

CARBOLITE[®]

Installation, Operation & Maintenance Instructions

Cupellation Furnaces
types CF 15 - CF 60

This manual is for the guidance of operators of the above Carbolite products and should be read before the furnace is connected to the electricity supply.

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**Manuals are supplied separately for the furnace controller
(and overtemperature controller when fitted).**

Please read the controller manuals before operating the furnace.

1.0 SYMBOLS & WARNINGS

1.1 Switches and Lights

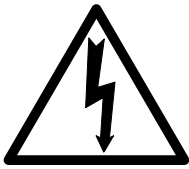


Instrument switch: when the instrument switch is operated the temperature control circuit is energised.



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

1.2 Warning Symbols



DANGER of electrical shock– read any warning printed by this symbol.



DANGER – hot surface. Read any warning printed by this symbol.
WARNING: all surfaces of a furnace may be hot.



DANGER – read any warning printed by this symbol.

2.0 INSTALLATION

2.1 Unpacking & Handling

Lift the furnace or its component sections by the base: do not apply any force to the door or to other protruding parts. Ensure that there are adequate lifting facilities before commencing.

Remove any packing material from the door gear and furnace chamber before use.

NOTE: This product contains **Refractory Ceramic Fibre** (better described as **Alumino Silicate Wool**) for precautions and advice in handling this material see the 'Repairs and Replacements' section.

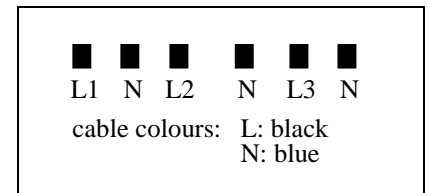
2.2 Split Model CF 24 or above (if ordered)

When transported as two components, connect them as follows. Remove the side panels from the top and the left-hand side from the base. Remove the four fixing bolts from the top of the base. Place the top onto the base, with the door above the control panel, and bolt the two halves together.

Connect the thermocouple comp. cables to the appropriate terminal blocks. There are two such cables, or three if chamber overtemperature control is fitted. The blocks and cables are labelled (e.g. 1, 2, 3).

Connect the door switch wire pair to the terminal block near the door mechanism.

Connect the power cables to the terminal blocks below the lower element holes. Because of different power supplies and national standards, the details may differ from the details shown, or the terminals may be in reverse order.



2.3 Siting & Setting Up

Place the furnace in a well ventilated room, away from other sources of heat, and on a floor or surface which is resistant to accidental spillage of hot materials. Do not place the furnace on an inflammable surface.

Ensure that there is free space around the furnace. Do not obstruct any of the vents in the control section: they are needed to keep the controls cool.

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

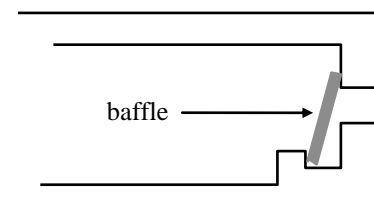
2.4 Heating Elements

These are very fragile and are supplied separately. Please see the fitting instructions in section 5.6.

2.5 Baffle (optional)

Not CF 60

The baffle, a refractory tile, may be fitted if required. It should be carefully placed at the back of the furnace chamber, as shown.



2.6 Electrical Connections

Connection by a qualified electrician is recommended.

Cupellation models have three internal circuits and are normally supplied for three phase use. A three phase supply may be either star or delta, but the furnace must only be connected to the type and voltage of supply for which it was made. If the furnace is ordered for a single phase supply, this may be Live to Neutral reversible or non-reversible, or Live to Live.

Check the furnace rating label before connection. The supply voltage should agree with the voltage on the label, and the supply capacity should be sufficient for the amperage on the label.

The supply should be fused at the next size equal to or higher than the amperage on the label. A table of the most common fuse ratings is also given in section 8.1 of this manual. Where a supply cable is present there are internal supply fuses; in this case customer fusing is preferred but not essential.

Furnace with supply cable: either wire directly to an isolator or fit with a line plug.

Furnace without supply cable: a permanent connection to a fused and isolated supply should be made to the internal terminals after temporary removal of the furnace back panel.

Connection by line plug: the plug should be within reach of the operator, and should be quickly removable.

Connection to isolating switch: this should operate on 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).

