Installation, Operation and Maintenance Instructions
400°C Clean Room Oven - HTCR Model: 28 Litres
3216 Controller

HTCR 4/28 + 3216 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.

Solenoid valve (if fitted): see section 10.5 for full details

Variable speed fan (if fitted): see section 10.6 for full details

Exhaust fan (if fitted): see section 10.7 for full details

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 by its base; do not use the door or any other projecting cover or component to support the equipment when moving it. Use a fork lift or pallet truck to move the product; position the product on a level surface and use an adequate number of personnel to safely move the product into position.

Carefully remove any packing material from inside and around the product before use. Avoid damaging the surrounding insulation when removing packing materials.

Locate the shelves as required.

Some models may be lifted by fitting lifting bolts to captive threads which are fitted in the top of the case, whilst others may have welded on lifting eyes.

NOTE: This product contains Refractory Ceramic Fibre (also known as Alumino Silicate Wool - ASW). For precautions and advice on handling this material see section 12.2.

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.
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 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></td>
<td></td>
<td></td>
<td>Reversible or Live-Live</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></td>
<td>N</td>
<td>Blue</td>
<td>to neutral</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>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)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>to earth (ground)</td>
</tr>
</tbody>
</table>
3.0 301 Controller

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

3.1 PID control

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

3.2 Basic Operation of the 301 Controller

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Display</td>
</tr>
<tr>
<td>B</td>
<td>Over-Temperature Key (if fitted) 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>
3.2.1 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><strong>HOLD</strong></th>
<th>Used to pause the current program and set new parameters.</th>
</tr>
</thead>
<tbody>
<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>tEYP</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>OPHi</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>CCL 1</strong></td>
<td>Select to access the single point calibration option.</td>
</tr>
<tr>
<td><strong>CCL 2</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>
3.2.4 Home Display

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

Finding the Home Display

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

3.2.5 Hold Mode

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

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

To enter 'Hold' mode:

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

To exit 'Hold' mode:

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

3.2.6 Checking the Temperature Setpoint from the Home Display

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

3.2.7 Changing the Temperature Setpoint

- Start at the Home Display.
- Repeatedly press the Page key to scroll through the Home Menu until \( SP_{\text{PC}} \) 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 \( SP_{\text{rr}} \) 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 \( 5^\circ \text{C} \) per minute \((300^\circ \text{C} \) per hour\), to prevent damage.
### 3.2.9 Changing the Timer Time

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

### 3.3 Advanced Operation

#### 3.3.1 Entering the Setup menu

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

#### 3.3.2 Changing the Timer Type

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

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

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

3.3.4 Changing the Maximum Output Power

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

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

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

Caution: Do not increase the power limit value to a value above the design level for the oven or furnace model, or to a value above that correctly calculated for silicon carbide elements. The heating elements could burn out, or other damage could be caused. Refer to the Fuses and Power Settings section of your product manual (section 15.0 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 \texttt{CL.ST} 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: \textbf{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 ™ 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 ™ 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.
- \( r \; S \) 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 \( t_1 \)**

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

**Timer Type \( t_2 \)**

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

**Timer Type \( t_3 \)**

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 \( t_4 \)**

On pressing the Timer key; 'Timer Type 4' waits for the setpoint to be reached, then begins the countdown. On completion of the countdown, the product continues to control as normal ('\( \text{End} \)' flashes on the display).
Timer Type 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><strong>t₁</strong></td>
<td><strong>Heating</strong></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></td>
<td>Current Temperature</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><strong>Heating</strong></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></td>
<td>Current Temperature</td>
</tr>
<tr>
<td>Timer Indicator</td>
<td>ON</td>
<td></td>
<td>ON</td>
</tr>
<tr>
<td><strong>t₃</strong></td>
<td><strong>Output</strong></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></td>
<td>Time Remaining</td>
</tr>
<tr>
<td>Timer Indicator</td>
<td>ON</td>
<td></td>
<td>ON</td>
</tr>
<tr>
<td><strong>t₄</strong></td>
<td><strong>Heating</strong></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></td>
<td>Current Temperature</td>
</tr>
<tr>
<td>Timer Indicator</td>
<td>ON</td>
<td></td>
<td>ON</td>
</tr>
<tr>
<td><strong>t₅</strong></td>
<td><strong>Heating</strong></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 t₅ 3 times Shows Time remaining</td>
<td></td>
<td>Current Temperature</td>
</tr>
<tr>
<td>Timer Indicator</td>
<td>ON</td>
<td></td>
<td>ON</td>
</tr>
</tbody>
</table>
3.6  Ramp Dwell Programming

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

3.6.1  Setting up a Ramp Dwell program

Set the Controller to Hold Mode:

- Start at the home display
- Press and hold the up and down keys together for 1.5 seconds.
- The display will flash **HOLD** to show that 'Hold' mode has been entered.
Set the Timer Type to £  

- 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 ££YP shows on the display.
- Use the up and down Arrow keys to set the value to £  
- 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 5POC 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 5PRr 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 £  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 15.0) 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 15.0).

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 - \textit{FACT}

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 - \textit{SEL}

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:
Measured Calibration Temp (°C) | Displayed Temp (°C) | Old Offset Value (°C) | New Offset Adjustment | New Offset Value (°C)
---|---|---|---|---
252 | 250 | 0 | 2 | 2
248 | 250 | 0 | -2 | -2
252 | 250 | 2 | 2 | 4

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 $CL1$ is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access $CL1$, 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 $CL1$.
- 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 $CL1$ 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 - $CL2$

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

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

- Start at the home display.
- Hold the Page Key for 1.5 seconds to access the Setup Menu.
- Press the Page key until **CL SE** is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access **CL L2**, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to **CL SE**.
- Use the up and down Arrow keys to scroll to **CL L2**.
- 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 **CL L2** 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 **CL L2**) and enter the password at this point when calibration adjustment is required again.

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

- Start at the home display.
- Hold the Page Key for 1.5 seconds to access the Setup Menu.
- Repeatedly press the Page key until **CL SE** is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access **CL L2**, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to **CL SE**.
- Use the up and down Arrow keys to scroll to **CL L2**.
- Press the Page key twice to access **OFSL**.
- Press the up or down Arrow keys to change the offset value.
- The value will then be stored without any further input.

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

- Start at the home display.
- Hold the Page Key for 1.5 seconds to access the Setup Menu.
- Repeatedly press the Page key until **CL SE** is displayed.
- Press the up or down Arrow keys to display the current calibration offset.
- If a password is required to access **CL L2**, enter the password using the up and down Arrow keys and press the Page key to accept. You will be returned to **CL SE**.
- Use the up and down Arrow keys to scroll to **CL L2**.
- Press the Page key three times to access **CAL H**.
- Press the up or down Arrow keys to change the offset value.
- The value will then be stored without any further input.
3.8.8 Changing the Calibration, High Temperature Offset - OFSH

- 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 CL2, 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 CL2.
- Press the Page key four times to access OFSH.
- Press the up or down Arrow keys to change the offset value.
- The value will then be stored without any further input.
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 OE shows on the display.
- Use the up and down Arrow keys to change the offset value.

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

3.9.3 Checking the Over-Temperature Sensor Temperature

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

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

- Start at the home display.
- Press and hold the Over-Temperature key.
- Press and hold the Page key for 1.5 seconds.
- Repeatedly press the Page key until CL.ST 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 Ott 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 OT 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 female 9-pin</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable 9-pin male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx</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>

---

*Carbolite Gero*
4.0 3508 Controller

4.1 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.

4.2 3508P1

The 3508P1 is a digital temperature controller which uses PID algorithm to give excellent temperature control when properly set. This controller can store and operate a single program of up to 20 segments. The 3508P1 can also be used as a simple temperature controller.

4.3 3508P10

The 3508P10 is a digital controller which uses PID algorithms to give excellent temperature control when properly set. This controller can store 10 programs of up to 50 segments each. Programs can be operated individually or linked by a Call parameter as sub-programs or to form single long programs. The 3508P10 can also be used as a simple temperature controller.

4.4 3508P25

The 3508P25 is a digital temperature controller which uses PID algorithms to give excellent temperature control when properly set. This controller has a maximum of 500 segments or 25 programs; each program has a maximum of 50 segments. For example 3508P25 could store 10 programs with 50 segments or 25 programs with 20 segments. Programs can be operated individually or linked by a Call parameter as sub-programs or to form single long programs. The 3508P25 can also be used as a simple temperature controller.
4.5 Basic Operation

Key

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Alarm Indicator</td>
</tr>
<tr>
<td>B</td>
<td>Power Output Indicator</td>
</tr>
<tr>
<td>C</td>
<td>Not Used</td>
</tr>
<tr>
<td>D</td>
<td>Runs, Holds, Resets the current program</td>
</tr>
<tr>
<td>E</td>
<td>Page</td>
</tr>
<tr>
<td>F</td>
<td>Scroll</td>
</tr>
<tr>
<td>G</td>
<td>Down</td>
</tr>
<tr>
<td>H</td>
<td>Up</td>
</tr>
<tr>
<td>I</td>
<td>Power Output Percentage</td>
</tr>
<tr>
<td>J</td>
<td>Program Setpoint Temperature (PSP) when a program is running</td>
</tr>
<tr>
<td>K</td>
<td>Setpoint Temperature (SP) when basic controlling</td>
</tr>
<tr>
<td>L</td>
<td>Measurement Temperature</td>
</tr>
</tbody>
</table>
4.5.1 Controller Layout

4.5.2 Keys

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/ Man</td>
<td>- Disabled</td>
</tr>
<tr>
<td>RUN/ HOLD</td>
<td>- Runs, Holds or Resets the current program. Hold down for 3 seconds to Reset.</td>
</tr>
<tr>
<td>Page Key</td>
<td>Scrolls through the page headings. Hold down for 3 seconds to access further levels, pass codes are required.</td>
</tr>
<tr>
<td>Scroll Key</td>
<td>Scrolls through parameters listed on pages.</td>
</tr>
<tr>
<td>Arrow Keys</td>
<td>▲▼ Adjust parameter values.</td>
</tr>
<tr>
<td>Page and Scroll together</td>
<td>▼▲ Press together to return to the home display or to acknowledge an alarm.</td>
</tr>
<tr>
<td>Page and Up together</td>
<td>▼▲ Press together quickly to scroll back up the page headings.</td>
</tr>
<tr>
<td>Scroll and Up together</td>
<td>▼▲ Press together quickly to scroll back up a parameter list.</td>
</tr>
</tbody>
</table>

Pressing any other combination of keys together has no effect.

