

Installation, Operation and Maintenance Instructions

1200 °C Split Tube Furnace - VST Model: 600mm

2416 Controller

VST 12/600 + 2416 Controller

Contents

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

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1.0 Symbols and Warnings

1.1 Switches and Lights



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



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



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

1.2 General Warnings



DANGER – Electric shock. Read any warning printed next to this symbol.

WARNING: Risk of fatal injury.



DANGER – Hot surface. Read any warning printed next to this symbol.

WARNING: All surfaces of a product may be hot.



DANGER – Read any warning printed next to this symbol.

1.0 Symbols and Warnings



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 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.

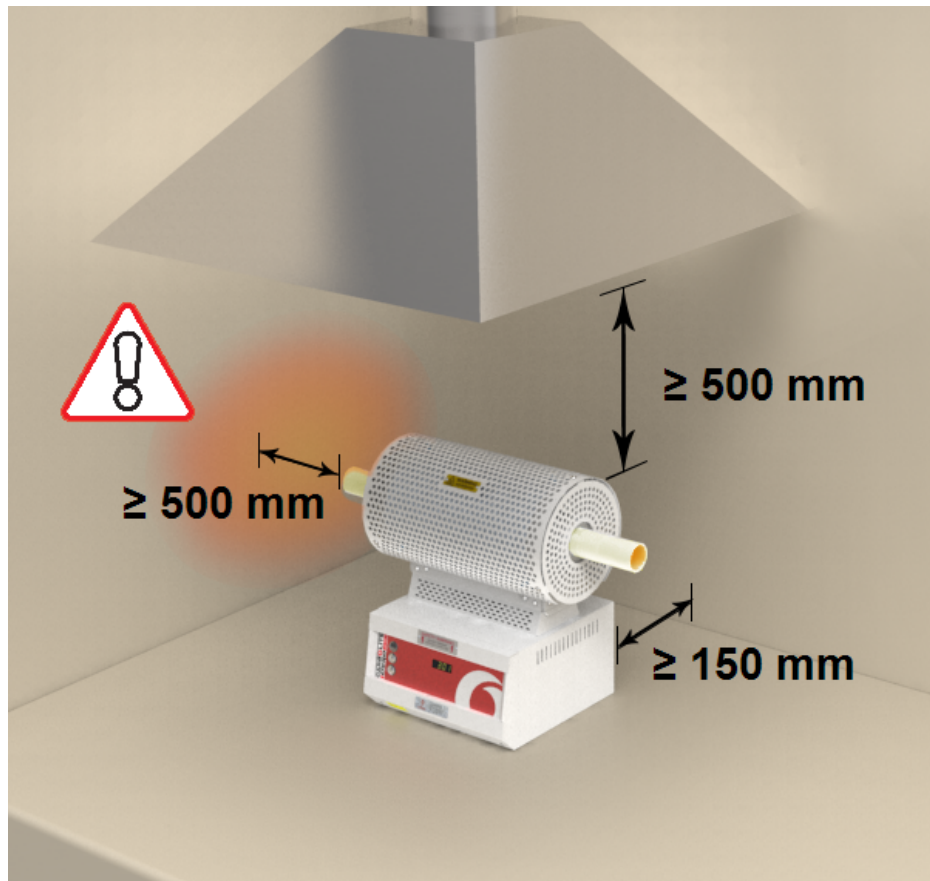
Unless otherwise stated elsewhere in this manual, ensure that there is **at least 150 mm** of free space around the back and sides of the product. Clear space is required above the product to dissipate heat.

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.



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.

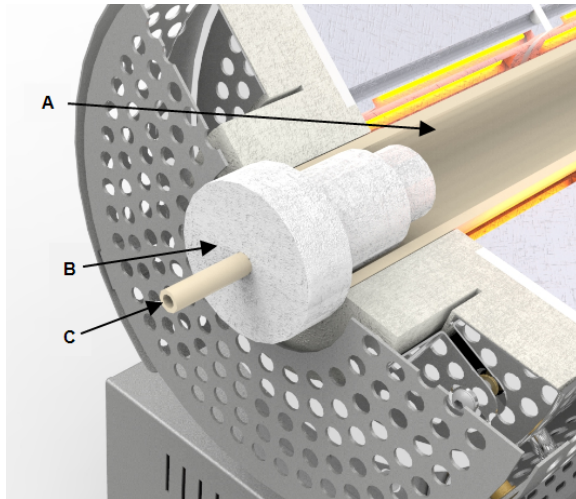
For optimum temperature uniformity, insulating plugs should be placed in the tube ends as shown in fig.1. With a long work tube, the stem of the plug assembly should line up with the end of the tube as in fig.2. Alignment of radiation shields is similar to that of plugs.

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.

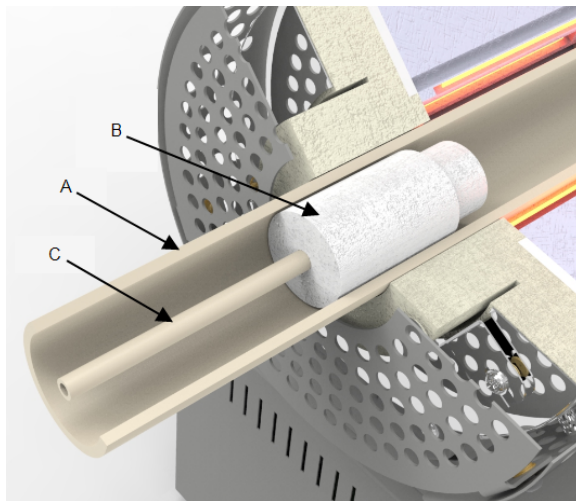
For vertical models with stainless steel seals, a hook and eye arrangement holds the upper insulating plug assembly.

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.

