Installation, Operation and Maintenance Instructions
1200 °C Split Tube Furnace - TVS Model: 600mm
3216 Controller + 3216CC End Zone Controllers

TVS 12/600 + 3216 Controller + 3216CC End Zone Controllers
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.

1.0 Symbols and Warnings .............................................................................................................. 7
  1.1 Switches and Lights .................................................................................................................... 7
  1.2 General Warnings ..................................................................................................................... 7

2.0 Installation ........................................................................................................................................ 9
  2.1 Unpacking and Handling ........................................................................................................... 9
  2.2 Siting and Setting Up ............................................................................................................... 9
  2.3 Electrical Connections ............................................................................................................. 12

3.0 3216 Controller ............................................................................................................................. 15
  3.1 PID control ................................................................................................................................ 15
  3.2 3216P1 ..................................................................................................................................... 15
  3.3 3216P5 ..................................................................................................................................... 15
  3.4 Operation .................................................................................................................................. 15
    3.4.1 Controller Layout .................................................................................................................. 15
    3.4.2 Keys ................................................................................................................................... 16
  3.5 Quick Start Guide ....................................................................................................................... 16
    3.5.1 Operation as a simple controller ........................................................................................ 16
    3.5.2 Changing the Setpoint ......................................................................................................... 16
    3.5.3 Using the Controller ............................................................................................................ 16
    3.5.4 Understanding User Levels ................................................................................................ 17
  3.6 Setting up the Controller .......................................................................................................... 18
    3.6.1 Maximum Output Power .................................................................................................... 18
    3.6.2 Customer ID ....................................................................................................................... 18
    3.6.3 Units .................................................................................................................................. 18
    3.6.4 Language ............................................................................................................................ 18
    3.6.5 Scrolling Text ....................................................................................................................... 19
    3.6.6 Customer Calibration .......................................................................................................... 19
    3.6.7 Holdback ............................................................................................................................. 20
  3.7 Programming ............................................................................................................................... 21
    3.7.1 Creating a Program .............................................................................................................. 21
    3.7.2 Program Number (3216P5 Only) ........................................................................................ 21
    3.7.3 Ramp Units ......................................................................................................................... 21
    3.7.4 Dwell Units ......................................................................................................................... 21
    3.7.5 Holdback ............................................................................................................................. 21
    3.7.6 Ramp Rate .......................................................................................................................... 21
3.7.7 Target Setpoint ........................................................................................................ 21
3.7.8 Dwell Time ............................................................................................................. 21
3.7.9 Running a Program ................................................................................................... 22
3.7.10 Program Status ...................................................................................................... 22
3.7.11 Process Value ........................................................................................................ 22
3.7.12 PSP, Segment Type and Number .......................................................................... 22
3.8 Controller Options ...................................................................................................... 25
  3.8.1 Digital Communications - RS232 .......................................................................... 25
  3.8.2 Digital Communications - RS485 .......................................................................... 25
  3.8.3 Comms Address ..................................................................................................... 25
  3.8.4 Alarm Option .......................................................................................................... 26
3.9 Temperature Controller Replacement .......................................................................... 26
3.10 3216 Controller Navigation Diagram ......................................................................... 26
4.0 3216CC Controller ....................................................................................................... 28
  4.1 3216CC ..................................................................................................................... 28
  4.2 PID control ................................................................................................................ 28
  4.3 Operation ................................................................................................................... 28
    4.3.1 Controller Layout ............................................................................................... 28
    4.3.2 Keys .................................................................................................................... 29
4.4 Quick Start Guide ......................................................................................................... 29
  4.4.1 Operation as a simple controller ............................................................................ 29
  4.4.2 Changing the Setpoint .......................................................................................... 29
  4.4.3 Using the Controller ............................................................................................. 29
  4.4.4 Understanding User Levels .................................................................................... 30
4.5 Setting up the Controller ............................................................................................. 31
  4.5.1 Setpoint Ramp Rate ............................................................................................... 31
    4.5.1.1 Setting Setpoint Ramp Rate .......................................................................... 31
    4.5.1.2 Running with Ramp Rate ............................................................................... 31
  4.5.2 Maximum Output Power ....................................................................................... 32
  4.5.3 Customer ID .......................................................................................................... 32
  4.5.4 Units ...................................................................................................................... 32
  4.5.5 Language ............................................................................................................... 32
4.6 Timer ............................................................................................................................ 32
  4.6.1 Setting the Timer .................................................................................................... 32
  4.6.2 Dwell Timer .......................................................................................................... 33
  4.6.3 Delayed Switch On Timer ..................................................................................... 33
  4.6.4 Soft Start Timer ..................................................................................................... 34
4.7 Running a Timer .......................................................................................................... 34
  4.7.1 Dwell Timer .......................................................................................................... 35
6.6 Tube Life ................................................................. 48
6.7 Pressure ...................................................................... 48
6.8 Power Adjustment ...................................................... 49
6.9 Running at Low Temperatures ..................................... 49

7.0 Maintenance .................................................................. 50
7.1 General Maintenance .................................................. 50
7.2 Maintenance Schedule ................................................ 50
    7.2.1 Cleaning ............................................................. 52
    7.2.2 Safety Switch ..................................................... 52
7.3 Calibration ..................................................................... 52
7.4 After-Sales Service ...................................................... 53
7.5 Recommended Spare Parts and Spare Parts Kit .......... 53

