Installation, Operation and Maintenance Instructions
1200°C Split Tube Furnace - HST Model: 450mm
2416 Controller

HST 12/450 + 2416 Controller
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.
Caution – Double Pole/Neutral Fusing
2.0 Installation

2.1 Unpacking and Handling

When unpacking or moving the product always lift it by its base or by both ends of the main body. Never lift it by its work tube or the surrounding insulation. Use two or more people to carry the product and control box. Remove any packing material from inside the product before use.

If an optional or special stand is separately supplied, assemble the product on to it. Some models may be supplied for customer mounting and may require customer preparation of mounting components before installation.

![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 and Setting Up

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.
Ensure that the product is placed in such a way that it can be quickly switched off or disconnected from the electrical supply.

If the product is supplied with a work tube or any accessories fit these into position.

For optimum temperature uniformity, insulating plugs should be placed in the tube ends as shown in fig.1. With a long work tube, the stem of the plug assembly should line up with the end of the tube as in fig.2. Alignment of radiation shields is similar to that of plugs.

If stainless steel seals with gas inlets are supplied, they are to be fitted as shown in fig.3; the stem of any insulating plug should touch the seal.

For vertical models with stainless steel seals, a hook and eye arrangement holds the upper insulating plug assembly.

Horizontal models: if heavy fittings are to be clamped to the end of an extended work tube they can increase the bending stress at the centre of the tube. Support such fittings in such a way that expansion of the tube is allowed.

If a metal work tube is being used in the product, ensure that it is earthed for operator safety.
2.0 Installation

Fig 1 - Insulating Plug (standard length tube)

Fig 2 - Insulating Plug (long work tube)

Key

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Tube</td>
</tr>
<tr>
<td>B</td>
<td>Insulating Plug</td>
</tr>
<tr>
<td>C</td>
<td>Stem</td>
</tr>
</tbody>
</table>
2.0 Installation

Fig 3 'Twin Clamp' End Seal

For assembly details refer to the separate work tube end seal manual.

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.

2.3 Electrical Connections

Connection by a qualified electrician is recommended.
2.0 Installation

The product covered by this manual normally requires a single phase A.C. supply, which may be Live to Neutral non-reversible, Live to Neutral reversible or Live to Live. Some models may be ordered for 3-phase use, which may be star or delta.

Check the product rating label before connection. The supply voltage should agree with the voltage on the label and the supply capacity should be sufficient for the current on the label.

The supply should be fused at the next size equal to, or higher than the current on the label. A table of the most common fuse ratings is also given towards the back of this manual. When the mains cable is factory fitted, internal fuses are also fitted. It is essential that the operator ensures that the product is correctly fused.

Products with a factory fitted supply cable are designed to be wired directly to an isolator or fitted with a line plug.

Products without a factory fitted supply cable require a permanent connection to a fused and isolated supply. The product's electrical access panel should be temporarily removed, and connections made to the internal terminals.

If the product is to be connected by line plug. The plug should be within reach of the operator and should be easy to remove.

When connecting the product to an isolating switch ensure that both conductors (single phase) or on all live conductors (three phase), and should be within reach of the operator.

The supply MUST incorporate an earth (ground).

Electrical Connection Details:

<table>
<thead>
<tr>
<th>Supply</th>
<th>Terminal Label</th>
<th>Cable Colour</th>
<th>Supply Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Live - Neutral</td>
<td>Reversible or Live-Live</td>
</tr>
<tr>
<td>1-phase</td>
<td>L</td>
<td>Brown</td>
<td>to live to either power conductor (For USA 200-240V, connect L1)</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Blue</td>
<td>to neutral to the other power conductor (For USA 200-240V, connect L2)</td>
</tr>
<tr>
<td></td>
<td>PE</td>
<td>Green/ Yellow</td>
<td>to earth (ground) to earth (ground)</td>
</tr>
</tbody>
</table>
### 3-phase Connections

