Installation, Operation and Maintenance Instructions
1800°C Chamber Furnace - HTF Model: 8 Litres
3508 Controller

HTF 18/8 + 3508 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 icon]

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

![Heat light icon]

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

1.2 Warning Symbols

![DANGER icon]

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

![DANGER icon]

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

![DANGER icon]

DANGER – Read any warning printed next to this symbol.

![FAULT icon]

FAULT - read any information printed by this symbol.
Caution – Double Pole/Neutral Fusing
2.0 Installation

2.1 Unpacking and Handling

When unpacking or moving the product always lift it by its base. Do not use the door or any other protruding parts. The product contains a transformer and is heavy: use two or more people to carry the product.

Remove any packing material from the door great and from inside the product chamber. Close the door with care to prevent any damage to insulation surfaces.

NOTE: This product contains Refractory Ceramic Fibre (also known as Alumino Silicate Wool - ASW). For precautions and advice on handling this material see section 8.2.

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.
If the product is to be used in a process which could liberate hazardous gases, then it should be installed together with a suitable fume extraction system. Ensure that the product is placed in such a way that it can be quickly switched off or disconnected from the electrical supply.

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 Fitting the Heating Elements

Please refer to the Element Installation and Replacement in section 8.0. Wear eye protection when handling the heating elements. The molybdenum disilicide elements are EXCEPTIONALLY FRAGILE and are packed separately, together with other items shown in the list.

<table>
<thead>
<tr>
<th>Separately Packed Items</th>
<th>1800 °C Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements</td>
<td>5</td>
</tr>
<tr>
<td>Element Clamps</td>
<td>10</td>
</tr>
<tr>
<td>Element Clips</td>
<td>10</td>
</tr>
<tr>
<td>Braids</td>
<td>1 set of 6</td>
</tr>
</tbody>
</table>
The installation of these elements is described in section 0.1.

### 2.4 Electrical Connections

Connection by a qualified electrician is recommended.

These models are designed only for single phase electrical supplies, or for two live phases and neutral of a 3-phase supply. The product must be connected only to the type and voltage of supply for which it was ordered.

Check that the supply voltage is compatible with the voltage on the label, and that the current capacity is sufficient for the current on the label, before connection to the electrical supply. A table of the most common ratings is given in section 11.0 towards the back of this manual.

Normally a supply cable is not fitted, and connection is to be made to terminal blocks accessed by removal of the left-hand end side cover (see section 8.3). The electrical supply cable must be properly connected and fitted with an appropriate strain relief at the entry to the case.

The electrical supply cable should be wired to an isolator or fitted with a line plug. The isolator must be within easy reach of the operator, or the line plug must be easily removable and on a lead not exceeding 3 m length. The line plug must allow the protective earth (ground) to be connected before the supply conductors and to be disconnected after them. The supply point must be marked as the disconnecting device for the furnace.

The electrical supply MUST incorporate an earth (ground).

Electrical Connection Details:

<table>
<thead>
<tr>
<th>Supply</th>
<th>Terminal Label</th>
<th>Cable Colour</th>
<th>Supply Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Live - Neutral</td>
</tr>
<tr>
<td>1-phase</td>
<td>L</td>
<td>Brown</td>
<td>to live</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Blue</td>
<td>to neutral</td>
</tr>
<tr>
<td></td>
<td>PE</td>
<td>Green/ Yellow</td>
<td>to earth (ground)</td>
</tr>
</tbody>
</table>
2.5 Power Supply Notes

Each model is manufactured for one of the following voltage ranges:

- 208 V
- 220 to 240 V
- 380 to 415 V (not HTF 17/5 or HTF 18/4)

It is not possible to modify and use a furnace manufactured for the 380-415 range on either of the other two voltage ranges listed above: there are too many component differences.

It is possible to modify a furnace manufactured for either 208 and 220-240, provided the thyristor unit is replaced. A transformer tapping must also be altered. See sections 8.4 and 8.10.

It is possible to alter the voltage within any of the ranges above, by reconnecting the incoming cable to the transformer to the appropriate primary tapping. The tappings are 208 - 220 - 230 - 240 V, or 380 - 400 - 415 V, and are labelled on the primary side of the transformer - see section 8.10. It is also necessary to adjust the setting of the thyristor stack: see section 8.4.

