it becomes very high.
- 10.2.6 The resistance of MoSi<sub>2</sub> won't increase with the frequent use of heating element, thus the new and used MoSi<sub>2</sub> heating elements can be used together.
- 10.2.7 The connection of the MoSi<sub>2</sub> heating element should be closely attached to the white aluminum head of the cold end of the heating element to prevent fire striking.
- 10.2.8 Testing the unit to see if all the repairs have worked is the form of verification.

### 10.3 Maintenance and cautions of SiC heating element:

- 10.3.1 The furnace temperature should not exceed the rated temperature for a long time during the operation to prevent any damage on the heating element; no flammable fluid and melted metal should be put into the furnace.
- 10.3.2 Be very careful to install and uninstall the SiC heating element as it is hard and brittle.
- 10.3.3 The SiC heating element should be stored in dry place to prevent its aluminized ends being moisturized and deteriorating.
- 10.3.4 The melted KOH, NaOH, Na<sub>2</sub>CO<sub>3</sub> and K<sub>2</sub>CO<sub>3</sub> will decompose SiC at red heat temperature, and alkaline, alkaline earth metals, sulphate and boride etc. may erode SiC, thus they should not be exposed to SiC.
- 10.3.5 The connection of the SiC heating element should be closely attached to the white aluminum head of the cold end of the heating element to prevent fire striking.
- 10.3.6 SiC reacts with Cl<sub>2</sub> at 600°C and with vapor at 1300-1400°C, it cannot be oxidized under 1000°C, but significantly
- 10.3.7 oxidized at 1350°C, a protective film of SiO<sub>2</sub> is generated on the surface of the SiC at 1350-1500°C to prevent SiC being further oxidized
- 10.3.8 The resistance of SiC will increase with the operation time k of the heating element; the reactions are as follow,  
$$\text{SiC} + 2\text{O}_2 = \text{SiO}_2 + \text{CO}_2$$
$$\text{SiC} + 4\text{H}_2\text{O} = \text{SiO}_2 + 4\text{H}_2 + \text{CO}_2$$
The more SiO<sub>2</sub> it contains, the more resistance it has, thus the new SiC heating element should not be used with the used heating element to prevent the unbalance of resistance which has very adverse effect on the temperature field and the SiC heating element.

### 10.4 Inspection

- 10.4.1 Every 3 – 6 months, qualified personnel should inspect the unit and keep any records of it maintenance for any City, State, or Federal Inspector.
- 10.4.2 Service Technician - equipment being serviced should at least be shut down for 4 hours prior to the Service Technician arriving.
- 10.4.3 Product specific risks that may affect service personnel:
- 10.4.4 Glass being broken - Use caution and proper gloves to handle broken glass.
- 10.4.5 Using Antistatic Gloves and or Grounding yourself is important so you won't get shocked.
- 10.4.6 Verification of the safe state of the equipment after repair:
  - 10.4.6.1 Visual inspections of the unit, is the first thing that will need to be done. Make sure that everything is adjusted or cleaned.
  - 10.4.6.2 Testing the unit to see if all the repairs have worked is the form of verification.

## 11. HEATING ELEMENT INTRODUCTION

### 11.1 MoSi<sub>2</sub> Heating Element

- 11.1.1 MoSi<sub>2</sub> heating element is made by powder metallurgic method through squeezing and sintering. If Si and Mo are evenly blended and granularity normally distributed the heating element will have little temperature difference in different areas when heated, which is favorable to form an even temperature field. The cold end and hot end of the MoSi<sub>2</sub> heating element are connected by projection welding.
- 11.1.2 The melting point of MoSi<sub>2</sub> is 2030°C, and there are two maximum operation temperatures as 1700°C and 1800°C for MoSi<sub>2</sub> heating element.
- 11.1.3 A protective glass film is generated on the surface of the MoSi<sub>2</sub> heating element when heated, which is of great oxidation resistance and can be generated again to prevent further oxidation when damaged during the operation.
- 11.1.4 Reductive gas may destroy the protective film of MoSi<sub>2</sub>; nevertheless, the MoSi<sub>2</sub> heating element can be operated under the circumstance of reductive gas at a temperature below 1350°C. The vapor of chlorine and sulphur are greatly corrosive to the MoSi<sub>2</sub> heating element.
- 11.1.5 Maximum temperature inside the chamber is related to the gas environment. If temperature in the chamber is higher than specified, heating elements will react with the gas and could be damaged. (Refer to table below).

