Installation, Operation and Maintenance Instructions
200°C Minimum Free Space Oven - MFS Model: MFS1 ISO/ASTM 3216 Controller

MFS1 ISO/ASTM + 3216 Controller
Contents

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

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1.0 Symbols and Warnings

1.1 Switches and Lights

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

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

1.2 General Warnings

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

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

DANGER – Read any warning printed next to this symbol.

Caution – Double Pole/Neutral Fusing
2.0 Installation

2.1 Unpacking and Handling

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

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

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

2.2 Siting and Setting Up

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

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

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

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

Unless otherwise stated elsewhere in this manual, ensure that there is at least 150 mm of free space around the back and sides of the product. Clear space is required above the product to dissipate heat.
Ensure that the product is placed in such a way that it can be quickly switched off or disconnected from the electrical supply.

Each chamber is fitted with an air guide (a horizontal plate dividing the top from the bottom), and a sample tray (in the lower part of the chamber). Ensure that these items are present. Do not remove the guide - it is required for correct gas flow within the unit.

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.

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

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

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

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

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

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

The supply MUST incorporate an earth (ground).

**Electrical Connection Details:**

<table>
<thead>
<tr>
<th>Supply</th>
<th>Terminal Label</th>
<th>Cable Colour</th>
<th>Supply Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></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>

**2.4 Gas Supply**

The MFS/1 ISO is intended to be used with nitrogen gas and is fitted with nitrogen flowmeters.

The MFS/1 ASTM is intended to be used with air and is fitted with air flowmeters.

There are two gas connections at the back of the product. The upper gas connection is the gas inlet; the lower gas connection is the gas outlet.

The maximum gas supply pressure must be regulated to 1 bar.

There are two flowmeters mounted in the control panel. The left hand flowmeter is used to adjust the flow rate of the gas passing into the oven chamber. The incoming gas passes through this flowmeter then into the heated chamber. The gas enters the upper
part of the chamber behind the air guide where it is pre-heated and brought to the front of the chamber. The gas then enters the portion of the chamber that contains the test samples flowing over and around the samples and exiting at the back of the chamber.

The flowmeter on the right is only used to test for leaks in the MFS/1 gas flow. The gas exiting the chamber passes through the valve positioned at the back of the product labelled “OFF/TEST”. The normal operating position for this valve is “OFF”. With the valve in this position the outlet gas passes directly from the chamber to the gas outlet connection. With the valve in the position “TEST” the gas exiting the chamber passes through the right hand flowmeter before passing to the gas outlet. With the valve in the “TEST” position the flow rates of both flowmeters should be equal. If the flowmeter on the right shows a lower flow rate this indicates there is a gas leak; check the door is sealed correctly as this is the most likely cause for a leak.

Do not leave the valve in the “TEST” position longer than is necessary to carry out the leakage check; otherwise water vapour will build up inside the right hand flowmeter.

2.5  **Desiccator (if supplied)**

The optional desiccator is designed for separate use and is not connected to the oven in any way. It is used for cooling the sample. Gas inlet and outlet are provided so that nitrogen can be passed over the cooling sample.

The maximum gas supply pressure must be regulated to 1 bar.
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>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>J</td>
</tr>
<tr>
<td>K</td>
</tr>
</tbody>
</table>
3.4.2 Keys

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

Scroll Key ▼ The scroll key is used to scroll through parameters.

Ack When pressed simultaneously the ACK function is used to:

Page and Scroll ▼ + ▼ Return to the Home Menu
When pressed simultaneously the ACK function is used to:

Scroll through parameters.

Ack • Acknowledge an alarm if activated.
Reset a program after the program has ended.

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

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

3.5 Quick Start Guide

3.5.1 Operation as a simple controller

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

3.5.2 Changing the Setpoint

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

The controller will immediately attempt to reach the setpoint and then maintain it.

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

3.5.3 Using the Controller

The parameters in the controller are first shown by a short code (mnemonic). After 5 Seconds a description of the parameter will scroll once along the display and then revert back to the mnemonic. The scrolling text can be interrupted at any time by a single press of any of the buttons, but will not scroll again until the parameter is returned to.

