Installation, Operation and Maintenance Instructions
1200°C E-Range Tube Furnaces - EST Model: 450mm
3216 Controller

EST 12/450B + 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.

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.
1.3 Warning Labels

On the front control panel there are 2 warning labels as shown in figure 1.3.1; they are numbered 7 and 8. These warnings must be followed for the safe operation of this furnace.

7- Warning label - Do not operate without a work tube.

The furnace must not be operated without the correctly sized work tube and correspond work tube adaptors or it could be possible for an operator to access electrically live element coils that could cause serious injury or death.

8- Warning label - Switch off the furnace before loading and unloading.

The furnace heaters must be switched OFF using the heater switch, item 2 in figure 1.3.1, when the furnace is being loaded or unloaded. The work tube can become electrically conductive at high temperatures, presenting a possible hazard to the operator. If element failure is left undetected the element could collapse onto the work tube.
Index to numbered items in Figure 1.3.1 and 1.3.2

1. Electrical supply switch - switches electrical power ON and OFF to the furnace.
2. Heater switch - switches electrical power ON and OFF to the furnace heating elements.
3. Heater ON light - indicates that the furnace heating elements are energized.
4. Product rating label indicating the product serial number and electrical information.
5. Access holes to front panel fixing screws.
6. Warning label - Disconnect the mains supply before removing this cover.
7. Warning label - Do not operate without a work tube.
8. Warning label - Switch OFF the furnace before loading and unloading.
9. Electrical power lead socket.
2.0 Installation

If the product has been transported or stored in humid conditions it must be dried out completely before operating the furnace. Contact Carbolite Gero Service for instructions.

2.1 Unpacking and Handling

When unpacking or moving the product, always lift it by its base or both ends of the main body. Never lift it by the end insulation or by a work tube. It may take 2 or 3 people to lift the furnace, depending on the size and configuration.

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

Place the product on a level surface in a well ventilated area.
Site away from other sources of heat and on a non-flammable surface that is resistant to accidental spillage or hot materials.
The surface on which the equipment is mounted should be stable and not subject to movement or vibrations.
The height of the mounting surface is important to avoid operator strain when loading and unloading samples.
Unless otherwise stated elsewhere in this manual, ensure that there is at least 150 mm of free space around the back and sides of the product. Clear space is required above the product to dissipate heat.

Work tubes:

It is recommended that the work tube has either insulation plugs or radiation shields fitted to minimise heat loss from both ends of the work tube. If the work tube has open ends, a significant amount of energy could be radiated from the ends of the work tube. Adjacent surfaces should always be made from a non-flammable material.
Ensure that the ends of the work tube are positioned at least 500 mm away from any adjacent surface so that any energy radiated cannot heat an adjacent surface to a dangerous temperature.
If the product is to be used in a process which could liberate hazardous gases, then it should be installed together with a suitable fume extraction system. Ensure that the product is placed in such a way that it can be quickly switched off or disconnected from the electrical supply.

2.3 Setting Up

The horizontal furnace models must have a work tube fitted before being used. The diameter of the work tube is a customer order option and therefore varies between tube furnaces.

Note: If a metal work tube is being used in the furnace, ensure that it is earthed. See 5.4.

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.

Fitting the standard length work tube in a split tube furnace

No tools required.
The fitting of the work tube is as follows with reference to figure 2.3.1. Please note that standard length work tubes are also referred to as tubes suitable for working in air. They are 150 mm longer than the heated length of the furnace (see the table in section 11.0). Read section 7.2 before fitting the work tube.

Figure 2.3.1 - view showing how to fit the standard length work tube in the split tube furnace. Note that the right hand furnace end guard (8) has been removed from the view for clarity to show the end adaptor and tube end stop.

