

# CARBOLITE<sup>®</sup>

## Installation, Operation & Maintenance Instructions

1100°C Chamber Furnaces  
ELF models

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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Please read the controller manuals before operating the furnace.

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## 1.0 INTRODUCTION

### 1.1 Models Covered by this Manual

This manual covers the Carbolite furnace models ELF 11/6B, ELF 11/14B and ELF 11/23B. The B suffix indicates differences from earlier models, in particular that the heating element is enclosed in an inner metal chamber, and the heating wires are partly exposed in the chamber sides and radiate freely into the chamber. The B models were not made before mid-2001.

The B versions also allow for a simple customer adjustment to increase the air flow through the chamber. Carbolite do not claim that this adjustment makes the furnace suitable for ashing or burn-off applications.

The B versions may be set to operate on any single-phase voltage in the range 200-240V (or 100-120V to order) by correct setting of the power limit parameter in the controller.

Because of model changes it is very important when ordering spares to state the furnace serial number or otherwise to identify the model correctly.

### 1.2 Switches and Lights

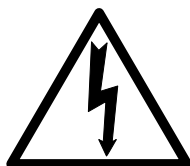


Instrument switch: when the instrument switch is operated the temperature control circuit is energised.



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

### 1.3 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 handling the furnace always lift it by its base. Never lift it by the door. Use two people to unpack and carry the furnace.

Carefully remove any packing material from the furnace chamber. Avoid damaging the surrounding insulation when removing packing materials.

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 Siting & Setting Up

Place the furnace in a well ventilated room, away from other sources of heat, and on a non-inflammable surface that is resistant to accidental spillage of hot materials.

Ensure that there is free space of at least 50mm around the furnace. Do not obstruct any of the case vents: they are needed to keep the controls and the case exterior cool.

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

### 2.3 Chimney

The chimney is a short length of ceramic tubing. If it is supplied unfitted, then fit it through the hole in the top of the furnace case.

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

### 2.4 Hearth

The chamber floor (hearth) is supplied with a ceramic tile. This may already be in position in the chamber. If it is packed separately, unwrap it and place it carefully on the chamber floor.

### 2.5 Door Vents

There is a plate fixed to the inner door panel (door plug carrier), accessible by removing the door insulation piece. This can be positioned to open up holes in the inner door, to allow an increased air flow in the chamber. Decide on the required position and fix the plate accordingly (see section 5.7).

### 2.6 Electrical Connections

*Connection by a qualified electrician is recommended.*

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

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>
<i>1-phase</i>	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)



Check the following before connection, by reference to the furnace rating label.

Voltage range: the voltage on the label and the actual supply voltage should be in the same range – either the range 200-240V or the range 100-120V. The furnace must not be connected to the wrong range.

Amps: the actual supply must be capable of supplying the required amps. It should be fused at the next available fuse size equal to or greater than the amps on the rating label.

A supply cable is fitted to 200-240V models, but may not be to 110-120V models. If there is no cable, remove the back panel and connect a suitably rated cable to the internal terminals.

Either wire the supply cable directly to an isolator or fit it with a line plug. The plug or isolator should be within easy reach of the operator to permit quick disconnection of the power.



For operator safety the supply **MUST** incorporate an earth (ground).

### **3.0 OPERATION**

#### **3.1 Operating Cycle**

The furnace is fitted with an instrument switch. The switch cuts off power to the controller.

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

As the furnace heats up the Heat light glows steadily at first and then flashes as the furnace approaches the desired temperature. For further information on temperature control, see controller manual.

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

#### **3.2 General Operating Notes**

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 for ELF models is 1100°C (2012°F).

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 cold object is placed in the chamber it may record the average temperature of the object and the element, which can lead to overheating of the element. Allow large objects to gain heat at a lower temperature and then adjust the controller setpoint to a temperature close to the desired maximum.

Materials such as case hardening compounds and other reactive salts may attack the wire elements, causing premature failure. The insulation chamber includes a ceramic hearth that helps to protect the insulated floor.