<table>
<thead>
<tr>
<th>3-phase</th>
<th>L1</th>
<th>Color</th>
<th>To Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black</td>
<td>to phase 1</td>
<td></td>
</tr>
<tr>
<td>L2</td>
<td>Black</td>
<td>to phase 2</td>
<td></td>
</tr>
<tr>
<td>L3</td>
<td>Black</td>
<td>to phase 3</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Light Blue</td>
<td>to neutral <em>(except delta)</em></td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td>Green/ Yellow</td>
<td>to earth <em>(ground)</em></td>
<td></td>
</tr>
</tbody>
</table>

---

**WARNING**

DO NOT connect a product ordered for three phase use to a single phase supply or to the wrong type of three phase supply.
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.
3.0 301 Controller

HM
Home Menu
Page Key
Black = Progress

SM
Setup Menu
Hold for 1.5 seconds
White = Return

OTHM
Over-Temperature Home Menu
Keep Held

OTSM
Over-Temperature Setup Menu
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>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HOLD</strong></td>
<td>Used to pause the current program and set new parameters.</td>
</tr>
<tr>
<td><strong>SP°C</strong></td>
<td>Used to set the desired temperature (setpoint) of the product (°C).</td>
</tr>
<tr>
<td><strong>SPrr</strong></td>
<td>Used to set the heating rate of the product, e.g. increase by 5°C per minute.</td>
</tr>
<tr>
<td><strong>t1, t2, t3, t4, t5</strong></td>
<td>Indicates the timer type in use. See section 3.5 for more details.</td>
</tr>
<tr>
<td><strong>tTyp</strong></td>
<td>Used to set the timer type.</td>
</tr>
<tr>
<td><strong>t.bnd</strong></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><strong>rSt</strong></td>
<td>Used to reset the timer.</td>
</tr>
<tr>
<td><strong>OPHt</strong></td>
<td>Used to set the maximum output power.</td>
</tr>
<tr>
<td><strong>CLSt</strong></td>
<td>Used to set the customer calibration type.</td>
</tr>
<tr>
<td><strong>FAct</strong></td>
<td>Used to select the factory calibration settings.</td>
</tr>
<tr>
<td><strong>PASS</strong></td>
<td>Flashes when a password is required to access further options.</td>
</tr>
<tr>
<td><strong>CCL1</strong></td>
<td>Select to access the single point calibration option.</td>
</tr>
<tr>
<td><strong>CCL2</strong></td>
<td>Select to access the dual point calibration options.</td>
</tr>
<tr>
<td><strong>OFSt</strong></td>
<td>Used to set the single point calibration offset temperature (°C).</td>
</tr>
<tr>
<td><strong>CAL L</strong></td>
<td>Used to set the low temperature point (°C) for dual point calibration.</td>
</tr>
<tr>
<td><strong>CAL H</strong></td>
<td>Used to set the high temperature point (°C) for dual point calibration.</td>
</tr>
<tr>
<td><strong>OFSl</strong></td>
<td>Used to set the offset value for the low temperature point (°C) for dual point calibration.</td>
</tr>
<tr>
<td><strong>OFSh</strong></td>
<td>Used to set the offset value for the high temperature point (°C) for dual point calibration.</td>
</tr>
<tr>
<td><strong>Ot</strong></td>
<td>Used to set the Over-Temperature limit (°C).</td>
</tr>
<tr>
<td><strong>Ott</strong></td>
<td>Displayed when the Over-Temperature protection has been activated.</td>
</tr>
<tr>
<td><strong>PV</strong></td>
<td>Displayed before the current temperature when checking the Over-Temperature sensor temperature.</td>
</tr>
</tbody>
</table>
3.0  301 Controller

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.
3.2.6 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 $SP^\circ C$ 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 $SP_{rr}$ 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°C per minute (300°C per hour), to prevent damage.
3.0 301 Controller

3.2.9  Changing the Timer Time

- Start at the Home Display.
- Repeatedly press the Page key to scroll through the Home Menu until \( t \), \( t^2 \), \( t^3 \), \( t^4 \) or \( t^5 \) 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 \( t \, \text{typ} \) 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 \( \text{t.bnd} \) 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 \( \text{OP.Hi} \) 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 $t_1$ 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 $E$ $t_1$ 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.
- \textit{rST} 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:

\textbf{Timer Type \textit{t1}}

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 ('\textit{End}' flashes on the display).