Gas	Maximum heating element temperature	
	GCF1600	GCF1700
Air, Oxygen (O <sub>2</sub> ), Nitrogen Dioxide (NO <sub>2</sub> ), Carbon Dioxide (CO <sub>2</sub> )	1600°C	1700°C
Helium (He), Neon (Ne), Argon (Ar)	1550°C	1650°C
Sulfur Dioxide (SO <sub>2</sub> )	1500°C	1600°C
Nitrogen (N <sub>2</sub> ), Carbon Monoxide (CO)	1400°C	1500°C
Wet Hydrogen (H <sub>2</sub> )	1300°C	1400°C
Dry Hydrogen (H <sub>2</sub> )	1250°C	1350°C

### 11.2 SiC Heating Element

- 11.2.1 SiC heating element is a high temperature nonmetallic heating element that is made from pure hexagonal carborundum through blank making, high temperature siliconization and recrystallization at 2200°C. The temperature on the surface may reach 1450°C, and the heating element will be aged rapidly and easily burnt out when the temperature exceeds 1500°C. The SiC heating element can work for more than 2,000 consecutive hours under proper operation conditions, besides the difference of internal quality, its durability is related to the surface loading (the larger surface loading, the shorter durability), the ambience, heating means (interrupted or non-interrupted) and the connection way (in series or in parallel) of the heating elements in use.
- 11.2.2 SiC is hard and brittle with a small expansion coefficient and durable against instant cooling, heating up and deformation, and it is chemically stable with great acid resistance and does not react with strong acid.
- 11.2.3 The resistance of SiC changes with the temperature of the element as SiC is a non-linear resistor. The resistance descends when the temperature rises from ambient temperature to about 900°C, while ascends when the temperature rises from about 900°C, that is, the SiC heating element has minimum resistance at about 900°C, and the resistance of SiC heating element is generally referred to the resistance at this temperature.
- 11.2.4 Maximum temperature inside the chamber is related to the gas environment. If temperature in the chamber is higher than specified, heating elements will react with the gas and could be damaged. (Refer to table below).

Gas	Maximum heating element temperature
Air	1400°C
Helium (He), Neon (Ne), Argon (Ar)	1400°C
Nitrogen (N <sub>2</sub> )	1270°C
Hydrocarbon gas	1150°C
Rough vacuum	1100°C
Hydrogen (H <sub>2</sub> )	1100°C

### 11.3 Replacing the Heating Element

If heating element is damage, please follow the instruction below for replacement.



Step 1



Step 2



Step 3



Step 4



Step 5



Step 6



Step 7

Step 1. Open the furnace cover

Step 2. Take off screws of clip for heating element

Step 3. Release the aluminum clip

Step 4. Take off screws of metal clip that tighten the ceramic block

Step 5. Take out the ceramic block between rods of U-shape heating element.

Step 6. Take out the heating element

Step 7. Replace with a new heating element. Put the ceramic block together with the heating element, and make sure it is in the same position.

Step 8. Follow the reserve steps to install heating element back.

