Installation, Operation and Maintenance Instructions
1500 °C Tube Furnace (3-zone) - TZF Model: 450mm
No Controller + 3216 End Zone Controllers

TZF 15/90/450 + No 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.

1.0 Symbols and Warnings ........................................................................................................... 5
  1.1 Switches and Lights ............................................................................................................. 5
  1.2 General Warnings ............................................................................................................... 5

2.0 Installation ............................................................................................................................. 7
  2.1 Unpacking and Handling .................................................................................................... 7
  2.2 Siting and Setting Up .......................................................................................................... 7
  2.3 Tube Fitting ......................................................................................................................... 9
  2.4 Heating Elements .............................................................................................................. 11
  2.5 Electrical Connections ...................................................................................................... 11

3.0 Temperature Controller ....................................................................................................... 13

4.0 3216 Controller ...................................................................................................................... 14
  4.1 PID control ......................................................................................................................... 14
  4.2 3216P1 ............................................................................................................................... 14
  4.3 3216P5 ............................................................................................................................... 14
  4.4 Operation ........................................................................................................................... 14
    4.4.1 Controller Layout ......................................................................................................... 14
    4.4.2 Keys ............................................................................................................................. 15
  4.5 Quick Start Guide ............................................................................................................... 15
    4.5.1 Operation as a simple controller .................................................................................. 15
    4.5.2 Changing the Setpoint ............................................................................................... 15
    4.5.3 Using the Controller .................................................................................................... 15
    4.5.4 Understanding User Levels ....................................................................................... 16
  4.6 Setting up the Controller .................................................................................................... 17
    4.6.1 Maximum Output Power ............................................................................................. 17
    4.6.2 Customer ID ............................................................................................................... 17
    4.6.3 Units ........................................................................................................................... 17
    4.6.4 Language ..................................................................................................................... 17
    4.6.5 Scrolling Text .............................................................................................................. 17
    4.6.6 Customer Calibration .................................................................................................. 18
    4.6.7 Holdback ..................................................................................................................... 18
  4.7 Programming ....................................................................................................................... 20
    4.7.1 Creating a Program ...................................................................................................... 20
    4.7.2 Program Number (3216P5 Only) ................................................................................ 20
7.0 Maintenance ........................................................................................................34
  7.1 General Maintenance ..........................................................................................34
  7.2 Maintenance Schedule .......................................................................................34
    7.2.1 Cleaning ........................................................................................................36
  7.3 Calibration ........................................................................................................36
  7.4 After-Sales Service .............................................................................................36
  7.5 Recommended Spare Parts and Spare Parts Kit .....................................................36
  7.6 Power Adjustment ...............................................................................................36
  7.7 Element Ageing ..................................................................................................37

8.0 Repairs and Replacements ...................................................................................38
  8.1 Safety Warning - Disconnection from Power Supply ..........................................38
  8.2 Safety Warning - Refractory Fibre Insulation ......................................................38
  8.3 Temperature Controller Replacement ..................................................................38
  8.4 Solid-State Relay Replacement ............................................................................39
  8.5 Thermocouple Replacement ..............................................................................39
  8.6 Element Fitting and Replacement ......................................................................40
    Element Fitting - Figures .....................................................................................41
  8.7 Fuse Replacement ...............................................................................................41

9.0 Fault Analysis .......................................................................................................42
  A. Furnace Does Not Heat Up ...................................................................................42
  B. Product Overheats ...............................................................................................43

10.0 Wiring Diagrams ................................................................................................44
  10.1 WC-13-31 ........................................................................................................44
  10.2 WC-U3-31 .........................................................................................................45
  10.3 Control by Broadcast Comms (control method B) .............................................46

11.0 Fuses and Power Settings ..................................................................................47
  11.1 Fuses ................................................................................................................47
  11.2 Power Settings ..................................................................................................47
    User Power Setting Adjustments ..........................................................................48

12.0 Specifications .....................................................................................................49
  12.1 Environment .....................................................................................................49
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 8.2.

2.2 Siting and Setting Up

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

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

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

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

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

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

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

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

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

If the product is supplied with a work tube then the holes at the end of the product chamber should be supplied at the correct size. Carefully line up the tube and ease it through the chamber.

