

CARBOLITE®

Installation, Operation & Maintenance Instructions

1200°C E-range Compact Tube furnaces

Models: EHA, EVA, EHC, EVC
EST, EVT, EZS, EVZ

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 over-temperature controller when fitted).*

Please read the controller manuals before operating the furnace.

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1 INTRODUCTION

1.1 Products Covered

This manual contains installation and operating instructions for the single-zone tube furnaces of model types EHA, EVA, EST and EVT, and the 3-zone models EHC, EVC, EZS and EVZ. The single-zone models use one controller or programmer operating all elements. The 3-zone models use three controllers, linked to achieve an extended uniform temperature region.

The horizontal tube furnaces EHA, EHC, EST and EZS are supplied with the controls in an integral base or separate control box. The “vertical” models EVA, EVC, EVT and EVZ are supplied with a stand for both vertical and horizontal use, the controls are in a separate box on a length of flexible conduit

The EST, EVT, EZS and EVZ are split tube furnace designs.

All models are supplied with a pair of “work tube adaptors”, which are made to suit the work tube outside diameter. Spare or replacement adaptors can be ordered.

1.2 Switches and Lights



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



Heater switch: the switch disconnects power to the heating elements; unless this switch is off there is a danger of electric shock when inserting objects into the furnace



Heater 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 next to this symbol.



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



DANGER – read any warning printed this next to symbol.

1.4 Warning Labels

On the front control panel there are 2 warning labels as shown in Figure 1-1 page 3; they are numbered 7 and 8. These warnings must be followed for the safe operation of this furnace.

- 7- **Warning label - Do not operate without a work tube.** The furnace must not be operated without the correctly sized work tube and matching correctly sized work tube adaptors or it could be possible for an operator to access electrically live element coils that could cause serious injury or death.
- 8- **Warning label - Switch off the furnace before loading and unloading.** The furnace heaters must be switched off using the heater switch item 2 in Figure 1-1 page 3 when the furnace is being loaded or unloaded. The work tube can become electrically conductive at high temperatures, presenting a possible hazard to an operator that could cause serious injury or death if an element failed and collapsed onto a work tube and was not detected.

Index to numbered items in Figure 1-1 and Figure 1-2

- 1- Electrical supply switch – switches electrical power on and off to the furnace.
- 2- Heater switch – switches electrical power on and off to the furnace heating elements.
- 3- Heater on light – indicates that the furnace heating elements are giving heat.
- 4- Product rating label indicates product serial number and electrical information.
- 5- Access hole to front panel fixing screws.
- 6- Warning label - Disconnect the mains supply before removing this cover.
- 7- Warning label - Do not operate without a work tube.
- 8- Warning label - Switch off the furnace before loading and unloading.
- 9- Electrical power lead socket.
- 10- Back panel fixing screws.

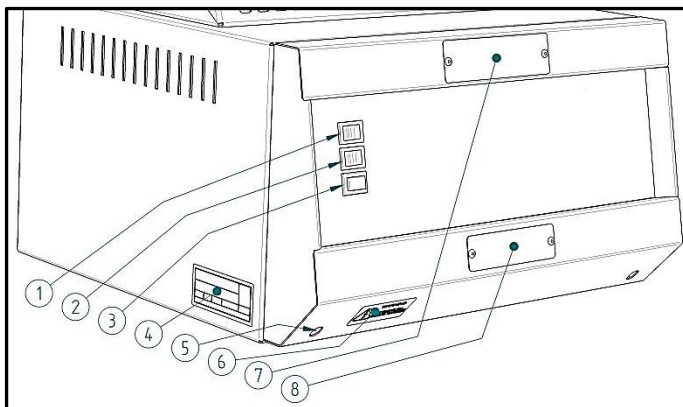


Figure 1-1. Control box layout and warning labels.

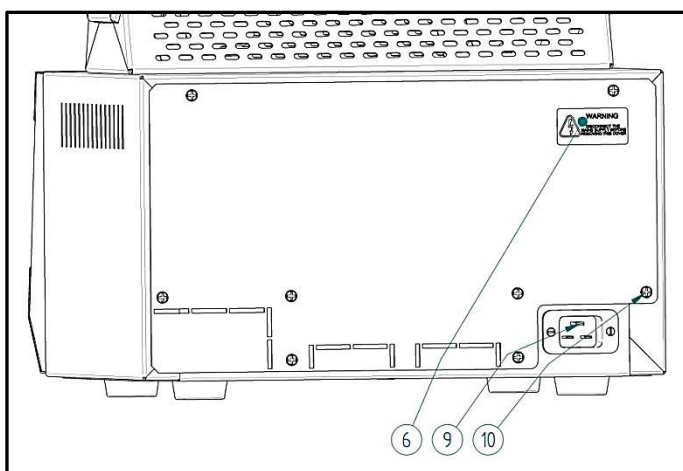


Figure 1-2. Back of control box showing mains lead socket

2 INSTALLATION



If the furnace has been transported or stored in humid conditions it must be dried out to restore its normal condition before completing the installation (see Section 9.2 page 25 for the drying out process).

2.1 Unpacking & Handling

When unpacking or moving the furnace, always lift it by its base or by both ends of the main body. Never lift it by the end insulation or by a work tube. It may take 2 or 3 people to lift the furnace, depending on size and configuration.

Remove any packing material from inside the furnace before use.

NOTE: This product contains **refractory ceramic fibre** (an **alumina silicate material**).

See section 5.2 page 19 'Repairs and Replacements' for precautions and advice in handling this material.

2.2 Siting

See Section 9.2 page 25, for Environment conditions before siting the furnace.

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 or close to any inflammable walls, ceiling or stored materials.

Ensure that there is free space of at least 300mm all around the sides and 1500mm above the furnace. If the furnace is to be used in a process which could liberate hazardous gases, then it should be installed together with a suitable fume extraction system. A direct connection to the furnace chimney should not be made. Do not obstruct any of the vents in the control box as they are required to keep the controls cool. Ensure that the furnace is placed in such a way that it can quickly be switched off or disconnected from the electrical supply.

2.3 Setting up – horizontal models

The EHA and EHC horizontal models must have work tubes fitted before being used. The diameter of the work tube is a customer order option and therefore varies between tube furnaces.



Note : If a metal work tube is being used in the furnace, ensure that it is earthed. See the safety warning in Section 3.5, page 18.

Fitting the standard work tube in an EHA/EHC furnace. (Tools required: 4mm Hex key.)

The fitting of the work tube is as follows with reference to Figure 2-2. Please note that standard work tubes are also referred to as tubes suitable for working in air. They are 150mm longer than the heated length of the furnace (see Table 9-1 page 24). Read section 5.2 before fitting the work tube.

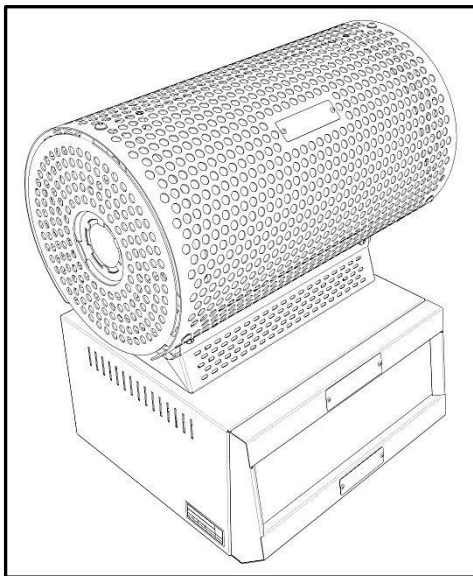


Figure 2-1. EHA model mounted on a control box.

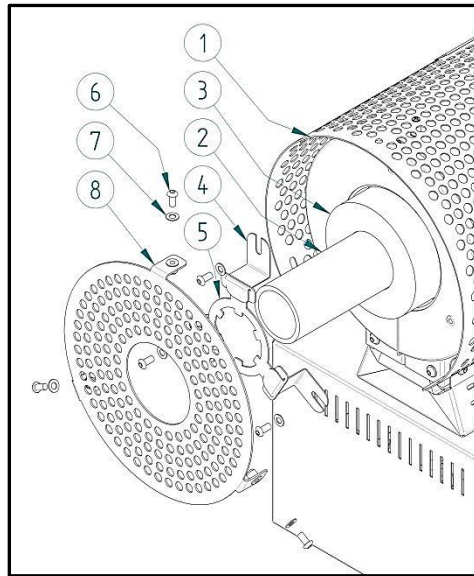


Figure 2-2. Exploded view showing how to fit the work tube in the EHA

Index to numbered items in Figure 2-2

1. EHA/EHC tube furnace
 2. Work tube (diameter customer option)
 3. Work tube adaptor (size dependent on work tube diameter)
 4. Work tube adaptor fixing bracket
 5. Work tube end stop (size dependent on work tube diameter)
 6. Fixing screws M6 x15
 7. Washer M6
 8. Tube furnace end guard
- Remove the work tube end guard (item 8) then remove the work tube adaptor fixing bracket (4) that holds in place the work tube end stop (5) and the work tube adaptor (3) from one side only. Note that if a different work tube with a different outer diameter is being fitted it will be necessary to fit new correctly sized work tube adaptors (3) in which case both end guards and work tube adaptor fixing brackets (4) will need removing.
 - Slide the work tube into the furnace through the work tube adaptor (3) until it reaches the opposite work tube end stop (5). Note that the work tube might be a tight fit when it is new and may need to be twisted backwards and forwards slightly as it slides in. For long work tubes it may be necessary to use a long wooden pole such as a broom handle to support and line up the work tube as it is pushed through. It may also take 2 people to perform this operation.
 - Reassemble the work tube end stop (5), work tube adaptor bracket (4) and tube end guard (8).