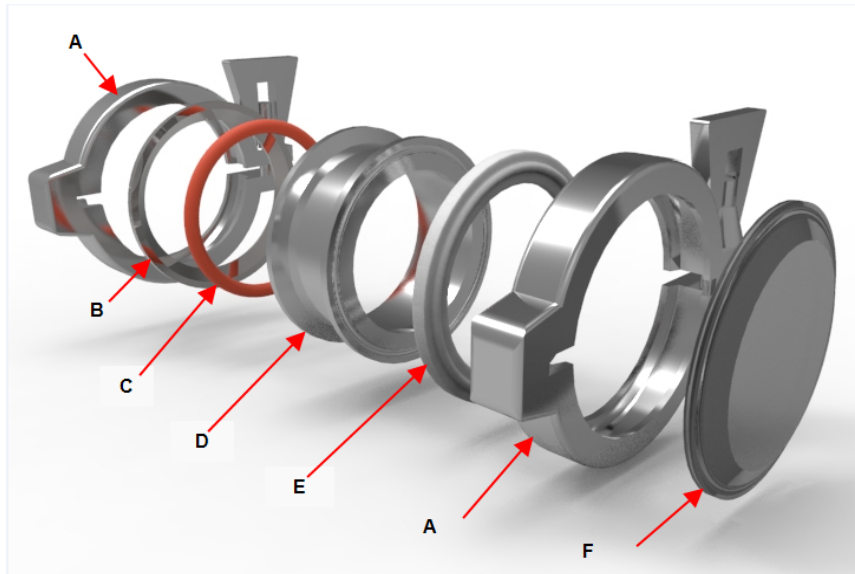


**Fig 1 - Insulating Plug
(standard length tube)**

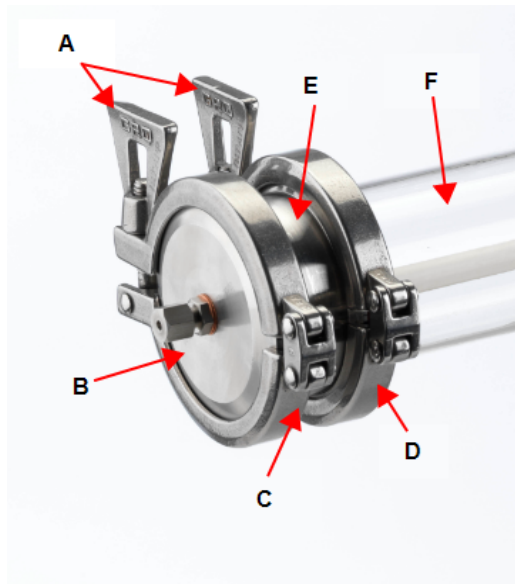


**Fig 2 - Insulating Plug
(long work tube)**

Key	
A	Tube
B	Insulating Plug
C	Stem



Key	
A	Clamp
B	Seal plate
C	'O' Ring seal
D	Seal sleeve
E	Clamp seal
F	End plate



Key	
A	Clamp
B	End plate
C	Clamp seal (between Seal sleeve and Clamp)
D	Seal sleeve
E	Seal plate & 'O' Ring seal (underneath clamp)
F	Tube

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:

Supply	Terminal Label	Cable Colour	Supply Types	
			Live - Neutral	Reversible or Live-Live
1-phase	L	Brown	to live	to either power conductor (For USA 200-240V, connect L1)
	N	Blue	to neutral	to the other power conductor (For USA 200-240V, connect L2)
	PE	Green/ Yellow	to earth (ground)	to earth (ground)

3-phase	L1	Black	to phase 1
	L2	Black	to phase 2
	L3	Black	to phase 3
	N	Light Blue	to neutral (except delta)
	PE	Green/ Yellow	to earth (ground)



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 2416 Controller

3.1 Description

This manual applies to the 2416, 2416CG and 2416P8 controllers.

Special customer requirements may result in changes to the available parameters and the navigation diagram. It is not possible to list all the possibilities in this manual.

2416CG Controller

The Eurotherm model 2416CG is a digital instrument with PID control algorithms which may be used as a simple controller or an 8-segment programmer. The 2416P8 is an eight-program model in which the programs can be stored independently or can be linked by a "call" parameter to form a single long program.

The 2416 Controller features:

- Easy use as a simple temperature controller, where on setting the required temperature the controller immediately attempts to reach and maintain it. Fig.1 indicates the type of temperature response when used in this way.
- By using one program segment, the control can be extended to include ramp-to-set-point. Fig.2 shows the effect.
- Alternatively, the 2416 Controller may be used as an 8-segment programmer, with each segment being a "Ramp", a "Step", a "Dwell", or "End". The program can be set to cycle if required. See fig. 3.
- Optional "modules" are available, in particular:
 - RS232 and RS432/485 digital communications modules;
 - Analogue communication modules;
 - "PDSIO" modules for communication with other controllers of similar or higher specification, for example, to allow cascade control;
- Alarm modules, which can be used to drive visible or audible alarms, or to provide volt-free contacts for customer use.

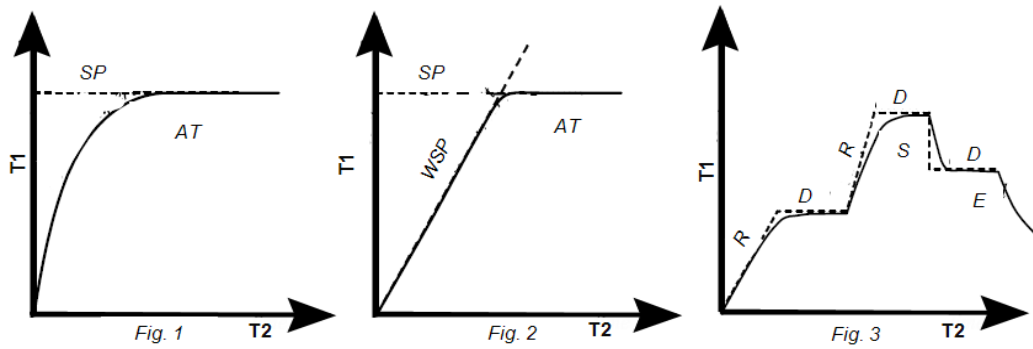


Fig 1 -Simple Control

Fig 2 - Control with Ramp-to-Setpoint
 Seg 1 = Ramp
 Seg 2 = End (Dwell)

Fig 3 - A Program

Key	
T1	Temperature
T2	Time
SP	Setpoint
AT	Actual Temperature
WSP	Working Setpoint
R	Ramp
D	Dwell
S	Step
E	End

3.2 Operation

Most Carbolite Gero products are fitted with an instrument switch which cuts off power to the controller and other parts of the control circuit. See section 5.0 for operating instructions.

To operate the 2416 Controller there must be power to the furnace or oven and the instrument switch must be on. If a time switch is included in the furnace or oven circuit, this must be in an ON position.

2416CG - Operation

When switched on, the controller lights up, goes through a short test routine and then displays the measured temperature and setpoint. Depending on its state when it was last switched off, it may start to control to the current setpoint of program. The output light glows or flashes to indicate that the control is occurring.

The buttons and indicators are used for the following purposes:



Key	
A	Output Light
B	Not Used
C	Page
D	Scroll
E	Down
F	Up
G	Run/Hold
H	Setpoint Temperature (SP)
I	Measured Temperature

Auto/ Manual	Disabled.	The unit is always in 'Auto' mode
RUN/HOLD	-	Used to start, stop or pause a program. Short presses cause it to alternate between 'Run' and 'Hold', but if it is held for 2 seconds the programmer goes into 'Reset' mode where it behaves as a simple controller.
Up + Down	▲ + ▼	To adjust the value of a parameter. Used to change the setpoint when the unit is being used as a simple controller ('Reset' mode). Holding down gives an accelerated parameter change.
Page	📄	Allows access to the parameters within the controller; most lists and parameters are hidden from the operator as they contain factory-set values which should not be altered. A single press of the page key shows the temperature units, normally °C; further presses reveal the lists indicated in the Navigation Diagram.
Scroll	🔍	Allows access to the parameters within a list. A single press displays the temperature units; further presses reveal the parameters in the current list. Some parameters are display-only, others may be altered by the operator.
Page + Scroll	📄 + 🔍	Press together to cause an immediate return to the 'Home List'
Run & Hold		Indicate the current mode: 'Run', 'Hold', or 'Reset' (Reset: both lights off). 'Run' flashes at the end of a program. 'Hold' flashes during holdback (when the program is paused to allow the temperature to catch up with a heating or cooling rate which is too fast).
Output Indicator		OP1 indicates that the programmer is calling for heat to be supplied. OP2 is not used.
SP2 and REM		Not generally used; indicate 'Second' or 'Remote' setpoint in use.

