Installation, Operation and Maintenance Instructions
1200°C Tube Furnace (3-zone) EHC Model: 450mm
301 Controller + 3216CC End Zone Controllers

EHC 12/450B + 301 Controller + 3216CC End Zone Controllers
Contents

This manual is for guidance on the use of the Carbolite Gero product specified on the front cover. This manual should be read thoroughly before unpacking and using the furnace or oven. The model details and serial number are shown on the back of this manual. Use the product for the purpose for which it is intended.

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1.0 Symbols and Warnings

1.1 Switches and Lights

Instrument switch: when the instrument switch is operated the temperature control circuit is energised.

Heat light: the adjacent light glows or flashes to indicate that power is being supplied to the elements.

Heat switch: the switch disconnects power to the heating elements; unless this switch is OFF there is a danger of electric shock when inserting objects into the product.

1.2 General Warnings

DANGER – Electric shock. Read any warning printed next to this symbol.
WARNING: Risk of fatal injury.

DANGER – Hot surface. Read any warning printed next to this symbol.
WARNING: All surfaces of a product may be hot.

DANGER – Read any warning printed next to this symbol.
1.3 Warning Labels

On the front control panel there are 2 warning labels as shown in figure 1.3.1; they are numbered 7 and 8. These warnings must be followed for the safe operation of this furnace.

7- Warning label - Do not operate without a work tube.

The furnace must not be operated without the correctly sized work tube and correspond work tube adaptors or it could be possible for an operator to access electrically live element coils that could cause serious injury or death.

8- Warning label - Switch off the furnace before loading and unloading.

The furnace heaters must be switched OFF using the heater switch, item 2 in figure 1.3.1, when the furnace is being loaded or unloaded. The work tube can become electrically conductive at high temperatures, presenting a possible hazard to the operator. If element failure is left undetected the element could collapse onto the work tube.
1.0 Symbols and Warnings

Index to numbered items in Figure 1.3.1 and 1.3.2

1. Electrical supply switch - switches electrical power ON and OFF to the furnace.
2. Heater switch - switches electrical power ON and OFF to the furnace heating elements.
3. Heater ON light - indicates that the furnace heating elements are energized.
4. Product rating label indicating the product serial number and electrical information.
5. Access holes to front panel fixing screws.
6. Warning label - Disconnect the mains supply before removing this cover.
7. Warning label - Do not operate without a work tube.
8. Warning label - Switch OFF the furnace before loading and unloading.
9. Electrical power lead socket.

Figure 1.3.1 - Control Box layout and warning labels.

Figure 1.3.2 - Back of control box showing mains lead socket.
2.0 Installation

If the product has been transported or stored in humid conditions it must be dried out completely before operating the furnace. Contact Carbolite Gero Service for instructions.

2.1 Unpacking and Handling

When unpacking or moving the product, always lift it by its base or both ends of the main body. Never lift it by the end insulation or by a work tube. It may take 2 or 3 people to lift the furnace, depending on the size and configuration.

NOTE: This product contains Refractory Ceramic Fibre (also known as Alumino Silicate Wool - ASW). For precautions and advice on handling this material see section 7.2.

2.2 Siting

Place the product on a level surface in a well ventilated area.
Site away from other sources of heat and on a non-flammable surface that is resistant to accidental spillage or hot materials.
The surface on which the equipment is mounted should be stable and not subject to movement or vibrations.
The height of the mounting surface is important to avoid operator strain when loading and unloading samples.
Unless otherwise stated elsewhere in this manual, ensure that there is at least 150 mm of free space around the back and sides of the product. Clear space is required above the product to dissipate heat.

Work tubes:

It is recommended that the work tube has either insulation plugs or radiation shields fitted to minimise heat loss from both ends of the work tube. If the work tube has open ends, a significant amount of energy could be radiated from the ends of the work tube. Adjacent surfaces should always be made from a non-flammable material.
Ensure that the ends of the work tube are positioned at least 500 mm away from any adjacent surface so that any energy radiated cannot heat an adjacent surface to a dangerous temperature.
If the product is to be used in a process which could liberate hazardous gases, then it should be installed together with a suitable fume extraction system. Ensure that the product is placed in such a way that it can be quickly switched off or disconnected from the electrical supply.

2.3 Setting Up

The horizontal models must have work tubes fitted before being used. The diameter of the work tube is a customer order option and therefore varies between tube furnaces.

Note: If a metal work tube is being used in the furnace, ensure that it is earthed. See 5.6.

Under no circumstances should any objects be placed on top of the product. Always ensure that any vents on the top of the product are clear of any obstruction. Always ensure all cooling vents and cooling fans (if fitted) are clear of any obstruction.

**Fitting the standard length work tube to furnace**

Tools required: 4 mm Allen key

Fitting work tube is as follows with reference to Figure 2.3.2. Please note that standard length work tubes are also referred to as tubes suitable for working in air. They are 150
mm longer than the heated length of the furnace (see the Specifications table at the back of this manual). Read section 7.2 before fitting the work tube.

Index to numbered items in Figure 2.3.2

1. Tube furnace body
2. Work tube (diameter customer option)
3. Work tube adaptor (size dependent on work tube diameter)
4. Work tube adaptor fixing bracket
5. Work tube end stop (size dependent on work tube diameter)
6. Fixing screws M6 x 15
7. Washer M6
8. Tube furnace end guard

- Remove the work tube end guard (8) then remove the work tube adaptor fixing bracket (4) that holds in place the work tube end stop (5) and the end adaptor (3) from one side only. Note that if a different work tube with a different outer diameter is being fitted it will be necessary to fit new correctly sized work tube adaptors (3) in which case both end guards and work tube adaptor fixing brackets (4) will need removing.
- Slide the work tube into the furnace through the work tube adaptor (3) until it reaches the opposite work tube end stop (5). Note that the work might be a tight fit when it is new and may need to be twisted backwards and forwards slightly as it slides in. For long work tubes it may be necessary to use a long wooden pole to support and line up the work tube as it pushed through. It may also take 2 people to perform this operation.
- Reassemble the work tube end stop (5), work tube adaptor bracket (4) and tube end guard (8).

**Fitting the extended work tube in the furnace**

Tools required 4 mm Allen key.

Fitting of the work tube is as follows with reference to Figure 2.3.2 to 2.3.8.
Before the extended work tube can be fitted, the work tube end stops for the standard length work tube (item 5 in figure 2.3.2) must be removed from both ends of the furnace. This is done by removing the furnace end guard (8) and the work tube adaptor brackets (4) to release the work tube end stop (5). The brackets should then be refitted.

- Fit the tube support bracket, (5), figure 2.3.4. Use the M6 button head screws and washers supplied.
- Fit the extended work tube guard, (4), figure 2.3.5. Use the M6 button head screws and washers supplied.
- Re-fit furnace end guard, (3), figure 2.3.6. Use the M6 button head screws and washers supplied.
- If supplied, fit the optional tube end seal assembly as shown in figures 2.3.9 and 2.3.10. Refer to manual MEN-ENDSEALS-01 for detailed fitting instructions.
- Fit the tube support bracket, (1), figure 2.3.7. Use the M6 button head screws and washers supplied.
- Finally, fit tube support collar, (2) and secure figure tight using (6) until the tube is secure to be used in a vertical arrangement. The fitting arrangement is shown in figure 2.3.8.
- Figure 2.3.3 - shows an exploded view of all the required parts.
- Figure 2.3.8 - shows the assembled parts as they would be used.
2.0 Installation

Figure 2.3.4

Figure 2.3.5

Figure 2.3.6

Figure 2.3.7

Figure 2.3.8
2.0 Installation

Figure 2.3.9 - Tube support and end seal assembly

Figure 2.3.10 - Tube support and end seal assembly

Index to numbered items in figure 2.3.3 - 2.3.10

1. Tube support bracket
2. Tube support collar
3. End guards
4. Extended work tube guard
5. End adaptor
6. Fluted grip knob

**Fitting the Optional Insulation Plugs and Radiation Shield**

For optimum temperature uniformity, insulation plugs or radiation shields should be placed in the work tube ends as shown below. With a standard work tube, the insulation plug must be fitted as shown in figure A.

If a gas/vacuum end seal is fitted, either horizontally or vertically, the insulation plug hooks onto the end seal hook; see figure B.

Alignment of radiation shields is similar to that of insulation plugs, see figure C.

If a metal work tube is being used in the furnace, ensure that it is earthed. See the safety warning in section 5.6.

*Figure A- Cross-section view showing standard length work tube insulation plug fitted*

*Figure B- Cross-section view showing extended work tube insulation plug fitted*

*Figure C- Cross-section view showing an extended length work tube with a radiation shield fitted*
Connection by a qualified electrician is recommended.

All furnaces in the range are single-phase and operate over the voltage ranges 100 to 110 volts or 200 - 240 volts. Check the rating label before connection, see "Warning Labels" for location of rating label. To check that the OP.Hi setting is correct for the appropriate voltage, or to change to another setting, follow the instructions in section 10.2.

The electrical supply should be fused at the next standard size equal to or higher than the design current. Where a supply cable is supplied there are internal supply fuses, in which case customer fusing is preferred but not essential. See section 10.0 for furnace rating power, current and fusing information.

The external connection should be either a permanent connection to a fused isolator supply or to a socket on a fused isolator supply; the isolating switch must operate on both conductors. Make sure that the isolator switch is within easy reach of the furnace operator.

### Terminal Connection Details

<table>
<thead>
<tr>
<th>Supply</th>
<th>Terminal Label</th>
<th>UK/ Europe Cable Colour</th>
<th>USA/ Canada Common Cable Colours</th>
<th>Supply Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-phase</td>
<td>L Brown</td>
<td>Red or Black</td>
<td>To live</td>
<td>to either power conductor</td>
</tr>
<tr>
<td></td>
<td>N Blue</td>
<td>White</td>
<td>To neutral</td>
<td>to the other power conductor</td>
</tr>
<tr>
<td></td>
<td>PE Green/ Yellow</td>
<td>Green or Green/ Yellow</td>
<td>To earth (ground)</td>
<td>to earth (ground)</td>
</tr>
</tbody>
</table>
3.0 301 Controller

Due to the complex nature of the furnace or oven control the use of technical terms throughout this manual is unavoidable. Explanations of these terms can be found in the "Glossary of Terms".

3.1 PID control

This controller uses PID (Proportional Integral Derivative) temperature control. This type of control uses a complex mathematical control system to adjust the heating power and achieve the desired temperature.