Fitting the standard work tube in an EST/EZS furnace. (No tools required.)

The fitting of the work tube is as follows with reference to Figure 2-3. Please note that standard work tubes are also referred to as tubes suitable for working in air. They are 150mm longer than the heated length of the furnace (see Table 9-1 page 24). Read section 5.2 before fitting the work tube.

- Release the top fixing clips item 4 in Figure 2-9; lift the lid by the handle (1).
- Place the work tube into the bottom half of the furnace in the tube adaptors, between the work tube end stops (5). Note that the work tube might be a tight fit when it is new and may need to be twisted backwards and forwards slightly as it is placed.
- Lower the lid by the handle and refasten the clips.
- Note in Figure 2-3 the right hand furnace end guard (8) is not shown so that the tube adaptor (3) and tube end stop (5) can be seen. It is not necessary to remove the guards to fit the work tube.

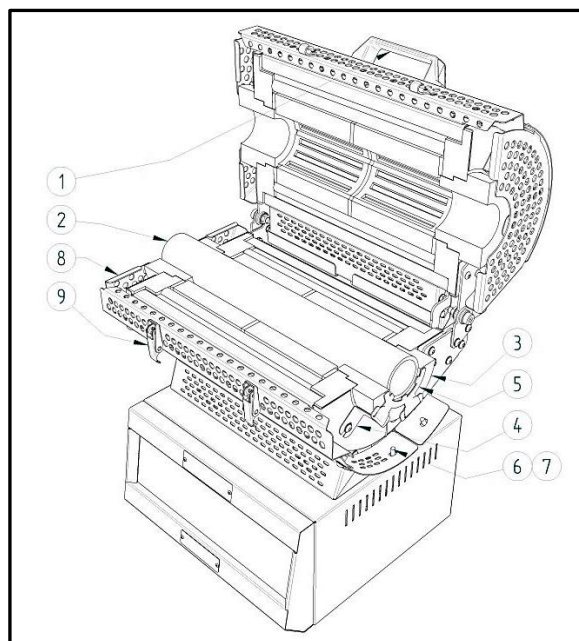


Figure 2-3. View showing how to fit the standard work tube in the EST/EZS. Note that the right hand furnace end guard item 8 has been removed from the view for clarity to show the tube adaptor and tube end stop.

Index to numbered items in Figure 2-3.

1. Top lifting handle
2. Work tube (diameter customer option)
3. Work tube adaptor (size dependent on work tube diameter)
4. Work tube adaptor fixing bracket
5. Work tube end stop (size dependent on work tube diameter)
6. Fixing screws M6 x15
7. Washer M6
8. Tube furnace end guard
9. Top fixing clip

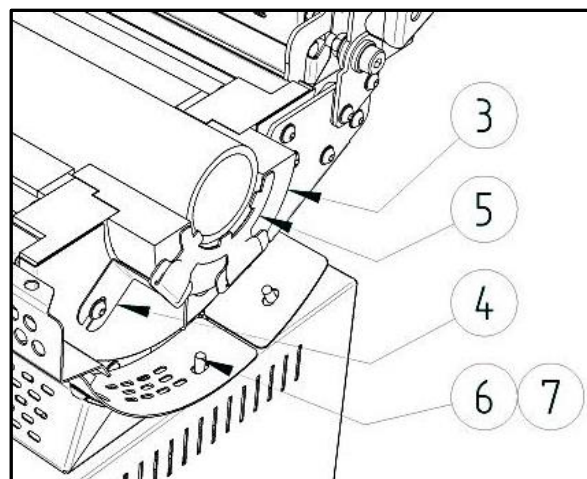


Figure 2-4. Close-up view of the tube end stop for a standard work tube on the EST/EZS. Note that the right hand furnace end guard item 8 has been removed from the view for clarity to show the tube adaptor and tube end stop.

Fitting the extended work tube in an EHA/EHC/EST/EZS furnace

(Tools required: 4mm Hex key.)

The fitting of the work tube is as follows with reference to Figure 2-2 on page 4, Figure 2-3 on page 5, Figure 2-5 and Figure 2-6 on page 6. Please note that extended work tubes are also referred to as tubes suitable for working in a modified atmosphere or vacuum. They are 450mm longer than the heated length of the furnace (see Table 9-1 page 24). Read section 5.2 before fitting the work tube.

- Before the extended work tube can be fitted, the work tube end stops for the standard work tube (item 5 in Figure 2-2, page 4 and Figure 2-3, page 5) must be removed from both ends of the furnace. This is done by removing the furnace end guard (8) and the work tube adaptor brackets (4) to release the work tube end stop. The guards and brackets should then be refitted..
- Fit the extended work tube bracket Item 2 Figure 2-5, page 6. Note that on the EHA/EST150 and EHA/EST300 models the fixing holes are in the furnace mounting cradle (10). The fixings required (11 and 12) also hold the furnace onto the cradle. Remove these fixing screws and reattach with support bracket (2) in place. Fit one bracket at a time so that the furnace is always held in place by the other end. On the EHA/EHC/EST/EVS450 and EHA/EHC/EST/EVS600 models the fixing holes are in the end on the terminal cover. Use the M6 washers (11) and M6x16 dome cap screws (12) supplied.
- For EHA/EHC models slide the extended work tube into the furnace through the work tube adaptor Figure 2-2 (3). Note that the work tube might be a tight fit when it is new and may need to be twisted backwards and forwards slightly as it slides in. For long work tubes it may be necessary to use a long wooden pole such as a broom handle to support and line up the work tube as it is pushed through. It may also take 2 people to perform this operation. Position the work tube so that an equal amount work tube extends from either end of the furnace.
- For EST/EVS models lift the lid by the handle (1) and position the work tube in the bottom half of the furnace on the work tube adaptors Figure 2-3 (3).
- For EHA/EHC/EST/EVS models, loosely fit the work tube support boss Figure 2-5 (5), "O" ring (6), clamp ring (7), clamp (8), extended work tube slide bracket (3) and adaptor plate (4) onto the work tube in the position shown in Figure 2-6 (approx. 77 to 79mm from the work tube end). Note that the clamp is on the outside of the bracket and that the gap of approximately 7 to 9mm on the inside of the bracket is to allow the work tube to expand at high temperatures.
- Tighten the compression clamp (8) then adjust the position of the slide bracket (3) until it is begins to support the weight of the work tube. Tighten the screw knobs (9) to hold in place and check the work tube ends are still supported, if not then readjust.
Note that the position of work tube supports should be checked each time before the furnace is used.

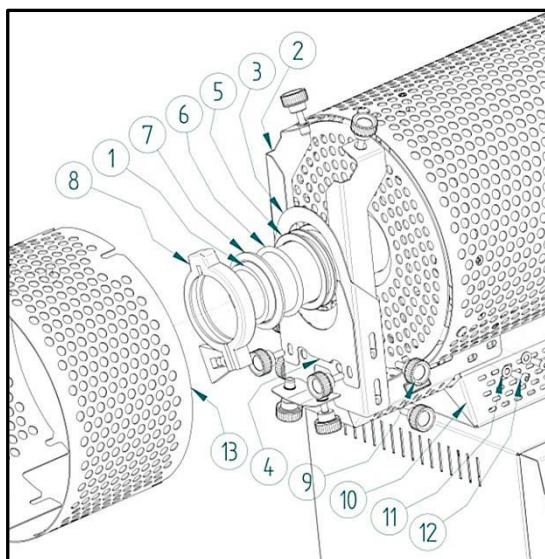


Figure 2-5. Exploded view showing how to fit extended work tube and supports on a EHA.

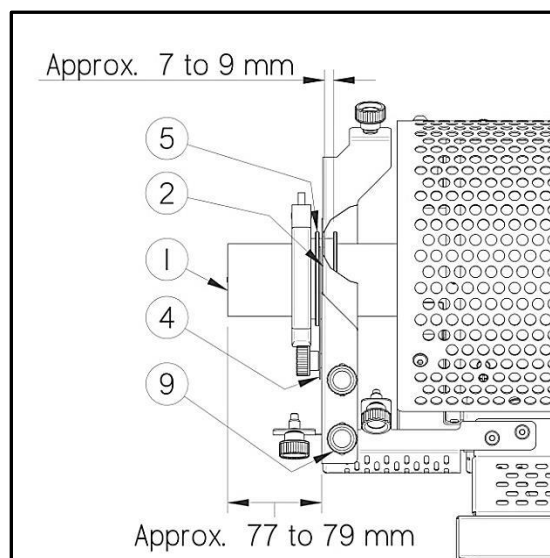


Figure 2-6. Cutaway assembled view showing the position of the support boss on the work tube.

Index to numbered items in Figure 2-5, Figure 2-6, Figure 2-7 and Figure 2-8.

1. Work tube (diameter customer option)
 2. Extended work tube support bracket
 3. Extended work tube slide bracket
 4. Work tube adaptor plates (adaptor plates for 25mm, 43mm and 63mm OD work tubes are supplied in a kit, select the correct ones to suit the work tube outside diameter)
 5. Work tube support boss (this is size dependent on work tube diameter)
 6. "O" ring
 7. Clamp ring
 8. Clamp
 9. M6 screw knob
 10. Furnace mounting cradle
 11. Washer M6
 12. Fixing screws M6x16 dome cap screw
 13. Extended work tube guard
 14. Gas/vacuum end seal option (fitting instructions: Installation, Operation & Maintenance Instructions Tube End Seal Gas and Vacuum Application MF64)
- If gas/vacuum end seals (14) (Figure 2-7, page 7) are required, follow the separate fitting instructions supplied with the end seals (Installation, Operation & Maintenance Instructions Tube End Seal Gas and Vacuum Application MF64) .If not, fit the end guard (13) by sliding it on and holding in place by the screw knobs (9).

