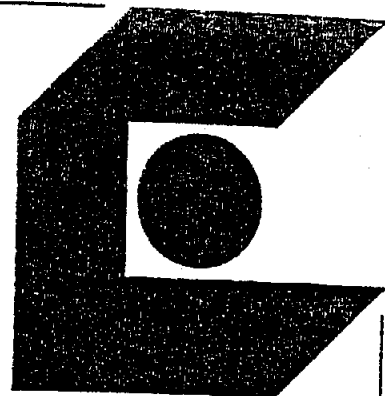


Furnace Operating and Maintenance Instructions



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

Contents

- 1.0 Setting Up Instructions
- 2.0 Operating Instructions
- 3.0 Temperature Controllers
- 4.0 Maintenance
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- 6.0 Recommended Spares
- 7.0 Fault Analysis
- 8.0 Repairs and Replacements
- 9.0 Wiring Diagrams
- 10.0 Specifications

This manual should supply all the information required for safe and trouble free furnace operation. If however any questions remain unanswered please contact your local Carbolite agent or our Service Department at the address at the end of this manual.

1.0 SETTING UP INSTRUCTIONS

- 1.1 Unpacking - always lift the furnace by the base and NEVER by the door mechanism. Remove any packing material from the door gear and furnace chamber.
- 1.2 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.
- 1.3 Fit the chimney (if supplied) into the hole provided in the top of the furnace. Square section chimneys should be secured using the trim plate and screws provided.
- 1.4 Check that the supply voltage is compatible with that stated on the furnace specification plate.
- 1.5 Connect the furnace to an earthed A.C. electrical supply. In the U.K., furnaces of less than 3 kW power may be connected to a 13 amp mains supply via a standard plug which should be wired as follows:-

Brown = Live (L) Blue = Neutral (N) Green/Yellow = Earth (E)

Alternatively, a qualified electrician must connect the furnace to a properly fused and isolated mains supply.

2.0 OPERATING INSTRUCTIONS

- 2.1 Switch on the electrical supply. The red "mains" light should glow.
- 2.2 Operate the instrument switch, located close to the "mains" light, to activate the temperature controller. One or more lights on the controller will become illuminated.
- 2.3 Close the door and adjust the temperature controller (see 3.0).
- 2.4 The furnace will now begin to heat up. The orange heater light will glow steadily at first and then flash as the furnace approaches the desired temperature.
- 2.5 **Operating Temperature.** Heating element life is shortened by use at temperatures close to maximum. Do not leave the furnace at high temperature when not required. If in doubt, the maximum temperature is shown on the specification plate.
- 2.6 Do not put towels etc. over the furnace cooling vents. They are needed to keep the electrical controls cool.
- 2.7 **Loading and Unloading.** 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.

When heating large objects (in particular poor conductors) take care to avoid shielding the thermocouple from the heating elements.

- 2.8 Door Switch - All chamber furnaces (except those with mineral insulated elements) incorporate a safety switch which interrupts the heating element circuit when the door is opened. This prevents the user touching a live heating element - but, of course, the furnace will not heat up if the door is left open.
- 2.9 Ventilation - If the furnace is to be used for heating materials which produce smoke or fumes, the chimney must be correctly fitted and unobstructed. Otherwise, soot will accumulate in the chamber and between the layers of insulation, causing an electrical breakdown of the heating elements. Furnaces used for this kind of application must be heated regularly up to maximum temperature and held for one hour to burn away the soot.

N.B. Furnaces type EML are not fitted with a chimney and should therefore not be used where vapour, smoke, or fumes are emitted. Carbolite OAF, GSM, and BOF furnaces are specifically designed for these applications and incorporate an extra large chimney.

- 2.10 Corrosive Materials - Materials such as case hardening compounds and other reactive salts readily penetrate the ceramic lining of the furnace chamber and attack the wire elements, causing premature failure. When such materials are being used, the furnace must be protected by a hearth plate or tray, preferably made from material such as Inconel.

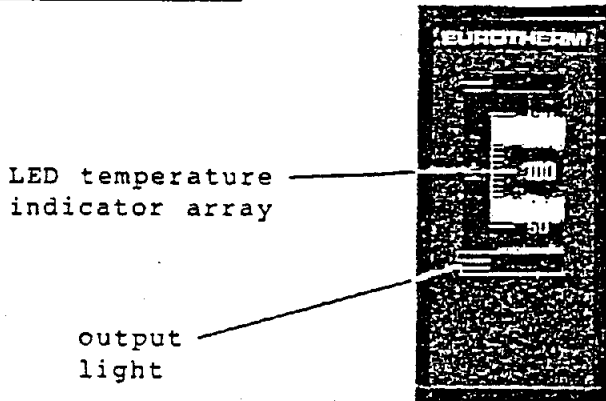
Non-metallic hearth plates reduce the heat transmission from the bottom of the furnace, and increase the element temperature in this area. This may result in premature element failure, particularly if the furnace is working near to maximum temperature. Under these circumstances, we recommend that the temperature be raised slowly over the last 300°C, allowing approximately 10 minutes soak at 100°C intervals.