In this manual the mnemonic will be shown first, followed by the scrolling text in brackets; e.g. PROG <PROGRAM NUMBER>
3.0 3216 Controller

3.5.4 Understanding User Levels

There are two user levels in the controller; Level 1 (Operator) and Level 2 (Supervisor). Level 1 (Operator) is for the day to day operation of the controller. These parameters are not protected by a security code.

Level 2 (Supervisor) provides access to additional parameters. Access to this level protected by a security code.

**To Enter Level 2**

1. Press and hold the page key for 3 seconds.
2. The display will show LEu 1 GOTO
3. Release the page Key
4. Press the up ▲ or down ▼ to choose LEu 2 (level 2)
5. Press the up ▲ or down ▼ to enter the code (Level 2 Code = 9).

If the correct code is entered, PASS should momentarily be displayed and then revert to the level 2 home display.

If an incorrect code is entered the display reverts back to Level 1 home display.

When level 2 operations have been completed, the supervisor must return to Level 1 either manually or by switching the instrument off and back on. There is no time out function.

**To Return to Level 1**

1. Press and hold the page Key
2. Press down ▼ to select LEu 1

It is not necessary to enter a code when going from a higher level to a lower level.

When level 1 is selected, the display reverts to the home display (See Controller Layout)

**Table showing parameters accessible in level 1 and Level 2**

<table>
<thead>
<tr>
<th>Operator LEVEL 1</th>
<th>Supervisor LEVEL 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>home display</td>
<td>home display</td>
</tr>
<tr>
<td>Programming</td>
<td>Programming</td>
</tr>
<tr>
<td>Program Status</td>
<td>Program Status</td>
</tr>
<tr>
<td></td>
<td>Alarms (if configured)</td>
</tr>
<tr>
<td></td>
<td>Current Transformer Input (if configured)</td>
</tr>
<tr>
<td></td>
<td>Comms (if configured)</td>
</tr>
<tr>
<td></td>
<td>Controller Setup</td>
</tr>
<tr>
<td></td>
<td>Customer Calibration</td>
</tr>
</tbody>
</table>

**TIP**

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

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

#### 3.6.1 Maximum Output Power

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

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

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

In many models the maximum output power setting depends on the supply voltage, see section 10.0.

#### 3.6.2 Customer ID

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

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

#### 3.6.3 Units

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

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

#### 3.6.4 Language

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

#### 3.6.5 Scrolling Text

If at any time the scrolling text is not required.

Press and hold the page ▼ for three seconds until “GOTO” is displayed.

Press scroll until the display shows. TEXT <ENABLE/ DISABLE SCROLLING TEXT> Use the up ▲ and down ▼ keys to select ON or OFF.
3.0 3216 Controller

3.6.6 Customer Calibration

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

Dual Offset

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

Press scroll \( \downarrow \) until the display shows CAL.P (Enter Calibration Code) Use the up \( \uparrow \) and down \( \downarrow \) 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 \( \uparrow \) and down \( \downarrow \) keys to enter the Low Temperature Point, which you want to apply an Offset.

Press scroll \( \downarrow \) until the display shows OFS.LO (Adjust Low Offset). Use the up \( \uparrow \) and down \( \downarrow \) keys to enter the amount Offset you want to apply to the Low Temperature Point.

Press scroll \( \downarrow \) until the display shows PNT.HI (Adjust High Point). Use the up \( \uparrow \) and down \( \downarrow \) keys to enter the High Temperature Point, which you want to apply an Offset.

Press scroll \( \downarrow \) until the display shows OFS.HI (Adjust High Offset). Use the up \( \uparrow \) and down \( \downarrow \) keys to enter the amount Offset you want to apply the High Temperature Point.

Once the calibration details have been entered, press scroll \( \downarrow \) until the display shows the next required parameter or return to the home list. The calibration data will now be protected by the pass code. To edit the data the above procedure must be followed.

Single Offset

If a constant offset is required across the temperature range, set the required “High Point” (PNT.HI) and “Low Point” (PNT.LO) to the required values (not the same), then set the “low Offset” (OFS.LO) and “High Offset” (OFS.HI) to the same value.