Operation as a Simple Controller


Press RUN/HOLD for 2 seconds to go into 'Reset' mode. Use down ▼ or up ▲ from the 'Home List' (i.e. when the temperature is displayed) to adjust the setpoint. The unit starts to control in the way indicated in Fig. 1.




Note that to use the Ramp Rate feature, as in Fig. 2, it is necessary to create a program. See the following sections.




3.3 Programming




Note that a currently active segment cannot be altered - put the programmer into 'Hold' or 'Reset' whenever it is necessary to do so to alter a parameter. Go into 'Reset' mode (i.e. press RUN/HOLD for 2 seconds) before starting to create or modify a program.

Press page  until 'ProG LiSt' is displayed.

Press scroll  to reveal the 'Holdback' and 'Loop Count' parameters. See sections 3.3.3 and 3.3.4 for a description of these.

Press scroll  to display 'SEG.n' (segment number); use down  or up  to move to the segment to be adjusted or created.

Press scroll  to see the 'tYPE' (segment type); use down  or up  to change the required segment type – see the table below.

Press scroll  to access the parameters appropriate to the type of segment chosen – see the following table – and use down  or up  to alter the values.

The final segment should be of type 'End', unless all program segments are used. Segments after 'End' are ignored.

Segment Type	Parameter	Function
RmP.r	TGt rATE	The target setpoint for this segment The ramp rate (rate of temperature change) in °/ minute
RmP.t	TGt dur	The target setpoint for this segment The duration of the segment. The controller calculates the rate of temperature rise necessary to achieve this duration.
Dwel	dur	The time in minutes to remain at the previous target temperature. 10ths of a minutes are allowed.
SteP	tGt	A new target temperature to be achieved as quickly as possible.
CaLL	PrG.n cyc.n	Only applicable to 2416P8. Calls another stored program given by 'PrG.n' as a subroutine, running it the number of times given by 'cyc.n'.
End	End.t	'Dwel' holds the temperature at the last target value. 'RSET' returns to simple controller operation; if the setpoint is set to zero then this effectively turns the heating off. 'SoP' sets the power to 0% – use of this is not recommended.

3.3.1 Programming Tips

Make sure the basic setpoint is set to zero to avoid unexpected heating at the end of a program.

If all segments are used so that there is no 'End' segment, then on completion the program automatically goes into 'Dwell'.

Dwell segments of length zero can be included. This is a way of allowing space for future program changes.

For an example of program creation, see section 3.3.6.


3.3.2 Multi-program model (2416P8)

The 'Program Edit' list contains the extra parameter 'PrG.n' and the 'Run' list contains the extra parameter 'PrG'. These features allow selection of the program to be edited or to be operated.

The extra segment type 'cALL' allows one program to call another as a subroutine; use this feature to create one or more long programs.

3.3.3 Holdback

'Holdback' can be used to prevent the program from operating ahead of the actual heating or cooling.

In the program list, scroll  to the 'Holdback' parameter and use down ▼ or up ▲ to set the holdback type as follows:

Band	Holdback applies to both heating and cooling
Lo	Holdback applies to heating only
Hi	Holdback applies to cooling only
Off	Holdback is off

Set 'Hb.V' to the value in °C beyond which holdback is to operate. Type 'BAnd' and a value of 10 °C is often a suitable combination, if holdback is required. In this case, if the actual temperature deviates outside ± 10 °C from the working setpoint, the holdback lamp of the front of the controller flashes and the program is held up until the temperature comes within range again.

The standard setting for holdback is OFF.

3.3.4 Program Cycling

The 'Loop Count' parameter 'CYC.n' can be set to control the number of times the program is run.


If 'CYC.n' = 1, the program stops at the end segment.



If 'CYC.n' = 5 (for example), the program runs 5 times: at the 'End' segment it returns to segment 1, until the 5th time through when it stops.

If 'CYC.n' = cont, the program never ends: it cycles continuously.

3.3.5 Running a Program

Press Run/ Hold to light up the 'Run' light. The program starts to operate.

To view the progress of a program from the 'Home' list, press scroll  to reveal the current segment ('SEG') and the total program time remaining in hours ('PrG.t').

























For a more detailed view, press page  to access the 'Run' list page and scroll  to see its contents as shown in the Navigation Diagram below. Provided the unit is first put into 'Hold' mode, temporary changes may be made to parameters; these apply only until the program ends or is reset.

To pause a program, press Run/ Hold; the 'Hold' light comes on. To terminate a program, press Run/ Hold for 2 seconds; the 'Run' and 'Hold' lights go out.

While the program is operating, the working setpoint is shown in the lower display.

3.3.6 Program example

The following sequence of entries creates and runs the program.

1. Press page  key until 'ProG LiSt' is displayed.
2. Press scroll  until 'CYC.n' is displayed and use the arrow key to select 1.
3. Press scroll  until 'SEG.n' is displayed and use the arrow key to select 1.
4. Press scroll  until 'tYPE' is displayed and use the arrow key to select rmP.r.
5. Press scroll  until 'tGt' is displayed and use the arrow key to select 600.
6. Press scroll  until 'rAtE' is displayed and use the arrow key to select 5.0.
7. Press scroll  until 'SEG.n' is displayed and use the arrow key to select 2.
8. Press scroll  until 'tYPE' is displayed and use the arrow key to select dwEl.
9. Press scroll  until 'dur' is displayed and use the arrow key to select 60.0.
10. Press scroll  until 'SEG.n' is displayed and use the arrow key to select 3.
11. Press scroll  until 'tYPE' is displayed and use the arrow key to select rmP.t.
12. Press scroll  until 'tGt' is displayed and use the arrow key to select 400.
13. Press scroll  until 'dur' is displayed and use the arrow key to select 60.0.
14. Press scroll  until 'SEG.n' is displayed and use the arrow key to select 4.
15. Press scroll  until 'tYPE' is displayed and use the arrow key to select 'dwEll'.
16. Press scroll  until 'dur' is displayed and use the arrow key to select 30.
17. Press scroll  until 'SEG.n' is displayed and use the arrow key to select 5.
18. Press scroll  until 'tYPE' is displayed and use the arrow key to select rmP.r.
19. Press scroll  until 'tGt' is displayed and use the arrow key to select 30.
20. Press scroll  until 'rAtE' is displayed and use the arrow key to select 5.0.
21. Press scroll  until 'SEG.n' is displayed and use the arrow key to select 6.
22. Press scroll  until 'tYPE' is displayed and use the arrow key to select 'End'.
23. Press scroll  until 'End.t' is displayed and use the arrow key to select 'dwEll'.
24. Press the page  key until you return to the main display.
25. Press the 'Run' key. The program operates.