3.0 TEMPERATURE CONTROLLER ADJUSTMENT

The new digital controllers have lots of features, only some of which are relevant to furnace control. We set out below the brief details you need in order to use the furnace. If you want to know more about your controller, contact our service department for a free booklet.

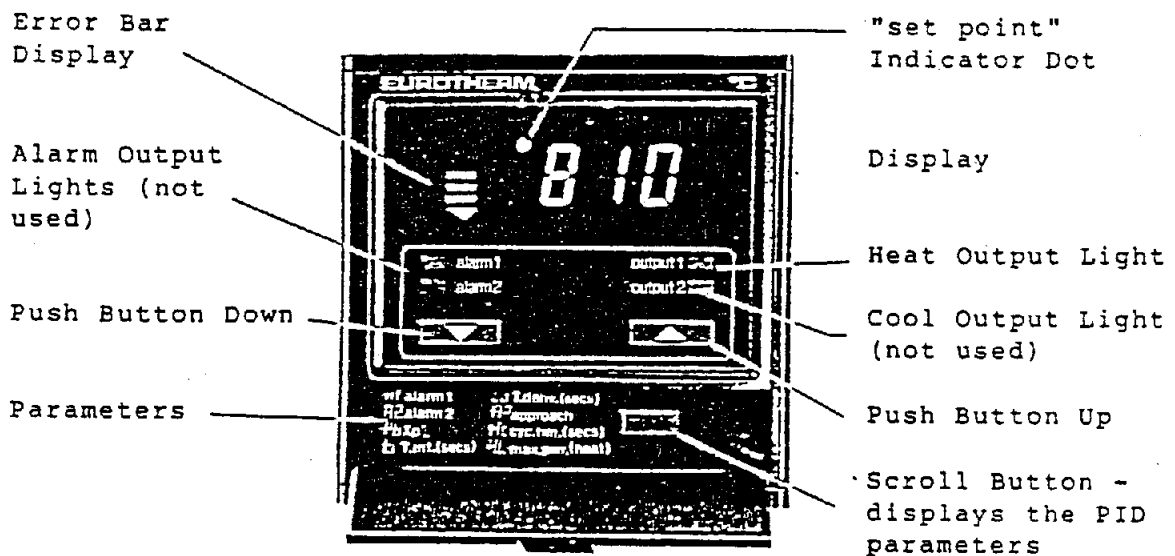
If your furnace is equipped with a controller which is not shown here then you will find details in a separate booklet included with this manual.

3.1 EURO THERM 103



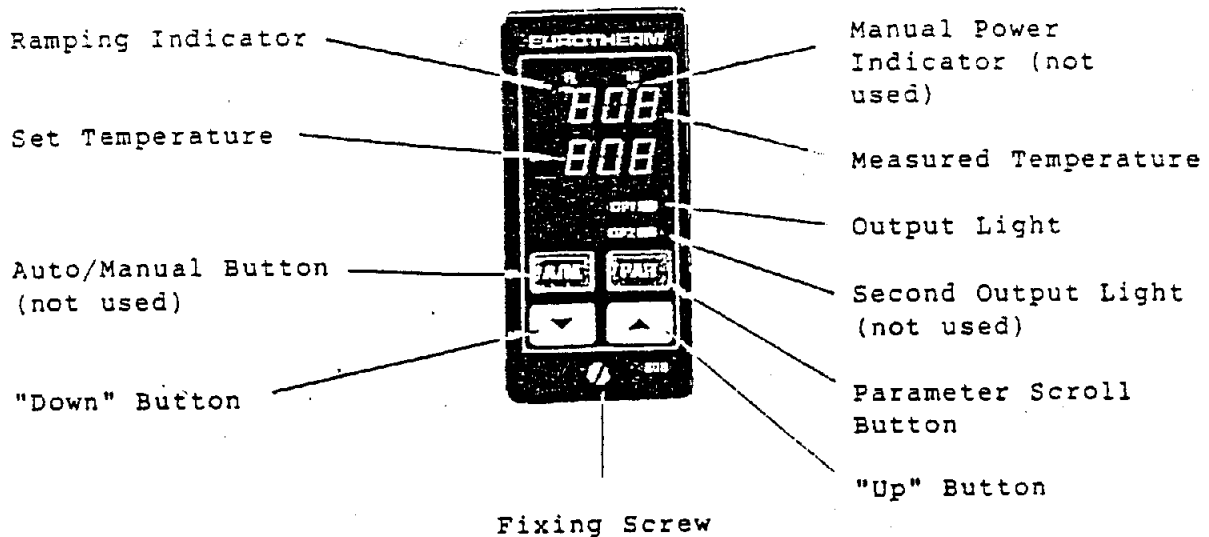
1. Open the controller cover door and use the thumbwheel to adjust the desired temperature.
2. The column of LEDs gives a bar graph indication of furnace temperature relative to the desired temperature.