Note: If no keys are pressed for 1 minute, the display returns to Home.

4.6 Quick Start Guide

4.6.1 Operation as a simple controller

When switched on the controller goes through a short test routine and then shows the measured temperature. Below it, the setpoint temperature (SP) and percentage of power output.

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

4.6.2 Changing the Setpoint

Press up ▲ or down ▼ to select the required SP. If the SP is higher than the measured temperature, the OP1 indicator will illuminate at the top of the display, indicating that the product is heating.

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

4.6.3 Resetting the programmer
To reset the programmer to simple controller mode, press RUN/HOLD for 2 seconds.

Operating the current program
- To avoid unwanted heating at the end of a program, set the SP temperature to zero before operating a program.
- Ensure the programmer is reset to simple controller mode before starting a program by pressing RUN/HOLD for 2 seconds.
- To start the program, press RUN/HOLD twice, RUN will light up on the display.

The displayed Program Setpoint (PSP) follows ramps, dwells and steps as the program runs. The SP temperature of the controller does not apply when a program is operating.
- To pause the program, press RUN/HOLD.
- To stop the program and return to simple controlling (reset), press RUN/HOLD for 2 seconds.

When the program ends, the programmer will either:
- Automatically reset to operation as a simple controller.
- Dwell at the last temperature of the program (with the RUN indicator flashing), until the operator presses RUN/HOLD for 2 seconds to manually reset, or presses RUN/HOLD once to restart the program.
- Turn power to the elements down to zero.

4.6.4 Understanding User Levels
There are two levels in the controller; Level 1 (Operator) and Level 2 (Supervisor). Level 1 (Operator) is for the day-to-day operation of the controller is not protected by a security code. There are 3 pages at this level. Page 1, Customer Identity, can only be altered in level 2. Page 2 shows the current program status. Page 3 is for writing and viewing programs.

Level 2 (Supervisor) requires a security code to enter, but once enable, provides access to additional parameters. A further 4 pages are accessible in this level as follows; Home, Customer identity, Control Output Hi percentage, Units.
To Enter Level 2:

1. Press and hold page for 3 seconds. The display will show “Access Goto Level 1”

2. Press up ▲ to select level 2. After a short pause the display will show “Access Pass code”.

3. Press up ▲ or down ▼ to enter the pass code. Pass is momentarily displayed. After a short pause the display will return to home, the controller is now in level 2.

When Level 2 operations have been completed the supervisor must return to Level 1 manually. It is not necessary to enter a code when going from a higher level to a lower level.

To Return to Level 1:

1. Press and hold page for 3 seconds. The display will show “Access Goto Level 2.”

2. Press down ▼ to go to level 1. After a short pause the display will revert to home, the controller is now in level 1.

### 4.7 Setting Up Controller

Before using the controller (or during its lifetime) certain parameters may have to be set, depending on specific requirements. To do this the controller must be set to Supervisor Level 2, see "Controller Navigation Diagrams".

#### 4.7.1 Maximum output power setting

Press page  until "Control Output Hi" is displayed. Press up ▲ or down ▼ to adjust the value.

Depending on the product model, the maximum power output setting may be accessible or locked.

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

In many models the maximum power output setting depends on the electrical supply voltage, refer to section 15.0.

#### 4.7.2 Customer ID.

A product identity number can be entered if required. This may be used to identify one of many units, for production or quality control systems.

Press page  until "Customer Identity" is displayed. Press up ▲ or down ▼ to select a number.
4.7.3 Units

Press page ▲ until "Units" is displayed. Press up ▲ or down ▼ to select:

<table>
<thead>
<tr>
<th>C</th>
<th>Celsius</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>K</td>
<td>Kelvin</td>
</tr>
</tbody>
</table>

4.7.4 Language

The text on the 3508 Controller can be shown in different languages, this can only be set at the factory and therefore must be specified at the time of placing an order.

4.8 Programming

4.8.1 Programming Notes

Programs can be created in Level 1 or Level 2 of the 3508 Controller.

For the P10 and P25, new programs can be created while the current program is operating.

To avoid unwanted heating at the end of a program, set the controller setpoint temperature to zero before operating a program.

All new unused programs show only 1 segment of type 'End'.

The minimum number of segments for a program is 2. The second being an 'End' type.

Ramp-to-setpoint control. To achieve this, create a two segment program. Set the first segment type as 'Rate' or 'Time'. Set the second segment type 'End' type 'Dwell'.

For the P10 and P25, programs can be linked together using a 'Call' segment. However, a lower number program can not be called and a program can not be ended with a call segment.

A program can be ended in four ways:

1. With 'End' segment set to S.OP the power to the elements is turned down to 0%, no matter what the 'Setpoint' temperature is.
2. With 'End' segment set to 'Reset' and the 'Setpoint' temperature turned down to zero, power to the elements will be 0%. To do this set the 'Setpoint' temperature to the minimum possible. For type B thermocouples this will be below zero.
3. With the 'End' segment set to 'Reset'. The controller will try to reach and maintain the 'Setpoint' temperature in place before the program started.
4. With the 'End' segment set to 'Dwell'. The controller will dwell at the 'PSP' of the last segment ("RUN" indicator flashes), until it is reset.

To reduce the number of segments in a program, change the last required segment to an 'End' type.

You will be asked to press ▼ to cancel or ▲ for OK.

To cancel all segments in a program, change the first segment to an 'End' type.
To alter parameters or segments of an operating program, this program must be held or reset. Press RUN/HOLD to pause the program, or press RUN/HOLD for 2 seconds to reset.

4.8.2 Holdback

Holdback can be used to prevent the program from operating ahead of the actual heating or cooling.

The holdback value is the amount, in degrees, by which the program setpoint can run ahead of the measured temperature before holdback operates. The value applies to a whole program.

To set the value press page twice, press scroll until 'Holdback Value' appears and press up or down to set.

Holdback can be used in 'Rate', 'Time' and 'Step' segments.

- For 'Rate' and 'Time' segments holdback will operate during the segment.
- For a 'Step' segment holdback delays continuation to the next segment until the step target is reached.

The 'Holdback Type' can be set as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Applies to heating only</td>
</tr>
<tr>
<td>High</td>
<td>Applies to cooling only</td>
</tr>
<tr>
<td>Band</td>
<td>Applies to both heating and cooling</td>
</tr>
<tr>
<td>Off</td>
<td>Holdback is switched off</td>
</tr>
</tbody>
</table>

To set the holdback type, press page twice, then press scroll until the display shows 'Holdback Type' for each segment and press up or down to set.

The default setting for holdback is 'OFF'.

4.8.3 Wait Segments

Wait prevents the program proceeding to the next segment, in a similar way to holdback, until the selected ‘Wait-For’ parameter has been met. There are 5 ‘Wait For’ parameters. The first 4 only work if there are configured inputs to the controller.

1. PrgIn1 Wait until Input 1 is true
2. PrgIn2 Wait until Input 2 is true
3. PrgIn 1&2 Wait until Inputs 1 AND 2 are true
4. PrgIn 1or2 Wait until Inputs 1 OR 2 is true
5. PVWaitIP Wait until the measured temperature reaches a threshold value before continuing. It can operate in one of 4 ways:
   1. 'Abs Hi' Wait until the measured temperature is greater than or equal to a value 'WaitVal' set for that segment.
   2. 'Abs Lo' Wait until the measured temperature is less than or equal to a value 'WaitVal' set for that segment.
3. ‘Dev Hi’ Wait until the measured temperature exceeds a fixed* threshold by an amount ‘WaitVal’ set for that segment.
4. ‘Dev Lo’ Wait until the measured temperature drops below a fixed* threshold by an amount ‘WaitVal’ set for that segment.

* The fixed threshold used by deviation parameters is set in the configuration level of the programmer and if required should be requested when purchasing a product from Carbolite Gero.

4.8.4 Program Cycling
The 'Cycles' parameter sets the number of times the program will operate. The default setting is 1 cycle.

To change the number of cycles, press page twice, then press scroll until the display shows 'Prog Cycles', then press up to set a finite number of cycles up to 999. Or press down to set cycling to continuous.

4.8.5 Creating a Program

From the home display, press page three times to get to the programming page, the display will show “ProgEdit 1”.

Program number

On P10 or P25 models press up or down to select a new program number. The display will show that new programs have only one segment.

Holdback Value

Press scroll until the display shows 'Holdback Value'. If required: Press up or down to set a value. This value will be used in any segment where a 'Holdback Type' is set.

Ramp Units

These apply to Rate segments only. Press scroll until the display shows 'Ramp Units'. Press up or down to select the ramp units of degrees per Hour, Min or Sec.

Number of program cycles

Press scroll until the display shows 'Cycles'. Press up or down to select more than one cycle.

Now create all the segments for your program, finishing with an 'End' segment. When parameters for each segment have been entered the display goes to the next segment number.

Segment Type

Press scroll until the display shows 'Segment Type'. Press up or down to select 'Rate', 'Time', 'Dwell', 'Step', 'Wait', 'GoBack', 'Call' or 'End'.

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Holdback Type

Press scroll ▼ until the display shows 'Holdback Type'. If required, press up ▲ or down ▼ to select 'Off', 'Low', 'High' or 'Band'.

Target Setpoint (Visible only for Rate, Time and Step segments)

Press scroll ▼ until the display shows 'Target SP'. Press up ▲ or down ▼ to set a value.

Ramp Rate (Visible only for Rate segments)

Press scroll ▼ until the display shows 'Ramp Rate'. Press up ▲ or down ▼ to set the number of degrees per 'Ramp Unit' as set above.