- Release the fixing clips (9 in figure 2.3.1), lift the lid by the handle (1).
- Place the work tube into the bottom half of the furnace in the tube adaptors, between the work tube end stops (5). Note that the work tube might be a tight fit when it is new and may need to be twisted backwards and forwards slightly as it is placed.
- Lower the lid by the handle and refasten the clips.
- Note in Figure 2.3.1 the right hand furnace end guard (8) is not shown so that the end adaptor (3) and tube end stop (5) can be seen. It is not necessary to remove the guards to fit the work tube.

Index to numbered items in Figure 2.3.1 and 2.3.2

1. Top lifting handle
2. Work tube (diameter customer option)
3. Work tube adaptor (size dependent on work tube diameter)
4. Work tube adaptor fixing bracket
5. Work tube end stop (size dependent on work tube diameter)
6. Fixing screws M6 x 15
7. Washer M6
8. Tube furnace end guard
9. Fixing clip
Fitting the extended work tube in the furnace

Tools required: 4 mm Allen key.

Fitting of the work tube is as follows, with reference to figures 2.3.1 to 2.3.10.

Before the extended work tube can be fitted, the work tube end stops for the standard length work tube (item 5 in figure 2.3.1 and figure 2.3.2) must be removed from both ends of the furnace. This is done by removing the furnace end guard (8) and the work tube adaptor brackets (4) to release the work tube end stop. The guards and brackets should then be refitted.

- Fit the tube support bracket, see (5) figure 2.3.5. Use the M6 button head screws and washers supplied.
- Fit the extended work tube guard, see (4) figure 2.3.6. Use the M6 button head screws and washers supplied.
- Re-fit furnace end guards, see (3) figure 2.3.7. Use the M6 button head screws and supplied washers.
- If supplied, fit the optional tube end seal assembly as shown in figures 2.3.11 and 2.3.12. Refer to manual MEN-ENDSEALS-01 for detailed fitting instructions.
- Fit the tube support bracket, see (1) figure 2.3.8. Use the M6 button head screws and washers supplied.
- Finally, fit the tube support collar, (2) and secure tightly using (6), until the tube is secure to be used in a vertical arrangement. The fitting arrangement is shown in figure 2.3.9.
- Figure 2.3.3 shows an exploded view of all the required parts.
- Figure 2.3.9 shows the assembled parts as they would be used.
Figure 2.3.7

Figure 2.3.8

Figure 2.3.9

Figure 2.3.10- Tube support assembled
Index to numbered items in Figure 2.3.3 - 2.3.12

1. Tube support bracket
2. Tube support collar
3. End guard
4. Extended work tube guard
5. End adaptor
6. Fluted grip knob

**Fitting the Optional Insulation Plugs and Radiation Shield**

For optimum temperature uniformity, insulation plugs or radiation shields should be placed in the work tube ends as shown below. With a standard work tube, the insulation plug must be fitted as shown in figure A.

If a gas/vacuum end seal is fitted, either horizontally or vertically, the insulation plug hooks onto the end seal hook; see figure B.

Alignment of radiation shields is similar to that of insulation plugs, see figure C.

If a metal work tube is being used in the furnace, ensure that it is earthed. See the safety warning in section 5.4.
2.4 Electrical Connections

Connection by a qualified electrician is recommended.

All furnaces in the range are single-phase and operate over the voltage ranges 100 to 110 volts or 200 - 240 volts. Check the rating label before connection, see "Warning Labels" for location of rating label. To check that the OP.Hi setting is correct for the appropriate voltage, or to change to another setting, follow the instructions in section 0.1.

The electrical supply should be fused at the next standard size equal to or higher than the design current. Where a supply cable is supplied there are internal supply fuses, in which case customer fusing is preferred but not essential. See section 10.0 for furnace rating power, current and fusing information.

The external connection should be either a permanent connection to a fused isolator supply or to a socket on a fused isolator supply; the isolating switch must operate on both conductors. Make sure that the isolator switch is within easy reach of the furnace operator.