#### Cautions:

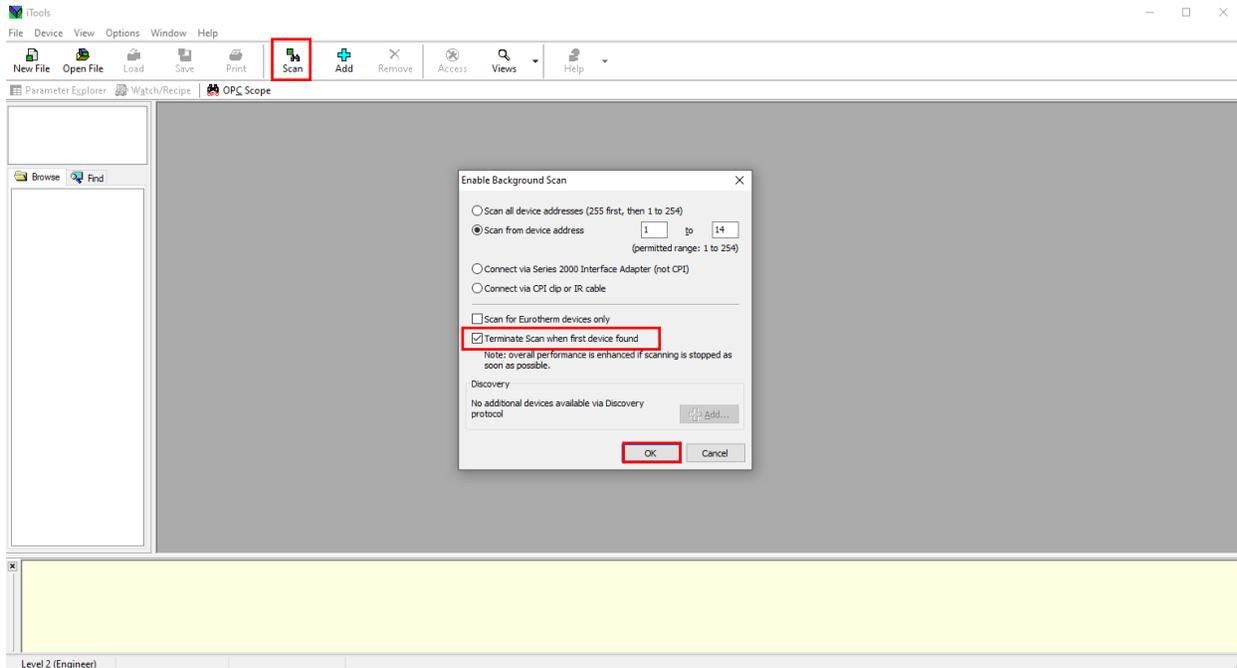
1. Keep the heat end of the heating element about 15mm from the bottom of the furnace cavity a space of 15mm when inserting the heating element.
2. When clamping the heating element with aluminum strip and tight clips, be sure not so tight that the MoSi<sub>2</sub> is broken or too loose that the contact is poor and cause high resistance and electric arc.
3. MoSi<sub>2</sub> heating elements have low resistance and are generally connected in series.
4. Be very careful in installation of heating elements as they are very brittle and fragile.
5. Use pyrocotton to cover the gap between the heating element and furnace cavity which is caused by the over-high temperature on top of the furnace.

## 12. SOFTWARE SETUP

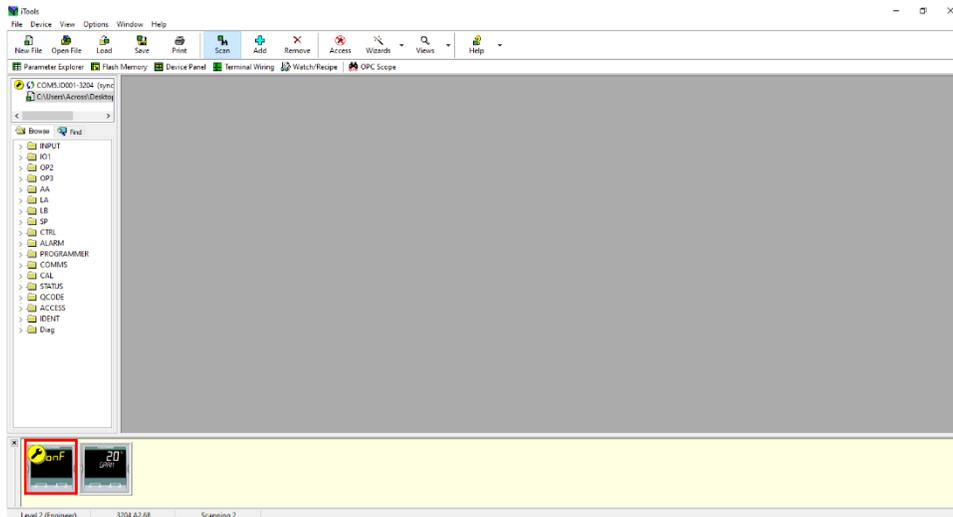
iTools is a configuration and monitoring package which will edit, store and 'clone' complete controller configurations. iTools can be used to configure all the functions of 3200 series controllers described in this manual.

