### 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
1.3 Hydrogen and Carbon Dioxide Warning

Applicable for furnaces constructed to use H\textsubscript{2} and CO\textsubscript{2} test gases with CO\textsubscript{2} 'Purge' gas.

- H\textsubscript{2} can form explosive gas mixtures, take precautions to avoid leakage of H\textsubscript{2}.
- H\textsubscript{2} and CO\textsubscript{2} can react to form CO.

see section 1.4.

Carbon dioxide (CO\textsubscript{2}) is a colourless, odourless and tasteless gas that is an asphyxiant. Rapid unconsciousness occurs at levels above 11%, levels of 20 - 30% are immediately hazardous to life.

Information extracted from Croner Publications Ltd. Substances Hazardous To Health.

To minimise the risks associated with CO\textsubscript{2} it is most important that the product is installed and operated in accordance with this instruction manual. If the product operator experiences any of the effects listed above, the product must be isolated from the gas and electricity supplies immediately and expert advice sought. For safety guidelines seek the gas manufacturers advice.

1.4 Carbon Monoxide Warning

Operation of the CAF furnace involves the use of carbon monoxide.

Carbon monoxide is a product of reaction of H\textsubscript{2} and CO\textsubscript{2}.

Carbon monoxide (CO) is a colourless, odourless, tasteless and inflammable gas which is acutely toxic. CO is introduced into the blood stream through the lungs and binds with the haemoglobin preventing it from carrying oxygen around the body. This can result in rapid damage to body tissues due to oxygen starvation. Since CO is an accumulating toxin it can be dangerous even when present in quite low concentrations over long periods of time. Individuals vary considerably in their reactions to concentrations of toxic gases; table 1 shows the typical effects of cumulative CO exposure.

Information extracted from Guidance Note EH43 (1996) from the Health and Safety Executive.

To minimise the risks associated with CO it is most important that the furnace is installed and operated in accordance with this instruction manual. If the furnace operator experiences any of the effects listed above, the furnace must be isolated from the gas and electricity supplies immediately and expert advice sought. For safety guidelines seek the gas manufacturers advice.

Table 1. Carbon monoxide in air:
## 1.0 Symbols and Warnings

<table>
<thead>
<tr>
<th>Parts per million</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>Recommended Exposure Limit (8 hours time weighted average concentration)</td>
</tr>
<tr>
<td>200</td>
<td>Headache after approximately 7 hours if resting or after 2 hours exertion</td>
</tr>
<tr>
<td>400</td>
<td>Headache with discomfort with possibility of collapse after 2 hours at rest or 45 minutes exertion.</td>
</tr>
<tr>
<td>1200</td>
<td>Palpitations after 30 minutes at rest or 10 minutes exertion.</td>
</tr>
<tr>
<td>2000</td>
<td>Unconscious after 30 minutes at rest or up to 10 minutes exertion.</td>
</tr>
</tbody>
</table>

For further information refer to:

- Guidance Note EH43 (1996) from the Health and Safety Executive. ISBN 0 11 883597 1
2.0 Installation

2.1 Unpacking and Handling

When unpacking and handling the product, always lift it by its base. Do not use the door or any other projecting cover or component to support the equipment when moving it. Use two or more people to carry the product where possible.

Carefully remove any packing material from inside and around the product before use.

Avoid damaging the surrounding insulation when removing packing materials.

![NOTE: This product contains Refractory Ceramic Fibre (also known as Alumino Silicate Wool - ASW). For precautions and advice on handling this material see section 6.2.]

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.
2.0 Installation

Depending on the application of the product, it may be appropriate to position it under an extraction hood. Ensure the extraction hood is switched on during use.

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

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 Heating Elements

The silicon carbide elements are VERY FRAGILE and are packed separately. Fit them accordingly to the instructions in section 6.0 for element fitting and replacement instructions.

2.4 Telescope

The telescope and its trunnion arm are packed separately and should be attached to the front of the product.
2.5 Electrical Connections

Connection by a qualified electrician is recommended.

This product requires a single-phase A.C. supply with earth (ground), which may be Live to Neutral non-reversible (polarised), Live to Neutral reversible (non-polarised), or Live to Live.