8.0 Repairs and Replacements ........................................... 54
8.1 Safety Warning - Disconnection from Power Supply ........ 54
8.2 Safety Warning - Refractory Fibre Insulation .............. 54
8.3 Temperature Controller Replacement ....................... 54
8.4 Solid-state Relay Replacement .................................... 55
8.5 Thermocouple Replacement ....................................... 55
8.6 Fuse Replacement ...................................................... 55
8.7 Element Replacement ................................................ 56

9.0 Fault Analysis ................................................................ 57
A. Furnace Does Not Heat Up .......................................... 57
B. Product Overheats ....................................................... 58

10.0 Wiring Diagrams ........................................................... 59
10.1 WC-13-70 ............................................................... 59
10.2 WC-13-71 ............................................................... 60
10.3 2- and 3-phase With Neutral .................................... 61
10.4 Independent Zones (control method C) ..................... 61
10.5 Control by Broadcast Comms (control method B) ....... 61
10.6 Three-phase without neutral (star - e.g. 380-415 V) ........ 61
10.7 Higher Voltages ....................................................... 62

11.0 Fuses and Power Settings ............................................ 63
11.1 Fuses ....................................................................... 63
11.2 Power Settings ........................................................ 63
    User Power Setting Adjustments .................................. 64

12.0 Specifications ............................................................. 65
12.1 Environment .................................................................................................................65
1.0 Symbols and Warnings

1.1 Switches and Lights

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

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

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

1.2 General Warnings

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

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

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

2.1 Unpacking and Handling

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

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

NOTE: This product contains Refractory Ceramic Fibre (also known as Alumino Silicate Wool - ASW). For precautions and advice on handling this material see section 8.2.

2.2 Siting and Setting Up

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

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

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

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

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

Work tubes:

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

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

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

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

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

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

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

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

If a metal work tube is being used in the product, ensure that it is earthed for operator safety.
2.0 Installation

Fig 1 - Insulating Plug (standard length tube)

Fig 2 - Insulating Plug (long work tube)

Key
A Tube
B Insulating Plug
C Stem
2.0 Installation

Fig 3 'Twin Clamp' End Seal

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

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

2.3 Electrical Connections

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

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

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

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

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

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

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

The supply MUST incorporate an earth (ground).

**Electrical Connection Details:**

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

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

⚠️ **DO NOT** connect a product ordered for three phase use to a single phase supply or to the wrong type of three phase supply.
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>
3.0  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.

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 11.0.

#### 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 \( \uparrow \) 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>
</table>
| To RUN a program | Press and quickly release ▲ + ▼ | Indicator – RUN = ON  
Scrolling Display – Current Program state |
| To HOLD a program | Press and quickly release ▲ + ▼ | Indicator – RUN = Flashing  
Scrolling Display – Program Hold |
| To RESET a program | Press and hold ▲ + ▼ for more than 1 second | Indicator – RUN = OFF  
Scrolling Display - None |
| | Program Ended | Indicator – RUN = OFF  
Scrolling Text – Program End |
| To RESET a program after it has completed | Press and hold ▲ + ▼ for more than 1 second or press and quickly release Ack | Indicator – RUN = OFF  
Scrolling Display - None |

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 \[ \text{scroll symbol} \] until the display shows WRK.OP <WORKING OUTPUT POWER>. This shows the power being used as a percentage.

Time Remaining

Press scroll \[ \text{scroll symbol} \] 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 \[ \text{scroll symbol} \] 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 \[ \uparrow \text{ up symbol} \], down \[ \downarrow \text{ down symbol} \] 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 \[ \uparrow \text{ up symbol} \], down \[ \downarrow \text{ down symbol} \] 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.

![Program Example Diagram](image-url)
### 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 female (25-pin) 9-pin</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx (2) 3</td>
<td></td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>Tx (3) 2</td>
<td></td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com (7) 5</td>
<td></td>
<td>5 (7) Com</td>
</tr>
<tr>
<td></td>
<td>7,8 (4,5) Link together</td>
<td>1,4,6 (6,8,20) Link together</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 female (25-pin) 9-pin</th>
<th>RS485 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) female</th>
</tr>
</thead>
<tbody>
<tr>
<td>- (2) 3</td>
<td></td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>+ (3) 2</td>
<td></td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com (7) 5</td>
<td></td>
<td>5 (7) Com</td>
</tr>
</tbody>
</table>

#### 3.8.3 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
3.0 3216 Controller

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]

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 (L1)
- Press the Scroll Key
- Hold the Page key for 3 seconds

### Level 2 (L2)
- Press the Scroll Key multiple times
- Locked - password required

### Access (A)
- * If configured
- Unlocked

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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Black</strong></td>
<td>Progress</td>
<td><strong>Dashed</strong></td>
</tr>
</tbody>
</table>
4.0 3216CC Controller

4.1 3216CC

This section should be disregarded unless the controller is used as an independent end zone controller.

The 3216CC Controller is a digital temperature controller which uses PID algorithms to give excellent temperature control when properly set. This controller can only be used as a simple temperature controller, it cannot be programmed.

