FB-25

HIGH TEMPERATURE CHAMBER *furnaces*

complete temperature CONTROL

- MAXIMUM TEMPERATURE 2050°C
- FRONT AND BOTTOM LOADING VERSIONS
- FAST HEAT UP MODELS
- NUMEROUS CHAMBER CAPACITIES
- CHOICE OF CONTROL SYSTEMS
- VARIOUS OPTIONS

CARBOLITE®

introduction

Carbolite has been in the forefront of furnace design for the past 60 years and our range of high temperature furnaces is the most comprehensive available from a single source. There are over 50 standard models and several specialist products with maximum operating temperatures between 1400 and 2050°C.

The range sets new standards in performance, safety and quality of construction. Included in the range are silicon carbide heated furnaces to 1600°C and front/bottom loading models at 1700°C and 1800°C which are heated by molybdenum disilicide ($MoSi_2$) elements, manufactured by Kanthal and known as Kanthal Super.

A recent addition is the introduction of a furnace heated by Zircothal elements which provide a furnace temperature of up to 2050°C in an oxidising atmosphere.

Versions are available with electrically operated doors and a variety of controller and programmer options.

outstanding features

The extensive general purpose range can be used for a wide variety of applications and in many different sectors of industry, test laboratories and research.

Examples of applications include:

- firing of ceramics
- calcining of ores and powders
- precious and exotic metals heat treatment
- sintering of ferrites
- glass melting
- crystal growth
- high temperature reacting studies
- optical fibre tests
- material properties evaluations

*S*tylish and sturdy

Modern compact styling which minimises bench space. The case is constructed from zinc coated steel and finished in a hard wearing two-tone stoved epoxy/polyester powder coating.

*C*onvection cooling

An air gap between the insulation and the outer case promotes convected air flow for a cool outer case. All 1700 and 1800°C models are provided with fan cooling.

*D*igital temperature control

The control module houses a range of digital instrumentation for precise temperature and process control. Push button setting with 1°C resolution. Programmers permit automated firing cycles.

*C*hamber exhaust vent

Promotes the extraction of fumes generated by the process.

*P*ositive break safety switch

Isolates power to the elements when the door is opened.

*S*olid state control

1400-1600°C models have zero voltage power switching and rapid cycle time for smooth and reliable control. 1700°C and 1800°C models have phase angle fired thyristor stacks.

complete temperature CONTROL

Door action

A vertical counterbalanced door mechanism keeps the hot door insulation away from the operator when the door is opened; this is particularly important at high temperatures. The bottom loading models have the obvious advantage of raising the hearth into the heated chamber.

Lightweight insulation

Provides faster heating and cooling times, increasing productivity and energy efficiency. This is standard on most models.

Service

Aided by the simplicity of design; warning lights help diagnosis; easy access to consumable parts is provided.

Options

- viewing port (glazed or unglazed)
- load thermocouple port
- calibration - access can be provided to insert a calibrated thermocouple beside the control thermocouple
- temperature indicators
- digital communications
- overtemperature protection (standard on 1700°C and 1800°C models)
- calibration certificates
- gas inlets
- flowmeters
- tables
- process timers

Note:
The EMF output of thermocouples operating above1600° C reduces significantly during the first 500 hours, resulting in the furnace temperature slowly rising. We therefore recommend regular calibration checks on these thermocouples.

Chemical Attack!

Furnaces are mostly made from oxides of aluminium (Al_2O_3 and SiO_2). These oxides can be chemically attacked by some materials. The most common ones are:

Low melting point metal oxides: Lead (Pb), Sodium (Na), Potassium (K); fluxes used in melting such as Lithium (Li) and Borax (B_2O_3); and case hardening salts, eg Potassium Cyanide (KCN).

Sulphur (S) and its compounds

Halogens - Chlorine (Cl), Fluorine (F) and Iodine (I)

Water (H_20) vapour can cause problems where it condenses and its presence accelerates chemical attack by the materials listed above.

