

# Across International

## GCF Series Controlled Atmosphere Muffle Furnace

### USER'S MANUAL



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Caution: Follow the steps below to remove all stuffing material (for GCF1400, GCF1600 and GCF1700 only), and read this manual carefully before using the furnace.



Unscrew and open the cover



Remove the stuffing material



Put the cover back and secure it

## 1. Specifications

|                                                 |        | <b>GCF1100B</b><br><b>(stainless steel interior)</b>                                                                       | <b>GCF1200</b>                                                                                                                    |
|-------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| Item                                            | UoM    | Value                                                                                                                      |                                                                                                                                   |
| Chamber Material                                |        | 304 Stainless steel                                                                                                        | Alumina fiber                                                                                                                     |
| Structure                                       |        | Double-layer housing with air cooling system                                                                               |                                                                                                                                   |
| Max. Output                                     | KW     | 11 x 7 x 4": 2.5 kW<br>11 x 7 x 7": 4 kW<br>11 x 9 x 9": 5 kW<br>15 x 11 x 11": 9 kW<br>17x14X14" 15KW                     | 12 x 8 x 5": 2.5 kW<br>12 x 8 x 8": 4 kW<br>12 x 10 x 10": 5 kW<br>16 x 12 x 12": 9 kW<br>20 x 16 x 16": 15Kw<br>20X20X20" : 18KW |
| Voltage                                         | V      | 220VAC                                                                                                                     |                                                                                                                                   |
| Frequency                                       | Hz     | 50/60                                                                                                                      |                                                                                                                                   |
| Phase                                           | Phase  | Single                                                                                                                     |                                                                                                                                   |
| Temp Range                                      | °C     | 0-1100                                                                                                                     | 0-1200                                                                                                                            |
| Constant Working Temp                           | °C     | 0-1000                                                                                                                     | 0-1200                                                                                                                            |
| Heating Rate                                    | °C/min | ≤15                                                                                                                        |                                                                                                                                   |
| Chamber Size (DxWxH)                            | Inch   | 11 x 7 x 4"<br>11 x 7 x 7"<br>11 x 9 x 9"<br>15 x 11 x 11"                                                                 | 12 x 8 x 5"<br>12 x 8 x 8"<br>12 x 10 x 10"<br>16 x 12 x 12"<br>20 x 16 x 16"<br>20 x 20 x 20"                                    |
| Overall Size (DxWxH)                            | Inch   | 18 x 21 x 22"<br>18 x 21 x 25"<br>18 x 23 x 27"<br>24 x 26 x 31"                                                           | 18 x 21 x 22"<br>18 x 21 x 25"<br>18 x 23 x 27"<br>24 x 26 x 31"<br>30 x 32 x 40"<br>38 x 37 x 50"                                |
| Temp Controller Precision                       | °C     | ±1                                                                                                                         |                                                                                                                                   |
| Temp Controller                                 |        | Shimaden fp93 (made in Japan), 4 programs and 40 segments<br>(ie. 4 x 10 segments or 2 x 20 segments) with PID adjustment. |                                                                                                                                   |
| Thermo Couple                                   | Type   | K                                                                                                                          |                                                                                                                                   |
| Heating Element                                 |        | Kanthal resistant coil wire                                                                                                |                                                                                                                                   |
| Surface Temp                                    | °C     | ≤45                                                                                                                        |                                                                                                                                   |
| Built-In Circuit Breaker<br>(220V single phase) |        | 11 x 7 x 4": 16A<br>11 x 7 x 7": 25A<br>11 x 9 x 9": 32A<br>15 x 11 x 11": 50A<br>17x14X14" 100A                           | 12 x 8 x 5": 16A<br>12 x 8 x 8": 25A<br>12 x 10 x 10": 32A<br>16 x 12 x 12": 40A<br>20 x 16 x 16": 80A                            |

|                    |                                                                                   |                     |
|--------------------|-----------------------------------------------------------------------------------|---------------------|
|                    |                                                                                   | 20 x 16 x 16": 100A |
| Communication Port | Serial or USB                                                                     |                     |
| Certification      |  |                     |

|                                                 |        | GCF1400                                                                                                                    | GCF1600/GCF1700                                                                                                                                                                                    |
|-------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Item                                            | UOM    | Value                                                                                                                      |                                                                                                                                                                                                    |
| Structure                                       |        | alumina fiber                                                                                                              |                                                                                                                                                                                                    |
| Structure                                       |        | Double-layer housing with air cooling system                                                                               |                                                                                                                                                                                                    |
| Max Output                                      | KW     | 6 x 6 x 6": 3 kW<br>8 x 8 x 8": 5 kW<br>12 x 8 x 8": 7 kW<br>12 x 10 x 10": 9 kW<br>16 x 12 x 12": 13 kW                   | 6 x 6 x 6": 3 kW<br>8 x 8 x 8": 5 kW<br>12 x 8 x 8": 7 kW<br>12 x 10 x 10": 9 kW<br>16 x 12 x 12": 13 kW<br>16 x 16 x 16": 18 kW                                                                   |
| Voltage                                         | V      | 220VAC                                                                                                                     |                                                                                                                                                                                                    |
| Frequency                                       | Hz     | 50/60                                                                                                                      |                                                                                                                                                                                                    |
| Phase                                           | Phase  | Single                                                                                                                     |                                                                                                                                                                                                    |
| Temp Range                                      | °C     | 0-1400                                                                                                                     | 0-1600/1700                                                                                                                                                                                        |
| Constant working Temp                           | °C     | 0-1300                                                                                                                     | 0-1500/1600                                                                                                                                                                                        |
| Heating Rate                                    | °C/min | ≤15                                                                                                                        |                                                                                                                                                                                                    |
| Chamber Size (DxWxH)                            | Inch   | 6 x 6 x 6"<br>8 x 8 x 8"<br>12 x 8 x 8"<br>12 x 10 x 10"<br>16 x 12 x 12"                                                  | 6 x 6 x 6"<br>8 x 8 x 8"<br>12 x 8 x 8"<br>12 x 10 x 10"<br>16 x 12 x 12"<br>16 x 16 x 16"                                                                                                         |
| Overall Size (DxWxH)                            | Inch   | 22 x 20 x 31"<br>22 x 21 x 33"<br>22 x 25 x 33"<br>24 x 25 x 37"<br>26 x 29 x 57"                                          | 22 x 20 x 31" / 22 x 20 x 33"<br>22 x 21 x 33" / 22 x 21 x 35"<br>22 x 25 x 33" / 22 x 25 x 35"<br>24 x 25 x 37" / 24 x 25 x 39"<br>26 x 29 x 57" / 26 x 29 x 59"<br>26 x 33 x 63" / 26 x 33 x 63" |
| Temp Controller Precision                       | °C     | ±1                                                                                                                         |                                                                                                                                                                                                    |
| Temp Controller                                 |        | Shimaden fp93 (made in Japan), 4 programs and 40 segments<br>(ie. 4 x 10 segments or 2 x 20 segments) with PID adjustment. |                                                                                                                                                                                                    |
| Thermo Couple                                   | Type   | S                                                                                                                          | B                                                                                                                                                                                                  |
| Heating Element                                 |        | SiC                                                                                                                        | 1800 MoSi <sub>2</sub>                                                                                                                                                                             |
| Surface Temp                                    | °C     | ≤45                                                                                                                        |                                                                                                                                                                                                    |
| Built-In Circuit Breaker<br>(220V single phase) |        | 6 x 6 x 6": 25A<br>8 x 8 x 8": 32A<br>12 x 8 x 8": 40A<br>12 x 10 x 10": 50A                                               | 6 x 6 x 6": 25A<br>8 x 8 x 8": 50A<br>12 x 8 x 8": 63A<br>12 x 10 x 10": 80A                                                                                                                       |

|                    |                                                                                    |                                            |
|--------------------|------------------------------------------------------------------------------------|--------------------------------------------|
|                    | 16 x 12 x 12": 63A                                                                 | 16 x 12 x 12": 100A<br>16 x 16 x 16": 120A |
| Communication Port | Serial or USB                                                                      |                                            |
| Certification      |  |                                            |

## 2. Introduction

GCF series controlled atmosphere furnaces feature a chamber with alumina fiber insulation or stainless steel interior (B models). A double walled steel internal housing helps minimize heat loss to exterior surface. Furnace operation is controlled by Shimaden 40-segment 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.

### The Benefits of a Controlled Atmosphere Furnace

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.

### Gases

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.
- Long life type S thermocouple.

### Safety

- Overheat protection shuts down the furnace if temperature is outside of acceptable range (refer to controller's manual) or when the thermocouple is broken or malfunctions.

- Power failure protection resumes furnace operation right after the point of failure when power is reestablished.



### 3. Gas Filling

- 1) Check furnace air tightness
  - a. Close furnace door, tighten all door screws and close all valves except one gas inlet
  - b. Fill the furnace with gas thru the gas inlet until pressure gauge reads 0.03MPa.
  - b. Hold this pressure for two hours and check if pressure gauge reading changes.
  - b. If pressure gauge reading drops, check and make sure all door screws are tightened properly and sealing gasket is clean and intact.
  
- 2) Outgas air in the chamber with inert gas
  - a. Inert gas should be filled into furnace before heating up
  - b. 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.
  - c. Generally, oxygen density will drop to 100ppm, if ten times of the volume of the furnace chamber inert gas is filled.
  - d. When oxygen density inside the furnace has reached the required level, close the gas exhausting valve to save inert gas.
  - e. 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(1.5 PSI for GCF1100B ) over 1ATM (pressure gauge reading 0 means 1 ATM).
  
- 3) Pre-vacuum the furnace chamber using a vacuum pump
  - a. Connect the pipe of the vacuum pump to any of the gas exhausting valves
  - b. Pre-vacuum the furnace chamber (to around -10 PSI)
  - c. Fill inert gas
  - d. Vacuum the furnace chamber again (to around -10 PSI)
  - e. Repeat this a few times until gas condition reach required level
  - f. However, the positive pressure must be less than 3 PSI (1.5 PSI for GCF1100B) over 1ATM (pressure gauge reading 0 means 1 ATM).
  
- 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 0.02MPa, 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.

- 5) Make sure gas is flowing properly before turning on the furnace
  
- 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 DO 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.

## 4. Warming Up the Furnace

For a new furnace or one that has not been used for more than 6 months, you need to warm up the furnace to get rid of moisture that trapped inside the furnace insulation blocks. Keep the furnace door slightly open during this process to allow moisture to get out. It is normal if you see some condensation on the furnace water panel afterward.