4.2 PID control

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

4.3 Operation

4.3.1 Controller Layout

Key

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

**Page Key**

The page key is used to access level 2 when held down for 3 seconds.

**Scroll Key**

The scroll key is used to scroll through parameters.

**Ack**

When pressed simultaneously the ACK function is used to:

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

**Page and Scroll**

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

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

4.4 Quick Start Guide

4.4.1 Operation as a simple controller

When switched on, the controller goes through a short test routine and then shows the measured temperature (PV = Process Value) in the upper part of the display and below it, the desired temperature (Setpoint).

4.4.2 Changing the Setpoint

Press Up ▲ or Down ▼ to select the required SP. If the SP is higher than the measured temperature, the OP1 indicator will illuminate in the top left corner of the display, indicating that the controller is calling for power (giving an output).

The controller will immediately attempt to reach the setpoint and then maintain it. This will cause the product to heat as quickly as possible which may not be appropriate where the product contains sensitive ceramic components. For products with ceramic components, e.g. a tube furnaces fitted with a long ceramic work tube, use the ramp rate feature set with a low heating rate such as 5°C per minute (300°C per hour), to prevent damage.

4.4.3 Using the Controller

The parameters in the controller are first shown by a short code (mnemonic). After 5 Seconds a description of the parameter will scroll once along the display and then revert back to the mnemonic. The scrolling text can be interrupted at any time by a single press of any of the buttons, but will not scroll again until the parameter is returned to. In this manual the mnemonic will be shown first, followed by the scrolling text in brackets; e.g. PROG <PROGRAM NUMBER>
4.4.4 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></td>
<td>Programming</td>
</tr>
<tr>
<td></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 set up (if configured)</td>
</tr>
<tr>
<td></td>
<td>Customer Calibration (if configured)</td>
</tr>
</tbody>
</table>

**TIP**
If while navigating the controller, a parameter has been passed or you need to access parameters which would be at the end of a scroll list, press and hold scroll and use up to return to a previous parameter.

4.5 Setting up the Controller

Before using the controller (or during its lifetime) certain parameters may have to be set, depending on specific requirements. To do this the controller must be set to supervisor level (Level 2).

4.5.1 Setpoint Ramp Rate

To control the rate at which the temperature rises to setpoint, the SP.RATE function is used.

Before setting the ramp rate, it is advisable to set the setpoint to a low value, preferably 0 °C (see section 4.4). Once the ramp rate has been set, the required setpoint can be entered from the home menu. Doing so will activate the ramp rate, which can be identified with the run indicator showing on the bottom of the display. While the ramp rate is active the working setpoint will be shown on the lower temperature display (this is the setpoint, set by the ramp rate).

When the process temperature has reached the setpoint value at the given ramp rate, the run indicator will turn off and the instrument will control at the required setpoint temperature.

Any further modifications to setpoint will cause the ramp rate to be activated and the instrument to control as described above.

**NOTE:** Ensure timer configuration is set to ‘none’ (see section 4.6) to use the setpoint ramp rate feature without any timer functions.

4.5.1.1 Setting Setpoint Ramp Rate

In supervisor level (level 2).

Press scroll until the display shows SP.Rate <setpoint rate limit>. Using up and down select the ramp rate required, in °C/Min.

4.5.1.2 Running with Ramp Rate

Press the up and down keys at the same time to activate the ramp rate. The "Run" indicator will illuminate and the scrolling text will read <RAMPING> to show the ramp rate is active. The ramp rate will then start from the current process temperature.

When the ramp reaches the setpoint temperature, the "Run" indicator will turn off and the instrument will maintain control at the setpoint.

To put the ramp rate into a hold condition, press the up and down keys and release. The "Run" indicator will flash and the scrolling text will read <HOLD> to show the ramp rate is on hold.
4.0 3216CC Controller

To cancel the ramp rate, press and hold the up ▲ and down ▼ keys until the "Run" indicator turns off.

4.5.2 Maximum Output Power

Press scroll ▶ until the display shows OP.HI <OUTPUT HIGH>. Use the up ▲ and down ▼ keys to select the output power required as a percentage. Once the setting is made, turn the instrument switch off and on to power cycle the temperature controller.

Depending on the furnace or oven model, the maximum output power setting OP.Hi may be accessible or locked.

For silicon carbide heated furnaces, the parameter is accessible to allow compensation for element ageing.

In many models the maximum output power setting depends on the supply voltage, see section 11.0.

4.5.3 Customer ID

A furnace or oven identification number can be entered if required. This maybe used to identify one of many units for production or quality control systems.

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

4.5.4 Units

Press scroll ▶ until the display shows UNITS <DISPLAY UNITS>. Use the up ▲ or down ▼ keys to select the required units.

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NONE</td>
<td>No units (Default °C)</td>
</tr>
<tr>
<td>°C</td>
<td>Celsius</td>
</tr>
<tr>
<td>°F</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>°K</td>
<td>Kelvin</td>
</tr>
<tr>
<td>PERC</td>
<td>% (shows °C value)</td>
</tr>
</tbody>
</table>

4.5.5 Language

The scrolling text on the 3216 can be shown in different languages, this can only be set at the factory and therefore must be specified at the time of placing an order.