Higher temperatures catalyse these reactions. If you need advice, please advise us of the quantities of material, the temperature, frequency and duration of the process.

1400°C, 1500°C and 1600°C
silicon carbide heated furnaces

This comprehensive range is available at 1400, 1500 and 1600°C with four popular capacities of 2.9, 7.8,14.8 and 35 litres (1600°C version has maximum capacity of 37.5 litres). Powerful silicon carbide heating elements provide fast heat up rates, typically 40 minutes to 1400°C depending on the model.

Silicon carbide heating elements are ideally suited to the rigorous firing cycles often required in laboratory furnaces. These elements withstand the stresses of intermittent operation and give long life at elevated temperatures. Furnaces using these elements are designed with excess power to ensure that ageing is easily corrected and heating performance is maintained. The average life of the elements may be several years, depending on operating temperatures and conditions. They are easy to replace when either hot or cold and require only the removal of the furnace back panel (the RHF 16/37 requires the removal of two side panels).

Two types of insulation are used: Hard wearing refractory brick around the doorway and in the floor to give resistance to abrasion and spillage. Lightweight ceramic fibre is used in all other areas to ensure energy efficiency and fast heating/cooling. The RHF 16/37 is insulated totally by hard wearing refractory brick.

A parallel upward opening door allows full and easy access to the chamber and keeps the hot face insulation away from the operator during loading/unloading. When the door is opened, a positive action safety switch automatically isolates power supply to the heating elements to protect the operator from contact with the live heating element.

Solid state thyristor based zero voltage switching, and rapid cycle time, give smooth and reliable control and are fully compliant with European EMC legislation.

RHF 15/3

complete
temperature
CONTROL

specification

Model	Max Temp (°C)	Volume (litres)	Internal Dimensions (mm) H	W	D	External Dimensions (mm) H*	W	D	Heat up to max temp less 100°C (empty chamber)	Max kW	Holding Power (kW)
RHF 14/3	1400	2.9	120	120	200	655	435	610	33	4.5	1.9
RHF 14/8	1400	7.8	170	170	270	705	505	675	22	8.0	3.2
RHF 14/15	1400	14.8	220	220	305	810	690	780	35	10.0	2.9
RHF 14/35	1400	35	250	300	465	885	780	945	38	16.0	6.0
RHF 15/3	1500	2.9	120	120	200	655	435	610	45	4.5	2.0
RHF 15/8	1500	7.8	170	170	270	705	505	675	40	8.0	3.5
RHF 15/15	1500	14.8	220	220	305	810	690	780	45	10.0	3.0
RHF 15/35	1500	35	250	300	465	885	780	945	46	16.0	6.2
RHF 16/3	1600	2.9	120	120	200	655	435	610	55	4.5	2.3
RHF 16/8	1600	7.8	170	170	270	705	505	675	60	8.0	4.0
RHF 16/15	1600	14.8	220	220	305	810	690	780	58	10.0	3.5
RHF 16/37	1600	37.5	250	300	500	1530	900	1000	180	10.0	5.0

* door closed

RHF 16/37

uniformity data

	Uniform envelope to ±5°C (mm)		
Model	Height	Width	Depth
RHF 14/3	70	70	135
RHF 14/8	120	120	140
RHF 14/15	140	140	270
RHF 14/35	170	220	350
RHF 15/3	70	70	135
RHF 15/8	120	120	140
RHF 15/15	140	140	270
RHF 15/35	170	220	350
RHF 16/3	70	70	145
RHF 16/8	120	120	150
RHF 16/15	140	140	280
RHF 16/37	170	220	350

1700°C and 1800°C molybdenum disilicide heated chamber furnaces

This range comprises the following models: RHF 1700°C with chamber capacities of 3.4, 10 and 25 litres; HTF 1800°C with chamber capacities of 3.4, 14.5 and 27 litres and the HTC 1800°C with a chamber capacity of 7.7 litres.