\textbf{Timer Type \textit{t2}}

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 ('\textit{End}' flashes on the display).

\textbf{Timer Type \textit{t3}}

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.

\textbf{Timer Type \textit{t4}}

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 ('\textit{End}' flashes on the display).
Timer Type 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 t1 or t4 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.
### 3.0 301 Controller

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><strong>t1</strong></td>
<td>Heating</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Timer</td>
<td>Starts when setpoint reached</td>
<td></td>
<td>Counts Down</td>
</tr>
<tr>
<td>Display</td>
<td>Flashes t1 3 times. Shows Time remaining.</td>
<td>Current Temperature</td>
<td>Cycling Current Temperature/ End</td>
</tr>
<tr>
<td>Timer Indicator</td>
<td>Flashing until setpoint reached</td>
<td></td>
<td>ON</td>
</tr>
<tr>
<td><strong>t2</strong></td>
<td>Heating</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Timer</td>
<td>Start Immediately</td>
<td></td>
<td>Counts Down</td>
</tr>
<tr>
<td>Display</td>
<td>Flashes t2 3 times Shows Time remaining.</td>
<td>Current Temperature</td>
<td>Cycling Current Temperature/ End</td>
</tr>
<tr>
<td>Timer Indicator</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td><strong>t3</strong></td>
<td>Output</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Timer</td>
<td>Starts Immediately</td>
<td></td>
<td>Counts Down</td>
</tr>
<tr>
<td>Display</td>
<td>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>Indicator</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td><strong>t4</strong></td>
<td>Heating</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Timer</td>
<td>Starts when setpoint reached</td>
<td></td>
<td>Counts Down</td>
</tr>
<tr>
<td>Display</td>
<td>Flashes t4 3 times Shows time remaining</td>
<td>Current Temperature</td>
<td>Cycling Current Temperature/ End</td>
</tr>
<tr>
<td>Timer Indicator</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td><strong>t5</strong></td>
<td>Heating</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Timer</td>
<td>Starts Immediately</td>
<td></td>
<td>Counts Down</td>
</tr>
<tr>
<td>Display</td>
<td>Flashes t 3 times Shows Time remaining</td>
<td>Current Temperature</td>
<td>Cycling Current Temperature/ End</td>
</tr>
<tr>
<td>Timer Indicator</td>
<td>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.

![Diagram of Ramp Dwell program](image)

### 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 **HOLD** to show that 'Hold' mode has been entered.
Set the Timer Type to \texttt{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 \texttt{t\_typ} shows on the display.
- Use the up and down Arrow keys to set the value to \texttt{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 \texttt{SP\_C} shows on the display.
- Use the up and down Arrow keys to alter the value (°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 \texttt{SP\_rr} shows on the display.
- Use the up and down Arrow keys to alter the value (°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.

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 - \( \text{Fact} \)

Factory calibration is the default setting, which has no offset adjustment. It simply displays the temperature measured by the control thermocouple.
3.0 301 Controller

3.8.2 Single Point Calibration - \( CCL \)

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 than the calibration offset.