4.6 Timer

4.6.1 Setting the Timer

A timer can be configured to operate in four different modes. These can be selected in level 2 (supervisor level) using the TM.CFG parameter as:-

- None
- Dwell Timer
• Delayed switch on timer
• Soft start timer

None

The timer is turned off, no timer configurations are available, the instrument works as a simple setpoint controller.

Press scroll ⬇️ until the display shows TM.CFG <TIMER CONFIGURATION>. Using the up ▲ down ▼ select NONE.

4.6.2 Dwell Timer

A dwell timer is used to control a process at a fixed temperature for a defined period. At the end of the time period the controller will switch off the output power to the elements.

Press scroll ⬇️ until the display shows TM.CFG <TIMER CONFIGURATION>. Using the up ▲ down ▼ select Dwell.

When Dwell parameter is selected, the Timer resolution (TM.RES), Time duration (DWELL) and Timer Threshold (THRES) functions become available.

Press scroll ⬇️ until the display shows TM.RES < Time resolution >. Use the up ▲ down ▼ to select the timer units in Min or Hours.

Press scroll ⬇️ until the display shows DWELL < SET TIME DURATION >. Use the up ▲ down ▼ to enter the time duration required.

Press scroll ⬇️ until the display shows THres < TIMER THRESHOLD >. Use the up ▲ down ▼ to select the temperature threshold that you require the timer to start at. The threshold value is ±n around the setpoint (n=threshold value).

Example: If the setpoint is set to 800 °C and the timer threshold is set to 2, after the timer is activated it will not start until the process value reaches 798 °C if ramping up or 802 °C if it is cooling.

Note: If the threshold is set to OFF, the timer will either; start to countdown as soon as it is activated with the mode keys or if a ramp rate has been set (see section 4.5.1), the timer will start as soon as the ramp reaches the setpoint. (see section 4.7.1)

4.6.3 Delayed Switch On Timer

The delayed switch on timer is used to switch on the output power to the elements after a set time period.

Press scroll ⬇️ until the display shows TM.CFG <TIMER CONFIGURATION>. Using the up ▲ down ▼ select dELY.

When delay parameter is selected, the Timer Resolution (TM.RES) and Time Duration (DWELL) functions become available.

Press scroll ⬇️ until the display shows TM.RES < Time Resolution >. Use the up ▲ down ▼ to select the timer units in Min or Hours.
Press scroll ⬆️ until the display shows Dwell < Set Time Duration >. Use the up ▲ down ▼ to enter the time duration required before the output power switches on.

### 4.6.4 Soft Start Timer

The Soft Start Timer is used to start a process at a reduced setpoint and power. The Soft Start Setpoint is used as a threshold only and is not a control point.

**Example:** Main Setpoint = 800 °C  
Max power limit = 75 % (This may be set at the factory)  
Soft Start Setpoint = 600 °C (Threshold)  
Soft Start Power Limit = 50% (Cannot be set above max power Limit)

When the timer is running, the maximum power is controlled by the Soft Start Setpoint of 600 °C and the Soft Start Power limit of 50%. This will continue until the timer ends or the current temperature exceeds the Soft Start Setpoint.

When the timer ends or the current temperature exceeds the Soft Start Setpoint, the instrument will start to control using the main setpoint of 800 °C and the Max Power Limit of 75%.

Press scroll ⬆️ until the display shows TM.CFG < Timer Configuration >. Using the up ▲ down ▼ select SF.st.

When Soft Start parameter is selected, the Timer Resolution (TM.RES), Time Duration (Dwell), Soft Start Setpoint (SS.SP) and Soft Start Power Limit (SS.PWR) functions become available.

Press scroll ⬆️ until the display shows TM.RES < Time resolution >. Use the up ▲ down ▼ to select the timer units in minutes or hours.

Press scroll ⬆️ until the display shows Dwell < Set Time Duration >. Use the up ▲ down ▼ to enter the time duration required, before the main instrument starts to control using the main setpoint and max power.

Press scroll ⬆️ until the display shows SS.SP < Soft Start Setpoint >. Use the up ▲ down ▼ to enter the Soft Start Setpoint.

Press scroll ⬆️ until the display shows SS.PWR < Soft Start Power Limit >. Use the up ▲ down ▼ to enter the Soft Start Power Limit.

### 4.7 Running a Timer

- **Run.** This starts the timer.  
- **Hold.** This stops the timer at the elapsed time. It will start again from the elapsed time when Run is selected again.  
- **Reset.** This sets the timer back to zero. It can be operated again from this state.  
- **End** cannot be set – it occurs automatically when the timer has counted down to zero.
- **Acknowledge** any timer after a timer has timed out using ACK function (see section 4.3.2) by pressing the ▲ and ◀ simultaneously.