Caution! - Do not make PNT.LO and PNT.HI the same value as the controller will not work correctly and could cause the product to overheat.

3.6.7 Holdback

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

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

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

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

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

3.7.1 Creating a Program

Programs can be created in level 1 or level 2 of the 3216P1 and 3216P5. Each program contains 8 Ramp/ Dwell pairs.

Note: A currently active program cannot be altered. Go into 'Reset' mode before starting to create or modify a program.

3.7.2 Program Number (3216P5 Only)

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

3.7.3 Ramp Units

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

3.7.4 Dwell Units

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

3.7.5 Holdback

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

3.7.6 Ramp Rate

Press scroll until the display shows RMP.1 <Ramp Rate 1>: Using the up ▲ down ▼ enter the value for the first ramp rate depending on the Ramp Units selected. If the Ramp segment is not required select “OFF”.

3.7.7 Target Setpoint

Press scroll until the display shows T.SP 1 <Target SP 1>: Enter the temperature that you want the product to ramp up to using “Ramp rate 1”.

If “Ramp Rate 1” has been set to “OFF”. The product will Heat/ Cool directly to the Target SP.

3.7.8 Dwell Time

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

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

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

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

### 3.7.9 Running a Program

If using the 3216P5 controller press scroll to display PROG <PROGRAM NUMBER>. Select the required Program Number before operating a Program.

Table below shows the key presses to operate a program.

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

### 3.7.10 Program Status

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

#### 3.7.11 Process Value

The upper display shows the current temperature of the product.

#### 3.7.12 PSP, Segment Type and Number

The lower display continually alternates between the programs current set value (Program SP = PSP) and scrolling text, indicating the current status of the program whether RAMP or DWELLING followed by the segment number.

Additional information can be obtained using the scroll key while the program is operating.
Working Output Power

From the home display, press scroll ▼ until the display shows WRK.OP <WORKING OUTPUT POWER>. This shows the power being used as a percentage.

Time Remaining

Press scroll ▼ until the display shows T.REMN <TIME REMAINING>. This shows the dwell time remaining for the current segment. There is no value for “Ramp Time Remaining” therefore when the program is ramping the dwell time set will be shown and will only begin to count down when the ramp has finished.

Program Review

Further presses of scroll ▼ will reveal the settings of the current program operating. These parameters are locked, while the program is operating.

Program Hold with Holdback

If a holdback value has been set (see section 3.6) and the program goes into a hold state, the red “HLD” indicator will light, until the current temperature catches up.

If while in this condition the program itself is put into “Hold” by pressing the up ▲, down ▼ together, the “HLD” indicator will turn off and the “Run” indicator will flash, indicating the program is on hold. When the program is started again by pressing the up ▲, down ▼ together, the “Run” indicator will stop flashing and show continually and the “HLD” indicator will light, if the current temperature has not caught up with the program.

Power Failure

If there is a power failure while the program is operating and the power is subsequently restored, the scrolling text will read <POWER FAIL - PROGRAM RESET>.

Press the “ACK” function to acknowledge this message, press the “ACK” function again to reset the program.

Alarms

Alarms are used to alert the operator when a pre-set level has been exceeded or a function error has occurred such as a sensor break. They are indicated by a scrolling message on the display and a flashing red ALM (Alarm) indicator. The alarm may also switch an output – usually a relay to allow external devices to be operated when an alarm occurs. Alarms only operate if they have been configured and are dependent on customer requirements.

How to acknowledge an alarm will depend on the type of latching which has been configured. A non-latched alarm will reset itself when the alarm condition is removed. A latched alarm requires acknowledgement with the “ACK” function before it is reset.

If an alarm has been activated the red “ALM” indicator will light and the scrolling text will indicate the type of alarm.

To acknowledge an alarm and cancel the “ALM” indicator, press “ACK” function.

Note: The alarm indicator may seem to be permanently on when viewed from above. When an alarm is active the indicator should only be flashing, to confirm this, the controller must be viewed directly from the front.
Program Example

The following sequence of entries creates and runs the program shown graphically below.