All models *(excluding the HTC)* feature lightweight fibre insulation, which allows rapid heating and cooling, but requires more care when loading to avoid accidental or abrasion damage. The HTC has a hard refractory brick lined chamber which provides a durable work area and excellent abrasion resistance, but reduces the heating and cooling rates.

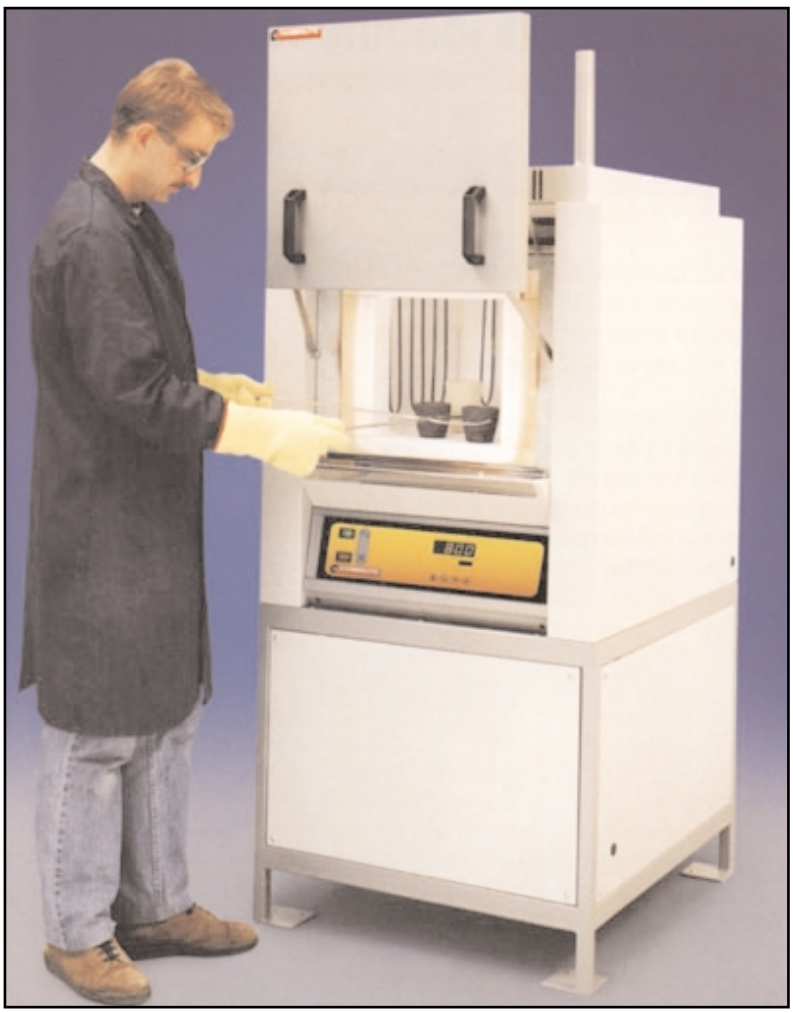
Heating in all models is provided by molybdenum disilicide elements, which are known as Kanthal Super Elements. They comprise molybdenum disilicide ($MoSi_2$) and a component which forms a dense protecting layer of glass around it at working temperature. This feature is the key to the superior properties of the Kanthal Super. The elements can be used continuously or intermittently and can either be used in air or with the usual protective gases. As Kanthal Super Elements do not increase in resistance with use, there is no need for a voltage reserve. Should an element fail it may be replaced without affecting other elements within the same circuit. Long life combined with ease of replacement contributes to a high degree of usage and low maintenance costs. The 'U' shaped elements, which are mounted on either side of the chamber (the HTF 18/27 also has elements located in the back of the chamber), are controlled using a sophisticated control circuit to meet with European EMC legislation.

The upward motion of the door keeps the hot face away from the operator, which is critical when working at such high temperatures, and allows easy and full access to the chamber. The RHF 3 and 10 litre capacity models are offered with a choice of either a manually or electrically operated door, whereas others models are available with an electrically operated door only; the HTF 18/27 model offers a manual door only. The gentle closure of the electric door protects both the heating elements and delicate loads from possible impact damage.