CONNECTION DETAILS			<i>supply type</i>	
Supply	Terminal label	Cable colour	<i>Live-Neutral</i>	<i>Reversible or Live-Live</i>
1-phase	L	Brown	To live	to either power conductor
	N	Blue	To neutral	to the other power conductor
	PE	Green/Yellow	To earth (ground)	to earth (ground)
supply	Terminal label	Cable colour		
3-phase	L1	Black	to phase 1	
	L2	Black	to phase 2	
	L3	Black	to phase 3	
	N	Light Blue	to neutral <i>except delta</i>	
	PE	Green/Yellow	to earth (ground)	

Technical Note

The furnaces covered by this manual have electronically controlled power limits. Do not attempt to calculate the Amps from the Wattage. High break capacity fuses should be used. Avoid fast-blow fuses and magnetic trip circuit breakers - consult Carbolite if in doubt.

3.0 **OPERATION**

The instructions for operating the temperature controller are given in a separate manual.

If the furnace is fitted with a time switch, see also the supplementary manual MS03.

3.1 **Operating Cycle**

The furnace is fitted with an Instrument switch. The switch cuts off power to the controller(s) and heating elements (via a contactor).

Connect the furnace to the electrical supply.

Operate the instrument switch to activate the temperature controller. The controller becomes illuminated and goes through a short test cycle.

Close the furnace door and adjust the temperature controller (see controller manual).

Set the element overtemperature controller to approximately 100°C above the maximum or set-point temperature. The element overtemperature controller does not trip the furnace when activated, and when once correctly set may be ignored (see also section 3.5).

Chamber overtemperature option only. If the chamber overtemperature controller has not yet been set as required, set it and activate it according to the instructions in the appropriate manual.

Unless a time switch is fitted and is off, the furnace starts to heat up. The Heat lights glow steadily at first and then flash as the furnace approaches the desired temperature or a program setpoint.

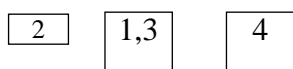
Chamber overtemperature option only. If the overtemperature trip operates then an indicator in the overtemperature controller flashes, and the heating elements are isolated. Find and correct the cause before resetting the overtemperature controller according to the instructions in the appropriate manual.

To turn the furnace off, set the Instrument switch to its off position; the controller display will go blank. If the furnace is to be left off unattended, isolate it the electrical supply.

3.2 **Instrument Layout**

The controllers are normally laid out as follows, although this may vary:

If controller is 301



If controller is 3216 or 3508



1 = Controller/Programmer

2 = Element Overtemperature Controller

3 = Chamber Overtemperature Controller (if fitted)

4 = Time Switch (if fitted)

3.3 **General Operating Advice**

Heating element life is shortened by use at temperatures close to maximum. Do not leave the furnace at high temperature when not required.

Clean up any spillages in the chamber; these contaminate the brickwork.

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

3.4 **Operator Safety**

The furnace incorporates a safety switch which interrupts the heating element circuit when the door is opened. This prevents the user touching a live heating element, but also prevents the furnace from heating up if the door is left open. The operation of this switch should be checked periodically – see section 4.1.2.

Avoid burns: furnace surfaces can be hot. Before you remove a hot object from the furnace make sure you have a safe place to put it down.

3.5 Overtemperature Control

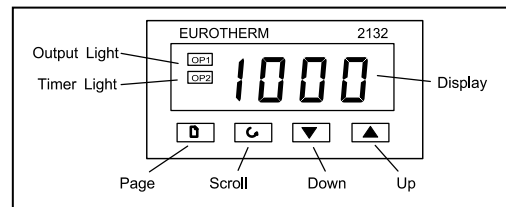
The furnace may be fitted with a “chamber overtemperature control”, if this has been ordered. The chamber overtemperature control stops further heating if an overtemperature condition is reached, and heating is not resumed until the system is manually reset. Operating instructions for the overtemperature controller are referred to in section 3.1 and detailed in the separate controller manual.

All cupellation furnaces also have an “element overtemperature control” which serves to cut power temporarily to the heating elements if the temperature in the immediate vicinity of the elements is too high. Heating resumes when the temperature drops, and manual resetting is not required. This is controlled by a Eurotherm 2132 (or similar).

2132 Element Controller

The model 2132 overtemperature controller is made by Eurotherm, and is fitted by Carbolite configured for immediate use.