3.2 Basic Operation of the 301 Controller

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Display</td>
</tr>
<tr>
<td>B</td>
<td>Over-Temperature Key (if fitted)</td>
</tr>
<tr>
<td>C</td>
<td>Page Key</td>
</tr>
<tr>
<td>D</td>
<td>Timer Key</td>
</tr>
<tr>
<td>E</td>
<td>Arrow Keys</td>
</tr>
<tr>
<td>F</td>
<td>Over-Temperature Indicator (if fitted)</td>
</tr>
</tbody>
</table>
### 3.2.1 Menu System

The 301 Controller is divided into two menus; the Home Menu and the Setup Menu. The Home Menu contains all the basic operating controls: setpoint, setpoint ramp rate and timer time. The Setup menu contains all the set up features: timer type, timer band, output power and customer calibration. The features available vary depending on operator input or product specification.

#### 3.2.2 Navigation Diagram

The following diagram details how to navigate to the various menu options within the 301 Controller. At each option, values can be set using the arrow keys.

---

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>Timer Indicator</td>
<td>The Timer indicator shows when the timer is active.</td>
</tr>
<tr>
<td>H</td>
<td>Output Indicator</td>
<td>The Output indicator shows when the controller is switching on the heating elements.</td>
</tr>
</tbody>
</table>
HM  Home Menu
SM  Setup Menu
OTHM Over-Temperature Home Menu
OTSM Over-Temperature Setup Menu

Page Key

Black = Progress
White = Return

Hold for 1.5 seconds
Keep Held
Press Page Key multiple times
Please note that the Over-Temperature Menu is only available when the Over-Temperature Protection option is fitted.

3.2.3 Basic Function Guide

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hold</td>
<td>Used to pause the current program and set new parameters.</td>
</tr>
<tr>
<td>Sp°C</td>
<td>Used to set the desired temperature (setpoint) of the product (°C).</td>
</tr>
<tr>
<td>Sprr</td>
<td>Used to set the heating rate of the product, e.g. increase by 5°C per minute.</td>
</tr>
<tr>
<td>t1,  t2,  t3,  t4,  t5</td>
<td>Indicates the timer type in use. See section 3.5 for more details.</td>
</tr>
<tr>
<td>tYP</td>
<td>Used to set the timer type.</td>
</tr>
<tr>
<td>t.bnd</td>
<td>Available when t1 or t4 is in use. Allows the timer to start the countdown before the desired setpoint is reached.</td>
</tr>
<tr>
<td>rSt</td>
<td>Used to reset the timer.</td>
</tr>
<tr>
<td>OPh1</td>
<td>Used to set the maximum output power.</td>
</tr>
<tr>
<td>CLSt</td>
<td>Used to set the customer calibration type.</td>
</tr>
<tr>
<td>Fact</td>
<td>Used to select the factory calibration settings.</td>
</tr>
<tr>
<td>PASS</td>
<td>Flashes when a password is required to access further options.</td>
</tr>
<tr>
<td>CCl1</td>
<td>Select to access the single point calibration option.</td>
</tr>
<tr>
<td>CCl2</td>
<td>Select to access the dual point calibration options.</td>
</tr>
<tr>
<td>OFSt</td>
<td>Used to set the single point calibration offset temperature (°C).</td>
</tr>
<tr>
<td>CALL</td>
<td>Used to set the low temperature point (°C) for dual point calibration.</td>
</tr>
<tr>
<td>CALH</td>
<td>Used to set the high temperature point (°C) for dual point calibration.</td>
</tr>
<tr>
<td>OFSL</td>
<td>Used to set the offset value for the low temperature point (°C) for dual point calibration.</td>
</tr>
<tr>
<td>OFSH</td>
<td>Used to set the offset value for the high temperature point (°C) for dual point calibration.</td>
</tr>
<tr>
<td>Ot</td>
<td>Used to set the Over-Temperature limit (°C).</td>
</tr>
<tr>
<td>ott</td>
<td>Displayed when the Over-Temperature protection has been activated.</td>
</tr>
<tr>
<td>PU</td>
<td>Displayed before the current temperature when checking the</td>
</tr>
<tr>
<td></td>
<td>Over-Temperature sensor temperature.</td>
</tr>
</tbody>
</table>
3.2.4 Home Display

The Home Display is the first display you see when the controller is switched on, it shows the actual temperature of the product. When entering the menus, the controller will automatically return to the Home Display if no keys are pressed for 30 seconds.

Finding the Home Display

- To find the Home Display from the Home Menu, press the Page key until the current temperature is shown on the display.
- To find the Home Display from the Setup Menu, press and hold the Page key for 1.5 seconds.

3.2.5 Hold Mode

'Hold' mode turns the output off; this allows parameters to be set without the controller instantly trying to control at the new settings.

When the output indicator is off, the Home Display flashes between the current temperature and Hold.

To enter 'Hold' mode:

- Start at the Home Display.
- Press and hold the up and down Arrow keys together for 1.5 seconds
- The display will flash Hold to show that 'Hold' mode has been entered.

To exit 'Hold' mode:

- Start at the Home Display.
- Press and hold the up and down Arrow keys together for 1.5 seconds OR start the timer (See "The Timer ").
- Note: The 'Hold' mode function is disabled when the timer function is operating.
3.0 301 Controller

3.2.6 Checking the Temperature Setpoint from the Home Display

- Start at the Home Display.
- Press either the up or down Arrow key.
- The setpoint will show on the display for 3 seconds before returning to the home display.

3.2.7 Changing the Temperature Setpoint

- Start at the Home Display.
- Repeatedly press the Page key to scroll through the Home Menu until $S^\text{POC}$ is displayed.
- Use the up and down Arrow keys to alter the value.
- A single press of the up or down Arrow key shows the current setting.
- To alter this, either keep the key pressed or press it again. The value will then be stored without any further input.

3.2.8 Changing the Temperature Setpoint Ramp Rate

- Start at the Home Display.
- Repeatedly press the Page key to scroll through home menu until $S^\text{Prr}$ is displayed.
- Use the up and down Arrow keys to turn off or alter the value.
- A single press of either the up or down Arrow key shows the current setting. To alter, either keep pressed or press again. The value will then be stored without any further input.
- See section 3.4 for more information.

This will cause the product to heat as quickly as possible which may not be appropriate where the product contains sensitive ceramic components. For products with ceramic components, e.g. a tube furnaces fitted with a long ceramic work tube, use the ramp rate feature set with a low heating rate such as $5^\circ\text{C}$ per minute ($300^\circ\text{C}$ per hour), to prevent damage.
3.2.9 Changing the Timer Time

- Start at the Home Display.
- Repeatedly press the Page key to scroll through the Home Menu until \( E_1, E_2, E_3, E_4 \) or \( E_5 \) shows on the display.
- Use the up and down Arrow keys to turn off, or alter the value.
- A single press of either the up or down Arrow key shows the current setting (Hr:Min).
- To alter this, either keep pressed or press again. The value will then be stored without any further input.
- See 3.5 for more information.

3.3 Advanced Operation

3.3.1 Entering the Setup menu

- Start at the Home Display.
- Press and hold the Page key for 1.5 seconds.
- The display will change to the first parameter in the Setup Menu.

3.3.2 Changing the Timer Type

- Start at the Home Display.
- Hold the Page key for 1.5 seconds to enter the set-up menu.
- Once entered, repeatedly press the Page key until \( ELP \) is displayed.
- Use the up and down Arrow keys to alter the value.

To alter this, either keep pressed or press again. The value will then be stored without any further input. A single press of the up or down key shows the current setting.

Note: This function is disabled when the timer is operating. See section 3.5 for more information on the timer types and functions.
3.3.3  Changing the Timer Band

- Start at the Home Display.
- Hold the Page key for 1.5 seconds to enter the Setup Menu.
- Once entered, repeatedly press the Page key until \( bnd \) is displayed.
- Use the up and down Arrow keys to turn off or alter the value.

A single press of the up or down key shows the current setting. To alter this, either keep pressed or press again. The value will then be stored without any further input. See section 3.5 for more information.

Note: This is only available when timer type 1 or 4 is selected.

3.3.4  Changing the Maximum Output Power

Note: Output Power is a product specific setting and will not appear on all furnaces and ovens.

- Start at the Home Display.
- Hold the Page key for 1.5 seconds to enter the set-up menu.
- Once entered, repeatedly press the Page key until \( OP Hi \) is displayed.
- Use the up and down Arrow keys to alter the value.

A single press shows the current setting. To alter this, either keep pressed or press again. The value will then be stored without any further input.

Caution: Do not increase the power limit value to a value above the design level for the oven or furnace model, or to a value above that correctly calculated for silicon carbide elements. The heating elements could burn out, or other damage could be caused. Refer to the Fuses and Power Settings section of your product manual (section 10.0 for more information on power limits).
3.3.5 Changing the Customer Calibration Type

- Start at the Home Display.
- Hold page key for 1.5 seconds to enter the set-up menu.
- Once entered, repeatedly press page key until CLST is displayed.
- Use the up and down Arrow keys to display the current calibration type.
- Use the up and down Arrow keys to display the password screen.
- Use the up and down Arrow keys to enter the Calibration Password (see 3.3.6).
- Press the page key to confirm password. The value will then be stored without any further input.
- See section 3.8 for more information.

3.3.6 Calibration Password

Once entered the calibration password remains active for 30 seconds after leaving the set up menu to allow time to revisit if necessary.

The Calibration Password for this instrument is: 525

3.4 Temperature Setpoint Ramp Rate

3.4.1 Setpoint Ramp Rate

The SPrr controls the rate at which the temperature in a furnace or oven changes per minute. When SPrr has a numeric value, e.g. 5 °C/ min, the product will attempt to heat or cool at that rate. When the value of Sprr = off, the product will heat or cool as quickly as possible.

Setpoint ramp rate is useful when materials susceptible to thermal shock are being heated.

3.4.2 Limitations of Setpoint Ramp Rate

The setpoint ramp rate should not be set higher than the maximum heat up or cool down rate of the furnace or oven.

The setpoint ramp rate only resets its start position when the ramp rate is changed or the controller is taken out of 'Hold' mode.

Changes in the temperature setpoint do not affect the ramp rate.

If the temperature is set below the current temperature of the furnace or oven then after a period of time adjusted to a temperature higher than the current temperature
without adjustment of the ramp rate, the controller can become out of step and appear to switch off.

Putting the controller into, then out of 'Hold' mode will reset the ramp rate and force the controller back into control.

### 3.5 The Timer

#### 3.5.1 Starting the Timer

- Start at the Home Display.
- Press the Timer key once to start the timer.

If the 301 Controller is in 'Hold' mode, pressing the Timer key will automatically exit 'Hold' mode and the controller will start to operate.