### 4.7.1 Dwell Timer

<table>
<thead>
<tr>
<th>Operation</th>
<th>Action</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>To RUN Timer</strong></td>
<td>Press and quickly release ▲ + ◀</td>
<td>Indicator – RUN = ON Scrolling Display – Timer Running</td>
</tr>
<tr>
<td><strong>To HOLD timer</strong></td>
<td>Press and quickly release ▲ + ◀</td>
<td>Indicator – RUN = Flashing Scrolling Display – Timer Hold</td>
</tr>
<tr>
<td><strong>To switch off Timer / Cancel</strong></td>
<td>Press and hold ▲ + ◀ for more than 1 second</td>
<td>Indicator – RUN = OFF Scrolling Display – None Static Text - OFF</td>
</tr>
<tr>
<td><strong>To return to home after reset</strong></td>
<td>Press and hold ▲ + ◀ for more than 1 second</td>
<td>Indicator – RUN = OFF Display – A-M &lt;LOOP MODE- AUTO MANUAL OFF&gt; Use the up ▲ or down ◀ to select AUTO</td>
</tr>
<tr>
<td><strong>Timer Ended</strong></td>
<td></td>
<td>Indicator – RUN = OFF Scrolling Text – Timer End Static Text - OFF</td>
</tr>
<tr>
<td><strong>To re-RUN Timer</strong></td>
<td>Press and quickly release ▲ + ◀</td>
<td>Indicator – RUN = ON Scrolling Display – Timer Running</td>
</tr>
<tr>
<td><strong>To RESET timer and return to home menu after timer end</strong></td>
<td>Press and quickly release Ack ▲ + ◀ for more than 1 second</td>
<td>Indicator – RUN = OFF Display – A-M &lt;LOOP MODE- AUTO MANUAL OFF&gt; Use the up ▲ down ◀ to select Auto</td>
</tr>
</tbody>
</table>

### 4.7.2 Power Failure While Using Dwell Timer

If there is a power failure while the timer is operating and the power is subsequently restored, the timer will reset and the static text will display "OFF" until the ▲ + ◀ keys are pressed to re-run the timer.
4.0 3216CC Controller

4.7.3 Running Dwell Timer with Ramp Rate
Set the ramp rate as outlined in section 4.5.1
Set the dwell time as outlined in section 4.6.2.
When the timer is set to operate with a set ramp rate, the timer will not start to count down until the setpoint has been reached with the ramp, at which time the timer will begin time count down.
The scrolling display will indicate “timer running” and the run indicator will be illuminated while the ramp rate is active and during the timer count down, after which the display will indicate the instrument has switched off power to the elements (see section 4.7.7), and the run indicator will switch off.

4.7.4 Running Dwell Timer with Ramp Rate & Threshold
Set the ramp rate as outlined in section 4.5.1.
Set the dwell time as outlined in section 4.6.2.
Set the threshold as outlined in section 4.6.3.
When the timer is set to operate with a set ramp rate and threshold, the timer will not start to count down until the process temperature has reached the threshold value (see example 4.6.3).
The scrolling display will indicate “timer running” and the run indicator will be illuminated while the ramp rate is active, while the process value is reaching the threshold value and during the timer count down, after which the display will indicate the instrument has switched off power to the elements (see section 4.7.1).

4.7.5 Delayed Switch on Timer

<table>
<thead>
<tr>
<th>Operation</th>
<th>Action</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>To RUN Timer</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = ON Scrolling Display – Timer Running Static Text - OFF</td>
</tr>
<tr>
<td>To HOLD timer</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = Flashing Scrolling Display – Timer Hold Static Text - OFF</td>
</tr>
<tr>
<td>To switch off Timer /</td>
<td>Press and hold ▲ + ▼ for more than 1 second Indicator – RUN = Off</td>
<td>Scrolling Display – None Static Text - OFF</td>
</tr>
<tr>
<td>Cancel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To return to home menu.</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = Off Display – A-M &lt;LOOP MODE-AUTO MANUAL OFF&gt; Use the up ▲ or down ▼ to select Auto</td>
</tr>
</tbody>
</table>
4.7.6 Running Delay Timer with Ramp Rate

Set the ramp rate as outlined in section 4.5.1.

Set the delay time as outlined in section 4.6.3.

When ramp rate is active with a delay timer the run indicator serves two functions:
- Indicates timer is running
- Indicates ramp rate is active

This means that when the timer has timed out the run indicator will still be illuminated if the ramp rate is still active and will continue to be illuminated until the ramp reaches setpoint, at which time it will switch off.

A characteristic of these combinations of parameters is that the scrolling text will continue to indicate timer running when the timer has timed out. Checking whether the timer has timed out or not can be done with the 'T.REMN' function. (see section 4.7.12)

The delay timer with ramp rate will function as outlined in the table above with the addition of the functions in the following table.

4.7.7 Delay timer with ramp rate functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Timer Ended When ramp rate active</th>
<th>Indicator – RUN = ON - if ramp rate active&lt;br&gt;Scrolling Text – Timer Running&lt;br&gt;Scrolling Display – None&lt;br&gt;Static Text - OFF&lt;br&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>To HOLD timer</td>
<td>Press and quickly release ▲ + ▼&lt;br&gt;</td>
<td>Indicator – RUN = Flashing&lt;br&gt;Scrolling Display – Timer Hold&lt;br&gt;Static Text - OFF&lt;br&gt;</td>
</tr>
<tr>
<td>To switch off Timer / Cancel</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator – RUN = ON - if ramp rate active&lt;br&gt;Scrolling Display – None&lt;br&gt;Static Text - OFF&lt;br&gt;</td>
</tr>
<tr>
<td>To re-RUN Timer</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator – RUN = ON&lt;br&gt;Scrolling Display – Timer Running&lt;br&gt;Static Text – OFF&lt;br&gt;</td>
</tr>
</tbody>
</table>
4.7.8 Power Failure While Using Delay Timer
If there is a power failure while the timer is operating and the power is subsequently restored, the timer will reset and will re-run from the power on time.

