



# Installation, Operation & Maintenance Instructions

1400°C - 1600°C Chamber Furnaces

RHF models: 3 litre - 35 litre

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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## CONTENTS

Section		page
1.0	Symbols & Warnings	1
2.0	Installation	2
3.0	Operation	4
4.0	Maintenance	5
5.0	Repairs & Replacements	7
6.0	Fault Analysis	10
7.0	Circuit Diagrams	12
8.0	Fuses & Power Settings	14
9.0	Specifications	16

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

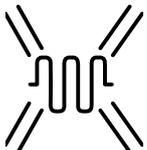
Please read the controller manuals before operating the furnace.

### **1.0 SYMBOLS & WARNINGS**

## 1.1 Switches and Lights

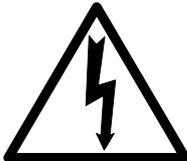


Supply Light: when the furnace is connected to the electrical supply the light in the adjacent switch glows



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

When unpacking or moving the furnace always lift it by its base. Never lift it by the door. Use two or more people to carry the furnace where possible. Remove any packing material from the door gear and furnace chamber before use.

### 2.2 Siting & Setting Up

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

If the chimney is supplied unfitted, then fit it into the hole in the top of the furnace case. If the furnace is to be used to heat substances which emit fumes, then a fume extraction duct of about 150mm inlet diameter may be placed directly above the chimney outlet. Do not make a sealed connection to the furnace chimney as this causes excessive airflow through the chamber and results in poor temperature uniformity.

### 2.3

## Heating Elements

The Silicon Carbide elements are VERY FRAGILE and are packed separately. Fit them according to the instructions in section 5.7.

## 2.4 Electrical Connections

*Connection by a qualified electrician is recommended.*

Models RHF 14/3, 15/3, 16/3 and 14/8 may be ordered for single phase use or for two phases out of a three phase supply with neutral. All other models may be ordered for single phase use or for three phase with or without neutral. The furnace must be connected only to the type and voltage of the supply for which it was ordered.

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).

ELECTRICAL CONNECTION DETAILS			<i>supply type</i>	
<b>Supply</b>	<b>Terminal label</b>	<b>Cable colour</b>	<i>Live-Neutral</i>	<i>Reversible or Live-Live</i>
<b>1-phase</b>	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)
<b>supply</b>	<b>Terminal label</b>	<b>Cable colour</b>		
<b>2- or 3-phase</b>	L1	Black	to phase 1	
	L2	Black	to phase 2	
	L3	Black	to phase 3 <i>except 2-phase</i>	
	N	Light Blue	to neutral <i>except delta</i>	
	PE	Green/Yellow	to earth (ground)	

## Technical Notes

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.

Two-phase models use two phases out of a 3-phase+neutral supply. One phase is unused. The neutral current is equal to the current in one of the used phases.

Model RHF 16/35 has unequal phases: L1 and L2 have 4 heating elements and L3 has 2 elements. In 4-wire configuration, one phase takes half the current of the other two, and the neutral also takes this half-amount (see also section 8.1).

## 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.*

*If cascade control is fitted, see the supplementary manual MS07.*

### **3.1 Operating Cycle**

The furnace is fitted with a combined Supply light and Instrument switch. The light is on whenever the furnace is connected to the supply. The switch cuts off power to the control circuit.

Connect the furnace to the electrical supply. The Supply light should glow.

Operate the instrument switch to activate the temperature controller; the **O** position is *off*, the **I** position *on*. The controller becomes illuminated and goes through a short test cycle.

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

*Overtemperature option only.* If the 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 light(s) glow steadily at first and then flash as the furnace approaches the desired temperature or a program setpoint.

*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 the instructions supplied.

To switch the furnace off, set the Instrument switch to **O**. If the furnace is to be left off, isolate it the electrical supply.

### **3.2 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. The maximum temperature is shown on the furnace rating label and on the back page of this manual.