Terminal Connection Details

<table>
<thead>
<tr>
<th>Supply</th>
<th>Terminal Label</th>
<th>UK/ Europe Cable Colour</th>
<th>USA/ Canada Common Cable Colours</th>
<th>Supply Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Live - Neutral</td>
</tr>
<tr>
<td>1-phase</td>
<td>L</td>
<td>Brown</td>
<td>Red or Black</td>
<td>To live</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Blue</td>
<td>White</td>
<td>To neutral</td>
</tr>
<tr>
<td></td>
<td>PE</td>
<td>Green/Yellow</td>
<td>Green or Green/Yellow</td>
<td>To earth (ground)</td>
</tr>
</tbody>
</table>

Supply Type:

- Live - Neutral: Connection to the live and neutral conductors.
- Reversible or Live - Live: Connection to the live conductor with the possibility to switch connections to another live conductor.
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

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
3.0 3216 Controller

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.

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.

Ack

Page and Scroll

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

Arrow Keys

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 maybe used to identify one of many units for production or quality control systems.

Press scroll ▲ until the display shows ID <CUSTOMER ID>. Use the up ▲ and down ▼ keys to enter your own identification number. This can range from 1-9999.

#### 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.
3.0 3216 Controller

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 \[\text{scroll}\] until the display shows PROG <PROGRAM NUMBER.> Select the program number.

3.7.3 Ramp Units

Press scroll \[\text{scroll}\] 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 \[\text{scroll}\] 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 \[\text{scroll}\] 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 \[\text{scroll}\] 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 \[\text{scroll}\] 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 \[\text{scroll}\] until the display shows DWELL. 1 <Dwell TIME 1>: Enter the time to dwell at “Target SP 1”. If the dwell segment is not required, use the down ▼ to select OFF, which is below the Zero value.

This Process is repeated for each of the 8 segments of the program.
If not all the segments are used for a program, the Ramp & Dwell of each of the subsequent segments should be set to OFF.

A program will end in one of two ways, either revert to the control setpoint or dwell at the temperature set in the last segment used. When a program finishes on a dwell and the dwell time expires the temperature will revert to the control setpoint.

Note: Before operating a program ensure that the control setpoint is set to Zero to avoid unexpected heating at the end of the program.

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>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.
3.8 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.

### 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:

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 option](image)

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>F</td>
<td>Fuse (2A)</td>
</tr>
<tr>
<td>S</td>
<td>Supply</td>
</tr>
<tr>
<td>L</td>
<td>Load</td>
</tr>
<tr>
<td>*</td>
<td>Normally open relay contacts</td>
</tr>
<tr>
<td>RO</td>
<td>Relay Output 240V 2A MAX</td>
</tr>
</tbody>
</table>

The purpose of the 2 amp fuse is to break the circuit to prevent overloading on the circuit due to high voltage.

The instrument configuration and parameters available to the operator depend on the customer requirements.

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.
Level 1
- Press the Scroll Key
- Hold the Page key for 3 seconds

Level 2
- Press the Scroll Key multiple times
- Locked - password required

Access
- If configured
- Unlocked

Do not raise the power limit (if accessible) above the design level for the product
- Multiple Program Only

Black = Progress
Dashed = Through multiple menus
White = Return
4.0 2132 Over-Temperature Controller Description (if fitted)

4.1 Description

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

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.
4.2.2 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

### Table:

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

Black = Progress

Dashed = Through to other options
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.

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

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

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

5.2 Safe Operation of the Furnace

For the safe operation of this furnace the following warnings must be followed:
5.0 Operation

Explosive Materials
The furnace must not be used to heat materials which could explode, or which could emit gases that could form explosive mixtures. If the safe heating of a material is dependent on its temperature, only heat these type of materials if the furnace has the optional over-temperature protection device fitted. Ensure that the over-temperature device is calibrated and set to an over-temperature safety limit that is sufficiently large as to avoid any hazards. If in doubt, seek expert advice before proceeding. Customers are responsible for carrying out their own risk assessments on the heating of materials.

