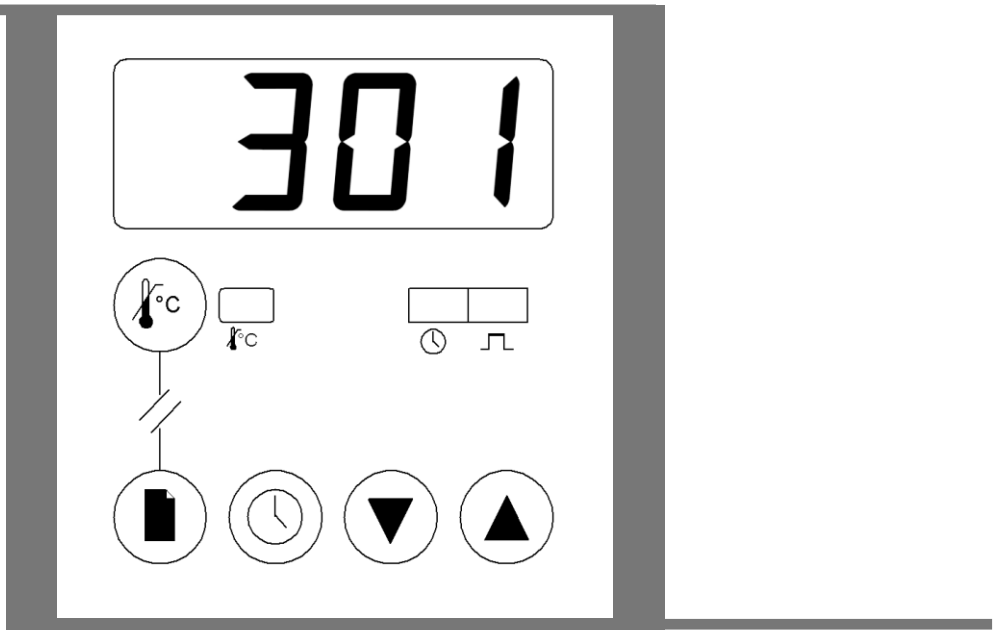
CARBOLITE®

IGERO 30-3000°C

Operating Instructions

Temperature Controller



Type 301

English / °C

part of VERDER scientific

MC16-EN – 1.05

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1 Introduction to the Controller and Manual

1.1 Using This Manual

This manual aims to explain how to set up and operate the 301 controller; it must be read in conjunction with the product main manual.

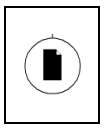
Due to the complex nature of furnace or oven control the use of technical terms throughout this manual is unavoidable. Explanations of these terms can be found in the 'Glossary of Terms' at the back of this manual.

1.2 PID Control

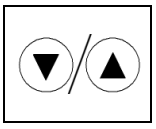
The 301 controller uses PID (Proportional Integral Derivative) temperature control. This type of control uses a complex mathematical control system to adjust the power being sent to the elements and hold the furnace or oven at the desired temperature.

1.3 Key Stroke Diagrams

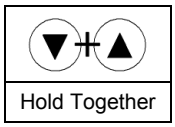
Throughout this manual, key stoke diagrams are used to quickly describe the key presses required on the controller to alter the desired value.



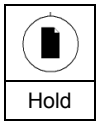
This symbol denotes a single press of the *Page* Key



This symbol denotes a single press of the *Up* Key **or** the *Down* Key

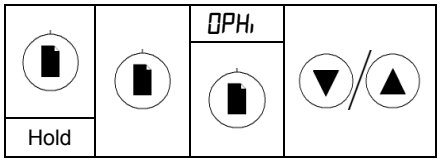


This symbol denotes a single press of the *Up* Key **and** the *Down* Key for 1.5 Secs

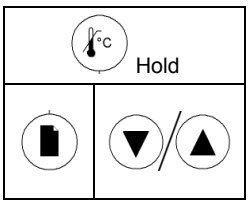


This symbol denotes pressing and holding the *Page* key for 1.5 seconds

Examples of key press sequences:



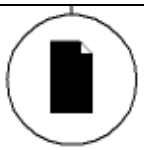
These symbols denote holding the *Page* key for 1.5 seconds, pressing the *Page* key twice (OPH1 should be showing on the display) then pressing the *Up* or *Down* arrow key.