3.2 EURO THERM 810

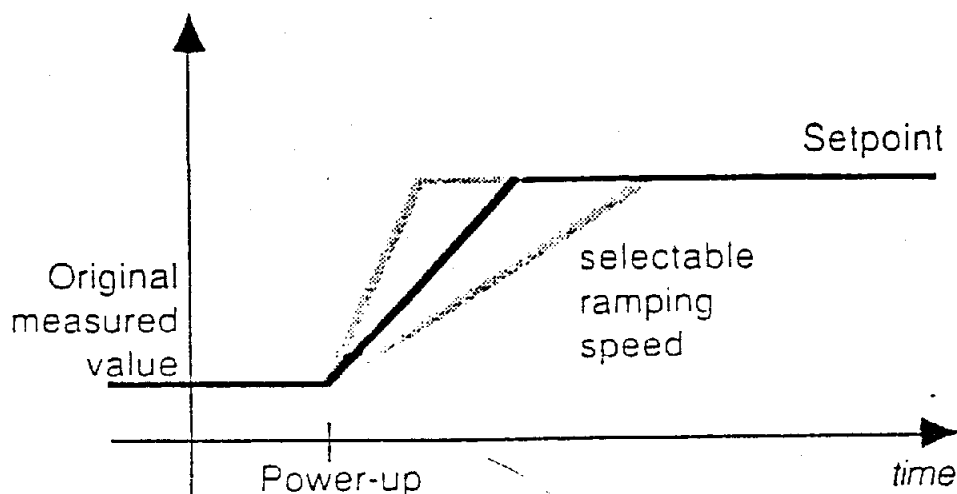


1. The 810 usually displays the temperature measured inside the furnace.
2. Push either "up" or "down" button for a moment and the 810 shows the "set" temperature that it is striving to achieve (note the flashing dot in the top left hand corner of the display). After a while it reverts to showing item 1.
3. Keep the "up" or "down" button depressed, and, after a delay, the set temperature will change to what you want.
4. The scroll button allows you to inspect the PID terms which have been preset by Carbolite, and should not be altered.

3.2 EUROTHERM 808

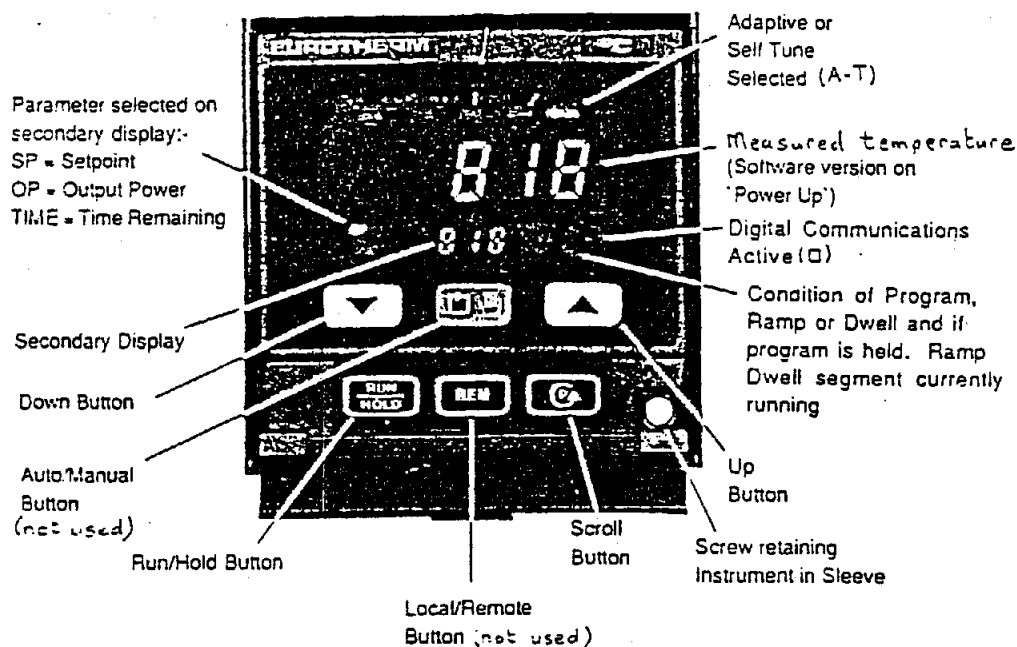


1. The upper display shows the actual temperature measured inside the furnace.
2. The lower display shows the "set point" or desired furnace temperature.
3. Press the "Up" or "Down" button to adjust the setpoint.
4. The output light indicates the state of the controller's output signal to the solid state relay (which in turn switches the power to the heating elements).
5. The above is all you need to know to start using the controller. What comes next is optional.
6. The controller has a "ramp to set point" feature which allows you to limit the rate of warmup - either to avoid thermal shock damage to the furnace or contents - or to control the rate of cool down.