Warm up the furnace before first use following steps below:

|             |           |          |
|-------------|-----------|----------|
| 0 - 200°C   | 50°C/hour | 4 hours  |
| 200 - 400°C | 20°C/hour | 10 hours |
| 400 - 600°C | 50°C/hour | 4 hours  |

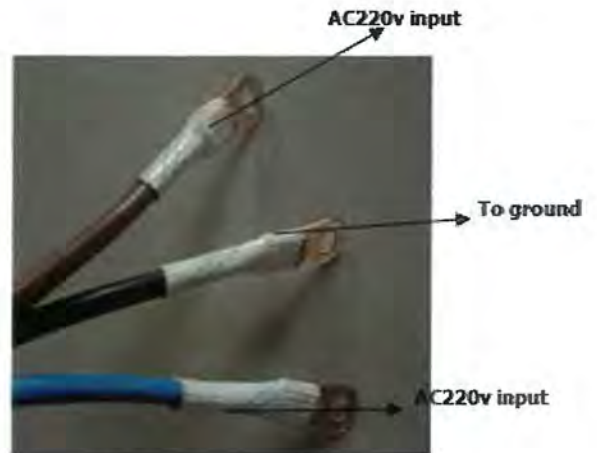
:

## 5. Wiring and Thermocouple Installation

- a. Furnace should be installed on a horizontal and shock-proof platform away from any explosive gases and materials.
- b. Our tube furnaces come with built-in circuit breaker. The brown and blue wires in Graph 2 should be connected to two AC220v and the dual-color/black wire to the ground.



Built-in circuit breaker



Graph 2

- c. The red wire in thermocouple should be connected to the positive pole on the thermocouple, and the green wire to the negative pole.



Graph 3

- d. When all the wires are connected, turn the LOCK knob to see if there is any display on the temperature controller, check the circuits if not.

### Thermocouple Installation

- Step 1. Insert thermocouple thru the provided thermocouple nut.  
 Step 2. Thread the rubber sealing o-ring over the thermocouple and secure it to the nut.  
 Step 3. Insert the assembled thermocouple into the thermocouple hole on the furnace.  
 Step 4. Tighten the nut.



Step 1



Step 2



Step 3



Step 4

## 6. Furnace Operation

- 1) Switch on the built-in circuit breaker; turn on the main power switch
- 2) Place sample material in the center of the furnace chamber.
- 3) Place the door thermo block, close the door firmly and tighten all screws.
- 4) Check air tightness of the furnace:  
Fill gas into the furnace until pressure meter reaches 3 PSI. After one hour, read the pressure meter again, if it drops, check furnace for leakage.
- 5) Flush the furnace chamber following the air outgassing steps, and then fill the required gas.  
Important: if gas pressure exceeds 0.02MPa (0.01MPa for GCF1100B) within the sealed chamber, do not leave the furnace alone without constant monitoring to prevent potential danger. Otherwise please keep the gas flowing.
- 6) Turn on the main power switch, temperature controller will light up.
- 7) Set the temperature controller (Please refer to the Shimaden Temperature Controller instruction. Other parameters of the controller have been set before leaving our factory).
- 8) Press the Turn On button, the AC connector will connect and you will hear a click sound. Check the circuit if not.
- 9) Press and hold the RUN/RST for three seconds to start the furnace.
- 10) (Important for GCF1600 and GCF1700 chamber furnaces! Skip this step for GCF1400 and GCF1100 chamber furnaces) 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).  
  
Solutions: a. set A value (prompt 306) to a lower number for the amp restriction trigger. b. 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.
- 11) For controlled atmosphere furnaces that equipped with SiC and MoSi<sub>2</sub> heating elements, it is possible that the protective film on the heating elements will fall after around 10 runs with various kinds of gases. In this case, run the furnace without gas for 5 to 8 hours at rated temperature to create a new film on the elements. This is an oxidization film that form after heating the heating elements in an oxygen environment.

## 7. Temperature Controller Operation

For detailed instructions of temperature controller operations, please refer to the instruction of the Shimaden FP93 temperature controller, the instructions here is only used to explain those commonly used or difficult operations for convenient use by the users.

### 1. Temperature controller features

- a. There are 6 PID controls and different PID controls are used for low temperature, medium temperature and high temperature to make the control more precise;
  - b. Power failure protection runs furnace from the point when the failure happened;
  - c. The temperature controller is able to display the current running degree range and the running time of such range;
  - d. Self-adjustment and overheat protected;
  - e. Automatically shuts down furnace after a program is done thru the ESTP function code.
2. Setting of the temperature controller program; 4 parameters are required for each sequence of program in setting:

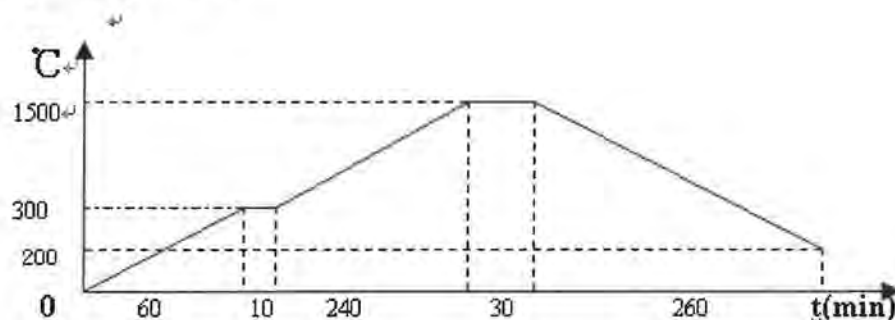
- (1) The starting temperature of the program;
- (2) The end temperature of the program;
- (3) The time required from the starting temperature to end temperature;
- (4) Setting the PID numbers of the program; (6 PID in total)

There are 40 sequences program for the temperature controller, which can be divided into two batches, four batches or one batch. The setting procedures include: press  on the temperature controller's initial picture for 3s, then press  to enter Picture 11, press  or  to set the numbers of program (The user can set the desired heat up curve only as the other parameters have been set before delivery from factory).

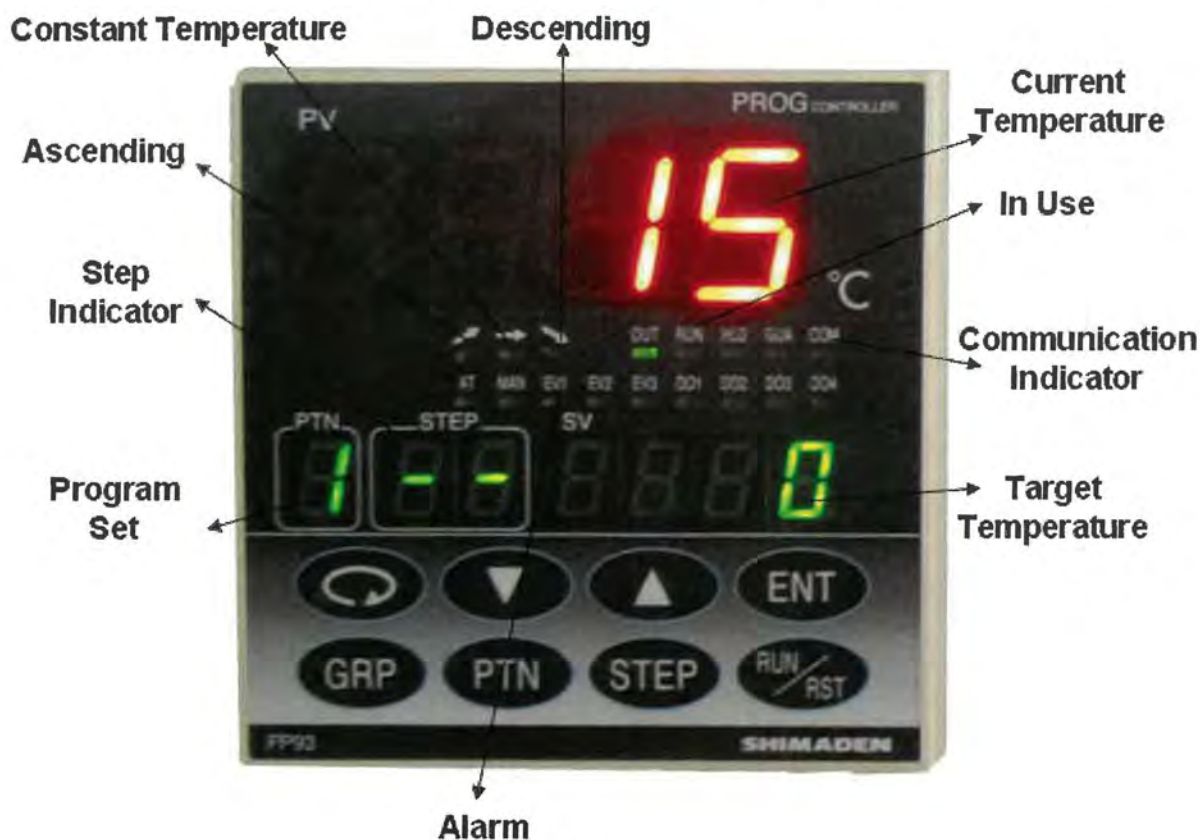


Picture 11

### 3. Setting up a sample curve



## Temperature Controller



1). Enter the program setting picture to set the first sequence program:



Picture 12



Picture 13



Picture 14



Picture 15



Picture 16



Picture 17



Picture 18



Picture 19



Picture 20

- (1) Press and release GPR button under the start picture (i.e. Picture 12) to enter Picture 13;
- (2) Press  to enter Picture 14 and set the initial temperature value for the first sequence

program under this picture, the default value is 0 (it is not necessary to change it);

- (3) Press STEP to enter Picture 15, press  $\nabla$  or  $\wedge$  to set the end value of the first sequence program, set the value as Picture 16 (the end temperature is 250°C in the first sequence program), then press ENT to confirm the entry;
- (4) Press  $\odot$  to enter Picture 17 that is for setting the time of the first sequence program, press  $\nabla$  or  $\wedge$  to set the time of the first sequence program, set the value as Picture 18 (the time is 40min), then press ENT to confirm the entry;
- (5) Press  $\odot$  to enter Picture 19 that is for setting of PID value in the first sequence program, press  $\nabla$  or  $\wedge$  to set the PID value of the first sequence program, set the value as Picture 20 (set as No. 1 PID), press ENT to confirm the entry; as the current should be limited when MoSi<sub>2</sub> is at low temperature, the maximum output O-H value has been limited prior to delivery from factory (No.1 PID should be used or there may be an excess of current at low temperature).

## 2). Setting the second sequence program:



Picture 21



Picture 22



Picture 23



Picture 24



Picture 25

- (1) The end temperature value in the first sequence program is the starting value in the second sequence program, thus the setting of starting temperature value is finished in the second sequence program;
- (2) Press STEP to enter Picture 21, press  $\nabla$  or  $\wedge$  to set the end value of the first sequence program, set the value as Picture 22 (the end temperature in the second sequence program is 250°C), press ENT to confirm the entry;
- (3) Press  $\odot$  to enter Picture 23 that is for setting the time of the second sequence program, press  $\nabla$  or  $\wedge$  to set the time of the first sequence program, set the value as Picture 24 (the time is 10min), press ENT to confirm the entry;
- (4) Press  $\odot$  to enter Picture 25 that is for setting the PID value in the second sequence program, press  $\nabla$  or  $\wedge$  to set the PID value in the first sequence program, set the value as Picture 20 (set as No. 1 PID), press ENT to confirm the entry.