4.7.9 Soft start Timer

<table>
<thead>
<tr>
<th>Operation</th>
<th>Action</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>To RUN Timer</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator - RUN = ON Scrolling Display - Timer Running Static Text - OFF</td>
</tr>
<tr>
<td>To HOLD timer</td>
<td>Press and quickly release ▲ + ▼</td>
<td>Indicator - RUN = Flashing Scrolling Display - Timer Hold Static Text - OFF</td>
</tr>
<tr>
<td>To switch off Timer/</td>
<td>Press and hold ▲ + ▼ for more than 1 second</td>
<td>Indicator - RUN = OFF Scrolling Display - None Static Text - OFF</td>
</tr>
<tr>
<td>Cancel</td>
<td>Timer Ended</td>
<td>Indicator - RUN = OFF Scrolling Text - Timer End Running Soft Start Timer</td>
</tr>
</tbody>
</table>

When the soft start timer is set to operate, the scrolling display will indicate “timer running” and the setpoint temperature, not the soft start setpoint.

4.7.10 Power Failure While Using Soft Start Timer
If there is a power failure while the timer is operating and the power is subsequently restored, the timer will reset and will re-run from the power on time.

4.7.11 Ramp Rate with Soft Start Timer
It is not recommended that the ramp rate function be used with a soft start timer.

Note: If the temperature is already above the threshold when the timer is set to operate, the timer will time out immediately.

4.7.12 Time Remaining
The time remaining of any 'Timer' mode can be checked at any time while a timer is active.

To view the time remaining, press scroll ▲ until the display shows T.REMN <TIME REMAINING>.

Note: The time remaining can be modified at any time while the count down timer is operating by pressing the up ▲ or down ▼ key while the time remaining function is active.
4.7.13 Alarms

Alarms are used to alert the operator when a pre-set level has been exceeded or a function error has occurred such as a sensor break. They are indicated by a 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 dependant 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 (see section 4.3.2) before it is reset.

If an alarm has been activated the red “ALM” indicator will illuminate 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.

4.8 Controller Options

As options can be ordered in a variety of combinations and for a variety of purposes, exact instructions are not given here. The full Eurotherm manual may be required to determine customer parameter settings. To reveal or hide parameters in the controllers it is necessary to go into configuration mode, a security code is needed. Please consult Carbolite Gero.

4.8.1 Digital Communications - RS232

If the RS232 option is supplied, the furnace is fitted with one sub-miniature D-socket connected to the controller comms module. RS232 is suitable for direct connection to a personal computer (PC) using a “straight through” cable as follows (the linked pins at the computer end are recommended but may not be necessary). The cable is usually 9-pin at the furnace end and 9-pin at the computer, but other alternatives are shown in parentheses.

<table>
<thead>
<tr>
<th>Product end of cable female (25-pin) 9-pin</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx (2)</td>
<td>3</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>Tx (3)</td>
<td>2</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com (7)</td>
<td>5</td>
<td>5 (7) Com</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7,8 (4,5) 1,4,6 (6,8,20)  Link together</td>
</tr>
</tbody>
</table>

Link together
4.0 3216CC Controller

4.8.2 Digital Communications - RS485

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

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

4.8.3 Comms Address

Typically the comms address is set to 1, but this can be changed. In the case of RS485 and multiple instruments it is necessary to set different addresses. To change the address value, access the level 2 list. In level 2 press the page key until the COMMS parameter is displayed. Press up ▲ down ▼ to select the address value.

4.8.4 Alarm Option

When an alarm board is fitted, which consists of a relay with voltage free contacts, for operator use, the contacts are taken to a panel plug on the control panel, wired as indicated:

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.

Before handling the controller: wear an anti-static wrist strap or otherwise avoid any possibility of damage to the unit by static electricity. Refer to the detailed instructions supplied with the replacement controller.
Ease apart the two lugs at the side; grip the instrument and withdraw it from its sleeve; push in the replacement.

4.9 3216CC Navigation Diagram

Do not raise the power limit (if accessible) above the design level for the product.
5.0 2132 Over-Temperature Controller Description (if fitted)

5.1 Description

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

5.2 Operation

5.2.1 Controls

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

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

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

Some components will operate after the over-temperature feature isolates the power supply e.g. cooling fans will continue to operate, provided that there is a power supply to the product. In some cases the product may not do so, if other options (such as a door switch) are fitted.
5.2.2 Operation
When switched on, the controller lights up, goes through a short test routine and then displays the measured temperature or the over-temperature setpoint.

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

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

The scroll key \(\text{\textdagger}\) allows access to the parameters within a list. Some parameters are display-only; others may be altered by the operator.

A single press of the scroll key \(\text{\textdagger}\) in the 'Home' list displays the temperature units; further presses reveal the parameters in the current list indicated in the navigation diagram.