#### 3.5.2 Checking the Time Remaining

- Start at the Home Display
- Press the Timer key once to check the time remaining.
- The display will flash the symbol 3 times.
- It will return to the Home Display automatically.

#### 3.5.3 Pausing the Timer

- Start at the Home Display
- Press and hold the Timer key for 1.5 seconds; the display alternately shows the symbol and the current temperature.
- To resume the timer, press the Timer key once.
3.5.4  Resetting the Timer

- When the timer count has ended, or the timer is paused, start at the Home Display.
- Press and hold the Timer key for 1.5 seconds.
- \( \text{r 5E} \) is displayed to indicate timer reset.

3.5.5  Timer Function Description

The 301 Controller has an in-built timer, which can be set to one of five types:

**Timer Type 1**
On pressing the Timer key; 'Timer Type 1' waits for the setpoint to be reached, then begins the countdown. On completion of the countdown, the product switches off power to the elements ('\( \text{End} \)' flashes on the display).

**Timer Type 2**
On pressing the Timer key; 'Timer Type 2' starts the countdown immediately. On completion of the countdown, the product switches off power to the elements ('\( \text{End} \)' flashes on the display).

**Timer Type 3**
On pressing the Timer key; 'Timer Type 3' immediately switches the product heating off and starts to countdown. On completion of the countdown, the furnace or oven switches on the power to the elements. This can be used to delay the start of heating.

**Timer Type 4**
On pressing the Timer key; 'Timer Type 4' waits for the setpoint to be reached, then begins the countdown. On completion of the countdown, the product continues to control as normal ('\( \text{End} \)' flashes on the display).
 Timer Type $t_5$

On pressing the Timer key; 'Timer Type 5' starts the countdown immediately. On completion of the countdown, the product continues to control as normal ('End' flashes on the display).

3.5.6 The Timer Temperature Band

Timer type $t_1$ or $t_4$ starts the countdown when the setpoint temperature is reached. It is possible to set the timer running before the setpoint is reached by adjustment of the timer temperature band 't.bnd', e.g. 't.bnd' set to a value of 3 will result in the timer starting to countdown 3°C before the temperature setpoint is reached. This is useful when furnaces or ovens that take a long time to reach setpoint, are at a sufficiently high temperature for a specific customer process to occur.
### 3.5.7 Timer Function Table

<table>
<thead>
<tr>
<th>t.typ</th>
<th>On Pressing the Timer Key</th>
<th>During the Countdown</th>
<th>Completion of the Countdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>t1</td>
<td>Heating: ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Timer: Starts when setpoint reached</td>
<td>Counts Down</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Display: Flashes t1 3 times. Shows Time remaining.</td>
<td>Current Temperature</td>
<td>Cycling Current Temperature/ End</td>
</tr>
<tr>
<td></td>
<td>Timer Indicator: Flashing until setpoint reached</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>t2</td>
<td>Heating: ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Timer: Start Immediately</td>
<td>Counts Down</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Display: Flashes t2 3 times Shows Time remaining.</td>
<td>Current Temperature</td>
<td>Cycling Current Temperature/ End</td>
</tr>
<tr>
<td></td>
<td>Timer Indicator: ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>t3</td>
<td>Output: OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td>Timer: Starts Immediately</td>
<td>Counts Down</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Display: Flashes t3 3 times Shows Time remaining</td>
<td>Time Remaining</td>
<td>END shows for 3 seconds then the Current Temperature.</td>
</tr>
<tr>
<td></td>
<td>Indicator: ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>t4</td>
<td>Heating: ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td>Timer: Starts when setpoint reached</td>
<td>Counts Down</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Display: Flashes t4 3 times Shows time remaining</td>
<td>Current Temperature</td>
<td>Cycling Current Temperature/ End</td>
</tr>
<tr>
<td></td>
<td>Timer Indicator: ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>t5</td>
<td>Heating: ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td>Timer: Starts Immediately</td>
<td>Counts Down</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Display: Flashes t3 3 times Shows Time remaining</td>
<td>Current Temperature</td>
<td>Cycling Current Temperature/ End</td>
</tr>
<tr>
<td></td>
<td>Timer Indicator: ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>
3.6 Ramp Dwell Programming

The 301 Controller has the capability to follow a Ramp Dwell program.

3.6.1 Setting up a Ramp Dwell program

Set the Controller to Hold Mode:

- Start at the home display
- Press and hold the up and down keys together for 1.5 seconds.
- The display will flash $\text{HOLD}$ to show that 'Hold' mode has been entered.
Set the Timer Type to \( t1 \)

- Start at the home display
- Press and hold the Page key for 1.5 seconds to enter the Setup Menu.
- Repeatedly press the Page key until \( t1YP \) shows on the display.
- Use the up and down Arrow keys to set the value to \( t1 \).
- The value will then be stored without any further input.
- See the 3.5 for more information.
- Press and hold down the page key for 1.5 seconds to return to Home Menu.

Set the Temperature Setpoint

- Start at the Home Display.
- Repeatedly press the Page key until \( SP^\circ C \) shows on the display.
- Use the up and down Arrow keys to alter the value (\( ^\circ C \)).
- The value will then be stored without any further input.
- Press and hold down the Page key for 1.5 seconds to return to the Home Menu.

Set the Setpoint Ramp Rate

- Start at the Home Display.
- Repeatedly press the Page key until \( SPrr \) shows on the display.
- Use the up and down Arrow keys to alter the value (\( ^\circ C/\) Min).
- The value will then be stored without any further input.
- Press and hold down the Page key for 1.5 seconds to return to the Home Menu.

Set the Dwell Time

- Start at the Home Display.
- Repeatedly press the Page key until \( t1 \) shows on the display.
- Use the up and down Arrow keys to either switch off or alter the value (Hr:Min)
- The value will then be stored without any further input.
- Press and hold down the Page key for 1.5 seconds to return to the Home Menu.
3.0 301 Controller

Start the Timer

- Start at the Home Display.
- Pressing the Timer key starts the program.
- Pressing the Timer key will automatically exit 'Hold' mode if set (see section 3.2.5 for more information) and the controller will start to operate.
- Press and hold down the Page key for 1.5 seconds to return to the Home Menu.

3.7 Maximum Output Setting

Depending on the furnace or oven model the maximum output power setting OP.Hi may be accessible or hidden.

For silicon carbide heated furnaces the parameter is accessible to allow compensation for element ageing, see the Fuses and Power Settings section of your product manual (section 10.0) for more information on power limits.

In many models the maximum output power setting depends on the supply voltage, refer to the Fuses and Power Settings section of your product manual (section 10.0).

3.8 Customer Calibration

The controller is calibrated for life at manufacture, there may however be sensor or other system errors which affect the accuracy of the measured temperature. Customer calibration is used to compensate for these errors. Access to this function is disabled when the timer is operating.

The 301 Controller has three types of customer calibration: factory calibration, single point calibration and dual point calibration. See sections 3.3.5 & 3.3.6 to access these.

3.8.1 Factory Calibration - \( F \bar{A}c \bar{E} \)

Factory calibration is the default setting, which has no offset adjustment. It simply displays the temperature measured by the control thermocouple.

3.8.2 Single Point Calibration - \( C \bar{E}L \)

Single point calibration uses an offset value to adjust the temperature over its whole range.

Single point calibration accurately sets the temperature for setpoint values close to the temperature at which the calibration offset is made. The accuracy is reduced for setpoint temperatures which are significantly higher or lower then the calibration offset.

Table showing examples of how to determine offset values:
The calibration temperature may be measured at the centre of the chamber or through a specially fitted port.

New Offset Value = Old Offset Value + New Offset adjustment

New Offset Adjustment = Measured Calibration Temperature – Displayed Temperature

Caution! - The procedure to determine the calibration temperature at the centre of a chamber is not covered in these instructions. If you are unsure how to do this safely, then seek advice as there is a risk of electric shock if done incorrectly.

3.8.3 Changing the Single Point Calibration Offset - OFSE

- Start at the home display.
- Hold the Page Key for 1.5 seconds to access the Setup Menu.
- Repeatedly press the Page key until CLSE is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access CLLI, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to CLSE.
- Use the up and down Arrow keys to scroll to CLLI.
- Press the Page key to access OFSE.
- Press the up or down Arrow keys to change the offset value.
- The value will then be stored without any further input.

Once CLLI has been selected as the customer calibration type, it is possible to start from the home display and go to OFSE directly, and enter the password at this point when the calibration adjustment is required again.

3.8.4 Dual Point Calibration - CLL2

Dual point calibration uses two offset values at two corresponding temperatures to progressively change the calibration as the temperature increases or decreases. This is a more accurate representation of how the temperature difference will occur.

Caution! - Do not make CALL and CALH the same value as the controller will not work correctly and could cause the furnace or oven to overheat.
3.8.5 Changing the Calibration, Low Temperature - **CALL**

- Start at the home display.
- Hold the Page Key for 1.5 seconds to access the Setup Menu.
- Press the Page key until **CL SE** is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access **CL2**, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to **CL SE**.
- Use the up and down Arrow keys to scroll to **CL2**.
- Press the Page key to access **CALL**.
- Press the up or down Arrow keys to change the offset value.
- The value will then be stored without any further input.

Once **CL2** has been selected as the customer calibration type, it is possible to start from the home display and go to **CALL** directly (or any of the other settings in **CL2**) and enter the password at this point when calibration adjustment is required again.

3.8.6 Changing the Calibration, Low Temperature Offset - **OFSL**

- Start at the home display.
- Hold the Page Key for 1.5 seconds to access the Setup Menu.
- Repeatedly press the Page key until **CL SE** is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access **CL2**, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to **CL SE**.
- Use the up and down Arrow keys to scroll to **CL2**.
- Press the Page key twice to access **OFSL**.
- Press the up or down Arrow keys to change the offset value.
- The value will then be stored without any further input.

3.8.7 Changing the Calibration, High Temperature - **CAL H**

- Start at the home display.
- Hold the Page Key for 1.5 seconds to access the Setup Menu.
- Repeatedly press the Page key until **CL SE** is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access **CL2**, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to **CL SE**.
- Use the up and down Arrow keys to scroll to **CL2**.
- Press the Page key three times to access **CAL H**.
- Press the up or down Arrow keys to change the offset value.
- The value will then be stored without any further input.
3.8.8 Changing the Calibration, High Temperature Offset - $OF_{SH}$

- Start at the home display.
- Hold the Page Key for 1.5 seconds to access the Setup Menu.
- Repeatedly press the Page key until $CL_{SE}$ is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access $CCL_{2}$, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to $CL_{SE}$.
- Use the up and down Arrow keys to scroll to $CCL_{2}$.
- Press the Page key four times to access $OF_{SH}$.
- Press the up or down Arrow keys to change the offset value.
- The value will then be stored without any further input.
3.9 Over-Temperature Protection

This controller may be fitted with the over-temperature protection option. If the over-temperature option is fitted the 301 display will include the Over-Temperature key and indicator (as shown in the diagram above). An independent control circuit and temperature sensor provide the over-temperature protection.