Duration (Visible only for Time and Dwell segments)

Press scroll ▼ until the display shows 'Duration'. Press up ▲ or down ▼ to set a value.

Wait For (Visible only for Wait segments)

Press scroll ▼ until the display shows 'Wait For'. Press up ▲ or down ▼ to select: PrgIn1, PrgIn2, PrgIn1In2, PrgIn1orIn2, PVWaitIP.

GoBack to segment number (visible only for GoBack segments)

Press scroll ▼ until the display shows 'GoBack Seg'. Press down ▼ to select a segment number to go back to.

GoBack Cycles (visible only for GoBack segments)

Press scroll ▼ until the display shows 'GoBack Cycles'. Press up ▲ or down ▼ to set a value.

Call Cycles (Visible only for call segments)

Press scroll ▼ until the display shows 'Call Cycles'. Press up ▲ or down ▼ to set a value.

End Type (Visible only for End segments)

Press scroll ▼ until the display shows 'End Type'. Press up ▲ or down ▼ to select: 'Reset', 'Dwell' or 'SafeOp'.

4.8.6 Running a Program

The current program can be started from the home display by pressing RUN/HOLD or by pressing page ▼ once, then scroll ▼ once (twice for P10 and P25), then press up ▲ or down ▼ to change the status to 'Run'.

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4.8.7 To pause (hold) a program
Press RUN/HOLD
or
Press page \( \text{until \ 'Program Status Reset' appears} \)
Press scroll \( \text{until the cursor moves to \ 'Reset'} \)
Press up \( \text{or down } \) \( \text{to select \ 'Hold'} \)
RUN/HLD will be displayed

4.8.8 To stop and reset a program
Press and hold RUN/HOLD
or
Press page \( \text{until \ 'Program Status Reset' appears} \)
Press scroll \( \text{until the cursor moves to \ 'Reset'} \)
Press up \( \text{or down } \) \( \text{to select \ 'Reset'} \)

4.8.9 To run a different program (P10 and P25)
To select a program
Press page \( \text{until \ 'Program Status Reset' appears} \)
Press scroll \( \text{then up } \text{or down } \text{to select a program number} \)

To operate the program
Press RUN/HOLD
or
Press scroll \( \text{until the cursor moves to \ 'Reset'} \)
Press up \( \text{or down } \) \( \text{to select \ 'Run'} \)
Run will be displayed

4.8.10 Program Status
While a program is operating the home display shows 3 values:
- Top: Measured temperature
- Centre: Program Setpoint (PSP)
- Bottom: Power output percentage

To see more detail:
Press page \( \text{once to go to the program status page. The top and centre values from} \)
\text{the home page remain on the display. The lower half of the screen now shows:} \)
• Current program number (P10 and P25 only)
• Current segment number
• Time remaining for that segment

Further presses of the scroll key while a program is operating will reveal additional information:

- Status. This can be changed to 'Hold', 'Reset' or 'Run' by pressing up ▲ or down ▼
- Program Setpoint (PSP)
- Current Segment Type. 'Step' and 'Call' segments are instant, so are only flashed on the screen, unless holdback is operating on that segment.
- Target Setpoint
- Segment Rate For 'Rate', 'Time' and 'Step' segments only
- Cycles left
- Program Time Left

4.8.11 Program Hold with Holdback

If a holdback value has been set and the program goes into a hold state, the green HLD indicator will flash until the measured temperature catches up.

While in this condition, the program itself is put into hold by pressing the RUN/HLD button, the 'HLD' indicator will stop flashing and remain on with the 'RUN' indicator. When the program is started again by pressing the RUN/HLD button, the 'HLD' indicator will flash again if the measured temperature has not caught up with the program.

Programming note: For P10 and P25 models, other programs can be created or changed whilst the current program is operating.

4.8.12 Power Failure Recovery

If there is a power interruption to the controller during a program, when power is restored the controller pauses the program, then ramps the temperature back up to the current program setpoint (PSP) before continuing the program.

• Power failure during ramp segments: The ramp rate will be that of the current ramp segment.
• Power failure during dwell segments: The ramp rate will be that of the previous ramp segment. If a previous ramp segment does not exist, then the dwell will continue at the current measured temperature.
• Power failure during time-to-target segments: The ramp rate will be that of the current segment. The ramp rate is maintained, but the time remaining is recalculated.

If there is a power interruption while controlling to setpoint, when power is restored the controller automatically calls for maximum power.
4.8.13  Alarms

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

How to acknowledge an alarm will depend on the type of latching which has been configured. A non-latched alarm will reset itself when the alarm condition is removed. A latched alarm requires acknowledgement with the 'ACK' function before it is reset.

If an alarm has been activated, the red 'ALM' indicator will flash and the text will indicate the type of alarm.

To acknowledge an alarm and cancel the 'ALM' indicator, press ![button] and ![button] together.

4.8.14  Program Example 1

The following sequence of entries creates and runs the program shown graphically below.

1. Turn the controller SP down to '0' by pressing down ![button].
2. Press page ![button] until 'Prog Segments Used' is displayed. On P10 or P25 models press up ![button] or down ![button] to select a new program number, (a program with only 1 segment).
3. Press scroll ![button] until 'Holdback Value' is displayed. Default ‘0’ degrees.
4. Press scroll ![button] until 'Ramp Units' is displayed. Press up ![button] or down ![button] to set to ‘Min’
5. Press scroll ![button] until 'Cycles' is displayed. Default ‘1’
6. Press scroll ![button] until 'Segment 1' is displayed
7. Press scroll ![button] until 'Segment Type' is displayed. Press up ![button] or down ![button] to select 'Rate''
8. Press scroll ![button] until 'Holdback Type' is displayed. Default ‘Off’
9. Press scroll ![button] until 'Target SP' is displayed. Press up ![button] or down ![button] to set to ‘400’ degrees.
10. Press scroll ![button] until 'Ramp Rate' is displayed. Press up ![button] or down ![button] to set to ‘5.0’ degrees per minute.

Repeat steps 6 to 10 for 4 more segments. Set 'Holdback' to the default ‘Off’. Enter the following parameters and values:

- Segment Type Dwell Duration '30:00.0’ minutes
- Segment Type Step Target SP '600’ degrees
- Segment Type Dwell Duration '30:00.0’ minutes
- Segment Type Time Target SP '200’ degrees, Duration '2:00:0’ hours

Finish the program with an 'End' segment:
11. Press scroll \( \uparrow \) until 'Segment Type' is displayed. Press up \( \uparrow \) or down \( \downarrow \) to select 'End'

12. Press scroll \( \uparrow \) until 'End Type' is displayed. Press up \( \uparrow \) or down \( \downarrow \) to select 'Reset'

13. Press page \( \leftarrow \) and scroll \( \uparrow \) together to return to the home display.

To run the program either press RUN/HOLD or:

14. Press page \( \leftarrow \) until 'Program Status' is displayed

15. Press scroll \( \uparrow \) until the cursor moves to the program status of 'Reset'

16. Press \( \uparrow \) to select 'Run'.
4.8.15 Program Example 2

The following sequence of entries creates and runs the program shown graphically below.

1. Turn the 'Setpoint' to '0' by pressing down ▼

2. Press page ‼ until 'Prog Segments Used' is displayed. On P10 and P25 models press up ▲ or down ▼ to select a new program number, (a program with only 1 segment).

3. Press scroll ◀ until 'Holdback Value' is displayed. Press up ▲ or down ▼ to set to ‘5’ degrees

4. Press scroll ◀ until 'Ramp Units' is displayed. Press up ▲ or down ▼ to set to ‘Min’
5. Press scroll until 'Cycles' is displayed. Default ‘1’

6. Press scroll until 'Segment 1' is displayed

7. Press scroll until 'Segment Type' is displayed. Press up ▲ or down ▼ to select 'Time'

8. Press scroll until 'Holdback Type' is displayed. Default ‘Off’

9. Press scroll until 'Target SP' is displayed. Press up ▲ or down ▼ to set to ‘600’ degrees

10. Press scroll until 'Duration' is displayed. Press up ▲ or down ▼ to set to ‘30:00.0’ minutes

Repeat steps 6 to 10 for 4 more segments. Enter the following parameters and values:
Note: Call segments are not available on single program models.

<table>
<thead>
<tr>
<th>Segment Type Type</th>
<th>Target SP</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramp Rate</td>
<td>‘400’</td>
<td>degrees per minute</td>
</tr>
<tr>
<td>Target SP</td>
<td>‘200’</td>
<td>degrees</td>
</tr>
<tr>
<td>Holdback</td>
<td>‘High’</td>
<td>Duration</td>
</tr>
<tr>
<td>‘30:00.0’ minutes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. Press scroll until 'Segment Type' is displayed. Press up ▲ or down ▼ to select 'End'

12. Press scroll until 'End Type' is displayed. Press up ▲ or down ▼ to select 'Dwell'

Repeat the sequence to create a short program ‘3’ as suggested in the diagram.