## 3). Setting the third sequence program:



Picture 26



Picture 27



Picture 28



Picture 29

- (1) The end temperature value in the second sequence program is the starting value in the third sequence program, thus the setting of starting temperature value is finished in the third sequence program;
- (2) Press STEP to enter Picture 26, press  $\nabla$  or  $\blacktriangle$  to set the end value of the third sequence program, set the value as Picture 27 (the end temperature in the third program is 900°C), press ENT to confirm the entry;
- (3) Press  $\odot$  to enter Picture 28 that is for setting the time of the third sequence program, press  $\nabla$  or  $\blacktriangle$  to set the time of the third sequence program, set the value as 01:30 (the time is 1h and 30min), press ENT to confirm the entry;
- (4) Press  $\odot$  to enter Picture 29 that is for setting the PID value of the third sequence program, press  $\nabla$  or  $\blacktriangle$  to set the PID value of the third sequence program, set as No.2 PID (select any number between 2 and 6 except 1), press ENT to confirm the entry.

## 4). Setting the fourth sequence program:



Picture 30



Picture 31



Picture 32

- (1) The end temperature value in the third sequence program is the starting value of the fourth sequence program, thus the setting of starting temperature value is finished in the fourth sequence program;
- (2) Press STEP to enter Picture 30, press  $\nabla$  or  $\blacktriangle$  to set the end value of the fourth sequence program ((the end temperature in the fourth program is 900°C), press ENT to confirm the entry;
- (3) Press  $\odot$  to enter Picture 31 that is for setting the time of the fourth sequence program, press  $\nabla$  or  $\blacktriangle$  to set the time of the fourth sequence program, set the value as 00:25 (the time is 0h and 25min), press ENT to confirm the entry;
- (4) Press  $\odot$  to enter Picture 32 that is for setting the PID value of the fourth sequence program, press  $\nabla$  or  $\blacktriangle$  to set the PID value of the fourth sequence program, set as No.2 PID (select any number between 2 and 6 except 1), press ENT to confirm the entry.

### 5). Setting the fifth sequence program:



Picture 33



Picture 34



Picture 35



Picture 36



Picture 45

- (1) The end temperature value in the fourth sequence program is the starting value of the fifth sequence program, thus the setting of starting temperature value is finished in the fifth sequence program;
- (2) Press STEP to enter Picture 33, press or to set the end value of the fifth sequence program ((the end temperature in the fourth program is 200°C), press ENT to confirm the entry;
- (3) Press to enter Picture 34 that is for setting the time of the fifth sequence program, press or to set the time of the fifth sequence program, set the value as 00:25 (the time is 0h and 25min), press ENT to confirm the entry;
- (4) Press to enter Picture 35 that is for setting the PID value of the fifth sequence program, press or to set the PID value of the fifth sequence program, set as No.3 PID (select any number between 2 and 6 except 1), press ENT to confirm the entry.

### 6). Setting the end process:

After everything is setup, press the "GPR" key until you back to the original setup screen. Press "GPR" once to enter Picture 12 and press until you enter Picture 45, "EStP" means "End Step". press or to set the last step. If the value is 5, furnace will stop operation automatically after step# 5.

4. Start the furnace (before starting the furnace, make sure you clean and outgas the chamber, fill it with protection gas and monitor the gas flow thru the flow meter)
  - (1) When the program setting is finished, press GRP until the Start Picture appears (Picture 12);
  - (2) See if the Turn On indicator is on, press it if not;
  - (3) Press RUN/RST 3S, the RUN indicator is on and the furnace start to run.
5. If there is any great difference between PV and SV in a certain temperature range, then set a constant temperature range for such temperature range to enable the automatic regulation when the temperature is reaching the constant temperature range. keep pressing in start picture until Picture 36 appears, turn to On from OFF and press ENT to confirm, the AT indicator is on, when the AT indicator is off, the temperature controller will set a new PID

parameter after automatic setting, modify the original PID and save it in the temperature controller (Caution: the current of the ammeter should not exceed 180A during the setting).

6. Use PID#1 for 0-250°C, PID#2 for 250-900°C and PID#3 for 900°C and above. (For reference only)
7. Steps turning off the furnace
  - (1) Press RUN/RST 3S, RUN indicator turns off, furnace stop running
  - (2) Press Off button
  - (3) Turn off SWITCH
  - (4)  Turning off gas: DO NOT turn off gas flow until your furnace is cooled down, otherwise air may flow into the chamber causing oxidization even explosion.

## 8. Furnace Maintenance

### 1) Maintenance and cautions of the furnace:

- (1) The furnace should be baked when it is operated for the first time or after a long time.  
Baking time: ambient temperature to 200°C, 2h; 200°C to 600°C, 4h, bake the furnace before conducting any sintering experiment to prevent the furnace cavity from cracking.
- (2) Clean the furnace frequently; check at regular interval to see if the furnace wires are in good connection.
- (3) This furnace can be operated under the following conditions:
  - a. indoors;
  - b. the ambient temperature is within  $\pm 5$  and 40°C;
  - c. the ambient relative humidity is no more than 85%;
  - d. there is no conductive dust, explosive gas and other aggressive gas that may damage the metal and insulation around the furnace.
- (4) 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.
- (5) Temperature should be generally controlled under 300°C in the operation. 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.
- (6) Try to take down the temperature as slow as possible (lower than 10°C/Min) to protect the insulation of the furnace chamber.

### 2) Maintenance and cautions of MoSi<sub>2</sub> heating element:

- (1) Be very careful to install and uninstall the MoSi<sub>2</sub> heating element as it is hard and brittle.

(2) The MoSi<sub>2</sub> heating element should be stored in dry place to prevent its aluminized ends being moisturized and deteriorating.

(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.

(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.

(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.

(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.

(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.

### 3) Maintenance and cautions of SiC heating element:

(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.

(2) Be very careful to install and uninstall the SiC heating element as it is hard and brittle.

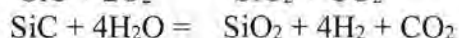
(3) The SiC heating element should be stored in dry place to prevent its aluminized ends being moisturized and deteriorating.

(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.

(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.

(6) SiC reacts with Cl<sub>2</sub> at 600°C and with vapor at 1300-1400°C, it can not be oxidized under 1000°C, but significantly 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.

(7) The resistance of SiC will increase with the operation time k of the heating element; the reactions are as follow,



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.

## 9. Replacing Heating Elements

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



step1



step2



step3



step4

step1. Open top cover

step2. Remove screws that secure the aluminum strips and heating elements

step3. Remove aluminum strips

step4. Remove screws on heating element cramps



Step5



step6



step7



step8

step5. Cut and remove insulation around heating elements

step6. Remove thermo blocks that secure the heating elements

Step7. Remove the insulation stuffing material in between the heating element terminals

Step8. Now you can remove and replace the heating elements.

### Cautions:

- a. 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.
- b. When clamping the heating element with aluminum strip and tight clips, be sure not so tight that the  $\text{MoSi}_2$  is broken or too loose that the contact is poor and cause high resistance and electric arc.
- c.  $\text{MoSi}_2$  heating elements have low resistance and are generally connected in series.
- d. Be very careful in installation of heating elements as they are very brittle and fragile.
- e. 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.

## 10. MoSi<sub>2</sub> Heating Element Introduction

- a. 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.
- b. 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.
- c. 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.
- d. 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.

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. SiC Heating Element Introduction

- a. 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.

- b. 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.
- c. 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.

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                              |

## 12. Troubleshooting for Typical Problems

| Problem                                                                            | Reason                              | Solution                                                  |
|------------------------------------------------------------------------------------|-------------------------------------|-----------------------------------------------------------|
| 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. | Talk to a maintenance personnel. |
|----------------------------------------------------------------|-----------------|----------------------------------|

Problem: Your PC can not recognize the furnace in Shimaden application

Solution: Press and hold the “cycle” button for 5 seconds and set the parameters as listed below. Then connect your furnace via the COM cable (do not use the USB adapter).



Prompt 5-35



Prompt 5-36



Prompt 5-37



Prompt 5-38



Prompt 5-39



Prompt 5-40



Prompt 5-41



Prompt 5-42

### 13. Temperature Controller Parameter Setting (please refer to the FP93 program controller manual)

(These parameters have been set; do not change them if you are new to them)



Picture 37



Picture 38



Picture 39



Picture 40



Picture 41



Picture 42



Picture 43



Picture 44

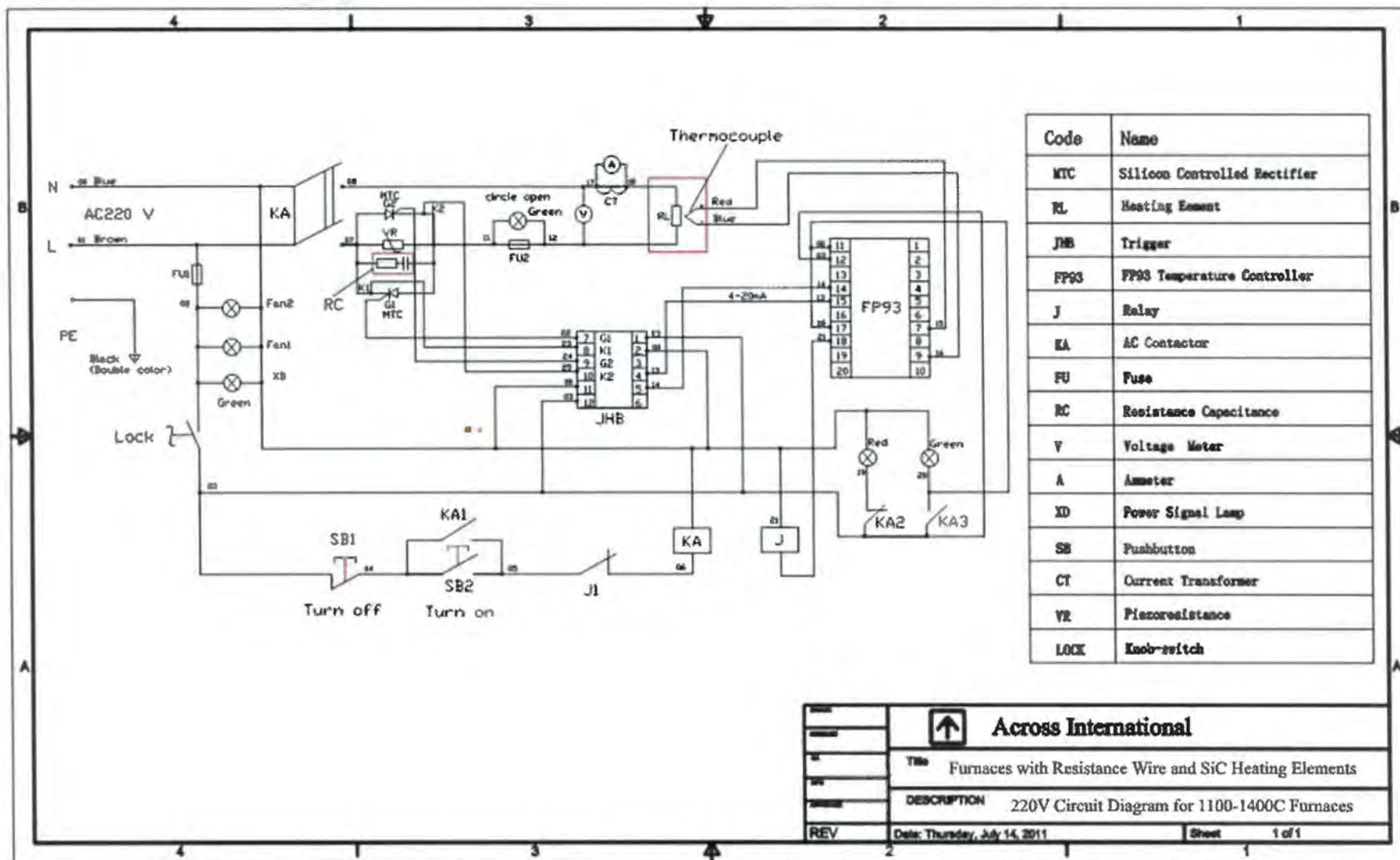
| Parameters                                                                                                                              | Interface<br>(Part # on Shimaden Controller) |                       | Functions                                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P                                                                                                                                       | 4-1                                          | See below for details | Turn down P if PV is in great difference from SV, only the pointer will swing a little more frequently                                                                     |
| I                                                                                                                                       | 4-3                                          |                       | When the ammeter pointer swings frequently, turn up I, only the meter will reflect a bit slowly                                                                            |
| d                                                                                                                                       | 4-4                                          |                       | Turn up d when PV is larger than SV, turn down d when PV is smaller than SV.                                                                                               |
| O-H                                                                                                                                     | 4-8 (see Pic. 44)                            |                       | Limit the maximum output                                                                                                                                                   |
| O-L                                                                                                                                     | 4-7                                          |                       | Limit the minimum output                                                                                                                                                   |
| The above 5 parameters are available in each PID, in regulating, regulate the parameters of the PID that controls the temperature range |                                              |                       |                                                                                                                                                                            |
| E1_A<br>E2_A<br>E3_A                                                                                                                    | 5-19 (see Pic. 41)<br>5-22<br>5-25           |                       | Three types of alarm may be set such as alarm on HR over temperature, alarm on LR low temperature, and alarm on Hd deviation etc. (For details, see Shimaden instructions) |
| E1HA<br>E2LA<br>E3OA                                                                                                                    | 1-11 (See Pic. 37)<br>1-12<br>1-13           |                       | The alarm points of the three types of alarm, the main power will be cut off automatically to protect the furnace when the furnace temperature exceeds this temperature.   |
| PV-S                                                                                                                                    | 1-15<br>(see Pic. 38)                        |                       | The program will be executed from the current PV measurement value other than from the starting value in the first step when it is ON.                                     |
| GURS                                                                                                                                    | 1-16                                         |                       | If 1 is set, the platform constant temperature time can be assured when the program but not the PV value reaches the platform.                                             |
| PcnT                                                                                                                                    | 1-14 (see Pic.40)                            |                       | Set the consecutive execution times of the program                                                                                                                         |
| HLD                                                                                                                                     | 0-5                                          |                       | If select ON, the program will be maintained in the current step.                                                                                                          |
| PV-b                                                                                                                                    | 5-10<br>(see Pic.43)                         |                       | Correct the temperature difference of the system, reduce the measured temperature is higher than the actual one, increase it if not.                                       |
| rRnG                                                                                                                                    | 5-5<br>(see Pic.39)                          |                       | Set the type of thermocouple, do not change it as it has been set before delivery from the factory.                                                                        |
| ESTP                                                                                                                                    | (see Pic.42)                                 |                       | Set the steps for automatic shutdown, e.g. if the picture shows 10, the furnace will be shutdown after step 10 is finished.                                                |