There are two uses for over-temperature protection:

1. To prevent a sample being heated in a furnace or oven from over-heating.
2. To provide an extra safety system to prevent the furnace or oven from heating in the event of a fault.

3.9.1 Over-Temperature (O/T) home display

When the Over-Temperature key is pressed and held the O/T home display is shown.

The home display shows the over-temperature limit setting.

**Finding the O/T home display from the O/T Home Menu:**

- Press and hold the Over-Temperature key.
- Repeatedly press the Page key until the O/T limit value shows on the display.

**Finding the O/T home display from the O/T Setup Menu:**

- Press and hold the Over-Temperature key.
- Press and hold the Page key for 1.5 seconds.
3.9.2 Changing the Over-Temperature Limit

Note: If protection of the sample being processed is required, the over-temperature limit is normally set 15 °C above the temperature setpoint of the controller. If protection of the furnace or oven is required, the over-temperature limit is normally set 15 °C above the maximum setpoint of the furnace or oven.

- Start at the home display.
- Press and hold the Over-Temperature key.
- Repeatedly press the Page key until OT shows on the display.
- Use the up and down Arrow keys to change the offset value.

A single press shows the current setting. To alter either keep pressed or press again. The value will then be stored without any further input.

3.9.3 Checking the Over-Temperature Sensor Temperature

- Start at the home display.
- Press and hold the Over-Temperature key.
- Press and hold the Page key for 1.5 seconds.
- Current temperature (PV) is displayed for 1 second, followed by the over-temperature sensor value for 3 seconds; this sequence is then repeated.
3.9.4 Over-Temperature Protection Calibration

The over-temperature protection circuit can be calibrated in the same way as the main controller. However, this is not normally necessary as the level of accuracy required for over-temperature protection is not as critical as it is for the main control temperature.

- Start at the home display.
- Press and hold the Over-Temperature key.
- Press and hold the Page key for 1.5 seconds.
- Repeatedly press the Page key until **CLST** is displayed.

Now follow the procedure in "Customer Calibration".

3.9.5 Over-Temperature Activation

During normal operation, the over-temperature indicator is green. If the temperature of the furnace or oven goes above the over-temperature limit, the over-temperature circuit activates. The power supply to the heating elements is switched off and the over-temperature indicator changes to flashing red.

Pressing the over-temperature key shows **OT** in the display to indicate that the over-temperature has been triggered.

The reason for the over-temperature activation must be investigated; an incorrect setting in the over-temperature limit is may be the cause. When you are satisfied with the reason for the over-temperature activation it can be reset.
3.9.6 Resetting Over-Temperature Activation

- Start at the home display.
- Press and hold the Over-Temperature key until \( \text{OT} \) is displayed.
- Repeatedly press the Page key until \( \text{OT} \) is displayed and the red indicator stops flashing.
- Press the up or down Arrow key to check the over-temperature limit value.
- Press the up or down Arrow key to alter the value if necessary.
- Press the Page key to return to the over-temperature display.

The over-temperature has now been reset.

If the temperature is still above the over-temperature setpoint then over-temperature indicator will be red but not flashing.

When the temperature falls below the over-temperature limit, the indicator changes back to green.

When the current temperature falls below the over-temperature setpoint, the furnace/oven starts to heat again.
3.10 RS232 Communication Option

The 301 Controller can be supplied with the capability to communicate with other devices via an RS232 link. If this option has been ordered, the furnace or oven will be supplied with a 9 pin ‘D’ socket for connecting to an external device. Plugging this into a computer will allow the controller to be accessed from that computer. The computer must have appropriate communication software installed such as Eurotherm’s ‘i-Tools’.

RS232 Communication Addressing:

<table>
<thead>
<tr>
<th>Modbus Address (Main)</th>
<th>= 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modbus Address (O/Temp)</td>
<td>= 3</td>
</tr>
<tr>
<td>Baud Rate</td>
<td>= 9600</td>
</tr>
<tr>
<td>Byte Format</td>
<td>= 8</td>
</tr>
</tbody>
</table>

RS232 Communication Cables

Connecting the furnace or oven to a computer is done via a "straight" cable as follows:

<table>
<thead>
<tr>
<th>Product end of cable female 9-pin</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable 9-pin male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx 3</td>
<td></td>
<td>3 Tx</td>
</tr>
<tr>
<td>Tx 2</td>
<td></td>
<td>2 Rx</td>
</tr>
<tr>
<td>Com 5</td>
<td></td>
<td>5 Com</td>
</tr>
</tbody>
</table>

3.11 Temperature Controller Replacement

Before handling the controller: wear an anti-static wrist strap or otherwise avoid any possibility of damage to the unit by static electricity. Refer to the detailed instructions supplied with the replacement controller.

If the temperature controller is fitted to the back of the control panel it can be separated from the base by removal of the screws. If the temperature controller is fitted inside the product base it can be separated from the top by removal of the screws.
### 3.12 Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setpoint (SP)</td>
<td>The target temperature the furnace or oven is trying to reach.</td>
<td>°C</td>
</tr>
<tr>
<td>Setpoint Ramp Rate (SPrr)</td>
<td>The speed at which the furnace or oven is allowed to heat up or cool down.</td>
<td>°C/ Min</td>
</tr>
<tr>
<td>Element</td>
<td>The heating device used in the furnace or oven.</td>
<td>-</td>
</tr>
<tr>
<td>Thermocouple</td>
<td>A thermoelectric device for measuring temperature.</td>
<td>-</td>
</tr>
<tr>
<td>PID</td>
<td>Proportional Integral Derivative: the control system used by the controller.</td>
<td>-</td>
</tr>
<tr>
<td>Over-Temperature</td>
<td>The condition which a furnace or oven may enter if part of the main control circuit fails.</td>
<td>-</td>
</tr>
<tr>
<td>Over-Temperature Protection</td>
<td>A system to prevent the product or process being damaged if it has gone into an Over-Temperature condition.</td>
<td>-</td>
</tr>
<tr>
<td>Furnace or Oven</td>
<td>This refers to the product purchased from Carbolite Gero.</td>
<td>-</td>
</tr>
</tbody>
</table>

### 3.13 Controller Fault

#### Fault Code Diagnostic Table

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Explanation</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>5br</td>
<td>Temperature sensor failure</td>
<td>Check all terminal connections between the temperature sensor (thermocouple) and temperature controller. It is recommended to loosen then tighten the screws in the terminal blocks in case the connections are oxidised. If this does not correct the error then replace the furnace or oven temperature sensor (thermocouple).</td>
</tr>
<tr>
<td>0000</td>
<td>Input over range</td>
<td></td>
</tr>
<tr>
<td>-000</td>
<td>Input under range</td>
<td></td>
</tr>
<tr>
<td>E-followed by numerical code</td>
<td>Controller Error</td>
<td>Turn the furnace or oven off and back on to see if this clears the error. If not contact Carbolite Gero Service – (see back cover)</td>
</tr>
</tbody>
</table>
4.0 3216CC Controller

4.1 3216CC

This section should be disregarded unless the controller is used as an independent end zone controller.

The 3216CC Controller is a digital temperature controller which uses PID algorithms to give excellent temperature control when properly set. This controller can only be used as a simple temperature controller, it cannot be programmed.

4.2 PID control

This controller uses PID (Proportional Integral Derivative) temperature control. This type of control uses a complex mathematical control system to adjust the heating power and achieve the desired temperature.

4.3 Operation

4.3.1 Controller Layout

Key

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Power Output Indicator</td>
</tr>
<tr>
<td>B</td>
<td>Alarm Indicator</td>
</tr>
<tr>
<td>C</td>
<td>Remote Indicator (when configured)</td>
</tr>
<tr>
<td>D</td>
<td>Page</td>
</tr>
<tr>
<td>E</td>
<td>Scroll</td>
</tr>
<tr>
<td>F</td>
<td>Down</td>
</tr>
<tr>
<td>G</td>
<td>Up</td>
</tr>
<tr>
<td>H</td>
<td>Run Indicator</td>
</tr>
<tr>
<td>I</td>
<td>Hold Indicator</td>
</tr>
<tr>
<td>J</td>
<td>Setpoint Temperature (SP)</td>
</tr>
<tr>
<td>K</td>
<td>Measurement Temperature</td>
</tr>
</tbody>
</table>
### 4.3.2 Keys

**Page Key**

The page key is used to access level 2 when held down for 3 seconds.

**Scroll Key**

The scroll key is used to scroll through parameters.

**Ack**

When pressed simultaneously the ACK function is used to:
- Return to the Home Menu
- Acknowledge an alarm if activated.
- Reset a program after the program has ended.

**Page and Scroll**

The arrow keys are used individually to adjust the selected parameters and in combinations to operate a program.

### Note:
If a parameter is selected and no further action is taken, the display will time out and revert back to the home display in its working level after approximately 1 minute.

### 4.4 Quick Start Guide

#### 4.4.1 Operation as a simple controller

When switched on, the controller goes through a short test routine and then shows the measured temperature (PV = Process Value) in the upper part of the display and below it, the desired temperature (Setpoint).

#### 4.4.2 Changing the Setpoint

Press Up ▲ or Down ▼ to select the required SP. If the SP is higher than the measured temperature, the OP1 indicator will illuminate in the top left corner of the display, indicating that the controller is calling for power (giving an output).

The controller will immediately attempt to reach the setpoint and then maintain it. This will cause the product to heat as quickly as possible which may not be appropriate where the product contains sensitive ceramic components. For products with ceramic components, e.g. a tube furnaces fitted with a long ceramic work tube, use the ramp rate feature set with a low heating rate such as 5°C per minute (300°C per hour), to prevent damage.

#### 4.4.3 Using the Controller

The parameters in the controller are first shown by a short code (mnemonic). After 5 Seconds a description of the parameter will scroll once along the display and then revert back to the mnemonic. The scrolling text can be interrupted at any time by a single press of any of the buttons, but will not scroll again until the parameter is returned to. In this manual the mnemonic will be shown first, followed by the scrolling text in brackets; e.g. PROG <PROGRAM NUMBER>
4.4.4 Understanding User Levels

There are two user levels in the controller; Level 1 (Operator) and Level 2 (Supervisor). Level 1 (Operator) is for the day to day operation of the controller. These parameters are not protected by a security code.