Examples:

- to alter a furnace made for a 240 V supply to 208 V: replace thyristor stack, move a cable to the 208 V transformer tapping, and adjust the thyristor stack.

- to change from a supply of 220 V to 230 V: move a cable to the 230 V, and adjust the thyristor stack.

Please contract Carbolite Gero Service for guidance and assistance if the power supply shown on the rating label does not match the power supply available.
3.0 3508 Controller

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 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.

3.3 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.

3.4 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.
3.5 Basic Operation

Key

| A | Alarm Indicator |
| B | Power Output Indicator |
| C | Not Used |
| D | Runs, Holds, Resets the current program |
| E | Page |
| F | Scroll |
| G | Down |
| H | Up |
| I | Power Output Percentage |
| J | Program Setpoint Temperature (PSP) when a program is running |
| K | Setpoint Temperature (SP) when basic controlling |
| L | Measurement Temperature |
3.0 3508 Controller

3.5.1 Controller Layout

3.5.2 Keys

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</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</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.

3.6 Quick Start Guide

3.6.1 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.

3.6.2 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.

3.6.3 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.

3.6.4 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.

### 3.7 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".

#### 3.7.1 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 11.0.

#### 3.7.2 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.
3.7.3 Units

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

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

3.7.4 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.

3.8 Programming

3.8.1 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.

3.8.2 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>Option</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'.

3.8.3 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.

3.8.4 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.

3.8.5 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.'
3.0 3508 Controller

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'.

3.8.6 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'.

3.8.7 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

3.8.8 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'

3.8.9 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

3.8.10 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 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

3.8.11 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.

3.8.12 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.
3.8.13 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 and together.

3.8.14 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 ▼.
2. Press page ▲ until 'Prog Segments Used' is displayed. On P10 or 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. Default '0’ 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 'Rate”
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 ‘400’ degrees.
10. Press scroll ▼ until 'Ramp Rate' is displayed. Press up ▲ or down ▼ 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 ⬆️ 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 'Reset'.

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

To run 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'.
3.8.15 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 一直到’Cycles’ is displayed. Default ‘1’
6. Press scroll 一直到'Segment 1' is displayed
7. Press scroll 一直到'Segment Type' is displayed. Press up ▲ or down ▼ to select ‘Time’
8. Press scroll 一直到'Holdback Type' is displayed. Default ‘Off’
9. Press scroll 一直到'Target SP' is displayed. Press up ▲ or down ▼ to set to ‘600’ degrees
10. Press scroll 一直到'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</th>
<th>Rate</th>
<th>Target SP</th>
<th>Ramp Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type Rate</td>
<td>‘400’ degrees. Ramp Rate ‘2.0’ degrees per minute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type Step</td>
<td>‘200’ degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type Dwell</td>
<td>Holdback ‘High’. Duration ‘30:00.0’ minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type Call</td>
<td>Call Prog ‘next number’. Call Cycles ‘2’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finish the program with an End segment:

11. Press scroll 一直到'Segment Type' is displayed. Press up ▲ or down ▼ to select ‘End’
12. Press scroll 一直到'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 ointments and scroll altogether to return to the home display
To operate the program either press RUN/HOLD or
14. Press page ointments until 'Program Status' is displayed
15. Press scroll ointments until the cursor moves to the program status of 'Reset'
16. Press ▲ to select 'Run'
### 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.
3.9.1 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 female (25-pin) 9-pin</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx</td>
<td>(2) 3</td>
<td>3 (2) Rx</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>

3.9.2 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 female (25-pin) 9-pin</th>
<th>RS485 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) female</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>(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>

3.9.3 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.

3.9.4 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.

3.9.5 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.

3.9.6 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.