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></td>
<td>Live - Neutral</td>
</tr>
<tr>
<td>1-phase</td>
<td>L</td>
<td>Brown</td>
<td>to live</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>to either power conductor (For USA 200-240V, connect L1)</td>
</tr>
<tr>
<td>N</td>
<td>Blue</td>
<td>to neutral</td>
<td>to the other power conductor (For USA 200-240V, connect L2)</td>
</tr>
<tr>
<td>PE</td>
<td>Green/ Yellow</td>
<td>to earth (ground)</td>
<td>to earth (ground)</td>
</tr>
</tbody>
</table>
2.0 Installation

2.6 Gas Connections

The product is fitted with two flow meters, one for Carbon Dioxide (CO₂) on the left and the other for Hydrogen (H₂) on the right. The output from the flow meters is mixed and taken directly to the work tube through a connection at the front.

There are no valves or non-return devices on this furnace. Regulated supplies of CO₂ and H₂ must be connected in a safe manner to ensure that all gas flow is through the work tube. The gas supply pressure required is 4 psi (0.276 bar) and must not exceed this.

At the back of the furnace is a copper exhaust vent pipe. The exhaust fumes are dangerous (see "Carbon Monoxide Warning"). The exhaust must be properly vented into a suitable duct or fume cupboard and must not be allowed to contaminate the atmosphere of the room in which the furnace is sited.
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) The Over-Temperature key is used to access the over-temperature menu. Note: Over-Temperature is an option.</td>
</tr>
<tr>
<td>C</td>
<td>Page Key The Page key is used to scroll through the parameters and switch between menus.</td>
</tr>
<tr>
<td>D</td>
<td>Timer Key The Timer key is used to start, view, pause and reset the timer.</td>
</tr>
<tr>
<td>E</td>
<td>Arrow Keys The Arrow keys are used to adjust the value of the selected parameter and pause the output power.</td>
</tr>
<tr>
<td>F</td>
<td>Over-Temperature Indicator (if fitted) The Over-Temperature indicator shows green in normal use. It flashes red when over-temperature is triggered and is constantly red when over-temperature is reset and waiting for the temperature to drop.</td>
</tr>
</tbody>
</table>
3.0 301 Controller

<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>

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

<table>
<thead>
<tr>
<th>HM</th>
<th>Home Menu</th>
<th>Page Key</th>
<th>Black = Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>Setup Menu</td>
<td>Hold for 1.5 seconds</td>
<td>White = Return</td>
</tr>
<tr>
<td>OTHM</td>
<td>Over-Temperature Home Menu</td>
<td>Keep Held</td>
<td></td>
</tr>
<tr>
<td>OTSM</td>
<td>Over-Temperature Setup Menu</td>
<td>Press Page Key multiple times</td>
<td></td>
</tr>
</tbody>
</table>
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>Button</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>t+yp</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>OPH1</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>CALL</strong></td>
<td>Used to set the low temperature point (°C) for dual point calibration.</td>
</tr>
<tr>
<td><strong>CALH</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>PU</strong></td>
<td>Displayed before the current temperature when checking the 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.
3.2.6 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°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 SPrr 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.
3.2.9 Changing the Timer Time

- Start at the Home Display.
- Repeatedly press the Page key to scroll through the Home Menu until \( t_1, t_2, t_3, t_4 \) 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 \( \text{typ} \) 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 \( t \text{ bnd} \) 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 \( \text{OP.} \text{Hi} \) 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 9.0 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 CLSE 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 $t$ - 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 $t$ 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.
- rSET 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 (‘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 (‘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 (‘End’ flashes on the display).
3.0 301 Controller

Timer Type E5

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 E1 or E4 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 'E bnd', e.g. 'E 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 t 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.

![Diagram of Ramp Dwell Programming]

### Key

<table>
<thead>
<tr>
<th>A</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Time</td>
</tr>
<tr>
<td>SPrr</td>
<td>Setpoint Ramp Rate (SPrr)</td>
</tr>
<tr>
<td>DT</td>
<td>Dwell Time t1</td>
</tr>
<tr>
<td>NCD</td>
<td>Natural Cool Down</td>
</tr>
</tbody>
</table>

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 *T*

- 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 *TYP* shows on the display.
- Use the up and down Arrow keys to set the value to *T*.
- 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°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 *SPrr* 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 *T* 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 9.0) 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 9.0).

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 - FRcE

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 - ClL 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 C.L.SE is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access C.L.1, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to C.L.SE.
- Use the up and down Arrow keys to scroll to C.L.1.
- 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 C.L.1 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 - C.L2

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 CAL.L and CAL.H 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 - \textit{CALL}

- Start at the home display.
- Hold the Page Key for 1.5 seconds to access the Setup Menu.
- Press the Page key until \textit{CL SE} is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access \textit{CL 2}, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to \textit{CL SE}.
- Use the up and down Arrow keys to scroll to \textit{CL 2}.
- Press the Page key to access \textit{CALL}.
- Press the up or down Arrow keys to change the offset value.
- The value will then be stored without any further input.