7. Try changing the setpoint. You will notice that the "ramping indicator" glows for a few moments. Touch the parameter button briefly while the ramping indicator is glowing. The indicator flashes and the lower digital display will momentarily display the instantaneous value of the ramping setpoint.
8. In most cases the controller is factory set so that the setpoint is ramped at the maximum rate of 100°C per minute. If desired you can slow this to a minimum of 0.01° per minute (0.6° per hour) as follows:
9. Push the parameter button. The lower display will show a letter "C" (confirming a celsius scale is in use) then the upper display will change to show SPrr (Set Point Ramp Rate) and the lower display will show the selected ramp rate. Adjust this value using the "Up" and "Down" buttons. (Note this value applies equally on heating and cooling).
10. If you are not able to alter the setpoint ramp rate in this way then it is probable that the rate has been locked at the factory in order to protect the furnace from thermal-shock damage. This is quite common on furnaces with ceramic work tubes. Contact our Service Department for further advice on this.

3.4 EUROTHERM 818P



1. To Heat Up and Hold One Temperature - (Controller Mode)

- (i) The upper display shows the actual temperature measured inside the furnace.
- (ii) The lower display shows the "set point" or desired furnace temperature. This is confirmed by the letters SP beside the lower display.
- (iii) You can raise or lower the set point by holding the up or down button depressed.

2. To Heat Up in Accordance with a Preset Program

- (i) Depress the scroll button concealed below the lower flap. The lower display will change to show output power P (% of full power), then Lr, then display the first ramp rate, Pr1, in degrees per minute.

This ramp rate value can be altered with the up/down buttons. Extreme values are "NONE" = Omit Segment and "STEP" = Infinite Rate of Rise.

- (ii) Press the scroll button again to display program Level 1, PL1, in degrees C.
- (iii) A third scroll depression will display the program dwell time at the previously set level 1.
- (iv) A program of up to 8 ramps and 8 dwells can be built up by using the above procedure, or you can cut short the program by setting a ramp or dwell segment to "End" by depressing the down button.
- (v) At the end of the program the furnace will maintain the last "level" set point. Make your last level zero if you want the furnace to cool down at the end of your program.
- (vi) After the program has been defined you can set the holdback value Hb which is the size of error between the programmed temperature and the measured temperature that will be tolerated before the programme pauses to wait for the furnace to catch up. This feature is turned off by holding the down button depressed.
- (vii) Finally you can prescribe a number of repetitions of your program by setting the loop counter PLC to something other than 1.
- (viii) Start your program by pushing the Run/Hold button. The program starting temperature will be that measured inside the furnace. If the furnace is hotter than level 1, the 818P will invert the programmed ramp and programme the furnace down to the level 1 temperature.
- (ix) The program can be paused by pushing the Hold button, and resumed by a further depression of the same button.
- (x) Cancel the program and revert to controller mode by pushing both "Up" and "Down" buttons together.
- (xi) The scroll button will initially allow setpoint, power and "time" remaining in a current dwell period to be displayed. Further scroll button depressions allow all the program parameters to be inspected. However, they can only be altered while the program is on "Hold".
- (xii) The number of program loops remaining is displayed using the up/down buttons while the "Lr" mnemonic displayed.

4.0 MAINTENANCE

Most standard laboratory furnaces do not require any routine maintenance other than removal of soot deposits mentioned in 2.9. and the replacement of consumable items as required.

5.0 AFTER SALES SERVICE

Carbolite has a team of Service Engineers who repair furnaces both at our factory and on our customers' premises throughout the world. We also sell spares by mail order. A phone call, telex, or fax, to our Service Department often enables a fault to be diagnosed and the necessary spare part despatched.

Please quote the furnace type, serial number, and supply voltage, in all correspondence.

6.0 RECOMMENDED SPARES KITS

Carbolite have available a replacement spares kit matched to each furnace. Each kit comprises 1 x thermocouple complete with sheath; 1 x solid state relay; 1 x spare heating element. Individual spares are also available - part numbers and prices on request.