The 2132 features easy setting of overtemperature setpoint, and reading of current temperature at the overtemperature sensor;



Operation

Use **Down** and **Up** to alter the overtemperature setpoint.

Set the element overtemperature controller to approximately 100°C above the maximum or setpoint temperature. The element overtemperature controller does not trip the furnace when activated, and when once correctly set may be ignored.

Press **Scroll** to view the present temperature as seen by the overtemperature controller. Press it twice, because the first press shows the temperature units (°C).

4.0 MAINTENANCE

4.1 General Maintenance

Preventive rather than reactive maintenance is to be preferred. The type and frequency depends on furnace use: the following are recommended.

4.1.1 Cleaning

Deposits may form inside the furnace, depending on the process. At appropriate intervals remove these by cleaning out as indicated in section 3.3. Check that the air outlet area is unobstructed.

The furnace 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.

4.1.2 Safety Switch

The door switch operation mentioned in 3.4 should be checked periodically to ensure that heating elements are isolated when the door is opened. In normal conditions the safety arrangement should outlast the furnace, but it could be affected by rough handling, a corrosive environment or work materials, or exceptional frequency of use.

A qualified electrician should check that the supply to the heating elements is cut, with and without power being on, when the door is open partially and fully; it is important that isolation is not just marginally achieved. The check is best made on the element terminals after removal of the furnace back: probing the element surface inside the furnace could be inconclusive because of surface oxidation. Note that all live supply wires of a 3-phase supply, and both live and neutral of a 1-phase supply, should be isolated when the door is opened.

4.1.3 Element Ageing and Power Adjustment

See sections 4.5 and 4.6.

4.2 Calibration

After prolonged use the controller and/or thermocouple could require recalibration. This would be important for processes which require accurate temperature readings or which use the furnace 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 can supply these items.

Depending on the controller, the controller manual may contain calibration instructions.

4.3 After Sales Service

Carbolite's service division (Carbolite Engineering Services) has a team of Service Engineers capable of repair, calibration and preventive maintenance of furnace and oven products at our customers' premises throughout the world. We also sell spares by mail order. A telephone call or fax often enables a fault to be diagnosed and the necessary spare part despatched.

Each furnace has its own record card at Carbolite. In all correspondence please quote the serial number, model type and voltage given on the rating label of the furnace. The serial number and model type are also given on the front of this booklet when supplied with a furnace.

To contact Carbolite Engineering Services or Carbolite see the back page of this manual.

4.4 Recommended Spares Kits

Carbolite can supply individual spares, 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 comprises one thermocouple, one sheath, one solid state relay, door insulation, a set of elements and a set of clips and braids. Individual spares are also available.

When ordering spares please quote the model details as requested above.

4.5 Element Ageing

Silicon carbide elements gradually increase in resistance with use: a process known as ageing. Their heating power reduces correspondingly. To ensure sufficient power to the furnace it may be necessary to adjust the power limit, and, ultimately, to replace the elements - taking care to readjust the power limit.

If the furnace does not reach temperature, or is slow, measure the element resistances and calculate the required power limit using the method given above. If it exceeds 100%, the elements have too high a resistance and need replacing: check your data and calculations with Carbolite.

See the separate manual supplied for how to adjust the controller. Always record the setting when first making an adjustment. If new elements are fitted, return the adjustments to the original value, or remeasure and recalculate. A table of standard power limits is given in section 8.2.

4.6 Power Adjustment

The furnace control system incorporates electronic power limiting. Power is supplied to the elements in bursts of about 1/3rd second duration. This prevents overheating of the elements. The power limit is programmed into the furnace controller and may be calculated as a percentage as follows:

$$\text{powerlimit} = (100 \times \text{targetpower} \times \text{ohms}) / \text{volts}^2$$

where targetpower is the wattage given on the furnace rating label

ohms is the overall resistance of the combined element circuits (see example)

volts is the voltage across each element circuit (e.g. 240 for a 415/240V supply)

example:

3-phase furnace with 2 elements of 6.7 ohms each in series per phase, running on 380/220V, with a target power of 8000W:

$$\text{ohms} = 6.7 \times 2/3 = 4.467$$

$$\text{powerlimit} = (100 \times 8000 \times 4.467) / (220 \times 220) = 74\%$$

A table of standard power limits is given in section 8.2.

Occasionally the power limit is set to zero to permit demonstration of the controls without the heating elements taking power. In this case the power limit is accessible to the operator and may be reset to its standard value or the value that it had before setting to zero.