### 12.1 Starting iTools

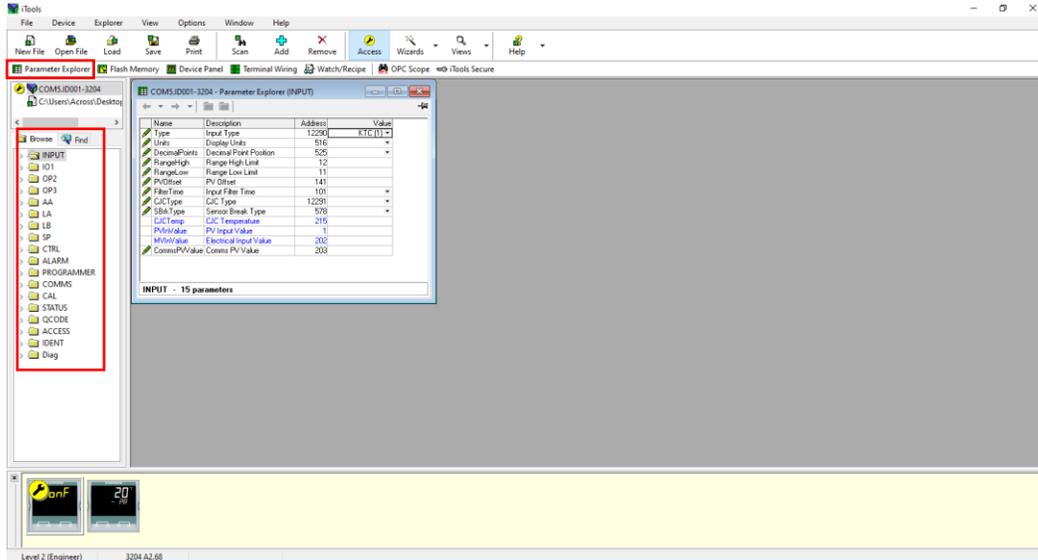
1. Download iTools from the USB supplied with the unit
2. Connect the furnace to the computer using the RS-485 to RS-232 to USB adapter.
3. Open iTools and select on "Scan" -> "Ok"



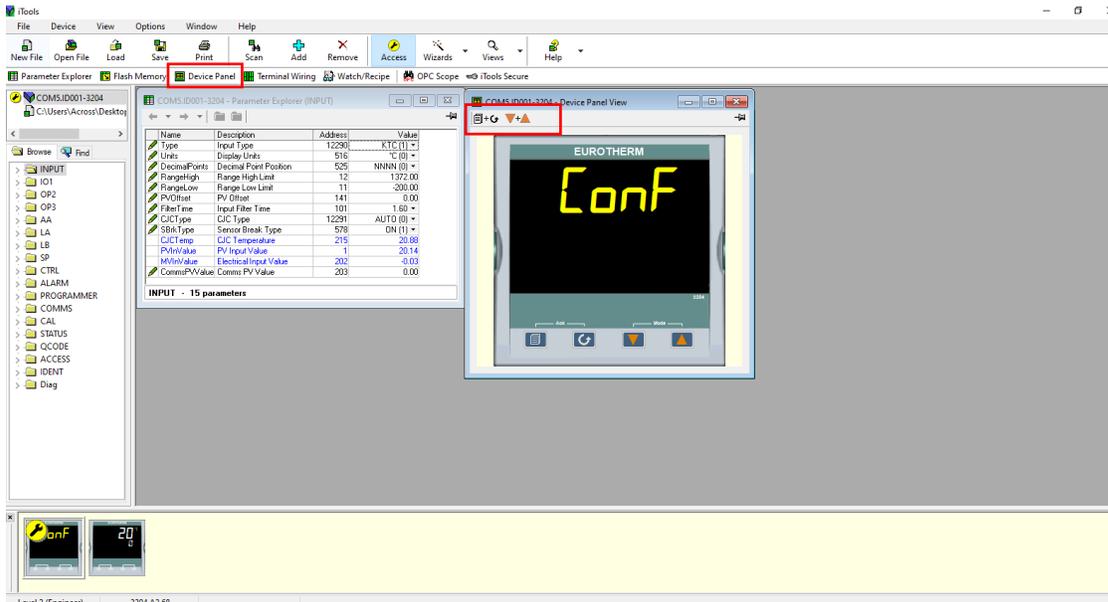
4. Once the controller is found, you will see it on the bottom panel



- The browser on the left shows the List Headers. To display parameters within a list double click the Header or select "Parameter Explorer". Click on a list header to display parameters associated with this list.