Order replacement parts kits as follows:-

Furnace ref.	Parts kit ref.	Furnace ref.	Parts kit ref.
EML 11/2	EML-11-2-0030	ESF 12/2	ESF-12-2-0050
EML 11/6	EML-11-6-0031	ESF 12/5	ESF-12-5-0051
GLM 11/2	GLM-11-2-0035	ESF 12/10	ESF-12-10-0052
GLM 11/3	GLM-11-3-0036	ESF 12/23	ESF-12-23-0053
GLM 11/7	GLM-11-7-0037	GSM 11/8	GSM-11-8-0132
LMF 12/2	LMF-12-2-0040	OAF 10/1	OAF-10-1-0130
LMF 12/3	LMF-12-3-0041	VMF 10/15	VMF-10-15-0134
LMF 12/7	LMF-12-7-0042	BOF 12/10	BOF-12-10-0133
LMF 12/15	LMF-12-15-0043	HRF 7/22	HRF-7-22-0080

Use only genuine Carbolite replacement parts. Unapproved spares may be incompatible and the fitting of same will invalidate the manufacturer's responsibility and warranty.

7.0 FAULT ANALYSIS

A. FURNACE WON'T HEAT UP

1. The orange HEAT light is ON. → The heating element has failed. → Check also that the SSR is working correctly.
2. The orange HEAT light is OFF. → The controller shows a very high temperature or a code such as "Snb" (Sensor break) or "Or". → The thermocouple has broken or has a wiring fault.

The controller shows a low temperature. → The door switch 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 red MAINS light is ON. → The controller could be faulty or not receiving a mains supply due to a faulty switch or wiring fault.

The red MAINS light is OFF. → Check the mains supply fuses and the 2 amp fuses mounted inside the furnace control compartment.

B. FURNACE OVERHEATS

1. The orange 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 furnace.

The thermocouple may be connected back to front.

The controller may be faulty.

2. The orange HEAT light does not go off with the instrument switch. → The solid state relay has failed "ON" → Check for an accidental wiring fault which could have overloaded the relay.

8.0 REPAIRS AND REPLACEMENTS

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

8.1 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 will 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.

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. 61 and the UK Health and Safety Executive Guidance Note EH46.

We will be pleased to provide further information on request. Alternatively our Service Department will quote for any repairs to be carried out at your premises or at our works.

8.2 Temperature Controller Replacement

The temperature controller can usually be withdrawn from its quick release housing as follows:-

- (a) Eurotherm 103 - Open the flap and withdraw the controller by pulling outwards.
- (b) Eurotherm 800 series - Undo the screw located behind the lower flap and withdraw the controller.
- (c) CPC-701 programmer - Remove the four mounting screws and disconnect the 12 way connector.

8.3 Solid-state Relay Replacement

- (a) Disconnect the furnace from the mains supply.
- (b) Remove the furnace rear panel. Make a careful note of how the wires are connected before disconnecting the solid state relay from its aluminium plate.
- (c) Replace and reconnect the solid state relay ensuring that a thin layer of white, heat-conducting silicon paste (as supplied) is applied between the new relay and the heatsink plate.

N.B. The blue disc-shaped "MOV" connected between the high voltage terminals of the relay protects the relay from brief periods of excess voltage, and must be replaced.

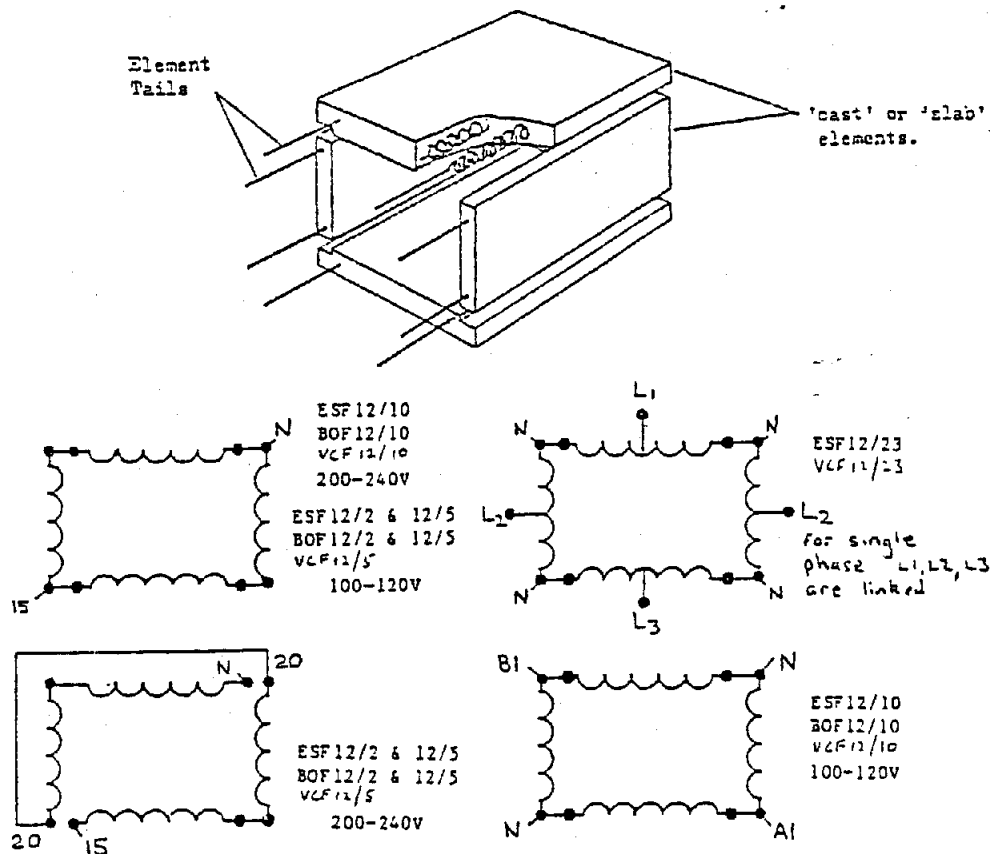
- (d) Replace the furnace rear panel.