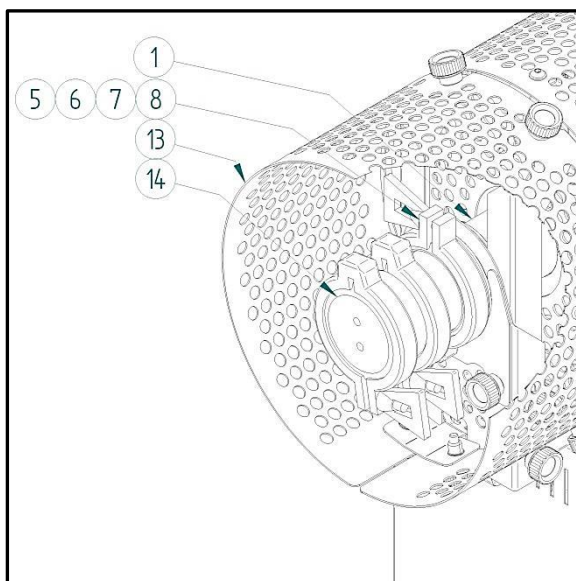


Figure 2-7. Cutaway view showing the extended work tube option with gas/vacuum end seals fitted.

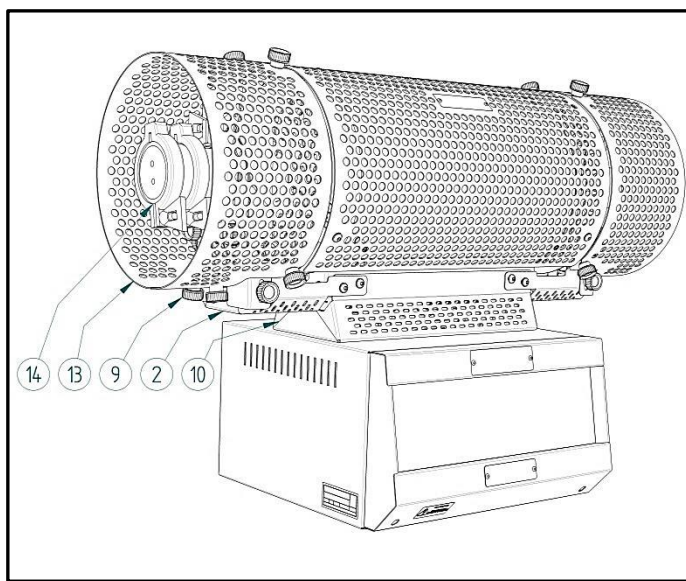


Figure 2-8. EHA furnace with the extended work tube, gas/vacuum end seal, work tube support and end guard options fitted.

2.4 Setting up – vertical Models

The EVA and EVC vertical models must have their stands assembled, the furnace mounted on the stand and their work tubes fitted before they can be used.

Assembling the stand and mounting the furnace - (Tools required: 4mm Hex key.)

The assembly of the vertical stand is as follows with reference to Figure 2-9, Figure 2-10 & Figure 2-11:

- Place the vertical stand base item (1) on the floor or bench on which it is to be assembled.
- Position the vertical stand upright (2) on the stand base in line with the fixing holes.
- Secure the stand upright to the base using the 6x M6 dome cap screws (4) and washers (3) supplied.
- Partially screw in the top M6 screw knobs, 2x (6) into the frame upright as shown in Figure 2-11.
- Hook the EVA/EVC/EVT/EVZ furnace onto the top screw knobs. This may take 2 people to lift the furnace.
- Fit the bottom screw knobs x2 and tighten all four.

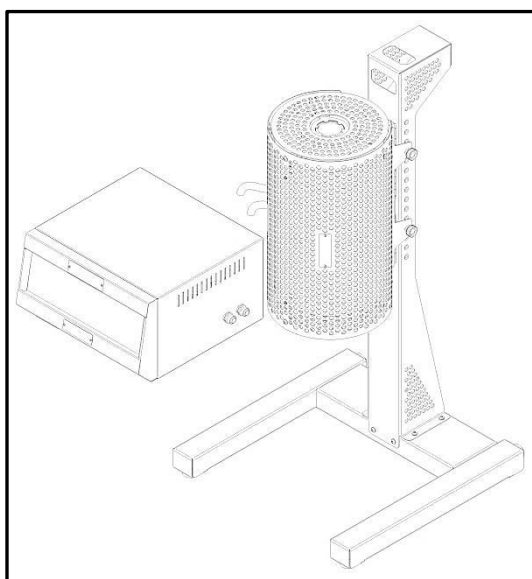


Figure 2-9. EVA vertical model mounted on its stand.

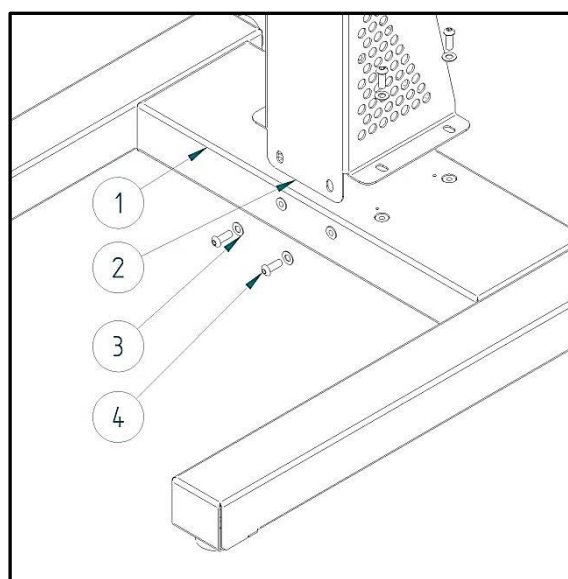


Figure 2-10. Assembling the EVA vertical stand.

Index to numbered items in Figure 2-10 and Figure 2-11

1. Vertical stand base
2. Vertical stand upright
3. Fixing screws M6x16 dome cap screw
4. Washer M6
5. EVA/ EVC Tube furnace
6. M6 screw knob

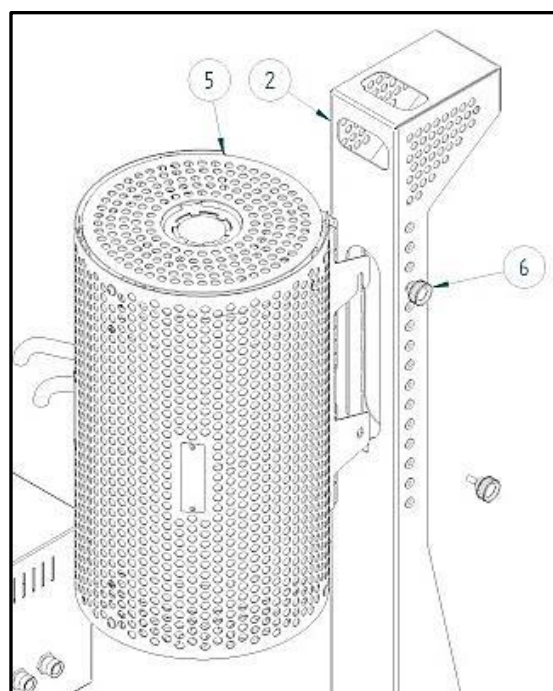


Figure 2-11. Mounting the EVA/EVC onto the vertical stand

Using the EVA/EVC/EVT/EVZ horizontally

The EVA and EVC models can be used either with the stand vertically as shown in Figure 2-9, page 8 or horizontally as shown in Figure 2-12.

To use horizontally simply tip the stand over into the horizontal position making sure that the flexible conduits are not trapped beneath the frame. This may take 2 people to do on the larger models.

The position of the furnace on the stand can be adjusted if necessary.

Note: To prevent injury to the operator and damage to the furnace this must only be done when the furnace is switched off and cold.

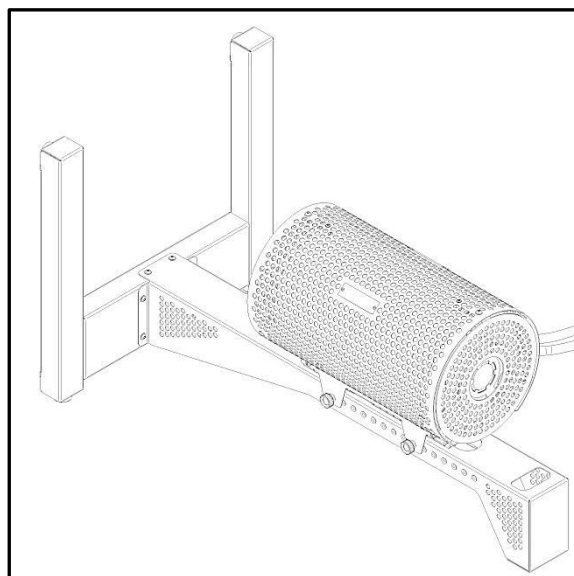


Figure 2-12. EVA/EVC positioned horizontally on the stand

Fitting the standard work tube in an EVA/EVC furnace. (Tools required: 4mm Hex key.)

Note that the EVT/EVZ models can only be used with the extended length work tube. This is to allow the work tube to be held in place when the furnace is opened in the vertical position. The diameter of the work tube is a customer order option and therefore varies between tube furnaces. The fitting of the work tube is as follows with reference to Figure 2-13. Note that standard work tubes are also referred to as tubes suitable for working in air; they are 150mm longer than the heated length of the furnace (see Table 9-1 page 24). Read section 5.2 page 19 before fitting the work tube.

