Installation, Operation and Maintenance Instructions
1600°C Coal Ash Fusion Furnace - CAF Model: 38mm Ø
3216 Controller

CAF 16/38 + 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.

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Symbols and Warnings</td>
<td>5</td>
</tr>
<tr>
<td>1.1 Switches and Lights</td>
<td>5</td>
</tr>
<tr>
<td>1.2 General Warnings</td>
<td>5</td>
</tr>
<tr>
<td>1.3 Hydrogen and Carbon Dioxide Warning</td>
<td>7</td>
</tr>
<tr>
<td>1.4 Carbon Monoxide Warning</td>
<td>7</td>
</tr>
<tr>
<td>2.0 Installation</td>
<td>9</td>
</tr>
<tr>
<td>2.1 Unpacking and Handling</td>
<td>9</td>
</tr>
<tr>
<td>2.2 Siting and Setting Up</td>
<td>9</td>
</tr>
<tr>
<td>2.3 Heating Elements</td>
<td>10</td>
</tr>
<tr>
<td>2.4 Telescope</td>
<td>10</td>
</tr>
<tr>
<td>2.5 Electrical Connections</td>
<td>11</td>
</tr>
<tr>
<td>2.6 Gas Connections</td>
<td>12</td>
</tr>
<tr>
<td>3.0 3216 Controller</td>
<td>13</td>
</tr>
<tr>
<td>3.1 PID control</td>
<td>13</td>
</tr>
<tr>
<td>3.2 3216P1</td>
<td>13</td>
</tr>
<tr>
<td>3.3 3216P5</td>
<td>13</td>
</tr>
<tr>
<td>3.4 Operation</td>
<td>13</td>
</tr>
<tr>
<td>3.4.1 Controller Layout</td>
<td>13</td>
</tr>
<tr>
<td>3.4.2 Keys</td>
<td>14</td>
</tr>
<tr>
<td>3.5 Quick Start Guide</td>
<td>14</td>
</tr>
<tr>
<td>3.5.1 Operation as a simple controller</td>
<td>14</td>
</tr>
<tr>
<td>3.5.2 Changing the Setpoint</td>
<td>14</td>
</tr>
<tr>
<td>3.5.3 Using the Controller</td>
<td>14</td>
</tr>
<tr>
<td>3.5.4 Understanding User Levels</td>
<td>15</td>
</tr>
<tr>
<td>3.6 Setting up the Controller</td>
<td>16</td>
</tr>
<tr>
<td>3.6.1 Maximum Output Power</td>
<td>16</td>
</tr>
<tr>
<td>3.6.2 Customer ID</td>
<td>16</td>
</tr>
<tr>
<td>3.6.3 Units</td>
<td>16</td>
</tr>
<tr>
<td>3.6.4 Language</td>
<td>16</td>
</tr>
<tr>
<td>3.6.5 Scrolling Text</td>
<td>17</td>
</tr>
<tr>
<td>3.6.6 Customer Calibration</td>
<td>17</td>
</tr>
<tr>
<td>3.6.7 Holdback</td>
<td>18</td>
</tr>
<tr>
<td>3.7 Programming</td>
<td>19</td>
</tr>
<tr>
<td>3.7.1 Creating a Program</td>
<td>19</td>
</tr>
</tbody>
</table>
3.7.2 Program Number (3216P5 Only) ................................................................. 19
3.7.3 Ramp Units ................................................................................................. 19
3.7.4 Dwell Units ................................................................................................ 19
3.7.5 Holdback ..................................................................................................... 19
3.7.6 Ramp Rate .................................................................................................. 19
3.7.7 Target Setpoint ........................................................................................... 19
3.7.8 Dwell Time .................................................................................................. 19
3.7.9 Running a Program ...................................................................................... 20
3.7.10 Program Status ......................................................................................... 20
3.7.11 Process Value ............................................................................................ 20
3.7.12 PSP, Segment Type and Number .............................................................. 20
3.8 Controller Options .......................................................................................... 23
  3.8.1 Digital Communications - RS232 ............................................................... 23
  3.8.2 Digital Communications - RS485 ............................................................... 23
  3.8.3 Comms Address ........................................................................................ 23
  3.8.4 Alarm Option ............................................................................................. 24
3.9 Temperature Controller Replacement ........................................................... 24
3.10 3216 Controller Navigation Diagram .......................................................... 24
4.0 2132 Over-Temperature Controller Description (if fitted) .............................. 26
  4.1 Description ..................................................................................................... 26
  4.2 Operation ....................................................................................................... 26
    4.2.1 Controls .................................................................................................. 26
    4.2.2 Operation ................................................................................................. 27
    4.2.3 Over-Temperature Operation ................................................................. 27
    4.2.4 Over-Temperature Alarm ....................................................................... 27
    4.2.5 Resetting the Over-Temperature Alarm .................................................. 27
    4.2.6 Sensor Break .......................................................................................... 27
  4.3 Audible Alarm ............................................................................................... 28
  4.4 Navigation Diagram ...................................................................................... 28
5.0 Operation ......................................................................................................... 29
  5.1 Operating Cycle ............................................................................................. 29
  5.2 Setting up for Coal Ash Fusion Test ............................................................... 29
  5.3 General Operating Advice ............................................................................ 30
  5.4 Tube Life ....................................................................................................... 30
  5.5 Operator Safety ............................................................................................. 32
6.0 Maintenance .................................................................................................... 33
  6.1 General Maintenance ..................................................................................... 33
  6.2 Maintenance Schedule .................................................................................. 33
6.2.1 Cleaning ........................................................................................................35
6.3 Element Ageing ...............................................................................................35
6.4 Calibration ........................................................................................................35
6.5 After-Sales Service ..........................................................................................35
6.6 Recommended Spare Parts and Spare Parts Kit .............................................36