For a tube of customer supply, ensure that there is approximately 1 mm free play at each end; if the tube is too tight, it may crack when heated. Increase the diameter of the hole by rotating the tube, which is abrasive. Remove loose powdered ceramic fibre with a vacuum cleaner and see section 8.0.

Contact Carbolite Gero if the holes in the product chamber are too large.

Ensure that the tube is centrally placed and reaches to or through the product end covers, so that there is no access to exposed electrical connections.
2.3 Tube Fitting

**Vertical Mode.** The product (if a tube is also supplied) has a plate or clip to retain the tube in position. See fig.1.

![Fig 1 - Vertical Tube Retention](image)

Fit any accessories supplied. For optimum temperature uniformity, ceramic insulation plugs or radiation shields should be placed in the tube ends as shown in fig.2. The ends of the insulation plugs or radiation shields should not protrude outside of the work tube.

NOTE: Insulation plugs or Radiation shields are strongly recommended for this product. Contact Carbolite Gero or Carbolite Gero Service for further information.
2.0 Installation

Expanded View of "Twin Clamp" End Seals:

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

If stainless steel end 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 end plate.

When stainless steel end seals are fitted in the vertical mode, a hook and eye, on the end of the plate holds the upper insulating plug or radiation shield assembly.

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 the fittings in such a way that longitudinal expansion of the tube is allowed.

If a metal work tube is being used in the product, ensure that it is earthed (grounded). There can be leakage of current through ceramic insulation at high temperatures.
2.4 Heating Elements

The silicon carbide elements are VERY FRAGILE and are packed separately. Fit them accordingly to the instructions in section 8.6.

2.5 Electrical Connections

Connection by a qualified electrician is recommended.

All models covered by this manual may be ordered for single phase A.C. supply, which may be Live to Neutral non-reversible, Live to Neutral reversible or Live to Live. Check the product rating label before connection. The supply voltage should agree with the voltage on the label and the supply capacity should be sufficient for the current on the label.

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

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

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

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

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

The supply MUST incorporate an earth (ground).
2.0 Installation

Electrical Connection Details:

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

2- or 3-phase

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

DO NOT connect a model ordered for three phase use to a single phase supply or to the wrong type of three phase supply.

Technical Notes
This model has an electronically controlled power limit. Do not attempt to calculate the Amps from the Wattage. High break capacity fuses should be used. Avoid fast-blow fuses and magnetic trip circuit breakers - consult Carbolite Gero if in doubt.
3.0 Temperature Controller

If this product is fitted with a temperature controller, instructions are provided separately.
4.0 3216 Controller

4.1 PID control

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

4.2 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.

4.3 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.

4.4 Operation

4.4.1 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>
4.4.2 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.

4.5 Quick Start Guide

4.5.1 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).

4.5.2 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.

4.5.3 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>
4.0 3216 Controller

4.5.4 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.
4.6 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).

4.6.1 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 11.0.

4.6.2 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.

4.6.3 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>

4.6.4 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.

4.6.5 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.
4.6.6 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 [·] until the display shows CAL.P (Enter Calibration Code) Use the up ▲ and down ▼ 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 ▲ and down ▼ keys to enter the Low Temperature Point, which you want to apply an Offset.

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

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

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

Once the calibration details have been entered, press scroll [·] 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.

4.6.7 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 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.
4.7 Programming

4.7.1 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.

4.7.2 Program Number (3216P5 Only)

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

4.7.3 Ramp Units

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

4.7.4 Dwell Units

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

4.7.5 Holdback

see section 4.6. Press scroll up 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.

4.7.6 Ramp Rate

Press scroll up 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”.

4.7.7 Target Setpoint

Press scroll up 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.

4.7.8 Dwell Time

Press scroll up 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.

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

4.7.10 Program Status

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

4.7.11 Process Value

The upper display shows the current temperature of the product.

4.7.12 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 4.6) 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.
### 4.8 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.

