Installation, Operation and Maintenance Instructions
1500 °C Rapid Heating Furnace - RHF Model: Litres
3216 Controller

RHF 15/3 + 3216 Controller
Contents

This manual is for guidance on the use of the Carbolite Gero product specified on the front cover. This manual should be read thoroughly before unpacking and using the furnace or oven. The model details and serial number are shown on the back of this manual. Use the product for the purpose for which it is intended.

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1.0 Symbols and Warnings

1.1 Switches and Lights

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

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

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

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

NOTE: This product contains Refractory Ceramic Fibre (also known as Alumino Silicate Wool - ASW). For precautions and advice on handling this material see section 7.2.

2.2 Siting and Setting Up

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

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

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

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

Unless otherwise stated elsewhere in this manual, ensure that there is at least 150 mm of free space around the back and sides of the product. Clear space is required above the product to dissipate heat.
Depending on the application of the product, it may be appropriate to position it under an extraction hood. Ensure the extraction hood is switched on during use.

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

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

2.3 Chimney

The chimney is a length of tubing. If it is supplied unfitted, then fit it through the hole in the top of the case.

If the product is to be used to heat substances that emit fumes, a fume extraction duct of approximately 75 mm - 150 mm inlet diameter may be placed directly above the chimney outlet.

Do not make a sealed connection to the product chimney as this causes excessive airflow through the chamber and results in poor temperature uniformity.
2.0 Installation

Key
| A | Duct (75mm-150mm diameter) |
| B | Ambient air is drawn into duct |
| C | Chimney |
| D | 25mm vertical gap between chimney and duct |

2.4 Heating Elements

The silicon carbide elements are VERY FRAGILE and are packed separately. Fit them accordingly to the instructions in section 7.0 for element fitting and replacement instructions.

2.5 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>Live - Neutral</td>
<td>Reversible or Live-Live</td>
</tr>
<tr>
<td>1-phase</td>
<td>L</td>
<td>Brown</td>
<td>to live</td>
</tr>
<tr>
<td></td>
<td>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>
<tr>
<td></td>
<td>N</td>
<td>Blue</td>
<td>to earth (ground)</td>
</tr>
<tr>
<td>3-phase</td>
<td>L1</td>
<td>Black</td>
<td>to phase 1</td>
</tr>
<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</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 product 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.

Two-phase models use two phases out of a 3-phase + neutral supply. One phase is unused. The neutral current is equal to the current in one of the used phases.
3.0 3216 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 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.

3.3 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.

3.4 Operation

3.4.1 Controller Layout

![Controller Diagram]

**Key**

A  Power Output Indicator
B  Alarm Indicator
C  Remote Indicator (when configured)
D  Page
E  Scroll
F  Down
G  Up
H  Run Indicator
I  Hold Indicator
J  Setpoint Temperature (SP)
K  Measurement Temperature
3.4.2 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

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

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

3.5 Quick Start Guide

3.5.1 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).

3.5.2 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.

3.5.3 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>
3.5.4 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 \( \text{Page} \) for 3 seconds.
2. The display will show LEu 1 GOTO
3. Release the page Key
4. Press the up \( \uparrow \) or down \( \downarrow \) to choose LEu 2 (level 2)
5. Press the up \( \uparrow \) or down \( \downarrow \) 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 \( \text{Page} \)
2. Press down \( \downarrow \) 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>
<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 \( \text{Scroll} \) and use up \( \uparrow \) to return to a previous parameter.
3.6 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).

3.6.1 Maximum Output Power

Press scroll \( \uparrow \) until the display shows OP.HI <OUTPUT HIGH>. Use the up \( \uparrow \) and down \( \downarrow \) 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 10.0.

3.6.2 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 \( \uparrow \) until the display shows ID <CUSTOMER ID>. Use the up \( \uparrow \) and down \( \downarrow \) keys to enter your own identification number. This can range from 1-9999.