- Remove the top work tube end guard (item 8) then remove the work tube adaptor fixing bracket (4) that holds the work tube end stop (7) and the work tube adaptor (3) in place. Note₍₁₎ it might be easier to do this with the furnace in the horizontal position as shown in Figure 2-12 page 9.
Note₍₂₎ if a different work tube with a different outer diameter is being fitted it will be necessary to fit new correctly sized work tube adaptors (3) in which case both end guards and work tube adaptor fixing brackets (4) will need removing.
- Slide the work tube into the furnace through the work tube adaptor (3) until it reaches the opposite work tube bottom stop (7). Note that the work tube might be a tight fit when it is new and may need to be twisted backwards and forwards slightly as it slides in. For long work tubes it may be necessary to use a long wooden pole such as a broom handle to support and line up the work tube as it is pushed through. It may also take 2 people to perform this operation.
- Reassemble the work tube end stop (7), work tube adaptor bracket (4) and the tube end guard (8).

Index to numbered items in Figure 2-13.

1. EHA/EHC tube furnace
2. Work tube adaptor (size dependent on work tube diameter)
3. Work tube (size diameter customer option)
4. Work tube adaptor fixing bracket
5. Fixing screws M6 x15
6. Washer M6
7. Work tube end stop (dependent on work tube diameter)
8. Tube furnace end guard

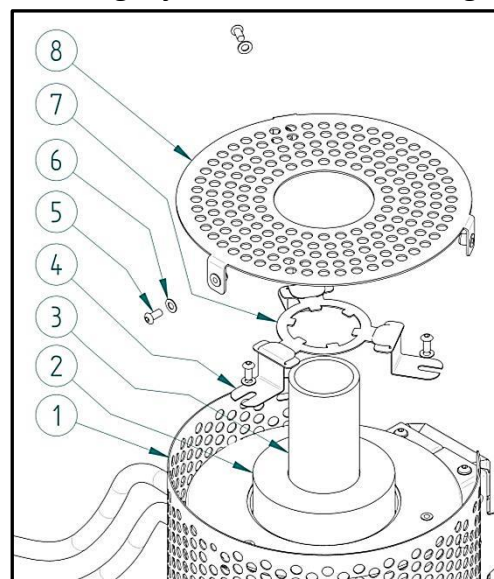


Figure 2-13. Exploded view showing how to fit the work tube in the EVA

Fitting the extended work tube in an EVA/EVC/EVT/EVZ furnace

(Tools required: 4mm Hex key.)

The fitting of the work tube is as follows with reference to Figure 2-3, page 5, Figure 2-13, page 9, Figure 2-15 and Figure 2-14 on page 10. Please note that extended work tubes are also referred to as 'tubes suitable for working in a modified atmosphere or vacuum'. They are 450mm longer than the heated length of the furnace (see Table 9-1 page 24). Read section 5.2 before fitting the work tube.

Note it is easier to fit the work tube with the furnace in the horizontal position as shown in Figure 2-12 page 9.

- For EVA/EVC models: before the extended work tube can be fitted, the work tube end stops for the standard work tube (Item 7 in Figure 2-13, page 9) must be removed from the top and bottom of the furnace. This is done by removing the end guard (8) and the work tube adaptor brackets (4) to release the work tube end stop. The guards and brackets are then refitted.
- EST/EVS models: these only use extended work tubes; no work tube end stops are supplied.
- Fit the extended work tube bracket Item 2 Figure 2-15, page 10. Note that on the EVA/EST150 and EVA/EST300 models the fixing holes are in the furnace mounting cradle (10). The fixings required (11 and 12) also hold the furnace onto the cradle. Remove these fixing screws and reattach with support bracket (2) in place. Fit one bracket at a time so that the furnace is always held in place by the other end.
On the EVA/EVC/EVT/EVZ450 and EVA/EVC/EVT/EVZ600 models the fixing holes are in the end of the terminal cover, use the M6 washers (11) and M6x16 dome cap screws (12) supplied
- For EVA/EVC models; with the furnace in the horizontal position, slide the extended work tube into the furnace through the work tube adaptor (3) Figure 2-13, page 9. Note that the work tube might be a tight fit when it is new and may need to be twisted backwards and forwards slightly as it slides in. For long work tubes it may be necessary to use a long wooden pole such as a broom handle to support and line up the work tube as it is pushed through. It may also take 2 people to perform this operation. Position the work tube so that an equal amount of work tube extends from either end of the furnace.
- For EST/EVS models; with the furnace in the horizontal position lift the lid by the handle Figure 2-3 (1) and position the work tube in the bottom half of the furnace on the work tube adaptors Figure 2-3 (3).

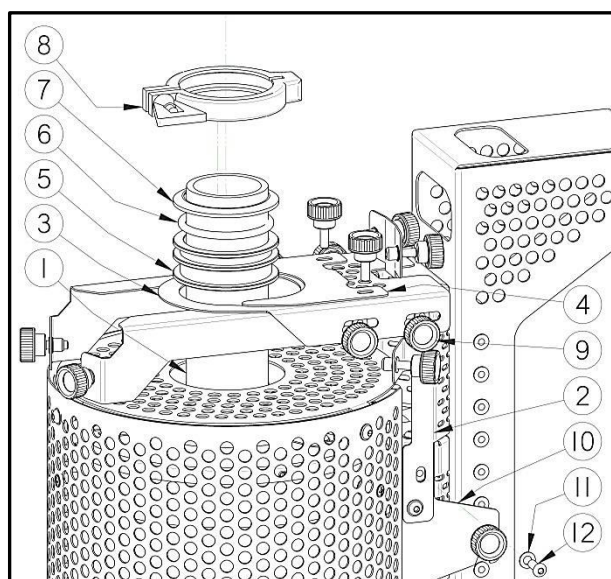


Figure 2-15. Exploded view of the parts in the supports for the extended work tube.

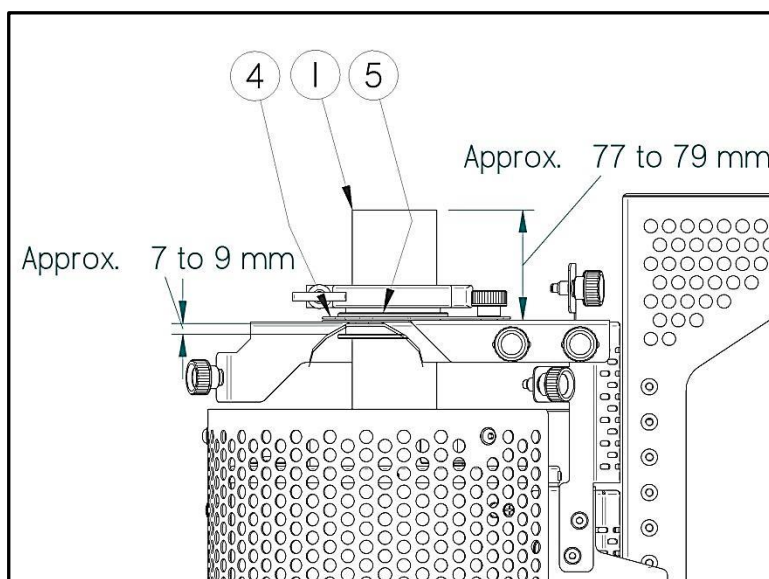


Figure 2-14. Cutaway assembled view of the supports for the extend work tube and their position.

- **Loosely** fit the work tube support boss Figure 2-15 (5), “O” ring (6), clamp ring (7), clamp (8), extended work tube slide bracket (3) and adaptor plate (4) onto the work tube in the position shown in Figure 2-14 (approximately 77 to 79mm from the work tube end). Note that the clamp is on the outside of the bracket and that the gap of approximately 7 to 9mm on the inside of the bracket is to allow the work tube to expand at high temperatures.
- Tighten the compression clamp (8) then adjust the position of the slide bracket until it begins to support the weight of the work tube. Tighten the screw knobs (9) to hold in place and check the work tube ends are still supported, if not then readjust.
Note that the position of work tube supports should be checked before each time the furnace is used

Index to numbered items in Figure 2-15, Figure 2-14, Figure 2-16, Figure 2-17 and Figure 2-18.

1. Work tube (diameter customer option)
2. Extended work tube support bracket
3. Extended work tube slide bracket
4. Work tube adaptor plates (adaptor plates for 25mm, 43mm and 63mm OD work tubes are supplied in a kit - select the correct ones to suit the work tube OD)
5. Work tube support boss (this is size dependent on work tube diameter)
6. “O” ring
7. Clamp ring
8. Clamp
9. M6 screw knob
10. Furnace mounting cradle
11. Washer M6
12. Fixing screws M6x16 dome cap screw
13. Extended work tube guard
14. Gas/vacuum end seal option (fitting instructions: Installation, Operation & Maintenance Instructions Tube End Seal Gas and Vacuum Application MF64)

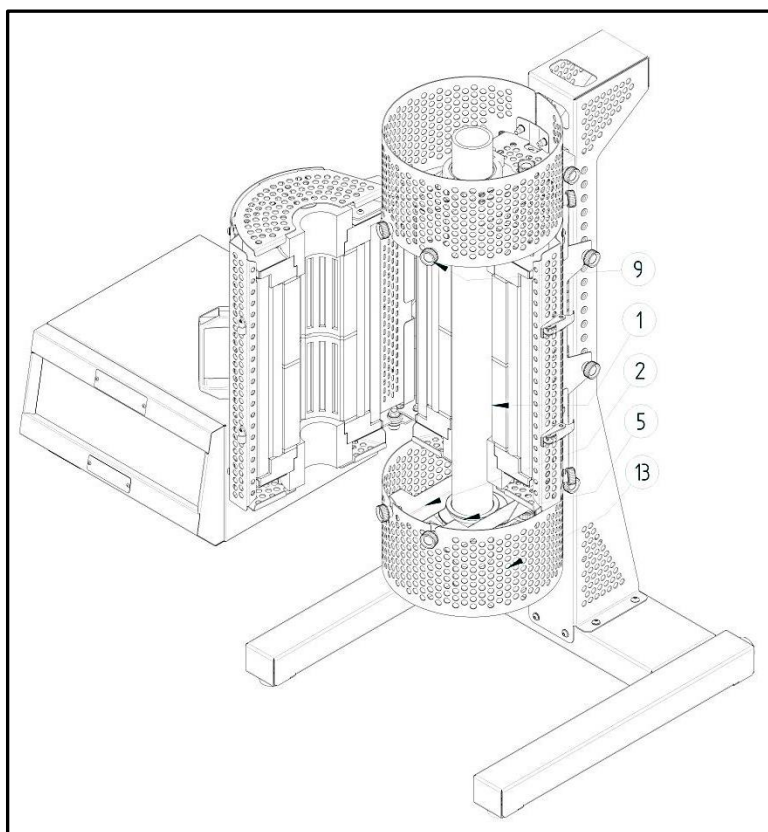


Figure 2-16. EVT with an extended work tube fitted.