Level 2 (Supervisor) provides access to additional parameters. Access to this level protected by a security code

**To Enter Level 2**

1. Press and hold the page key for 3 seconds.
2. The display will show LEu 1 GOTO
3. Release the page Key
4. Press the up or down to choose LEu 2 (level 2)
5. Press the up or down to enter the code (Level 2 Code = 9).

If the correct code is entered, PASS should momentarily be displayed and then revert to the level 2 home display.

If an incorrect code is entered the display reverts back to Level 1 home display.

When level 2 operations have been completed, the supervisor must return to Level 1 either manually or by switching the instrument off and back on. There is no time out function.

**To Return to Level 1**

1. Press and hold the page Key
2. Press down to select LEu 1

It is not necessary to enter a code when going from a higher level to a lower level. When level 1 is selected, the display reverts to the home display (See Controller Layout)

**Table showing parameters accessible in level 1 and Level 2**

<table>
<thead>
<tr>
<th>Operator LEVEL 1</th>
<th>Supervisor LEVEL 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>home display</td>
<td>home display</td>
</tr>
<tr>
<td></td>
<td>Programming</td>
</tr>
<tr>
<td></td>
<td>Program Status</td>
</tr>
<tr>
<td></td>
<td>Alarms (if configured)</td>
</tr>
<tr>
<td></td>
<td>Current Transformer Input (if configured)</td>
</tr>
<tr>
<td></td>
<td>Comms (if configured)</td>
</tr>
<tr>
<td></td>
<td>Controller set up (if configured)</td>
</tr>
<tr>
<td></td>
<td>Customer Calibration (if configured)</td>
</tr>
</tbody>
</table>

**TIP**
If while navigating the controller, a parameter has been passed or you need to access parameters which would be at the end of a scroll list, press and hold scroll ▲ and use up ▲ to return to a previous parameter.

4.5 Setting up the Controller

Before using the controller (or during its lifetime) certain parameters may have to be set, depending on specific requirements. To do this the controller must be set to supervisor level (Level 2).

4.5.1 Setpoint Ramp Rate

To control the rate at which the temperature rises to setpoint, the SP.RATE function is used.

Before setting the ramp rate, it is advisable to set the setpoint to a low value, preferably 0 °C (see section 4.4). Once the ramp rate has been set, the required setpoint can be entered from the home menu. Doing so will activate the ramp rate, which can be identified with the run indicator showing on the bottom of the display. While the ramp rate is active the working setpoint will be shown on the lower temperature display (this is the setpoint, set by the ramp rate).

When the process temperature has reached the setpoint value at the given ramp rate, the run indicator will turn off and the instrument will control at the required setpoint temperature.

Any further modifications to setpoint will cause the ramp rate to be activated and the instrument to control as described above.

**NOTE:** Ensure timer configuration is set to ‘none’ (see section 4.6) to use the setpoint ramp rate feature without any timer functions.

4.5.1.1 Setting Setpoint Ramp Rate

In supervisor level (level 2).

Press scroll ▲ until the display shows SP.Rate <setpoint rate limit>. Using up ▲ and down ▼ select the ramp rate required, in °C/Min.

4.5.1.2 Running with Ramp Rate

Press the up ▲ and down ▼ keys at the same time to activate the ramp rate. The "Run" indicator will illuminate and the scrolling text will read <RAMPING> to show the ramp rate is active. The ramp rate will then start from the current process temperature.

When the ramp reaches the setpoint temperature, the "Run" indicator will turn off and the instrument will maintain control at the setpoint.

To put the ramp rate into a hold condition, press the up ▲ and down ▼ keys and release. The "Run" indicator will flash and the scrolling text will read <HOLD> to show the ramp rate is on hold.
To cancel the ramp rate, press and hold the up ▲ and down ▼ keys until the "Run" indicator turns off.

4.5.2 Maximum Output Power

Press scroll 🔽 until the display shows OP.HI <OUTPUT HIGH>. Use the up ▲ and down ▼ keys to select the output power required as a percentage. Once the setting is made, turn the instrument switch off and on to power cycle the temperature controller.

Depending on the furnace or oven model, the maximum output power setting OP.Hi may be accessible or locked.

For silicon carbide heated furnaces, the parameter is accessible to allow compensation for element ageing.

In many models the maximum output power setting depends on the supply voltage, see section 10.0.

4.5.3 Customer ID

A furnace or oven identification number can be entered if required. This maybe used to identify one of many units for production or quality control systems.

Press scroll 🔽 until the display shows ID <CUSTOMER ID>. Use the up ▲ and down ▼ keys to enter your own identification number. This can range from 1-9999.

4.5.4 Units

Press scroll 🔽 until the display shows UNITS <DISPLAY UNITS>. Use the up ▲ or down ▼ keys to select the required units.

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NONE</td>
<td>No units (Default °C)</td>
</tr>
<tr>
<td>°C</td>
<td>Celsius</td>
</tr>
<tr>
<td>°F</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>°K</td>
<td>Kelvin</td>
</tr>
<tr>
<td>PERC</td>
<td>% (shows °C value)</td>
</tr>
</tbody>
</table>

4.5.5 Language

The scrolling text on the 3216 can be shown in different languages, this can only be set at the factory and therefore must be specified at the time of placing an order.

4.6 Timer

4.6.1 Setting the Timer

A timer can be configured to operate in four different modes. These can be selected in level 2 (supervisor level) using the TM.CFG parameter as:-

- None
- Dwell Timer
• Delayed switch on timer
• Soft start timer

None

The timer is turned off, no timer configurations are available, the instrument works as a simple setpoint controller.

Press scroll \( \uparrow \) until the display shows TM.CFG <TIMER CONFIGURATION>. Using the up ▲ down ▼ select NONE.

4.6.2 Dwell Timer

A dwell timer is used to control a process at a fixed temperature for a defined period. At the end of the time period the controller will switch off the output power to the elements.

Press scroll \( \uparrow \) until the display shows TM.CFG <TIMER CONFIGURATION>. Using the up ▲ down ▼ select Dwell.

When Dwell parameter is selected, the Timer resolution (TM.RES), Time duration (DWELL) and Timer Threshold (THRES) functions become available.

Press scroll \( \uparrow \) until the display shows TM.RES < Time resolution >. Use the up ▲ down ▼ to select the timer units in Min or Hours.

Press scroll \( \uparrow \) until the display shows DWELL < SET TIME DURATION >. Use the up ▲ down ▼ to enter the time duration required.

Press scroll \( \uparrow \) until the display shows THres < TIMER THRESHOLD >. Use the up ▲ down ▼ to select the temperature threshold that you require the timer to start at.

The threshold value is ±n around the setpoint (n=threshold value).

Example: If the setpoint is set to 800 °C and the timer threshold is set to 2, after the timer is activated it will not start until the process value reaches 798 °C if ramping up or 802 °C if it is cooling.

Note: If the threshold is set to OFF, the timer will either; start to count down as soon as it is activated with the mode keys or if a ramp rate has been set (see section 4.5.1 ), the timer will start as soon as the ramp reaches the setpoint. (see section 4.7.1)

4.6.3 Delayed Switch On Timer

The delayed switch on timer is used to switch on the output power to the elements after a set time period.

Press scroll \( \uparrow \) until the display shows TM.CFG <TIMER CONFIGURATION>. Using the up ▲ down ▼ select dELY.

When delay parameter is selected, the Timer Resolution (TM.RES) and Time Duration (DWELL) functions become available.

Press scroll \( \uparrow \) until the display shows TM.RES < Time Resolution >. Use the up ▲ down ▼ to select the timer units in Min or Hours.
Press scroll ▲ until the display shows Dwell < Set Time Duration >. Use the up ▲ down ▼ to enter the time duration required before the output power switches on.

4.6.4 Soft Start Timer

The Soft Start Timer is used to start a process at a reduced setpoint and power. The Soft Start Setpoint is used as a threshold only and is not a control point.

Example: Main Setpoint = 800 °C

Max power limit = 75% (This may be set at the factory)

Soft Start Setpoint = 600 °C (Threshold)

Soft Start Power Limit = 50% (Cannot be set above max power Limit)

When the timer is running, the maximum power is controlled by the Soft Start Setpoint of 600 °C and the Soft Start Power limit of 50%. This will continue until the timer ends or the current temperature exceeds the Soft Start Setpoint.

When the timer ends or the current temperature exceeds the Soft Start Setpoint, the instrument will start to control using the main setpoint of 800 °C and the Max Power Limit of 75%.

Press scroll ▲ until the display shows TM_CFG < Timer Configuration >. Using the up ▲ down ▼ select SF.st.

When Soft Start parameter is selected, the Timer Resolution (TM.RES), Time Duration (DWELL), Soft Start Setpoint (SS.SP) and Soft Start Power Limit (SS.PWR) functions become available.

Press scroll ▲ until the display shows TM.RES < Time resolution >. Use the up ▲ down ▼ to select the timer units in minutes or hours.

Press scroll ▲ until the display shows DWELL < Set Time Duration >. Use the up ▲ down ▼ to enter the time duration required, before the instrument starts to control using the main setpoint and max power.

Press scroll ▲ until the display shows SS.SP < Soft Start Setpoint >. Use the up ▲ down ▼ to enter the Soft Start Setpoint.

Press scroll ▲ until the display shows SS.PWR < Soft Start Power Limit >. Use the up ▲ down ▼ to enter the Soft Start Power Limit.

4.7 Running a Timer

- **Run**: This starts the timer.
- **Hold**: This stops the timer at the elapsed time. It will start again from the elapsed time when Run is selected again.
- **Reset**: This sets the timer back to zero. It can be operated again from this state.
- **End**: cannot be set – it occurs automatically when the timer has counted down to zero.
- **Acknowledge** any timer after a timer has timed out using ACK function (see section 4.3.2) by pressing the ▲ and ▼ simultaneously.