When heating large objects, in particular poor conductors, avoid shielding the thermocouple from the heating elements. The thermocouple is intended to sense the temperature near the heating element, but if a large object is placed in the chamber it may record the average temperature of the object and the elements, which can lead to overheating of the elements. Allow large objects to gain heat at a lower temperature and then reset the controller to a temperature close to the desired maximum.

When heating materials which produce smoke or fumes, the chimney must be correctly fitted and unobstructed. Otherwise, soot can accumulate in the chamber and could possibly cause an electrical breakdown of the heating element.

If the furnace is used to heat materials which emit smoke or fumes, regularly heat it up to maximum temperature for one hour without load to burn away the soot.

Materials such as case hardening compounds and other reactive salts may penetrate the furnace chamber lining and attack the insulation, or the elements, causing premature failure. Use of a hearth tile may be advisable: please consult our technical department.

### **3.3**

### **Atmospheres**

When an optional gas inlet is fitted there is a label near the inlet saying "INERT GAS ONLY". In practice *inert* or *oxidising* gases may be used, but *not combustible or toxic gases*. Chamber furnaces are not gas tight, so it should be understood that gas usage may be high, and that the chamber is likely always to contain some air. Residual oxygen levels of 1% are to be expected.

### **3.4 Operator Safety**

There is a safety switch which interrupts the heating element circuit when the door is opened. The user cannot touch a live heating element, but the furnace does not heat up if the door is left open.

Avoid burns. Carbolite can supply tongs, face masks, and heat resistant gloves. Before you remove a hot object from the furnace make sure you have a safe place to put it down.

## **4.0**

## **MAINTENANCE**

### **4.1 Routine Maintenance**

Adjustment of the power setting may be required from time to time as described in 4.5. Otherwise no routine maintenance is required for removal of soot deposits as mentioned in section 3.2 and for the replacement of consumable items as required.

The outer surfaces may be cleaned with a damp cloth. Do not allow water to enter the interior of the case, tube or control box. Do not clean with organic solvents.

### **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 (Thermal 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 Thermal 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. This can save time in the event of a breakdown. Each kit comprises one thermocouple, one sheath, one solid state relay, one door insulation piece, a set of elements, and a set of braids. Individual spares are also available.

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

### **4.5**

### **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 as supplied with new furnaces 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.

### **4.6 Element Aging**

Silicon carbide elements gradually increase in resistance with use: a process known as aging. 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 in given is section 8.2.

## **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



This furnace contains refractory fibres in its thermal insulation. These materials may be in the form of fibre blanket or felt, vacuum formed board or shapes, mineral wool slab or loose fill fibre.

Normal use of the furnace 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, we strongly recommend that safety precautions are taken whenever the materials are handled.

**Exposure to dust from fibre which has been used at high temperatures may cause respiratory disease.**

**When handling fibre always use an approved mask, eye protection, gloves and long sleeved clothing.**

**Avoid breaking up waste material. Dispose of waste fibre 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 Ceramic Fibre Industry Association Bulletin No. 11 and the UK Health and Safety Executive Guidance Note EH46.

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

201. 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, 2416, 2408 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

## **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.

## **5.6 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:

*negative: white      positive (type R): orange*

Disconnect the thermocouple from its terminal block.

Bend the metal tag, or release the screw, 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 sheath is refastened.

## **5.7 Element Fitting and Replacement**

*Replacements: read the section on element aging (4.6). 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 furnace back panel 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.

*Replacements: make a note of the actual braid and cable connections to the elements. Disconnect the braids or cables and carefully withdraw each element.*

*New furnace: the diagrams indicate the connections, but the number and positions of terminal blocks may differ from those shown. For example, there may be 3 x N on a 3-phase furnace. If you have any problems with this procedure, please contact our service division. A common feature of all the RHF models is that elements are always 2 in series between 200-240 volts (for 110V, 2 in parallel).*