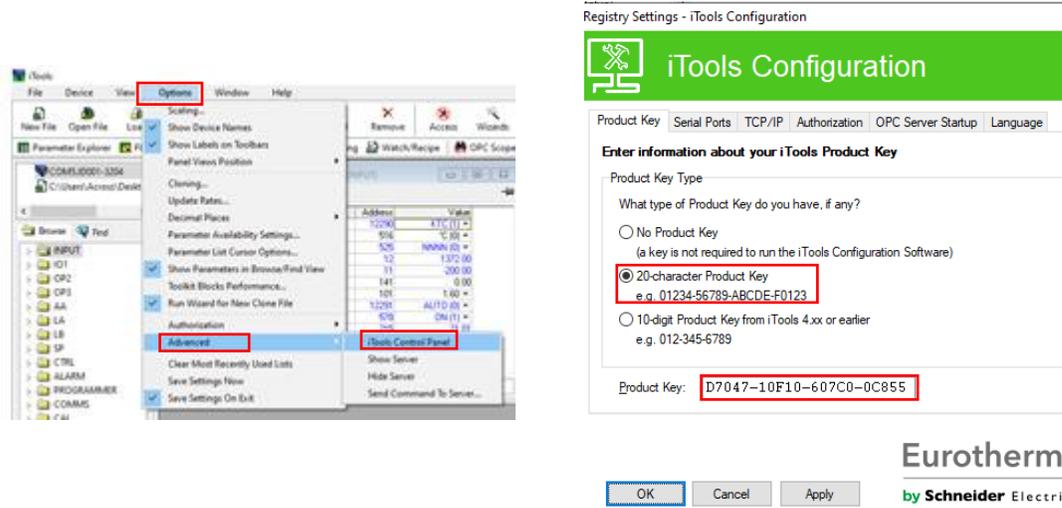


- The instrument view may be turned on off using the 'View' menu and selecting 'Panel Views'. You can access the current program/ heating profile by selecting "Programmer" in the left panel. You can run the controller from the software by pressing the up and down arrow under device panel.



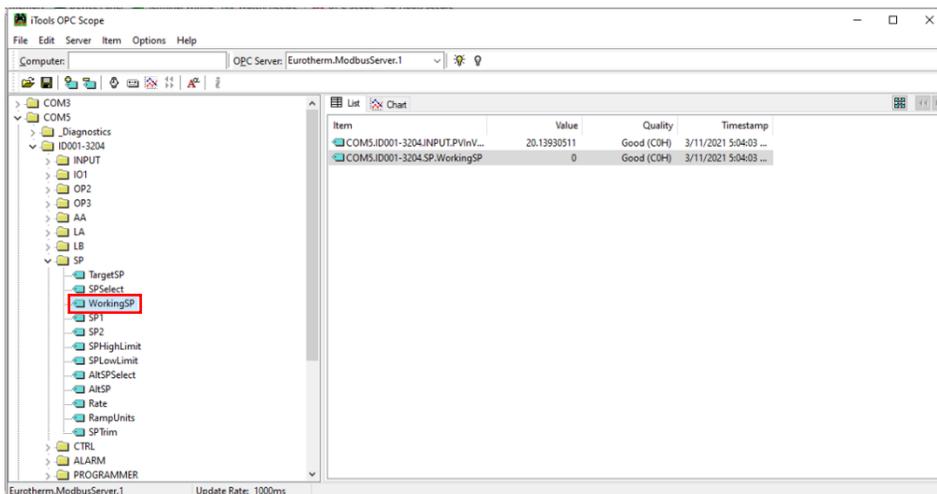
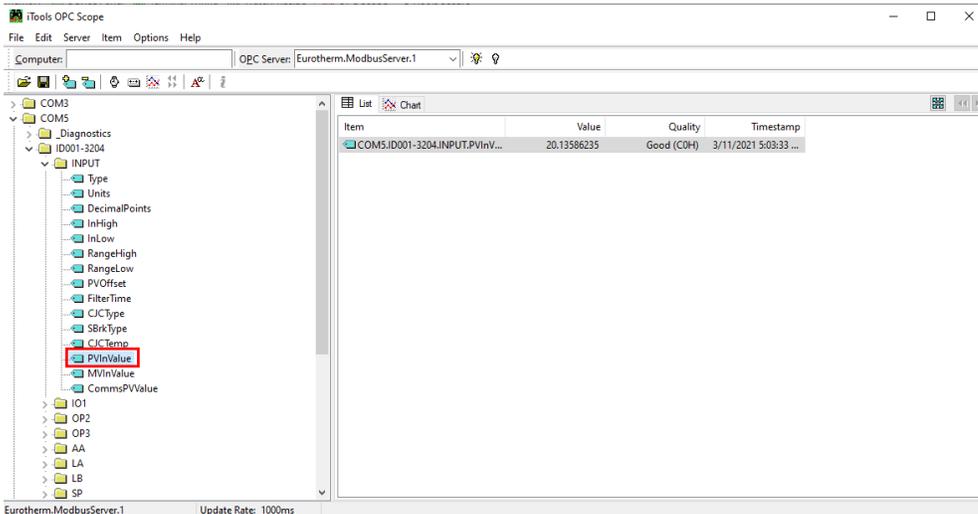
12.2 Data Recording