8.4 Thermocouple Replacement

- (a) Disconnect the furnace from the mains supply, and remove the furnace rear panel.
- (b) Disconnect the thermocouple from its terminal block. This may be easier if the block is first removed from the furnace body. Do not lose the porcelain spacers under the block that hold it away from the furnace body.
- (c) Release the screw which secures the thermocouple sheath.
- (d) Withdraw the sheath and shake out any fragments of broken thermocouple.
- (e) Re-assemble with a new thermocouple ensuring that:
 - the thermocouple is not twisted as it is being inserted;
 - the porcelain spacers are replaced;
 - the blue, negative, side of the thermocouple is connected to the blue (or blue striped) wire of the compensating cable.

8.5 Slab Element Replacement (ESF, BOF furnaces etc.)

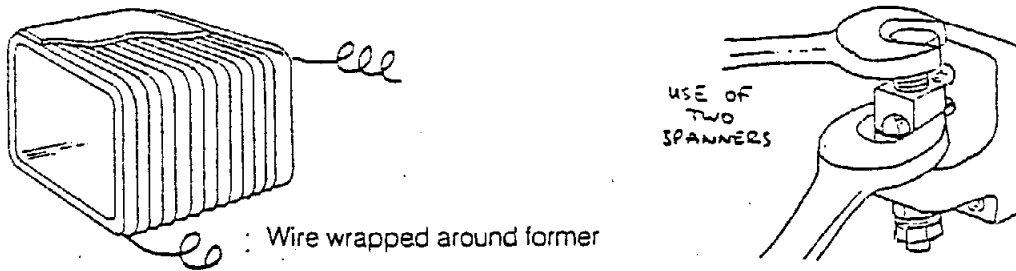
The chamber of this type of furnace is formed by 4 separate slab elements in which a coiled wire heating element is embedded. In the event of failure, any one or all slabs may be replaced.



- Disconnect the furnace from the mains supply and see safety note 8.1.
- Remove the furnace rear panel, and make a simple drawing of how the wires are connected to the elements.
- Release the screws which secure the element terminal blocks on the faulty elements. (Element tails become brittle with use, so great care must be taken during removal, unless you intend to replace them all).
- Open the furnace door and slide out the faulty element(s). Pushing on the tails may sometimes help to start the slab moving. If 2 elements fuse together both will have to be replaced.
- Check the condition of the insulation adjacent to the faulty element(s). Replace the insulation if it is excessively cracked or has radically changed colour or texture (see 8.1).
- Slide in the new element(s). Guide the tails through the existing holes in the insulation and re-connect the element terminal blocks.
- Cut off any excess tail wire, replace the back panel and reconnect the electrical supply.
- Switch the furnace ON and heat to 900°C without interruption, then soak for 1 hour.

8.6 Muffle Element Replacement (EML, LMF, GLM, VMF, OAF furnaces)

The chamber of this type of furnace is formed by winding resistance heating wire on to a refractory muffle former. In the event of failure, the whole "wound muffle" assembly must be replaced.