Table showing examples of how to determine offset values:

<table>
<thead>
<tr>
<th>Measured Calibration Temp (°C)</th>
<th>Displayed Temp (°C)</th>
<th>Old Offset Value (°C)</th>
<th>New Offset Adjustment</th>
<th>New Offset Value (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>252</td>
<td>250</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>248</td>
<td>250</td>
<td>0</td>
<td>-2</td>
<td>-2</td>
</tr>
<tr>
<td>252</td>
<td>250</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

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 - \( DFSE \)

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

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

3.8.4 Dual Point Calibration - \( CCL2 \)

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.
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 **CLSE** is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access **CLL2**, 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 **CLL2**.
- 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 **CLL2** 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 **CLL2**) 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 **CLSE** is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access **CLL2**, 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 **CLL2**.
- 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 - **CALH**

- 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 **CLL2**, 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 **CLL2**.
- Press the Page key three times to access **CALH**.
- 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 - OF5H

- 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 CCL2, 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 CCL2.
- Press the Page key four times to access OF5H.
- 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 $\Delta T$ 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 ($T_{PU}$) 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 CL.5E 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 ØE E 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 ØFE is displayed.
- Repeatedly press the Page key until ØE 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</th>
<th>= 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Main)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Modbus Address</th>
<th>= 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(O/Temp)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Baud Rate</th>
<th>= 9600</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Byte Format</th>
<th>= 8</th>
</tr>
</thead>
</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</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>female 9-pin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rx</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Tx</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Com</td>
<td>5</td>
<td>5</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 2132 Over-Temperature Controller Description (if fitted)

4.1 Description

This over-temperature controller is fitted and supplied ready to use by Carbolite Gero. It is a digital instrument with a latching alarm, requiring no additional panel controls. The controller features easy setting of over-temperature setpoint and reading of current temperature by the over-temperature sensor.

4.2 Operation

4.2.1 Controls

Most Carbolite Gero products are fitted with an instrument switch which cuts off power to the controller and other parts of the control circuit.

To operate the controller, power must be supplied to the product and the instrument switch must be on. If a time switch is included in the product circuit, this must be in the 'ON' position.

When an over-temperature condition occurs, the controller cuts the power to a contactor, which in turn cuts power to the heating elements. Power is not restored until the controller is 'reset'.

Some components will operate after the over-temperature feature isolates the power supply e.g. cooling fans will continue to operate, provided that there is a power supply to the product. In some cases the product may not do so, if other options (such as a door switch) are fitted.
4.2.2 Operation

When switched on, the controller lights up, goes through a short test routine and then displays the measured temperature or the over-temperature setpoint.

The page key allows access to parameter lists within the controller.

A single press of the page key displays the temperature units, normally set to °C; further presses reveal the lists indicated in the navigation diagram.

The scroll key allows access to the parameters within a list. Some parameters are display-only; others may be altered by the operator.

A single press of the scroll key in the 'Home' list displays the temperature units; further presses reveal the parameters in the current list indicated in the navigation diagram.

To return to the 'Home' list at any time, press page and scroll together, or wait for 45 seconds.

The down and up keys are used to alter the setpoint or other parameter values.

4.2.3 Over-Temperature Operation

Use down and up to alter the over-temperature setpoint. This should normally be set a little above the working temperature (for example 15 °C above). The product is supplied with the over-temperature set at 15 °C above the furnace or oven maximum working temperature.

Press scroll twice view the present temperature as measured by the over-temperature controller. Press it twice, the first press shows the temperature units (°C).

4.2.4 Over-Temperature Alarm

If an over-temperature condition occurs, the OP2 indicator flashes and an alarm message 2FSH also flashes, alternating with the setpoint. Power to the heating elements is disconnected.

4.2.5 Resetting the Over-Temperature Alarm

To acknowledge the alarm press scroll and page together.

If the alarm is acknowledged while there is still an over-temperature condition, the OP2 indicator stops flashing but continues to glow. The 2FSH alarm continues to flash until the over-temperature condition is cleared (by the temperature falling), when normal operation resumes.

If the alarm is acknowledged when the temperature has dropped (or after the over-temperature setpoint has been raised) so that the over-temperature condition no longer exists, then the furnace or oven immediately resumes normal operation.