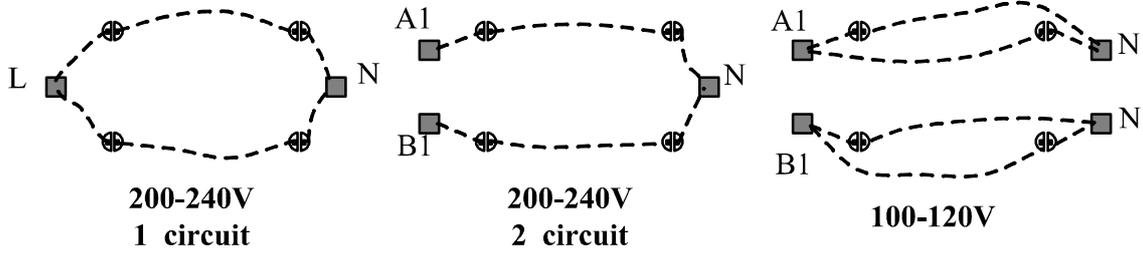
Carefully insert the new elements into the furnace. Position elements so that the split along the length is vertical.

Attach the braids according to the notes made, or according to the appropriate diagram below

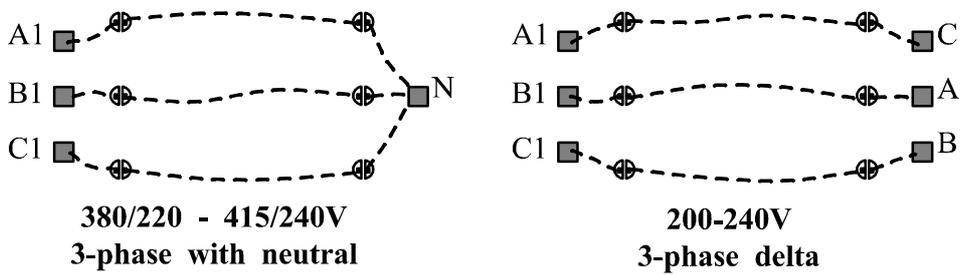
Replace the furnace back panel and connect the furnace to the supply.

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

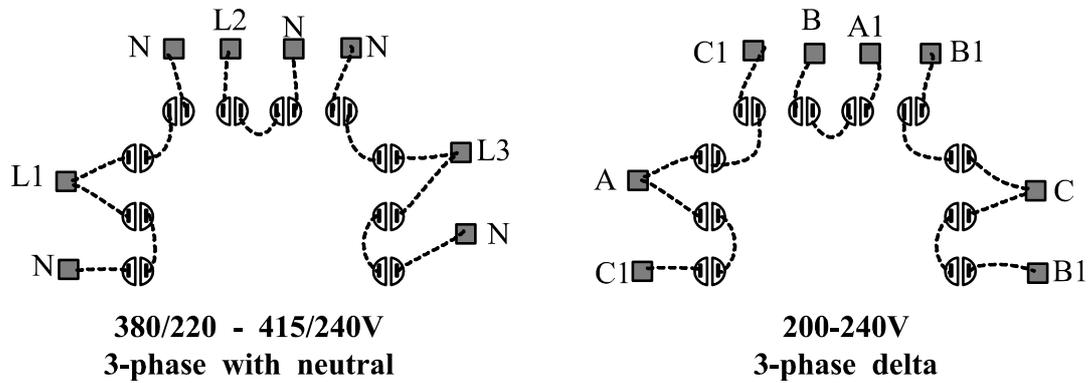
**Example Element Connections - 4 elements**



**Example Element Connections - 6 elements**



**Example Element Connections - Model RHF 16/35 (10 elements)**



6.0

## FAULT ANALYSIS

### A. Furnace Does Not Heat Up

- |    |                                     |  |  |
|----|-------------------------------------|--|--|
| 1. | The <b>HEAT</b> light is <b>ON</b>  | → The heating element has failed   | → Check also that the SSR is working correctly   |
| 2. | The <b>HEAT</b> light is <b>OFF</b> | The controller shows a <b>very high temperature</b> or a code such as S.br | → The thermocouple has broken or has a wiring fault  |
|    |                                     | The controller shows a <b>low temperature</b>                              | → 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           |
|    |                                     | There are no lights glowing on the controller                              | → The <b>SUPPLY</b> light is <b>ON</b> → The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault |
|    |                                     |  | → The <b>SUPPLY</b> light is <b>OFF</b> → Check the supply fuses and any fuses in the furnace control compartment                        |