- Once you have the controller configured, a 20-character product key will need to be entered to be able to record data continuously through the process. Under "Options" -> "Advanced" -> iTools Control Panel and type in the following product key "D7047-10F10-607C0-0C855" -> "Ok"

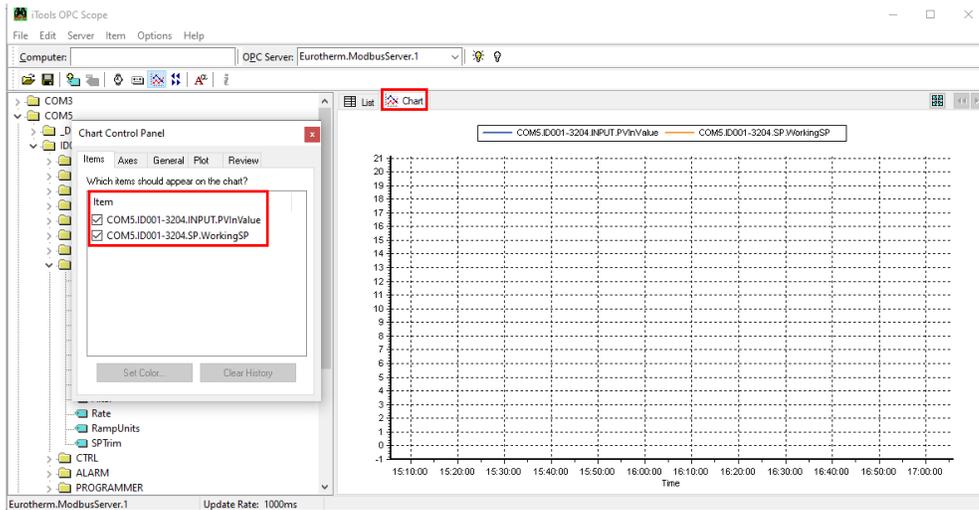


Eurotherm.  
by Schneider Electric

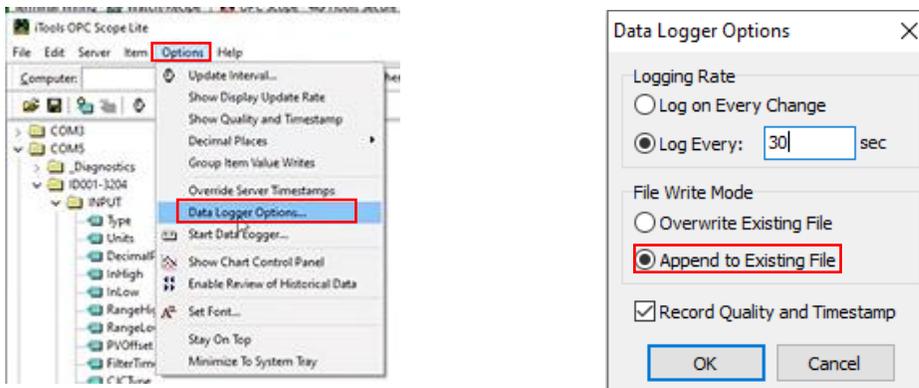
- Click on "OPC Scope"
- To plot set value and present value follow the steps as in picture below