3.6.3 Units

Press scroll \( \uparrow \) until the display shows UNITS <DISPLAY UNITS>. Use the up \( \uparrow \) or down \( \downarrow \) 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>

3.6.4 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.

3.6.5 Scrolling Text

If at any time the scrolling text is not required.

Press and hold the page \( \uparrow \) for three seconds until “GOTO” is displayed.

Press scroll \( \uparrow \) until the display shows. TEXT <ENABLE/ DISABLE SCROLLING TEXT> Use the up \( \uparrow \) and down \( \downarrow \) keys to select ON or OFF.
3.0 3216 Controller

3.6.6 Customer Calibration

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

Dual Offset

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

Press scroll \( \text{ كال } \) until the display shows CAL.P (Enter Calibration Code) Use the up ▲ 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 \( \text{ كال } \) 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 \( \text{ كال } \) 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 \( \text{ كال } \) 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 \( \text{ كال } \) 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.

3.6.7 Holdback

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

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

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

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

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

3.7.1 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.

3.7.2 Program Number (3216P5 Only)

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

3.7.3 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.

3.7.4 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.

3.7.5 Holdback

see section 3.6. 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.

3.7.6 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”.

3.7.7 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.

3.7.8 Dwell Time

Press scroll ▲ until the display shows DELL. 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.

3.7.9 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>

3.7.10 Program Status

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

3.7.11 Process Value

The upper display shows the current temperature of the product.

3.7.12 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 3.6) 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.
### 3.0 3216 Controller

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMP.1</td>
<td>5°C/Min</td>
<td>RMP.1</td>
<td>4°C/Min</td>
<td>RMP.1</td>
<td>OFF</td>
</tr>
<tr>
<td>T.SP1</td>
<td>600°C</td>
<td>T.SP1</td>
<td>400°C</td>
<td>T.SP1</td>
<td>600°C</td>
</tr>
<tr>
<td>Dwel.1</td>
<td>30 Min</td>
<td>Dwel.1</td>
<td>30 Min</td>
<td>Dwel.1</td>
<td>60 Min</td>
</tr>
</tbody>
</table>

### 3.8 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.

#### 3.8.1 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.

- **Product end of cable** female (25-pin) 9-pin
- **RS232 Cable: product to PC**
- **Computer end of cable** 9-pin (25-pin) male

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tx</td>
<td>(3)</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Com</td>
<td>(7)</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 3.8.2 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:

- **Product end of cable** female (25-pin) 9-pin
- **RS485 Cable: product to PC**
- **Computer end of cable** 9-pin (25-pin) female

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>(3)</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Com</td>
<td>(7)</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 3.8.3 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.

3.8.4 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]

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 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.

3.10 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.
### 3.0 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>
</tbody>
</table>
| ** | 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 |
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.

### 4.2 Operation

#### 4.2.1 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.
4.0 2132 Over-Temperature

4.2.2 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.

4.2.3 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).

4.2.4 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.

4.2.5 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.

4.2.6 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.
4.3 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 4.2.

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

4.4 Navigation Diagram
5.0 Operation

5.1 Operating Cycle

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

Connect the product to the electrical supply.

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

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

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

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

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

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

5.2 General Operating Notes

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 11.0 towards the back of this manual.

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

When heating materials that produce smoke or fumes, the chimney must be correctly fitted and unobstructed. If not, soot will accumulate in the chamber and could possibly cause an electrical breakdown of the heating element. If the furnace is used to heat
materials that emit smoke or fumes, regularly heat it up to maximum temperature for one hour with the chamber empty to burn away the soot.

Materials such as case hardening compounds and other reactive salts may penetrate the furnace chamber lining and attack the wire elements, causing premature failure. Use of a hearth tile may be advisable: please consult the Carbolite Gero technical department.

5.3 Use of Probes

Any metal object used to probe into the product chamber while the product is connected to the electrical supply must be earthed. This applies in particular to metal sheathed thermocouples, where the sheaths must be earthed. The refractory material of the chamber lining becomes partly conductive at high temperatures and the electric potential inside the chamber can be at any value between zero and the supply voltage. Unearthed probes can cause serious electric shock.