### 3.10 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.

### 3.11 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.
3.11.1 Operator Level 1 - No 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>Page Key</td>
<td></td>
<td>←</td>
<td>White = Return</td>
</tr>
<tr>
<td>Scroll Key</td>
<td></td>
<td>*</td>
<td>Visible Parameters depend on the Segment Type</td>
</tr>
</tbody>
</table>
3.11.2 Operator Level 1 - Program Running

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HD</td>
<td>Home Display</td>
<td>Controller identity when using more than one controller</td>
</tr>
<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>See previous diagram: Operator Level 1 - No Program Running</td>
<td></td>
</tr>
</tbody>
</table>
3.11.3 Supervisor Level 2

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>To enter Level 2</td>
<td>Scroll Key</td>
</tr>
<tr>
<td>B</td>
<td>Level 2</td>
<td>Locked before Pass Code entered</td>
</tr>
<tr>
<td>L1</td>
<td>Level 1 Home Display</td>
<td>Unlocked</td>
</tr>
<tr>
<td>L2</td>
<td>Level 2 Home Display</td>
<td>Black = Progress</td>
</tr>
<tr>
<td></td>
<td>Page Key</td>
<td>See previous diagram: Operator Level 1 - No Program Running</td>
</tr>
<tr>
<td></td>
<td>Hold Page Key for 3 seconds</td>
<td>If configured</td>
</tr>
<tr>
<td></td>
<td>Arrow Key</td>
<td></td>
</tr>
</tbody>
</table>
4.0 3508 Dual Loop Cascade Control (if fitted)

4.1 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.

4.2 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

4.0  3508 Dual Loop Cascade
4.3 **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.

4.4 **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
– SP I = 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 SP I. 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.

4.5 **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.

4.6 **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:

\[
\text{working temperature} + (\text{maximum temperature} \times FF/100) + 15 \degree C
\]

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.
5.0 2132 Over-Temperature Controller Description (if fitted)

5.1 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.

5.2 Operation

5.2.1 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.
5.2.2 Operation

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

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

The scroll key allows access to the parameters within a list. Some parameters are display-only; others may be altered by the operator. A single press of the scroll key in the 'Home' list displays the temperature units; further presses reveal the parameters in the current list indicated in the navigation diagram.

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

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

5.2.3 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).

5.2.4 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.

5.2.5 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.

5.2.6 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.
5.3 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 5.2.

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

5.4 Navigation Diagram

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HL</td>
<td>Home List</td>
<td>Page Key</td>
</tr>
<tr>
<td>OTSP</td>
<td>Over-Temperature Setpoint</td>
<td>Scroll Key</td>
</tr>
<tr>
<td>AL</td>
<td>Access List</td>
<td>For factory access to list and parameters not available to the operator.</td>
</tr>
</tbody>
</table>
6.0 Operation

6.1 Operating Cycle

The product is fitted with an instrument switch. The switch cuts off power to the controllers and contactor.

Connect the product to the electrical supply. The cooling fans will operate.

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.

The heat light glows brightly at first, more dimly as the product temperature approaches a program setpoint.

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

To switch the product off, turn the instrument switch off. The case cooling fans continue to operate. Leave the fans on until the product cools to below 300 °C. If the product is to be left unattended, isolate it from the electrical supply.

6.2 Operator Safety

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

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

Before removing a hot object from the product, make sure there is a safe place to put it down. If necessary use tongs, face masks and heat resistant gloves. Heat resistant clothing and face protection can guard against the effects of radiated heat when the furnace is open.
When the product is opened during operation there is considerable radiated heat. Do not keep any flammable objects near the product, nor objects which could be damaged by radiated heat.

6.3 Loading The Furnace

When heating large objects, in particular poor conductors, avoid shielding the thermocouple from the heating elements. Also ensure that nothing is within 15 mm of the elements.

The thermocouple is intended to sense the temperature near the heating element. However if a large object is placed in the chamber it may record the average temperature of the object and the elements, which can lead to over heating of the elements. Allow large objects to gain heat at a lower temperature and then reset the controller to a temperature close to the desired maximum.

Take care that nothing hits the elements when loading and unloading.

6.4 Opening the Door

![Warning]

Take great care when loading or unloading the furnace chamber. See section 6.2. Before removing a hot object from the furnace, ensure a suitable surface is available on which to put it.

Do not open the door at high temperatures. If possible, do not open it above 200 °C. If it is necessary to load or unload work at elevated temperatures, keep the door open for as short a period as possible. The insulation cools quickly and may crack through thermal shock.

The heating elements and the insulation are very susceptible to mechanical shock. At all times operate the door gently to avoid mechanical shock.

Opening the door when the furnace is very hot can cause hot air to be sucked by the case cooling fans towards the thermal cut out and activate it (see section 6.11). Avoid excessive door opening and shut it as soon as possible.