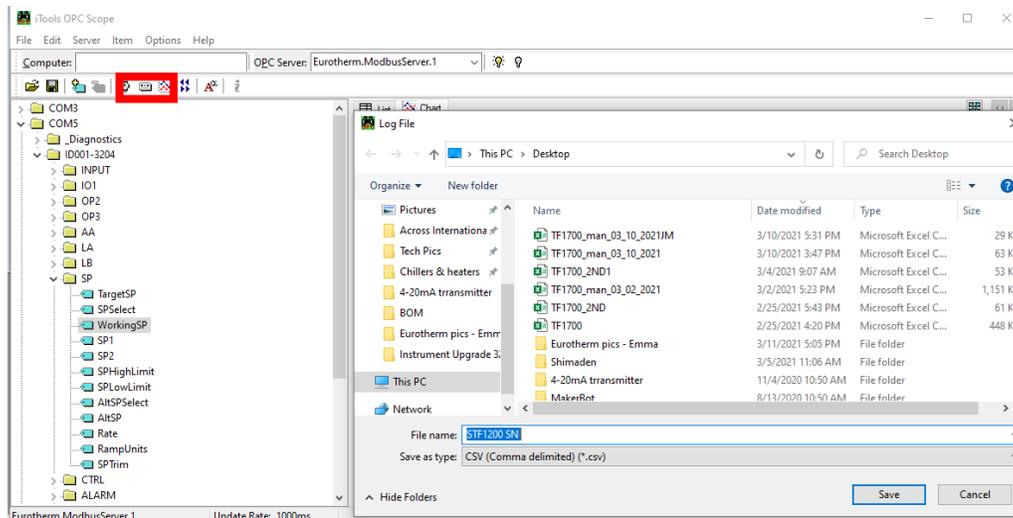
- To display the present value and the set point in a chart format, under OPC Scope click on “Chart” and select the two items as below