5.4 Atmospheres

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

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

5.5 Heating Elements

If SiC heating elements are used close to their maximum operation temperature of 1600 °C it is possible for bubbles of silica to form on the surface of the elements. The size of the bubbles can vary. This is an indication that the elements temperature has exceeded 1625 °C. The silica bubble can be removed, if they are a nuisance to the application, by careful use of a vacuum cleaner with an appropriate exhaust filter. To reduce the likelihood of silica bubbles forming, heat the furnace using a reduced heating rate and if possible use a lower setpoint.

5.6 Silicon Carbide Protection Tiles Option

This product is available with optional heating element protection tiles. When this option is specified, silicon carbide (SiC) tiles are added to the insulation assembly, positioned on both sides of the chamber to create a barrier between the working chamber and the heating elements. This will protect the heating elements from potentially harmful contaminants that might be placed in the chamber.
This option is ideal for processes which can create acids, water, fumes or aggressive gases that can react with and damage the heating elements.

The addition of the heating element protection tiles option reduces the width of the internal chamber and the maximum operating temperature. Please refer to the "Specifications" section of this manual for further details.

### 5.7 Operator Safety

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

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

Before removing a hot object from the product, make sure there is a safe place to put it down. If necessary use tongs, face masks and heat resistant gloves. Heat resistant clothing and face protection can guard against the effects of radiated heat when the furnace is open.

When the product is opened during operation there is considerable radiated heat. Do not keep any flammable objects near the product, nor objects which could be damaged by radiated heat.
6.0 Maintenance

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

6.2 Maintenance Schedule

<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>Safety Switch Function</td>
<td>Set a safe temperature above ambient, and open the door to see if the heater light goes out</td>
<td>Daily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bi-Annually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually</td>
</tr>
<tr>
<td>Safety Switch Function</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit</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>(if fitted)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td>(if fitted)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Door Plug</td>
<td>Visual inspection, checking the seal and whether it is free of damage</td>
<td>Daily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bi-Annually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually</td>
</tr>
<tr>
<td>Door Plug</td>
<td>Replacement where necessary</td>
<td></td>
</tr>
<tr>
<td>Chimney / Extraction</td>
<td>Check and clean if necessary</td>
<td>Daily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bi-Annually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually</td>
</tr>
<tr>
<td>Electrical Safety (external)</td>
<td>Visual check of external cables and plugs</td>
<td>Daily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bi-Annually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually</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></td>
<td></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>Daily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bi-Annually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually</td>
</tr>
<tr>
<td>Operational Check</td>
<td>Check that all functions are working normally</td>
<td></td>
</tr>
</tbody>
</table>

**DANGER! ELECTRIC SHOCK.** Risk of fatal injury. Only electrically qualified personnel should attempt these maintenance procedures.
## 6.0 Maintenance

<table>
<thead>
<tr>
<th>Operational Check</th>
<th>Thorough inspection and report incorporating a test of all functions</th>
</tr>
</thead>
<tbody>
<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>Hearth</td>
<td>Visual check for fit and damage</td>
</tr>
<tr>
<td>Cooling Fans (if fitted)</td>
<td>Check whether the cooling fans are working</td>
</tr>
</tbody>
</table>
6.2.1 Cleaning
Soot deposits may form inside the furnace, depending on the process. At appropriate intervals remove these by heating as indicated in the General Operation Notes.

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

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

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

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

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

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

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

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

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

6.3 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.

6.4 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.

6.5 Recommended Spare Parts and Spare Parts Kit

Carbolite Gero can supply individual spare parts or a kit of the items most likely to be
required. Ordering a kit in advance can save time in the event of a breakdown.
Each kit consists of one thermocouple, one sheath, one solid-state relay, one door
insulation piece, a set of elements, a set of element clips and a set of braid and clips.
Individual spare parts are also available.
When ordering spare parts please quote the model details as requested above.