4.2.6 Sensor Break

The over-temperature cut-out system also operates if the over-temperature control thermocouple breaks or becomes disconnected. The message S.br flashes where the measured temperature is normally displayed.
4.3 Audible Alarm

If an audible alarm is supplied for use with the over-temperature controller, it is normally configured to sound on over-temperature condition and to stop sounding when the alarm is acknowledged as given in section 4.2.

Note: the alarm may sound during controller start-up.

4.4 Navigation Diagram

<table>
<thead>
<tr>
<th>HL</th>
<th>Home List</th>
<th>Page Key</th>
<th>Black = Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTSP</td>
<td>Over-Temperature Setpoint</td>
<td>Scroll Key</td>
<td>Dashed = Through to other options</td>
</tr>
<tr>
<td>AL</td>
<td>Access List</td>
<td>!</td>
<td>For factory access to list and parameters not available to the operator.</td>
</tr>
</tbody>
</table>
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 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.
5.3 Operator Safety

The ceramic materials used in this product become electrically conductive at high temperatures. In these models there are partially exposed heating coils in the chamber and there is a danger of contact even with the furnace closed. DO NOT use any conductive tools within the work tube without isolating it. If a metal work tube is used, it must be earthed.

Switch off the heater switch whenever loading or unloading the product. The elements are isolated when the heater switch is OFF.

This product incorporates a safety switch which interrupts the heating element circuit when the furnace is opened. This prevents the operator touching a live heating element and also prevents the product from heating up if the furnace is left open. The operation of this switch should be checked periodically.

Depending on use, the surfaces in the working chamber and the chamber load may still be very hot after the appliance is switched off. Touching these surfaces may cause burns. Use suitable personal protective equipment or wait until the appliance cools down to ambient temperature.

Before removing a hot object from the product, make sure there is a safe place to put it down. If necessary use tongs, face masks and heat resistant gloves. Heat resistant clothing and face protection can guard against the effects of radiated heat when the furnace is open.
5.4 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).

![Diagram of A Tube and B Crucible]

**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 \div \text{internal diameter in mm} \times \text{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.**

5.5 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.

5.6 Power Adjustment

The control system incorporates electronic power limiting. The power limit parameter OP.Hi is accessible to the operator and can be used to adjust the furnace to the actual...
supply voltage.
The models covered by this manual are designed for use over the range of voltages 200 V - 250 V (or, if ordered, 100 V - 125 V), and the power limit parameter is set accordingly. These models may be adjusted to a different voltage within the range: the power limit should be reset to match OP.Hi, see 10.0
Refer to section 3.0 for power adjustment instructions.

5.7 Running at Low Temperatures
The power limit may be adjusted to a low level in order to achieve better control when operating the product at a low temperature. Before changing the power limit, record the default settings for possible future use. Refer to the Power Settings section of this manual for default power limits. If the product fails to reach the desired temperature, refer to the Temperature Controller and Fault Analysis sections.
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 Weekly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bi-Annually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually</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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit (if fitted)</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Switch Function (split models only)</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Safety (external)</td>
<td>Visual check of external cables and plugs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></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></td>
<td></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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Check</td>
<td>Check that all functions are working normally</td>
<td></td>
</tr>
<tr>
<td></td>
<td></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></td>
<td></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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End Plugs / Radiation Shields</td>
<td>Visual check for damage or wear, and cleaning of the power plate area</td>
<td></td>
</tr>
</tbody>
</table>
### 6.0 Maintenance

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

**Performance**

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

6.2.1 Cleaning
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.

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.

6.2.2 Safety Switch
When correctly functioning, the safety switch will isolate all live conductors (live and neutral connections) within the heating element circuit(s) when the product door is opened. The safety switch should be checked regularly to ensure that this occurs.

The safety switch should not fail under normal working conditions, however rough handling, exposure to corrosive materials/ environments, or exceptionally frequent use, could compromise the safety system.