7.0 Repairs and Replacements .............................................................................37
7.1 Safety Warning - Disconnection from Power Supply ....................................37
7.2 Safety Warning - Refractory Fibre Insulation ...............................................37
7.3 Temperature Controller Replacement ..........................................................37
7.4 Solid-State Relay Replacement ....................................................................38
7.5 Thermocouple Replacement .........................................................................38
7.6 Element Replacement ....................................................................................39
7.7 Fuse Replacement ..........................................................................................39

8.0 Fault Analysis ..................................................................................................40
A. Furnace Does Not Heat Up .............................................................................40
B. Product Overheats ..........................................................................................41

9.0 Wiring Diagrams .............................................................................................42
9.1 WA-11-00 .......................................................................................................42
9.2 WA-11-01 .......................................................................................................43

10.0 Fuses and Power Settings ............................................................................44
10.1 Fuses ...............................................................................................................44
10.2 Power Settings .............................................................................................44

11.0 Specifications ...............................................................................................45
11.1 Environment ..................................................................................................45
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.
1.0 Symbols and Warnings

Caution – Double Pole/Neutral Fusing
1.3 Hydrogen and Carbon Dioxide Warning

Applicable for furnaces constructed to use H₂ and CO₂ test gases with CO₂ 'Purge' gas.

- H₂ can form explosive gas mixtures, take precautions to avoid leakage of H₂.
- H₂ and CO₂ can react to form CO.

see section 1.4.

Carbon dioxide (CO₂) is a colourless, odourless and tasteless gas that is an asphyxiant. Rapid unconsciousness occurs at levels above 11%, levels of 20 - 30% are immediately hazardous to life.

Information extracted from Croner Publications Ltd. Substances Hazardous To Health.

To minimise the risks associated with CO₂ it is most important that the product is installed and operated in accordance with this instruction manual. If the product operator experiences any of the effects listed above, the product must be isolated from the gas and electricity supplies immediately and expert advice sought. For safety guidelines seek the gas manufacturers advice.

1.4 Carbon Monoxide Warning

Operation of the CAF furnace involves the use of carbon monoxide.

Carbon monoxide is a product of reaction of H₂ and CO₂.

Carbon monoxide (CO) is a colourless, odourless, tasteless and inflammable gas which is acutely toxic. CO is introduced into the blood stream through the lungs and binds with the haemoglobin preventing it from carrying oxygen around the body. This can result in rapid damage to body tissues due to oxygen starvation. Since CO is an accumulating toxin it can be dangerous even when present in quite low concentrations over long periods of time. Individuals vary considerably in their reactions to concentrations of toxic gases; table 1 shows the typical effects of cumulative CO exposure.

Information extracted from Guidance Note EH43 (1996) from the Health and Safety Executive.

To minimise the risks associated with CO it is most important that the furnace is installed and operated in accordance with this instruction manual. If the furnace operator experiences any of the effects listed above, the furnace must be isolated from the gas and electricity supplies immediately and expert advice sought. For safety guidelines seek the gas manufacturers advice.