- If gas/vacuum end seals (14) Figure 2-17, page 12 are being fitted follow the separate fitting instructions supplied with the end seals (Installation, Operation & Maintenance Instructions Tube End Seal Gas and Vacuum Application MF64) otherwise, fit the end guard (13) by sliding on and hold in place by the screw knobs (9).

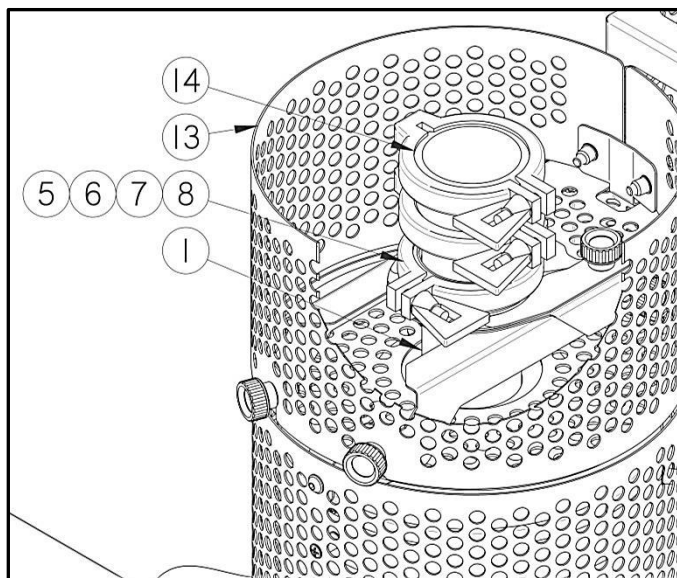


Figure 2-17. Cutaway view of the EVA showing the extended work tube option with gas/vacuum end seals fitted.

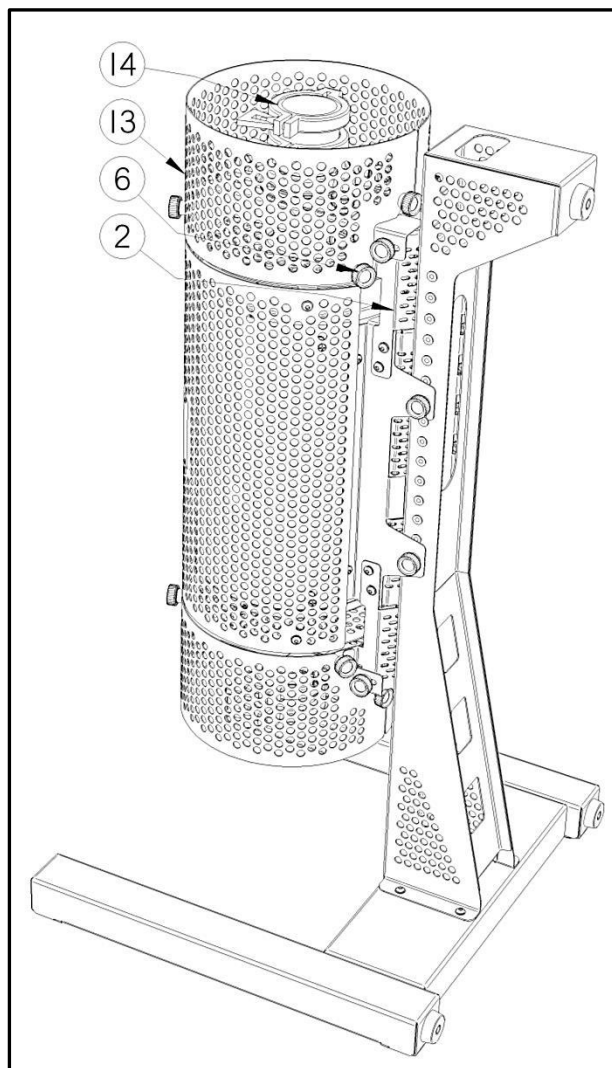


Figure 2-18. EHA furnace with the extended work tube, gas/vacuum end seal, work tube support and end guard options fitted.

2.5 Setting up – vertical models supplied without a stand

Any of the E-range vertical furnaces (EVA / EVC / EVT / EVZ) can be supplied without a stand for either wall mounting on a wall bracket (order option) or into a customer's own test rig/mounting frame.

 It is the customer's responsibility to carry out a risk assessment on the siting and mounting of the furnace and to ensure that it is operated in a safe manner, (see section 2.2 on page 3 for recommended siting instructions).

The fitting of the work tube is covered in either sections 2.3 or section 2.4 depending on the model.

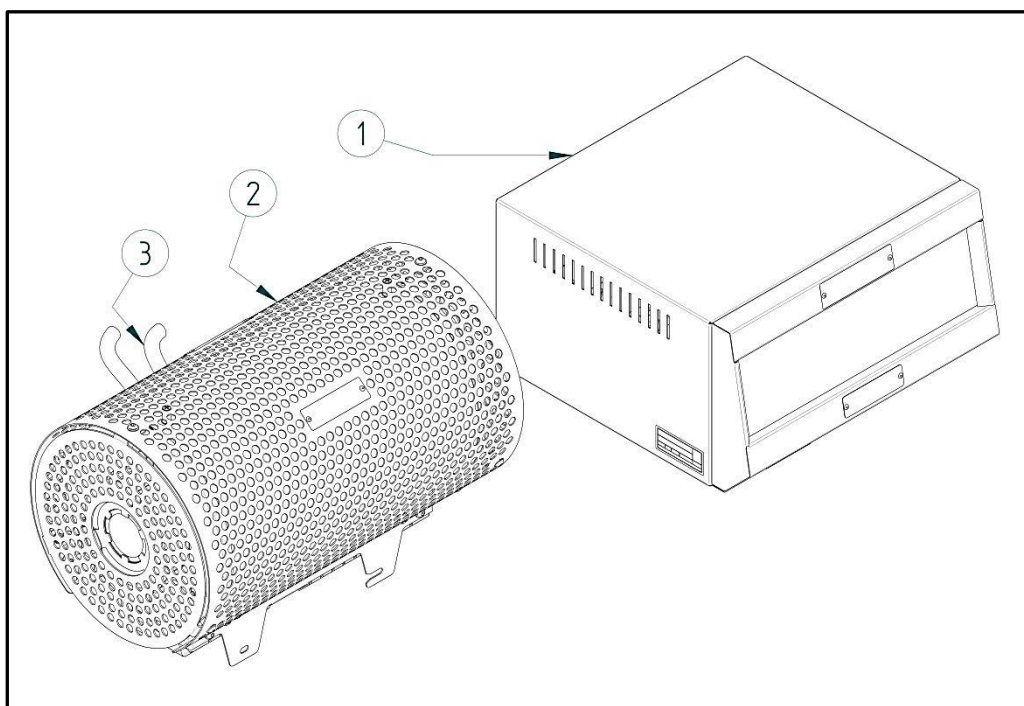


Figure 2-19. EVA 12/300 furnace shown without a stand for customers own mounting as an example.

Index to numbered items in Figure 2-19.

- 1- Control box
- 2- Furnace body
- 3- Connecting conduit between furnace and control box.

Fitting the optional insulating plugs and radiation shield

For optimum temperature uniformity insulating plugs or radiation shields should be placed in the work tube ends as shown in Figure 2-21, Figure 2-20 and Figure 2-22. With an extended work tube the stem (8) of the insulation plug assembly lines up with the end of the work tube.

If a gas/vacuum end seal is fitted (4), either horizontally or vertically, the insulation plug hooks onto the end seal hook; see Figure 2-20.

Alignment of radiation shields is similar to that of insulation plugs see Figure 2-22.

If a metal work tube is being used in the furnace, ensure that it is earthed. See the safety warning in section 3.5.

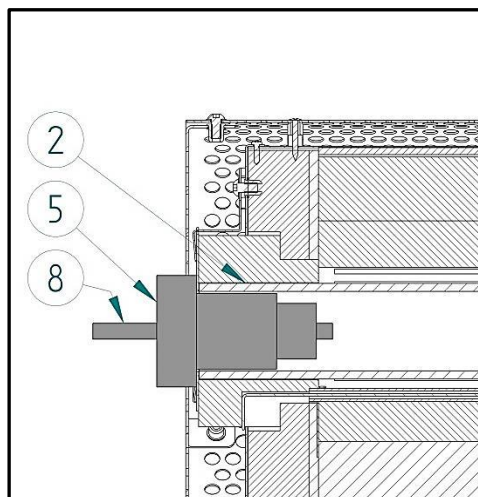


Figure 2-21. Cross-section view showing standard length work tube insulation plug fitted.