#### 4.8.1 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) 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>

4, 14, 6 (20) Link together

7, 8 (4, 5) Link together

#### 4.8.2 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) 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>

4.8.3 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

### Table

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMP.1 = 5°C/Min</td>
<td>RMP.1 = 4°C/Min</td>
<td>RMP.1 = OFF</td>
<td>RMP.1 = 3°C/Min</td>
<td>RMP.1 = 5°C</td>
</tr>
<tr>
<td>T.SP1 = 600°C</td>
<td>T.SP1 = 400°C</td>
<td>T.SP1 = 600°C</td>
<td>T.SP1 = 800°C</td>
<td>T.SP1 = 400°C</td>
</tr>
<tr>
<td>Dwel.1 = 30 Min</td>
<td>Dwel.1 = 30 Min</td>
<td>Dwel.1 = 60 Min</td>
<td>Dwel.1 = OFF</td>
<td>Dwel.1 = 480 Min</td>
</tr>
</tbody>
</table>
address value, access the level 2 list. In level 2 press the page key until the COMMS parameter is displayed. Press up ▲ down ▼ to select the address value.

4.8.4 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.

4.9 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.

4.10 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.
4.0 3216 Controller

<table>
<thead>
<tr>
<th>L1</th>
<th>Level 1</th>
<th>Press the Scroll Key</th>
<th>Hold the Page key for 3 seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2</td>
<td>Level 2</td>
<td>Press the Scroll Key multiple times</td>
<td>Locked - password required</td>
</tr>
<tr>
<td>A</td>
<td>Access</td>
<td>* If configured</td>
<td>Unlocked</td>
</tr>
<tr>
<td>**</td>
<td>Do not raise the power limit (if accessible) above the design level for the product</td>
<td>~ Multiple Program Only</td>
<td>Black = Progress</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.0 2132 Over-Temperature Controller Description (if fitted)

5.1 Description

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

5.2 Operation

5.2.1 Controls

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

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

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

Some components will operate after the over-temperature feature isolates the power supply e.g. cooling fans will continue to operate, provided that there is a power supply to the product. In some cases the product may not do so, if other options (such as a door switch) are fitted.
5.0 2132 Over-Temperature

5.2.2 Operation

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

The page key \( \text{Page} \) allows access to parameter lists within the controller.

A single press of the page key \( \text{Page} \) displays the temperature units, normally set to °C; further presses reveal the lists indicated in the navigation diagram.

The scroll key \( \text{Scroll} \) 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 \( \text{Scroll} \) 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 \( \text{Page} \) and scroll \( \text{Scroll} \) together, or wait for 45 seconds.

The down \( \text{Down} \) and up \( \text{Up} \) keys are used to alter the setpoint or other parameter values.

5.2.3 Over-Temperature Operation

Use down \( \text{Down} \) and up \( \text{Up} \) 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 \( \text{Scroll} \) twice view the present temperature as measured by the over-temperature controller. Press it twice, the first press shows the temperature units (°C).

5.2.4 Over-Temperature Alarm

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

5.2.5 Resetting the Over-Temperature Alarm

To acknowledge the alarm press scroll \( \text{Scroll} \) and page \( \text{Page} \) together.

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

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

5.2.6 Sensor Break

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

If an audible alarm is supplied for use with the over-temperature controller, it is normally configured to sound on over-temperature condition and to stop sounding when the alarm is acknowledged as given in section 5.2.

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

5.4 Navigation Diagram

<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>
6.0 Operation

6.1 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.

There is also a heater switch which can be used to disconnect power to the elements. Operate the instrument switch to activate the temperature controller. The controller becomes illuminated and goes through a short test cycle.

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

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

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

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

To 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.

6.2 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.

6.3 3-Zone Control Methods

There are two different control options (B & C).

(B) Retransmission of Setpoint using Broadcast Communications.

(C) Independent control

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

For method B, the control zones are linked so that they all follow the centre zone controller in a master-slave approach.
B. Retransmission of Setpoint using Broadcast communications

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.

Additional communication modules are fitted in the controllers, rather than an additional thermocouple. 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 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 ▲ up ▼ down and select NO. Where the end zone controller is a 3508 use the ▲ up ▼ down to select SP1, (SP1 = Local, and SP2 = Remote). There is no need to alter the centre zone controller.