3.4 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.


3.4.1 Digital Communications - RS232

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

Product end of cable female (25-pin) 9-pin			RS232 Cable: product to PC	Computer end of cable 9-pin (25-pin) male		
Rx	(2)	3	—————	3	(2)	Tx
Tx	(3)	2	—————	2	(3)	Rx
Com	(7)	5	—————	5	(7)	Com
				7,8 1,4,6	(4,5) (6,8,20)	Link together Link together

3.4.2 Digital Communications - RS485

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

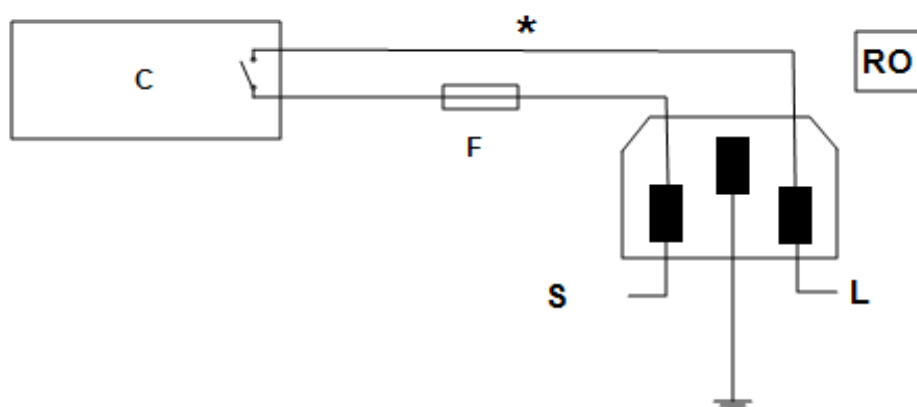
Product end of cable female (25-pin) 9-pin			RS485 Cable: product to PC	Computer end of cable 9-pin (25-pin) female		
-	(2)	3		3	(2)	Tx
+	(3)	2		2	(3)	Rx
Com	(7)	5		5	(7)	Com

3.4.3 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.

3.4.4 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:



Key	
C	Temperature Controller
F	Fuse (2A)
S	Supply
L	Load
*	Normally open relay contacts
RO	Relay Output 240V 2A MAX

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.

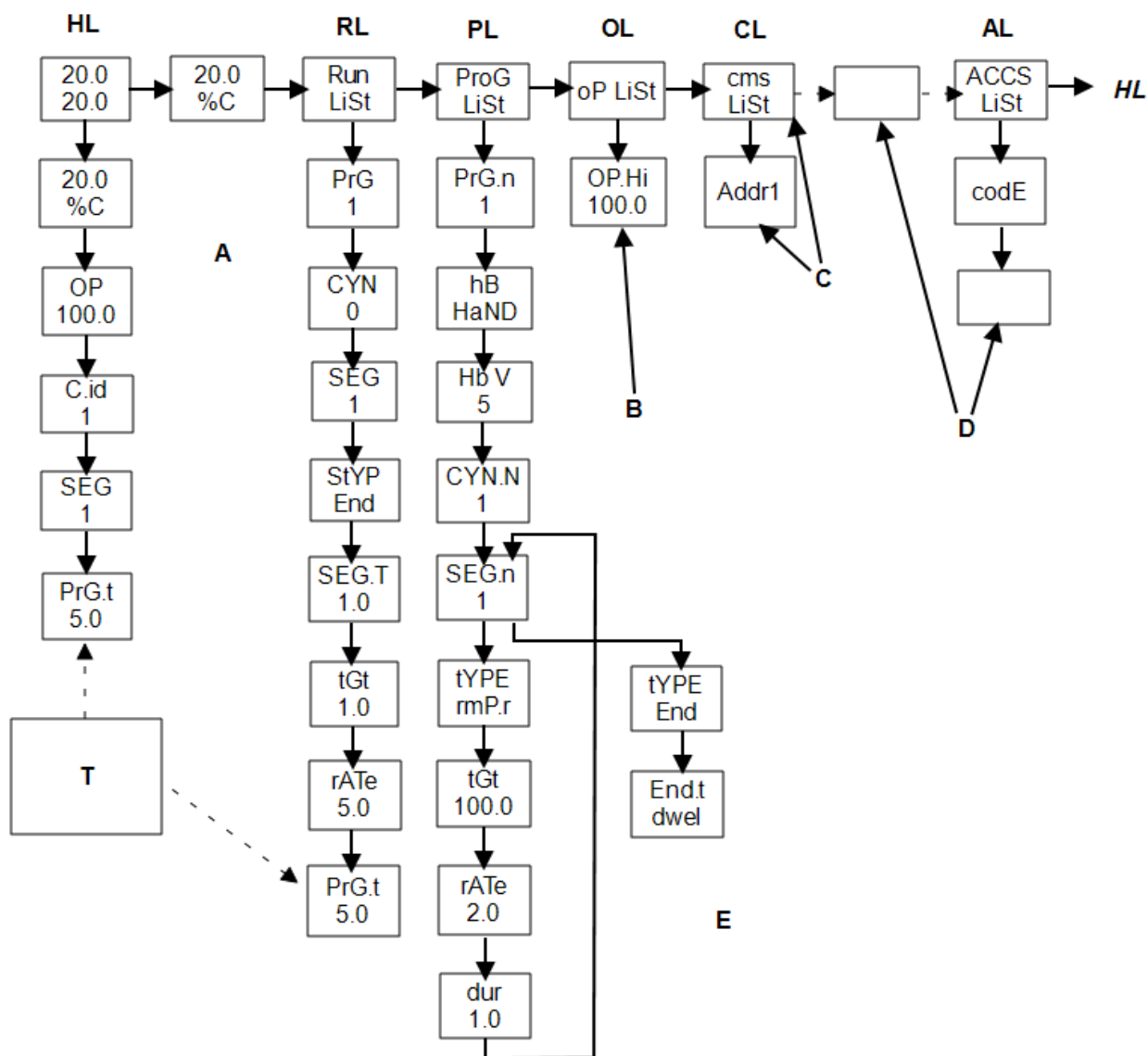
3.5 Temperature Controller Replacement



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.

3.6 Navigation Diagram



4.0 2132 Over-Temperature Controller Description (if fitted)

4.1 Description



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

4.2 Operation

4.2.1 Controls

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

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


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


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


4.2.2 Operation

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

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

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



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

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

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

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

4.2.3 Over-Temperature Operation

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

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

4.2.4 Over-Temperature Alarm

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

4.2.5 Resetting the Over-Temperature Alarm

To acknowledge the alarm press scroll  and page  together.