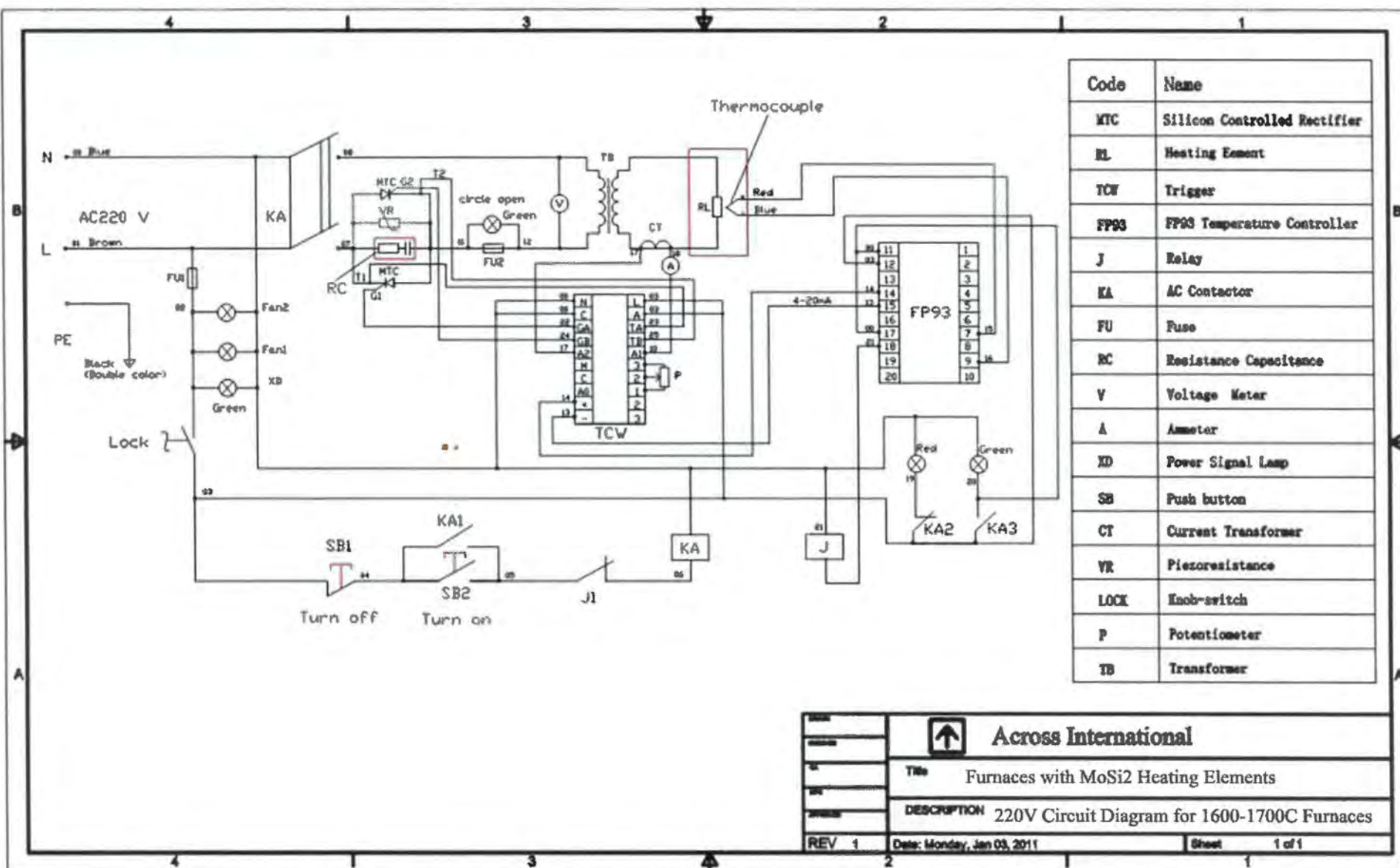
## 14. Package and Accessories

Please check and make sure you have all items listed below. If you see anything missing please contact our office.

| Item | Name                                              | Quantity |
|------|---------------------------------------------------|----------|
| 1    | GCF controlled atmosphere furnace                 | 1        |
| 2    | Furnace manual                                    | 1        |
| 3    | FP93 temp controller manual                       | 1        |
| 4    | Stainless steel tongs                             | 1        |
| 5    | Furnace door block                                | 1        |
| 6    | Flow meter                                        | 1        |
| 7    | Thermocouple                                      | 1        |
| 8    | Alumina cushion block                             | 1        |
| 9    | Thermal gloves                                    | 1        |
| 10   | Alumina crucible                                  | 5        |
| 11   | Fuse                                              | 2        |
| 12   | Computer interface kit                            | 1        |
| 13   | Water pump                                        | 1        |
| 14   | Spare heating element (except for GCF1100 series) | 2        |

## 15. Schematic





## 16. PID Operation (for reference only)

1) Press GRP three times from initial picture to enter Picture 50, press STEP to shift within 1-6 PID (e.g. press STEP to shift to Picture 51), then press  to enter Picture 52, 53 and 54 in turn, press  or  to modify their value respectively and press ENT to confirm the entry.



Picture 50



Picture 51



Picture 52



Picture 53



Picture 54

### 2) Operation guidelines

- Find the optimal parameter for setting in the order from small to large.
- Proportional comes first followed by integral, and finally for differential.
- The dial scale should be set as large as possible, for the curve fluctuates frequently.
- Turn down the dial scale when the curve extends sharply.
- Reduce the integral time when the curve deviates and reverts slowly.
- Delay the integral time when the curve fluctuates at a long cycle.
- Reduce the differential when the curve fluctuates at a faster frequency.
- Delay the differential time when the curve has high moment but fluctuates slowly.
- An ideal curve has two waves in which the first one is higher than the other at a scale of 4:1. Watch carefully before regulation and make more analyses as possible, and your operations will be good.

**A.** Generally, P can be set at about 2.0, I at about 90, and D set larger for low temperature and smaller for high temperature.

**B.** When the regulation goes too far before reaching the stable status, increase the proportion to endure the excessive regulation if the time to reach the stable status is not strictly required.

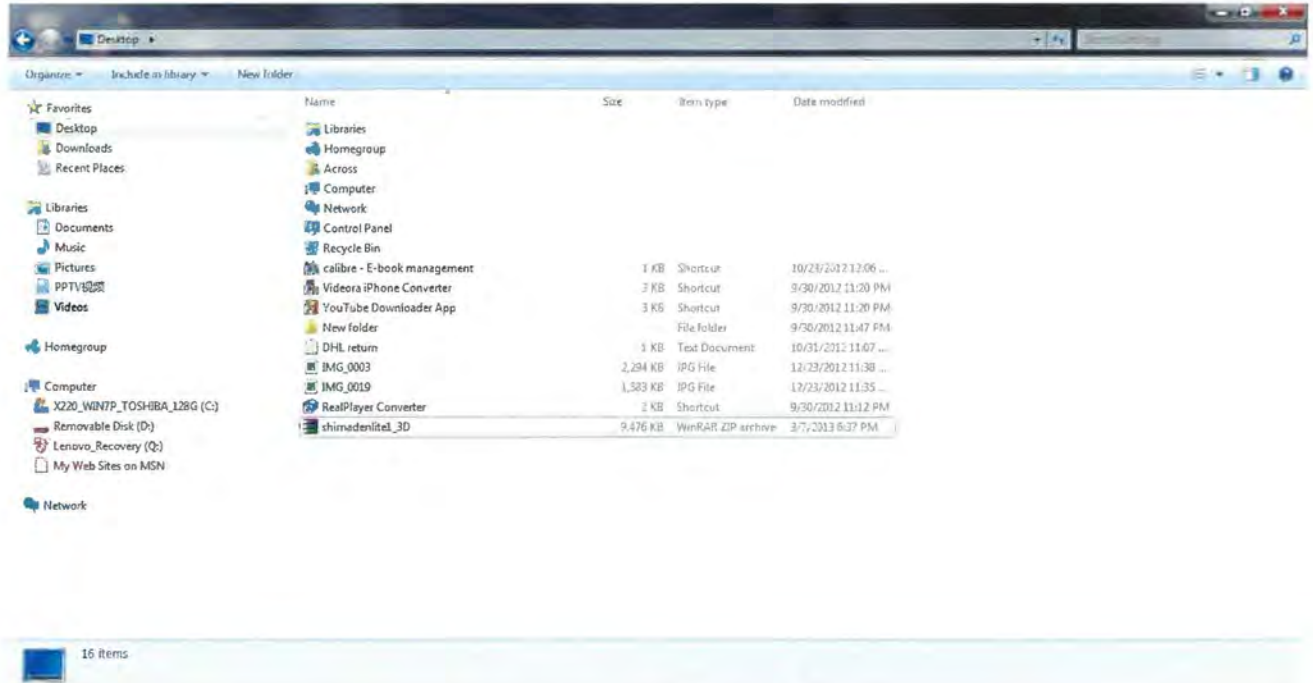
**C.** If the time to reach the stable status is to be reduced while a bit excessive regulation is allowable, the proportional band may be reduced adequately.