A cool outer case temperature is maintained by electric fans which accelerate the movement of air in the gap between the insulation and the outer case.

Adjustable overtemperature protection is fitted as standard. An additional thermocouple and controller are linked to a contactor. The system can be set to protect the furnace or adjusted to a lower temperature to protect a valuable furnace load.

RHF 17/3E



HTF 18/27

specification

Model	RHF 17/3	RHF 17/10	RHF 17/25	HTF 18/3	HTC 18/8	HTF 18/15	HTF 18/27
Insulation type	Fibre	Fibre	Fibre	Fibre	Brick	Fibre	Fibre
Max temp (°C)	1700	1700	1700	1800	1800	1800	1800
Litre capacity	3.4	10	25	3.4	7.7	14.5	27
Chamber dimensions (mm)							
Height	150	225	300	150	190	220	300
Width	150	200	275	150	150	220	300
Depth	150	225	300	150	270	300	300
Door action:							
Manual	✓	✓	✗	✗	✗	✗	✓
Electric	✓	✓	✓	✓	✓	✓	✗
Heat up time to max less 100°C (mins)	40	40	45	55	150	55	55
Maximum power (kW)	4.8	8.0	12.0	5.6	8.0	9.0	18.0
Holding power at 100°C below max temp (kW)	1.7	3	5	2.1	3	4.4	6.8
External dimensions (mm)							
Height (door closed)	540	620	1800	620	1580	1580	1610
Width	660	840	1100	840	690	690	780
Depth	480	590	680	590	800	800	945
Electrical supply							
220-240v, single phase	✓	✓	✓	✓	✓	✓	✓
380-415v, 3 phase + N	✗	✗	✓	✗	✓	✓	✓
Net weight (kg)	85	138	403	120	210	270	440

Bottom loading furnaces

BLF 17/3

Included in Carbolite's innovative designs are the six models which comprise the range of high temperature bottom loading furnaces.

There are three models at both 1700°C and 1800°C, with capacities of 3.4, 7.9 and 21 litres. The smallest version is a bench mounted unit, whereas the two larger units are floor standing models.

This range of furnaces offers several advantages and is suitable for firing and sintering of advanced ceramics and high temperature glass melting. Excellent temperature uniformity is obtained by the inclusion of molybdenum disilicide heating elements which are positioned around the walls of the chamber ensuring uniform heating of the sample. A combination of dense refractory brick hot face insulation and a secondary low thermal mass layer of insulation provides a robust chamber with an efficient utilisation of power.

The electrically operated elevator hearth ensures operator safety and prevents direct radiation of heat from the chamber walls. It also ensures smooth loading and unloading of the workpiece/crucible and allows both heavy and delicate loads to be handled easily. The loading platform has a full travel which allows the complete chamber height to be used.

Fast heating and cooling of the sample is obtained by having the ability to move the sample in and out of the furnace when hot or cold.

The furnace can be adapted to accommodate an atmosphere other than air. This is possible by placing a large inverted alumina crucible in a groove in the hearth. It is possible to partly fill this groove with alumina (Al_2O_3) or Zirconia (ZrO_2) powder to improve the sealing. Gas inlet and outlet connections allow atmospheres to be introduced from below the hearth and spread by radial channels cut into the surface of the hearth so that the inlet cannot be blocked by the sample positioned on the hearth. The top of the furnace can be adapted to include the facility to insert a probe thermocouple or provide access for a stirrer.

Versions with rotating hearths are also available, please ask for details.