### 4.7.1 Dwell Timer

<table>
<thead>
<tr>
<th>Operation</th>
<th>Action</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>To RUN Timer</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = ON Scrolling Display – Timer Running</td>
</tr>
<tr>
<td>To HOLD timer</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = Flashing Scrolling Display – Timer Hold</td>
</tr>
<tr>
<td>To switch off Timer / Cancel</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = OFF Scrolling Display – None Static Text - OFF</td>
</tr>
<tr>
<td>To return to home after reset</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = OFF Scrolling Text – Timer End Static Text - OFF</td>
</tr>
<tr>
<td></td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = OFF Scrolling Display – Timer Running</td>
</tr>
<tr>
<td></td>
<td>Press ▲ + ▼</td>
<td>Indicator – RUN = OFF Scrolling Display - None</td>
</tr>
<tr>
<td>To RESET timer and return to home menu after timer end</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = OFF Scrolling Display – A-M &lt;LOOP MODE- AUTO MANUAL OFF&gt; Use the up ▲ or down ▼ to select Auto</td>
</tr>
</tbody>
</table>

### 4.7.2 Power Failure While Using Dwell Timer

If there is a power failure while the timer is operating and the power is subsequently restored, the timer will reset and the static text will display “OFF” until the ▲ + ▼ keys are pressed to re-run the timer.
### 4.7.3 Running Dwell Timer with Ramp Rate

Set the ramp rate as outlined in section 4.5.1.

Set the dwell time as outlined in section 4.6.2.

When the timer is set to operate with a set ramp rate, the timer will not start to count down until the setpoint has been reached with the ramp, at which time the timer will begin time count down.

The scrolling display will indicate “timer running” and the run indicator will be illuminated while the ramp rate is active and during the timer count down, after which the display will indicate the instrument has switched off power to the elements (see section 4.7.7), and the run indicator will switch off.

### 4.7.4 Running Dwell Timer with Ramp Rate & Threshold

Set the ramp rate as outlined in section 4.5.1.

Set the dwell time as outlined in section 4.6.2.

Set the threshold as outlined in section 4.6.3.

When the timer is set to operate with a set ramp rate and threshold, the timer will not start to count down until the process temperature has reached the threshold value (see example 4.6.3).

The scrolling display will indicate “timer running” and the run indicator will be illuminated while the ramp rate is active, while the process value is reaching the threshold value and during the timer count down, after which the display will indicate the instrument has switched off power to the elements (see section 4.7.1).

### 4.7.5 Delayed Switch on Timer

<table>
<thead>
<tr>
<th>Operation</th>
<th>Action</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>To RUN Timer</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = ON&lt;br&gt;Scrolling Display – Timer Running&lt;br&gt;Static Text - OFF</td>
</tr>
<tr>
<td>To HOLD timer</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = Flashing&lt;br&gt;Scrolling Display – Timer Hold&lt;br&gt;Static Text - OFF</td>
</tr>
<tr>
<td>To switch off Timer / Cancel</td>
<td>Press and hold ▲ + ▼ for more than 1 second Indicator – RUN = Off</td>
<td>Scrolling Display – None&lt;br&gt;Static Text - OFF</td>
</tr>
<tr>
<td>To return to home menu. After Resetting timer</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = Off&lt;br&gt;Display – A-M &lt;LOOP MODE-AUTO MANUAL OFF&gt; Use the up ▲ or down ▼ to select Auto</td>
</tr>
</tbody>
</table>
### 4.7.6 Running Delay Timer with Ramp Rate

Set the ramp rate as outlined in section 4.5.1.
Set the delay time as outlined in section 4.6.3.

When ramp rate is active with a delay timer the run indicator serves two functions:
- Indicates timer is running
- Indicates ramp rate is active

This means that when the timer has timed out the run indicator will still be illuminated if the ramp rate is still active and will continue to be illuminated until the ramp reaches setpoint, at which time it will switch off.

A characteristic of these combinations of parameters is that the scrolling text will continue to indicate timer running when the timer has timed out. Checking whether the timer has timed out or not can be done with the 'T.REMN' function. (see section 4.7.12)

The delay timer with ramp rate will function as outlined in the table above with the addition of the functions in the following table.

### 4.7.7 Delay timer with ramp rate functions

<table>
<thead>
<tr>
<th>To HOLD timer</th>
<th>Timer Ended When ramp rate active</th>
<th>Indicator – RUN = ON - if ramp rate active</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Press and quickly release ▲ + ▼</td>
<td>Scrolling Display – Timer Hold</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static Text - OFF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To switch off Timer / Cancel</th>
<th>Timer Ended</th>
<th>Indicator – RUN = ON - if ramp rate active</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Scrolling Display – None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static Text - OFF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To re-RUN Timer</th>
<th>Timer Ended</th>
<th>Indicator – RUN = ON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Press and quickly release ▲ + ▼</td>
<td>Scrolling Display – Timer Running</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static Text – OFF</td>
</tr>
</tbody>
</table>
4.7.8 Power Failure While Using Delay Timer

If there is a power failure while the timer is operating and the power is subsequently restored, the timer will reset and will re-run from the power on time.

4.7.9 Soft start Timer

<table>
<thead>
<tr>
<th>Operation</th>
<th>Action</th>
<th>Indication</th>
</tr>
</thead>
</table>
| To RUN Timer            | Press and quickly release ▲ + ▼             | Indicator - RUN = ON
|                         |                                             | Scrolling Display - Timer Running        |
|                         |                                             | Static Text - OFF                        |
| To HOLD timer           | Press and quickly release ▲ + ▼             | Indicator - RUN = Flashing               |
|                         |                                             | Scrolling Display - Timer Hold           |
|                         |                                             | Static Text - OFF                        |
| To switch off Timer/    | Press and hold ▲ + ▼ for more than 1 second | Indicator - RUN = OFF                    |
| Cancel                  |                                             | Scrolling Display - None                 |
|                         |                                             | Static Text - OFF                        |
| Timer Ended             |                                             | Indicator - RUN = OFF                    |
|                         |                                             | Scrolling Text - Timer End               |
|                         |                                             | Running Soft Start Timer                 |

When the soft start timer is set to operate, the scrolling display will indicate "timer running" and the setpoint temperature, not the soft start setpoint.

4.7.10 Power Failure While Using Soft Start Timer

If there is a power failure while the timer is operating and the power is subsequently restored, the timer will reset and will re-run from the power on time.

4.7.11 Ramp Rate with Soft Start Timer

It is not recommended that the ramp rate function be used with a soft start timer.

Note: If the temperature is already above the threshold when the timer is set to operate, the timer will time out immediately.

4.7.12 Time Remaining

The time remaining of any 'Timer' mode can be checked at any time while a timer is active.

To view the time remaining, press scroll ▶ until the display shows T.REMN <TIME REMAINING>.

Note: The time remaining can be modified at any time while the count down timer is operating by pressing the up ▲ or down ▼ key while the time remaining function is active.
4.7.13 Alarms

Alarms are used to alert the operator when a pre-set level has been exceeded or a function error has occurred such as a sensor break. They are indicated by a scrolling message on the display and a flashing red ALM (Alarm) indicator. The alarm may also switch an output – usually a relay to allow external devices to be operated when an alarm occurs. Alarms only operate if they have been configured and are dependant on customer requirements.

How to acknowledge an alarm will depend on the type of latching which has been configured. A non-latched alarm will reset itself when the alarm condition is removed. A latched alarm requires acknowledgement with the “ACK” Function (see section 4.3.2) before it is reset.

If an alarm has been activated the red “ALM” indicator will illuminate and the scrolling text will indicate the type of alarm.

To Acknowledge an alarm and cancel the “ALM” indicator, press ACK function.

Note: The alarm indicator may seem to be permanently on when viewed from above. When an alarm is active the indicator should only be flashing, to confirm this, the controller must be viewed directly from the front.

4.8 Controller Options

As options can be ordered in a variety of combinations and for a variety of purposes, exact instructions are not given here. The full Eurotherm manual may be required to determine customer parameter settings. To reveal or hide parameters in the controllers it is necessary to go into configuration mode, a security code is needed. Please consult Carbolite Gero.

4.8.1 Digital Communications - RS232

If the RS232 option is supplied, the furnace is fitted with one sub-miniature D-socket connected to the controller comms module. RS232 is suitable for direct connection to a personal computer (PC) using a “straight through” cable as follows (the linked pins at the computer end are recommended but may not be necessary). The cable is usually 9-pin at the furnace end and 9-pin at the computer, but other alternatives are shown in parentheses.

<table>
<thead>
<tr>
<th>Product end of cable</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable</th>
<th>Computer end of cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>female (25-pin) 9-pin</td>
<td></td>
<td>9-pin (25-pin) male</td>
<td></td>
</tr>
<tr>
<td>Rx</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Tx</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Com</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Link together

4.0 3216CC Controller
4.8.2 Digital Communications - RS485
If an RS485 option is supplied, the furnace is fitted with two D-sockets. Connection between products is by “straight” cable as follows:

<table>
<thead>
<tr>
<th>Product end of cable female (25-pin) 9-pin</th>
<th>RS485 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) female</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>+</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Com</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

4.8.3 Comms Address
Typically the comms address is set to 1, but this can be changed. In the case of RS485 and multiple instruments it is necessary to set different addresses. To change the address value, access the level 2 list. In level 2 press the page key until the COMMS parameter is displayed. Press up ▲ down ▼ to select the address value.

4.8.4 Alarm Option
When an alarm board is fitted, which consists of a relay with voltage free contacts, for operator use, the contacts are taken to a panel plug on the control panel, wired as indicated:

The purpose of the 2 amp fuse is to break the circuit to prevent overloading on the circuit due to high voltage.

The instrument configuration and parameters available to the operator depend on the customer requirements.

Before handling the controller: wear an anti-static wrist strap or otherwise avoid any possibility of damage to the unit by static electricity. Refer to the detailed instructions supplied with the replacement controller.
Ease apart the two lugs at the side; grip the instrument and withdraw it from its sleeve; push in the replacement.

4.9 3216CC Navigation Diagram

Do not raise the power limit (if accessible) above the design level for the product.
5.0 Operation

5.1 Operating Cycle

This product is fitted with an instrument switch which cuts off power to the control circuit.

Connect the product to the electrical supply.

Turn on the instrument switch to activate the temperature controllers. The controllers illuminate and go through a short test cycle.

**Over-Temperature option only.** If the digital over-temperature option has not yet been set as required, set and activate it according to the over-temperature controller instructions.

Switch on the heater switch, located on the instrument panel. Unless a time switch is fitted and is switched off, the product will start to heat up. The Heat light(s) glow steadily at first and then flash as the product approaches the desired temperature or a program setpoint.

**Over-Temperature option only.** If the over-temperature circuit has tripped, an indicator on the over-temperature controller flashes and the heating elements are isolated. Find and correct the cause before resetting the over-temperature controller according to the instructions supplied.

To switch off power to the heating elements, use the heater switch. To switch the product off, use both the heater switch and the instrument switch. If the product is to be left switched off and unattended, isolate it from the electrical supply.