Note that if the door vents are open then the entry of cold air through the vents can give rise to a cool area in the chamber.

The moulded light weight ceramic fibre insulation can easily be marked by accidental contact with tongs etc. Some fine cracks may be visible at the front of the insulation, or may develop in the surface of the chamber due to the progressive shrinkage of the ceramic fibres. Cracks are not usually detrimental to the functioning of the furnace.

When heating materials that produce smoke or fumes, the chimney must be correctly fitted and unobstructed. Otherwise, soot may accumulate in the chamber and could possibly cause an electrical breakdown of the heating element. To prevent this, regularly heat the furnace up to maximum temperature for one hour without load to burn away the soot.

Light weight 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.

### 3.3 Use of Probes

Any metal object used to probe into the furnace chamber while the furnace is connected to the supply must be earthed (grounded). This applies in particular to metal sheathed thermocouples, where the sheaths must be earthed. The refractory material of the chamber lining becomes partly conducting at high temperatures, and the electric potential inside the chamber can be at any value between zero and the supply voltage. Unearthed probes can cause serious electric shock.



### 3.4 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.

### 3.5 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.

### 3.6 Power Adjustment

The furnace control system incorporates electronic power limiting, which is used in some models to compensate for voltage to achieve the same power over a range of voltage supplies. In other models the power limit is set to 100% over all common voltages. The power limit parameter may be accessible to the operator, but should not generally be altered.

See section 8.3 for details of power limit settings. DO NOT adjust the power to a level higher than the design level stated: this may cause fuse to blow, and could damage the heating elements.

The power limit may be set to a lower limit if the furnace is to be used at a low temperature only: this may give better control stability. It may set to zero to permit demonstration of the controls without the heating elements taking power; to resume heating reset it to its standard value.

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## **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**

Soot deposits may form inside the furnace, depending on the process. At appropriate intervals remove these by heating as indicated in section 3.2.

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 3.5 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 both live and neutral sides of the element should be isolated when the door is opened.

### **4.2 Calibration**

After prolonged use the controller and/or thermocouple could require recalibration. This would be important for processes that require accurate temperature readings or that 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 and sheath, one solid state relay, one door insulation piece, and one complete heating chamber.

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

## 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 Warning - 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](http://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

The temperature controller is fitted inside the furnace base, which can be separated from the top by removal of six screws.

 Before handling the controller: **wear an anti-static wrist strap** or otherwise avoid any possibility of damage to the unit by static electricity.

See the instructions supplied with the replacement controller.

### 5.4 Solid-state Relay Replacement

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

Make a note of the wire connections to the solid state relay, and disconnect them.

Remove the solid state relay from the base panel.

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 base panel or aluminium plate.

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:

negative: white  
 positive (type K): green

Disconnect the thermocouple from its terminal block and withdraw the thermocouple from its sheath. It is advisable also to remove the sheath and shake out any broken pieces of thermocouple.

Fit the replacement thermocouple and reconnect, observing the colour coding.

Refit the back panel.

### 5.6 Element Replacement



See section 5.2 - wearing a face mask is recommended.

The element is supplied in the form of a complete inner chamber.

Disconnect the furnace from the supply and remove the furnace case back panel. Pull the chimney out of the top of the furnace.

Make a note of the wiring connections (see also thermocouple colours, section 5.5.)

Disconnect the element power leads and the thermocouple connections. Remove the thermocouple and support tube.

Using a socket spanner undo the four bolts that fasten the insulation box. These are located under the insulation box in the two cross supports.

Remove the insulation box by carefully sliding it out through the back of the furnace case.

Take the new insulation box and carefully slide it into the back of the furnace up to the front face. DO NOT support the insulation box by putting your hand inside it – the insulation is fragile.