Table 1. Carbon monoxide in air:
1.0 Symbols and Warnings

<table>
<thead>
<tr>
<th>Parts per million</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>Recommended Exposure Limit (8 hours time weighted average concentration)</td>
</tr>
<tr>
<td>200</td>
<td>Headache after approximately 7 hours if resting or after 2 hours exertion</td>
</tr>
<tr>
<td>400</td>
<td>Headache with discomfort with possibility of collapse after 2 hours at rest or 45 minutes exertion.</td>
</tr>
<tr>
<td>1200</td>
<td>Palpitations after 30 minutes at rest or 10 minutes exertion.</td>
</tr>
<tr>
<td>2000</td>
<td>Unconscious after 30 minutes at rest or up to 10 minutes exertion.</td>
</tr>
</tbody>
</table>

For further information refer to:

- Guidance Note EH43 (1996) from the Health and Safety Executive. ISBN 0 11 883597 1
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.
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.

2.3 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.

2.4 Telescope

The telescope and its trunnion arm are packed separately and should be attached to the front of the product.
2.5 Electrical Connections

Connection by a qualified electrician is recommended.

This product requires a single-phase A.C. supply with earth (ground), which may be Live to Neutral non-reversible (polarised), Live to Neutral reversible (non-polarised), or Live to Live.

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

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

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

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

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

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

The supply MUST incorporate an earth (ground).

Electrical Connection Details:

<table>
<thead>
<tr>
<th>Supply</th>
<th>Terminal Label</th>
<th>Cable Colour</th>
<th>Supply Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-phase</td>
<td>L</td>
<td>Brown</td>
<td>Live - Neutral to live</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reversible or Live-Live</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Blue</td>
<td>to neutral</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>to the other power conductor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(For USA 200-240V, connect L2)</td>
</tr>
<tr>
<td></td>
<td>PE</td>
<td>Green/ Yellow</td>
<td>to earth (ground)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>to earth (ground)</td>
</tr>
</tbody>
</table>
2.6 Gas Connections

The product is fitted with two flow meters, one for Carbon Dioxide (CO₂) on the left and the other for Hydrogen (H₂) on the right. The output from the flow meters is mixed and taken directly to the work tube through a connection at the front.

There are no valves or non-return devices on this furnace. Regulated supplies of CO₂ and H₂ must be connected in a safe manner to ensure that all gas flow is through the work tube. The gas supply pressure required is 4 psi (0.276 bar) and must not exceed this.

At the back of the furnace is a copper exhaust vent pipe. The exhaust fumes are dangerous (see "Carbon Monoxide Warning"). The exhaust must be properly vented into a suitable duct or fume cupboard and must not be allowed to contaminate the atmosphere of the room in which the furnace is sited.
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

<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>
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 Page and Scroll When pressed simultaneously the ACK function is used to:

- Return to the Home Menu
- Acknowledge an alarm if activated.
- Reset a program after the program has ended.

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

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

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 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.

### 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 ▼ 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 10.0.

#### 3.6.2 Customer ID

A furnace or oven identification number can be entered if required. This may be 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.

#### 3.6.3 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>

#### 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 📚 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.

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 ⬇️ 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 ⬇️ 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.
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 \( \uparrow \) until the display shows PROG <PROGRAM NUMBER.> Select the program number.

3.7.3 Ramp Units
Press scroll \( \uparrow \) until the display shows RAMP.U <Ramp Units>: Use the up \( \uparrow \) down \( \downarrow \) to select the Ramp Units of Hour, Min or Seconds.

3.7.4 Dwell Units
Press scroll \( \uparrow \) until the display shows DWEL.U <Dwell Units>: Use the up \( \uparrow \) down \( \downarrow \) to select the Dwell Units of Hour or Min.

3.7.5 Holdback
see section 3.6. Press scroll \( \uparrow \) until the display shows H.BACK <Program Holdback>: If a holdback value is required, use the up \( \uparrow \) down \( \downarrow \) to enter the required value or select “OFF” if no holdback is required.