These symbols denote holding the *Overtemperature* key down while pressing the *Page* key, followed by the *Up* or *Down arrow* key.

2 Basic Operation

2.1 Keys

Page Key		The *Page* key is used to scroll through the parameters and switch between menus.
Timer Key		The *Timer* key is used to start, view, pause and reset the timer.
Arrow Keys		The *Arrow* keys are used to adjust the value of the selected parameter and pause the output power.
Overtemperature Key		The *Overtemperature* key is used to access the Overtemperature menu. *Note: Overtemperature is an option*

2.2 Indicators

Output Indicator		The *Output* indicator shows when the controller is sending power to the elements.
Timer Indicator		The *Timer* indicator shows when the timer is active.
Overtemperature Indicator		The *Overtemperature* indicator shows green in normal use. It flashes red when overtemperature is triggered and is constantly red when overtemperature is reset and waiting for the temperature to drop.

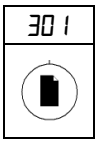
2.3 Menu System

The 301 controller is divided into two menus; the home menu and the set up menu. The home menu contains all the basic operating controls: setpoint, setpoint ramp rate and timer time. The set up menu contains all the set up features: timer type, timer band, output power and customer calibration. The features available vary depending on user input or product specification.

2.4 Home display

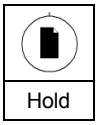
The Home display is the first display you see when the controller is switched on. It shows the actual temperature of the furnace or oven and will be referred to as PV throughout this manual. If you enter the menus, the controller will automatically return to the Home display if no keys are pressed for 30 seconds.

2.4.1 Finding the Home display from the Home menu



Press the *Page* key until the PV is shown on the display (301 shown as example).

2.4.2 Finding the Home screen from the Set up menu



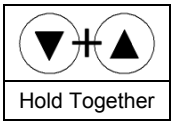
Press and hold the *Page* key for 1.5 seconds

2.5 Hold Mode

Hold mode turns the output off; this allows for parameters to be set without the controller instantly trying to control at the new settings.

Hold mode is shown on the display by the output indicator being off and the home display flashing between the PV and HOLd.

To enter Hold mode:

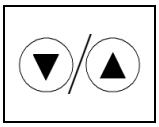


Start at the Home display
Press and hold the *Up* and *Down arrow* keys together for 1.5 seconds.
The display will flash HOLd to show that hold mode has been entered.

To exit Hold Mode:
Start at the Home display.
Press and hold the *Up* and *Down arrow* keys together for 1.5 seconds *OR* start the timer (See section 5).

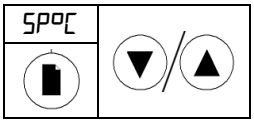
Note: The Hold Mode function is disabled when the Timer function is running.

2.6 Checking the Temperature Setpoint from the Home display



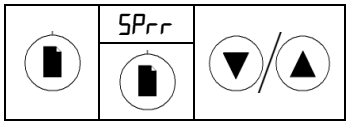
Start at the Home display
Press an *Up* or *Down arrow* key.
The display will then flash SPoC 3 times.
The Setpoint will show on the display for 3 seconds before returning to the Home display.

2.7 Changing the Temperature Setpoint



Start at the Home display
Press the *Page* key to scroll through the home menu until SPoC shows on the display
Use the *Up* and *Down arrow* keys to alter the value (°C) – a single press shows the current setting, To alter, either keep pressed or press again.
The value will then be stored without any further input.