**D.** If the measured value fluctuates slowly around the set value, increase the integral time or proportional band.

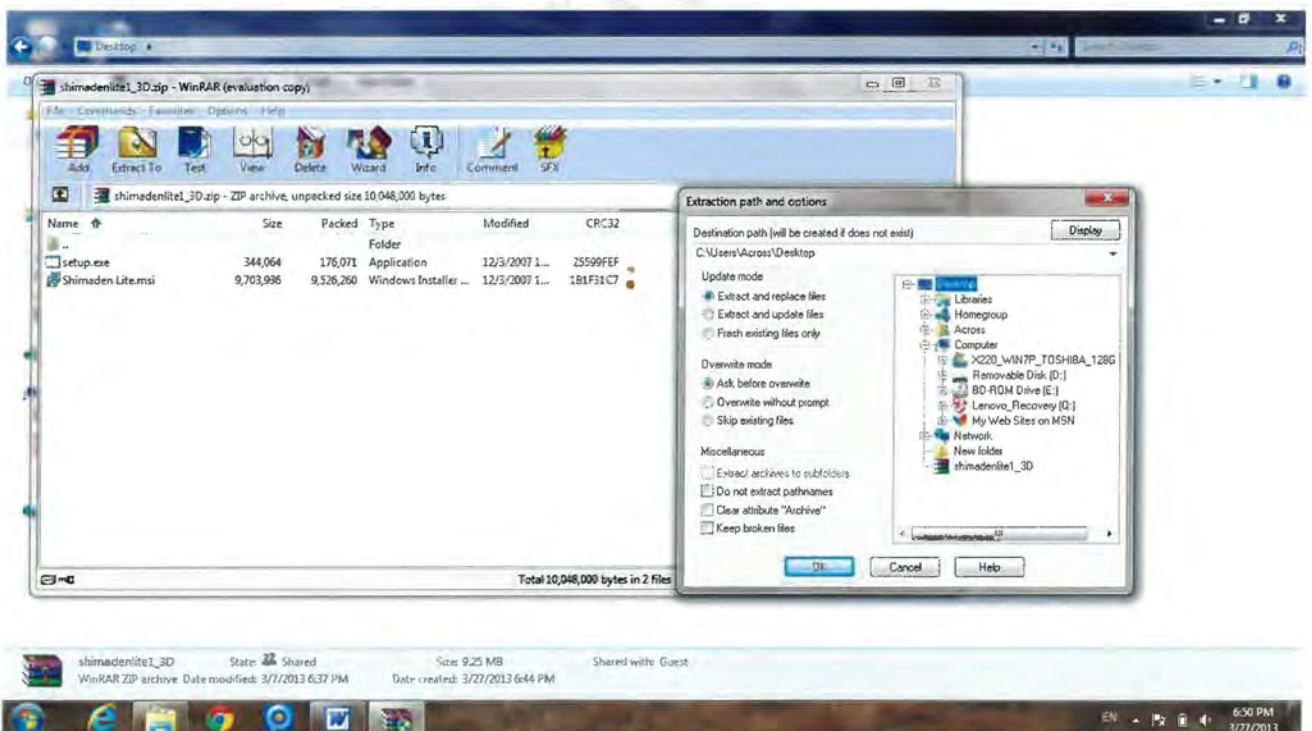
**E.** When the measured value fluctuates frequently around the set value, reduce the integral time adequately.

## 17. Software setup

### Step 1: Find the zipped setup package



### Step 2: Unzip and extract the package to a location



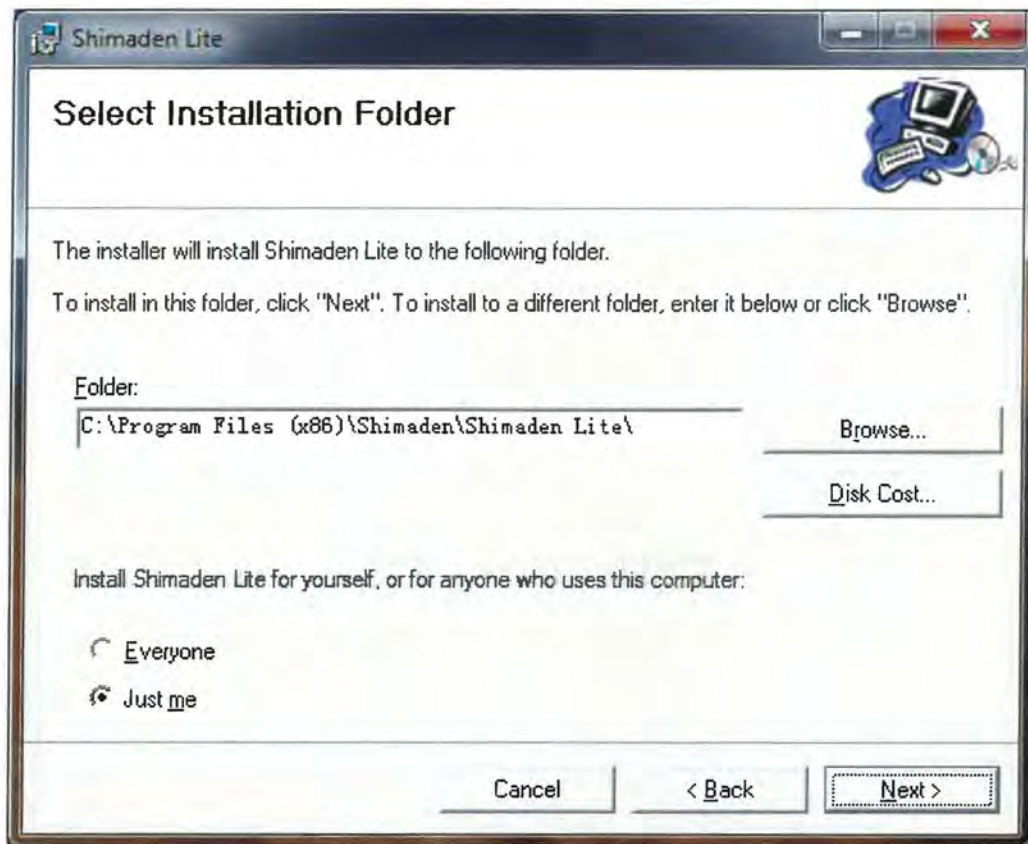
Step 3: Double click the setup.exe, then click "Next" to continue



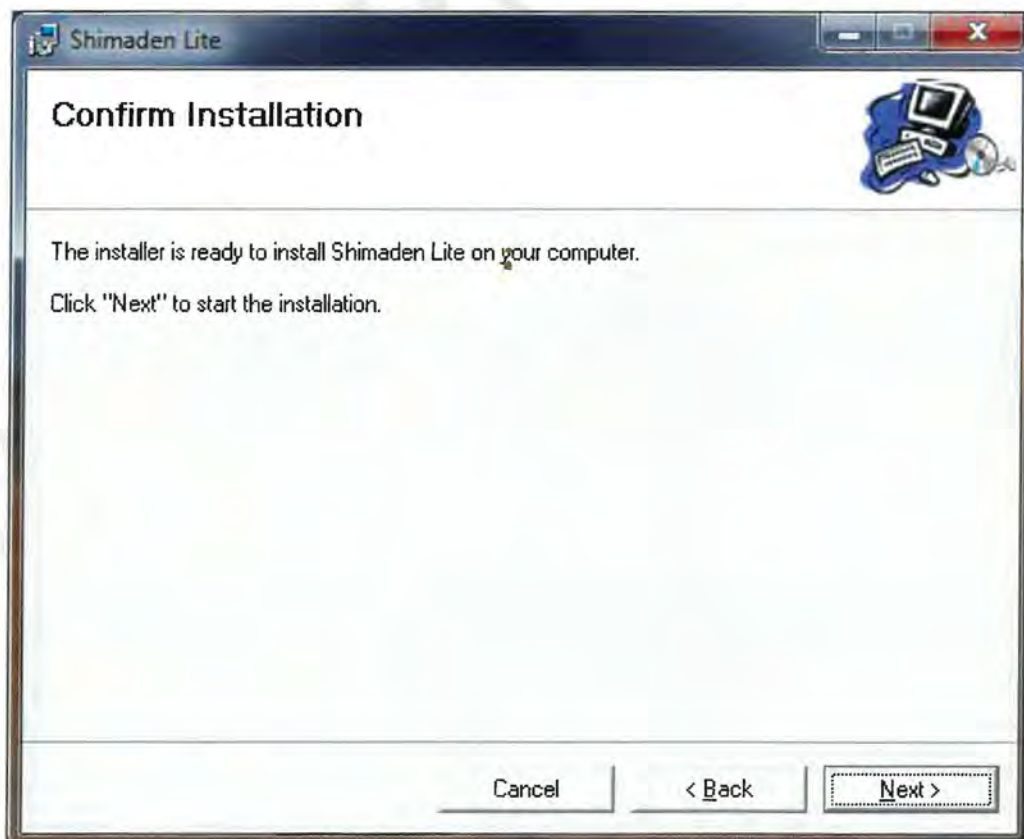
Step 4: Click "I Agree" and click "Next"