3.7.6 Ramp Rate
Press scroll \( \uparrow \) until the display shows RMP.1 <Ramp Rate 1>: Using the up \( \uparrow \) down \( \downarrow \) 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 \( \uparrow \) 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 \( \uparrow \) 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 \( \downarrow \) 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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrolling Display – Current Program state</td>
</tr>
<tr>
<td>To HOLD a program</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = Flashing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrolling Display – Program Hold</td>
</tr>
<tr>
<td>To RESET a program</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrolling Display - None</td>
</tr>
<tr>
<td></td>
<td>Program Ended</td>
<td>Indicator – RUN = OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrolling Text – Program End</td>
</tr>
<tr>
<td>To RESET a program after it has completed</td>
<td>Press and hold ▲ + ▼ for more than 1 second or press and quickly release Ack</td>
<td>Indicator – RUN = OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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 /controllers until the display shows WRK.OP <WORKING OUTPUT POWER>. This shows the power being used as a percentage.

Time Remaining

Press scroll /controllers 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 /controllers 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.

![Graphical representation of the program sequence]
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.

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

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

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.
### L1 Level 1

- **Press the Scroll Key**

### L2 Level 2

- **Press the Scroll Key multiple times**

### Access

- **If configured**

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

### **Multiple Program Only**

### **Locked - password required**

### **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.
4.2.2 Operation

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

The page key allows access to parameter lists within the controller.

A single press of the page key displays the temperature units, normally set to °C; further presses reveal the lists indicated in the navigation diagram. See section 4.4.

The scroll key allows access to the parameters within a list. Some parameters are display-only; others may be altered by the operator.

A single press of the scroll key in the 'Home' list displays the temperature units; further presses reveal the parameters in the current list indicated in the navigation diagram.

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

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

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

<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>! For factory access to list and parameters not available to the operator.</td>
<td></td>
</tr>
</tbody>
</table>
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 Setting up for Coal Ash Fusion Test

The CAF 16/38 is designed to be compatible with the following:


The test procedure is entirely manual and under the operator's control. An example of the procedure is as follows:

Heat the product up to its starting temperature.

Open the product door and swing it clear of the work tube to allow access. Load the sample into the work tube. The sample tile with one or two samples on it should be placed centrally along the length of the work tube.

Set the ramp rate on the controller, if required, to limit the heating rate. A rate of 7 °C/ min is suggested and is factory pre-set.

Set the controller to heat the product up to the final temperature. Swing the telescope into place to allow observation of the sample.
Watch the sample and record the temperature at which it fuses. Make all other records such as time and temperature as required by your own organisation.

Switch off and allow to cool down; or set the setpoint to zero or to the normal test starting temperature, so that the temperature is displayed as the furnace cools.

Note: Do not operate the product at temperatures above 815 °C (1499 °F) with the door open. The product door must not be left open longer than is necessary to load and unload samples from the work tube.

Sample tiles can be obtained from Carbolite Gero. A brass mould to assist with forming samples is supplied with the product.

5.3 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 11.0 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.

5.4 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).

![Diagram of a tube with a crucible]

**Key**

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

*Fig 4 - Avoidance of thermal contact*
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 $400 \div \text{internal diameter in mm to give (°C/min)}$; for 75 mm i/ d tubes this comes to 5 °C per minute. The controller can be set to limit both the heating and cooling rate.
5.5 **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).

Warning: Do not use the product if the work tube is cracked as there is a risk of exposure to carbon monoxide gas. See "Carbon Monoxide Warning"
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

CUSTOMER QUALIFIED PERSONNEL

<table>
<thead>
<tr>
<th>Maintenance Procedure</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<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>Daily</td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit</td>
<td>Electrical measurement</td>
<td>Monthly</td>
</tr>
<tr>
<td>Door Plug</td>
<td>Visual inspection, checking the seal and whether it is free of any damage</td>
<td>Bi-Annually</td>
</tr>
<tr>
<td>Door Plug</td>
<td>Replacement where necessary</td>
<td>Anually</td>
</tr>
<tr>
<td>Extraction Pipe</td>
<td>Check that the connection is tight, and clean out the pipe if necessary</td>
<td></td>
</tr>
<tr>
<td>Electrical Safety (external)</td>
<td>Visual check of external cables and plugs</td>
<td></td>
</tr>
<tr>
<td>Electrical Safety (internal)</td>
<td>Physically check all connections and cleaning of the power plate area</td>
<td></td>
</tr>
<tr>
<td>Gas Safety (external)</td>
<td>Visually check that all pipework is in place and free of damage. Physically check that all connections are tight</td>
<td></td>
</tr>
<tr>
<td>Gas Safety (internal)</td>
<td>Leak test the gas system</td>
<td></td>
</tr>
<tr>
<td>Cooling Fans</td>
<td>Check whether the cooling fans are working</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>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><strong>Element Circuit</strong></td>
<td>Electrical measurement</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td>Measure the current drawn on each phase / circuit</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.