To return to the 'Home' list at any time, press page \(\text{\textregistered}\) and scroll \(\text{\textdagger}\) together, or wait for 45 seconds.

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

5.2.3 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 \(\text{\textdagger}\) twice view the present temperature as measured by the over-temperature controller. Press it twice, the first press shows the temperature units (°C).

5.2.4 Over-Temperature Alarm

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

5.2.5 Resetting the Over-Temperature Alarm

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

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

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

5.2.6 Sensor Break

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

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

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

5.4 Navigation Diagram

<table>
<thead>
<tr>
<th>HL</th>
<th>Home List</th>
<th>Page Key</th>
<th>Black = Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTSP</td>
<td>Over-Temperature Setpoint</td>
<td>Scroll Key</td>
<td>Dashed = Through to other options</td>
</tr>
<tr>
<td>AL</td>
<td>Access List</td>
<td>! For factory access to list and parameters not available to the operator.</td>
<td></td>
</tr>
</tbody>
</table>
6.0 Operation

6.1 Operating Cycle

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

Connect the product to the electrical supply.

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

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

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

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

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

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

6.2 Control Method

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

**Note:** Despite its vertical orientation, the heated zones of the KVZ model are labelled to correspond with the relevant control module on the CC-T1 touchscreen controller display (Left, Main, Right).

6.3 3-Zone Control Methods

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

(A) Back to back thermocouples
(B) Retransmission of Setpoint
(C) Independent control
The models listed in this manual are designed to achieve an extended uniform temperature zone, through use of three control zones, rather than achieving different temperatures in each zone.

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

**Note:**
- Option A is **NOT** applicable when using the CC-T1 controller
- Option B is **NOT** applicable when using the Eurotherm 2132 End Zone Controller

**A. Back-to-Back Thermocouples**

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

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

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

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

**B. Retransmission of Setpoint**

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

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

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

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

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

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

C. Independent Control

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

6.4 General Operating Advice

Heating element life is shortened by overheating. Do not leave the product at high temperature when it is not required. The maximum temperature is shown on the product rating label and in section 12.0 towards the back of this manual.

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

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

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

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

6.6 Tube Life

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

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

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

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

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

6.7 Pressure

Work tubes are not able to accept high internal pressure. When gas seals or similar fittings are in use, the gas pressure should be restricted to a maximum of 0.2 bar (3 psi). A pressure of approximately half of that should normally be sufficient to achieve the desired flow rate. The operator must ensure that the exhaust path from the tube is not blocked, so that excess pressure does not occur.
A suitably regulated gas supply should always be used.
It is recommended that a pressure relief system should be used to avoid an over pressurisation of the work tube.
Please note: A product should not be heated up if any valves that have been fitted are closed to create a sealed volume. A sealed work tube should not be heated from cold due to the pressure increase caused by the trapped air or gas expanding during the heating process.

6.8 Power Adjustment
The control system incorporates electronic power limiting. The power limit parameter OP.Hi is accessible to the operator and can be used to adjust the furnace to the actual supply voltage.
The models covered by this manual are designed for use over the range of voltages 200 V - 250 V (or, if ordered, 100 V - 125 V), and the power limit parameter is set accordingly. These models may be adjusted to a different voltage within the range: the power limit should be reset to match OP.Hi, see 11.0
Refer to section 3.0 for power adjustment instructions.

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

7.1 General Maintenance

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

7.2 Maintenance Schedule

CUSTOMER QUALIFIED PERSONNEL

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

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

<table>
<thead>
<tr>
<th>Performance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element Circuit</td>
<td>Electrical measurement</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>Measure the current drawn on each phase / circuit</td>
</tr>
<tr>
<td>Cooling Fans (if fitted)</td>
<td>Check whether the cooling fans are working</td>
</tr>
</tbody>
</table>
7.0 Maintenance

7.2.1 Cleaning
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.

7.2.2 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.

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

### 7.4 After-Sales Service

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

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

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

### 7.5 Recommended Spare Parts and Spare Parts Kit

Carbolite Gero can supply individual spare parts or a kit of the items most likely to be required. Ordering a kit in advance can save time in the event of a breakdown. Each kit consists of one of each type of thermocouple, one solid state relay and two heating elements.

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

8.1 Safety Warning - Disconnection from Power Supply

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

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

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

8.2 Safety Warning - Refractory Fibre Insulation

**Insulation made from High Temperature Insulation Wool**

Refractory Ceramic Fibre, better known as (Alumina silicate wool - ASW).

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

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

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

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

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

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

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

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

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

8.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
8.4 **Solid-state Relay Replacement**

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

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.

8.5 **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.

Thermocouple cable colour codings are:

<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.

8.6 **Fuse Replacement**

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

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

If any fuse has failed, it is advisable for an electrician to check the internal circuits.

Replace any failed fuses with the correct type. For safety reasons do not fit larger capacity fuses without first consulting Carbolite Gero.
The fuses are located at the cable entry point. Remove the back panel or control box back panel to gain access to the fuses.

### 8.7 Element Replacement

**See section 8.2 - wearing a face mask is required.**

Remove the three screws from each end and lift out the half-circular insulation assembly.

Make a plan of all the cable connections and disconnect the cables.