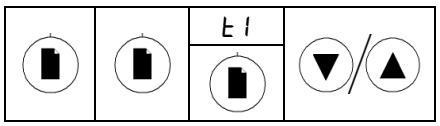
2.8 Changing the Temperature Setpoint Ramp Rate



Start at the Home display.
Press the *Page* key to scroll through the home menu until SPrr shows on the display.
Use the *Up* and *Down arrow* keys to switch off or alter the value (°C/min) – a single press shows the current setting. To alter, either keep pressed or press again.
The value will then be stored without any further input.

See section 4 for more information on Temperature Setpoint Ramp Rate.

2.9 Changing the Timer Time

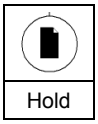


Start at the Home display.
Press the *Page* key to scroll through the home menu until t1, t2, t3, t4 or t5 shows on the display.
Use the *Up* and *Down arrow* keys either to switch off or alter the value (Hr:Min) – a single press shows the current setting. To alter either keep pressed or press again.
The value will then be stored without any further input.

See section 5 for more information on The Timer.

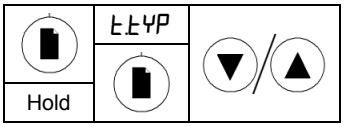
3 Advanced Operation

3.1 Entering the Set Up menu



Start at the Home display.
Press and hold the *Page* key for 1.5 seconds
The display will change to the first parameter in the set up menu.

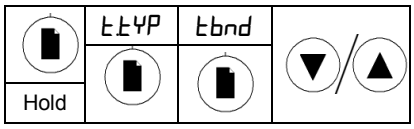
3.2 Changing the Timer Type



Start at the Home display.
Press and hold the *Page* key for 1.5 seconds to enter the set up menu.
Press the *Page* key until t.tYP shows on the display.
Use the *Up* and *Down arrow* keys to alter the value (t 1 to t5) – See section 5. – a single press shows the current setting, To alter, either keep pressed or press again.
The value will then be stored without any further input.

Note: This function is disabled when the timer is running.
See section 5.5 and 5.7 for more information on the timer types and functions.

3.3 Changing the Timer Band



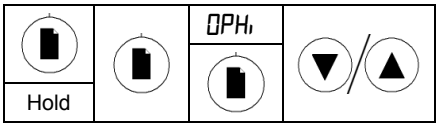
Note: This is only available when timer type 1 or 4 is selected.
Start at the Home display.
Press and hold the *Page* key for 1.5 seconds to enter the set up menu.
Press the *Page* key until t.bnd shows on the display.
Use the *Up* and *Down arrow* keys either to turn off or alter the value – a single press shows the current setting, To alter, either keep pressed or press again.
The value will then be stored without any further input.

See section 5.6 for more information on The Timer Temperature Band.

3.4 Changing the Maximum Output Power

Note: *Output Power is a product specific setting and will not appear on all furnaces and ovens*

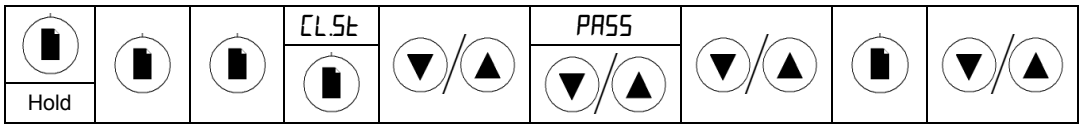
See section 7 for more information on Output Power.



Start at the Home display.
Press and hold the *Page* key for 1.5 seconds to enter the set up menu.
Press the *Page* key until OPH1 shows on the display.
Use the *Up* and *Down arrow* keys to alter the value (% power) – a single press shows the current setting. To alter either keep pressed or press again.
The value will then be stored without any further input.