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 (unless edited). To make this adjustment, enter level 2 menu of the end zone controllers (see controller operating instruction), scroll to LOC.T (local trim) and use the ▲ up ▼ down 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 with the use of three control zones rather than achieving different temperatures in each zone.

6.4 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 12.0 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.
6.5 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).

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.

6.6 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)

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

Do not set too high a heating or cooling rate. As tubes are susceptible to thermal shock and may break. Tubes which extend beyond the heated part of the furnace are more at risk. A general rule for maximum heating or cooling rate is $400 \div \text{internal diameter in mm} \times (\degree\text{C/ min})$; 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.

6.7 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.
7.0 Maintenance

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

7.2 Maintenance Schedule

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>Bi-Annually</td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit (if fitted)</td>
<td>Electrical measurement</td>
<td>6</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>Bi-Annually</td>
</tr>
<tr>
<td>Safety Switch Function (split models only)</td>
<td>Electrical measurement</td>
<td>6</td>
</tr>
<tr>
<td>Electrical Safety (external)</td>
<td>Visual check of external cables and plugs</td>
<td>6</td>
</tr>
<tr>
<td>Electrical Safety (internal)</td>
<td>Physically check all connections and cleaning of the power plate area</td>
<td>6</td>
</tr>
</tbody>
</table>

Function

<table>
<thead>
<tr>
<th>Maintenance Procedure</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Calibration</td>
<td>Tested using certified equipment, frequency dependent on the standard required</td>
<td>6</td>
</tr>
<tr>
<td>Operational Check</td>
<td>Check that all functions are working normally</td>
<td>6</td>
</tr>
<tr>
<td>Operational Check</td>
<td>Thorough inspection and report incorporating a test of all functions</td>
<td>6</td>
</tr>
<tr>
<td>Work Tube Position</td>
<td>Visually check that the tube is central to the heated zone (horizontally / vertically)</td>
<td>6</td>
</tr>
<tr>
<td>End Plugs / Radiation Shields</td>
<td>Visual check for damage or wear, and cor-</td>
<td>6</td>
</tr>
</tbody>
</table>
### 7.0 Maintenance

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

<table>
<thead>
<tr>
<th>Performance</th>
<th></th>
</tr>
</thead>
<tbody>
<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>
7.0 Maintenance

7.2.1 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.

![Warning]
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.

7.3 Calibration
After prolonged use, the controller and/or thermocouple may require recalibration. This is important for processes that require accurate temperature readings or for those that use the product close to its maximum temperature. A quick check using an independent thermocouple and temperature indicator should be made from time to time to determine whether full calibration is required. Carbolite Gero can supply these items. Depending on the controller fitted, the controller instructions may contain calibration instructions.

7.4 After-Sales Service
Carbolite Gero Service has a team of Service Engineers who can offer repair, calibration and preventive maintenance of furnace and oven products both at the Carbolite Gero factory and at customers’ premises throughout the world. A telephone call or email often enables a fault to be diagnosed and the necessary parts to be despatched.

In all correspondence please quote the serial number and model type given on the rating label of the product. The serial number and model type are also given on the back of this manual when supplied with the product.

Carbolite Gero Service and Carbolite Gero contact information can be found on the back page of this manual.

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

Please consult Carbolite Gero's Sales Department for details of recommended spare parts.

7.6 Power Adjustment
The product's control system incorporates electronic power limiting. Power is supplied to the elements in bursts of approximately 0.33 seconds duration. This prevents overheating of the elements. The power limit is programmed into the product controller.

A table of standard power limits is supplied with new products, it is given in section 11.0
7.7 Element Ageing

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

If the product does not reach temperature, or is slow, check the power limit setting and increase the value by 5%. It is recommended to make a note of the new settings and the date of the adjustment in section 11.0. Increase the power limit in steps of 5% until the product regains its original performance.

If the power limit is set to 100% a new set of heating elements is required.

Please note: it is not possible to use the cold resistance of the element as a measure of ageing as the cold resistance is not an accurate indicator of hot resistance. Hot resistance is used to calculate furnace power.