**Weekly check:**
The following check can be carried out by a general operator:

- On the temperature controller, set a safe temperature above ambient. The heater lights should illuminate.
- Open the door and check the heater lights. They should no longer be illuminated.

If the heater lights remain illuminated when the door is open, discontinue use and contact Carbolite Gero Service.

**Annual check:**
The following checks should be carried out by a qualified electrician, as specified in the "Maintenance Schedule" section of this manual:

- Remove the element access panel and take a voltage measurement from the heating element terminals. Do not attempt to take a reading from the heating element itself as surface oxidation will give an unreliable contact.
- Ensure that power to the heating elements is switched off when the door is opened.

Contact Carbolite Gero Service and discontinue use of the product if it is found that the heating elements are not fully isolated during these checks.

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 one thermocouple, one solid state relay and two heating elements (four heating elements for 900 mm heated length furnaces.

When ordering spare parts please quote the model details as requested above.
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-eg. 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.

1. Make a note of the wire connections to the solid state relay, then disconnect them.
2. Remove the solid state relay from the base panel or aluminium plate.
3. Replace and reconnect the solid state relay ensuring that the bottom of it has good thermal contact with the base panel or aluminium plate.
4. 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 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.
7.0 Repairs and Replacements

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

7.7 Element Replacement

See section 7.2 - wearing a face mask is required.

Remove the three screws from each end and lift out the half-circular insulation assembly.

Make a plan of all the cable connections and disconnect the cables.

Remove the thermocouple(s) by withdrawing them from the sheaths built into the elements. Remove the plates through which the element tails are located. Remove the keep plates from each side of the insulation assembly.

Lift out the element to be replaced; save any insulation sleeves for possible reuse.

Bend or cut the new element tails as necessary and fit any insulation sleeves; feed the tails through and fit the element into place.

Refit the keep plates on each side. Refit the tail termination plates, ensuring that the element tails do not touch any metal parts. Refit the thermocouple(s).

Connect all the wiring according to the plan previously made and complete the reassembly of the product.

Check that the product is controlling properly to rule out the possibility that the element failed because of a fault in the control system.

Wherever two different sizes of elements are fitted, the 150 mm elements are at the ends and the 200 mm elements in the centre.

If ordering a spares kit, the correct number and size of heating elements will be supplied.
# 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><strong>1.</strong> The HEAT light is ON</td>
<td>The heating element has failed</td>
<td>Check also that the SSR is working correctly</td>
</tr>
<tr>
<td><strong>2.</strong> The HEAT light is OFF</td>
<td>The controller shows a very high temperature or code such as S.br</td>
<td>The thermocouple has broken or has a wiring fault</td>
</tr>
<tr>
<td></td>
<td>The controller shows a low temperature</td>
<td>The door switch(es) (if fitted) may be faulty or need adjustment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The contactor/relay (if fitted) may be faulty</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The heater switch (if fitted) may be faulty or need adjustment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The SSR could be failing to switch on due to internal failure, faulty logic wiring from the controller, or faulty controller</td>
</tr>
<tr>
<td></td>
<td>There are no lights glowing on the controller</td>
<td>Check the supply fuses and any fuses in the furnace control compartment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault.</td>
</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>Product only heats up when the instrument switch is ON</td>
<td>The controller shows a very high temperature</td>
</tr>
<tr>
<td></td>
<td>The controller shows a low temperature</td>
<td>The thermocouple may be faulty or may have been removed out of the heating chamber</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The thermocouple may be connected the wrong way around</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty</td>
</tr>
<tr>
<td>2.</td>
<td>Product heats up when the instrument switch is OFF</td>
<td>The SSR has failed &quot;ON&quot;</td>
</tr>
</tbody>
</table>
9.0  Wiring Diagrams