13. Press page and scroll together to return to the home display

To operate the program either press RUN/HOLD or

14. Press page until 'Program Status' is displayed

15. Press scroll until the cursor moves to the program status of 'Reset'

16. Press ▲ to select 'Run'
### Segment

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 'Time'</td>
<td>Type 'Rate'</td>
<td>Type 'Step'</td>
<td>Type 'Dwell'</td>
<td>Type 'Call'</td>
<td>Type 'End'</td>
</tr>
<tr>
<td>Target 600°C</td>
<td>Target 400°C</td>
<td>Target 200°C</td>
<td>Duration 30 min</td>
<td>Call prog 3</td>
<td>End Type 'Dwell'</td>
</tr>
<tr>
<td>Duration 30min</td>
<td>Rate 2°C/min</td>
<td></td>
<td>H back type 'High'</td>
<td></td>
<td>Call cycles 2n</td>
</tr>
<tr>
<td>* Segment 4 'Holdback Value' 5°C</td>
<td>** P10 and P25 only</td>
<td></td>
<td></td>
<td></td>
<td>*** Program 3 Example</td>
</tr>
</tbody>
</table>

### 4.9 Controller Options

As options can be ordered in a variety of combinations and for a variety of purposes, exact instructions are not given here. The full Eurotherm manual may be required to determine customer parameter settings. To reveal or hide parameters in the controllers it is necessary to go into configuration mode, a security code is needed. Please consult Carbolite Gero.
4.9.1 Digital Communications - RS232

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

<table>
<thead>
<tr>
<th>Product end of cable</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>female (25-pin) 9-pin</td>
<td>3</td>
<td>3 (2)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2 (3)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5 (7)</td>
</tr>
<tr>
<td>Rx</td>
<td></td>
<td>Tx</td>
</tr>
<tr>
<td>Tx</td>
<td></td>
<td>Rx</td>
</tr>
<tr>
<td>Com</td>
<td></td>
<td>Com</td>
</tr>
</tbody>
</table>

- (2) 3
+ (3) 2
Com (7) 5
7,8 4,5
1,4,6 6,8,20
Link together
Link together

4.9.2 Digital Communications - RS485

If an RS485 option is supplied, the furnace is fitted with two D-sockets. Connection between products is by “straight” cable as follows:

<table>
<thead>
<tr>
<th>Product end of cable</th>
<th>RS485 Cable: product to PC</th>
<th>Computer end of cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>female (25-pin) 9-pin</td>
<td>3</td>
<td>3 (2)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2 (3)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5 (7)</td>
</tr>
<tr>
<td>-</td>
<td></td>
<td>Tx</td>
</tr>
<tr>
<td>+</td>
<td></td>
<td>Rx</td>
</tr>
<tr>
<td>Com</td>
<td></td>
<td>Com</td>
</tr>
</tbody>
</table>

4.9.3 Comms Address

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

4.9.4 Alarm Option

When an alarm board is fitted, which consists of a relay with voltage free contacts, for operator use, the contacts are taken to a panel plug on the control panel, wired as indicated:
The purpose of the 2 amp fuse is to break the circuit to prevent overloading on the circuit due to high voltage.

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

4.9.5 Remote Input and Output (Analogue Communications)

When analogue communications are fitted, the contacts are taken to insulated terminal sockets on the control panel.

Controller configuration depends on customer requirements.
Remote input (when specified) may be switched on and off using the remote setpoint enable parameter in the controller level 2, if this was made available for a particular application. In level 2 press page until ‘REM SP Enable’ is displayed, press up ▲ or down ▼ to select SP1 (the normal controller setpoint) or SP2 (the remote input setpoint), ‘SPX’ will appear in the top left corner of the display.
Remote output does not require switching on and off.

4.9.6 Program segment output

When the customer requirement is for program segment output, an extra parameter is revealed in the PROG list. For each program segment, after the segment type and settings, the parameter EVENT OUTS appears. This has values on and off. If the value
is set to on, then the relay closes during the segment and a small 1 appears in the top left of the screen. If more than one program segment output is fitted, then there are extra boxes depending on how many event outputs there are.

### 4.10 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.

Ease apart the two lugs at the side; grip the instrument and withdraw it from its sleeve; push in the replacement.

### 4.11 Controller Navigation Diagrams

The following diagrams detail how to navigate to the various menu options within the 3508 Controller. At each option, values can be set using the arrow keys.
4.11.1 Operator Level 1 - No Program Running

<table>
<thead>
<tr>
<th>HD</th>
<th>Home Display</th>
<th>Controller identity when using more than one controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>R/O</td>
<td>Read Only</td>
<td>Black = Progress</td>
</tr>
<tr>
<td>Page Key</td>
<td>White = Return</td>
<td></td>
</tr>
<tr>
<td>Scroll Key</td>
<td>Visible Parameters depend on the Segment Type</td>
<td></td>
</tr>
</tbody>
</table>
4.11.2 Operator Level 1 - Program Running

<table>
<thead>
<tr>
<th>HD</th>
<th>Home Display</th>
<th>!</th>
<th>Controller identity when using more than one controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>R/O</td>
<td>Read Only</td>
<td></td>
<td>Black = Progress</td>
</tr>
<tr>
<td></td>
<td>Page Key</td>
<td>→</td>
<td>White = Return</td>
</tr>
<tr>
<td></td>
<td>Scroll Key</td>
<td>*</td>
<td>See previous diagram: Operator Level 1 - No Program Running</td>
</tr>
</tbody>
</table>

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4.11.3 Supervisor Level 2

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>To enter Level 2</td>
<td>Scroll Key</td>
</tr>
<tr>
<td>B</td>
<td>Locked before Pass Code entered</td>
</tr>
<tr>
<td>L1</td>
<td>Unlocked</td>
</tr>
<tr>
<td>L2</td>
<td>Black = Progress</td>
</tr>
<tr>
<td>Page Key</td>
<td>See previous diagram: Operator Level 1 - No Program Running</td>
</tr>
<tr>
<td>Hold Page Key for 3 seconds</td>
<td>If configured</td>
</tr>
<tr>
<td>Arrow Key</td>
<td>**</td>
</tr>
</tbody>
</table>
5.0 3508 Dual Loop Cascade Control (if fitted)

5.1 Principle of Cascade Control

When cascade control is fitted, the Load Loop 3508 senses the temperature of the workload, and the Element Loop 3508 senses the element temperature. Depending on the oven or furnace model, the Load Thermocouple may be in a fixed position, or may be movable. The Element Thermocouple is fixed in a predetermined position near the heating elements. The Load Thermocouple should be placed as near as possible to the work to be heated.

The Load Loop communicates with the Element Loop, calling for heat according to the load temperature and the current program or set point. The Element Loop regulates the heat according to element temperature and the requests from the Load Loop.

The element temperature could, in principle, vary between the furnace or oven maximum and minimum, regardless of the working temperature of the load. In practice, the cascade control system is configured to limit the element temperature to a band around the load temperature, typically of ±10% of the set-point temperature.

The set point of the load loop, shown at the top of the display, can be adjusted by the operator. The Element Loop, shown at the bottom of the display, should not be adjusted by the operator & will automatically regulate the element temperature to achieve the Load set temperature.

In a three-zone furnace for which the “three zone cascade” option has been ordered the centre zone is a 3508 Dual Loop & separate end zone controls are fitted. The operator sets the Load loop set point on the 3508 centre zone. The end zone controllers work automatically & need no adjustment by the operator.

5.2 Operation of Cascade Control

The operator may ignore all the complications of the system, and program the Load Loop according to the standard instructions for that controller. The home display shows the load loop at the top of the display and the Element loop at the bottom. By pressing the page key, separate views of load and element loops will be shown.
The Element Loop should never be adjusted. Note that the elements usually run at a higher temperature than the load.
Because the details of the customer’s cascade application (in particular the nature of the load) are generally not known, the feed forward parameter (FF Trim) is made easily accessible in level 2 (Refer to instrument operating instructions). Its default setting is 2%. If overshoot of the load temperature occurs – often a problem at low temperatures – then FF Trim can be reduced in order to limit the amount of overshoot. However, if FF trim is reduced too much, the load may not reach the desired temperature. If the load does not reach the desired temperature or is slow in the final stages, FF Trim can be increased: a maximum of 10% is suggested.

When attempting to control at very low temperatures it can become a problem to achieve stable control because of excessive power being supplied during heating. The available power can be limited using the power limit parameter OP.Hi, make a note of the original settings before adjusting. For power settings please refer to the fuse and power section at the back of the manual. If the parameter is normally set to 100%, try initially setting it to 50% to improve stability. Avoid settings below 40% where possible (though some furnaces require low settings for reasons unconnected with cascade control).
Power Limit View
5.3 Bypassing Cascade Control

This applies where the Control Thermocouple is a removal probe (e.g. in a tube furnace), or where for other reasons it may be required to operate the furnace or oven directly from the Element Loop.

To operate without Cascade Control the load thermocouple has to remain connected at all time; or a link has to be made across the thermocouple input connections.

5.4 3508P1 Element Loop (Loop 2)

In these circumstances the Element Controller is configured with the local/remote parameter, accessible in level 2 (Refer to instrument operating instructions).

To switch cascade control on or off. In Level 2, press Scroll until the display shows $L-r$.

Using the up ▲ down ▼ set:
- $SP2$ = cascade control on
- $SP1$ = cascade control off

The top left hand side of the screen will show $SPX$ when $SP2$ is enabled. The instrument operates as an independent Programmer/Controller when $L-r$ is set to $SP1$. To return to cascade control, change the $L-r$ parameter to $SP2$. Also note that cooling at low temperatures takes longer per degree than it does at high temperatures.

5.5 Caution

If the Load Thermocouple is removable, leave it in the furnace or oven chamber whenever possible. Operating with the Cascade Control active and with the Load Thermocouple in an unheated position (such as lying on the work bench) may cause the furnace or oven to heat up to its maximum temperature, wasting power and possibly shortening element life.

5.6 Over-temperature Control

Where over-temperature control is fitted, it normally protects against failure of the control system or of a component such as a power control relay. The over-temperature controller must be set at a level higher than the greatest element temperature, typically 15 °C above maximum.

If the working temperature is less than the maximum temperature, then it may be possible to set the over-temperature limit as follows:

$$\text{working temperature} + (\text{maximum temperature} \times \text{FF/100}) + 15 °C$$

where FF is the Feed Forward percent parameter value (e.g. 10)

Example: for working at 800 °C in a 1200 °C product, the over-temperature limit could be set to $800+120+15=935$. 
6.0 2416 Controller

6.1 Description

This manual applies to the 2416, 2416CG and 2416P8 controllers. Special customer requirements may result in changes to the available parameters and the navigation diagram. It is not possible to list all the possibilities in this manual.

2416CG Controller

The Eurotherm model 2416CG is a digital instrument with PID control algorithms which may be used as a simple controller or an 8-segment programmer. The 2416P8 is an eight-program model in which the programs can be stored independently or can be linked by a "call" parameter to form a single long program.