See the controller instructions for how to adjust the controller. Always record the setting when first making an adjustment. If new elements are fitted, return the adjustments to the original value. A table of standard power limits is given in section 11.0.
8.0 Repairs and Replacements

8.1 Safety Warning - Disconnection from Power Supply

Immediately switch the product off in the event of unforeseen circumstances (e.g. large amount of smoke). Allow the product to return to room temperature before inspection.

Always ensure that the product is disconnected from the electrical supply before repair work is carried out.

Caution: Double pole/neutral fusing may be used in this product.

8.2 Safety Warning - Refractory Fibre Insulation

Insulation made from High Temperature Insulation Wool
Refractory Ceramic Fibre, better known as (Alumina silicate wool - ASW).

This product contains **alumino silicate wool** products in its thermal insulation. These materials may be in the form of blanket or felt, formed board or shapes, slab or loose fill wool.

Typical use does not result in any significant level of airborne dust from these materials, but much higher levels may be encountered during maintenance or repair.

Whilst there is no evidence of any long term health hazards, it is strongly recommended that safety precautions are taken whenever the materials are handled.

**Exposure to fibre dust may cause respiratory disease.**

When handling the material, always use approved respiratory protection equipment (RPE-eg. FFP3), eye protection, gloves and long sleeved clothing.

Avoid breaking up waste material. Dispose of waste in sealed containers.

After handling, rinse exposed skin with water before washing gently with soap (not detergent). Wash work clothing separately.

Before commencing any major repairs it is recommended to make reference to the European Association representing the High Temperature Insulation Wool industry (www.ecfia.eu).

Further information can be provided on request. Alternatively, Carbolite Gero Service can quote for any repairs to be carried out either on site or at the Carbolite Gero factory.

8.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
8.4 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.

8.5 Thermocouple Replacement

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

Thermocouple cable colour codings are:

<table>
<thead>
<tr>
<th>Thermocouple leg</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>positive (type R)</td>
<td>orange</td>
</tr>
<tr>
<td>negative</td>
<td>white</td>
</tr>
</tbody>
</table>

Disconnect the thermocouple from its terminal block and withdraw the thermocouple from its sheath by bending the metal tag or releasing the screw to release. It is also advisable to remove the sheath and shake out any broken pieces of thermocouple.
Re-assemble with a new thermocouple, observing the colour coding, ensuring that the thermocouple is not twisted as it is being inserted and that the metal tag is bent back to grip the sheath.
Refit the element access panel.
8.0 Repairs and Replacements

8.6 Element Fitting and Replacement

Replacements: see section 7.7. If at any time the power limit has been increased, reset it to its original value (see section 11.0 at the back of this manual for the original value).

New elements must not be mixed with aged elements. If a single element fails in an aged set of elements then replace with a new set. The remaining aged elements can be used as spare parts in the future.

⚠️ Disconnect the product from the electrical supply.

Remove the end guards to gain access to the element connections.

Remember that the elements are fragile and expensive and that they can be damaged by contamination: handle them with care and keep them clean.

Replacements: make a note of the actual braid and cable connections to the elements. For rod elements disconnect the clips, lift off the braids and carefully withdraw each element. Refer to the image below.

Carefully insert the new elements into the product. Ensure that the rod elements are placed centrally: the same length should be outside the insulation at each end.

TZF: The 3 rod elements are connected in series, using braids. The 6 double-spiral elements are fitted 3 in series at each end, connected by 10 mm cable. See fig. 9. In the case of 3-phase + neutral, each set of elements is connected to a live from an SSR at one end, at to neutral at the other. In the case of 3-phase delta (no neutral), each set of elements is connected to a live from an SSR at one end and a direct live from another phase at the other. The normal phase connections are A1-C, B1-A, C1-B.

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

If aged elements have been replaced, reset the products power limit.

If you have any problems with this procedure, please contact the Carbolite Gero service division.
8.7 **Fuse Replacement**

Fuses are marked on the wiring diagram with type codes, e.g. F1, F2. For more information on fuses refer to section 11.0.