9.1  WA-11-00
Connections below show single phase.

Key

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1, F2, F3</td>
<td>Fuses</td>
</tr>
<tr>
<td>FIL</td>
<td>Filter</td>
</tr>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>TC</td>
<td>Control Thermocouple</td>
</tr>
<tr>
<td>SSR</td>
<td>Solid State Relay</td>
</tr>
<tr>
<td>H</td>
<td>Heat Lamp</td>
</tr>
<tr>
<td>EL</td>
<td>Element(s)</td>
</tr>
<tr>
<td>SW</td>
<td>Instrument Switch(es)</td>
</tr>
<tr>
<td>FM</td>
<td>Fan Motor</td>
</tr>
<tr>
<td>*</td>
<td>Fan Models Only</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>L</td>
<td>Live</td>
</tr>
<tr>
<td>PE</td>
<td>Earth</td>
</tr>
</tbody>
</table>

Cables

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BU</td>
<td>Blue</td>
</tr>
<tr>
<td>R</td>
<td>Red</td>
</tr>
<tr>
<td>GR/Y</td>
<td>Green + Yellow</td>
</tr>
<tr>
<td>G</td>
<td>Grey</td>
</tr>
<tr>
<td>P</td>
<td>Pink</td>
</tr>
</tbody>
</table>
9.2 **WA-11-70**
Connections below show single phase with safety switches.

![Wiring Diagram]

**Key**
- F1, F2, F3: Fuses
- FIL: Filter
- R1/1, R1/2: Relay Contactor
- R1: Relay
- C: Temperature Controller
- TC: Control Thermocouple
- SSR: Solid State Relay
- SSW-A, SSW-B: Safety Switch(es)
- H: Heat Lamp
- EL: Element(s)
- SW: Instrument Switch(es)
- N: Neutral
- L: Live
- PE: Earth

**Cables**
- BU: Blue
- R: Red
- GR/Y: Green + Yellow
- G: Grey
- P: Pink
9.3 **WA-11-71**
Connections below show single phase with safety switches and over-temperature control.

![Diagram of Connections]

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1, F2, F3</td>
<td>Fuses</td>
</tr>
<tr>
<td>FIL</td>
<td>Filter</td>
</tr>
<tr>
<td>R1/1, R1/2</td>
<td>Relay Contactor</td>
</tr>
<tr>
<td>R1</td>
<td>Relay</td>
</tr>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>TC</td>
<td>Control Thermocouple</td>
</tr>
<tr>
<td>OT</td>
<td>Over-Temperature Controller</td>
</tr>
<tr>
<td>OTC</td>
<td>Over-Temperature Thermocouple</td>
</tr>
<tr>
<td>SSR</td>
<td>Solid State Relay</td>
</tr>
<tr>
<td>SSW-A, SSW-B</td>
<td>Safety Switch</td>
</tr>
<tr>
<td>H</td>
<td>Heat Lamp</td>
</tr>
<tr>
<td>EL</td>
<td>Element(s)</td>
</tr>
<tr>
<td>SW</td>
<td>Instrument Switch(es)</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>L</td>
<td>Live</td>
</tr>
<tr>
<td>PE</td>
<td>Earth</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BU</td>
<td>Blue</td>
</tr>
<tr>
<td>R</td>
<td>Red</td>
</tr>
<tr>
<td>GR/Y</td>
<td>Green + Yellow</td>
</tr>
<tr>
<td>G</td>
<td>Grey</td>
</tr>
<tr>
<td>P</td>
<td>Pink</td>
</tr>
</tbody>
</table>
9.4 WA-11-30

Connections below show single phase with indirect safety switch(es).