6.3 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.

Once the heating elements have been in use for some time, they should only be replaced as a set. Single elements may be replaced (in the case of breakage, for example) when the elements are reasonably new.

6.4 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.

6.5 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.
6.6 **Recommended Spare Parts and Spare Parts Kit**

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

Each kit consists of a thermocouple and sheath, a solid state relay, a set of heating elements and a set of clips and braids.

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

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.

7.5 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; retain any porcelain spacers.
Withdraw the thermocouple from its sheath and remove any broken bits of thermocouple.
Re-assemble with a new thermocouple observing the colour coding.
Refit the element access panel.
7.6  Element Replacement

Disconnect the product from the electrical supply.
Remove the complete front panel. Remove the thermocouple cover and the square plate from the back panel.
The elements are expensive and fragile and can be damaged by contamination: handle them with care and keep them clean.

Replacements only: make a note of the actual braid and cable connections to the elements. Disconnect the clips with the special tool provided (or with finger pressure, depending on the type of clips supplied), lift off the braids and carefully withdraw each element. See fig. 5.

Carefully insert the new elements into the product.

Attach the connection braids according to the note made above or to the appropriate diagram, fig. 6. Use the special tool (or finger pressure) to fit the clips. Take care that adjacent clips do not touch each other.
Replace the product end panels and connect the product to the electrical supply.

![Fig.5. - Use of Clip Tool](image5)

![Fig.6. Element Connections](image6)

7.7  Fuse Replacement

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

<table>
<thead>
<tr>
<th>A. Furnace Does Not Heat Up</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. The HEAT light is ON</strong></td>
</tr>
<tr>
<td>2. The HEAT light is OFF</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### B. Product Overheats

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

9.1 WA-11-00
Connections below show single phase.

Key

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Live</td>
</tr>
<tr>
<td>L</td>
<td>Live</td>
</tr>
<tr>
<td>PE</td>
<td>Neutral</td>
</tr>
<tr>
<td>GR/Y</td>
<td>Green + Yellow</td>
</tr>
<tr>
<td>BU</td>
<td>Blue</td>
</tr>
<tr>
<td>R</td>
<td>Red</td>
</tr>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>F1</td>
<td>Fuses</td>
</tr>
<tr>
<td>FIL</td>
<td>Filter</td>
</tr>
<tr>
<td>F2</td>
<td>Fuses</td>
</tr>
<tr>
<td>F3</td>
<td>Fuses</td>
</tr>
<tr>
<td>SW</td>
<td>Instrument Switch(es)</td>
</tr>
<tr>
<td>TC</td>
<td>Control Thermocouple</td>
</tr>
<tr>
<td>SSR</td>
<td>Solid State Relay</td>
</tr>
<tr>
<td>H</td>
<td>Heat Lamp</td>
</tr>
<tr>
<td>EL</td>
<td>Element(s)</td>
</tr>
<tr>
<td>FM</td>
<td>Fan Motor</td>
</tr>
<tr>
<td>*</td>
<td>Fan Models Only</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>L</td>
<td>Live</td>
</tr>
<tr>
<td>PE</td>
<td>Earth</td>
</tr>
</tbody>
</table>

Cables

<table>
<thead>
<tr>
<th>Symbol</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>
9.2 WA-11-01
Connections below show single phase with over-temperature controller.
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>
<tr>
<td>Customer Fuses</td>
<td>Required if no supply cable fitted. Recommended if cable fitted.</td>
<td>See rating label for current; See table below for fuse rating.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAF 16/38</td>
<td>1-phase</td>
<td>110-120</td>
<td>63 A</td>
</tr>
<tr>
<td>CAF 16/38</td>
<td>1-phase</td>
<td>220-240</td>
<td>25 A</td>
</tr>
</tbody>
</table>

10.2  Power Settings

The setting for the power limit parameter in the controller (OP.Hi) should be 100% for the model listed in this manual.

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>Internal Bore (mm)</th>
<th>Net Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAF 16/38</td>
<td>1600</td>
<td>4.5</td>
<td>38</td>
<td>67</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
<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>
<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 © 2018 Carbolite Gero Limited