Do not operate without a work tube. The furnace must not be operated without the correctly sized work tube and correspond work tube adaptor. Otherwise, an operator can access electrically live element coils that could cause serious injury of death.

Switch off the furnace before loading and unloading. The furnace elements must be switched off using the heater switch, item 2 in "Warning Labels", when the furnace is being loaded or unloaded. The work tube can become electrically conductive at high temperatures. If an element has failed and collapsed onto the work tube, the work tube will become live causing serious injury or death.

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.

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

5.4 Operator Safety

The ceramic materials used in the product manufacture become electrically conductive to some extent at high temperatures. DO NOT use any conductive tools within the product without isolating it. If a metal work tube is used, it must be earthed (grounded).
Switch off the heater switch whenever loading or unloading the product. The elements are isolated when the heater switch is OFF. This switch cuts both sides of the circuit via a contactor.

5.5 Tube Life

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

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

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

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

5.6 Pressure

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

A suitably regulated gas supply should always be used.

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

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

Work tubes of IAP material are impervious. Sillimanite may look similar but is porous. Ensure that the correct tube material is in use before connecting and using gases other than inert gases, such as nitrogen.
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

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

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

<table>
<thead>
<tr>
<th>Seals (if fitted)</th>
<th>Check all seals and O-rings and clamps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance</strong></td>
<td></td>
</tr>
<tr>
<td>Element Circuit</td>
<td>Electrical measurement <img src="image" alt="Warning Icon" /></td>
</tr>
<tr>
<td>Power Consumption</td>
<td>Measure the current drawn on each phase / circuit</td>
</tr>
<tr>
<td>Cooling Fans (if fitted)</td>
<td>Check whether the cooling fans are working</td>
</tr>
</tbody>
</table>
6.2.1 Cleaning
The product's outer surface may be cleaned with a damp cloth. Do not allow water to enter the interior of the case or chamber. Do not clean with organic solvents.

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

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.

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

For vertical models it may be necessary to dismount the furnace from its stand and remove the terminal cover.

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

<table>
<thead>
<tr>
<th>thermocouple leg</th>
<th>colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>positive (type N)</td>
<td>pink</td>
</tr>
<tr>
<td>negative</td>
<td>white</td>
</tr>
</tbody>
</table>

Disconnect the thermocouple from its terminal block.

Carefully withdraw the thermocouple from the product and remove any broken bits of thermocouple.

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

Insert the new thermocouple into position, restoring any removed porcelain spacers and ensuring correct polarity.

Re-assemble the furnace.

### 7.6 Element Replacement

Individual elements are not available for this model of product, if an element fails then a complete element assembly is required. For details and fitting instructions contact Carbolite Gero Service, see the back page of this manual for contact information.
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

## A. Furnace Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td>The HEAT light is ON</td>
<td>The heating element has failed</td>
</tr>
<tr>
<td><strong>2.</strong></td>
<td>The HEAT light is OFF</td>
<td>The controller shows a very high temperature or code such as S.br</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller shows a low temperature</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>There are no lights glowing on the controller</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### B. Product Overheats

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

9.1 WA-11-30
Connections below show single phase with indirect safety switch(es).

Key

<table>
<thead>
<tr>
<th>Symbol</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>SSR</td>
<td>Solid State Relay</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>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-11-70
Connections below show single phase with safety switches.

