Installation, Operation and Maintenance Instructions
1200 °C Tube Furnace (3-zone) - TZF Model: 550mm
3508 Controller + 3216 End Zone Controllers

TZF 12/65/550 + 3508 Controller + 3216 End Zone Controllers
This manual is for guidance on the use of the Carbolite Gero product specified on the front cover. This manual should be read thoroughly before unpacking and using the furnace or oven. The model details and serial number are shown on the back of this manual. Use the product for the purpose for which it is intended.

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1.0 Symbols and Warnings

1.1 Switches and Lights

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

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

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

1.2 General Warnings

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

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

- **DANGER** – Read any warning printed next to this symbol.
Caution – Double Pole/Neutral Fusing
2.0 Installation

2.1 Unpacking and Handling

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

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

![NOTE: This product contains Refractory Ceramic Fibre (also known as Alumino Silicate Wool - ASW). For precautions and advice on handling this material see section 9.2.]

2.2 Siting and Setting Up

Place the product on a level surface in a well ventilated area.

Site away from other sources of heat and on a non-flammable surface that is resistant to accidental spillage or hot materials.

The surface on which the equipment is mounted should be stable and not subject to movement or vibrations.

The height of the mounting surface is important to avoid operator strain when loading and unloading samples.

Unless otherwise stated elsewhere in this manual, ensure that there is at least 150 mm of free space around the back and sides of the product. Clear space is required above the product to dissipate heat.

Work tubes:

It is recommended that the work tube has either insulation plugs or radiation shields fitted to minimise heat loss from both ends of the work tube. If the work tube has open ends, a significant amount of energy could be radiated from the ends of the work tube. Adjacent surfaces should always be made from a non-flammable material.

Ensure that the ends of the work tube are positioned at least 500 mm away from any adjacent surface so that any energy radiated cannot heat an adjacent surface to a dangerous temperature.
2.0 Installation

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

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

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

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

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

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

If a metal work tube is being used in the product, ensure that it is earthed for operator safety.
Fig 1 - Insulating Plug (standard length tube)

Fig 2 - Insulating Plug (long work tube)

Key
A Tube
B Insulating Plug
C Stem
2.0 Installation

Fig 3 'Twin Clamp' End Seal

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

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

2.3 Electrical Connections

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

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

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

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

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

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

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

The supply MUST incorporate an earth (ground).

**Electrical Connection Details:**

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

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

**WARNING:**

DO NOT connect a product ordered for three phase use to a single phase supply or to the wrong type of three phase supply.
3.0 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.
### 3.0 3508 Controller

#### 3.5 Basic Operation

![Controller Diagram]

**Key**

<table>
<thead>
<tr>
<th></th>
<th>Description</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>
</tbody>
</table>
3.5.1 Controller Layout

3.5.2 Keys

<table>
<thead>
<tr>
<th>A/ Man</th>
<th>Disabled</th>
</tr>
</thead>
<tbody>
<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.

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 12.0.

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:

<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>

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'.
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 \( \text{page} \) until 'Program Status Reset' appears
Press scroll \( \text{scroll} \) until the cursor moves to 'Reset'
Press up \( \uparrow \) or down \( \downarrow \) 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 \( \text{page} \) until 'Program Status Reset' appears
Press scroll \( \text{scroll} \) until the cursor moves to 'Reset'
Press up \( \uparrow \) or down \( \downarrow \) to select 'Reset'

3.8.9 To run a different program (P10 and P25)
To select a program
Press page \( \text{page} \) until 'Program Status Reset' appears
Press scroll \( \text{scroll} \) then up \( \uparrow \) or down \( \downarrow \) to select a program number
To operate the program
Press RUN/HOLD
or
Press scroll \( \text{scroll} \) until the cursor moves to 'Reset'
Press up \( \uparrow \) or down \( \downarrow \) 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 \( \text{page} \) 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
3.0  3508 Controller

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

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

To run the program either press RUN/HOLD or:

14. Press page \( \backslash \) 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'.
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'

---

**Time Display Examples**

<table>
<thead>
<tr>
<th>Time</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:05:3</td>
<td>Min/Sec/10th Sec</td>
</tr>
<tr>
<td>21:10:05</td>
<td>Hour/Min/Sec</td>
</tr>
<tr>
<td>196:10</td>
<td>Hour/Min</td>
</tr>
</tbody>
</table>