### B. Furnace Overheats

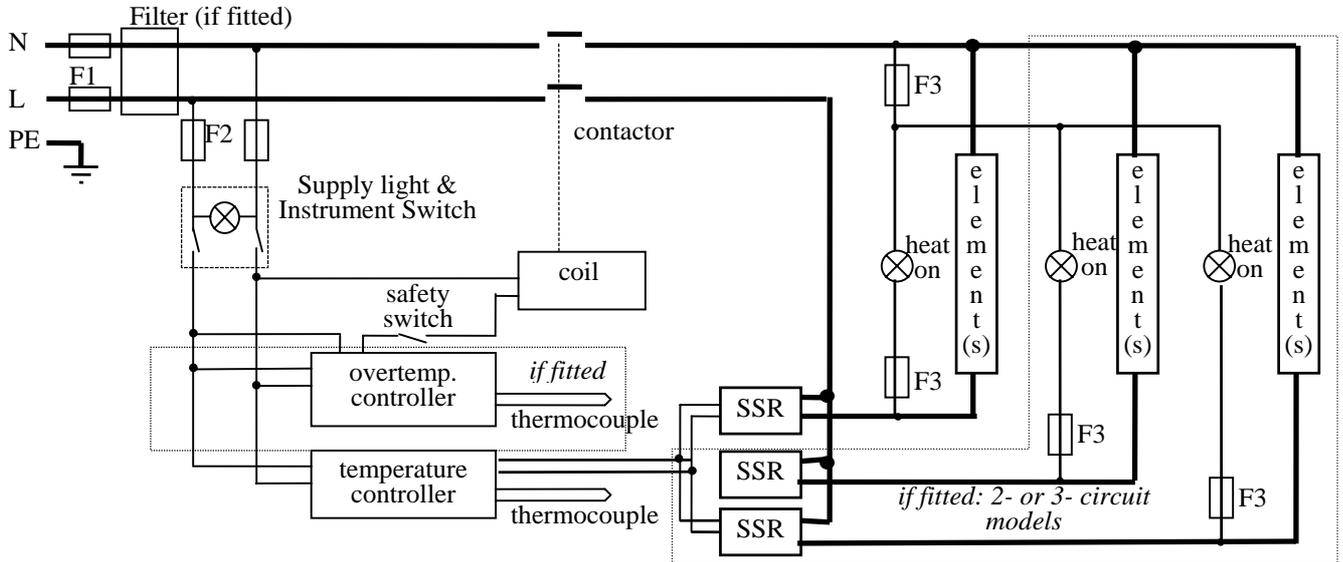
- |    |   |   |  |
|----|---|---|--|
| 1. | The <b>HEAT</b> light goes <b>OFF</b> with the instrument switch        | → The controller shows a <b>very high</b> temperature | → The controller is faulty   |
|    |   | → The controller shows a <b>low</b> temperature       | → The thermocouple may have 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 <b>HEAT</b> light <b>does not go off</b> with the instrument switch | → The SSR has failed "ON"                             | → Check for an accidental wiring fault which could have overloaded the SSR                     |

**CIRCUIT DIAGRAMS**

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

EMC Filters (if fitted): dependent on the model there may be one filter, or more than one fitted in parallel. The circuit diagram examples do not show multiple filter arrangements.