1. Press scroll until the display shows RAMP.U <SP RAMP UNITS>. Select MIN.
2. Press scroll until the display shows DWELL.U <DWELL UNITS>. Select MIN.
3. Press scroll until the display shows RMP.1 <RAMP RATE 1>. Select 5
4. Press scroll until the display shows T.SP1 <TARGET SP 1>. Select 600
5. Press scroll until the display shows DWEL.1 <DWELL TIME 1>. Select 30
6. Press scroll until the display shows RMP.2 <RAMP RATE 2>. Select 4
7. Press scroll until the display shows T.SP2 <TARGET SP 2>. Select 400
8. Press scroll until the display shows DWEL.2 <DWELL TIME 2>. Select 30
9. Press scroll until the display shows RMP.3 <RAMP RATE 3>. Select OFF
10. Press scroll until the display shows T.SP3 <TARGET SP 3>. Select 600
11. Press scroll until the display shows DWEL.3 <DWELL TIME 3>. Select 60
12. Press scroll until the display shows RMP.4 <RAMP RATE 4>. Select 3
13. Press scroll until the display shows T.SP4 <TARGET SP 4>. Select 800
14. Press scroll until the display shows DWEL.4 <DWELL TIME 4>. Select OFF
15. Press scroll until the display shows RMP.5 <RAMP RATE 5>. Select 5
16. Press scroll until the display shows T.SP5 <TARGET SP 5>. Select 400
17. Press scroll until the display shows DWEL.5 <DWELL TIME 5>. Select 480
18. Press the ACK function to return to the home display.
19. Press the up ▲ and down ▼ keys together, to operate the program.
### 3.8 Controller Options

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

#### 3.8.1 Digital Communications - RS232

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

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

- 7,8 (4,5) Link together
- 1,4,6 (6,8,20) Link together

#### 3.8.2 Digital Communications - RS485

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

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

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

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

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

3.9 Temperature Controller Replacement

Before handling the controller: wear an anti-static wrist strap or otherwise avoid any possibility of damage to the unit by static electricity. Refer to the detailed instructions supplied with the replacement controller.

Ease apart the two lugs at the side; grip the instrument and withdraw it from its sleeve; push in the replacement.

3.10 3216 Controller Navigation Diagram
The following diagram details how to navigate to the various menu options within the 3216 Controller. At each option, values can be set using the arrow keys.
### 3.0 3216 Controller

<table>
<thead>
<tr>
<th></th>
<th>L1</th>
<th>Level 1</th>
<th>Press the Scroll Key</th>
<th>Hold the Page key for 3 seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L2</td>
<td>Level 2</td>
<td>Press the Scroll Key multiple times</td>
<td>Locked - password required</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>Access</td>
<td>* If configured</td>
<td>Unlocked</td>
</tr>
<tr>
<td></td>
<td>**</td>
<td>Do not raise the power limit (if accessible) above the design level for the product</td>
<td>~ Multiple Program Only</td>
<td>Black = Progress</td>
</tr>
</tbody>
</table>
4.0 2132 Over-Temperature Controller Description (if fitted)

4.1 Description

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

4.2 Operation

4.2.1 Controls

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

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

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

Some components will operate after the over-temperature feature isolates the power supply e.g. cooling fans will continue to operate, provided that there is a power supply to the product. In some cases the product may not do so, if other options (such as a door switch) are fitted.
4.0 2132 Over-Temperature

4.2.2 Operation

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

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

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

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

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

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

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

4.2.3 Over-Temperature Operation

Use down and up to alter the over-temperature setpoint. This should normally be set a little above the working temperature (for example 15 °C above). The product is supplied with the over-temperature set at 15 °C above the furnace or oven maximum working temperature.

Press scroll twice view the present temperature as measured by the over-temperature controller. Press it twice, the first press shows the temperature units (°C).

4.2.4 Over-Temperature Alarm

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

4.2.5 Resetting the Over-Temperature Alarm

To acknowledge the alarm press scroll and page together.

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

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

4.2.6 Sensor Break

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

If an audible alarm is supplied for use with the over-temperature controller, it is normally configured to sound on over-temperature condition and to stop sounding when the alarm is acknowledged as given in section 4.2.