---

**Segment Table**

<table>
<thead>
<tr>
<th>Segment</th>
<th>Type</th>
<th>Target</th>
<th>Duration</th>
<th>Type</th>
<th>Target</th>
<th>End Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>'Rate'</td>
<td>400°C</td>
<td>30 min</td>
<td>'Dwell'</td>
<td>600°C</td>
<td>'Reset'</td>
</tr>
<tr>
<td>2</td>
<td>'Dwell'</td>
<td>5°C/min</td>
<td>600°C</td>
<td>'Step'</td>
<td>200°C</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>'Dwell'</td>
<td>5°C/min</td>
<td>200°C</td>
<td>'Time'</td>
<td>5°C/min</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>'Dwell'</td>
<td>5°C/min</td>
<td>5°C/min</td>
<td>'End'</td>
<td>200°C</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>'Dwell'</td>
<td>5°C/min</td>
<td>200°C</td>
<td>'End'</td>
<td>5°C/min</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>'Dwell'</td>
<td>5°C/min</td>
<td>200°C</td>
<td>'End'</td>
<td>5°C/min</td>
<td></td>
</tr>
</tbody>
</table>

---

28
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</th>
<th>Rate</th>
<th>Target SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
<td>400’ degrees</td>
</tr>
<tr>
<td>Ramp Rate</td>
<td></td>
<td>2.0’ degrees per minute</td>
</tr>
<tr>
<td>Target SP</td>
<td>200’ degrees</td>
<td></td>
</tr>
<tr>
<td>Holdback</td>
<td>'High'</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>‘30:00.0’ minutes</td>
<td></td>
</tr>
<tr>
<td>Call</td>
<td>'next number’</td>
<td></td>
</tr>
<tr>
<td>Call Cycles</td>
<td>‘2’</td>
<td></td>
</tr>
</tbody>
</table>

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 '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'
### 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 (2) 3</td>
<td></td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>Tx (3) 2</td>
<td></td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com (7) 5</td>
<td></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>- (2) 3</td>
<td></td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>+ (3) 2</td>
<td></td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com (7) 5</td>
<td></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.

Remote 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

<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>
3.0 3508 Controller

3.11.3 Supervisor Level 2

To enter Level 2 Scroll Key

Level 2 Locked before Pass Code entered

Level 1 Home Display Unlocked

Level 2 Home Display Black = Progress

Page Key * See previous diagram: Operator Level 1- No Program Running

Hold Page Key for 3 seconds ** If configured

Arrow Key
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.
4.0  3508 Dual Loop Cascade

<table>
<thead>
<tr>
<th>Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>

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.

![Feed Forward View](image)

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
4.3  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:
- $SP_2$ = cascade control on
- $SP_1$ = cascade control off

The top left hand side of the screen will show $SP_X$ when $SP_2$ is enabled. The instrument operates as an independent Programmer/Controller when $L-r$ is set to $SP_1$. To return to cascade control, change the $L-r$ parameter to $SP_2$. 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:

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

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 3216 Controller

5.1 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.

5.2 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.

5.3 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.

5.4 Operation

5.4.1 Controller Layout

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Power Output Indicator</td>
</tr>
<tr>
<td>B</td>
<td>Alarm Indicator</td>
</tr>
<tr>
<td>C</td>
<td>Remote Indicator (when configured)</td>
</tr>
<tr>
<td>D</td>
<td>Page</td>
</tr>
<tr>
<td>E</td>
<td>Scroll</td>
</tr>
<tr>
<td>F</td>
<td>Down</td>
</tr>
<tr>
<td>G</td>
<td>Up</td>
</tr>
<tr>
<td>H</td>
<td>Run Indicator</td>
</tr>
<tr>
<td>I</td>
<td>Hold Indicator</td>
</tr>
<tr>
<td>J</td>
<td>Setpoint Temperature (SP)</td>
</tr>
<tr>
<td>K</td>
<td>Measurement Temperature</td>
</tr>
</tbody>
</table>
5.4.2 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 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.

5.5 Quick Start Guide

5.5.1 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).

5.5.2 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.

5.5.3 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>
5.5.4 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.
5.6 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).

5.6.1 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 12.0.

5.6.2 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.

5.6.3 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>

5.6.4 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.

5.6.5 Scrolling Text

If at any time the scrolling text is not required.

Press and hold the page ⬇ for three seconds until “GOTO” is displayed.

Press scroll ⬇ until the display shows. TEXT <ENABLE/ DISABLE SCROLLING TEXT>
Use the up ▲ and down ▼ keys to select ON or OFF.
5.0 3216 Controller

5.6.6 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 \( \downarrow \) until the display shows CAL.P (Enter Calibration Code) Use the up \( \uparrow \) down \( \downarrow \) 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 \( \uparrow \) and down \( \downarrow \) keys to enter the Low Temperature Point, which you want to apply an Offset.