The 2416 Controller features:

- Easy use as a simple temperature controller, where on setting the required temperature the controller immediately attempts to reach and maintain it. Fig.1 indicates the type of temperature response when used in this way.
- By using one program segment, the control can be extended to include ramp-to-set-point. Fig.2 shows the effect.
- Alternatively, the 2416 Controller may be used as an 8-segment programmer, with each segment being a "Ramp", a "Step", a "Dwell", or "End". The program can be set to cycle if required. See fig. 3.
- Optional "modules" are available, in particular:
  - RS232 and RS432/485 digital communications modules;
  - Analogue communication modules;
  - "PDSIO" modules for communication with other controllers of similar or higher specification, for example, to allow cascade control;
  - Alarm modules, which can be used to drive visible or audible alarms, or to provide volt-free contacts for customer use.
**Fig 1 - Simple Control**

**Fig 2 - Control with Ramp-to-Setpoint**
- Seg 1 = Ramp
- Sep 2 = End (Dwell)

**Fig 3 - A Program**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Temperature</td>
</tr>
<tr>
<td>T2</td>
<td>Time</td>
</tr>
<tr>
<td>SP</td>
<td>Setpoint</td>
</tr>
<tr>
<td>AT</td>
<td>Actual Temperature</td>
</tr>
<tr>
<td>WSP</td>
<td>Working Setpoint</td>
</tr>
<tr>
<td>R</td>
<td>Ramp</td>
</tr>
<tr>
<td>D</td>
<td>Dwell</td>
</tr>
<tr>
<td>S</td>
<td>Step</td>
</tr>
<tr>
<td>E</td>
<td>End</td>
</tr>
</tbody>
</table>
6.2 Operation

Most Carbolite Gero products are fitted with an instrument switch which cuts off power to the controller and other parts of the control circuit. See section 10.0 for operating instructions.

To operate the 2416 Controller there must be power to the furnace or oven and the instrument switch must be on. If a time switch is included in the furnace or oven circuit, this must be in an ON position.

2416CG - Operation

When switched on, the controller lights up, goes through a short test routine and then displays the measured temperature and setpoint. Depending on its state when it was last switched off, it may start to control to the current setpoint of program. The output light glows or flashes to indicate that the control is occurring.

The buttons and indicators are used for the following purposes:

<table>
<thead>
<tr>
<th>Key</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Output Light</td>
</tr>
<tr>
<td>B</td>
<td>Not Used</td>
</tr>
<tr>
<td>C</td>
<td>Page</td>
</tr>
<tr>
<td>D</td>
<td>Scroll</td>
</tr>
<tr>
<td>E</td>
<td>Down</td>
</tr>
<tr>
<td>F</td>
<td>Up</td>
</tr>
<tr>
<td>G</td>
<td>Run/Hold</td>
</tr>
<tr>
<td>H</td>
<td>Setpoint Temperature (SP)</td>
</tr>
<tr>
<td>I</td>
<td>Measured Temperature</td>
</tr>
</tbody>
</table>
Auto/Manual | Disabled. | The unit is always in 'Auto' mode
--- | --- | ---
RUN/HOLD | - | Used to start, stop or pause a program. Short presses cause it to alternate between 'Run' and 'Hold', but if it is held for 2 seconds the programmer goes into 'Reset' mode where it behaves as a simple controller.
Up + Down | ▲ + ▼ | To adjust the value of a parameter. Used to change the setpoint when the unit is being used as a simple controller ('Reset' mode). Holding down gives an accelerated parameter change.
Page | | Allows access to the parameters within the controller; most lists and parameters are hidden from the operator as they contain factory-set values which should not be altered. A single press of the page key shows the temperature units, normally °C; further presses reveal the lists indicated in the Navigation Diagram.
Scroll | | Allows access to the parameters within a list. A single press displays the temperature units; further presses reveal the parameters in the current list. Some parameters are display-only, others may be altered by the operator.
Page + Scroll | ▼ + ◇ | Press together to cause an immediate return to the 'Home List'
Run & Hold | | Indicate the current mode: 'Run', 'Hold', or 'Reset' (Reset: both lights off).
 | | 'Run' flashes at the end of a program.
 | | 'Hold' flashes during holdback (when the program is paused to allow the temperature to catch up with a heating or cooling rate which is too fast).
Output Indicator | | OP1 indicates that the programmer is calling for heat to be supplied.
 | | OP2 is not used.
SP2 and REM | | Not generally used; indicate 'Second' or 'Remote' setpoint in use.

**Operation as a Simple Controller**

Press RUN/HOLD for 2 seconds to go into 'Reset' mode. Use down ▼ or up ▲ from the 'Home List' (i.e. when the temperature is displayed) to adjust the setpoint. The unit starts to control in the way indicated in Fig. 1.

*Note that to use the Ramp Rate feature, as in Fig. 2, it is necessary to create a program. See the following sections.*
6.3 Programming

Note that a currently active segment cannot be altered - put the programmer into 'Hold' or 'Reset' whenever it is necessary to do so to alter a parameter. Go into 'Reset' mode (i.e. press RUN/HOLD for 2 seconds) before starting to create or modify a program.

Press page \[\square\] until 'ProG LiSt' is displayed.

Press scroll \[\square\] to reveal the 'Holdback' and 'Loop Count' parameters. See sections 6.3.3 and 6.3.4 for a description of these.

Press scroll \[\square\] to display 'SEG.n' (segment number); use down \[\downarrow\] or up \[\uparrow\] to move to the segment to be adjusted or created.

Press scroll \[\square\] to see the 'tYPE' (segment type); use down \[\downarrow\] or up \[\uparrow\] to change the required segment type – see the table below.

Press scroll \[\square\] to access the parameters appropriate to the type of segment chosen – see the following table – and use down \[\downarrow\] or up \[\uparrow\] to alter the values.

The final segment should be of type 'End', unless all program segments are used. Segments after 'End' are ignored.

<table>
<thead>
<tr>
<th>Segment Type</th>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>RmP.r</td>
<td>TGT</td>
<td>The target setpoint for this segment</td>
</tr>
<tr>
<td></td>
<td>RATE</td>
<td>The ramp rate (rate of temperature change) in °/ minute</td>
</tr>
<tr>
<td>RmP.t</td>
<td>TGT</td>
<td>The target setpoint for this segment</td>
</tr>
<tr>
<td></td>
<td>dur</td>
<td>The duration of the segment. The controller calculates the rate of temperature rise necessary to achieve this duration.</td>
</tr>
<tr>
<td>Dwel</td>
<td>dur</td>
<td>The time in minutes to remain at the previous target temperature. 10ths of a minutes are allowed.</td>
</tr>
<tr>
<td>SteP</td>
<td>tGt</td>
<td>A new target temperature to be achieved as quickly as possible.</td>
</tr>
<tr>
<td>CaLL</td>
<td>PrG.n</td>
<td>Only applicable to 2416P8. Calls another stored program given by 'PrG.n' as a subroutine, running it the number of times given by 'cyc.n&quot;.</td>
</tr>
<tr>
<td></td>
<td>cyc.n</td>
<td></td>
</tr>
<tr>
<td>End</td>
<td>End.t</td>
<td>'Dwel' holds the temperature at the last target value. 'RSET' returns to simple controller operation; if the setpoint is set to zero then this effectively turns the heating off. 'SoP' sets the power to 0% – use of this is not recommended.</td>
</tr>
</tbody>
</table>

6.3.1 Programming Tips

Make sure the basic setpoint is set to zero to avoid unexpected heating at the end of a program.
If all segments are used so that there is no 'End' segment, then on completion the program automatically goes into 'Dwell'.

Dwell segments of length zero can be included. This is a way of allowing space for future program changes.

For an example of program creation, see section 6.3.6.

6.3.2 Multi-program model (2416P8)
The 'Program Edit' list contains the extra parameter 'PrG.n' and the 'Run' list contains the extra parameter 'PrG'. These features allow selection of the program to be edited or to be operated.

The extra segment type 'cALL' allows one program to call another as a subroutine; use this feature to create one or more long programs.

6.3.3 Holdback
"Holdback' can be used to prevent the program from operating ahead of the actual heating or cooling.

In the program list, scroll to the 'Holdback' parameter and use down ▼ or up ▲ to set the holdback type as follows:

<table>
<thead>
<tr>
<th>Band</th>
<th>Holdback applies to both heating and cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lo</td>
<td>Holdback applies to heating only</td>
</tr>
<tr>
<td>Hi</td>
<td>Holdback applies to cooling only</td>
</tr>
<tr>
<td>Off</td>
<td>Holdback is off</td>
</tr>
</tbody>
</table>

Set 'Hb.V' to the value in °C beyond which holdback is to operate. Type 'BAnd' and a value of 10 °C is often a suitable combination, if holdback is required. In this case, if the actual temperature deviates outside ±10 °C from the working setpoint, the holdback lamp of the front of the controller flashes and the program is held up until the temperature comes within range again.

The standard setting for holdback is OFF.

6.3.4 Program Cycling
The 'Loop Count' parameter 'CYC.n' can be set to control the number of times the program is run.

If 'CYC.n' = 1, the program stops at the end segment.

If 'CYC.n' = 5 (for example), the program runs 5 times: at the 'End' segment it returns to segment 1, until the 5th time through when it stops.

If 'CYC.n' = cont, the program never ends: it cycles continuously.

6.3.5 Running a Program
Press Run/ Hold to light up the 'Run' light. The program starts to operate.

To view the progress of a program from the 'Home' list, press scroll to reveal the current segment ('SEG') and the total program time remaining in hours ('PrG.t').
For a more detailed view, press page  
 to access the 'Run' list page and scroll  
 to see its contents as shown in the Navigation Diagram below. Provided the unit is first put into 'Hold' mode, temporary changes may be made to parameters; these apply only until the program ends or is reset.

To pause a program, press Run/ Hold; the 'Hold' light comes on. To terminate a program, press Run/ Hold for 2 seconds; the 'Run' and 'Hold' lights go out.