5.0 REPAIRS & REPLACEMENTS

5.1 Safety Warning – Disconnection from Supply

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



5.2 Safety Note - Refractory Fibrous Insulation

Insulation made from High Temperature Insulation Wool

Refractory Ceramic Fibre, (better described as Alumino 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, mineral wool slab or loose fill wool.

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

Exposure to fibrous dust may cause respiratory disease.

When handling the material always use an approved respiratory protection equipment (RPE-i.e. 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 we recommend reference to the European Association representing the High Temperature Insulation Wool industry (www.ecfia.eu)

We can provide further information on request. Alternatively our service division can quote for any repairs to be carried out at your premises or ours.

5.3 Temperature Controller Replacement

301. These controllers are fitted to the back of the control panel, which can be separated from the base by removal of two screws.



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 instructions supplied with the replacement controller.

2132, 3216, 3508 etc. Ease apart the two lugs at the side; grip the instrument and withdraw it from its sleeve; push in the replacement.

5.4 Solid-state Relay Replacement

Disconnect the furnace from the supply and remove the furnace back panel.

Make a note how the wires are connected 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 heat-conducting thermal pad is sandwiched between the relay and the base panel or aluminium plate. Alternatively a thin layer of white, heat-conducting silicon paste may be applied between the new relay and the plate.

The new solid state relay contains a built-in MOV which protects it from short periods of excess voltage. If the old relay had a separate disc-shaped "MOV" connected between the high voltage terminals of the old relay, discard the old MOV.

Replace the removed panel.

5.5 Thermocouple Replacement

Disconnect the furnace from the supply, and remove the furnace back panel.

Make a note of the thermocouple connections. The negative leg of the thermocouple is marked blue. Compensating cable colour codings are:

<i>negative</i>	<i>positive (type R)</i>
white	orange

Disconnect the thermocouple from its terminal block.

Remove the screw or other fitting to release the thermocouple sheath, withdraw the sheath, and shake out any fragments of thermocouple.

Re-assemble with a new thermocouple observing the colour coding, ensuring that the thermocouple is not twisted as it is being inserted and that the screw is refitted to grip the sheath.

5.6 Element Fitting and Replacement

Replacements: read the section on element ageing (4.5). If at any time the power limit has been increased, reset it to its original value (section 8.2), or measure the resistances and recalculate the limit.

Disconnect the furnace from the electrical supply and remove the side panels to gain access to the element connections.

Remember that the elements are fragile and expensive, and that they can be damaged by contamination: handle them with care and keep them clean.

First Fitting: The furnace is supplied with all element connection braids in position, except for 3 off loose braids. Insert the elements as explained below, and connect the fitted braids to the adjacent element ends. Connect the loose braids in pairs to the unconnected ends, on the same side of the furnace as the element power terminals.

Replacements: Replace each element in turn. Release the clips using the tool provided. Move the braids and carefully withdraw each element: it may be necessary to remove the element sleeve with the element.

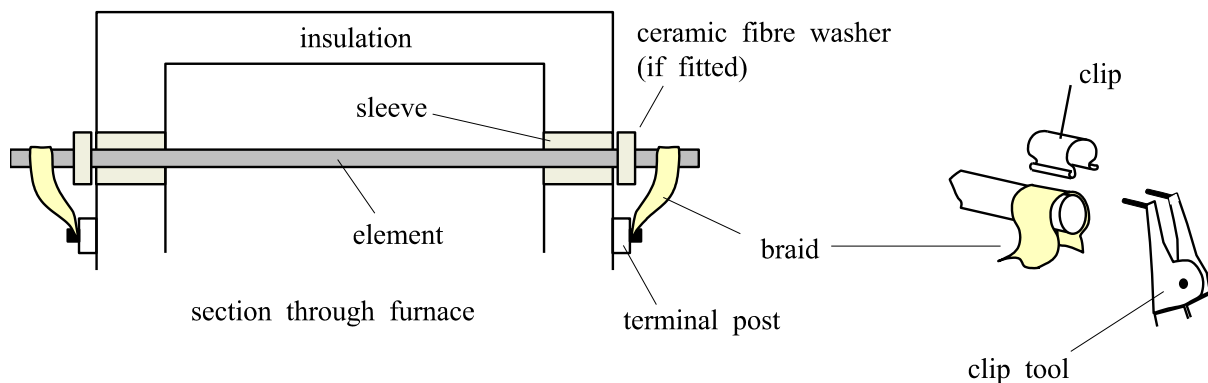
Carefully insert the new element, locating the sleeves as shown. Sleeves are fragile: it may be necessary to use new ones. Ensure that the element hot zone is equally placed within the chamber.