6.5 Insulation Cracking

In these furnaces the insulation material is susceptible to surface cracking as a result of high temperature cycling; this is a normal occurrence and such cracking is not detrimental to the performance of the furnace.

6.6 Atmospheres & Corrosive Materials

In oxidising atmospheres, metal oxides react with the silica layer on the surface of the elements and may lead to premature failure. Protect the elements from splashes of molten metal and dust when loading the furnace and from fumes developed when melting, especially from fluxes. Also avoid compounds with a high alkali content.

The furnace is designed for use up to its maximum temperature in oxidising atmospheres, but can be operated successfully in neutral or carburising atmospheres. It
may be used with nitrogen, argon or helium atmospheres to 1600 °C. Reducing atmospheres are not recommended. Sulphur dioxide is not harmful in low concentrations. However chlorine and fluorine attacks oxidised elements and should be avoided. A harmful gas is produced and collects in poorly ventilated spaces.

The furnace is not recommended for burning off carbonaceous materials. Other Carbolite Gero furnaces are available for this application.

When an optional gas inlet is fitted there is a label near the inlet saying "INERT GAS ONLY".

The chamber is not gas tight, the gas usage may be high and the chamber is always likely to contain some air. Residual oxygen of approximately 1% to 2% is to be expected.

Periodically operate the furnace in air at 1500 °C for an hour to ensure the protective glaze on the elements surface is maintained.

The hearth can be protected from abrasion, if required, by the provision of a secondary plate. This consumable item can either be in lightweight ceramic fibre or in dense, hard-wearing alumina refractory.

6.7 Pestling

The furnace is fitted with molybdenum disilicide elements and is therefore susceptible to pesting. Pestling can be seen as a yellowish crystal growth on the surface of the element. It occurs when the element surface temperature is around 450 °C and is caused by the air oxidising with the molybdenum in the element compound. Under normal operating conditions (above 800 °C) pesting is not a problem and can often be seen occurring naturally on the element terminals.

operating the furnace for prolonged periods at temperature below 600 °C will cause pesting to occur on the element surface and will eventually damage the elements.

Heating on a slow ramp rate or dwelling at temperatures below 600 °C for short periods will not cause a problem providing the furnace is operated above 1400 °C at regular intervals to recondition the element surfaces.

Large amounts of pesting occurring on the element terminals must be removed in accordance with good health and safety practices.

6.8 Explosive Materials

The product must not be used to heat materials which could explode, or which could emit gases that could form explosive mixtures.

6.9 Notes on Temperature Control

This product is designed for heating and cooling at controlled rates. The heating and cooling rates can be set in the temperature programmer. The programmer enables the furnace to heat or cool at slower rates as desired and variable "hold" (dwell) periods can be programmed as required.
The programmer is used in conjunction with a phase angle thyristor power controller, which incorporates a current limit potentiometer pre-set by Carbolite Gero, but which will require adjustment in the event of change of supply voltage. The elements are connected in series across the low voltage output of a transformer housed in the furnace case. Molybdenum disilicide elements do not age, if an element fails it is not necessary to replace the complete set.

### 6.10 Thermocouple Warnings

1. The output from 1700-1800 °C thermocouples when used regularly at temperatures greater than 1650 °C can deteriorate and decrease with age faster than if used at temperatures below 1650 °C; this will cause the furnace to operate at temperatures higher than indicated.

Operators are advised to periodically check the thermocouple output, either by a calibration test or by comparing the output with a new reference thermocouple which has been subjected to high temperatures for a minimum length of time.

Failure to check the thermocouple regularly may result in overheating of the work and the furnace, with consequential damage to both.

2. The thermocouples fitted to these models give very low outputs below approximately 600 °C and do not give accurate readings at low temperatures. They may show a negative temperature when the furnace is started from cold.

This furnace is not intended to operate with a setpoint below 600 °C.

### 6.11 Thermal Cutouts

There is a thermal cutout on the interior case surface at the centre top near the chimney. In the event of fan failure or any other reason for case over heating, power to the heating elements is cut.

To reset the thermal cutout, first isolate the furnace from the electrical supply. Remove the top panel and press upwards the button on the cutout device. TAKE CARE - the chimney may be hot.

There is a further thermal cutout in the element circuit transformer which cuts power if the transformer core overheats. This is self-resetting.