While the program is operating, the working setpoint is shown in the lower display.

6.3.6 Program example

The following sequence of entries creates and runs the program.

1. Press page  
key until 'ProG LiSt' is displayed.
2. Press scroll  
until 'CYC.n' is displayed and use the arrow key to select 1.
3. Press scroll  
until 'SEG.n' is displayed and use the arrow key to select 1.
4. Press scroll  
until 'tYPE' is displayed and use the arrow key to select rmP.r.
5. Press scroll  
until 'tGt' is displayed and use the arrow key to select 600.
6. Press scroll  
until 'rAtE' is displayed and use the arrow key to select 5.0.
7. Press scroll  
until 'SEG.n' is displayed and use the arrow key to select 2.
8. Press scroll  
until 'tYPE' is displayed and use the arrow key to select dwEl.
9. Press scroll  
until 'dur' is displayed and use the arrow key to select 60.0.
10. Press scroll  
until 'SEG.n' is displayed and use the arrow key to select 3.
11. Press scroll  
until 'tYPE' is displayed and use the arrow key to select rmP.t.
12. Press scroll  
until 'tGt' is displayed and use the arrow key to select 400.
13. Press scroll  
until 'dur' is displayed and use the arrow key to select 60.0.
14. Press scroll  
until 'SEG.n' is displayed and use the arrow key to select 4.
15. Press scroll  
until 'tYPE' is displayed and use the arrow key to select 'dwEll'.
16. Press scroll  
until 'dur' is displayed and use the arrow key to select 30.
17. Press scroll  
until 'SEG.n' is displayed and use the arrow key to select 5.
18. Press scroll  
until 'tYPE' is displayed and use the arrow key to select rmP.r.
19. Press scroll  
until 'tGt' is displayed and use the arrow key to select 30.
20. Press scroll  
until 'rAtE' is displayed and use the arrow key to select 5.0.
21. Press scroll  
until 'SEG.n' is displayed and use the arrow key to select 6.
22. Press scroll  
until 'tYPE' is displayed and use the arrow key to select 'End'.
23. Press scroll  
until 'End.t' is displayed and use the arrow key to select 'dwEll'.
24. Press the page  
key until you return to the main display.
25. Press the 'Run' key. The program operates.
6.4 Controller Options

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

6.4.1 Digital Communications - RS232

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

<table>
<thead>
<tr>
<th>Product end of cable</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>female (25-pin) 9-pin</td>
<td></td>
<td>9-pin (25-pin) male</td>
</tr>
<tr>
<td>Rx</td>
<td>(2) 3</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>Tx</td>
<td>(3) 2</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com</td>
<td>(7) 5</td>
<td>5 (7) Com</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7,8 (4,5) Link together</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,4,6 (6,8,20) Link together</td>
</tr>
</tbody>
</table>

6.4.2 Digital Communications - RS485

If an RS485 option is supplied, the furnace is fitted with two D-sockets. Connection between products is by “straight” cable as follows:

<table>
<thead>
<tr>
<th>Product end of cable</th>
<th>RS485 Cable: product to PC</th>
<th>Computer end of cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>female (25-pin) 9-pin</td>
<td></td>
<td>9-pin (25-pin) female</td>
</tr>
<tr>
<td>-</td>
<td>(2) 3</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>+</td>
<td>(3) 2</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com</td>
<td>(7) 5</td>
<td>5 (7) Com</td>
</tr>
</tbody>
</table>

6.4.3 Comms Address

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

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

![Diagram of alarm option](image)

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>F</td>
<td>Fuse (2A)</td>
</tr>
<tr>
<td>S</td>
<td>Supply</td>
</tr>
<tr>
<td>L</td>
<td>Load</td>
</tr>
<tr>
<td>*</td>
<td>Normally open relay contacts</td>
</tr>
<tr>
<td>RO</td>
<td>Relay Output 240V 2A MAX</td>
</tr>
</tbody>
</table>

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

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

### 6.5 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.

Ease apart the two lugs at the side; grip the instrument and withdraw it from its sleeve; push in the replacement.
6.6 Navigation Diagram
7.0 3216 Controller

7.1 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.

7.2 3216P1

The 3216P1 is a digital temperature controller which uses PID algorithms to give excellent temperature control. This controller can store and operate a single program of 8 ramp/dwell segments. The 3216P1 can also be used as a simple temperature controller.

7.3 3216P5

The 3216P5 is a digital temperature controller which uses PID algorithms to give excellent temperature control. This controller can store up to 5 programs of 8 ramp/dwell segments. The 3216P5 can also be used as a simple temperature controller.

7.4 Operation

7.4.1 Controller Layout

<table>
<thead>
<tr>
<th>Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>J</td>
</tr>
<tr>
<td>K</td>
</tr>
</tbody>
</table>
7.0 3216 Controller

7.4.2 Keys

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

Scroll Key  
The scroll key is used to scroll through parameters.

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

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

Scroll Key  
The scroll key is used to scroll through parameters.

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

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

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

7.5 Quick Start Guide

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

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

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

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

7.5.4 Understanding User Levels

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

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

To Enter Level 2

1. Press and hold the page key for 3 seconds.
2. The display will show LEu 1 GOTO
3. Release the page Key
4. Press the up ▲ or down ▼ to choose LEu 2 (level 2)
5. Press the up ▲ or down ▼ to enter the code (Level 2 Code = 9).
   If the correct code is entered, PASS should momentarily be displayed and then revert to the level 2 home display.
   If an incorrect code is entered the display reverts back to Level 1 home display.

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

To Return to Level 1

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

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

Table showing parameters accessible in level 1 and Level 2

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

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

7.6 Setting up the Controller

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

7.6.1 Maximum Output Power

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

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

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

In many models the maximum output power setting depends on the supply voltage, see section 15.0.

7.6.2 Customer ID

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

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

7.6.3 Units

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

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

7.6.4 Language

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

If at any time the scrolling text is not required.

Press and hold the page \[\text{ }\] for three seconds until “GOTO” is displayed.

Press scroll \[\text{ }\] until the display shows TEXT <ENABLE/ DISABLE SCROLLING TEXT>

Use the up \[\text{ }\] and down \[\text{ }\] keys to select ON or OFF.

7.6.6 Customer Calibration

The 3216 Controller series are calibrated for life at manufacture, there may however be sensor or other system errors, which affect the accuracy of the measured temperature. Customer calibration can be used to compensate for these errors.

Dual Offset

Dual point calibration uses two offset values at two corresponding temperatures; this changes the calibration linearly as the temperature increases or decreases.

Press scroll \[\text{ }\] until the display shows CAL.P (Enter Calibration Code) Use the up \[\text{ }\] and down \[\text{ }\] keys to enter the password code. (Calibration Pass Code = 95). When the correct password has been entered the display will show PNT.LO. If the wrong pass code is entered the display will revert to zero pass code, until the correct pass code is entered.

When the correct pass code is entered and PNT.LO (Adjust Low Point) is displayed. Use the up \[\text{ }\] and down \[\text{ }\] keys to enter the Low Temperature Point, which you want to apply an Offset.

Press scroll \[\text{ }\] until the display shows OFS.LO (Adjust Low Offset). Use the up \[\text{ }\] and down \[\text{ }\] keys to enter the amount Offset you want to apply to the Low Temperature Point.

Press scroll \[\text{ }\] until the display shows PNT.HI (Adjust High Point). Use the up \[\text{ }\] and down \[\text{ }\] keys to enter the High Temperature Point, which you want to apply an Offset.

Press scroll \[\text{ }\] until the display shows OFS.HI (Adjust High Offset). Use the up \[\text{ }\] and down \[\text{ }\] keys to enter the amount Offset you want to apply the High Temperature Point.

Once the calibration details have been entered, press scroll \[\text{ }\] until the display shows the next required parameter or return to the home list. The calibration data will now be protected by the pass code. To edit the data the above procedure must be followed.

Single Offset

If a constant offset is required across the temperature range, set the required “High Point” (PNT.HI) and “Low Point” (PNT.LO) to the required values (not the same), then set the “low Offset” (OFS.LO) and “High Offset” (OFS.HI) to the same value.
7.6.7 Holdback

If the temperature ramp rate of the program is quicker than the product can achieve, the program will wait until the temperature of the product catches up.

e.g. If a holdback value of 10 is set and the program is set to ramp to a setpoint of 600 °C, the program will reach 600 °C, then go into a hold state; the hold indicator will light until the product temperature reaches 590 °C, the program will then continue to control again.

The holdback will only apply once per segment, therefore when control has been re-established, the holdback will not apply again to that segment, even if the product temperature goes outside the holdback band.

Holdback can only be accessed in supervisor level (level 2) by scrolling with the scroll keys until the display shows H.BACK <PROGRAM HOLDBACK>: Use the up and down keys to select the required Holdback value.

If a multi programmer is used, each program can have its own holdback value assigned to it.

Note: When a holdback is set, each segment used must have a Ramp Rate assigned to it, in order for it to be recognised by the program. 
7.7 Programming

7.7.1 Creating a Program

Programs can be created in level 1 or level 2 of the 3216P1 and 3216P5. Each program contains 8 Ramp/Dwell pairs.

Note: A currently active program cannot be altered. Go into 'Reset' mode before starting to create or modify a program.

7.7.2 Program Number (3216P5 Only)

Press scroll ♦ until the display shows PROG <PROGRAM NUMBER.> Select the program number.

7.7.3 Ramp Units

Press scroll ♦ until the display shows RAMP.U <Ramp Units>: Use the up ▲ down ▼ to select the Ramp Units of Hour, Min or Seconds.

7.7.4 Dwell Units

Press scroll ♦ until the display shows DWEL.U <Dwell Units>: Use the up ▲ down ▼ to select the Dwell Units of Hour or Min.

7.7.5 Holdback

see section 7.6. Press scroll ♦ until the display shows H.BACK <Program Holdback>: If a holdback value is required, use the up ▲ down ▼ to enter the required value or select “OFF” if no holdback is required.