<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>SSR</td>
<td>Solid State Relay</td>
</tr>
<tr>
<td>SSW-A, SSW-B</td>
<td>Safety Switch(es)</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>L</td>
<td>Live</td>
</tr>
<tr>
<td>PE</td>
<td>Earth</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 - F2: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EST 450B</td>
<td>1-phase</td>
<td>200-208 V</td>
<td>10 A</td>
</tr>
<tr>
<td>EST 450B</td>
<td>1-phase</td>
<td>220-240 V</td>
<td>10 A</td>
</tr>
</tbody>
</table>

**F1 Internal Supply Fuses**
- Fitted if supply cable fitted.
- Fitted on board to some types of EMC filter.
- 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)

**F2 Auxiliary Circuit Fuses**
- Fitted on board to some types of EMC filter.
- May be omitted up to 25 Amp/phase supply rating.
- 2 Amps glass type F
- On board: 20 mm x 5 mm
- Other: 32 mm x 6 mm

**Customer Fuses**
- Required if no supply cable fitted.
- Recommended if cable fitted.
- See rating label for current;
- See table below for fuse rating.
**10.2 Power Settings**

The power limit settings (OP.Hi) for this model is as follows. 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 one from the table. To adjust the parameter refer to the "Changing the Maximum Output Power" of the control section of the manual.

All standard models covered by this manual are fitted with elements designed for use over the range of voltages 100 V-120 V and 200 V-240 V; the power limit parameter is set according to the table below.

The power limit depends on the voltages follows:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>200 V</th>
<th>208 V</th>
<th>220 V</th>
<th>230 V</th>
<th>240 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage (%)</td>
<td>100</td>
<td>100</td>
<td>89</td>
<td>82</td>
<td>77</td>
</tr>
</tbody>
</table>

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

Carbolite Gero reserves the right to change the specification without notice.
All models have cylindrical elements with wire mounted in the surface of the insulation material.
All models can accept work tubes up to a maximum outside diameter of 60 mm.
All models have a maximum operation temperature of 1200°C (1100°C continuous).

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>Minimum Work Tube Length (mm)</th>
<th>Tube length for use with modified atmosphere (mm)</th>
<th>Heated Length (mm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EST 12/450B</td>
<td>1200</td>
<td>2.0</td>
<td>600</td>
<td>900</td>
<td>450</td>
<td>20</td>
</tr>
</tbody>
</table>

Horizontal single-zone tube furnaces.

Work tube adaptors, extended work tube supports, insulation plugs and gas/ vacuum end seals are available from Carbolite Gero for work tubes with outside diameters of 32 mm, 46 mm and 60 mm.

11.1 Environment

The furnaces contain electrical parts and should be stored and used in indoor conditions as follows:

**Ambient temperature working range**

Temperature: 5 °C to 40 °C

Note: when operating the furnace at temperatures close to the maximum and the ambient temperature is above 30 °C, the allowed external temperature defined in EN 61010-1:2010 may be exceeded.

**Relative humidity**

Maximum 80% up to 31 °C, decreasing linearly to 50% at 40 °C.

**Important safety notice:**

After transportation or storage in humid conditions, the furnace could fail to meet all the safety requirements of BSEN 61010-2-010 until it has completed the drying out process to restore its normal condition.

**Warning:**

It cannot be assumed that the furnace will meet all the safety requirements of BSEN 61010-2-010 during the drying out process.
**Furnace drying out process**

**Step 1.** Before the furnace is connected to the electrical supply, remove the back panel and check for signs of moisture on the electrical circuits. If visible signs of moisture are present then allow it to dry out in ambient temperature for at least 24 hours. If the problem persists ensure that the furnace is isolated and contact Carbolite Gero Service for more information.

**Step 2.** Complete the Installation procedure (see section 2.1)

**Step 3.** After reading the controller operation instructions, heat the furnace following the temperature profile given below. This will need to be done manually on furnaces with basic control option or programmed into the controller if an advanced control option is fitted:

- Ramp the setpoint temperature @ 2 °C/ minute to 100 °C and dwell for 2 hours.
- Ramp the setpoint temperature @ 2 °C/ minute to 300 °C and dwell for 3 hours.
- Ramp the setpoint temperature @ 3 °C/ minute to 1100 °C and dwell for 1 hour.
- Cool naturally to ambient temperature.
- Furnace drying out process is complete.
<table>
<thead>
<tr>
<th>Engineer Name</th>
<th>Date</th>
<th>Record of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
</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

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