Connect the braids. Check that the braids cannot touch each other or the case, and that there is no short circuit to earth.

Replace the furnace back panel and connect the furnace to the supply.

If aged elements have been replaced, reset the furnace power limit.

Refit the panels and test the furnace.



5.7 **Fuse Replacement**

Fuses are marked on the circuit diagram (section 7.0) with type codes, e.g. F1, F2. A list of the correct fuses is given in section 8.1. *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.

The fuses are near the cable entry point, and access is by removal of the back panel.

6.0 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 a code such as S.br
 - The door switch(es) (if fitted) may be faulty or need adjustment
 - The contactor (if fitted) may be faulty
 - The SSR could be failing to switch on due to internal failure, faulty logic wiring from the controller, or faulty controller
 - The controller shows a **low temperature**
 - 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
 - There are no lights glowing on the controller

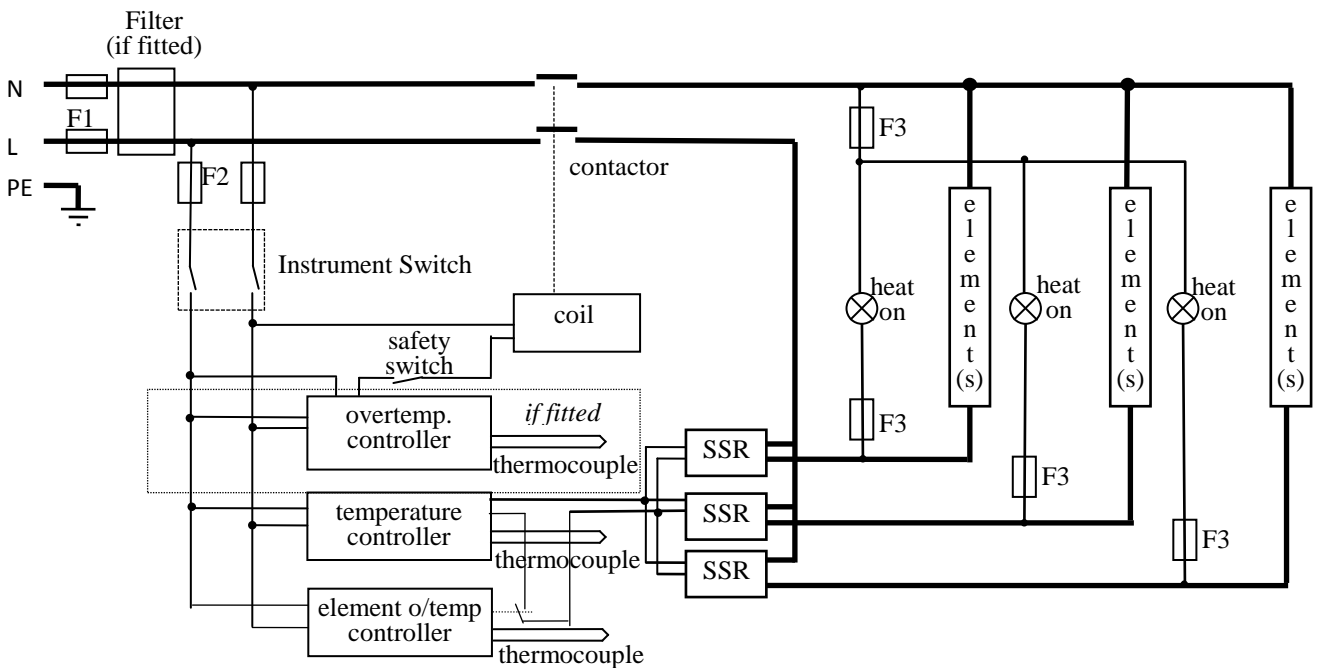
B. Furnace Overheats

1. The **HEAT** light goes **OFF** with the instrument switch
 - The controller shows a **very high** temperature
 - The controller is faulty
 - The controller shows a **low** temperature
 - The thermocouple may have been shorted out or may have been moved out of the heating chamber
 - The thermocouple may be mounted the wrong way round
 - The controller may be faulty
2. The **HEAT** light **does not go off** with the instrument switch
 - The SSR has failed "ON"
 - Check for an accidental wiring fault which could have overloaded the SSR