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

4.4 Navigation Diagram

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

5.1 Operating Cycle

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

Connect the product to the electrical supply.

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

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.

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

5.2 Operator Safety

The chamber of the product is earthed (grounded), and the door may be opened safely while the product is switched on.

Always disconnect the product from the electrical supply before making any repairs.
6.0 Maintenance

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

6.2 Maintenance Schedule

CUSTOMER QUALIFIED PERSONNEL

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

<table>
<thead>
<tr>
<th>Maintenance Procedure</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td></td>
<td>Daily</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 the relevant controller manual</td>
<td></td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit (if fitted)</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td>Door Seal</td>
<td>Visual inspection - check for splits and make sure it seals</td>
<td></td>
</tr>
<tr>
<td>Door Seal</td>
<td>Replacement</td>
<td></td>
</tr>
<tr>
<td>Electrical Safety (external)</td>
<td>Visual check of external cables and plugs</td>
<td></td>
</tr>
<tr>
<td>Electrical Safety (internal)</td>
<td>Physically check all connections and cleaning of the power plate area</td>
<td></td>
</tr>
<tr>
<td>Gas Safety - ISO model (external)</td>
<td>Carry out the leak test as detailed in this manual.</td>
<td></td>
</tr>
<tr>
<td>Gas Safety – ISO model (internal)</td>
<td>If the leak test has failed and the door is making a good seal then an internal leak test is needed.</td>
<td></td>
</tr>
<tr>
<td>Air System Integrity (ASTM model)</td>
<td>Carry out the leak test as detailed in this manual.</td>
<td></td>
</tr>
</tbody>
</table>

Function

<table>
<thead>
<tr>
<th>Maintenance Procedure</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Calibration</td>
<td>Tested using certified equipment, frequency dependent on the standard required</td>
<td></td>
</tr>
<tr>
<td>Operational Check</td>
<td>Check that all functions are working normally</td>
<td></td>
</tr>
</tbody>
</table>
## 6.0 Maintenance

<table>
<thead>
<tr>
<th>Operational Check</th>
<th>Thorough inspection and report incorporating a test of all functions</th>
</tr>
</thead>
</table>

### Performance

<table>
<thead>
<tr>
<th>Circulating Fan (if fitted)</th>
<th>Visual check to see if it is running</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Element Circuit</th>
<th>Electrical measurement</th>
</tr>
</thead>
</table>
6.2.1 Cleaning
Soot deposits may form inside the furnace, depending on the process. At appropriate intervals remove these by heating as indicated in the General Operation Notes.

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

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

6.4 After-Sales Service
Carbolite Gero Service has a team of Service Engineers who can offer repair, calibration and preventive maintenance of furnace and oven products both at the Carbolite Gero factory and at customers’ premises throughout the world. A telephone call or email often enables a fault to be diagnosed and the necessary parts to be despatched.
In all correspondence please quote the serial number and model type given on the rating label of the product. The serial number and model type are also given on the back of this manual when supplied with the product.
Carbolite Gero Service and Carbolite Gero contact information can be found on the back page of this manual.

6.5 Recommended Spare Parts and Spare Parts Kit
Carbolite Gero can supply individual spare parts or a kit of the items most likely to be required. Ordering a kit in advance can save time in the event of a breakdown.
Each kit consists of one thermocouple, one solid state relay and one heating element.
When ordering spare parts please quote the model details as requested above.

6.6 Power Adjustment
The control system incorporates electronic power limiting, but for the model listed in this manual the power limit is set to 100%. The power limit parameter OP.Hi may be accessible to the operator, but should not generally be altered.
In some cases the supply voltage may be outside the range 220-240 V or the 3-phase equivalent, the power limit parameter may be set to a value other than 100%. Do not increase the value to 100%, see section 10.0 for details of power limit settings.
7.0 Repairs and Replacements

7.1 Safety Warning - Disconnection from Power Supply

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

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

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

7.2 Safety Warning - Refractory Fibre Insulation

**Insulation made from High Temperature Insulation Wool**

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

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

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

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

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

When handling the material, always use approved respiratory protection equipment (RPE-eg. FFP3), eye protection, gloves and long sleeved clothing. Avoid breaking up waste material. Dispose of waste in sealed containers.