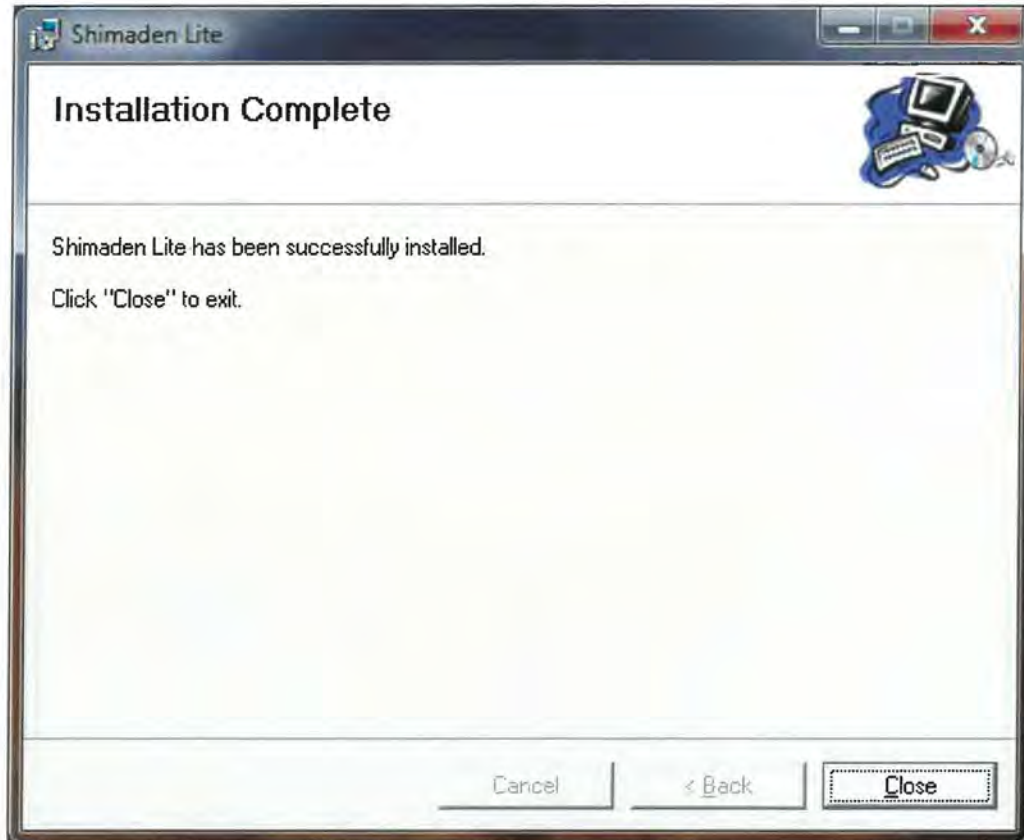
Step 5: Click "Everyone" or "Just me" and click "Next"



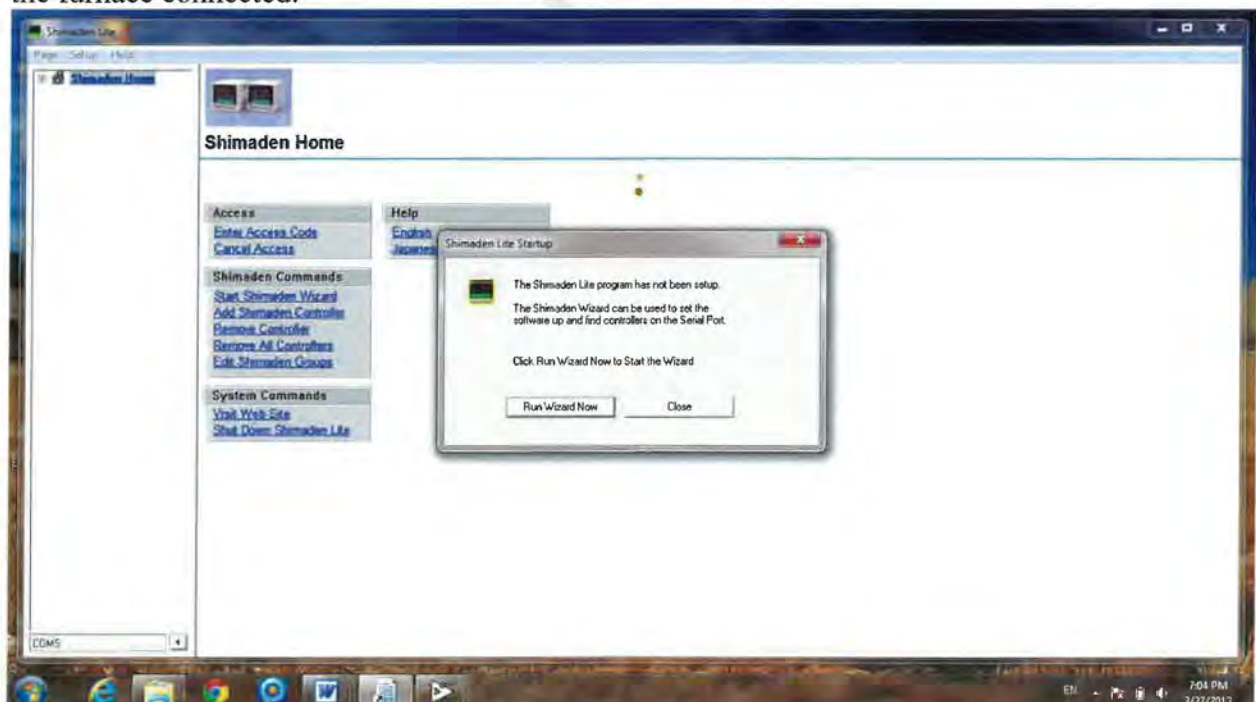
Step 6: Click "Next"



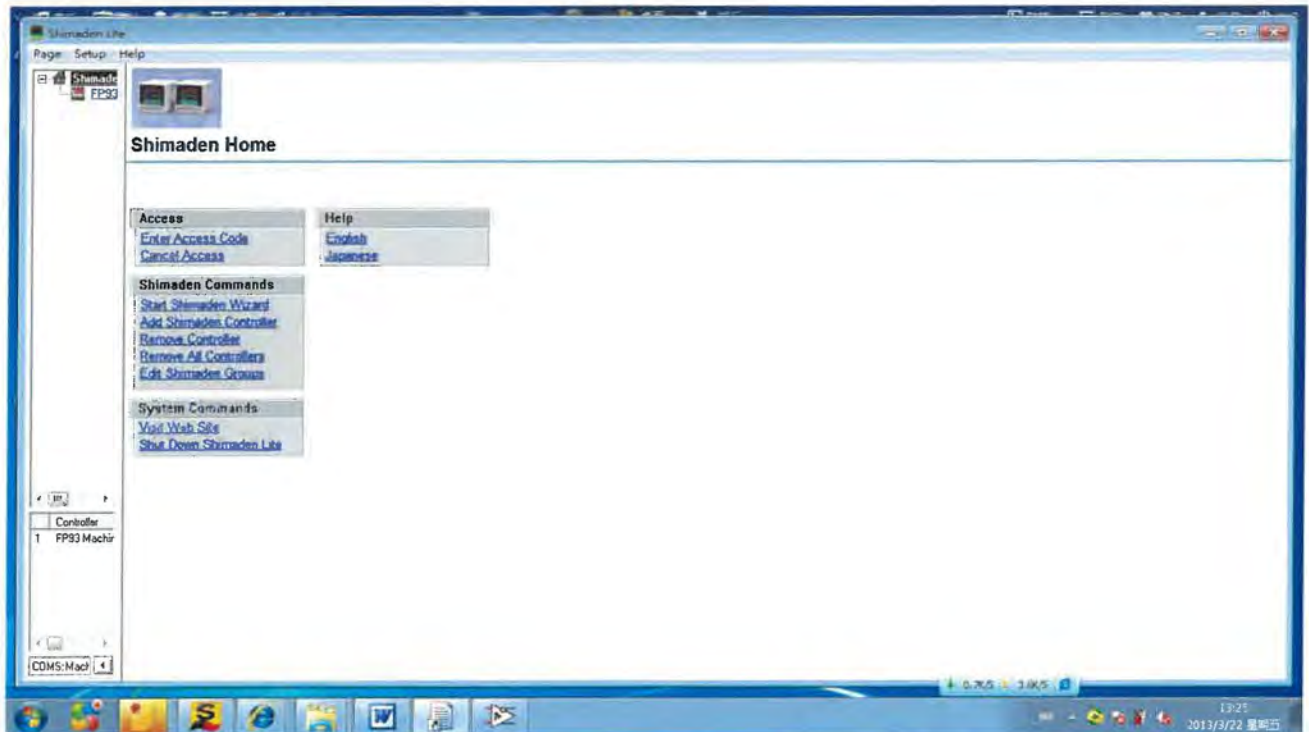
Step 7: Click “Close” to exit setup when it is done



Step 8: After installation is completed. Connect furnace to you PC via a COM/serial or USB cable. Then double click the “Shimaden Lite” icon on your desktop. You will see either screen A or B below. Click “Run Wizard Now” on screen A or “Start Shimaden Wizard” on screen B to look for the furnace connected.