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

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

4.2.6 Sensor Break

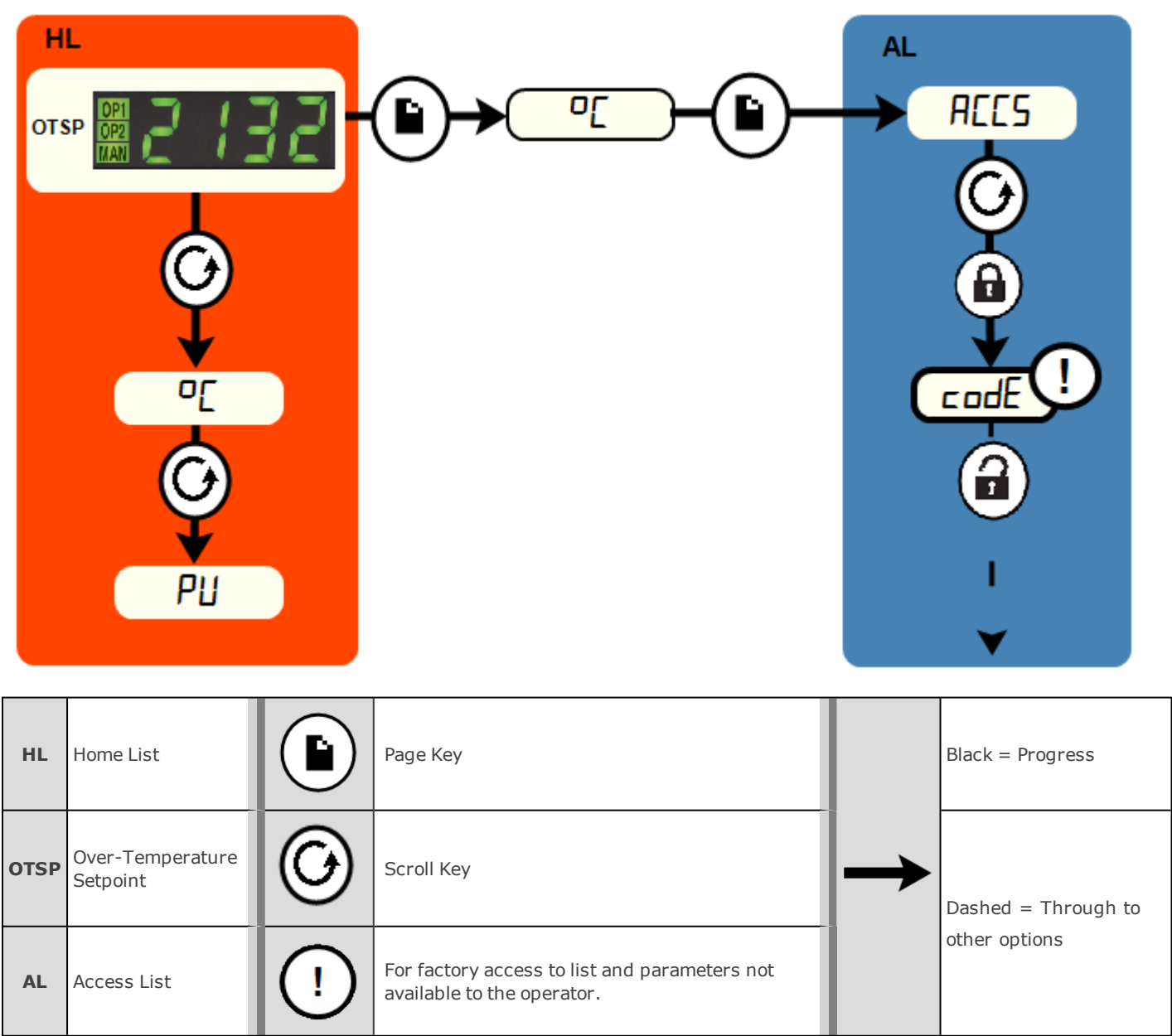
The over-temperature cut-out system also operates if the over-temperature control thermocouple breaks or becomes disconnected. The message S.br flashes where the measured temperature is normally displayed.

4.3 Audible Alarm

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

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

4.4 Navigation Diagram



5.0 Operation

5.1 Operating Cycle

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

Connect the product to the electrical supply.

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

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

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

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

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

5.2 General Operating Advice



Heating element life is shortened by overheating. Do not leave the product at high temperature when it is not required. The maximum temperature is shown on the product rating label and in section 11.0 towards the back of this manual.



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

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

5.3 Operator Safety



The ceramic materials used in this product become electrically conductive at high temperatures. In these models there are partially exposed heating coils in the chamber and there is a danger of contact even with the furnace closed. DO NOT use any conductive tools within the work tube without isolating it. If a metal work tube is used, it must be earthed.



Switch off the heater switch whenever loading or unloading the product. The elements are isolated when the heater switch is OFF.



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



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

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

5.4 Tube Life

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

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



Fig 4 - Avoidance of thermal contact

Do not set too high a heating or cooling rate. As tubes are susceptible to thermal shock and may break. Tubes which extend beyond the heated part of the furnace are more at risk. A general rule for maximum heating or cooling rate is $400 \div \text{internal diameter in mm to give } (^\circ\text{C/ min})$; for 75 mm i/ d tubes this comes to 5 °C per minute. The controller can be set to limit both the heating and cooling rate.

5.5 Pressure

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

A suitably regulated gas supply should always be used.

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

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

5.6 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 10.0

Refer to section 3.0 for power adjustment instructions.

5.7 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.

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.

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

	rect positioning					
Seals (if fitted)	Check all seals and O-rings and clamps					
Performance						
Element Circuit	Electrical measurement 					
Power Consumption	Measure the current drawn on each phase / circuit					
Cooling Fans (if fitted)	Check whether the cooling fans are working					

6.2.1 Cleaning

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



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

6.2.2 Safety Switch

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

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

Weekly check:

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

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

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

Annual check:

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

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

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

6.3 Calibration

After prolonged use, the controller and/or thermocouple may require recalibration. This is important for processes that require accurate temperature readings or for those that

use the product close to its maximum temperature. A quick check using an independent thermocouple and temperature indicator should be made from time to time to determine whether full calibration is required. Carbolite Gero can supply these items. Depending on the controller fitted, the controller instructions may contain calibration instructions.

6.4 After-Sales Service

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

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

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

6.5 Recommended Spare Parts and Spare Parts Kit

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

Each kit consists of one thermocouple, one solid state relay and two heating elements (four heating elements for 900 mm heated length furnaces).

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

7.0 Repairs and Replacements

7.1 Safety Warning - Disconnection from Power Supply



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



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

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

7.2 Safety Warning - Refractory Fibre Insulation



**Insulation made from High Temperature Insulation Wool
Refractory Ceramic Fibre, better known as (Alumina silicate
wool - ASW).**

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

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

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

Exposure to fibre dust may cause respiratory disease.

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

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

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

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

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

7.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.

7.4 Solid-State Relay Replacement



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

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

7.5 Thermocouple Replacement

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



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

Thermocouple cable colour codings are:

thermocouple leg	colour
positive (type N)	pink
negative	white

Disconnect the thermocouple from its terminal block.