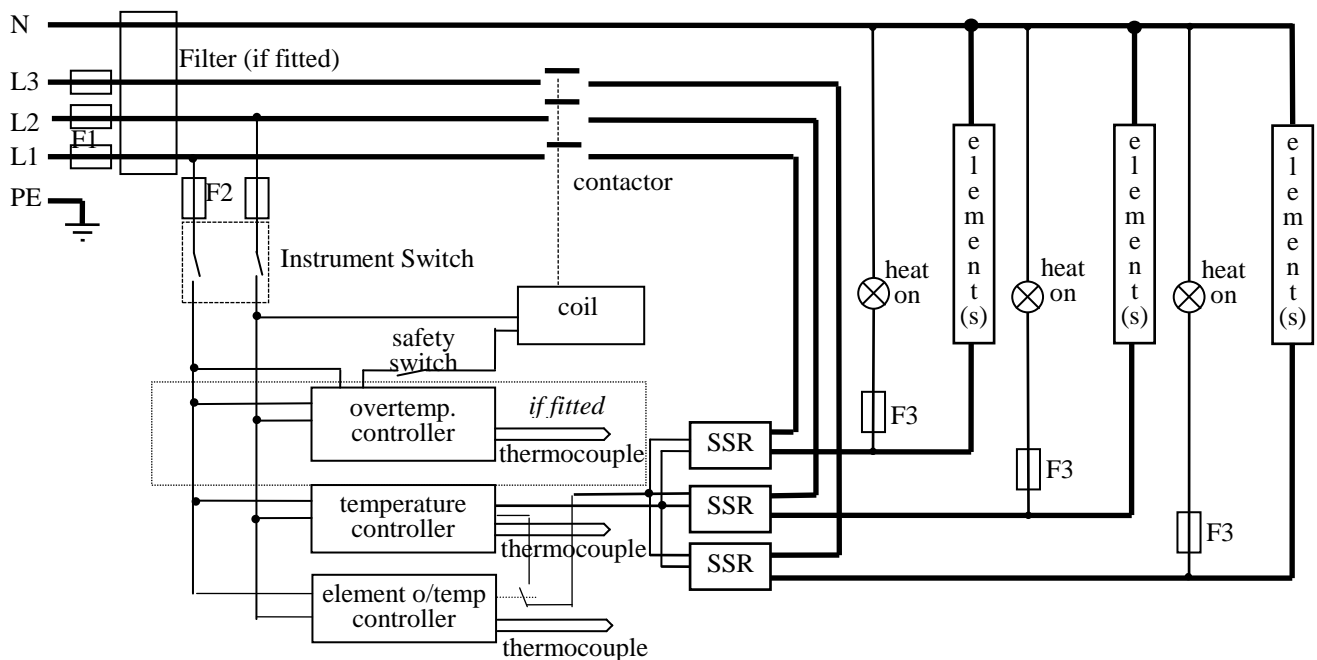
7.0 CIRCUIT DIAGRAMS

In these models the safety switch in the diagram is a positive-break door switch.