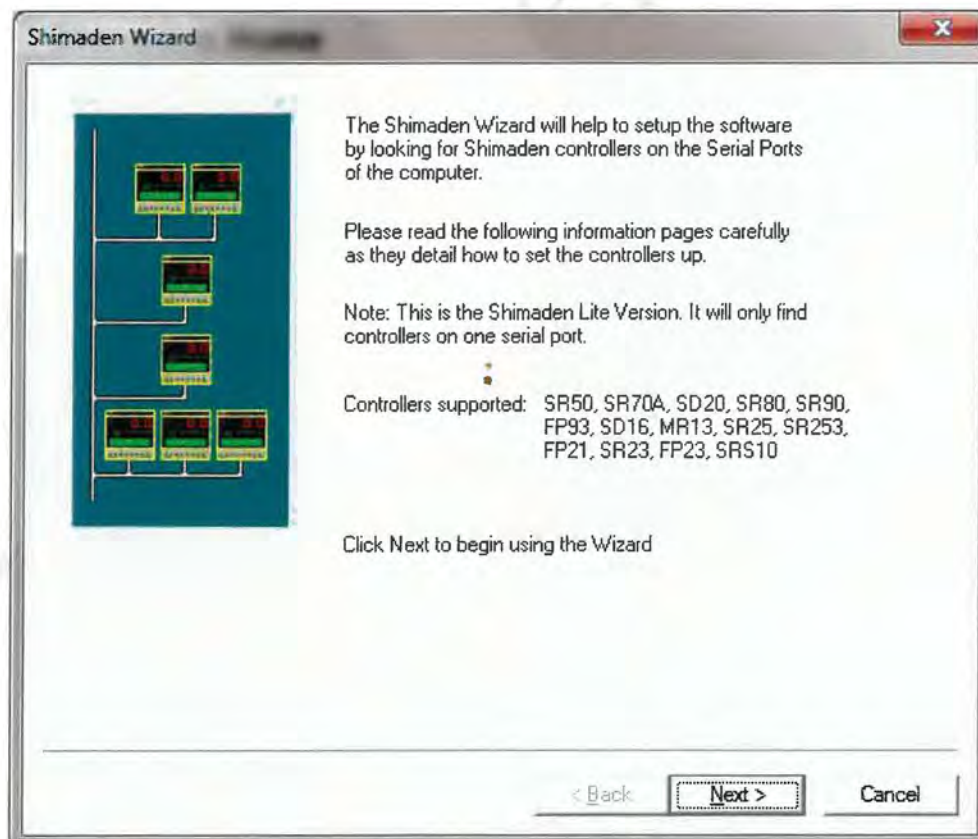


Screen A

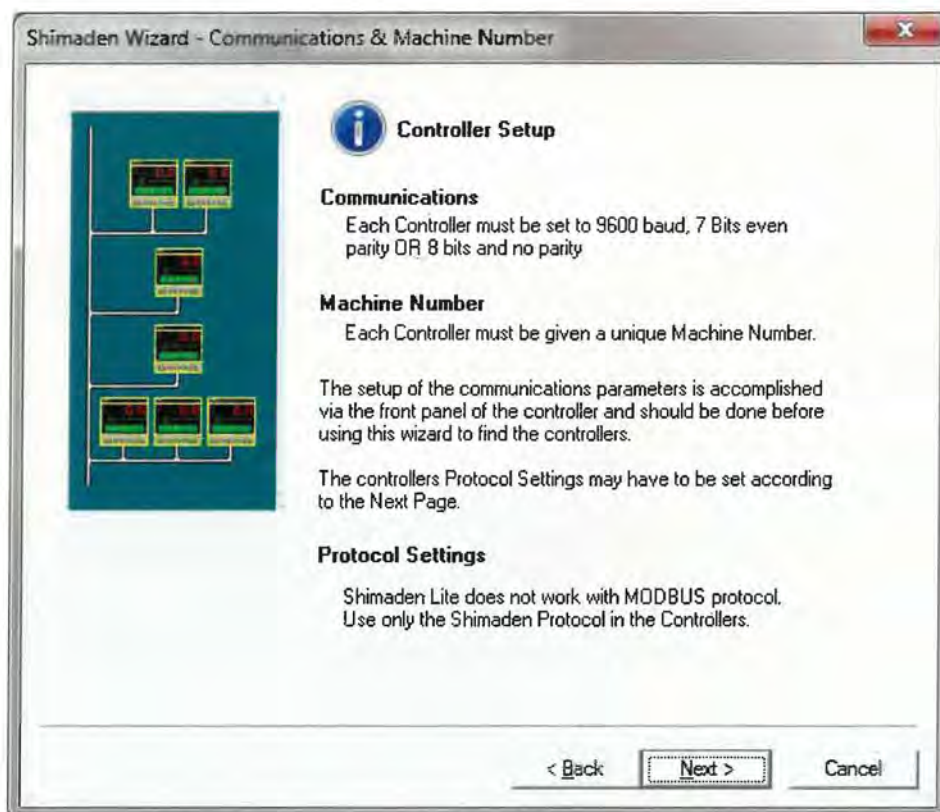


Screen B

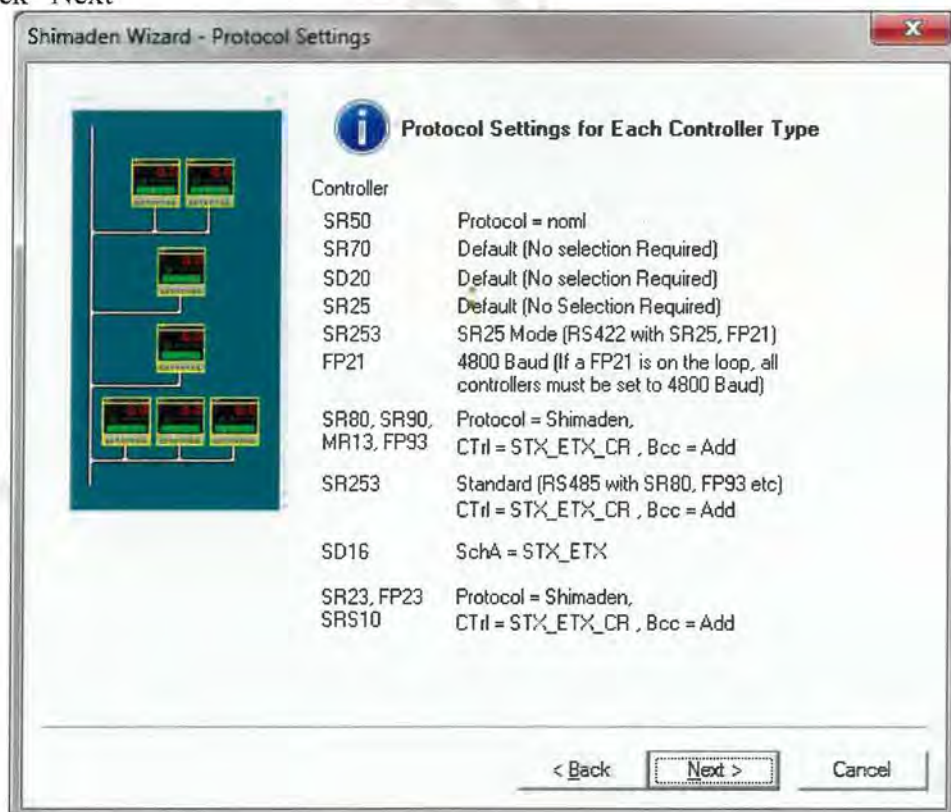
Step 9: Click "Next"



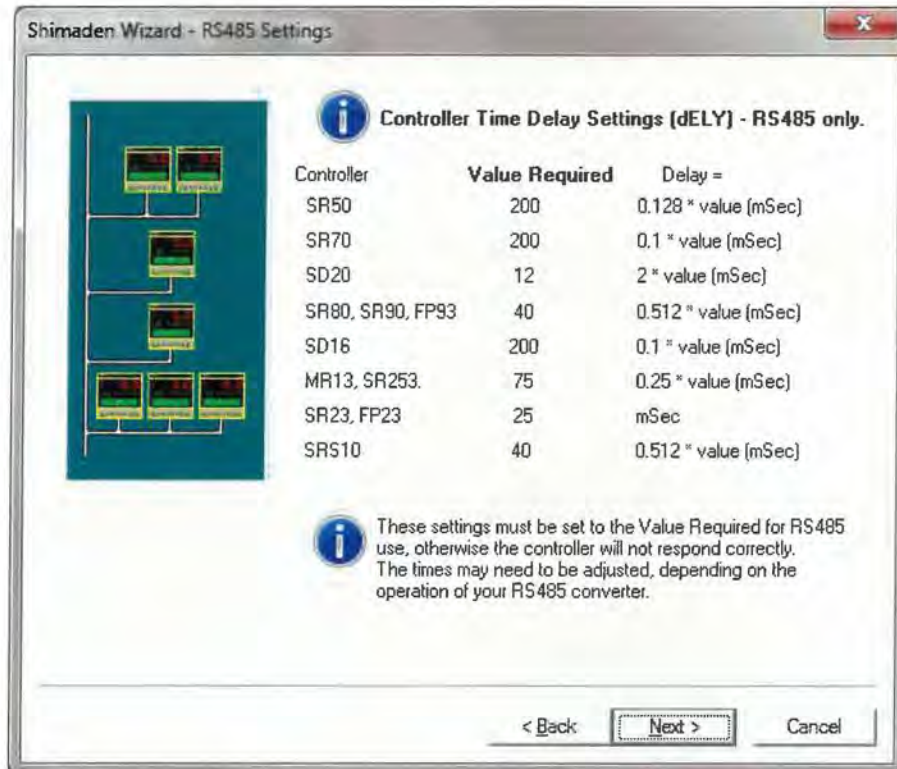
Step 10: Click "Next"



Step 11: Click "Next"



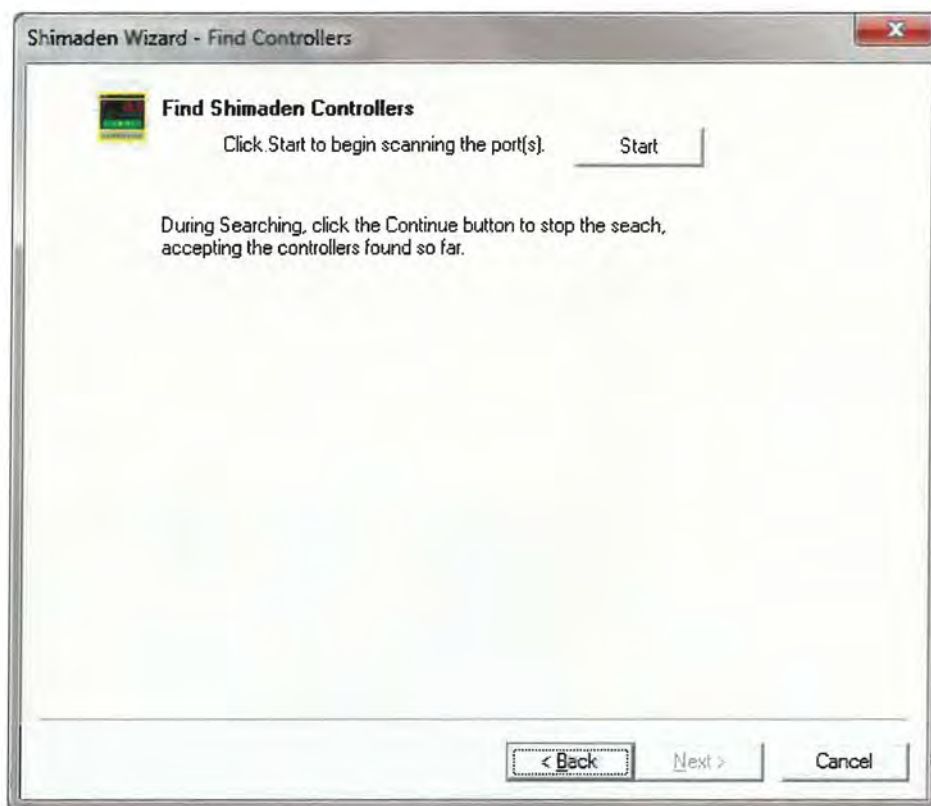
Step 12: Click “Next”



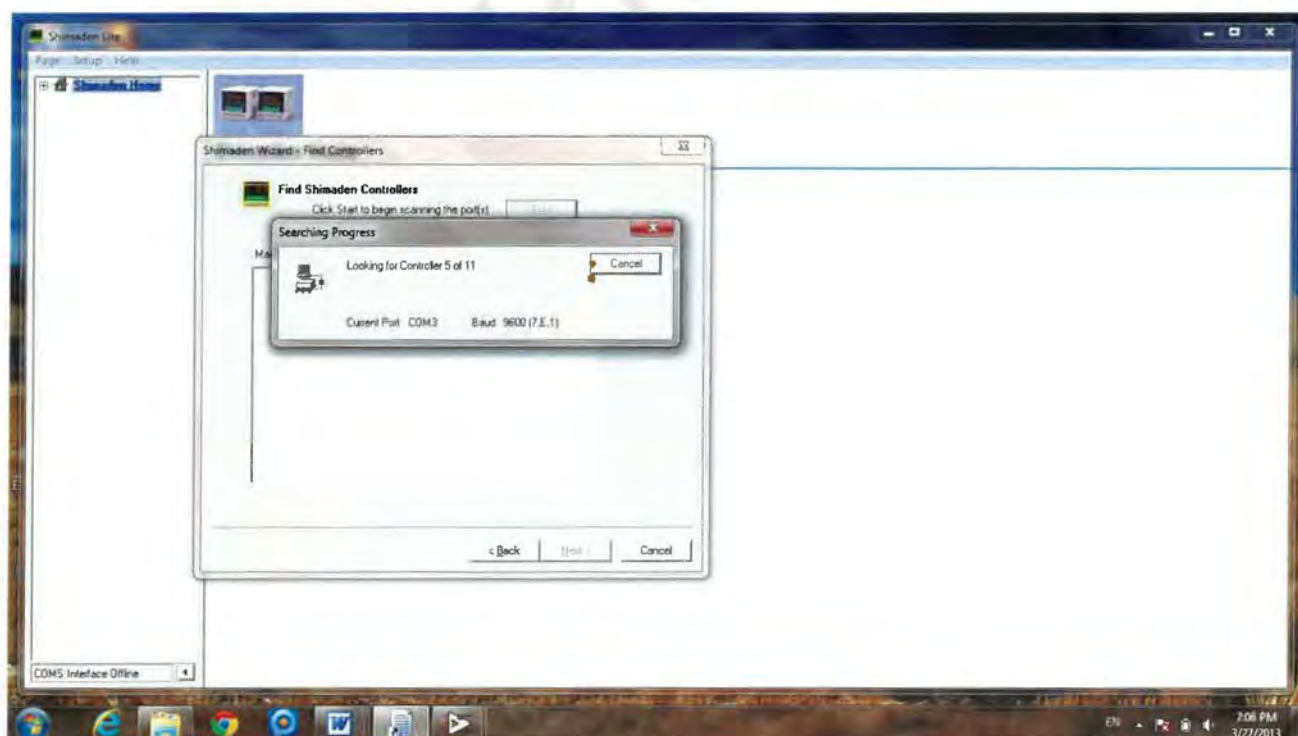
Step 13: In this screen, make sure at least one of the COM/SERIAL ports is checked; otherwise the COM/serial cable might not be connected properly or there is no proper driver installed for the USB cable, and furnace is not recognized. Check and make sure the COM/serial cable is OK and connected securely. If you are using the USB cable, try removing it and connecting the furnace directly via the COM/SERIAL cable. If one of the ports is checked, click “Next”.