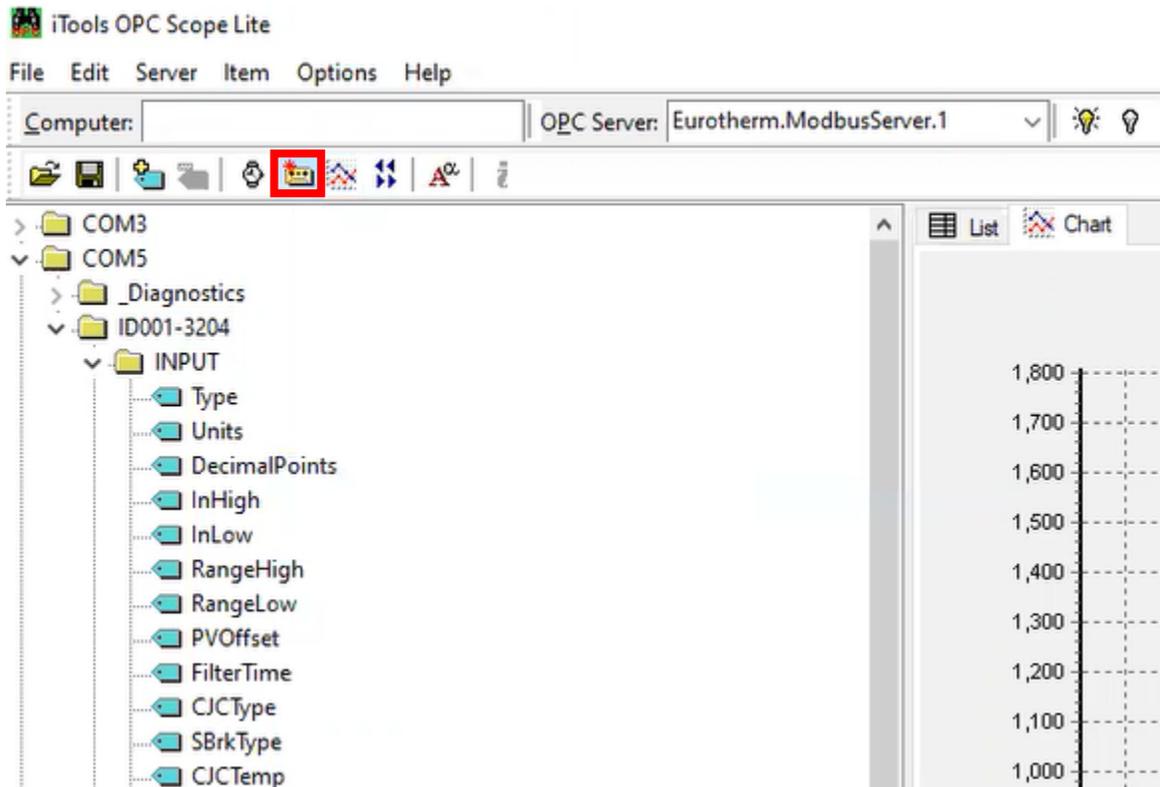


- You can change the logging rate by click on “Options” under OPC Scope -> “Data Logger Options”. Under “File Write Mode” select “Append to Existing File” -> “OK”

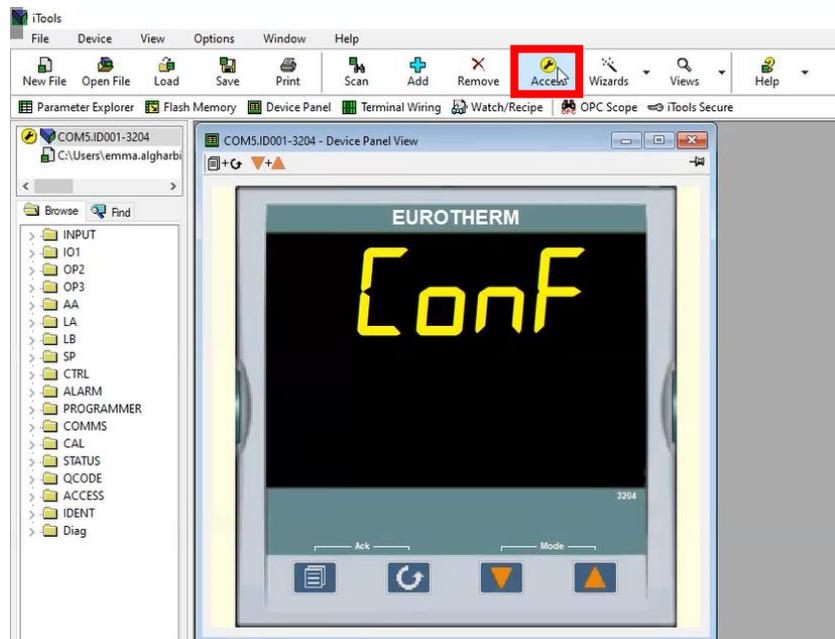


- To enable data recording, click on start data logging icon and select the path for the excel file -> “Save”. Then, data logging icon will turn yellow indicating that the data logging has started





7. To exit out of configuration mode -> click on “Access” and the communication will stop



## 13. WARRANTY

Across International (AI) warrants for the original user of this product in the U.S.A. only that this product will be free from defects in material and workmanship for a period of one year from the date of delivery to the original user – the “Warranty Period”.

During the warranty period, AI, at its election and expense, will repair or replace the product or parts that are proven to manufacturer’s satisfaction to be defective, or at manufacturer’s option, refund the price or credit (against the price of future purchases of the product) the price of any products that are proven to manufacturer’s satisfaction to be defective.

This warranty does not include any labor charges if outside of the U.S.A. This warranty does not cover any damage due to accident, misuse, negligence, or abnormal use. This warranty is void in the event that repairs are made by anyone other than AI without prior authorization from AI.

Use of AI’s product in a system that includes components not manufactured by AI is not covered by this warranty. Any alteration or removal of the serial number on AI’s products will void this warranty. Under no circumstances will AI be liable for indirect, incidental, consequential, or special damages.

The terms of this warranty are governed by the laws of the states of New Jersey and Nevada without regards to the principles of conflicts of laws thereof. If any provision of this limited warranty is held to be unenforceable by any court of competent jurisdiction, the remainder of this limited warranty will remain in full force and effect.

This warranty is in lieu of and excludes all other warranties or obligations, either express or implied. AI expressly disclaims all implied warranties, including without limitation, the warranties of merchantability and fitness for a particular purpose.

After the warranty period, AI will continue to provide support and spare parts at a reasonable cost.



Returning shipment: Save the shipping crate until you are sure your unit is consistently working properly. If for any reason you must return the unit, first contact AI for a return material authorization (RMA) number.

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