Caution: *Do not increase the power limit value to a value above the design level for the oven or furnace model, or to a value above that correctly calculated for Silicon Carbide elements. The heating elements could burn out, or other damage could be caused. Refer to the main manual supplied with the Furnace or Oven.*

3.5 Changing the Customer Calibration Type



Start at the Home display.
Press and hold the *Page* key for 1.5 seconds to enter the set up menu.
Press the *Page* key until CL.SE shows on the display.
Press the *Up* or *Down arrow* key to display the current calibration type -
(FACt, CAL 1 or CAL2)
Press the *Up* or *Down arrow* key to display the password screen.
Press the *Up* or *Down arrow* keys to enter the Calibration Password (Section 3.6).
Press the *Page* key to confirm the password.
Use the *Up* and *Down arrow* keys to select the calibration type.
The value will then be stored without any further input.

See Section 8 for more information on Customer Calibration.

3.6 Calibration Password

Once entered the calibration password remains active for 30 seconds after leaving the setup menu to allow time to revisit if necessary.

The Calibration Password for this instrument is: **525**

4 Temperature Setpoint Ramp Rate

4.1 Setpoint Ramp Rate

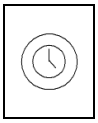
The setpoint ramp rate controls the rate at which the temperature in a furnace or oven changes over 1 minute. It can be set for heating and cooling applications.
Setpoint ramp rate is useful when materials susceptible to thermal shock are being used.

4.2 Limitations of setpoint Ramp Rate

The setpoint ramp rate should not be set higher than the maximum heat up or cool down rate of the furnace or oven.
The setpoint ramp rate only resets its start position when the ramp rate is changed or the controller it taken out of Hold mode.
Changes in the temperature setpoint do not affect the ramp rate.
If the temperature is set below the current temperature of the furnace or oven then after a period of time adjusted to a temperature higher than the current temperature with out adjustment of the ramp rate, the controller can become out of step and appear to switch off.
Putting the controller in to, then out of Hold mode will reset the ramp rate and force the controller back into control.

5 The Timer

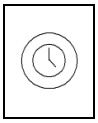
5.1 Starting the Timer



Start at the Home display.
Press the *Timer* key once to start the timer.

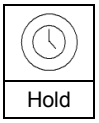
If you are in Hold Mode, pressing the timer key will automatically exit Hold Mode and the controller will start to run.

5.2 Checking the time remaining



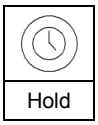
While the Timer is running
Start at the Home display
Press the *Timer* key once to check the time remaining.
The display will then flash t- 3 times.
The time remaining will show on the display for 3 seconds before returning to the home display.

5.3 Pausing The Timer



Start at the Home Display
Press and hold the *Timer* key for 1.5 seconds. The display alternately shows t1 and PU. To resume the timer press the *Timer* key once.

5.4 Resetting The Timer



When the Timer count has ended or the timer is paused.
Start at the Home display
Press and hold the *Timer* key for 1.5 seconds
rSt is displayed to indicate timer reset.

5.5 Timer Function Description

The 301 controller has an in-built timer, which can be set to one of five types:

Timer Type t1

On pressing the *Timer* key; Timer Type 1 waits for the setpoint to be reached, then begins the countdown. On completion of the countdown, the furnace or oven switches the power off to the elements (End flashes on the display).

Timer Type t2

On pressing the *Timer* key; Timer Type 2 starts the countdown immediately. On completion of the countdown, the furnace or oven switches the power off to the elements (End flashes on the display).

Timer Type t3

On pressing the *Timer* key; Timer Type 3 immediately switches the furnace or oven off and starts to countdown. On completion of the countdown, the furnace or oven switches the power on to the elements.

Timer Type t4

On pressing the *Timer* key; Timer Type 4 waits for the setpoint to be reached then begins the countdown. On completion of the countdown, the furnace or oven continues to control as normal (End flashes on the display).

Timer Type t5

On pressing the *Timer* key; Timer Type 5 starts the countdown immediately. On completion of the countdown, the furnace or oven continues to control as normal (End flashes on the display).