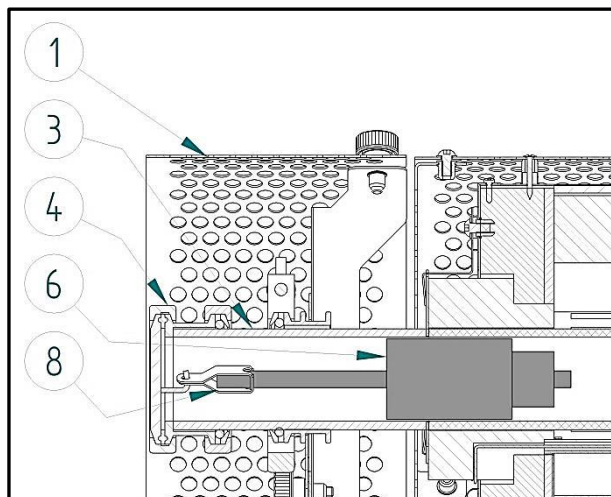


Figure 2-20. Cross-section view showing extended work tube insulation plug fitted.

Index to numbered items in Figure 2-21, Figure 2-20 and Figure 2-22

1. Extended work tube guard
2. Standard work tube
3. Extended work tube
4. Gas/vacuum end seal
5. Insulation plug for standard work tube
6. Insulation plug for extended work tube
7. Radiation shield for extended work tube
8. Insulation plug stem

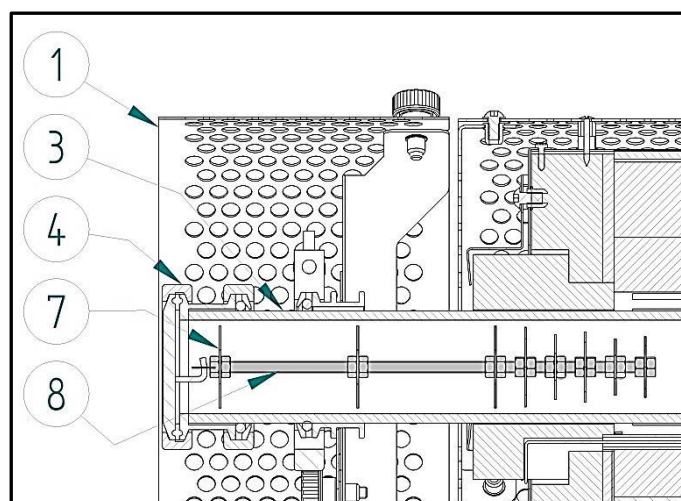


Figure 2-22. Cross-section view showing extended work tube radiation shield fitted

2.6 Electrical Connections



The electrical supply MUST incorporate an earth (ground).

Connection by a qualified electrician with the correct certification to meet local legislation is recommended.

All E-range furnaces are single-phase models and operate over the voltage ranges 100V to 110V or 200V-240V. The furnace is wired and has a configured “output power setting” (OP.Hi) related to supply voltage according to the original order. Check the furnace rating label before connection, (see Figure 1-1 page 3 for location of rating label). To check that OP.Hi setting is correct for the appropriate voltage, or to change to another setting, follow the instructions in section 8.3 page 24.

The electrical supply should be fused at the next standard size equal to or higher than the design amperage. Where a supply cable is supplied there are internal supply fuses, in which case customer fusing is preferred but not essential. See section 8.2, page 23 for furnace rated power, current and fusing information.

All 200 to 240volt furnaces are supplied with 2 leads. Each has a type EL-711 straight plug at one end to EC 63020 that plugs in the back of the control panel see Figure 1-2 page. The mains plug at the other end which is either a standard UK plug type EL-210 to BS1363 fused at 13A or a European plug type EL-202 to CEE7. If another type of mains plug is required, cut off the mains plug from one of the leads and connect the appropriate locally sourced plug. This should be done by an electrically competent person. See Table 2-1 below for wire colour coding.

For 100 to 110 volt furnaces no mains lead is supplied and there is a blanking plate which covers the mains lead socket position (see Figure 1-2 page 3).

On these furnaces drill/punch a hole in the side of the case for a mains cable to fit through with the appropriate strain relief glands; the position for this is shown in Figure 2-23. Terminate the cable inside the case on the terminal block as shown in Figure 2-24 using the terminals marked L N PE, (see Table 2-1 below for terminal details). The external connection should be either a permanent connection to a fused isolator supply or to a socket on a fused isolator supply; the isolating switch must operate on both conductors. Make sure that the isolator switch is within in easy reach of the furnace operator.

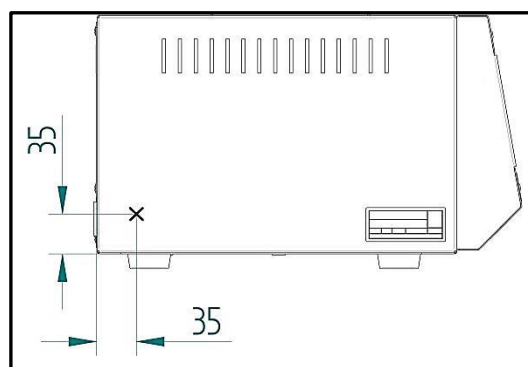


Figure 2-23. Position of cable entry on 100v to 110v models with heated lengths of 450 or 600mm.

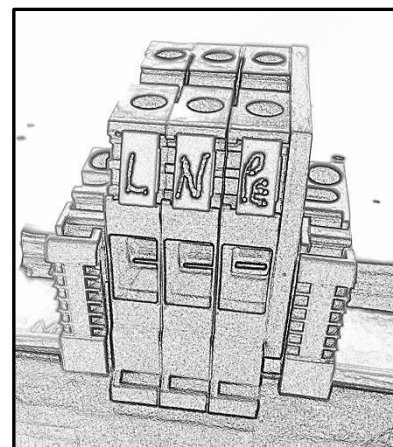


Figure 2-24. Internal terminal block for mains wiring connection on 100v to 110v models.

Table 2-1. Terminal connection details.

Supply	Terminal label	UK/Europe Cable colour	USA/Canada Common Cable colours	Supply type	
				Live-Neutral	Reversible or Live-Live
1-phase	L	Brown	Red or Black	To live	to either power conductor
	N	Blue	White	To neutral	to the other power conductor
	PE	Green/Yellow	Green or Green/Yellow	To earth (ground)	to earth (ground)

3 **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 **Before Operating the Furnace**

For the safe operation of this furnace the following warnings must be followed:



Explosive Materials

The furnace must not be used to heat materials which could explode, or which could emit gases that could form explosive mixtures.

If the safe heating of a material is dependent on its temperature then only heat these type of materials if the furnace has the optional over-temperature protection device fitted, even then ensure that the over-temperature device is calibrated and set to an over temperature safety limit that is sufficiently large as to avoid any hazards, if in doubt then seek expert advice. Customers are responsible for carrying out their own risk assessments on the heating of materials.



Do not operate without a work tube. The furnace must not be operated without the correctly sized work tube for the furnace which has the matching correctly sized work tube adaptors or it could be possible to for an operator to access electrically live element coils that could cause serious injury or death.



Switch off the furnace before loading and unloading. The furnace heaters must be switched off using the heater switch item 2 in Figure 1-1 page 3 when the furnace is being loaded or unloaded. This is because the work tube can become electrically conductive at high temperatures, presenting a possible hazard to an operator that could cause serious injury or death if an element failed and collapsed onto a work tube and was not detected.

3.2 **Operating cycle**

The furnace is fitted with an instrument switch. The switch cuts off power to the control circuit. There is also a Heater switch that can be used to disconnect power to the elements.

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.

Single zone models, EHA and EVA: Set the temperature controller to the desired set point or program - see the controller manual.

3-zone models, EHC and EVC, with control methods A & B: Set the slave (end zone) controllers to the desired offset temperature, usually zero. Set the main (central) temperature controller to the desired set point or program. See section 3.3 and/or the separate manual(s) for the controller(s).

3-zone models, EHC and EVC, with control method C: Set the three controllers to the desired temperatures. See the separate manual(s) for the controller(s).

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

Switch on the Heater switch, located on the instrument panel. 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 set point.

Over-temperature option only. If the over-temperature trip operates then an indicator in the over-temperature controller flashes and the heating elements are isolated. Find and correct the cause before resetting the over-temperature controller according the instructions supplied.

To switch the furnace off, use both the Heater switch and the Instrument switch. If the furnace is to be left off unattended, isolate it from the electrical supply.

3.3 3-zone Control Methods – models EHC and EVC

These models are typically designed to achieve an extended uniform temperature zone by the use of three control zones. The end-zone length for the 3-zone models is 1 element (150mm). The control zones are typically linked so that the end controllers follow the central controller in a master-slave approach, in one of two ways. Alternatively independent control zones may be ordered. There are thus three control methods (A, B & C).

Achieving temperature differences across the zones: a small temperature difference may be achievable, but this is limited by the effect of radiated heat inside the furnace body, and in the work tube, and depends also upon the furnace contents.

A. Back-to-Back Thermocouples

This is the most commonly supplied option.

The central zone of the work tube is controlled directly by the central temperature controller. Each end zone thermocouple is wired in opposition to a central reference thermocouple, and the small voltage resulting when the zones are at different temperatures is used by the end zone controller. There are thus four thermocouples. The circuit diagram in section 7.2 (A) shows the thermocouple arrangement.

Set the set point of the end zone controllers to zero. Alternatively, a small temperature difference (offset) can be created by setting a non-zero value, but the sum of the main controller set-point and the slave controller offset **MUST NOT** exceed the furnace maximum temperature. The “measured temperature” display shows the actual offset.

To alter the set point refer to the control manual supplied with this furnace.