- (a) Disconnect the furnace from the mains supply and see safety note 8.1.
- (b) Remove the furnace rear panel to gain access to the brick-box (containing the insulation and muffle element).
- (c) Unfasten the electrical connections to the brick box and remove the thermocouple and sheath. If the connections are secured by hexagonal nuts, 2 spanners should be used to avoid cracking the porcelain mounting.
- (d) Undo the self tapping screws around the door way, and hook bolts at the back to release the brick box.
- (e) Support the front of the brick box as you withdraw it from the case so it does not fall onto the electrical connections below.
- (f) Remove the brick box lid and top insulating board, noting how it is assembled and the position of the heating element wires (or "tails").
- (g) Pull the element tails out of the terminal blocks and remove sufficient insulation to allow access to the heating element. Check and replace damaged insulation (see 8.1).
- (h) Refit the new heating element, ensuring that the tails are separated from the element by at least a 25 mm layer of insulation. Most heating elements can be fitted either way round, but some may be marked "F" for front.
- (i) Feed the heating element tails through the terminal blocks and tighten the clamping screws using two spanners as before. Cut off excess element tails.
- (j) Complete the fitting of the insulation and refit the lid. Don't use any cement unless supplied by Carbolite, as other types may attack the heating element.
- (k) Replace and fasten the brick box into the furnace case.
- (l) Replace the thermocouple, sheath and electrical connections (see 8.4).

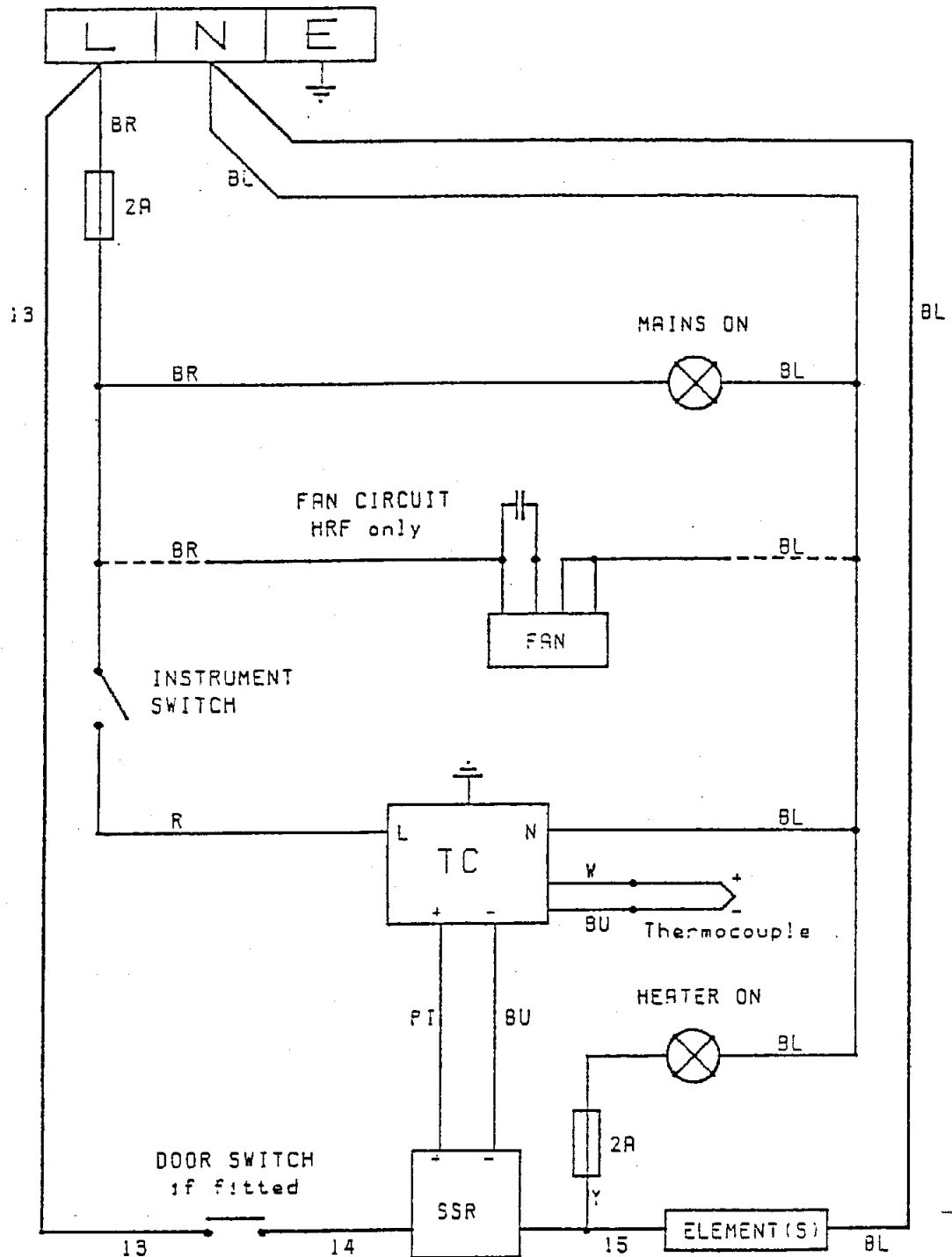
- (m) Replace and tighten the electrical connections to the element terminal blocks. The brass connector should be slightly loose in its porcelain support block to allow for expansion.
- (n) Replace the back panel and reconnect the electrical supply.
- (o) Switch the furnace ON and heat to 900°C without interruption, and then soak for 1 hour.