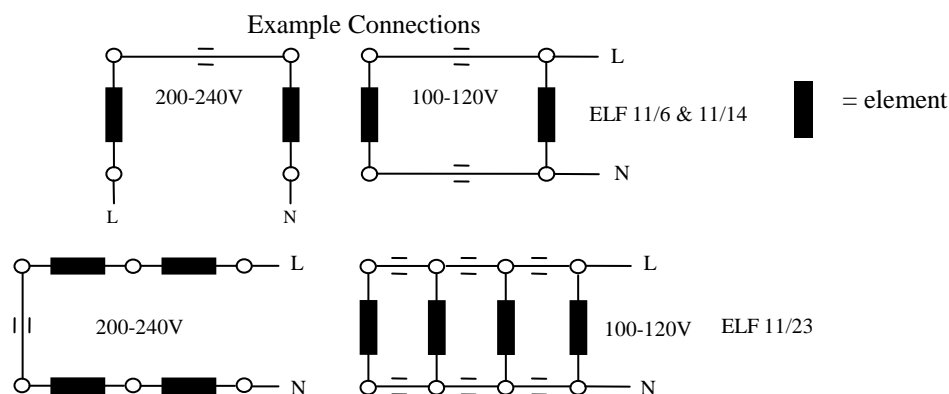
Locate the insulation box fixing holes and replace the four bolts.

Refit the chimney, thermocouple support tube and thermocouple.

Remake all the thermocouple and element connections according to the notes made. If in doubt, see the diagram below: on the 200-240V models there are two heating coils in series; on the 100-120V models two in parallel.

Refit the back panel and run the furnace for 30 minutes at 800°C without interruption to ensure complete burn-off of any organic binders. Smoke may be observed during this process, so it should be carried out in a well-ventilated area.

Check that the furnace is controlling properly to rule out the possibility that previous element failed because of a fault elsewhere in the control circuit.





## **Door Plug Replacement**

The “door plug” is also known as the “door insulation piece”.

Lower the furnace door to the fully open position.

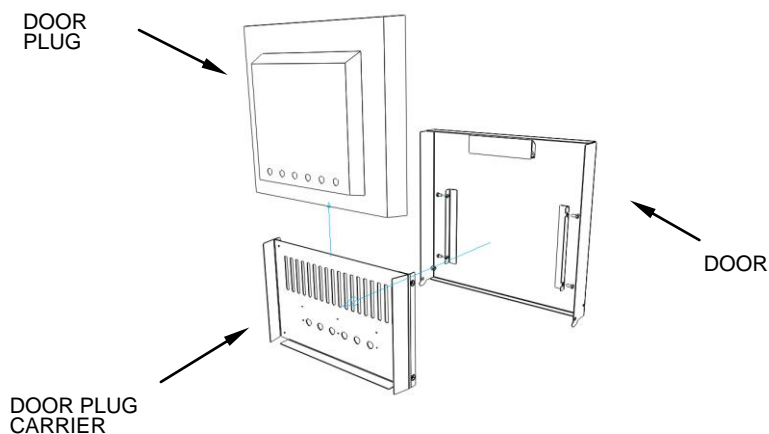
Loosen the four M6 Screws, two on either side of the door plug carrier.

Remove the door plug and carrier

Remove the air inlet blanking plate screws (section 5.7).

Slide the door plug upwards out of the carrier.

Slide the new door plug into the carrier ensuring that the air inlet holes are aligned, and re-assemble in the reverse order.



## **5.7 Air Inlet Adjustment**

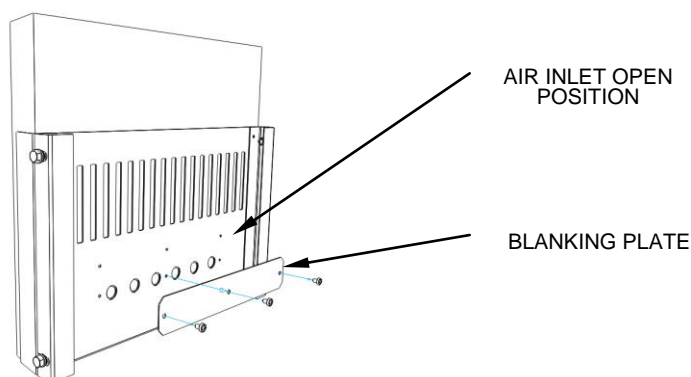
The air inlet is on the inner door panel (door plug carrier), and is supplied in the closed position. It can be altered to the open position as follows.