*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.
## 9.0 Fault Analysis

### A. Furnace Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> The HEAT light is ON</td>
<td>The heating element has failed</td>
<td>Check also that the SSR is working correctly</td>
</tr>
<tr>
<td><strong>2.</strong> The HEAT light is OFF</td>
<td>The controller shows a very high temperature or code such as S.br</td>
<td>The thermocouple has broken or has a wiring fault</td>
</tr>
<tr>
<td></td>
<td>The controller shows a low temperature</td>
<td>The door switch(es) (if fitted) may be faulty or need adjustment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault</td>
</tr>
<tr>
<td></td>
<td>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></td>
</tr>
</tbody>
</table>
### B. Product Overheats

<table>
<thead>
<tr>
<th></th>
<th>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></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></td>
<td>The thermocouple may be connected the wrong way around</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The controller may be faulty</td>
</tr>
<tr>
<td>2.</td>
<td>Product heats up when the instrument switch is OFF</td>
<td>The SSR has failed &quot;ON&quot;</td>
<td>Check for an accidental wiring fault that could have overloaded the SSR</td>
</tr>
</tbody>
</table>
10.0 Wiring Diagrams

10.1 WC-13-31
Connections below show single phase with indirect safety switches and over-temperature control.
10.2 WC-U3-31
Connections below show 3-phase +N with safety switches and over-temperature control.

![Wiring Diagram]

Products with this wiring arrangement may be converted between the following supply voltages (please refer to the table within section 11.0 for compatible phases with the product):

- 3-phase + neutral in the range 380/220 V - 415/240 V
- 3-phase delta in the range 220 V - 240 V
- Single phase in the range 220 V - 240 V
- 208 V model: can be converted between 208 V delta and 208 V 1-phase

Please contact Carbolite Gero Service for details.
10.3 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:

```
master  slave  slave
HD      HD      HD
HE      HE      HE
HF      HF      HF
```
11.0 Fuses and Power Settings

11.1 Fuses

F1-F3: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th>F1</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>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 15/450</td>
<td>1-phase</td>
<td>200-240</td>
<td>50 A</td>
</tr>
<tr>
<td>TZF 15/450</td>
<td>3-phase Delta</td>
<td>200-240</td>
<td>32 A</td>
</tr>
<tr>
<td>TZF 15/450</td>
<td>3-phase + N</td>
<td>380-415</td>
<td>25 A</td>
</tr>
</tbody>
</table>

11.2 Power Settings

The power limit settings (parameter OP.Hi) for this model are voltage dependant. The figures represent the maximum percentage of time that controlled power is supplied to the elements. Do not attempt to “improve performance” by setting a value higher than the recommended values. To adjust the parameter refer to the "Changing the Maximum Output Power" of the control section of the manual.

<table>
<thead>
<tr>
<th>Model</th>
<th>Volts:</th>
<th>208 V</th>
<th>200 V</th>
<th>220 V</th>
<th>230 V</th>
<th>240 V</th>
<th>380 V</th>
<th>400 V</th>
<th>415 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>TZF 15/450</td>
<td>(1-phase/ 3-phase)</td>
<td>31</td>
<td>34</td>
<td>31</td>
<td></td>
<td>33</td>
<td>37</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>
11.0 Fuses and Power Settings

**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>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</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.
12.0 Specifications

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>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 15/450</td>
<td>1500</td>
<td>5.0</td>
<td>90</td>
<td>900-1200</td>
<td>450</td>
<td>39</td>
</tr>
</tbody>
</table>

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

12.1 Environment

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

Temperature: 5 °C - 40 °C

Relative humidity: Maximum 80 % up to 31 °C decreasing linearly to 50 % at 40 °C
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>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The products covered in this manual are only a small part of the wide range of ovens, chamber furnaces and tube furnaces manufactured by Carbolite Gero for laboratory and industrial use. For further details of our standard or custom built products please contact us at the address below, or ask your nearest stockist.

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

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

---

**Carbolite Gero Ltd,**  
Parsons Lane, Hope, Hope Valley, S33 6RB, England.  
Telephone: + 44 (0) 1433 620011  
Fax: + 44 (0) 1433 621198  
Email: Info@carbolite-gero.com  
www.carbolite-gero.com

Copyright © 2019 Carbolite Gero Limited