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

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

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

Re-assemble the furnace.

7.6 Fuse Replacement

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

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

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

Replace any failed fuses with the correct type. For safety reasons do not fit larger capacity fuses without first consulting Carbolite Gero.

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

7.7 Element Replacement



See section 7.2 - 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.

If ordering a spares kit, the correct number and size of heating elements will be supplied.

8.0 Fault Analysis

A. Furnace Does Not Heat Up				
1.	The HEAT light is ON	►	The heating element has failed	► Check also that the SSR is working correctly
2.	The HEAT light is OFF	►	The controller shows a very high temperature or code such as S.br	► The thermocouple has broken or has a wiring fault
		►	The controller shows a low temperature	► The door switch(es) (if fitted) may be faulty or need adjustment
				► The contactor/relay (if fitted) may be faulty
				► The heater switch (if fitted) may be faulty or need adjustment
				► The SSR could be failing to switch on due to internal failure, faulty logic wiring from the controller, or faulty controller
		►	There are no lights glowing on the controller	► Check the supply fuses and any fuses in the furnace control compartment
				► The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault.

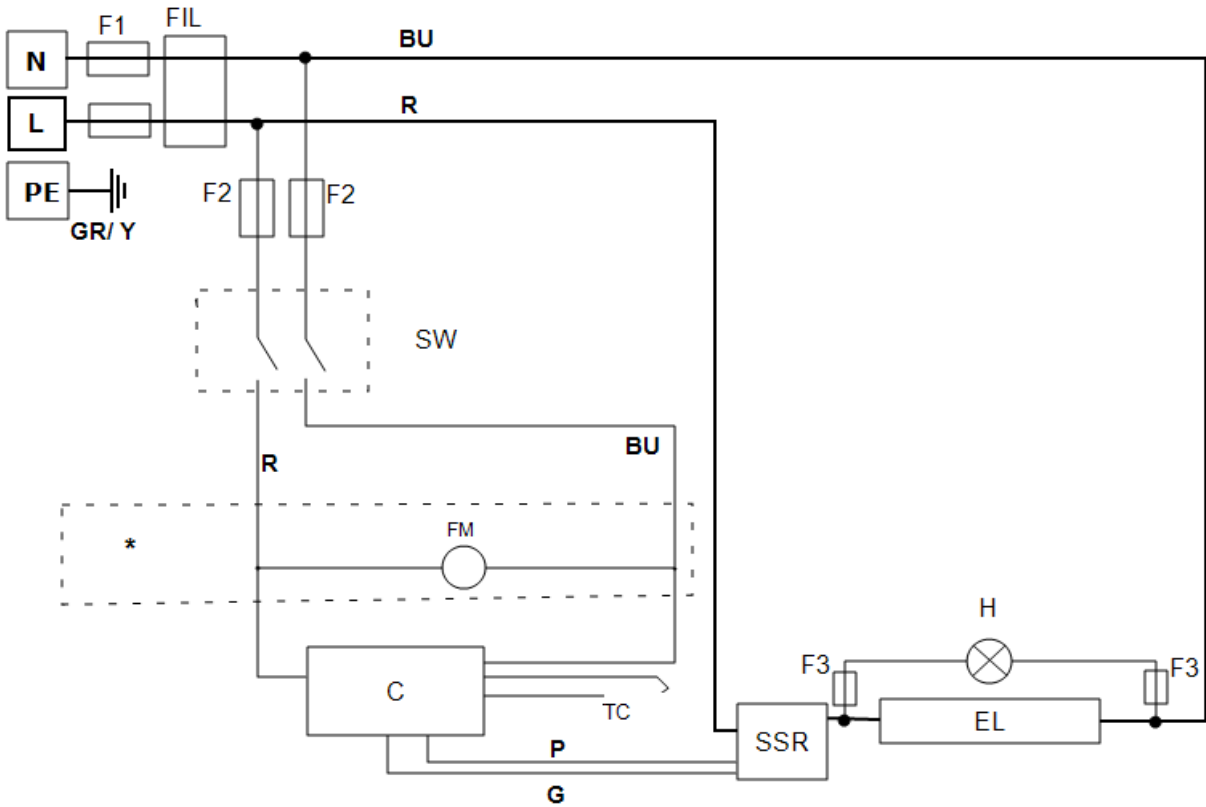
B. Product Overheats

1.	Product only heats up when the instrument switch is ON	►	The controller shows a very high temperature	►	The controller is faulty
		►	The controller shows a low temperature	►	The thermocouple may be faulty or may have been removed out of the heating chamber
				►	The thermocouple may be connected the wrong way around
				►	The controller may be faulty
2.	Product heats up when the instrument switch is OFF	►	The SSR has failed "ON"	►	Check for an accidental wiring fault that could have overloaded the SSR

9.0 Wiring Diagrams

9.1 WA-11-00

Connections below show single phase.