**Key**
- F1, F2, F3: Fuses
- FIL: Filter
- R1/1, R1/2: Relay Contactor
- R1: Relay
- C: Temperature Controller
- TC: Control Thermocouple
- SSR: Solid State Relay
- SSW: Safety Switch
- H: Heat Lamp
- EL: Element(s)
- SW: Instrument Switch(es)
- N: Neutral
- L: Live
- PE: Earth

**Cables**
- BU: Blue
- R: Red
- GR/Y: Green + Yellow
- G: Grey
- P: Pink
9.5 WA-11-31

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

Key

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1, F2, F3</td>
<td>Fuses</td>
</tr>
<tr>
<td>FIL</td>
<td>Filter</td>
</tr>
<tr>
<td>R1/1, R1/2</td>
<td>Relay Contactor</td>
</tr>
<tr>
<td>R1</td>
<td>Relay</td>
</tr>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>OT</td>
<td>Over-Temperature Controller</td>
</tr>
<tr>
<td>OTC</td>
<td>Over-Temperature Thermocouple</td>
</tr>
<tr>
<td>TC</td>
<td>Control Thermocouple</td>
</tr>
<tr>
<td>SSR</td>
<td>Solid State Relay</td>
</tr>
<tr>
<td>SSW</td>
<td>Safety Switch</td>
</tr>
<tr>
<td>H</td>
<td>Heat Lamp</td>
</tr>
<tr>
<td>EL</td>
<td>Element(s)</td>
</tr>
<tr>
<td>SW</td>
<td>Instrument Switch(es)</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>L</td>
<td>Live</td>
</tr>
<tr>
<td>PE</td>
<td>Earth</td>
</tr>
<tr>
<td>*</td>
<td>If Fitted</td>
</tr>
</tbody>
</table>

Cables

<table>
<thead>
<tr>
<th>Cable</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>BU</td>
<td>Blue</td>
</tr>
<tr>
<td>R</td>
<td>Red</td>
</tr>
<tr>
<td>GR/Y</td>
<td>Green + Yellow</td>
</tr>
<tr>
<td>G</td>
<td>Grey</td>
</tr>
<tr>
<td>P</td>
<td>Pink</td>
</tr>
</tbody>
</table>
10.0 Fuses and Power Settings

10.1 Fuses

F1 - F3: 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>F3</td>
<td>Heat Light Fuses</td>
<td>May be omitted up to 25 Amp/phase supply rating.</td>
<td>2 Amps glass type F 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</th>
</tr>
</thead>
<tbody>
<tr>
<td>HST 12/450</td>
<td>1-phase</td>
<td>200-240</td>
<td>12 A</td>
</tr>
</tbody>
</table>

10.2 Power Settings

The power limit settings (parameter OP.Hi) for this model are voltage dependant. 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 recommended values. To adjust the parameter refer to the "Changing the Maximum Output Power" of the control section of the manual.

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>100</th>
<th>110</th>
<th>120</th>
<th>200</th>
<th>208</th>
<th>220</th>
<th>230</th>
<th>240</th>
<th>380</th>
<th>400</th>
<th>415</th>
<th>440</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (%)</td>
<td>100</td>
<td>90</td>
<td>75</td>
<td>-</td>
<td>100</td>
<td>90</td>
<td>82</td>
<td>75</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</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.

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>Work Tube Bore (mm)</th>
<th>Work Tube Length (mm)</th>
<th>Heated Length (mm)</th>
<th>Net Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HST 12/450</td>
<td>1200</td>
<td>2.25</td>
<td>25 - 100</td>
<td>600 - 900</td>
<td>450</td>
<td>33</td>
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</tbody>
</table>

Split Tube Furnaces Heated by resistance wire moulded in refractory fibre. Horizontal models in an opening case.

Also models based on above, but of other lengths, supplied to special order.

Note: Weights are approximate for horizontal models and do not include fittings or vertical stands.

11.1 Environment

The models listed in this manual contain electrical parts and should be stored and used in indoor conditions as follows:

Temperature: 5 °C - 40 °C

Relative humidity: Maximum 80 % up to 31 °C decreasing linearly to 50 % at 40 °C
<table>
<thead>
<tr>
<th>Engineer Name</th>
<th>Date</th>
<th>Record of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<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:

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