Remove the door plug and carrier as described in section 0.

Remove the three screws holding the blanking plate into position and remove the blanking plate.

Position the blanking plate in the upper position clear of the air inlet holes and align the screw holes.

Replace the three screws to hold the blanking plate in new position. Note that the screws must be replaced to fix the door plug into position.



## 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 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 (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
    - 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

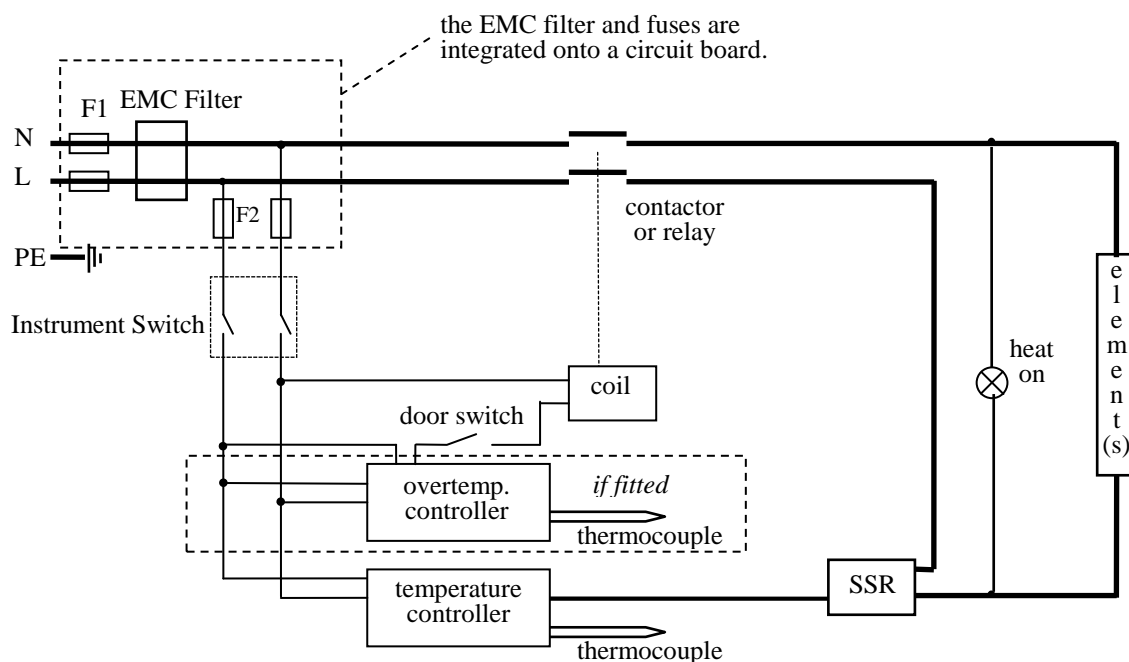
### B. Furnace Overheats

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 that could have overloaded the SSR

## 7.0 ELF 6L & 14L CIRCUIT DIAGRAM AND FUSES

### 7.1 200-240V models

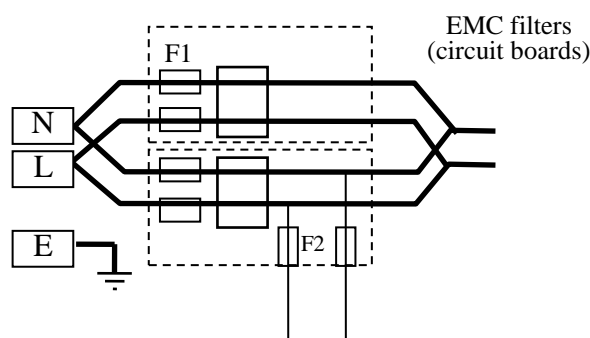
*NOTE – models before mid-2002: two door switches were fitted directly in the element circuit, instead of a single switch and contactor.*