7.1 Single Phase

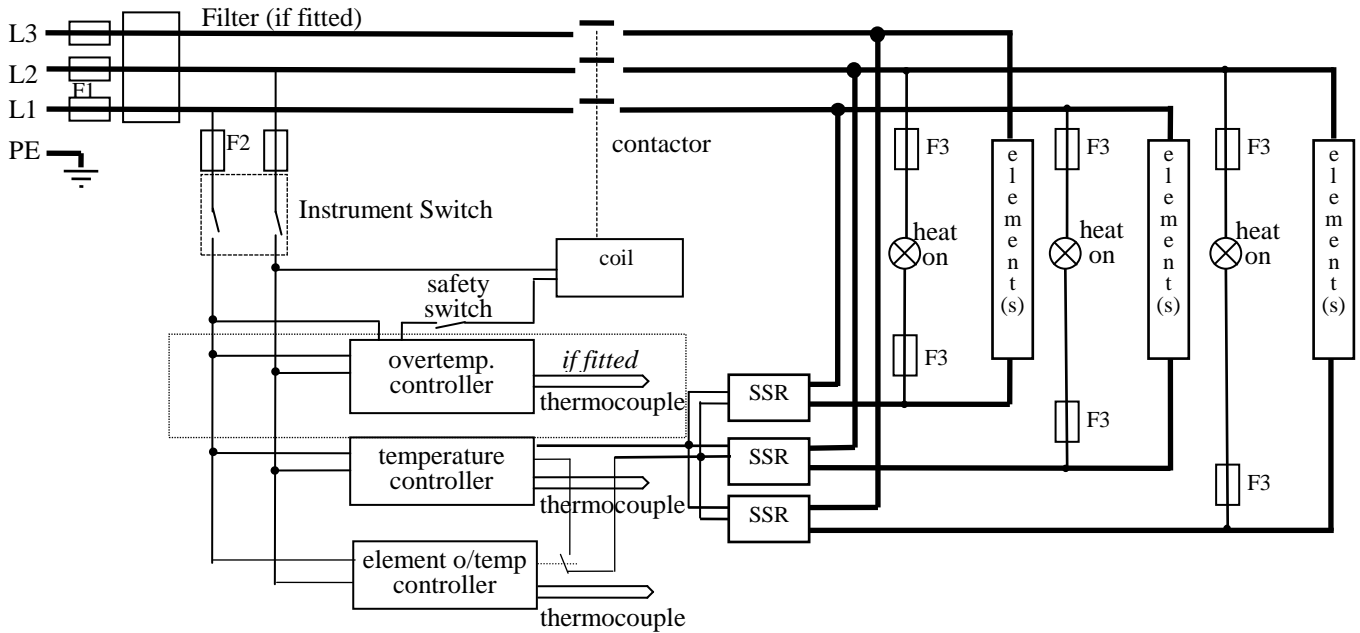


7.2 3-phase with neutral

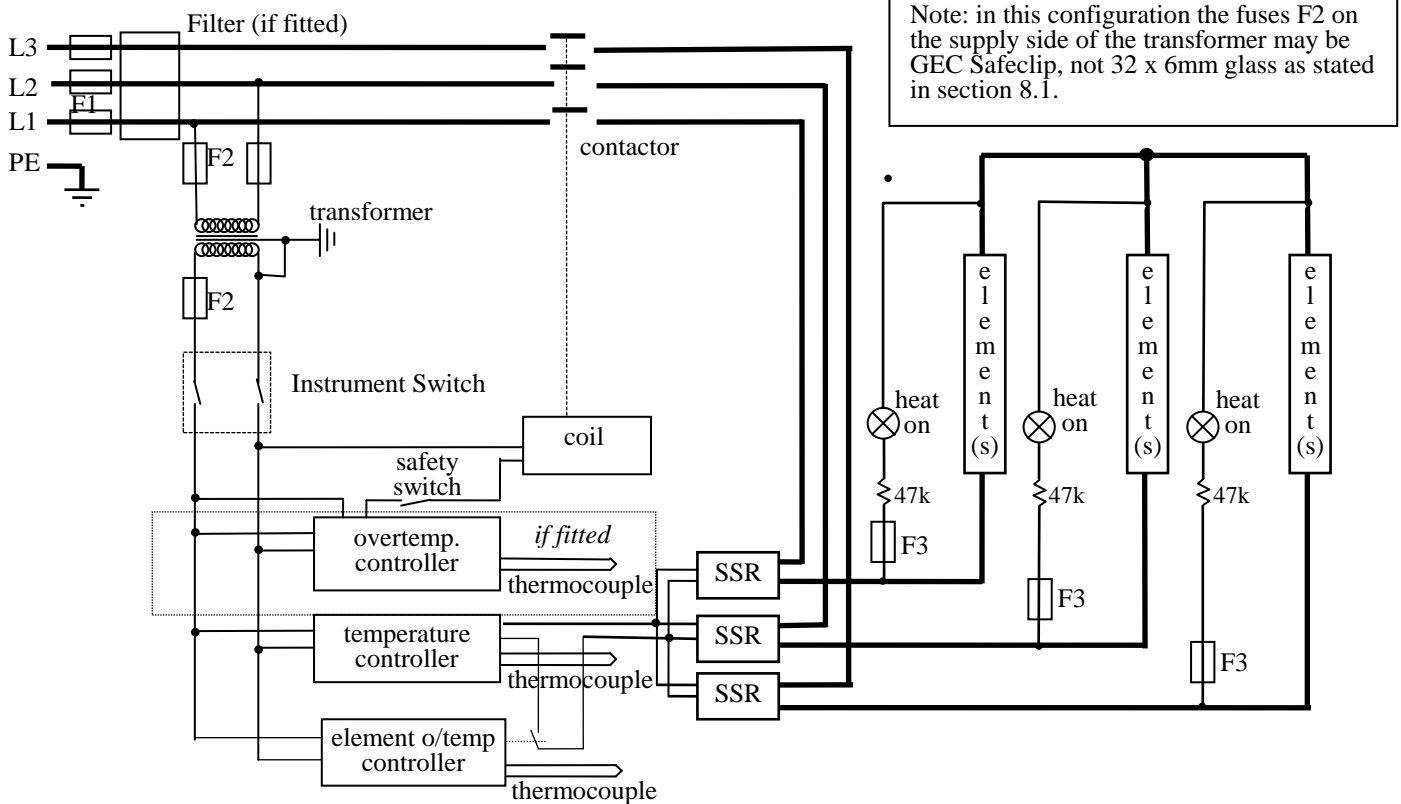


note on 3-phase: depending on filter(s) fitted, there may 3 separate neutral wires from the elements to the neutral supply.

3-phase without neutral (delta – e.g. 208-240V)



7.3 3-phase without neutral (star – e.g. 380V or above)



7.4 Higher Voltages (e.g. 440V, 480V 3-phase)

The diagram above (7.3) normally applies, with neutral (if present) not being used. For single phase models of 254V or above, diagram 7.1 applies except that a control circuit transformer is included as in diagram 7.3.

8.0 FUSES & POWER SETTINGS

8.1 Fuses

F1-F3: Refer to the circuit diagrams.

<i>F1</i>	Internal supply fuses	Fitted if supply cable fitted. Fitted on board to some types of EMC filter.	on-board and up to 16 Amps: 32mm x 6mm type F other: GEC Safeclip
<i>F2</i>	Auxiliary circuit fuses	Fitted on board to some types of EMC filter. May be omitted up to 25Amp/phase supply rating.	2 Amps glass type F On board: 20mm x 5mm Other: 32mm x 6mm
<i>F3</i>	Heat Light fuses	May be omitted up to 25 Amp/phase supply rating.	2 Amps glass type F 32mm x 6mm
	Customer fuses	Required if no supply cable fitted. Recommended if cable fitted.	See rating label for amperage; see table below for fuse rating.

Model	Phases	Volts	Supply Fuse Rating
CF 15	1-phase	200 - 240	80A