If either thermal cutout is activated, then a fault light on the control panel is illuminated.
6.12 General Operating Advice

Heating element life is shortened by overheating. Do not leave the product at high temperature when it is not required. The maximum temperature is shown on the product rating label and in section 12.0 towards the back of this manual.

When heating large objects, in particular poor conductors, avoid shielding the thermocouple from the heating elements. The thermocouple is intended to sense the temperature near the heating elements. However, if a large object is placed in the chamber it may record the average temperature of the object and the elements, this can lead to overheating of the elements. Allow large objects to gain heat at a lower temperature and then reset the controller to a temperature close to the desired maximum, or heat using a slowly controlled ramp rate. For more information refer to the controller instructions.

The product's elements are very susceptible to mechanical shock. Take great care when loading or unloading the chamber. If it is necessary to load or unload work at elevated temperatures, keep the door open for as short a period as possible. The insulation cools quickly and may crack though thermal shock.

For improved insulation and element life it is recommended to heat and cool at a slow ramp rate e.g. 5 °C/minute, and to avoid opening the door at high temperatures.

On first installing the elements and on subsequent element replacement, operate the product at 1500 °C for an hour to create a protective glaze on the element surface.
### 7.0 Maintenance

#### 7.1 General Maintenance

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

#### 7.2 Maintenance Schedule

[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>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td></td>
</tr>
<tr>
<td>Safety Switch Function</td>
<td>Set a safe temperature above ambient, and open the door to see if the heater light goes out</td>
</tr>
<tr>
<td>Safety Switch Function</td>
<td>Electrical measurement</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>
</tr>
<tr>
<td>Over-Temperature Safety Circuit (if fitted)</td>
<td>Electrical measurement</td>
</tr>
<tr>
<td>Door Plug</td>
<td>Visual inspection, checking the seal and whether it is free of damage</td>
</tr>
<tr>
<td>Door Plug</td>
<td>Replacement where necessary</td>
</tr>
<tr>
<td>Chimney / Extraction</td>
<td>Check and clean if necessary</td>
</tr>
<tr>
<td>Electrical Safety (external)</td>
<td>Visual check of external cables and plugs</td>
</tr>
<tr>
<td>Electrical Safety (internal)</td>
<td>Physically check all connections and cleaning of the power plate area</td>
</tr>
<tr>
<td><strong>Function</strong></td>
<td></td>
</tr>
<tr>
<td>Temperature Calibration</td>
<td>Tested using certified equipment, frequency dependent on the standard required</td>
</tr>
<tr>
<td>Operational Check</td>
<td>Check that all functions are working normally</td>
</tr>
</tbody>
</table>
# 7.0 Maintenance

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

## Performance

<table>
<thead>
<tr>
<th>Element Circuit</th>
<th>Electrical measurement</th>
<th><img src="https://via.placeholder.com/60x60" alt="Warning" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Consumption</td>
<td>Measure the current drawn on each phase / circuit</td>
<td><img src="https://via.placeholder.com/60x60" alt="Warning" /></td>
</tr>
<tr>
<td>Hearths</td>
<td>Visual check for fit and damage</td>
<td><img src="https://via.placeholder.com/60x60" alt="Warning" /></td>
</tr>
<tr>
<td>Cooling Fans (if fitted)</td>
<td>Check whether the cooling fans are working</td>
<td><img src="https://via.placeholder.com/60x60" alt="Warning" /></td>
</tr>
</tbody>
</table>
7.2.1 Cleaning
Soot deposits may form inside the furnace, depending on the process. At appropriate intervals remove these by heating as indicated in the General Operation Notes.

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

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

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

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

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

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

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

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

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

7.2.3 Other Electrical Components
Regular visual or electrical checks should be made on the condition of the electrical supply cable. All internal fuses and visible internal cables should be inspected periodically.
7.0 Maintenance

7.2.4 Element Glaze

Depending on the use, heating elements may lose their glaze and gain a rough appearance. They should be checked from time to time. If the glaze has disappeared, it may be restored by heating the furnace up to 1500 °C, without load, for approximately 2 hours.

7.3 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.

7.4 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.

7.5 Recommended Spare Parts and Spare Parts Kit

Carbolite Gero can supply individual spare parts or a kit of the items most likely to be required. Ordering a kit in advance can save time in the event of a breakdown.