6.6 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 10.0. 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 10.0.
6.7 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 10.0.
7.0 Repairs and Replacements

7.1 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.

7.2 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.

7.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
7.4 Solid-State Relay Replacement

Disconnect the product from the power supply and remove the appropriate cover as given above.

1. Make a note of the wire connections to the solid state relay, then disconnect them.
2. Remove the solid state relay from the base panel or aluminium plate.
3. Replace and reconnect the solid state relay ensuring that the bottom of it has good thermal contact with the base panel or aluminium plate.
4. Replace the access panel.

7.5 Fuse Replacement

Fuses are marked on the wiring diagram with type codes, e.g. F1, F2. For more information on fuses refer to section 10.0. 

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

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

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

7.6 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.
7.7 Element Fitting and Replacement

See section 7.2 - wearing a face mask is required.

Replacements: see section 6.6. If at any time the power limit has been increased, reset it to its original value (see section 10.0 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.

<table>
<thead>
<tr>
<th>Part</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements</td>
<td>4</td>
</tr>
<tr>
<td>Centre braids</td>
<td>2</td>
</tr>
<tr>
<td>End braids (attached to the terminal blocks)</td>
<td>4</td>
</tr>
<tr>
<td>Nuts</td>
<td>8</td>
</tr>
<tr>
<td>Bolts</td>
<td>8</td>
</tr>
<tr>
<td>Washers</td>
<td>16</td>
</tr>
</tbody>
</table>

Tools required:

- 1 x screwdriver cross-head
- 2 x 10 mm spanner
Remove the furnace back panel 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. Disconnect the braids or cables and carefully withdraw each element.

New furnace: The diagrams indicate the connections, but the number and positions of terminal blocks may differ from those shown. For example, there may be $3 \times N$ on a 3-phase furnace. If you have any problems with this procedure, please contact the Carbolite Gero Service department. A common feature of all the RHF models is that elements are always 2 in series between 200 - 240 V (for 110 V, 2 in parallel).

Carefully disconnect the element braids from the heating elements using two 10 mm spanners. Use two spanners to avoid putting any force onto the fragile heating elements. Make a note of the connections.
Remove the two centre braids and carefully place them aside. Disconnect the four end braids and bend them out of the way.

Carefully remove the old elements from the furnace. Avoid damaging the insulation as this can be hazardous to your health if inhaled. Refer to section 2.1
Carefully insert the new elements into the furnace. Position elements so that the split along the length is vertically positioned.

Attach the braids according to the notes made, or according to the appropriate diagram below.

Ensure the element braids are positioned so that they do not touch each other, and are clear of the back panel when it is re-fitted.

Replace the furnace back panel and connect the furnace to the electrical supply.

**Example Element Connections - 4 Elements**

- **200-240 V**
  - Single Phase

- **200-240 V**
  - 3 Phase + Neutral

- **100-120 V**
  - 3-Phase Delta
# 8.0 Fault Analysis

## A. Furnace Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The HEAT light is ON</td>
<td>The heating element has failed</td>
<td>Check also that the SSR is working correctly</td>
</tr>
<tr>
<td>2. 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 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>There are no lights glowing on the controller</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></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>
### 8.0 Fault Analysis

#### B. Product Overheats

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Product only heats up when the instrument switch is ON</strong></td>
<td><strong>The controller shows a very high temperature</strong></td>
</tr>
<tr>
<td></td>
<td><strong>The controller shows a low temperature</strong></td>
<td><strong>The thermocouple may be faulty or may have been removed out of the heating chamber</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>The thermocouple may be connected the wrong way around</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>The controller may be faulty</strong></td>
</tr>
<tr>
<td>2.</td>
<td><strong>Product heats up when the instrument switch is OFF</strong></td>
<td><strong>The SSR has failed &quot;ON&quot;</strong></td>
</tr>
</tbody>
</table>
9.0 Wiring Diagrams

9.1 WA-12-30
9.2 WA-12-31
Connections below show single phase with safety switches and over-temperature control.
9.3 **WA-22-30**

Connections below show 2-phase +N with indirect safety switches.