### 7.2 100-120V models

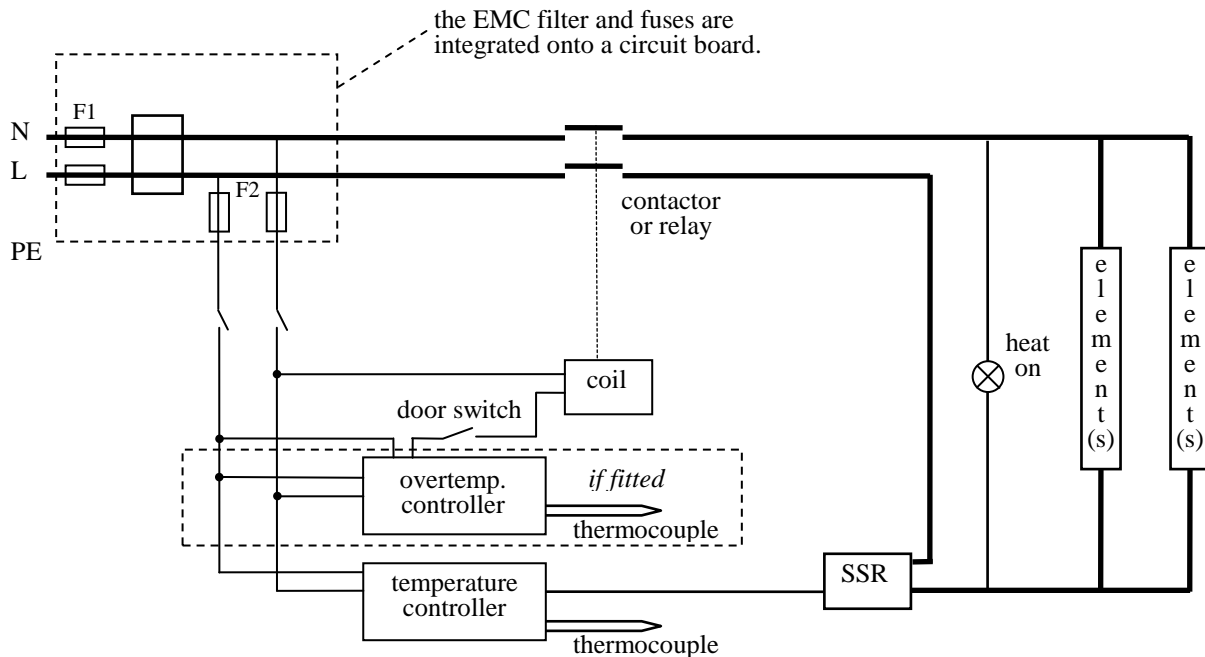
Differences in the 100-120V models:

There are two EMC filter units in parallel. Four supply fuses are fitted, at the same individual ratings as for the 240V models.