Each kit consists of one thermocouple, one sheath, one power thyristor, one door insulation piece and a set of elements, clips and braid, element clamps and insulators. Individual spare parts are also available.

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

7.6 Power Adjustment (Controller)

The product's controller incorporates a power limit parameter OP.Hi, which is usually inaccessible to the operator.

The correct setting for the power limit depends on the supply voltage, table given in section 11.0.
7.7 Power Adjustment (Thyristor)

The current-limiting thyristor stacks which control power to the elements are fitted with an adjustable resistor which is factory set to limit the maximum current supplied. In the event of a change of supply voltage, or the fitting of a new thyristor, further adjustment may be required.

The maximum element currents for this model are listed in section 11.0. Please contact Carbolite Gero for further information.

7.8 Low Voltage Compensation

If the supply voltage proves to be routinely below the nominal figure for which the furnace has been set up, there is a "+2%" position on the transformer primary side which may be used instead of the standard position, see section 8.10.
8.0 Repairs and Replacements

8.1 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.

8.2 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.

8.3 Side Panel Removal

Except where explicitly stated, always disconnect the electrical supply before removing the side panel.
Remove the panel by loosening the four fixing screws (behind plastic caps) at the left-hand end of the furnace; do not remove the screws. Lift the panel about 15 mm and then pull off to the side.

8.4 Thyristor Replacement and Adjustment

Replacement
To replace the thyristor unit, isolate the furnace from the electrical supply and remove the left-hand side cover. See section 8.3. Make a note of all wiring to the thyristor, then disconnect it. Replace the unit and connect the wiring again.

Note that the thyristor unit requires replacement if changing from, or to, a 208 V supply.

If the thyristor unit has been replaced because of a change of voltage, the correct transformer tapping should also be set. See section 8.10 for panel removal instructions.

Adjustment

After any thyristor unit replacement, or any change of voltage or transformer tapping, the potentiometer on the thyristor must be adjusted to give the correct element current. This should be done by a qualified person, as there are dangerous voltages inside the control compartment. It also requires a calibrated non-intrusive clip-on ammeter.

Before connecting the electrical supply, turn the potentiometer on the thyristor fully to the left (anti-clockwise). This sets the output current of the thyristor to ‘off’.

Connect the electrical supply with the side cover off. TAKE CARE! Set the furnace temperature to maximum. Allow the furnace to start heating up.

Measure the current through the element circuit. This is carried out with the clip-on meter around one pair of thick cables on the left-hand side of the transformer (as seen when facing the control side of the furnace).

Adjust the potentiometer on the face of the thyristor unit. Adjust it slowly to the right (clockwise) to increase the current, pausing to allow the time for response at the meter. Keep adjusting to obtain an ammeter reading of between 149 to 150 A for the HTF 1700 or 139 to 140 A for the HTF 1800. This adjustment should be set up within the first 5 minutes of heat up from ambient and should finally be checked when the furnace temperature is approximately 100 °C below its maximum temperature. Make further adjustments if necessary at this temperature.

Disconnect the electrical supply to ensure safe replacement of the side panel. See section 8.1

8.5 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
8.6 Fuse Replacement

Access to internal fuses is by removal of the furnace side cover (see section 8.3). See section 11.0 for details of fuses fitted.

8.7 Thermocouple Replacement

Disconnect the product from the supply and remove the product's element access panel.

Make a note of the thermocouple connections. The negative leg of the thermocouple is marked blue. The "compensating" cable for 1700 & 1800 °C thermocouples is plain copper.

Disconnect the thermocouple from its terminal block.

Undo the screw to release the thermocouple sheath; withdraw the sheath and shake out any fragments of thermocouple.

Re-assemble with a new thermocouple observing the colour coding. Ensure that the thermocouple is not twisted as it is being inserted and that the metal tag is bent back, or the screw inserted, to grip the sheath.

8.8 Element Installation and Replacement

See section 8.2 - wearing a face mask is required.

See section 0.1 - Safety Warning - molybdenum disilicide.

Molybdenum disilicide elements form a glazed surface when heated. Internal stresses can form through heating and cooling which render the glaze fragile. The glaze can sometimes splinter into a shower of sharp particles when handled. Always wear eye protection when handling the elements.