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

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

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

Once the calibration details have been entered, press scroll \( \downarrow \) 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.

![Caution! - Do not make PNT.LO and PNT.HI the same value as the controller will not work correctly and could cause the product to overheat.]

5.6.7 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 buttons 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.
5.7 Programming

5.7.1 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

5.7.2 Program Number (3216P5 Only)
Press scroll until the display shows PROG <PROGRAM NUMBER.> Select the program number.

5.7.3 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.

5.7.4 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.

5.7.5 Holdback
see section 5.6. 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.

5.7.6 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”.

5.7.7 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.

5.7.8 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.

5.7.9 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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrolling Display – Current Program state</td>
</tr>
<tr>
<td>To HOLD a program</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = Flashing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrolling 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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrolling Display - None</td>
</tr>
<tr>
<td></td>
<td>Program Ended</td>
<td>Indicator – RUN = OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrolling Text – Program End</td>
</tr>
<tr>
<td>To RESET a program after it has</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = OFF</td>
</tr>
<tr>
<td>completed</td>
<td>and quickly release Ack ▼</td>
<td>Scrolling Display - None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrolling Text – Program End</td>
</tr>
</tbody>
</table>

5.7.10 Program Status

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

5.7.11 Process Value

The upper display shows the current temperature of the product.

5.7.12 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 ⬇️ until the display shows WRK.OP <WORKING OUTPUT POWER>. This shows the power being used as a percentage.

Time Remaining

Press scroll ⬇️ 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 ⬇️ 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 5.6) 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 ▲, down ▼ 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 ▲, down ▼ 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.
5.8 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.

5.8.1 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 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 (2)</td>
<td>3</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>Tx (3)</td>
<td>2</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com (7)</td>
<td>5</td>
<td>5 (7) Com</td>
</tr>
</tbody>
</table>

5.8.2 Digital Communications - RS485

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

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

5.8.3 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.

5.8.4 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:

![Diagram of alarm board wiring](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.

**5.9 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.

**5.10 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

**A**  
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
6.0 2132 Over-Temperature Controller Description (if fitted)

6.1 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.

6.2 Operation

6.2.1 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.
6.0 2132 Over-Temperature

6.2.2 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.

6.2.3 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).

6.2.4 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.

6.2.5 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.

6.2.6 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.
6.3 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 6.2.

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

6.4 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>
7.0 Operation

7.1 Operating Cycle

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

Connect the product to the electrical supply.

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

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

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

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

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

7.2 Control Method

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

7.3 3-Zone Control Methods

There are three different control options (A, B & C).

(A) Back to back thermocouples

(B) Retransmission of Setpoint

(C) Independent control

The models listed in this manual are designed to achieve an extended uniform temperature zone, through use of three control zones, rather than achieving different temperatures in each zone.

For A & B, the control zones are linked so that they all follow the centre zone controller in a master-slave approach.
A. Back-to-Back Thermocouples

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

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

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

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

B. Retransmission of Setpoint

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

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

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

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

For products with the CC-T1 controller, please refer to the separate CC-T1 controller manual for details on how to set an offset trim.

To make this adjustment on other controllers, enter the level 2 menu of the end zone controllers (see controller operating instruction), scroll to LOC.T (local trim) and use the ⬆ up ⬇ down buttons to enter the desired positive or negative value. This will then be added to, or subtract from, the end zone set temperature. There is no need to alter the centre zone controller.

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

7.4 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 13.0 towards the back of this manual.

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

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

7.5 Operator Safety

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

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

7.6 Tube Life

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

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

![Fig 4 - Avoidance of thermal contact](image)

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

7.7 Pressure

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

A suitably regulated gas supply should always be used.

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

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

The product control system incorporates electronic power limiting. The power limit parameter OP.Hi is accessible to the operator and can be used to adjust the product to the actual supply voltage.

Some models covered by this manual are fitted with 208 V elements and are designed for use over the range of voltages 200 V - 250 V; the power limit parameter is set accordingly. These models may be relocated to a different voltage within the range: the power limit should be reset to match the voltage.

To check whether the furnace is a 208 V model:

- look at the OP.Hi parameter
- make a note of the value and compare with the 12.0;
- observe the rating label; if a range of voltages is stated, it is not a 208 V multi-voltage model;
- if in doubt, check with Carbolite Gero – each product has its own record card.

Refer to the controller instructions for how to change the power limit.