5.6 The Timer Temperature Band

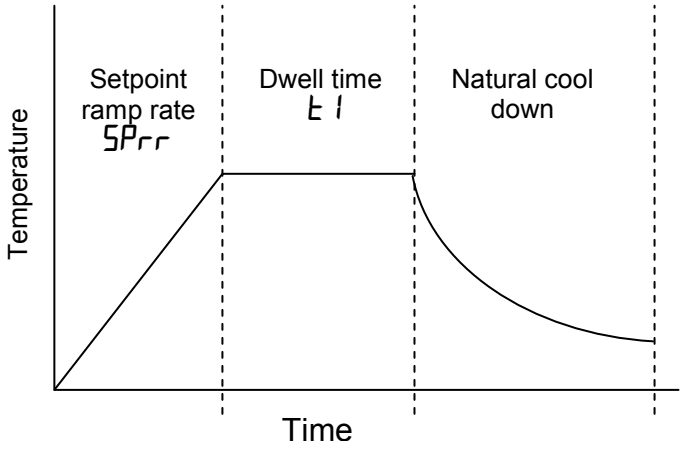
Timer type t1 or t4 starts the count down when the setpoint temperature is reached. It is possible to set the timer going before setpoint is reached by adjustment of the timer temperature band t.bnd. e.g. t.bnd set to a value of 3 will result in the timer starting to count down 3°C before the temperature setpoint is reached. This is practically useful when furnaces or ovens that take a long time to reach setpoint are at a sufficiently high temperature for a given customer process to occur.

5.7 Timer Function Table

t.tYP		On Pressing the *Timer* key	During the Countdown	On completion of the Countdown
t1	Output	On	On	Off
	Timer	Starts when Setpoint reached	Counts Down	Off
	Display	Flashes t1 3 times. Shows Time left for 3 secs.	PV	Cycling PV / End
	Timer Indicator	Flashing until setpoint reached	On	Off
t2	Output	On	On	Off
	Timer	Start Immediately	Counts Down	Off
	Display	Flashes t2 3 times Shows Time left for 3 secs	PV	Cycling PV / End
	Timer Indicator	On	On	Off
t3	Output	Off	Off	On
	Timer	Start Immediately	Counts Down	Off
	Display	Flashes t3 3 times Shows Time Remaining	Time Remaining	END shows 3 secs then PV
	Timer Indicator	On	On	Off
t4	Output	On	On	On
	Timer	Starts when Setpoint reached	Counts Down	Off
	Display	Flashes t4 3 times Shows Time left for 3 secs	PV	Cycling PV / End
	Timer Indicator	Flashing until setpoint reached	On	Off
t5	Output	On	On	On
	Timer	Start Immediately	Counts Down	Off
	Display	Flashes t5 3 times Shows Time left for 3 secs	PV	Cycling PV / End
	Timer Indicator	On	On	Off

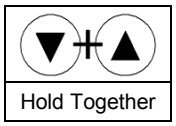
6 Ramp Dwell Programming

The 301 controller has the capability to follow a Ramp Dwell program.



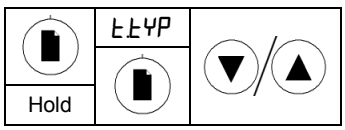
6.1 Setting up a Ramp Dwell program

Set the Controller to Hold Mode:



Start at the Home display
Press and hold the *Up* and *Down arrow* keys together for 1.5 seconds.
The display will flash HOLd to show that hold mode has been entered.

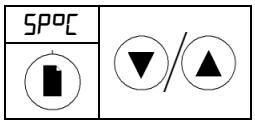
Set the Timer Type to t 1



Start at the Home display.
Press and hold the *Page* key for 1.5 seconds to enter the set up menu.
Press the *Page* key until tTYP shows on the display.
Use the *Up* and *Down arrow* keys to set the value to t 1
The value will then be stored without any further input.