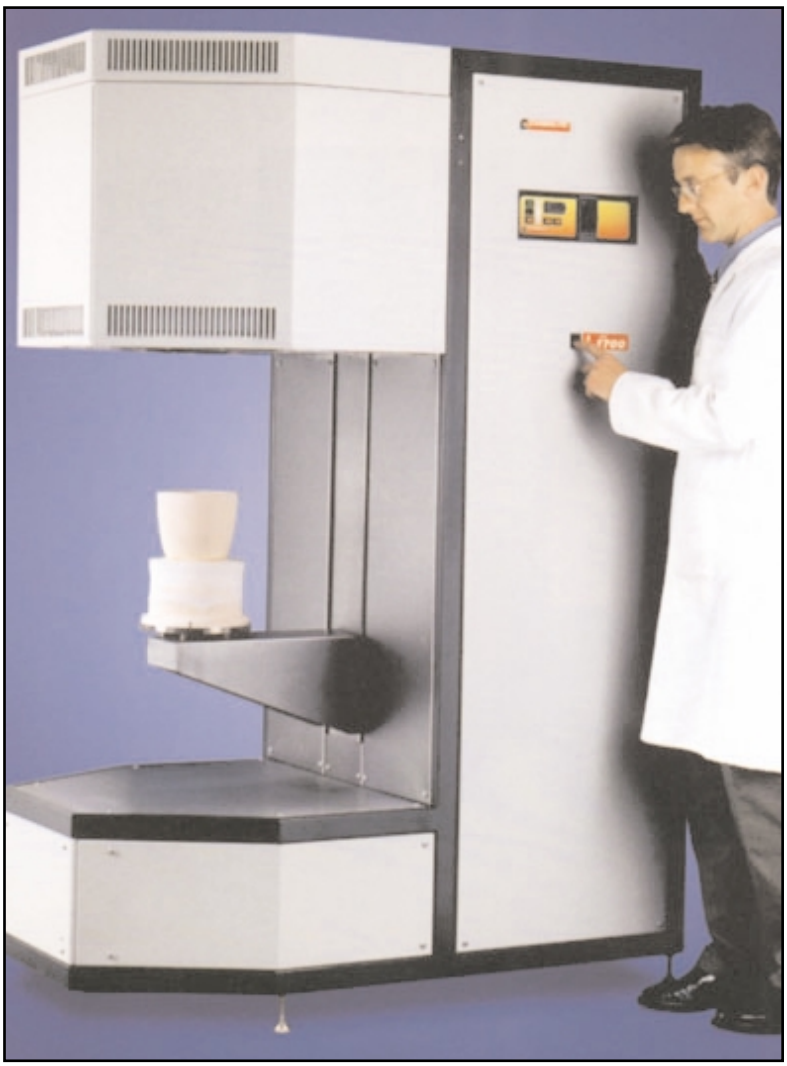
A choice of programmable controllers is available together with other advanced temperature control options, including computer communications. An independent overtemperature control is fitted as standard and can either be set to protect the furnace or adjusted to a lower temperature to protect a valuable load.

Options include flowmeters, crucible clamps, radiation shutters, crucibles and hearth cages.