7.9 Running at Low Temperatures

The power limit may be adjusted to a low level in order to achieve better control when operating the product at a low temperature. Before changing the power limit, record the default settings for possible future use. Refer to the Power Settings section of this manual for default power limits. If the product fails to reach the desired temperature, refer to the Temperature Controller and Fault Analysis sections.
8.0 Maintenance

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

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

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Seals (if fitted)</strong></td>
<td>Check all seals and O-rings and clamps</td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td></td>
</tr>
<tr>
<td>Element Circuit</td>
<td>Electrical measurement ❗</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>Measure the current drawn on each phase / circuit</td>
</tr>
<tr>
<td>Cooling Fans (if fitted)</td>
<td>Check whether the cooling fans are working</td>
</tr>
</tbody>
</table>
8.2.1 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.

8.3 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.

8.4 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.

8.5 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 of each type of thermocouple, one solid state relay and one heating element

When ordering spare parts please quote the model details as requested above.
9.0 Repairs and Replacements

9.1 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.

9.2 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.

9.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
9.4 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.

9.5 Thermocouple Replacement

The coverings and guards which must be removed to gain access to the thermocouple depend on the model, its orientation (horizontal or vertical), and possibly other options and fittings.

It will usually be necessary to separate the product from its base or stand. On horizontal models one outer end-cap will need to be removed and on vertical models the terminal cover. Within some models the thermocouple lies inside the product body; the body must be removed from the control base and the end-cap and insulation ring removed from one end.

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

<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>

Disconnect the thermocouple from its terminal block. Withdraw the thermocouple from its sheath and remove any broken bits of thermocouple.

Bend the new thermocouple carefully to match the shape of the original (working from the terminal end). Should the length differ from that of the original this will usually not be important provided that the thermocouple tip is within a tube diameter's distance from the product centre.

Insert the new thermocouple into position, restoring any removed porcelain spacers and ensuring correct polarity. Re-assemble the product.
### 9.6 Element Replacement

> **See section 9.2 - wearing a face mask is required.**

The coverings and guards which must be removed to enable replacement of the wound tube element depend on the furnace model, its orientation (horizontal or vertical), and other options and fittings. The general procedure is:

1. **Disconnect the product from the electrical supply.**
2. **Remove all outer guards, meshes and terminal covers from the product's body.** For a horizontally mounted product remove the product body from its base; to reach the bolts or screws which fix the body to the base, remove the back panel from the base.
3. **Disconnect all electrical leads from the terminal blocks on the product case.** Note the colours and positions of the connecting leads to enable correct reassembly. Take care not to crack porcelain terminal blocks - use two spanners where appropriate.
4. **Remove the thermocouples.**
5. **Lay the furnace body horizontally with the split in the cylindrical case uppermost.**
6. **Remove the two metal end-caps from the body.** Except TZF 12/38, undo the self-tapping screws which hold the terminal strip to the case join. The case should spring open slightly. Remove the ceramic board disc from one end.
7. **Use a sharp knife to cut right through the insulation down to the wire-wound tube element along the whole length of the body, but do not cut either of the ceramic board end discs.** The knife cut must be in line with the element lead wires. Slide the element gently out through the end of the product body.
8. **Check the cylindrical case and clean out as appropriate.**
9. **Remove any insulation sleeving from the tails of the old element and fit to the replacement element.**
10. **Slide in the new element(s).** Close up the product again, refitting the terminal strip (where applicable) and the end-caps. Any cut made in the insulation should close up completely: if the insulation appears loose or damaged in any way, please contact the Carbolite Gero service division.
11. **Reverse the rest of the disassembly process.** Take care to make all connections to the correct terminals. Do not over tighten the connectors in porcelain terminal blocks.
12. **Let the product heat up at its maximum rate to 900 °C without interruption and then soak for 1 hour.** Fumes may be emitted: this should be done in conditions of good ventilation.
13. **Check that the product is controlling properly to rule out the possibility that the element failed because of a fault in the control system.**
14. **If you have any problems with this procedure, please contact the Carbolite Gero service division.**
9.7  Fuse Replacement

Fuses are marked on the wiring diagram with type codes, e.g. F1, F2. For more information on fuses refer to section 12.0.