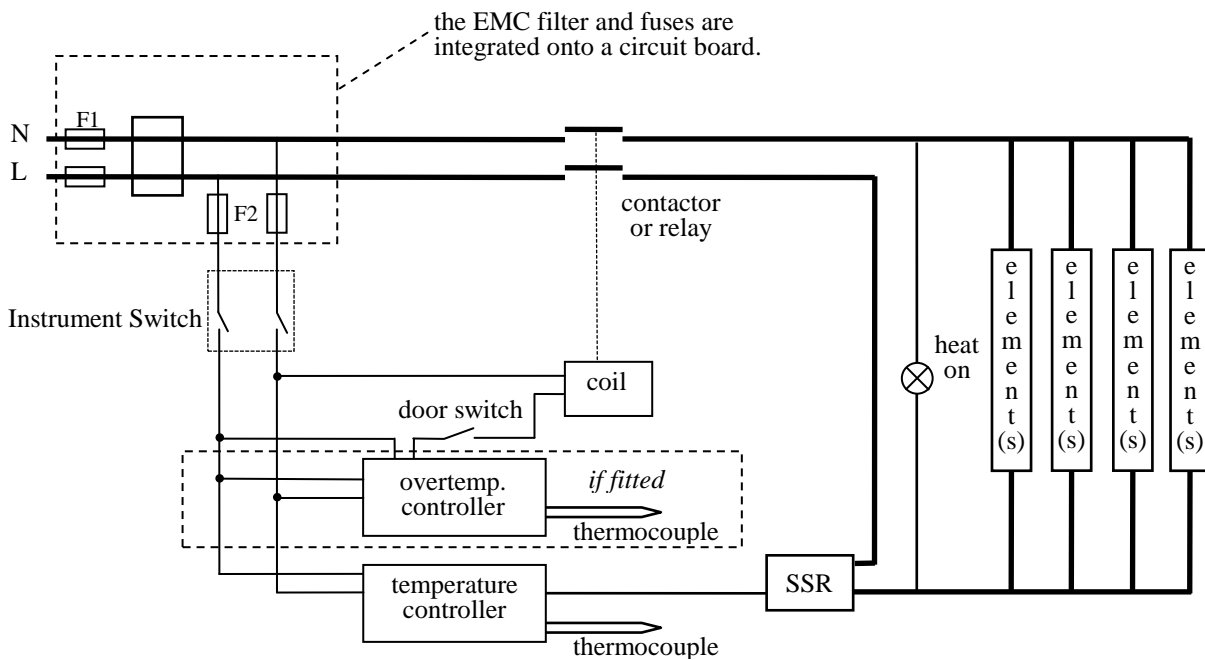


## 8.0 ELF 23L CIRCUIT DIAGRAM AND FUSES

8.1 200-240V models



104 - 120V models



**Fuses**

**8.2** Fuses are marked on the circuit diagram (above) with type codes, e.g. F1, F2. A list of the correct fuses is tabled below.

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.

The fuses are mounted on an EMC filter circuit board. The smaller fuses F2 (when present) are for the control circuit only.

*F1-F2: Refer to the circuit diagram.*

<i>F1</i>	Internal supply fuses	32mm x 6mm type F fitted on EMC filter circuit board(s)
<i>F2</i>	Auxiliary circuit fuses	20mm x 5mm type F fitted on EMC filter circuit board
	<b>Customer fuses</b>	Use fast-blow fuses to minimum rating shown

Model	phases	Volts	Supply Fuse Rating (Amps) F1	Aux. Fuse F2	Customer Fuse Rating
ELF 11/6B	1-phase	200-240V	10A (2 off)	2A*	10A
ELF 11/6B	1-phase	100-120V	10A (4 off)	2A	20A
ELF 11/14B	1-phase	200-240V	12.5A (2 off)	2A	12.5A
ELF 11/14B	1-phase	100-120V	12.5A (4 off)	2A	25A
ELF 11/23B	1-phase	200-240V	25A (2 off)	2A	25A
ELF 11/23B	1-phase	100-120V	50A (2 off)	2A	50A

\* fuse not present unless overtemperature option is fitted

**8.3** The furnace control system incorporates electronic power control, including a “power limit” parameter that is used to reduce the effective voltage to 208V (or 104V); the values of the power limit for different voltages are as follows:

ELF 11/6B ELF 11/14B ELF 11/23B	Voltage:	100 200	104 208	110 220	115 230	120 240
	Power	100%	100%	89%	81%	75%

## 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)			Approx. Capacity (l)	Net Weight (kg)
			H	W	D		
<i>Chamber furnaces heated by coiled resistance wire embedded in light weight ceramic fibre forming the furnace chamber.</i>							
ELF 11/6B	1100°C	2	160	180	205	5.9	24
ELF 11/14B	1100°C	2.6	200	220	315	13.8	31
ELF 11/23B	1100°C	5	715	506	660	23	52

### 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



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 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.

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*For preventive maintenance, repair and calibration of all Furnace and Oven products, please contact:*

**Carbolite Engineering Services**

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