**7.1 Single Phase**

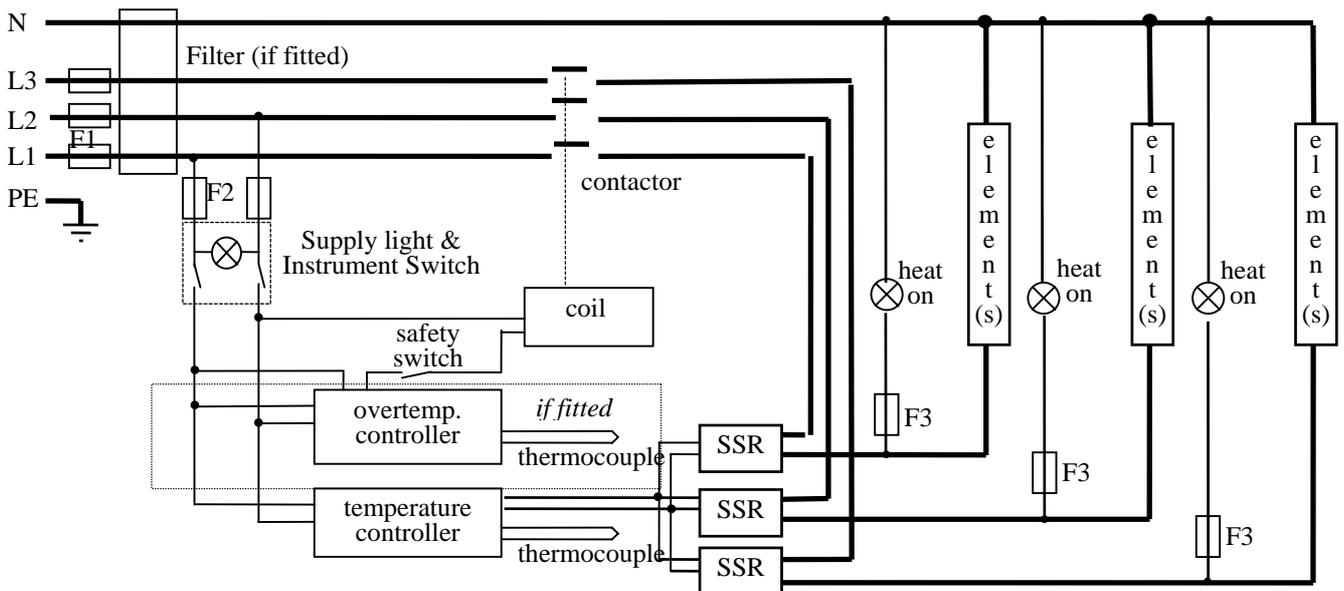


**7.2 2-phase with neutral**

As the following 3-phase diagram, except that one phase is not present.

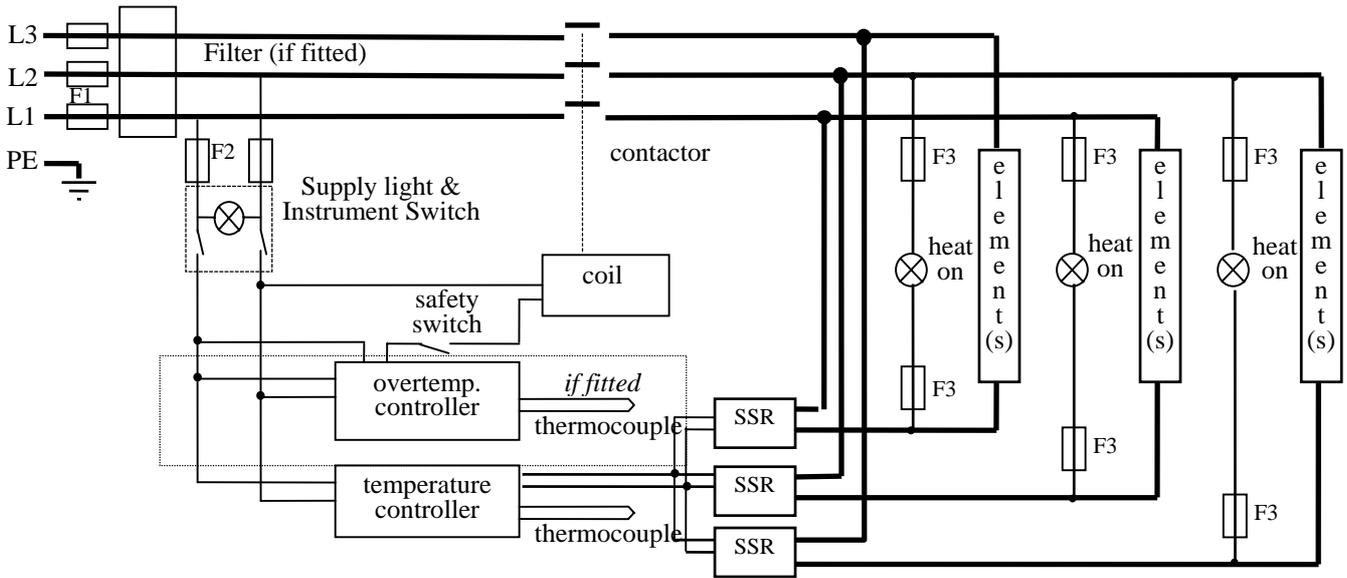
Note that if the phase current is less than 25A/phase, a direct safety switches may be fitted in the element circuit, rather than the switch shown in the coil circuit.