CF 15	3-phase +N	380/220-415/240	25A
CF 15	3-phase delta	208 - 240	40A
CF 24	1-phase	200 - 240	100A
CF 24	3-phase + N	380/220-415/240	32A
CF 24	3-phase delta	208 - 240	50A
CF 50	3-phase + N	380/220-415/240	50A
CF 50	3-phase delta	208 - 240	80A
CF 60	3-phase + N	380/220-415/240	63A
CF 60	3-phase delta	208 - 240	125A

8.2 Power Settings

The power limit settings (parameter \overline{DPH}_i) for these models on various supply voltages are as follows. The figures represent the maximum percentage of time that controlled power is supplied to the elements. Do not attempt to “improve performance” by setting a value higher than the correct one from the table.

Model	Volts:	200V	208V	220V 380V	230V 400V	240V 415V	254V 440V
CF 15		68	63	56	51	47	42
CF 24		97	89	80	73	67	60
CF 50		87	80	72	66	60	54
CF 60		78	72	64	59	54	48

9.0 SPECIFICATIONS

Carbolite reserves the right to change specifications without notice.

9.1 Models Covered by this Manual

MODEL	Max. Temp. (°C)	Max. Power (kW)	Chamber Size (mm)			Net Weight (kg)
			H	W	D	
<i>Cupellation Furnaces, heated by Silicon Carbide elements</i>						
CF 15	1200°C	9.0	122	220	350	306
CF 24	1200°C	14.5	205	225	450	
CF 50	1200°C	20	230	350	550	
CF 60	1200°C	31	250	400	650	

9.2 Environment

The furnaces contain 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

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