7.7.6 Ramp Rate

Press scroll ♦ until the display shows RMP.1 <Ramp Rate 1>: Using the up ▲ down ▼ enter the value for the first ramp rate depending on the Ramp Units selected. If the Ramp segment is not required select “OFF”.

7.7.7 Target Setpoint

Press scroll ♦ until the display shows T.SP 1 <Target SP 1>: Enter the temperature that you want the product to ramp up to using “Ramp rate 1”.

If “Ramp Rate 1” has been set to “OFF”. The product will Heat/ Cool directly to the Target SP.

7.7.8 Dwell Time

Press scroll ♦ until the display shows DWELL. 1 <DWell TIME 1>: Enter the time to dwell at “Target SP 1”. If the dwell segment is not required, use the down ▼ to select OFF, which is below the Zero value.

This Process is repeated for each of the 8 segments of the program.
If not all the segments are used for a program, the Ramp & Dwell of each of the subsequent segments should be set to OFF.

A program will end in one of two ways, either revert to the control setpoint or dwell at the temperature set in the last segment used. When a program finishes on a dwell and the dwell time expires the temperature will revert to the control setpoint.

**Note:** Before operating a program ensure that the control setpoint is set to Zero to avoid unexpected heating at the end of the program.

### 7.7.9 Running a Program

If using the 3216P5 controller press scroll to display PROG <PROGRAM NUMBER>. Select the required Program Number before operating a Program.

Table below shows the key presses to operate a program.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Action</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>To RUN a program</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = ON \nScrolling Display – Current Program state</td>
</tr>
<tr>
<td>To HOLD a program</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = Flashing \nScrolling Display – Program Hold</td>
</tr>
<tr>
<td>To RESET a program</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = OFF \nScrolling Display - None</td>
</tr>
<tr>
<td></td>
<td>Program Ended</td>
<td>Indicator – RUN = OFF \nScrolling Text – Program End</td>
</tr>
<tr>
<td>To RESET a program after it has completed</td>
<td>Press and hold ▲ + ▼ for more than 1 second or press and quickly release Ack</td>
<td>Indicator – RUN = OFF \nScrolling Display - None</td>
</tr>
</tbody>
</table>

### 7.7.10 Program Status

While the program is operating in level 1 or level 2, the home display shows two values at any one time:

### 7.7.11 Process Value

The upper display shows the current temperature of the product.

### 7.7.12 PSP, Segment Type and Number

The lower display continually alternates between the programs current set value (Program SP = PSP) and scrolling text, indicating the current status of the program whether RAMP or DWELLING followed by the segment number.

Additional information can be obtained using the scroll key while the program is operating.
Working Output Power

From the home display, press scroll \( \uparrow \) until the display shows WRK.OP <WORKING OUTPUT POWER>. This shows the power being used as a percentage.

Time Remaining

Press scroll \( \uparrow \) until the display shows T.REMN <TIME REMAINING>. This shows the dwell time remaining for the current segment. There is no value for “Ramp Time Remaining” therefore when the program is ramping the dwell time set will be shown and will only begin to count down when the ramp has finished.

Program Review

Further presses of scroll \( \uparrow \) will reveal the settings of the current program operating. These parameters are locked, while the program is operating.

Program Hold with Holdback

If a holdback value has been set (see section 7.6) and the program goes into a hold state, the red “HLD” indicator will light, until the current temperature catches up.

If while in this condition the program itself is put into “Hold” by pressing the up \( \uparrow \), down \( \downarrow \) together, the “HLD” indicator will turn off and the “Run” indicator will flash, indicating the program is on hold. When the program is started again by pressing the up \( \uparrow \), down \( \downarrow \) together, the “Run” indicator will stop flashing and show continually and the “HLD” indicator will light, if the current temperature has not caught up with the program.

Power Failure

If there is a power failure while the program is operating and the power is subsequently restored, the scrolling text will read <POWER FAIL - PROGRAM RESET>.

Press the “ACK” function to acknowledge this message, press the “ACK” function again to reset the program.

Alarms

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

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

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

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

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

The following sequence of entries creates and runs the program shown graphically below.

1. Press scroll until the display shows RAMP.U <SP RAMP UNITS>. Select MIN.  
2. Press scroll until the display shows DWELL.U <DWELL UNITS>. Select MIN.  
3. Press scroll until the display shows RMP.1 <RAMP RATE 1>. Select 5  
4. Press scroll until the display shows T.SP1 <TARGET SP 1>. Select 600  
5. Press scroll until the display shows DWEL.1 <DWELL TIME 1>. Select 30  
6. Press scroll until the display shows RMP.2 <RAMP RATE 2>. Select 4  
7. Press scroll until the display shows T.SP2 <TARGET SP 2>. Select 400  
8. Press scroll until the display shows DWEL.2 <DWELL TIME 2>. Select 30  
9. Press scroll until the display shows RMP.3 <RAMP RATE 3>. Select OFF  
10. Press scroll until the display shows T.SP3 <TARGET SP 3>. Select 600  
11. Press scroll until the display shows DWEL.3 <DWELL TIME 3>. Select 60  
12. Press scroll until the display shows RMP.4 <RAMP RATE 4>. Select 3  
13. Press scroll until the display shows T.SP4 <TARGET SP 4>. Select 800  
14. Press scroll until the display shows DWEL.4 <DWELL TIME 4>. Select OFF  
15. Press scroll until the display shows RMP.5 <RAMP RATE 5>. Select 5  
16. Press scroll until the display shows T.SP5 <TARGET SP 5>. Select 400  
17. Press scroll until the display shows DWEL.5 <DWELL TIME 5>. Select 480
18. Press the ACK function to return to the home display.  
19. Press the up ▲ and down ▼ keys together, to operate the program.
### 7.8 Controller Options

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

#### 7.8.1 Digital Communications - RS232

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

<table>
<thead>
<tr>
<th>Product end of cable</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>female (25-pin) 9-pin</td>
<td></td>
<td>9-pin (25-pin) male</td>
</tr>
<tr>
<td>Rx</td>
<td>(2) 3</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>Tx</td>
<td>(3) 2</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com</td>
<td>(7) 5</td>
<td>5 (7) Com</td>
</tr>
</tbody>
</table>

7,8 (4,5) Link together

1,4,6 (6,8,20) Link together

#### 7.8.2 Digital Communications - RS485

If an RS485 option is supplied, the furnace is fitted with two D-sockets. Connection between products is by “straight” cable as follows:

<table>
<thead>
<tr>
<th>Product end of cable</th>
<th>RS485 Cable: product to PC</th>
<th>Computer end of cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>female (25-pin) 9-pin</td>
<td></td>
<td>9-pin (25-pin) female</td>
</tr>
<tr>
<td>-</td>
<td>(2) 3</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>+</td>
<td>(3) 2</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com</td>
<td>(7) 5</td>
<td>5 (7) Com</td>
</tr>
</tbody>
</table>

7.8.3 Comms Address

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

7.8.4 Alarm Option

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

```
<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>F</td>
<td>Fuse (2A)</td>
</tr>
<tr>
<td>S</td>
<td>Supply</td>
</tr>
<tr>
<td>L</td>
<td>Load</td>
</tr>
<tr>
<td>*</td>
<td>Normally open relay contacts</td>
</tr>
<tr>
<td>RO</td>
<td>Relay Output 240V 2A MAX</td>
</tr>
</tbody>
</table>
```

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

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

### 7.9 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.

Ease apart the two lugs at the side; grip the instrument and withdraw it from its sleeve; push in the replacement.

### 7.10 3216 Controller Navigation Diagram

The following diagram details how to navigate to the various menu options within the 3216 Controller. At each option, values can be set using the arrow keys.
L1  Level 1

Press the Scroll Key

Hold the Page key for 3 seconds

L2  Level 2

Press the Scroll Key multiple times

Locked - password required

Access

If configured

Unlocked

**  Do not raise the power limit (if accessible) above the design level for the product

Multiple Program Only

Black = Progress

Dashed = Through multiple menus

White = Return
8.0 Temperature Controller

If this product is fitted with a temperature controller, instructions are provided separately.
9.0 2132 Over-Temperature Controller Description (if fitted)

9.1 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.

9.2 Operation

9.2.1 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.
9.2.2 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. See section 9.4.

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.

9.2.3 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).

9.2.4 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.

9.2.5 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.

9.2.6 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.
9.3 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 9.2.

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

9.4 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>
10.0 Operation

10.1 Operating Cycle

The product is fitted with an instrument switch. The switch cuts off power to the controllers and elements. The circulation fan will operate when the instrument switch is on. An optional door switch may be fitted. If so, ensure that the door is closed to operate the fans and heating elements.

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.

**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 the product off, turn off the instrument switch. If the product is to be left unattended, isolate the electricity supply.

DO NOT switch off if the temperature is above 100 °C - damage could be caused to the fan and motor. Adjust the controller to allow the temperature to fall.

10.2 Over-Temperature Control (if fitted)

The over-temperature controller should typically be set at 15 °C above the main controller. If an over-temperature condition occurs, check the main controller is functioning correctly.

An over-temperature condition cuts off power to the heating elements. A light in the over-temperature controller flashes. To reset this, refer to the over-temperature control section of this manual.

10.3 Explosive Vapours

Unless your product includes the stoving and curing option, this model is not suitable for drying or heat treatment applications where vapours are released that are combustible or which can form explosive mixtures with air. Carbolite Gero manufactures other products suitable for these applications.
10.4 Atmospheres

When an optional gas inlet is fitted, there is a label near the inlet saying "INERT GAS ONLY". In practice, inert or oxidising gases may be used, but not combustible or toxic gases.

10.5 Solenoid Valve with Manual Switch (if fitted)

If ordered the solenoid valve is operated using the panel mounted switch. When the switch is in the 'ON' position the solenoid valve will allow gas to flow. Ensure the installation and use of the product does not create a hazardous atmosphere. The workspace must have sufficient ventilation.

10.6 Variable Speed Fan (if fitted)

If fitted, the variable speed control is fitted in the air circulation fan circuit. A panel mounted rotary dial is used to control the speed.