Once \textit{CL 2} has been selected as the customer calibration type, it is possible to start from the home display and go to \textit{CALL} directly (or any of the other settings in \textit{CL 2}) and enter the password at this point when calibration adjustment is required again.

3.8.6 Changing the Calibration, Low Temperature Offset - \textit{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 \textit{CL SE} is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access \textit{CL 2}, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to \textit{CL SE}.
- Use the up and down Arrow keys to scroll to \textit{CL 2}.
- Press the Page key twice to access \textit{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 - \textit{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 \textit{CL SE} is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access \textit{CL 2}, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to \textit{CL SE}.
- Use the up and down Arrow keys to scroll to \textit{CL 2}.
- Press the Page key three times to access \textit{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 - **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 **CL5E** 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 **CL5E**.
- Use the up and down Arrow keys to scroll to **CL2**.
- 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 \( \Omega T \) 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 (\( PU \)) 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 CLSE 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 OTE 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 OTT is displayed.
- Repeatedly press the Page key until 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:

- Modbus Address (Main) = 2
- Modbus Address (O/Temp) = 3
- Baud Rate = 9600
- Byte Format = 8

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>_________________________</td>
<td>3</td>
</tr>
<tr>
<td>Tx</td>
<td>_________________________</td>
<td>2</td>
</tr>
<tr>
<td>Com</td>
<td>_________________________</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>Definition</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>$br</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>E-</td>
<td>followed by numerical code</td>
<td>Controller Error</td>
</tr>
<tr>
<td>E-</td>
<td>followed by numerical code</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 Operation

4.1 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.

The product will heat up according to the controller setpoint or program, unless a time switch is fitted and switched off.

As the product heats up, the heat light glows steadily at first and then flashes as the product approaches the desired temperature. For more information on temperature control see the controller instructions.

**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 turn the product off, set the instrument switch to its off position. The controller display will go blank. If the product is to be left unattended, isolate it from the electrical supply.

4.2 Setting up for Coal Ash Fusion Test

The CAF 16/38 is designed to be compatible with the following:


The test procedure is entirely manual and under the operator's control. An example of the procedure is as follows:

Heat the product up to its starting temperature.

Open the product door and swing it clear of the work tube to allow access. Load the sample into the work tube. The sample tile with one or two samples on it should be placed centrally along the length of the work tube.

Set the ramp rate on the controller, if required, to limit the heating rate. A rate of 7 °C/ min is suggested and is factory pre-set.

Set the controller to heat the product up to the final temperature. Swing the telescope into place to allow observation of the sample.
Watch the sample and record the temperature at which it fuses. Make all other records such as time and temperature as required by your own organisation.

Switch off and allow to cool down; or set the setpoint to zero or to the normal test starting temperature, so that the temperature is displayed as the furnace cools.

Note: Do not operate the product at temperatures above 815 °C (1499 °F) with the door open. The product door must not be left open longer than is necessary to load and unload samples from the work tube.

Sample tiles can be obtained from Carbolite Gero. A brass mould to assist with forming samples is supplied with the product.

4.3 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 10.0 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.

4.4 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).

**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 $400 \div \text{internal diameter in mm}$ to give $(\degree C/\text{min})$; 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.
4.5 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).

Warning: Do not use the product if the work tube is cracked as there is a risk of exposure to carbon monoxide gas. See "Carbon Monoxide Warning"
5.0 Maintenance

5.1 General Maintenance

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

5.2 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>Door Plug</td>
<td>Visual inspection, checking the seal and whether it is free of any damage</td>
<td></td>
</tr>
<tr>
<td>Door Plug</td>
<td>Replacement where necessary</td>
<td></td>
</tr>
<tr>
<td>Extraction Pipe</td>
<td>Check that the connection is tight, and clean out the pipe if necessary</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>Gas Safety (external)</td>
<td>Visually check that all pipework is in place and free of damage. Physically check that all connections are tight</td>
<td></td>
</tr>
<tr>
<td>Gas Safety (internal)</td>
<td>Leak test the gas system</td>
<td></td>
</tr>
<tr>
<td>Cooling Fans</td>
<td>Check whether the cooling fans are working</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>
</tbody>
</table>
# 5.0 Maintenance

<table>
<thead>
<tr>
<th>Operational Check</th>
<th>Thorough inspection and report incorporating a test of all functions</th>
</tr>
</thead>
</table>

## Performance

<table>
<thead>
<tr>
<th>Element Circuit</th>
<th>Electrical measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>![Warning Icon]</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>Measure the current drawn on each phase / circuit</td>
</tr>
</tbody>
</table>
5.0 Maintenance

5.2.1 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.