Sometimes a furnace using this type of control does not cool down: the end zone controllers try to remain at the current central temperature. Should this occur, contact Carbolite’s technical department.

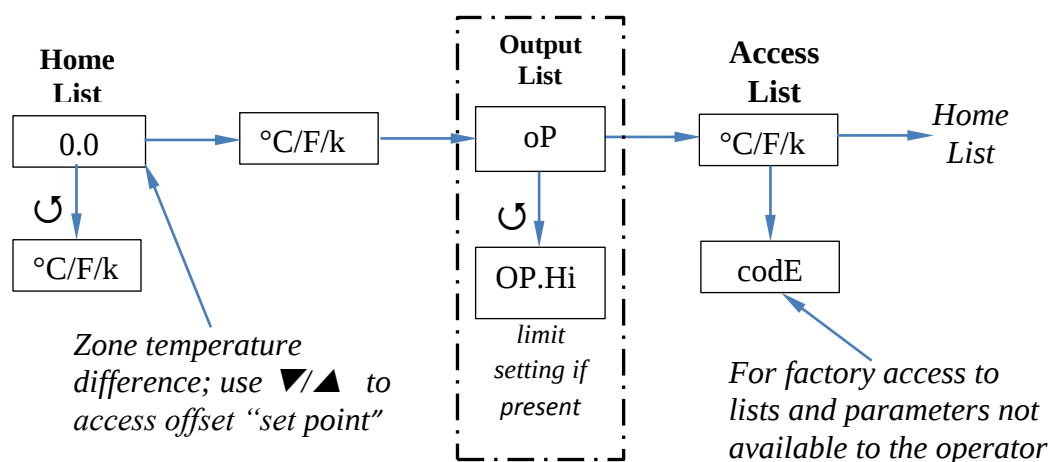


Figure 3-1. 2132 Slave Controller navigation

B. Retransmission of Set point Using Broadcast Communications

When this is ordered there are three independent thermocouples connected to the three controllers. The controllers are linked together, the central controller communicating the desired set point to the end zone controllers.

Additional communication modules are fitted in the controllers, rather than an additional thermocouple as in A. The communication between the controllers of the Eurotherm 3000 series is known as Broadcast comms. The wiring connections between the controllers are shown in section 7.3 page 22.

It is possible to switch off the linked control and allow the controllers to work independently. In level 2 of the end zone controller (see controller operating instruction), scroll to L-r and use the ▲ Up ▼ Down and select NO. There is no need to alter the centre controller.

It is possible to use local trim in the end zone controllers to enter a positive or negative adjustment from the centre zone temperature. Once entered this trim will always be added or subtracted from the retransmitted set temperature. In level 2 of the end zone controller (see controller operating instruction), scroll to LOC.T (local trim) and use the ▲ Up ▼ Down enter the desired positive or negative difference to be added to the end zone set temperature. There is no need to alter the centre controller.

C. Independent Control

In this case the three controllers are completely independent. Remember that it is not possible to maintain very different zone temperatures because of heat transfer within the furnace body and work tube.

3.4 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 rating label and in section 9.1 page 24 of this manual.

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.

3.5 Operator Safety

 The ceramic materials used in furnace manufacture become electrically conductive to some extent at high temperatures. Also, there are partially exposed heating coils in the chamber. DO NOT use any conductive tools within the work tube without isolating it. If a metal work tube is used, it must be earthed (grounded).

 Switch off the Heater switch whenever loading or unloading the furnace. The elements are isolated when the Heater switch is OFF (see Figure 1-1, page 3). This switch cuts both sides of the circuit via a contactor

3.6 Work tube Life

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

Poor thermal contact should be encouraged between the work piece and the work tube; crucibles or boats should be of low thermal mass and should have feet to reduce the contact with the work tube (Figure 3-2).

Do not set too high a heating rate. Large diameter work tubes are more susceptible to thermal shock than smaller diameters. Work tubes that extend beyond the heated part of the furnace are more at risk. A general rule for maximum heating rate is 400/internal diameter (°C/min); for 75mm i/d work tubes this comes to 5°C per minute. The controller can be set to limit the heating rate.

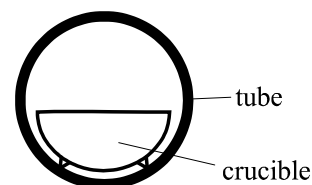


Figure 3-2. Diagram Showing Poor Thermal contact of Work piece to Avoid Work tube Cracking

3.7 Pressure

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

3.8 Gas Tightness

IAP material work tubes are impervious; sillimanite may look similar but is porous. Ensure that the correct work tube material is used before connecting and using any gases other than inert gases such as nitrogen.

4 MAINTENANCE

4.1 General Maintenance

No routine maintenance is required. The outer surfaces may be cleaned with a damp cloth. Do not allow water to enter the interior of the control box, work tube or furnace insulation/element assembly (main body of the furnace where the work tube is located). Do not clean with organic solvents.

4.2 Calibration

After prolonged use the controller and/or thermocouple may require recalibration. This is 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. These items can be supplied by Carbolite.

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 email often enables a fault to be diagnosed and the necessary spare part despatched. Please see back page of this manual for Carbolite Engineering Services contact details.

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.

Models EHA, EVA: Each kit comprises one thermocouple and one solid state relay.

Models EHC, EVC: Each kit comprises two thermocouples of different length, and one solid state relay.

When ordering spares please quote the model details i.e. model type and serial number as stated on the rating label.

5 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)
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. This controller is fitted to the back of the control panel; in many models this 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 detailed 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 back panel from the base or control box.

Make a note of how the wires are connected to the solid state relay, and disconnect them.

Remove the solid state relay (SSR) 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.

Replace the removed panel.

5.5 Thermocouple Replacement

The coverings and guards which must be removed to gain access to the thermocouple depend on the model, and possibly other options and fittings. For horizontal models it will be necessary to separate the cylindrical body from the base, or remove some guards under the protruding ends of the body. For the vertical models it will be necessary to dismount the furnace from its stand, and remove the mesh terminal cover.

Disconnect the furnace from the supply, and separate the furnace body and/or remove covers and guards as necessary.

Make a note of the thermocouple connections. Type N colour codings are:

<i>negative</i>	<i>positive (type N)</i>
white	pink

Disconnect the thermocouple from its terminal block.

Withdraw the thermocouple from the end of the furnace: ensure no broken bits remain.

If the thermocouple is supplied straight or coiled, bend it carefully to match the shape of the original (working from the terminal end). Should the length differ from that of the original this will usually not be important provided that the thermocouple tip is within a work tube diameter's distance from the furnace centre. End zone thermocouple tips should be approximately two-thirds of the way along the end element.

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

Re-assemble the furnace.

5.6 Element Replacement

Individual elements are not available for this model of furnace, if an element fails then a complete element assembly is required. For details and fitting instructions contact Carbolite Engineering Services, see back of this manual for contact information.

5.7 Fuse Replacement

Fuses are marked on the circuit diagram (section 7) with type codes, e.g. F1, F2. A list of the correct fuses is given in section 8 page 23.

If a 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.

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

6 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 heater 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 | → 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 in correct wiring or other fault which could have overloaded the SSR |

7 CIRCUIT DIAGRAMS

7.1 **Single Phase 200 to 240V wiring diagram for:
EHA12/150B to EHA12/600B & EVA12/150B to EVA12/600B**

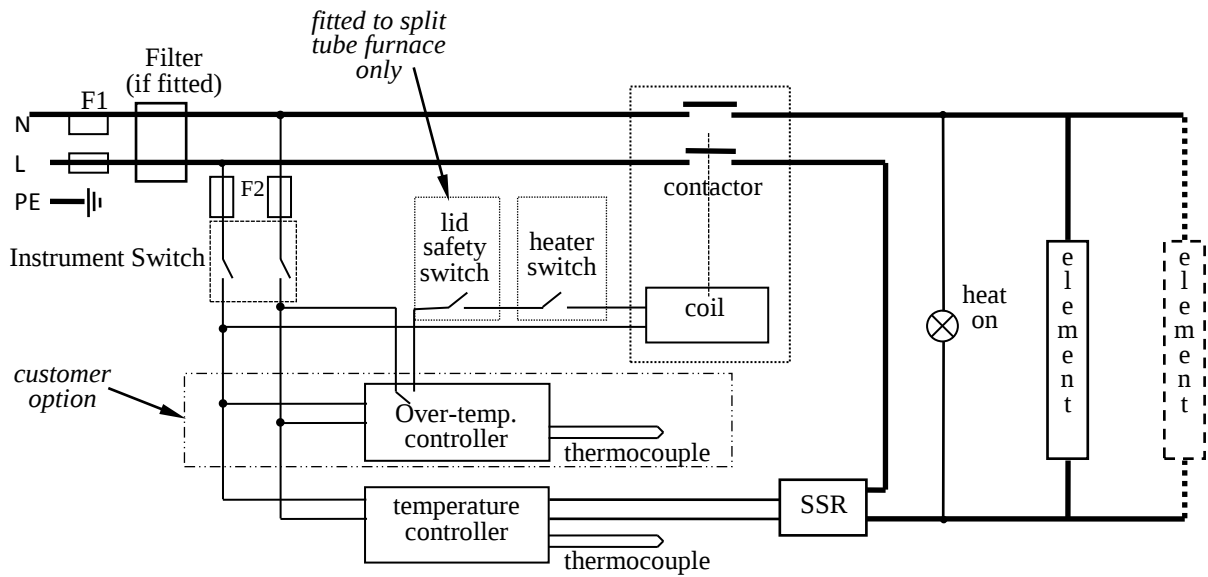
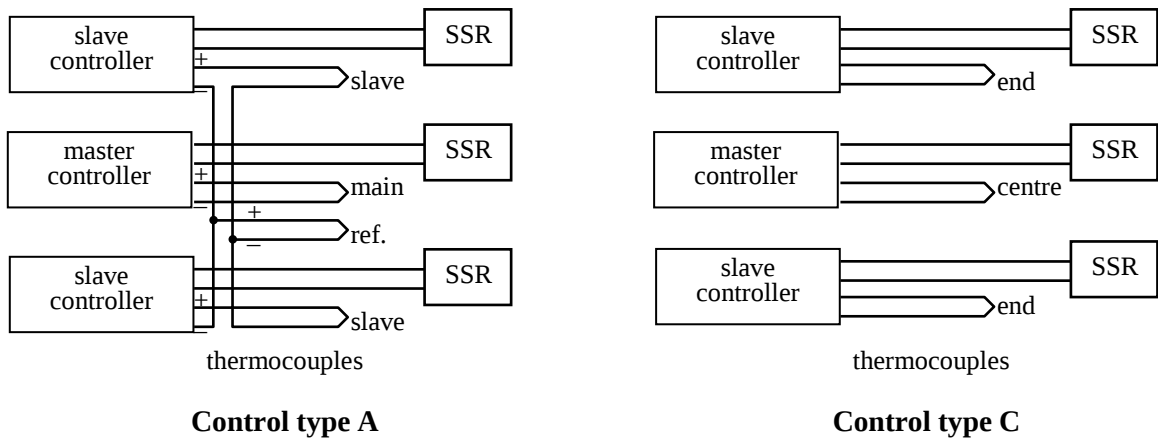