**7.3 3-phase with neutral**

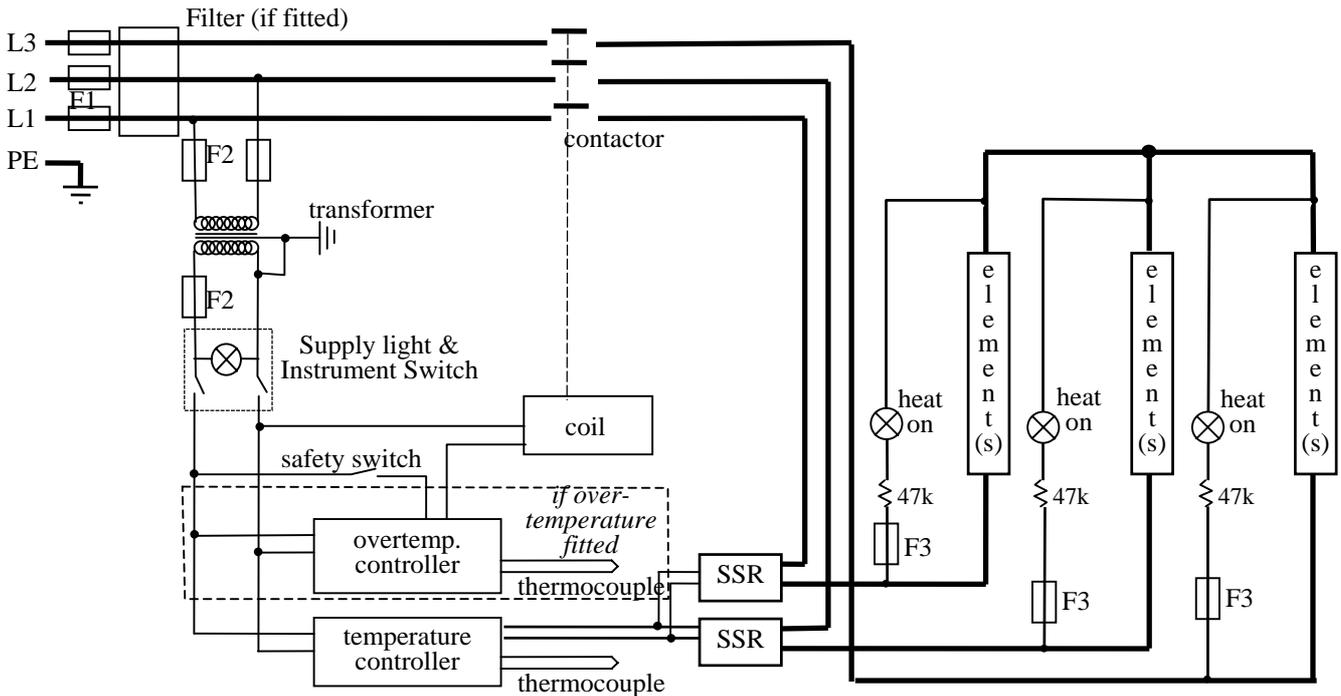


note on (2- and) 3-phase: depending on filter(s) fitted, there may be (2 or) 3 separate neutral wires from the elements to the neutral supply.