5.3 Element Ageing
Silicon carbide elements gradually increase in resistance with use; a process known as ageing. Their heating power reduces correspondingly. To ensure sufficient power to the product, it may be necessary to adjust the power limit and, ultimately, replace the elements - taking care to readjust the power limit.

Once the heating elements have been in use for some time, they should only be replaced as a set. Single elements may be replaced (in the case of breakage, for example) when the elements are reasonably new.

5.4 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.

5.5 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.
5.6 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 a thermocouple and sheath, a solid state relay, a set of heating elements and a set of clips and braids. When ordering spare parts please quote the model details as requested above.
6.0 Repairs and Replacements

6.1 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.

6.2 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.

6.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
6.4 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.

6.5 Thermocouple Replacement

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 R)</td>
<td>orange</td>
</tr>
<tr>
<td>negative</td>
<td>white</td>
</tr>
</tbody>
</table>

Disconnect the thermocouple from its terminal block; retain any porcelain spacers.
Withdraw the thermocouple from its sheath and remove any broken bits of thermocouple.
Re-assemble with a new thermocouple observing the colour coding.
Refit the element access panel.
6.6 Element Replacement

Disconnect the product from the electrical supply.

Remove the complete front panel. Remove the thermocouple cover and the square plate from the back panel.

The elements are expensive and fragile and can be damaged by contamination: handle them with care and keep them clean.

Replacements only: make a note of the actual braid and cable connections to the elements. Disconnect the clips with the special tool provided (or with finger pressure, depending on the type of clips supplied), lift off the braids and carefully withdraw each element. See fig. 5.

Carefully insert the new elements into the product.

Attach the connection braids according to the note made above or to the appropriate diagram, fig. 6. Use the special tool (or finger pressure) to fit the clips. Take care that adjacent clips do not touch each other.

Replace the product end panels and connect the product to the electrical supply.

![Fig.5. - Use of Clip Tool](image1)

![Fig.6. Element Connections](image2)

6.7 Fuse Replacement

Fuses are marked on the wiring diagram with type codes, e.g. F1, F2. For more information on fuses refer to section 9.0.

*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.
# 7.0 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>
</tbody>
</table>

### Additional Notes:
- If the controller shows a low temperature:
  - The door switch(es) (if fitted) may be faulty or need adjustment
  - The contactor/relay (if fitted) may be faulty
  - The heater switch (if fitted) may be faulty or need adjustment
  - The SSR could be failing to switch on due to internal failure, faulty logic wiring from the controller, or faulty controller

- There are no lights glowing on the controller:
  - Check the supply fuses and any fuses in the furnace control compartment
  - The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault.
## 7.0 Fault Analysis

### 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>The controller shows a very high temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller shows a low temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><strong>Product heats up when the instrument switch is OFF</strong></td>
<td>The SSR has failed &quot;ON&quot;</td>
</tr>
</tbody>
</table>
8.0 Wiring Diagrams

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

Key
- F1, F2, F3: Fuses
- FIL: Filter
- C: Temperature Controller
- TC: Control Thermocouple
- SSR: Solid State Relay
- H: Heat Lamp
- EL: Element(s)
- SW: Instrument Switch(es)
- FM: Fan Motor
- *: Fan Models Only
- N: Neutral
- L: Live
- PE: Earth

Cables
- BU: Blue
- R: Red
- GR/Y: Green + Yellow
- G: Grey
- P: Pink

---

Diagram illustrating connections for WA-11-00, showing single phase setup with labels for key components and colored cables.
8.2 WA-11-01
Connections below show single phase with over-temperature controller.
9.0 Fuses and Power Settings

9.1 Fuses

F1-F3: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAF 16/38</td>
<td>1-phase</td>
<td>110-120</td>
<td>63 A</td>
</tr>
<tr>
<td>CAF 16/38</td>
<td>1-phase</td>
<td>220-240</td>
<td>25 A</td>
</tr>
</tbody>
</table>

9.2 Power Settings

The setting for the power limit parameter in the controller (OP.Hi) should be 100% for the model listed in this manual.

Please refer to the rating label for product specific information.
10.0 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>Internal Bore (mm)</th>
<th>Net Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAF 16/38</td>
<td>1600</td>
<td>4.5</td>
<td>38</td>
<td>67</td>
</tr>
</tbody>
</table>

10.1 Environment

The models listed in this manual contains 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>
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</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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