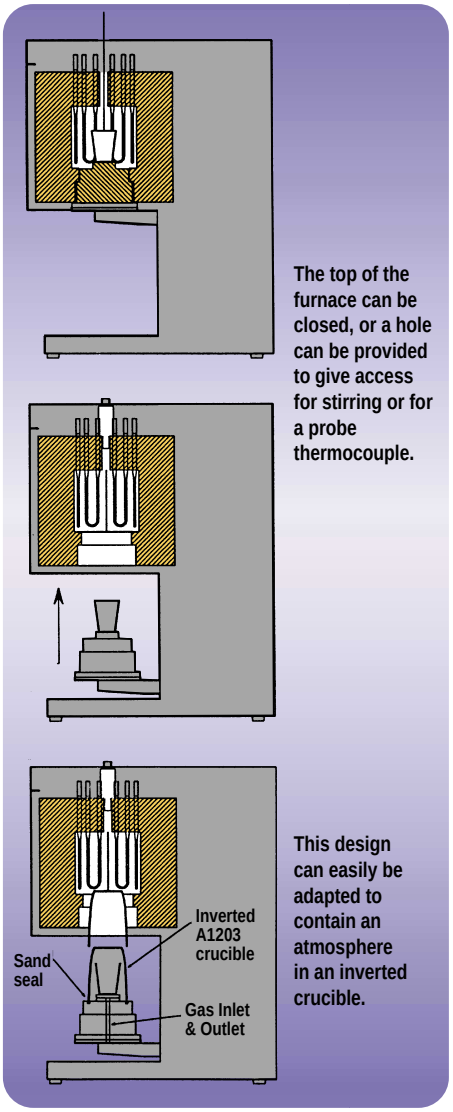
complete temperature CONTROL

specification

Model	BLF 17/3	BLF 17/8	BLF 17/21	BLF 18/3	BLF 18/8	BFL 18/21
Maximum temp (°C)	1700	1700	1700	1800	1800	1800
Litre capacity	3.4	7.9	21	3.4	7.9	21
Internal dimensions (mm) Height Diameter	 190 150	 250 200	 300 300	 190 150	 250 200	 300 300
External dimensions (mm) Height Width Depth	 975 750 530	 1950 1360 800	 1850 1250 850	 975 750 530	 1950 1360 800	 1850 1250 850
Heat up time to 100°C below max temp (mins)	80	80	180	110	110	250
Max kW	5	9	12	6	10	12



BLF 17/8



The top of the furnace can be closed, or a hole can be provided to give access for stirring or for a probe thermocouple.

This design can easily be adapted to contain an atmosphere in an inverted crucible.

Ultra high temperature furnaces

The latest introduction into the extensive range of high temperature furnaces provided by Carbolite is the Zircothal furnace developed by Kanthal, with a maximum operating temperature of 2050°C+.

Zircothal heating elements do not conduct electricity below 800°C and must therefore be preheated before becoming electrically conductive. This is achieved by heating an outer furnace chamber by four Kanthal Super 1900 elements. The inner work chamber is heated by four Zircothal elements controlled by an optical pyrometer and is insulated by ZrO_2 bricks.

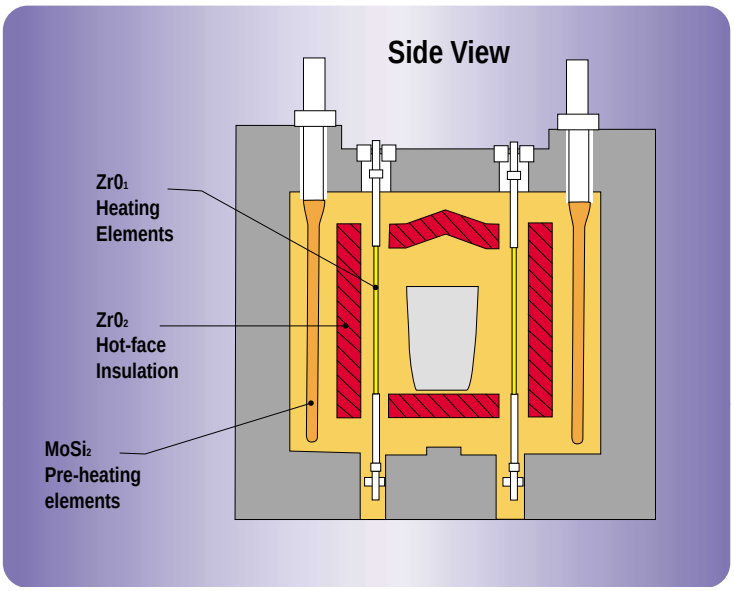
Control of the preheating element temperature is by type B thermocouple. An optical fibre device is used to monitor the element temperature; this ensures good control (accuracy of ±1% of actual temperature) at high temperature without the drift in accuracy suffered by thermocouples after long exposure to very high temperatures.

On this model, the Eurotherm 902P programmer is offered which has 16 segments and a simple operator interface.