Handle the heating elements with extreme care as they are very fragile. Also, avoid touching the heating surface (the thin part of the element), as the material is susceptible to corrosive damage from skin contact.

Initial Installation:

The elements, clips and braids are packed separately. Handle them carefully while unpacking.

Fit the insulation blocks to the elements. Locate the clamps over the elements, and tighten carefully. The length of element above the fixing clamps should be as follows:
1700 °C models:  42 mm
1800 °C models:  45 mm

Lower the elements into position, and connect the braids according to the scheme shown below, using the clip tool provided. The braids must be held tightly to the element as the clips are fitted:

**good contact is essential**; poor contact can lead to sparking and destruction of the top of the element.

Ensure that the elements are correctly placed: the thin part of the element, and the tapered section, should ideally be entirely within the heating chamber; the element should not touch the bottom of the chamber.

**Important** - There should be a minimum clearance of 10 mm below the bottom of the element, and a minimum clearance of 15 mm from the sides of the chamber. The elements should be parallel with the side walls.

*Replacements:*

Read the section above on initial installation.

Remove the aluminium braids and clips using the clip tool provided with the furnace. Lift out the old elements and the insulation blocks: handle the insulation pieces with care as they are fragile.

Carefully loosen and remove the clamps.

Prepare and install the new elements as explained above.

Heat up the furnace to a moderate temperature and ensure that the furnace is controlling properly, in case the previous element failure resulted from a fault in the control system.

After installing new elements run the furnace at 1500 °C for an hour. This creates a protective glaze on the element surface.
Use of Clip Tool

The tool comprises two levers.
1. Clip tool
2. Apply hand pressure

Key

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Braid</td>
</tr>
<tr>
<td>B</td>
<td>Roof Insulation</td>
</tr>
<tr>
<td>C</td>
<td>Element block</td>
</tr>
<tr>
<td>D</td>
<td>Element</td>
</tr>
<tr>
<td>E</td>
<td>Element Clamp</td>
</tr>
<tr>
<td>*</td>
<td>See text</td>
</tr>
</tbody>
</table>
8.9 Insulation Replacement

See section 8.2 - wearing a face mask is required.

After any replacement of insulation material, run the furnace at 1500 °C to burn off volatile matter. Do this in a well ventilated area. Try to ensure that there is some chamber ventilation, but not too much as this could result in cracked insulation.

8.10 Transformer Tappings

A change of transformer tapping is required if the electrical supply voltage differs from the present setting.

To access the transformer tappings, first disconnect the furnace from the electrical supply and then remove the left-hand side cover (see section 8.3). Positions below are given from a viewing position at the left end of the furnace.

On the left side are the secondary tappings, which should not require change, but can be checked against the following data:

<table>
<thead>
<tr>
<th>HTF 17/5</th>
<th>27 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTF 17/10</td>
<td>38 V</td>
</tr>
<tr>
<td>HTF 18/4</td>
<td>31.1 V</td>
</tr>
<tr>
<td>HTF 18/8</td>
<td>43.8 V</td>
</tr>
</tbody>
</table>

On the right side is a terminal strip with the following connections (208 to 240 V version shown).
The thermal trip connection forms part of the circuit to the contactor coil.
The L and N connection may alternatively be L1 and L2 for a live-to-live supply. The L side should be connected to the correct tapping to match the electrical supply voltage.
The link wire should be in position as shown unless the electrical supply voltage is always low, in which case there is the option of moving one end to the +2% terminal.
Important - Changing the transformer primary tapping (including the +2%) requires adjustment of the thyristor current - see section 8.4.
The terminal between the link connection is not used.

8.11 Fuse Replacement
Fuses are accessed by removal of the appropriate panel, as described in the '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.