8.8 Mineral Element Replacement (HRF 7/22 furnace)

This type of element consists of a resistance wire which is centred in a metal tube by a compressed powder. These elements may be bent into "U" or other shapes without losing the electrical insulation.

- (a) Disconnect the furnace from the mains supply and see safety-note 8.1. Remove the back panel.
- (b) Carefully note how the elements are connected, and remove the electrical leads from them.
- (c) Unscrew the gland caps on the faulty element, and carefully prise open the split compression collars, which should be retained for fitting to the new element.
- (d) Remove the chimney, open the furnace door and slide out the chamber liner.
- (e) Withdraw the element through the front of the furnace.
- (f) Insert the new element through the glands and refit the compression collars. Their centres should be approximately 40 mm from the end of the element. Firmly tighten the gland cap, ensuring the element lies centrally between the chamber liner and the insulation.
- (g) Reconnect the electrical leads, refit the chamber liner and back panel, and reconnect the mains supply.

WIRING DIAGRAM
Single Circuit Furnace Without Contactor



R Red
BR Brown
BL Black
W White
Y Yellow
PI Pink
BU Blue
P Purple
G Grey

SSR Solid state relay
or thyristor stack

TC Temperature Controller
or Programmer

10.0 Specification

10.1 Technical Data

Model	EML		GLM			LMF				ESF				GSM	OAF	VMF	BOF	HRF
Part No.	11/2	11/6	11/2	11/3	11/7	12/2	12/3	12/7	12/15	12/2	12/5	12/10	12/23	11/8	10/1	10/15	12/10	7/22
Max. Temp.	1100°C		1100°C			1200°C				1200°C				1100°C	1000°C	1000°C	1200°C	750°C
Max. rec. continuous working temp.	1050°C		1050°C			1150°C				1150°C				1050°C	1000°C	1000°C	1150°C	700°C
Temp. Sensor	NiCr/NiAl thermocouple					Pt/Pt 13% Rh. thermocouple				Pt/Pt 13% Rh. thermocouple								
Maximum Power Rating (kw)	1.75	2.75	1.75	2.5	3.0	1.75	2.5	3.0	6.0	1.85	2.5	3.0	6.0	3.0	3.9	2.3	3.0	3.0
Heating Times* (mins)	65	70	60	55	95	65	65	105	125	85	125	160	110	95	65		175	75

*approx time for an empty furnace to reach 100°C below maximum

10.2 Optional Extras

PD Analogue Controller	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
PID Digital Controller	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Programmer	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓
Over Temp. Controller	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 phase	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X
Stand	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X
Chimney**	X	X	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Gas Inlet	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	✓	✓

S = STANDARD FITTING ✓ = OPTIONAL EXTRA X = NOT AVAILABLE

10.3 Dimensions

CHAMBER SIZE	90	120	100	90	120	100	90	120	140	100	130	155	200	120	90	65	155	220
W	150	175	125	150	175	125	150	175	190	130	155	180	250	175	170	90	180	200
D	185	305	150	235	355	150	235	355	560	185	280	365	410	345	455	270	365	495
EXTERNAL SIZE	90	120	100	90	120	100	90	120	140	100	130	155	200	120	90	65	155	220
H	425	480	575	600	625	575	600	625	580	575	600	625	740	625	625	600	625	590
W	335	405	410	435	460	410	435	460	475	410	435	460	560	460	460	435	460	450
D	410	500	420	500	610	420	500	610	750	420	500	610	700	610	635	500	610	870
Volume (litres)	2.5	6.4	1.9	3.2	7.4	1.9	3.2	7.4	14.0	2.4	5.2	10.2	22.5	7.2	6.9	1.6	10.2	22
Net Weight (kg)	20	25	35	40	50	35	40	50	90	35	50	60	80	50	60	37	60	65

10.4 Standard Voltages

All furnaces are available in 240v, 220v, 200v or 110v, 50/60 Hz with other voltages on application.

The furnaces covered in this manual are just a small part of the wide range of equipment manufactured by Carbolite. For further details of our standard or custom built chamber and tube furnaces, for laboratory or production use please contact us at the address below or ask your nearest stockist.

**Carbolite
Furnaces**

Specialists in the design and manufacture of electric furnaces for quality control, research and industrial applications.



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A member of the Thermal Scientific Group