Please note that there is a minimum setting at which the fan motor starts up when the product is switched on. It is recommended that the speed of the fan is not set below 50%, as there would be very little air flow around the chamber and also risk overheating the fan motor.

10.7 Exhaust Fan (if fitted)

To operate the exhaust fan use the fan switch on the control panel; this is only functional when the instrument switch is on.

The level of air exhaust can be controlled by adjusting the slider under the exhaust box.

When the exhaust fan is turned on, there may be a drop in internal temperature before the product recovers to the setpoint value.

The airflow should be adjusted to the minimum required by the process to reduce the amount of energy wasted in heating air.
# 11.0 Maintenance

## 11.1 General Maintenance

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

## 11.2 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></td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bi-Anually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually</td>
</tr>
<tr>
<td><strong>Safety</strong></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 Seal</td>
<td>Visual inspection - check for splits or fraying</td>
<td></td>
</tr>
<tr>
<td>Door Seal</td>
<td>Replacement</td>
<td></td>
</tr>
<tr>
<td>Air Vent</td>
<td>Check and clean 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><strong>Function</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Calibration</td>
<td>Tested using certified equipment, frequency dependent on the standard required</td>
<td></td>
</tr>
<tr>
<td>Operational Check</td>
<td>Check that all functions are working normally</td>
<td></td>
</tr>
<tr>
<td>Operational Check</td>
<td>Thorough inspection and report incorporating a test of all functions</td>
<td></td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 11.0 Maintenance

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling Fans (if fitted)</td>
<td>Check whether the cooling fans are working</td>
<td></td>
</tr>
<tr>
<td>Circulating Fan (if fitted)</td>
<td>Visual check to see if it is running</td>
<td></td>
</tr>
<tr>
<td>Circulating Fan (if fitted)</td>
<td>Check bearings and replace if necessary</td>
<td></td>
</tr>
<tr>
<td>Element Circuit</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td>Power Consumption</td>
<td>Measure the current drawn on each phase / circuit</td>
<td></td>
</tr>
<tr>
<td>Shelves</td>
<td>Visual check for fit and damage</td>
<td></td>
</tr>
</tbody>
</table>
11.0 Maintenance

11.2.1 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.

11.3 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.

11.4 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.

11.5 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 a fan and motor assembly, a thermocouple, a solid state relay, an element (or set of elements) and a door seal. Individual spare parts are also available.

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

11.6 Power Adjustment
The control system incorporates electronic power limiting, but for the model listed in this manual the power limit is set to 100%. The power limit parameter OP.Hi may be accessible to the operator, but should not generally be altered.
In some cases the supply voltage may be outside the range 220-240 V or the 3-phase equivalent, the power limit parameter may be set to a value other than 100%. Do not increase the value to 100%, see section 15.0 for details of power limit settings.
12.0 Repairs and Replacements

12.1 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.

12.2 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.

12.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
12.4 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.

12.5 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 K)</td>
<td>green</td>
</tr>
<tr>
<td>negative</td>
<td>white</td>
</tr>
</tbody>
</table>

Undo any clips holding the thermocouple. Remove the air guide from the oven chamber. Disconnect the thermocouple from its terminal block. Unscrew the compression fitting inside the chamber and pull the thermocouple into the chamber. Cut through the thermocouple behind the olive and remove the two parts. Loosely assemble compression fitting with a new ferrule. Feed in new thermocouple through from the back. Tighten the compression fitting. Refit the air guide. Bend the thermocouple to match the shape of the previous part and refit any clips.
Refit the element access panel.

Compression fittings are only fitted to moisture extraction and stoving and curing products. If fitted, ferrules need replacing.

12.6 Element Replacement

To find out whether the element failure was caused by a fault in the control circuit, operate the oven at a low temperature and check that it is functioning correctly.
to replace the element, remove the rear panel and internal air guides. The element terminals are accessed from the back.
Disconnect the wires from the element terminals. Ferrules in the compression fitting are designed for single usage and need to be replaced with the element. Remove the element by undoing the element fitting. Slightly withdraw the element. Cut through the ferrules and the element. Remove the three parts of the element.
Install a new element from inside the chamber. Install the new ferrules and replace the compression fitting. Tighten the compression fitting to ensure the chamber is gas tight.

12.7 **Fuse Replacement**

Fuses are accessed by removal of the panel as explained in 'Panel Removal' section. Depending on the model, supply fuses and control circuit fuses may be mounted in their own holders, or may be on a circuit board that contains an EMC filter. The fuses are marked with their ratings.

Take care not to disconnect the wires leading from the EMC filter without first recording their positions: they must be reconnected to the correct terminals.
## 13.0 Fault Analysis

### A. Oven Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The temperature controller is OFF</td>
<td>No power from supply</td>
</tr>
<tr>
<td>2.</td>
<td>The temperature controller is ON</td>
<td>The controller shows a very high temperature or a code such as EEE or --- or S.br</td>
</tr>
<tr>
<td></td>
<td>The controller shows a low temperature</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>The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault</td>
</tr>
</tbody>
</table>

### B. Oven Overheats

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Oven 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 have been shorted out or may have been moved out of the oven</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The thermocouple may be connected the wrong way round</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty</td>
</tr>
<tr>
<td>2.</td>
<td>Oven heats up when the instrument switch is OFF</td>
<td>The SSR has failed &quot;ON&quot;</td>
</tr>
</tbody>
</table>
14.0 Wiring Diagrams

14.1 WV-11-01

![Wiring Diagram]

**Key**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1, F2</td>
<td>Fuses</td>
</tr>
<tr>
<td>FIL</td>
<td>Filter</td>
</tr>
<tr>
<td>SW</td>
<td>Instrument Switch</td>
</tr>
<tr>
<td>R1</td>
<td>Relay (Coil)</td>
</tr>
<tr>
<td>R1/1, R1/2</td>
<td>Relay Contactor</td>
</tr>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>OT</td>
<td>Over-Temperature Controller</td>
</tr>
<tr>
<td>TC</td>
<td>Thermocouple</td>
</tr>
<tr>
<td>SSR</td>
<td>Solid State Relay</td>
</tr>
<tr>
<td>EL</td>
<td>Element(s)</td>
</tr>
<tr>
<td>*</td>
<td>If Fitted</td>
</tr>
<tr>
<td>L</td>
<td>Live</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>PE (GR/Y)</td>
<td>Earth (Green+Yellow)</td>
</tr>
</tbody>
</table>
14.2 WS-10-01 - Isolating for 208 V version only

The transformer changes the supply voltage of the control circuit into the desired operating range for the controller and other components.

The supply voltage as shown is taken from a single phase supply or from the phase-to-phase voltage of a 3-phase supply.

The instrument circuit is modified as follows.

![Wiring Diagram](image_url)

**Key**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1, F2</td>
<td>Fuses</td>
</tr>
<tr>
<td>FIL</td>
<td>Filter (if fitted)</td>
</tr>
<tr>
<td>TX</td>
<td>Transformer</td>
</tr>
<tr>
<td>SW</td>
<td>Instrument Switch</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>L1</td>
<td>Live</td>
</tr>
<tr>
<td>PE</td>
<td>Earth</td>
</tr>
</tbody>
</table>
15.0 Fuses and Power Settings

15.1 Fuses

F1-F2: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th>Fuses</th>
<th>Description</th>
<th>Fuse Type/Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1 Internal Supply Fuses</td>
<td>Fitted if supply cable fitted. Fitted on board to some types of EMC filter.</td>
<td>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)</td>
</tr>
<tr>
<td>F2 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>Customer Fuses</td>
<td>Required if no supply cable fitted. Recommended if cable fitted. See rating label for current; See table below for fuse rating.</td>
<td></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>6/500</td>
<td>3-phase + Neutral</td>
<td>400 V</td>
<td>25 A (per phase)</td>
</tr>
</tbody>
</table>

15.2 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>Volts</th>
<th>208 V</th>
<th>220 V</th>
<th>230 V</th>
<th>240 V</th>
<th>380 V</th>
<th>400 V</th>
<th>415 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>-</td>
</tr>
</tbody>
</table>

15.3 Fuses

F1-F2: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th>Fuses</th>
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</tr>
</tbody>
</table>
Customer Fuses | Required if no supply cable fitted. Recommended if cable fitted. | See rating label for current; See table below for fuse rating.

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/28</td>
<td>1-phase</td>
<td>220-240</td>
<td>6 A</td>
</tr>
<tr>
<td>5/18</td>
<td>1-phase</td>
<td>230</td>
<td>10 A</td>
</tr>
<tr>
<td>6/500</td>
<td>3-phase + N</td>
<td>380-415</td>
<td>25 A</td>
</tr>
</tbody>
</table>

### 15.4 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>Volts</th>
<th>208 V</th>
<th>220 V</th>
<th>230 V</th>
<th>240 V</th>
<th>380 V</th>
<th>400 V</th>
<th>415 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (%)</td>
<td>88</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Power (%)</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Please refer to the rating label for product specific information.
## 16.0 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 (mm)</th>
<th>External (mm)</th>
<th>Approx Capacity (l)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>H W D</td>
<td>H W D</td>
<td></td>
</tr>
<tr>
<td><strong>HTCR 6/500</strong></td>
<td>600</td>
<td>12</td>
<td>800 800 800</td>
<td>1305 1115 1450</td>
<td>500</td>
</tr>
</tbody>
</table>

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>Chamber Size (mm)</th>
<th>Approx Capacity (l)</th>
<th>Net Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>H W D</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HTCR 4/28</strong></td>
<td>400</td>
<td>1</td>
<td>305 305 305</td>
<td>28</td>
<td>62</td>
</tr>
</tbody>
</table>

## 16.1 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>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
The products covered in this manual are only a small part of the wide range of ovens, chamber furnaces and tube furnaces manufactured by Carbolite Gero for laboratory and industrial use. For further details of our standard or custom built products please contact us at the address below, or ask your nearest stockist.

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

**Carbolite Gero Service**

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

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