5.2 Control Method

Set the three temperature controllers to the desired setpoints. The setting and operation of the end zone controllers depends on the 3-zone control options selected when the product was ordered. These options are described in the 3-zone control methods section.

**Note:** Despite its vertical orientation, the heated zones of the KVZ model are labelled to correspond with the relevant control module on the CC-T1 touchscreen controller display (Left, Main, Right).

5.3 Safe Operation of the Furnace

For the safe operation of this furnace the following warnings must be followed:
Explosive Materials
The furnace must not be used to heat materials which could explode, or which could emit gases that could form explosive mixtures. If the safe heating of a material is dependent on its temperature, only heat these type of materials if the furnace has the optional over-temperature protection device fitted. Ensure that the over-temperature device is calibrated and set to an over-temperature safety limit that is sufficiently large as to avoid any hazards. If in doubt, seek expert advice before proceeding. Customers are responsible for carrying out their own risk assessments on the heating of materials.

Do not operate without a work tube. The furnace must not be operated without the correctly sized work tube and correspond work tube adaptor. Otherwise, an operator can access electrically live element coils that could cause serious injury of death.

Switch off the furnace before loading and unloading. The furnace elements must be switched off using the heater switch, item 2 in "Warning Labels", when the furnace is being loaded or unloaded. The work tube can become electrically conductive at high temperatures. If an element has failed and collapsed onto the work tube, the work tube will become live causing serious injury or death.

5.4 3-Zone Control Methods
There are three different control options (A, B & C).
(A) Back to back thermocouples
(B) Retransmission of Setpoint
(C) Independent control
The models listed in this manual are designed to achieve an extended uniform temperature zone, through use of three control zones, rather than achieving different temperatures in each zone.
For A & B, the control zones are linked so that they all follow the centre zone controller in a master-slave approach

Note:
- Option A is NOT applicable when using the CC-T1 controller
- Option B is NOT applicable when using the Eurotherm 2132 End Zone Controller

A. Back-to-Back Thermocouples
This is the most commonly supplied option. The centre zone of the tube furnace is controlled directly by the centre zone temperature controller. The two end zone
thermocouples are wired in opposition to the centre zone reference thermocouple. If the temperatures of the centre and end zones are the same then 0°C will be displayed on the end zone controllers. If the end zone temperatures are either higher or lower than the centre zone, the end zone controller will display the difference in temperature (higher = positive value, lower = negative value).

It is best practice to set the setpoint of the two end zone controllers to zero. Alternatively, a small temperature difference (offset) can be created by setting a non-zero value, for example to compensate for heat losses at the end or where using a gas flow. However, the sum of the centre zone controller setpoint and the end zone controller offset MUST NOT exceed the furnace maximum temperature.

To alter the setpoint with the display showing the Home screen, press Down ▼ or Up ▲ once to display the setpoint and then press again or hold down to adjust it. The display returns to the measured temperature when no key is pressed for a short period of time.

Sometimes a furnace using this type of control does not cool down because the end zones lose heat first and therefore the end zone controllers try to compensate for this by switching on the end zone elements, preventing the furnace from cooling.

B. Retransmission of Setpoint

Three independent thermocouples are connected to three controllers. The three controllers are linked together and the centre zone controller communicates the desired setpoint to the end zone controllers. If the centre zone controller is set to a setpoint or is running a program, the end zone controllers will automatically follow.

For products with the CC-T1 controller, please refer to the separate CC-T1 controller manual for details on enabling and disabling setpoint retransmission.

For other products, additional communication modules are fitted in the controllers. The communication between the controllers of the Eurotherm 3000 series is known as Broadcast communications. It is possible to switch off the linked control and allow the controllers to work independently. In the level 2 menu of the end zone controllers (see controller operating instruction), scroll to L-r. Where the end zone controller is a 3216 use the ▲ up ▼ down buttons and select NO. Where the end zone controller is a 3508 use the ▲ up ▼ down buttons to select SP1, (SP1 = Local, and SP2 = Remote). There is no need to alter the centre zone controller.

It is possible to set an offset (local trim) between the centre and end zone controllers. This can be either a positive or negative difference from the centre zone temperature. Once entered, this offset will always be added to, or subtracted from, the retransmitted setpoint temperature.

For products with the CC-T1 controller, please refer to the separate CC-T1 controller manual for details on how to set an offset trim.
To make this adjustment on other controllers, enter the level 2 menu of the end zone controllers (see controller operating instruction), scroll to LOC.T (local trim) and use the ▲ up ▼ down buttons to enter the desired positive or negative value. This will then be added to, or subtract from, the end zone set temperature. There is no need to alter the centre zone controller.

**C. Independent Control**

The three controllers are completely independent. Note that it is not possible to maintain very different temperatures in the three zones because of heat transfer between the zones. The models listed in this manual are designed to achieve an extended uniform temperature zone by the use of three control zones rather than achieving different temperatures in each zone.

### 5.5 General Operating Advice

Heating element life is shortened by overheating. Do not leave the product at high temperature when it is not required. The maximum temperature is shown on the product rating label and in section 11.0 towards the back of this manual.

Lightweight ceramic fibre insulation can easily be marked by accidental contact. Some fine cracks may develop in the surface of the insulation due to the progressive shrinkage of the insulation materials. Cracks are not usually detrimental to the functioning or the safety of the product.

Clean up any spillages in the insulation, as these can increase the rate of degradation of the insulation material.

### 5.6 Operator Safety

The ceramic materials used in the product manufacture become electrically conductive to some extent at high temperatures. **DO NOT** use any conductive tools within the product without isolating it. If a metal work tube is used, it must be earthed (grounded).

Switch off the heater switch whenever loading or unloading the product. The elements are isolated when the heater switch is OFF. This switch cuts both sides of the circuit via a contactor.
5.7 Tube Life

A ceramic work tube may crack if work pieces are inserted too quickly or at temperatures below 900 °C (when the tube is more brittle). Large work pieces should also be heated slowly to ensure that large temperature differences do not arise.

Poor thermal contact should be encouraged between the work piece and the tube; crucibles or boats should be of low thermal mass and should have feet to reduce the contact with the tube (fig. 4).

![Key](image)

<table>
<thead>
<tr>
<th>A</th>
<th>Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Crucible</td>
</tr>
</tbody>
</table>

*Fig 4 - Avoidance of thermal contact*

Do not set too high a heating or cooling rate. As tubes are susceptible to thermal shock and may break. Tubes which extend beyond the heated part of the furnace are more at risk. A general rule for maximum heating or cooling rate is 400 ÷ internal diameter in mm to give (°C/ min); for 75 mm i/ d tubes this comes to 5 °C per minute. The controller can be set to limit both the heating and cooling rate.

5.8 Pressure

Work tubes are not able to accept high internal pressure. When gas seals or similar fittings are in use, the gas pressure should be restricted to a maximum of 0.2 bar (3 psi). A pressure of approximately half of that should normally be sufficient to achieve the desired flow rate. The operator must ensure that the exhaust path from the tube is not blocked, so that excess pressure does not occur.

A suitably regulated gas supply should always be used.

It is recommended that a pressure relief system should be used to avoid an over pressurisation of the work tube.

Please note: A product should not be heated up if any valves that have been fitted are closed to create a sealed volume. A sealed work tube should not be heated from cold due to the pressure increase caused by the trapped air or gas expanding during the heating process.

5.9 Gas Tightness

Work tubes of IAP material are impervious. Sillimanite may look similar but is porous. Ensure that the correct tube material is in use before connecting and using gases other
than inert gases, such as nitrogen.
6.0 Maintenance

6.1 General Maintenance

Preventive rather than reactive maintenance is recommended. The type and frequency depends on the product use; the following are recommended.

6.2 Maintenance Schedule

CUSTOMER QUALIFIED PERSONNEL

DANGER! ELECTRIC SHOCK. Risk of fatal injury. Only electrically qualified personnel should attempt these maintenance procedures.

<table>
<thead>
<tr>
<th>Maintenance Procedure</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daily</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit (if fitted)</td>
<td>Set an over-temperature setpoint lower than the displayed temperature and check for an over-temperature alarm as detailed in this manual</td>
<td></td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit (if fitted)</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td>Safety Switch Function (split models only)</td>
<td>Set a safe temperature above ambient, and open the furnace to see if the heater light goes out</td>
<td></td>
</tr>
<tr>
<td>Safety Switch Function (split models only)</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td>Electrical Safety (external)</td>
<td>Visual check of external cables and plugs</td>
<td></td>
</tr>
<tr>
<td>Electrical Safety (internal)</td>
<td>Physically check all connections and cleaning of the power plate area</td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Calibration</td>
<td>Tested using certified equipment, frequency dependent on the standard required</td>
<td></td>
</tr>
<tr>
<td>Operational Check</td>
<td>Check that all functions are working normally</td>
<td></td>
</tr>
<tr>
<td>Operational Check</td>
<td>Thorough inspection and report incorporating a test of all functions</td>
<td></td>
</tr>
<tr>
<td>Work Tube Position</td>
<td>Visually check that the tube is central to the heated zone (horizontally / vertically)</td>
<td></td>
</tr>
<tr>
<td>End Plugs / Radiation Shields</td>
<td>Visual check for damage or wear, and cor-</td>
<td></td>
</tr>
</tbody>
</table>
### 6.0 Maintenance

<table>
<thead>
<tr>
<th>Rect Positioning</th>
<th>Seals (if fitted)</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Check all seals and O-rings and clamps</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Element Circuit</th>
<th>Electrical measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Consumption</td>
<td>Measure the current drawn on each phase / circuit</td>
</tr>
<tr>
<td>Cooling Fans (if fitted)</td>
<td>Check whether the cooling fans are working</td>
</tr>
</tbody>
</table>
6.0 Maintenance

6.2.1 Cleaning
Soot deposits may form inside the furnace, depending on the process. At appropriate intervals remove these by heating as indicated in the General Operation Notes.

The product's outer surface may be cleaned with a damp cloth. Do not allow water to enter the interior of the case or chamber. Do not clean with organic solvents.

6.3 Calibration
After prolonged use, the controller and/or thermocouple may require recalibration. This is important for processes that require accurate temperature readings or for those that use the product close to its maximum temperature. A quick check using an independent thermocouple and temperature indicator should be made from time to time to determine whether full calibration is required. Carbolite Gero can supply these items.
Depending on the controller fitted, the controller instructions may contain calibration instructions.