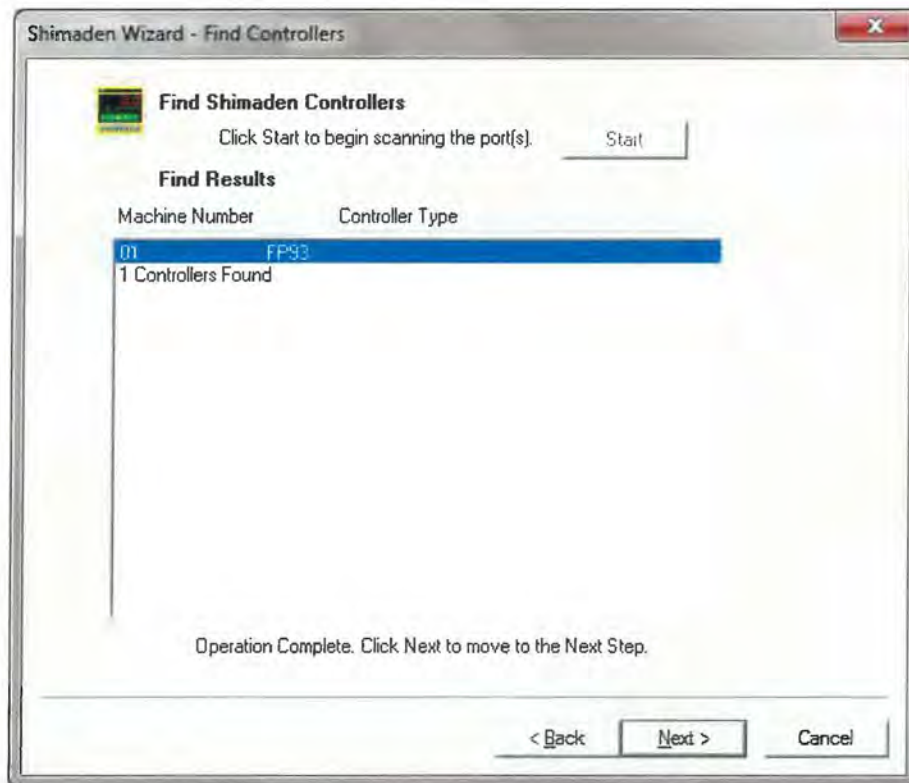
Step 14: Click "Start" to begin scanning the port(s)



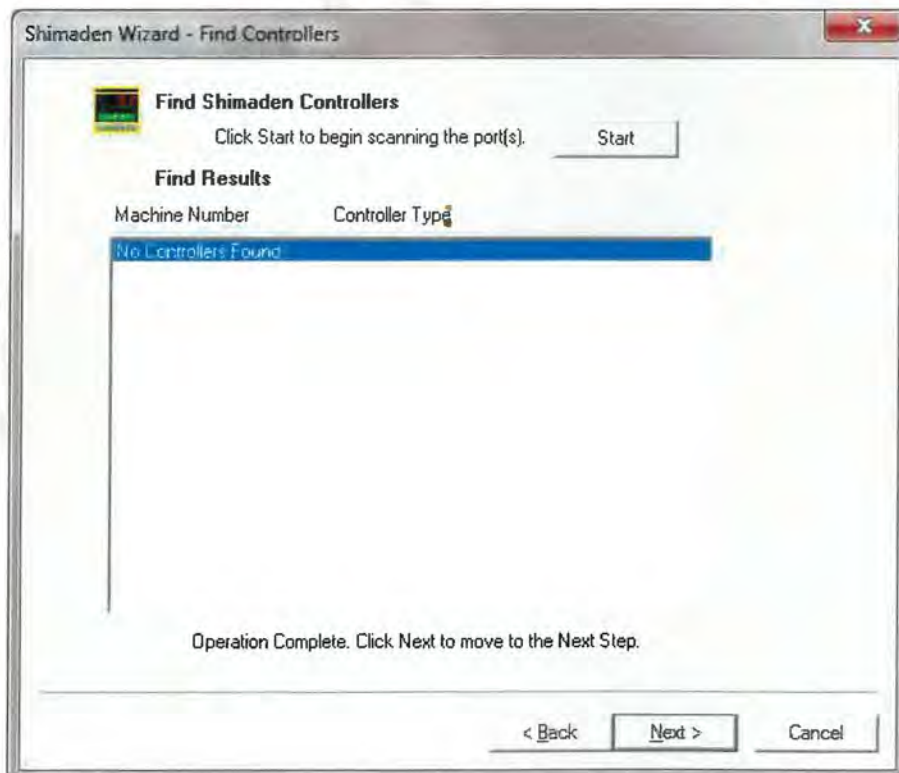
Step 15: Wait for the setup to find your furnace



Step 16: If you see “01      FP93, 1 Controllers Found”, it means your furnace is found. Click “01 FP93” and click “Next” to continue.



If you see “No Controllers Found”, follow the steps below to resolve the issue.



Step 1. Press and hold the “cycle” button on the Shimaden temperature controller for 5 seconds and set the parameters as listed below.



Prompt 5-35



Prompt 5-36



Prompt 5-37



Prompt 5-38



Prompt 5-39



Prompt 5-40



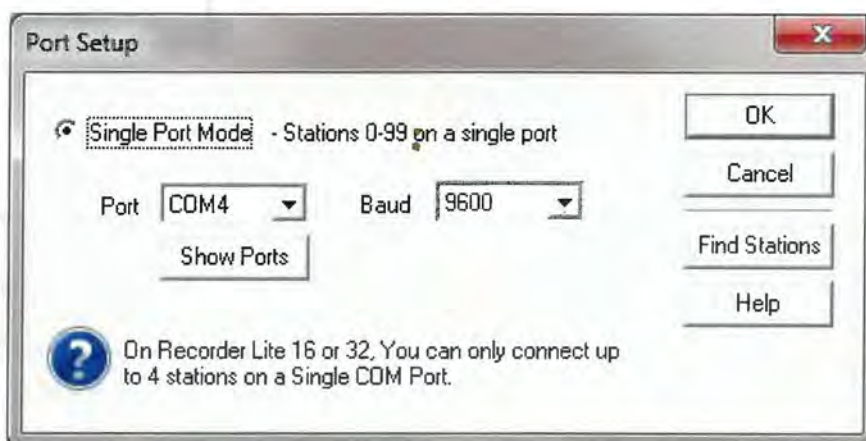
Prompt 5-41



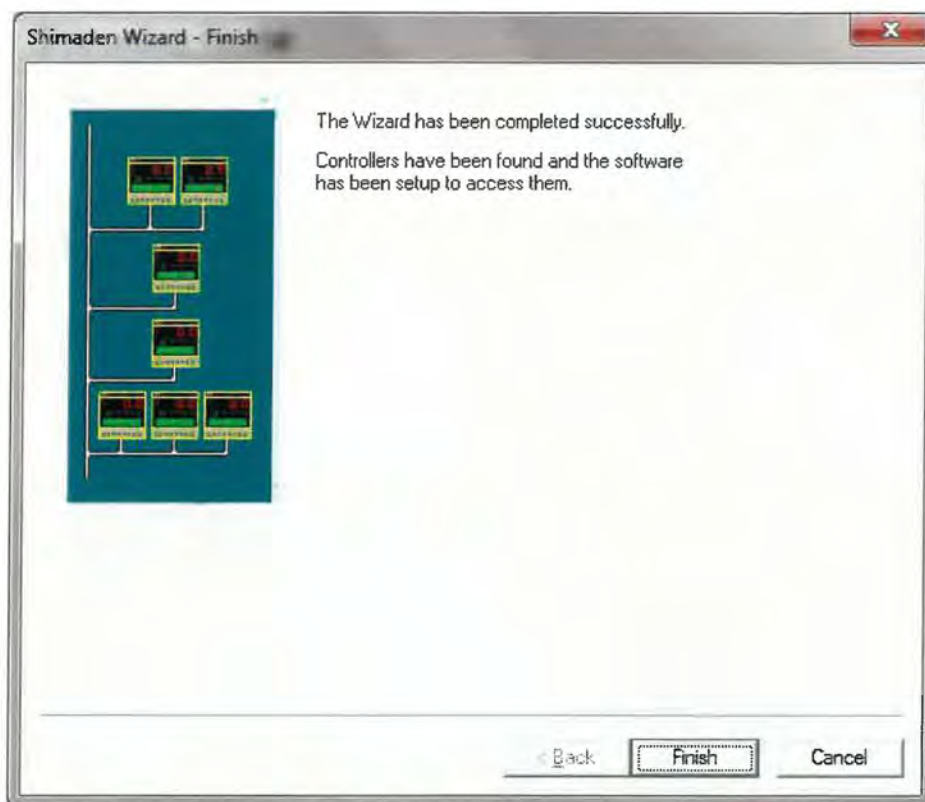
Prompt 5-42

Step 2. Connect your furnace via the COM/serial cable (do not use the USB adapter) and try running the setup wizard again. You can try using the USB adapter again after connecting the furnace successfully via the serial cable, make sure you have the proper USB adapter driver for your computer's operation system.

Step 3. Make sure the port and baud are selected correctly, by going to “Setup” in the top menu and choose “Port Setup”.



Step 17: Click “Finish”



Step 18: Click “FP93 Machine” under “Shimaden Home” on the left



Step 19: If you see this screen, your furnace is connected!



## 18. Support

We offer one year limited replacement warranty for all electronic parts from the date we shipped the goods. If you find any defective parts caused by manufacturer please feel free to contact us and we will replace them for you. However, Across International is not responsible for any damage or consequence damage caused by misuse. After the warranty period, we will continue to provide support and spare parts at a reasonable cost.

### Contact information:

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111 Dorsa Ave, Livingston, NJ 07039

Email: [support@AcrossInternational.com](mailto:support@AcrossInternational.com)

Tel: 888-988-0899

Fax: 888-988-1899