Remove the thermocouple(s) by withdrawing them from the sheaths built into the elements. Remove the plates through which the element tails are located. Remove the keep plates from each side of the insulation assembly.

Lift out the element to be replaced; save any insulation sleeves for possible reuse.

Bend or cut the new element tails as necessary and fit any insulation sleeves; feed the tails through and fit the element into place.

Refit the keep plates on each side. Refit the tail termination plates, ensuring that the element tails do not touch any metal parts. Refit the thermocouple(s).

Connect all the wiring according to the plan previously made and complete the reassembly of the product.

Check that the product is controlling properly to rule out the possibility that the element failed because of a fault in the control system.

Wherever two different sizes of elements are fitted, the 150 mm elements are at the ends and the 200 mm elements in the centre.

<table>
<thead>
<tr>
<th>Elements: Each element is a half-cylinder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 12/600</td>
</tr>
<tr>
<td>Model 12/600 E</td>
</tr>
</tbody>
</table>
## A. Furnace Does Not Heat Up

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

### B. Product Overheats

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td>Product only heats up when the instrument switch is ON</td>
<td>The controller shows a very high temperature</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><strong>2.</strong></td>
<td>Product heats up when the instrument switch is OFF</td>
<td>The SSR has failed &quot;ON&quot;</td>
</tr>
</tbody>
</table>
10.0 Wiring Diagrams

10.1 WC-13-70
Safety Switch A - A 2-pole Heater Switch is fitted directly in the element circuit in models up to 16 A rating.

Safety Switch B - A door switch is fitted into the contactor coil circuit. Above 16 A a 1-pole Heater Switch is fitted into the same circuit, in series.
10.2 WC-13-71
Connections below show single phase with indirect safety switches and over-temperature control.
10.3 2- and 3-phase With Neutral

Each SSR is connected to a different phase. The control circuit is taken between L1 and N.
Safety switch A applies for 2-phase. Safety switch B applies for 3-phase.
If type F1 fuse is present, one per phase if fitted.
If type F2 fuse is present, one is fitted; if type F3 fuse is present, one per phase is fitted.
Note that on 2- or 3-phase models there may be three separate neutrals taken to a common supply terminal, depending on EMC filter requirements.

10.4 Independent Zones (control method C)

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

10.5 Control by Broadcast Comms (control method B)

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

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

```
  master    slave    slave
       HD     HD      HD
       HE     HE      HE
       HF     HF      HF
```

10.6 Three-phase without neutral (star - e.g. 380-415 V)

The circuit is similar to "Control by Broadcast Comms (control method B)", but the “neutral” ends of the elements are not connected to a neutral terminal block.
The control circuit contains an isolating transformer to reduce the control voltage to 240 V or similar.
10.7 Higher Voltages

For 254 V or above 1-phase or 440/254 V or above 3-phase, an isolating transformer is included in the control circuit after the F2 fuses.
11.0 Fuses and Power Settings

11.1 Fuses

F1 - F3: Refer to the circuit diagrams.

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVS 12/600</td>
<td>1-phase</td>
<td>200-240</td>
<td>16 A</td>
</tr>
<tr>
<td>TVS 12/600</td>
<td>3-phase + N</td>
<td>380-415</td>
<td>10 A</td>
</tr>
<tr>
<td>TVS 12/600</td>
<td>3-phase Delta</td>
<td>200-240</td>
<td>10 A</td>
</tr>
<tr>
<td>TVS 12/600 E</td>
<td>1-phase</td>
<td>200-240</td>
<td>16 A</td>
</tr>
<tr>
<td>TVS 12/600 E</td>
<td>3-phase + N</td>
<td>380-415</td>
<td>10 A</td>
</tr>
<tr>
<td>TVS 12/600 E</td>
<td>3-phase Delta</td>
<td>200-240</td>
<td>10 A</td>
</tr>
</tbody>
</table>

11.2 Power Settings

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

<table>
<thead>
<tr>
<th>Volts:</th>
<th>208 V</th>
<th>200 V</th>
<th>220 V</th>
<th>230 V</th>
<th>240 V</th>
<th>380 V</th>
<th>400 V</th>
<th>415 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (%)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>89</td>
<td>89</td>
</tr>
</tbody>
</table>
### User Power Setting Adjustments

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

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

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

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>Work Tube Bore (mm)</th>
<th>Recommended Work Tube Length for use in air (mm)</th>
<th>Heated Length (mm)</th>
<th>Net Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVS 12/600</td>
<td>1200</td>
<td>3.0</td>
<td>25-106</td>
<td>950</td>
<td>600</td>
<td>40</td>
</tr>
</tbody>
</table>

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

12.1 Environment

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

- **Temperature:** 5 °C - 40 °C
- **Relative humidity:** Maximum 80 % up to 31 °C decreasing linearly to 50 % at 40 °C
Service Record

<table>
<thead>
<tr>
<th>Engineer Name</th>
<th>Date</th>
<th>Record of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The products covered in this manual are only a small part of the wide range of ovens, chamber furnaces and tube furnaces manufactured by Carbolite Gero for laboratory and industrial use. For further details of our standard or custom built products please contact us at the address below, or ask your nearest stockist.

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

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

---

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

Copyright © 2019 Carbolite Gero Limited