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

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

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

7.3 Temperature Controller Replacement

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

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

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

7.5 Thermocouple Replacement

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

Thermocouple cable colour codings are:

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

Disconnect the thermocouple from its terminal block.
Remove the gland nut from the rear of the chamber; it may be necessary temporarily to remove some insulation material. Withdraw the thermocouple.
Fit the replacement thermocouple and reconnect, observing the colour coding and refit the element access panel.

7.6 Element Replacement

See section 7.2 - wearing a face mask is required.

Disconnect the product from the electrical supply and remove the back panel.
Make a note of the wiring and piping connections; see section above which refers to the thermocouple colour coding.
Disconnect terminal blocks, thermocouple and gas pipes to obtain access to the slab element which lies beneath the chamber casting. If necessary, undo the door hinges to allow the whole assembly to slide out. Make a note of all disconnections.
Replace the element with the new one and reverse the assembly procedure.
7.7 Fuse Replacement

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

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

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

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

#### A. Oven Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The temperature controller is OFF</td>
<td>No power from supply</td>
</tr>
<tr>
<td>2.</td>
<td>The temperature controller is ON</td>
<td>The controller shows a very high temperature or a code such as EEE or --- or S.br</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The controller shows a low temperature</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>The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault</td>
</tr>
</tbody>
</table>

#### B. Oven Overheats

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

9.1 WV-11-00
Connections below show single phase with instrument switch(es).

Key

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F1, F2</td>
<td>Fuses</td>
</tr>
<tr>
<td>FIL</td>
<td>Filter</td>
</tr>
<tr>
<td>SW</td>
<td>Instrument Switch</td>
</tr>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>TC</td>
<td>Thermocouple</td>
</tr>
<tr>
<td>SSR</td>
<td>Solid State Relay</td>
</tr>
<tr>
<td>EL</td>
<td>Element(s)</td>
</tr>
<tr>
<td>*</td>
<td>If Fitted</td>
</tr>
<tr>
<td>L</td>
<td>Live</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>PE (GR/Y)</td>
<td>Earth (Green+Yellow)</td>
</tr>
</tbody>
</table>

Connections below show single phase with instrument switch(es).
10.0 Fuses and Power Settings

10.1 Fuses

F1-F2: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th></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>F1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td>Instrument Circuit Fuses</td>
<td></td>
<td>20 mm x 5 mm glass, 2 Amps type F1; omitted in MFS/1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Volts</th>
<th>Phase</th>
<th>Supply Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFS /1 ISO</td>
<td>220 - 240 V</td>
<td>1-phase</td>
<td>2 A</td>
</tr>
<tr>
<td>MFS /1 ISO</td>
<td>110 - 120 V</td>
<td>1-phase</td>
<td>6 A</td>
</tr>
<tr>
<td>MFS /1 ASTM</td>
<td>220 - 240 V</td>
<td>1-phase</td>
<td>2 A</td>
</tr>
<tr>
<td>MFS /1 ASTM</td>
<td>110 - 120 V</td>
<td>1-phase</td>
<td>6 A</td>
</tr>
</tbody>
</table>

10.2 Power Settings

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

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

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>Chamber Size</th>
<th>Approx Capacity (l)</th>
<th>Net Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Free space Ovens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MFS /1 ISO</td>
<td>210</td>
<td>0.5</td>
<td>25 185 290</td>
<td>1.4</td>
<td>22</td>
</tr>
<tr>
<td>MFS /1 ASTM</td>
<td>210</td>
<td>0.5</td>
<td>25 185 290</td>
<td>1.4</td>
<td>22</td>
</tr>
</tbody>
</table>

11.1 Environment

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

Temperature: 5 °C - 40 °C

Relative humidity: Maximum 80 % up to 31 °C decreasing linearly to 50 % at 40 °C
## Service Record

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

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

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

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Fax: + 44 (0) 1433 621198  
Email: Info@carbolite-gero.com  
www.carbolite-gero.com