Note: The main fuses for PF 30 models are located in an external fuse holder positioned next to the IEC socket for the power supply cable.
8.0 Repairs and Replacements
# 9.0 Fault Analysis

## A. Furnace Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The HEAT light(s) are ON.</td>
<td>An ohm meter applied to the element circuit shows an open circuit.</td>
<td>A heating element has failed.</td>
</tr>
<tr>
<td>2. The HEAT light(s) are OFF.</td>
<td>The controller shows a very high temperature or a code such as S.br.</td>
<td>The thermocouple has broken or has a wiring fault.</td>
</tr>
<tr>
<td></td>
<td>The controller shows a low temperature.</td>
<td>The door switch may be faulty or need adjustment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The thyristor fuse may have blown.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The power thyristor could be failing to switch on due to internal failure, faulty wiring from the controller, or fault controller.</td>
</tr>
<tr>
<td></td>
<td>There are no lights glowing on the controller.</td>
<td>Check the supply fuses and any fuses in the product control compartment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault.</td>
</tr>
<tr>
<td></td>
<td>The fault light on the control panel is on</td>
<td>The thermal cutout on the case or in the transformer has activated.</td>
</tr>
</tbody>
</table>
## B. Product Overheats

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The HEAT light goes OFF with the instrument switch.</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 furnace.</td>
</tr>
<tr>
<td></td>
<td>The controller may be faulty.</td>
<td>The thermocouple may be connected the wrong way around.</td>
</tr>
</tbody>
</table>
| 2. | The HEAT light does not go off with the instrument switch and the fault persists when a 2 A control fuse is removed from its fuse-holder. | The power thyristor has failed "ON". | Check for an accidental wiring fault which could have overloaded the thyristor.  
*Isolate the furnace if this fault persists.* |
10.0 Wiring Diagrams

10.1 Single Phase 208 V, 220-240 V

Thermal cutouts:
- case temperature sensor
- transformer temperature sensor

Wire colour:
- BU: Blue
- R: Red
- P: Pink
- G: Grey
10.2 Two phase 380/ 220 V - 415/ 240 V

Thermal cutouts:
- case temperature sensor
- transformer temperature sensor

Wire colour:
- BU: Blue
- R: Red
- P: Pink
- G: Grey
10.0 Wiring Diagrams

GR/ Y Green & Yellow
11.0 Fuses and Power Settings

11.1 Fuses

F1-F2: Refer to the circuit diagrams.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Internal Supply Fuses</td>
<td>Fitted if supply cable fitted. Fitted on board to some types of EMC filter.</td>
</tr>
<tr>
<td>F2</td>
<td>Auxiliary Circuit Fuses</td>
<td>Fitted on board to some types of EMC filter. May be omitted up to 25 Amp/phase supply rating.</td>
</tr>
<tr>
<td>Thyristor Fuse</td>
<td></td>
<td>Ferraz Protistor of the rating shown</td>
</tr>
<tr>
<td>Customer Fuses</td>
<td>Required if no supply cable fitted. Recommended if cable fitted.</td>
<td>See rating label for current; See table below for fuse rating.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating</th>
<th>Thyristor Fuse Rating</th>
<th>Current Limit (element circuit)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTF 18/8</td>
<td>1-phase</td>
<td>208</td>
<td>32 A</td>
<td>50 A</td>
<td>140 A</td>
</tr>
<tr>
<td>HTF 18/8</td>
<td>1-phase</td>
<td>220-240</td>
<td>32 A</td>
<td>50 A</td>
<td>140 A</td>
</tr>
<tr>
<td>HTF 18/8</td>
<td>2-phase</td>
<td>380-415</td>
<td>16 A</td>
<td>30 A</td>
<td>140 A</td>
</tr>
</tbody>
</table>

* 2-phase designs use the line-to-line voltage; neutral is used for the control circuit
† see section 7.7 - the current limit setting at lower temperatures is 146 A.

11.2 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 (V)</th>
<th>208</th>
<th>220</th>
<th>230</th>
<th>240</th>
<th>380</th>
<th>400</th>
<th>415</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (%)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Please refer to the rating label for product specific information.
12.0 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>Chamber Size</th>
<th>Approx Capacity (l)</th>
<th>Max Load (kg)</th>
<th>Net Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTF 18/8</td>
<td>1800</td>
<td>6.2</td>
<td>210 H 190 W 190 D</td>
<td>8.2</td>
<td>4</td>
<td>113</td>
</tr>
</tbody>
</table>

* Maximum power as measured, included ancillary components and transformer losses.

12.1 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

altitude: not exceeding 2000 m

electrical supply: fluctuation not exceeding 10%

overvoltage: category II IEC60364-4-443

pollution: degree 2
## Service Record

<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>
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<td></td>
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</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:

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