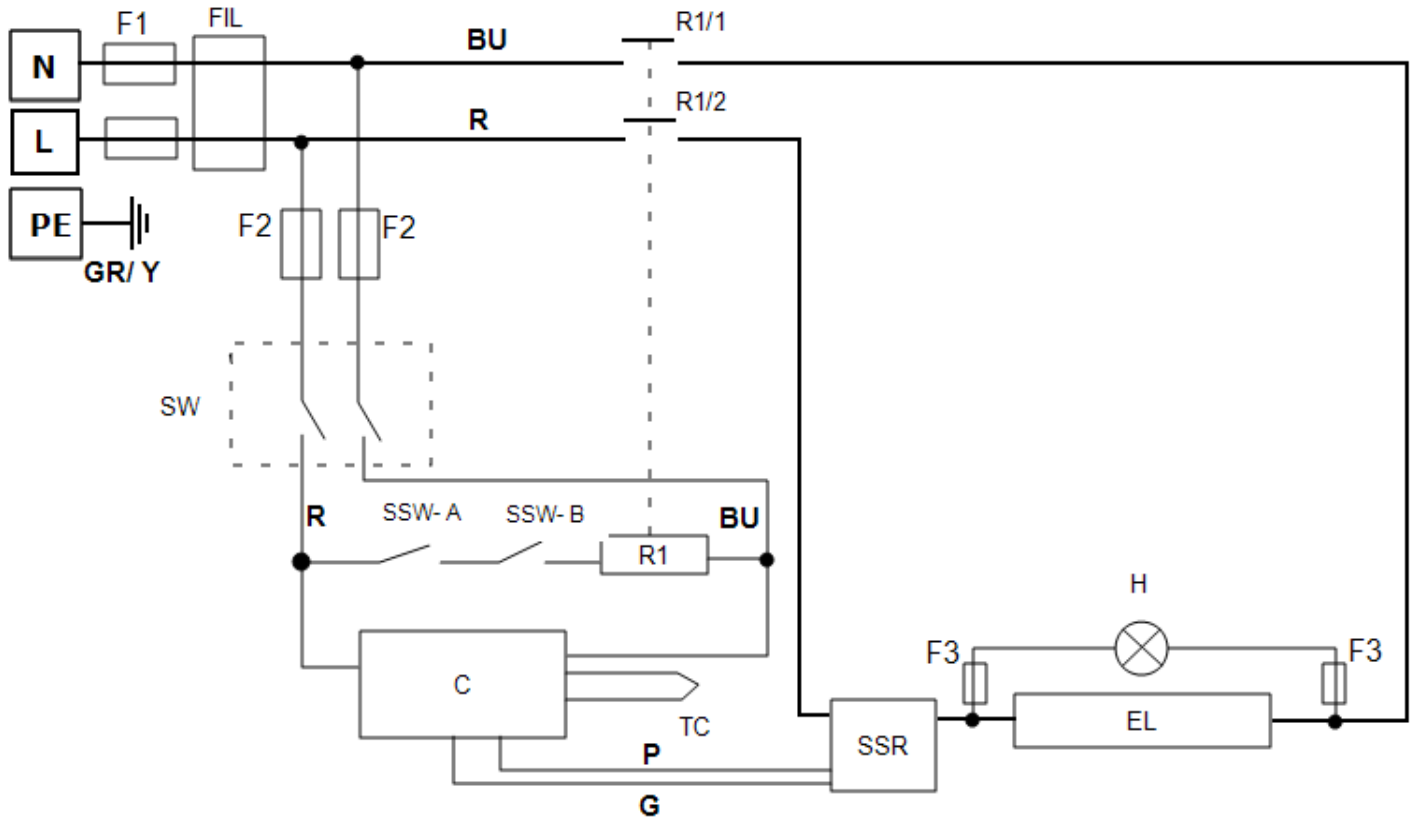


Key	
F1, F2, F3	Fuses
FIL	Filter
C	Temperature Controller
TC	Control Thermocouple
SSR	Solid State Relay
H	Heat Lamp
EL	Element(s)
SW	Instrument Switch(es)
FM	Fan Motor
*	Fan Models Only
N	Neutral
L	Live
PE	Earth

Cables	
BU	Blue
R	Red
GR/Y	Green + Yellow
G	Grey
P	Pink

9.2 WA-11-70

Connections below show single phase with safety switches.

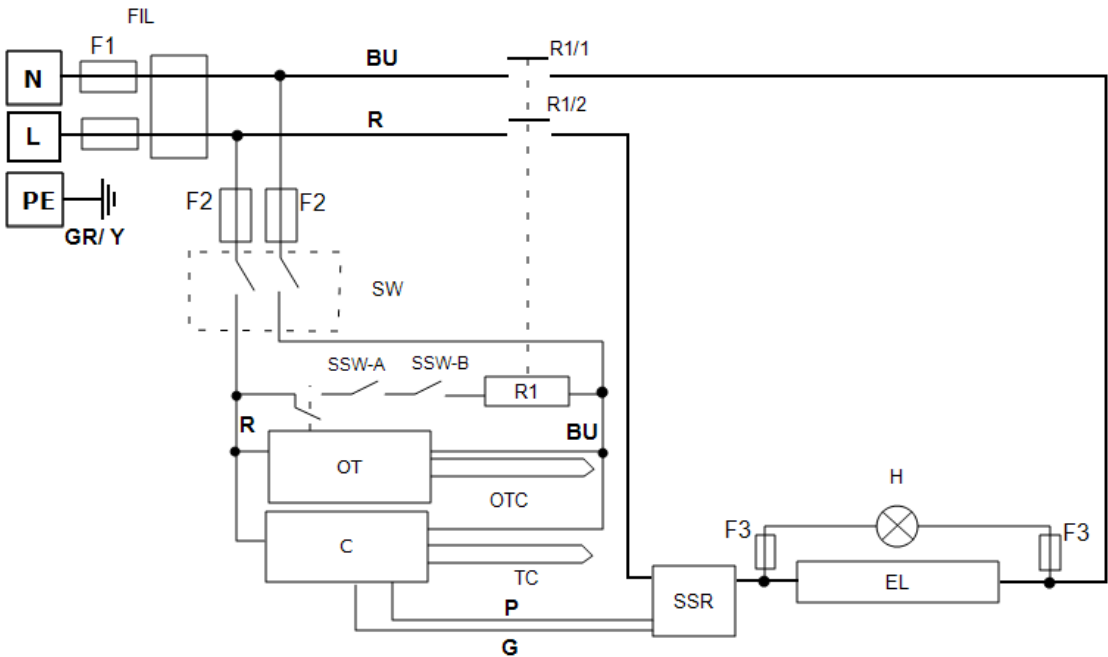


Key	
F1, F2, F3	Fuses
FIL	Filter
R1/1, R1/2	Relay Contactor
R1	Relay
C	Temperature Controller
TC	Control Thermocouple
SSR	Solid State Relay
SSW-A, SSW-B	Safety Switch(es)
H	Heat Lamp
EL	Element(s)
SW	Instrument Switch(es)
N	Neutral
L	Live
PE	Earth

Cables	
BU	Blue
R	Red
GR/Y	Green + Yellow
G	Grey
P	Pink

9.3 WA-11-71

Connections below show single phase with safety switches and over-temperature control.