Figure 7-1. Wiring diagram for the EHA and EVA models

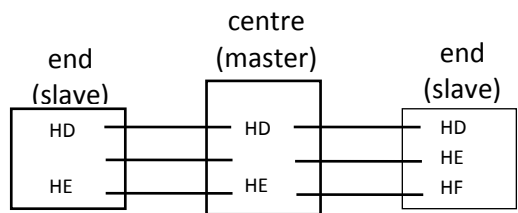
7.2 **Three-zone models**

The element circuit in the 3-zone versions remains the same as in diagram Figure 7-1, but the control circuit contains three controllers and additional thermocouples. The sub-circuits for the three control methods referred to in section 3.3 are:



Control type B - the diagram is like C, plus the connections between the controllers indicated in section 3.3 C.

7.3 **Three-zone control – Broadcast Comms**



8 FUSES & POWER SETTINGS

8.1 Fuses -

For wiring diagram information on F1 and F2 refer to Figure 7-1 page 22, for fuse values refer to Table 8-2 and Table 8-3.

Table 8-1. Fuse type information.

F1	Internal supply fuses	Fitted to all E range models. Each circuit has 2 fuses, in most cases fitted to the EMC filter board.	32mm x 10mm type F
F2	Auxiliary circuit fuses	Fitted to all E range models. In most cases fitted to the EMC filter board.	2 Amps On board: 20mm x 5mm type F Other: 32mm x 6mm type F
	Customer fuses	Required to protect customer supply circuit and lead.	See rating label for amperage; see Table 8-2 and Table 8-3 for minimum supply and fuse ratings.

8.2 Table of internal fuse and external supply ratings.

All furnace models are single phase. Most models have internal fusing as in the Table 8-2 and Table 8-3 below. Customers should check the rated amps in the tables below and make sure that their electrical supply is rated accordingly (or at least the next fuse size up from the rated amps table). Customers should also fit external fusing if their particular model of furnace does not have internal fuses. The function of the customer's (external) fuse is to protect the customer's wiring. All electrical connections other than where it is just a simple plug into an existing correctly rated electrical supply must be carried out by an electrically competent person with the correct certification to meet local legislation.

Table 8-2. Fuse ratings for 100 to 110V Supply Voltages

	Model	Power rating (Watts)	Internal supply fuses F1	Internal instrument fuses F2	Furnace rated amps 1-phase 100-110V
Single Zone	EHA/EVA/EST/EVT 12/150	750	2x10A	2x2A	7A
	EHA/EVA/EST/EVT 12/300	1480	2x16A	2x2A	14.5A
	EHA/EVA/EST/EVT 12/450	1960	2x20A	2x2A	19A
	EHA/EVA/EST/EVT 12/600	2480	2x25A	2x2A	24A
Three Zone	EHC/EVC/EZS/EVZ 12/450	1960	2x20A	2x2A	19A
	EHC/EVC/EZS/EVZ 12/600	2480	2x25A	2x2A	24A

Table 8-3. Fuse ratings for 200 to 240V Supply Voltages

	Model	Power rating (Watts)	Internal supply fuses F1	Internal instrument fuses F2	Furnace rated amps 1-phase 200-240V
Single Zone	EHA/EVA/EST/EVT 12/150	750	2x4A	2x2A	3.5A
	EHA/EVA/EST/EVT 12/300	1480	2x10A	2x2A	7.1A
	EHA/EVA/EST/EVT 12/450	1960	2x10A	2x2A	9.5A
	EHA/EVA/EST/EVT 12/600	2480	2x12A	2x2A	12A
Three Zone	EHC/EVC/EZS/EVZ 12/450	1960	2x10A	2x2A	9.5A
	EHC/EVC/EZS/EVZ 12/600	2480	2x12A	2x2A	12A

8.3 Power Settings & Adjustment

The furnace control system incorporates electronic power limiting. The power limit parameter OP.Hi is accessible to the operator, and must be used to match the furnace to the actual supply voltage. All models covered by this manual are fitted with either 104V or 208V elements and are designed for use over the range of voltages 100V -110V or 200V-240V, the power limit parameter is set accordingly. These models may be relocated safely to a different voltage within the range. Note also that the E-range furnaces are designed for optimal temperature control in the range 500°C to 1200°C. Below this temperature range some temperature instability may be observed and the controller may overshoot its set point temperature by more than 20°C. Temperature stability and setpoint temperature overshoot can be improved by setting a suitably small ramp rate and/or reducing the power limit setting for OP.Hi.

The power limit settings for OP.Hi depending on the voltages and temperature ranges are given in Table 8-4.

Table 8-4. Power setting OP.Hi for actual electrical power supply voltage.

Supply Voltage	100V	104V	110V	200V	208V	220V	230V	240V
<i>OP.Hi Setting for 500°C to 1200°C</i>	100	100	93	100	100	93	85	78
<i>OP.Hi Setting for 100°C to 550°C</i>	33	33	31	33	33	31	28	26

Power Adjustment -Set the Heater Switch to Off to prevent heating while adjusting the power limit. Refer to the separate controller manual supplied with this furnace to alter the value of OP.Hi to the correct value as shown in Table 8-4, (it is good practice to write down the original value). Note if a too high a setting is made for a given voltage then this could result in the elements burning out, or a fuse could blow.

9 SPECIFICATIONS

-Carbolite reserves the right to change specifications without notice.

9.1 Models covered by this manual

EHA/EST models – horizontal single-zone tube furnaces with controls in integral base.

EVA/EVT models – vertical single-zone tube furnaces with controls in separate base.

EHC/EZS models – horizontal 3-zone tube furnaces with controls in integral base.

EVC/EVZ models – vertical 3-zone tube furnaces with controls in separate base.

EST/EVT/EZS/EVZ models – are of a split tube furnace design.

All models have cylindrical elements with wire formed in the surface of the insulation material.

All models can accept work tubes up to a maximum outside diameter of 60mm.

All models have a maximum operating temperature of 1200°C (1100° continuous).

Model names are of the type “EHA 12/300B” where 300 is the heated length. Sizes range from 150-600mm heated length (EHA/EVA/EST/EVT) or 450- 600mm (EHC/EVC/EZS/EVZ).

Table 9-1. Recommended work tube lengths.

Heated Length(mm)	Max. Power(W)	Standard work tube length (mm)	Extended work tube length (mm)
150	750	300	600
300	1480	450	750
450	2000	600	900
600	2540	750	1050

Work tube adaptors, extended work tube supports, insulation plugs, and gas/vacuum end seals are available from Carbolite for work tubes with outside diameters of 32mm, 46mm and 60mm.

9.2 Environment

The furnaces contain electrical parts and should be stored and used in indoor conditions as follows:

Ambient temperature working range.

Temperature : 5°C to 40°C

Note: In ambient temperatures above 30°C and where the operating temperature is close to maximum the allowable external surface temperature defined in EN 61010-1:2010 may be exceeded

Relative humidity.

Maximum 80% up to 31°C, decreasing linearly to 50% at 40°C.



Important safety notice:

After transportation or storage in humid conditions the furnace could fail to meet all the safety requirements of BSEN 61010-2-010 until it has completed the drying-out process to restore its normal condition.

Warning:

It cannot be assumed that the furnace will meet all the safety requirements of BSEN 61010-2-010 during the drying out process.

Furnace drying out process.

Step 1. Before the furnace is connected to the electrical supply remove the back panel and check for signs of moisture on the electrical circuits. If visible signs of moisture are present then allow it to dry out in ambient temperature for at least 24 to 48 hours then re-check.

Step 2. Complete the Installation procedure Section: 2, page 3.

Step 3. After reading the controller operation instructions manual, supplied separately, heat the furnace following the temperature profile given below. This will need to be done manually on furnaces with the basic control option or programmed into the controller if an advanced control option is fitted:

- Ramp the set-point temperature @ 2°C/minute to 100°C and dwell for 2 hours.
- Ramp the set-point temperature @ 2°C/minute to 300°C and dwell for 3 hours.
- Ramp the set-point temperature @ 3°C/minute to 1100°C and dwell for 1 hour.
- Cool naturally to ambient temperature.
- Furnace drying out process is complete.

Notes:

Notes:

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.

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

Carbolite Engineering Services

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