6.4 After-Sales Service
Carbolite Gero Service has a team of Service Engineers who can offer repair, calibration and preventive maintenance of furnace and oven products both at the Carbolite Gero factory and at customers’ premises throughout the world. A telephone call or email often enables a fault to be diagnosed and the necessary parts to be despatched.
In all correspondence please quote the serial number and model type given on the rating label of the product. The serial number and model type are also given on the back of this manual when supplied with the product.
Carbolite Gero Service and Carbolite Gero contact information can be found on the back page of this manual.

6.5 Recommended Spare Parts and Spare Parts Kit
Carbolite Gero can supply individual spare parts or a kit of the items most likely to be required. Ordering a kit in advance can save time in the event of a breakdown.
Each kit consists of two thermocouples of different lengths, one solid state relay and one complete tube body element set. When ordering spare parts please quote the model details i.e. model type and serial number as stated on the rating label.
7.0 Repairs and Replacements

7.1 Safety Warning - Disconnection from Power Supply

Immediately switch the product off in the event of unforeseen circumstances (e.g. large amount of smoke). Allow the product to return to room temperature before inspection.

Always ensure that the product is disconnected from the electrical supply before repair work is carried out.

Caution: Double pole/neutral fusing may be used in this product.

7.2 Safety Warning - Refractory Fibre Insulation

Insulation made from High Temperature Insulation Wool
Refractory Ceramic Fibre, better known as (Alumina silicate wool - ASW).

This product contains **alumino silicate wool** products in its thermal insulation. These materials may be in the form of blanket or felt, formed board or shapes, slab or loose fill wool.

Typical use does not result in any significant level of airborne dust from these materials, but much higher levels may be encountered during maintenance or repair.

Whilst there is no evidence of any long term health hazards, it is strongly recommended that safety precautions are taken whenever the materials are handled.

**Exposure to fibre dust may cause respiratory disease.**

When handling the material, always use approved respiratory protection equipment (RPE-e.g. FFP3), eye protection, gloves and long sleeved clothing.

Avoid breaking up waste material. Dispose of waste in sealed containers.

After handling, rinse exposed skin with water before washing gently with soap (not detergent). Wash work clothing separately.

Before commencing any major repairs it is recommended to make reference to the European Association representing the High Temperature Insulation Wool industry (www.ecfia.eu).

Further information can be provided on request. Alternatively, Carbolite Gero Service can quote for any repairs to be carried out either on site or at the Carbolite Gero factory.

7.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
7.4 Solid-state Relay Replacement

Disconnect the product from the power supply and remove the appropriate cover as given above.

Make a note of the wire connections to the solid state relay and disconnect them.
Remove the solid state relay from the base panel or aluminium plate.
Replace and reconnect the solid state relay ensuring that the bottom of it has good thermal contact with the base panel or aluminium plate.
Replace the access panel.

7.5 Thermocouple Replacement

For vertical models it may be necessary to dismount the furnace from its stand and remove the terminal cover.

Disconnect the product from the power supply. Remove terminal cover to gain access to the thermocouple connections. Make a note of the thermocouple connections.

Thermocouple cable colour codings are:

<table>
<thead>
<tr>
<th>thermocouple leg</th>
<th>colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>positive (type N)</td>
<td>pink</td>
</tr>
<tr>
<td>negative</td>
<td>white</td>
</tr>
</tbody>
</table>

Disconnect the thermocouple from its terminal block.
Carefully withdraw the thermocouple from the product and remove any broken bits of thermocouple.
Bend the new thermocouple carefully to match the shape of the original (working from the terminal end). Should the length differ from that of the original this is usually not important provided that the thermocouple tip is within a work tube diameter's distance from the furnace centre.
Insert the new thermocouple into position, restoring any removed porcelain spacers and ensuring correct polarity.
Re-assemble the furnace.

7.6 Element Replacement

Individual elements are not available for this model of product, if an element fails then a complete element assembly is required. For details and fitting instructions contact Carbolite Gero Service, see the back page of this manual for contact information.
7.7 Fuse Replacement

Fuses are marked on the wiring diagram with type codes, e.g. F1, F2. For more information on fuses refer to section 10.0. *Depending on model and voltage, the different fuse types may or may not be fitted.*

If any fuse has failed, it is advisable for an electrician to check the internal circuits. Replace any failed fuses with the correct type. For safety reasons do not fit larger capacity fuses without first consulting Carbolite Gero.

The fuses are located at the cable entry point. Remove the back panel or control box back panel to gain access to the fuses.
## 8.0 Fault Analysis

### A. Furnace Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The HEAT light is ON</td>
<td>The heating element has failed</td>
</tr>
<tr>
<td>2.</td>
<td>The HEAT light is OFF</td>
<td>The controller shows a very high temperature or code such as S.br</td>
</tr>
<tr>
<td></td>
<td>The controller shows a low temperature</td>
<td></td>
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<tr>
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</tr>
</tbody>
</table>
## B. Product Overheats

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Product only heats up when the instrument switch is ON</strong></td>
<td><strong>The controller shows a very high temperature</strong></td>
</tr>
<tr>
<td></td>
<td><strong>The controller shows a low temperature</strong></td>
<td><strong>The thermocouple may be faulty or may have been removed out of the heating chamber</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>The thermocouple may be connected the wrong way around</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>The controller may be faulty</strong></td>
</tr>
<tr>
<td>2.</td>
<td><strong>Product heats up when the instrument switch is OFF</strong></td>
<td><strong>The SSR has failed &quot;ON&quot;</strong></td>
</tr>
</tbody>
</table>
9.0 Wiring Diagrams

9.1 WC-13-30

Connections below show single phase with indirect safety switches and over-temperature control.

9.2 WC-13-31

Connections below show single phase with indirect safety switches and over-temperature control.
**10.0 Fuses and Power Settings**

**10.1 Fuses**

F1 - F2: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th></th>
<th>Internal Supply Fuses</th>
<th>Fitted if supply cable fitted. Fitted on board to some types of EMC filter.</th>
<th>GEC Safeclip of the type shown (glass type F up to 16 A) 38 mm x 10 mm type F fitted on EMC filter circuit board(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td>Auxiliary Circuit Fuses</td>
<td>Fitted on board to some types of EMC filter. May be omitted up to 25 Amp/phase supply rating.</td>
<td>2 Amps glass type F  On board: 20 mm x 5 mm  Other: 32 mm x 6 mm</td>
</tr>
<tr>
<td></td>
<td>Customer Fuses</td>
<td>Required if no supply cable fitted. Recommended if cable fitted.</td>
<td>See rating label for current; See table below for fuse rating.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHC 12/450B</td>
<td>1-phase</td>
<td>200-208</td>
<td>10 A</td>
</tr>
<tr>
<td>EHC 12/450B</td>
<td>1-phase</td>
<td>220-240</td>
<td>10 A</td>
</tr>
</tbody>
</table>
10.2 Power Settings

The power limit settings (OP.Hi) for this model is as follows. The figures represent the maximum percentage of time that controlled power is supplied to the elements. Do not attempt to "improve performance" by setting a value higher than the one from the table. To adjust the parameter refer to the "Changing the Maximum Output Power" of the control section of the manual.

All standard models covered by this manual are fitted with elements designed for use over the range of voltages 100 V-120 V and 200 V-240 V; the power limit parameter is set according to the table below.

The power limit depends on the voltages follows:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>100 V</th>
<th>120 V</th>
<th>200 V</th>
<th>208 V</th>
<th>220 V</th>
<th>230 V</th>
<th>240 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage (%)</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>100</td>
<td>89</td>
<td>81</td>
<td>75</td>
</tr>
</tbody>
</table>

Please refer to the rating label for product specific information.
11.0 Specifications

Carbolite Gero reserves the right to change the specification without notice.

All models have cylindrical elements with wire mounted in the surface of the insulation material.

All models can accept work tubes up to a maximum outside diameter of 60 mm.

All models have a maximum operation temperature of 1200°C (1100°C continuous).

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>Minimum Work Tube Length (mm)</th>
<th>Tube length for use with modified atmosphere (mm)</th>
<th>Heated Length (mm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHC 12/450B</td>
<td>1200</td>
<td>2.0</td>
<td>600</td>
<td>900</td>
<td>450</td>
<td>20</td>
</tr>
</tbody>
</table>

Horizontal 3-zone tube furnaces.

Work tube adaptors, extended work tube supports, insulation plugs and gas/vacuum end seals are available from Carbolite Gero for work tubes with outside diameters of 32 mm, 46 mm and 60 mm.

11.1 Environment

The furnaces contain electrical parts and should be stored and used in indoor conditions as follows:

**Ambient temperature working range**

Temperature: 5 °C to 40 °C

Note: when operating the furnace at temperatures close to the maximum and the ambient temperature is above 30 °C, the allowed external temperature defined in EN 61010-1:2010 may be exceeded.

**Relative humidity**

Maximum 80% up to 31 °C, decreasing linearly to 50% at 40 °C.

**Important safety notice:**

After transportation or storage in humid conditions, the furnace could fail to meet all the safety requirements of BSEN 61010-2-010 until it has completed the drying out process to restore its normal condition.

**Warning:**

It cannot be assumed that the furnace will meet all the safety requirements of BSEN 61010-2-010 during the drying out process.
Furnace drying out process

Step 1. Before the furnace is connected to the electrical supply, remove the back panel and check for signs of moisture on the electrical circuits. If visible signs of moisture are present then allow it to dry out in ambient temperature for at least 24 hours. If the problem persists ensure that the furnace is isolated and contact Carbolite Gero Service for more information.

Step 2. Complete the Installation procedure (see section 2.1)

Step 3. After reading the controller operation instructions, heat the furnace following the temperature profile given below. This will need to be done manually on furnaces with basic control option or programmed into the controller if an advanced control option is fitted:

- Ramp the setpoint temperature @ 2 °C/ minute to 100 °C and dwell for 2 hours.
- Ramp the setpoint temperature @ 2 °C/ minute to 300 °C and dwell for 3 hours.
- Ramp the setpoint temperature @ 3 °C/ minute to 1100 °C and dwell for 1 hour.
- Cool naturally to ambient temperature.
- Furnace drying out process is complete.
<table>
<thead>
<tr>
<th>Engineer Name</th>
<th>Date</th>
<th>Record of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>
The products covered in this manual are only a small part of the wide range of ovens, chamber furnaces and tube furnaces manufactured by Carbolite Gero for laboratory and industrial use. For further details of our standard or custom built products please contact us at the address below, or ask your nearest stockist.

For preventive maintenance, repair and calibration of all furnace and oven products, please contact:

**Carbolite Gero Service**

Telephone: + 44 (0) 1433 624242  
Fax: +44 (0) 1433 624243  
Email: ServiceUK@carbolite-gero.com