Samples are loaded via a side hinged door with an opening measuring 88mm high x 87mm wide.

specification

Max operating temperature		2050°C+
Litre capacity		0.9
Usable chamber dimensions (mm)	(H) (W) (D)	88 87 115
Heat-up time - 20-2000°C		6.5 - 7 hours with empty chamber
Cool down time - 2000-500°C		6 hours
External dimensions (mm)	(H) (W) (D)	1700 890 550
Max power (kW)		15
Nominal power at 2000°C (kW)		6
Power supply		400/230V, 3 phase 50Hz



N T R O L

temperature control systems

A choice of control systems is available including controllers which simply heat up the furnace and hold at one temperature indefinitely and more complex programming systems. Access to parameters is simple and easy to understand and is customised to present only those parameters which need to be viewed or adjusted.

Carbolite 201 Controllers

The 201 is a three term PID microprocessor controller with the facility of an adjustable single ramp rate to set point, either up or down. It is a high precision instrument exclusive to Carbolite and is jointly designed by Eurotherm and ourselves. This partnership allows us to offer a high performance controller with minimal overshoot at an economical cost.
The measured temperature is provided by large LED's located behind a wipe clean membrane panel. The setpoint is displayed and adjusted by pressing either the raise or lower button.

Eurotherm 2416 CC

The Eurotherm 2416 CC is an advanced setpoint programming temperature controller with eight segments, any of which can be a ramp, step or dwell. It is housed in a compact 1/16 din size measuring 48 x 48mm.
It provides precise control with the advanced PID control algorithm giving stable 'straight-line' control of the process. Power feedback is used to stabilise the output power and hence the controlled temperature against supply voltage fluctuations. The controller continually corrects for drift and this gives high stability and rapid response to process changes.

Eurotherm 2408 CP

The Eurotherm 2408 CP contains the same features as the 2416 CC, but with 16 segments and is housed in a 1/8 din size measuring 48 x 96mm high. The larger case allows for more options including storage of up to 20 separate programmes.

Overtemperature Protection

An independent overtemperature protection system may be justifiable to protect expensive heating elements or valuable furnace contents. Where the Carbolite 201 controller is the main controller, an overtemperature protection facility is integrated into the same display panel and incorporates an independent power supply and control circuit. When required with other main controllers, a separate Eurotherm 2132 digital controller is fitted. This unit is housed in a compact 1/32 din size measuring 24 x 48mm wide. The additional control unit uses a separate thermocouple and operates a contactor to shut down the furnace in the event of the set temperature being exceeded.

Communications Software

IPSC communicates with one programmer at a time and allows data logging. It also shows a graph of furnace temperature and set point on the computer screen and allows storage of programs on disc, and easy editing and error free downloading to the furnace programmer.

Other Options Additional control systems can be supplied and they include cascade control, multi-segment programmers and process timers. The Carbolite 201 controller is also available with an integral process timer. When the working setpoint is reached, a timed period starts and can either end with an audible alarm or to switch off the power at the end of the time period.

Standard Electrical Supply

When ordering, always quote the model, controller and the preferred type of electrical supply from the list. Please indicate the frequency (50 or 60 Hertz) and number of phases. For 3-phase supplies (where applicable), please state whether a neutral is available (if so, please quote both the phase-to-phase and the phase-to-neutral voltages, eg 380.220V). Typical single phase voltages are 100, 110, 200, 208, 220, 240 and 254V. 3-phase voltages **without** neutral are typically 220, 380, 415 and 440V. 3-phase voltages **with** neutral are typically 220/127, 380/220, 415/240 and 440/254.

Note

As a result of continuous product development, we reserve the right to change specifications and illustrations. In the unlikely event of one of our standard products not meeting your requirements, we have the capability to design and manufacture a unit specifically tailored to meet your needs.
Carbolite manufactures in compliance with the relevant safety standards to BS EN 61010-1: 1993 & 61010-2-010: 1995. All products carry the CE mark which indicates compliance with all relevant European safety directives; ie Low Voltage Directive and ElectroMagnetic Compatibility directive.

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