---

**Key**

- F1, F2, F3: Fuses
- FIL: Filter
- R1/1, R1/2: Relay Contactor
- R1: Relay
- C: Temperature Controller
- TC: Control Thermocouple
- SSR: Solid State Relay
- SSW: Safety Switch
- H: Heat Lamp
- EL: Element(s)
- SW: Instrument Switch(es)
- N: Neutral
- L1/L2: Live
- PE: Earth

**Cables**

- BU: Blue
- R: Red
- GR/Y: Green + Yellow
- G: Grey
- P: Pink
9.4 WA-22-31
Connections below show 2-phase +N with indirect safety switches and over-temperature control.

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1, F2, F3</td>
<td>Fuses</td>
</tr>
<tr>
<td>FIL</td>
<td>Filter</td>
</tr>
<tr>
<td>R1/1, R1/2</td>
<td>Relay Contactor</td>
</tr>
<tr>
<td>R1</td>
<td>Relay</td>
</tr>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>TC</td>
<td>Control Thermocouple</td>
</tr>
<tr>
<td>OT</td>
<td>Over-Temperature</td>
</tr>
<tr>
<td>OTC</td>
<td>Over-Temperature Thermocouple</td>
</tr>
<tr>
<td>SSW</td>
<td>Safety Switch</td>
</tr>
<tr>
<td>H</td>
<td>Heat Lamp</td>
</tr>
<tr>
<td>EL</td>
<td>Element(s)</td>
</tr>
<tr>
<td>SW</td>
<td>Instrument Switch(es)</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>L1/L2</td>
<td>Live</td>
</tr>
<tr>
<td>PE</td>
<td>Earth</td>
</tr>
<tr>
<td>*</td>
<td>If fitted</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cables</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>BU</td>
<td>Blue</td>
</tr>
<tr>
<td>R</td>
<td>Red</td>
</tr>
<tr>
<td>GR/Y</td>
<td>Green + Yellow</td>
</tr>
<tr>
<td>G</td>
<td>Grey</td>
</tr>
<tr>
<td>P</td>
<td>Pink</td>
</tr>
</tbody>
</table>
10.0  Fuses and Power Settings

10.1  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>
</tbody>
</table>

| Customer Fuses | Required if no supply cable fitted. Recommended if cable fitted. | See rating label for current; See table below for fuse rating. |

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHF 15/3</td>
<td>1-phase</td>
<td>200-240 V</td>
<td>40 A</td>
</tr>
<tr>
<td>RHF 15/3</td>
<td>2-phase+N</td>
<td>380/220 - 415/240 V</td>
<td>20 A</td>
</tr>
</tbody>
</table>

10.2  Power Settings

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

<table>
<thead>
<tr>
<th>Volts</th>
<th>200 V</th>
<th>208 V</th>
<th>220 V</th>
<th>380 V</th>
<th>230 V</th>
<th>400 V</th>
<th>240 V</th>
<th>415 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (%)</td>
<td>52</td>
<td>49</td>
<td>44</td>
<td>40</td>
<td>37</td>
<td></td>
<td></td>
<td></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>
<td></td>
<td></td>
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<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.
11.0 Specifications

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>Chamber Size</th>
<th>Approx Capacity (l)</th>
<th>Net Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber furnaces heated by silicon carbide elements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RHF 15/3</td>
<td>1500</td>
<td>4.5</td>
<td>120</td>
<td>120</td>
<td>205</td>
</tr>
<tr>
<td>with SiC Protection Tile Option</td>
<td>1400</td>
<td>4.5</td>
<td>120</td>
<td>80</td>
<td>205</td>
</tr>
</tbody>
</table>

11.1 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
## Notes


## 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:

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Fax: +44 (0) 1433 624243
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