**7.4 3-phase without neutral (delta – 208 to 240V)**



**7.5 3-phase without neutral (star – e.g. 380 to 415V)**



Note: in this configuration the fuses F2 on the supply side of the transformer may be GEC Safeclip, not 32 x 6mm glass as stated in section 8.1.

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

The diagram above (7.5) 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 7.5.

**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 10 Amp/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

<b>Customer fuses</b>	Required if no supply cable fitted. Recommended if cable fitted.	See rating label for amperage; see table below for fuse rating.
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Model	phases	Volts	Supply Fuse Rating
RHF 14/3	1-phase	200-240	32A (or 30A)
RHF 14/3	2-phase + N	380/220 - 415/240	16A/ph (or 15A)
RHF 15/3,16/3	1-phase	200-240	40A
RHF 15/3,16/3	2-phase + N	380/220 - 415/240	20A/ph
RHF 14/8	1-phase	200-240	63A
RHF 14/8	2-phase + N	380/220 - 415/240	32A/ph (or 30A)
RHF 15/8,16/8	1-phase	200-240	63A
RHF 15/8,16/8	3-phase + N	380/220 - 415/240	20A/ph
RHF 15/8,16/8	3-phase delta	220-240	32A/ph
RHF 15/8,16/8	3-phase delta	208	40A/ph
RHF 14/15	3-phase + N	380/220 - 415/240	25A
RHF 14/15	3-phase delta	220-240, 208	40A/ph
RHF 15/15,16/15	3-phase + N	380/220 - 415/240	25A/ph
RHF 15/15,16/15	3-phase delta	220-240, 208	50A/ph
RHF 15/15,16/15	3-phase + N	380/220 - 415/240	25A/ph
RHF 15/15,16/15	3-phase delta	220-240, 208	50A/ph
RHF 14/35, 15/35	3-phase + N	380/220 - 415/240	40A/ph
RHF 14/35, 15/35	3-phase delta	220-240, 208	63A/ph
RHF 16/35	3-phase + N	380/220 - 415/240	40A/ph ( <i>see note</i> )
RHF 16/35	3-phase delta	220-240, 208	63A/ph ( <i>see note</i> )

*380-415V 3-wire: same ratings as 3-phase+N*

RHF 16/35 – technical note.

All phases should be fused as indicated: the same wire size is used in all three internal circuits. For the delta configuration the furnace power is set lower to bring the rated current below 63 Amps. The current ratings for the three phases are:

	380/220 – 415/240	208-240 delta
Furnace Power	16000W	15000W
Phase 1	40 Amps	63 Amps
Phase 2	40 Amps	48 Amps
Phase 3	20 Amps	48 Amps

## 8.2 Power Settings

The power limit settings (parameter OP.Hi) for the RHF 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	230V	240V	380V	400V	415V
RHF 14/3		90	83	74	68	63	74	68	63
RHF 15/3		62	57	51	47	43	51	47	43
RHF 16/3		62	57	51	47	43	51	47	43
RHF 14/8		90	83	74	68	63	74	68	63
RHF 15/8		60*	56*	76	69	63	76	69	63
RHF 16/8		73*	68*	74	68	62	74	68	62
RHF 14/15		92	85	76	69	64	76	69	64
RHF 15/15		71	66	59	54	49	59	54	49
RHF 16/15		73	68	61	55	51	61	55	51
RHF 14/35		93	86	77	71	65	77	71	65
RHF 15/35		93	86	77	71	65	77	71	65
RHF 16/35 (star)		-	-	-	-	-	85	78	71
RHF 16/35 (delta)		-	89	79	73	67	-	-	-

\* these models use different elements in 200-208V versions