*Depending on model and voltage, the different fuse types may or may not be fitted.*

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

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

### A. Furnace Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The HEAT light is ON</td>
<td>The heating element has failed</td>
</tr>
<tr>
<td>2.</td>
<td>The HEAT light is OFF</td>
<td>The controller shows a very high temperature or code such as S.br</td>
</tr>
<tr>
<td></td>
<td>The controller shows a low temperature</td>
<td>The door switch(es) (if fitted) may be faulty or need adjustment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The contactor/relay (if fitted) may be faulty</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The heater switch (if fitted) may be faulty or need adjustment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The SSR could be failing to switch on due to internal failure, faulty logic wiring from the controller, or faulty controller</td>
</tr>
<tr>
<td></td>
<td>There are no lights glowing on the controller</td>
<td>Check the supply fuses and any fuses in the furnace control compartment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault.</td>
</tr>
</tbody>
</table>
### B. Product Overheats

<table>
<thead>
<tr>
<th>1. Product only heats up when the instrument switch is ON</th>
<th>The controller shows a very high temperature</th>
<th>The controller is faulty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The controller shows a low temperature</td>
<td>The thermocouple may be faulty or may have been removed out of the heating chamber</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The thermocouple may be connected the wrong way around</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty</td>
</tr>
<tr>
<td>2. Product heats up when the instrument switch is OFF</td>
<td>The SSR has failed &quot;ON&quot;</td>
<td>Check for an accidental wiring fault that could have overloaded the SSR</td>
</tr>
</tbody>
</table>
11.0 Wiring Diagrams

11.1 WC-13-01
Connections below show single phase with indirect safety switches and over-temperature control.
11.2 WC-13-31
Connections below show single phase with indirect safety switches and over-temperature control.
11.3 2- and 3-phase With Neutral

Each SSR is connected to a different phase. The control circuit is taken between L1 and N.

Safety switch A applies for 2-phase. Safety switch B applies for 3-phase.

If type F1 fuse is present, one per phase if fitted.

If type F2 fuse is present, one is fitted; if type F3 fuse is present, one per phase is fitted.

Note that on 2- or 3-phase models there may be three separate neutrals taken to a common supply terminal, depending on EMC filter requirements.

11.4 Independent Zones (control method C)

When this is ordered there are three independent thermocouples (instead of the four shown) connected to the three controllers; the words “master” and “slave” may be replaced by “centre” and “end”.

11.5 Control by Broadcast Comms (control method B)

When this is ordered there are three independent thermocouples connected to the three controllers; the controllers are linked together (not shown), and remain “master” and “slave”.

The communication between the controllers of the Eurotherm 3000 series is known as Broadcast comms. The wiring connections between the controllers are as follows:
12.0 Fuses and Power Settings

12.1 Fuses

F1-F3: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th></th>
<th>Internal Supply Fuses</th>
<th>Fitted if supply cable fitted. Fitted on board to some types of EMC filter.</th>
<th>GEC Safeclip of the type shown (glass type F up to 16 A) 38 mm x 10 mm type F fitted on EMC filter circuit board(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td>Auxiliary Circuit Fuses</td>
<td>Fitted on board to some types of EMC filter.  May be omitted up to 25 Amp/phase supply rating.</td>
<td>2 Amps glass type F  On board: 20 mm x 5 mm  Other: 32 mm x 6 mm</td>
</tr>
<tr>
<td>F3</td>
<td>Heat Light Fuses</td>
<td>May be omitted up to 25 Amp/phase supply rating.</td>
<td>2 Amps glass type F  32 mm x 6 mm</td>
</tr>
<tr>
<td></td>
<td>Customer Fuses</td>
<td>Required if no supply cable fitted. Recommended if cable fitted.</td>
<td>See rating label for current; See table below for fuse rating.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>TZF 12/65/550</td>
<td>1-phase</td>
<td>110-120</td>
<td>20 A</td>
</tr>
<tr>
<td>TZF 12/65/550</td>
<td>1-phase</td>
<td>200-240</td>
<td>10 A</td>
</tr>
<tr>
<td>TZF 12/65/550</td>
<td>2-or 3-phase</td>
<td>380/220-415/240</td>
<td>6 A</td>
</tr>
</tbody>
</table>

12.2 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>200</th>
<th>208</th>
<th>220</th>
<th>230</th>
<th>240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (%)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
### User Power Setting Adjustments

<table>
<thead>
<tr>
<th>Date</th>
<th>% Power</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Note: If a new set of elements are fitted then return the power settings to the original value.

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

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>Work Tube Bore (mm)</th>
<th>Work Tube Length (mm)</th>
<th>Heated Length (mm)</th>
<th>Net Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TZF 12/65/550</td>
<td>1200</td>
<td>2.0</td>
<td>65</td>
<td>600</td>
<td>550</td>
<td>38</td>
</tr>
</tbody>
</table>

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

13.1 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
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>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

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

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

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