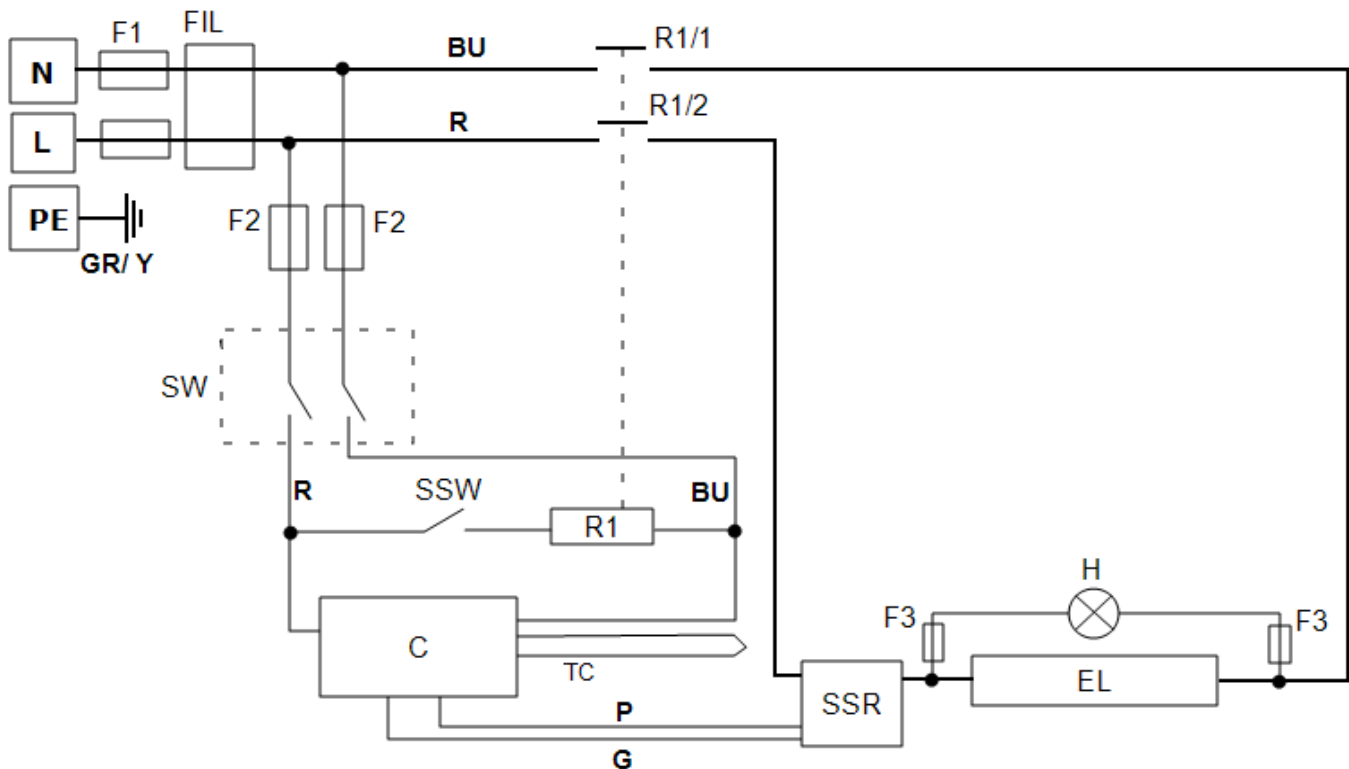


Key	
F1, F2, F3	Fuses
FIL	Filter
R1/1, R1/2	Relay Contactor
R1	Relay
C	Temperature Controller
TC	Control Thermocouple
OT	Over-Temperature Con- troller
OTC	Over-Temperature Ther- mocouple
SSR	Solid State Relay
SSW-A, SSW-B	Safety Switch
H	Heat Lamp
EL	Element(s)
SW	Instrument Switch(es)
N	Neutral
L	Live
PE	Earth

Cables	
BU	Blue
R	Red
GR/Y	Green + Yellow
G	Grey
P	Pink

9.4 WA-11-30

Connections below show single phase with indirect safety switch(es).

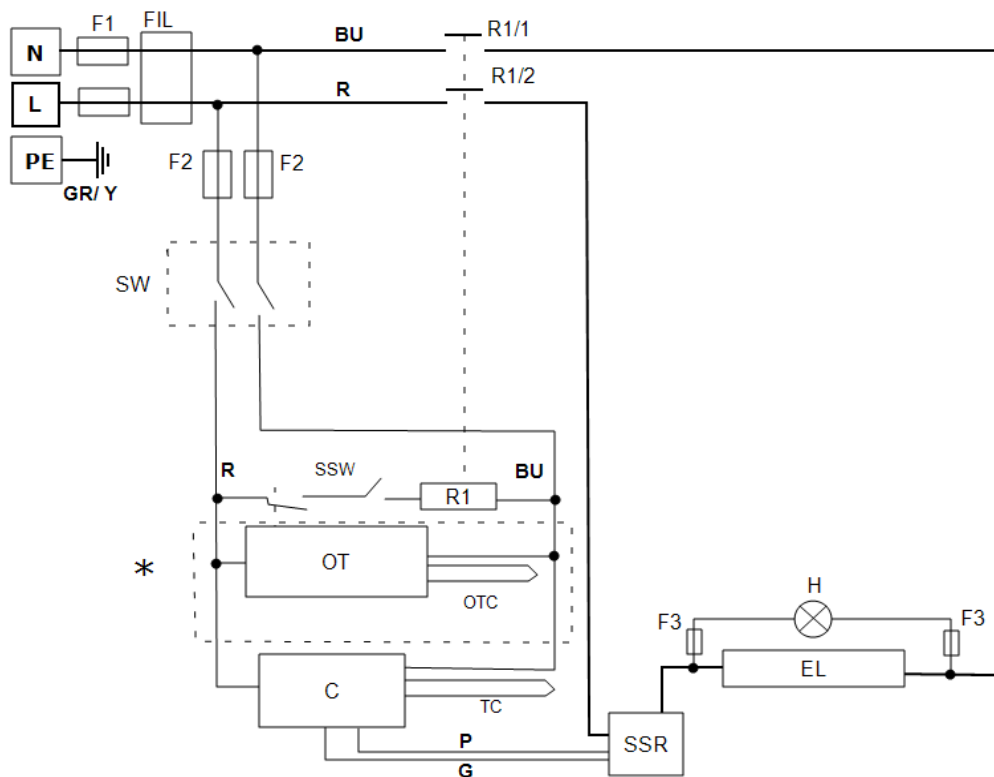


Key	
F1, F2, F3	Fuses
FIL	Filter
R1/1, R1/2	Relay Contactor
R1	Relay
C	Temperature Controller
TC	Control Thermocouple
SSR	Solid State Relay
SSW	Safety Switch
H	Heat Lamp
EL	Element(s)
SW	Instrument Switch(es)
N	Neutral
L	Live
PE	Earth

Cables	
BU	Blue
R	Red
GR/Y	Green + Yellow
G	Grey
P	Pink

9.5 WA-11-31

Connections below show single phase with safety switches and over-temperature control.



Key	
F1, F2, F3	Fuses
FIL	Filter
R1/1, R1/2	Relay Contactor
R1	Relay
C	Temperature Controller
OT	Over-Temperature Controller
OTC	Over-Temperature Thermocouple
TC	Control Thermocouple
SSR	Solid State Relay
SSW	Safety Switch
H	Heat Lamp
EL	Element(s)
SW	Instrument Switch(es)
N	Neutral
L	Live
PE	Earth
*	If Fitted

Cables	
BU	Blue
R	Red
GR/Y	Green + Yellow
G	Grey
P	Pink

10.0 Fuses and Power Settings

10.1 Fuses

F1 - F3: Refer to the circuit diagrams.

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

Model	Phases	Volts	Supply Fuse Rating
VST 12/600	1-phase	200-240	16 A
VST 12/600	3-phase + N	380/220-415/240	6 A
VST 12/600	3-phase Delta	200-240	10 A

10.2 Power Settings

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

Voltage (V)	100	110	120	200	208	220	230	240	380	400	415	440
Power (%)	-	-	-	100	100	90	82	75	45	82	75	57

Please refer to the rating label for product specific information.

11.0 Specifications

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

Model	Max Temp (°C)	Max Power (kW)	Work Tube Bore (mm)	Work Tube Length (mm)	Heated Length (mm)	Net Weight (kg)
Split Tube Furnaces Heated by resistance wire moulded in refractory fibre. Vertical models with a variety of stand and fixing options.						
VST 12/600	1200	3.0	25 - 100	750	600	38
Also models based on above, but of other lengths, supplied to special order						

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

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

[illegible]

Engineer Name	Date	Record of Work

ProductLabel

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

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