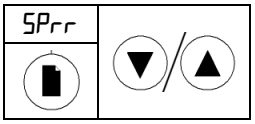
See Section 5.6 for the timer temperature band setting.

Set the Temperature setpoint.



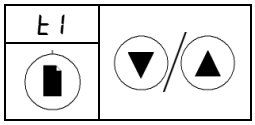
Start at the Home display
Press the *Page* key until SPoC shows on the display
Use the *Up* and *Down arrow* keys to alter the value (°C)
The value will then be stored without any further input.

Set the Setpoint ramp rate



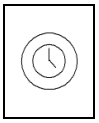
Press the *Page* key until SPrr shows on the display.
Use the *Up* and *Down arrow* keys to switch off or alter the value (°C/min)
The value will then be stored without any further input.

Set the Dwell time



Press the *Page* key until t 1 shows on the display.
Use the *Up* and *Down arrow* keys either to switch off or alter the value (Hr:Min)
The value will then be stored without any further input.

Start the Timer



Start at the Home Display
Press the timer key to start the program.
Pressing the timer key will also automatically exit hold mode if set (see section 2.5) and the controller will start to run.

7 Maximum Output Setting

Depending on the furnace or oven model the maximum output power setting OPH, may be accessible or hidden.
For silicon carbide heated furnaces the parameter is accessible to allow compensation for element ageing, refer to the product manual for details.
In many models the maximum output power setting depends on the supply voltage, refer to the product manual for details.

8 Customer Calibration

The controller is calibrated for life at manufacture, there may however be sensor or other system errors which affect the accuracy of the measured temperature. Customer calibration is used to compensate for these errors. This function is disabled when the timer is running.

The 301 controller has three types of customer calibration: factory calibration, single point calibration and dual point calibration. See section 3.5 & 3.6 to access these.

8.1 Factory Calibration - FACt

Factory calibration is the default setting, which has no offset adjustment. It simply displays the temperature measured by the control thermocouple.

8.2 Single Point Calibration - CAL 1

Single point calibration uses an offset value to adjust the temperature over its whole range. Single point calibration accurately sets the temperature for setpoint values close to the temperature at which the calibration offset is made. This accuracy is reduced for setpoint temperatures which are significantly higher or lower than this.

Table showing examples of how to determine offset values

Measured Calibration temp (°C)	Displayed temp (°C)	Old Offset Value (°C)	New Offset Adjustment	New Offset Value (°C)
252	250	0	2	2
248	250	0	-2	-2
252	250	2	2	4

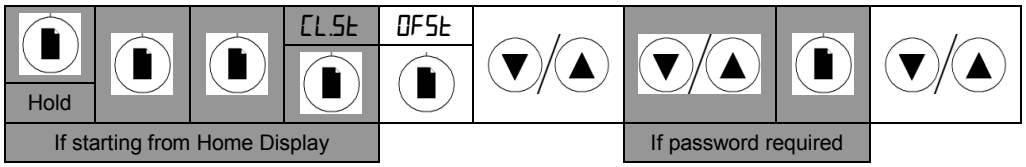
The calibration temperature may be measured at the centre of the chamber or through a specially fitted port.

New Offset Value = Old Offset Value + New Offset adjustment

New Offset Adjustment = Measured Calibration Temperature – Displayed Temperature

Caution! - *The procedure to determine the calibration temperature at the centre of a chamber is not covered in these instructions. If you are unsure how to do this safely, then seek advice as there is a risk of electric shock if done incorrectly.*

8.2.1 Changing the Single Point Calibration Offset OFSt



Starting from CL.St after C.CL 1 has been selected.
Press the *Page* key until OFSt shows on the display.
Press the *Up* or *Down arrow* key to display the current calibration offset.
Press the *Up* or *Down arrow* key to change the offset value.
The value will then be stored without any further input.

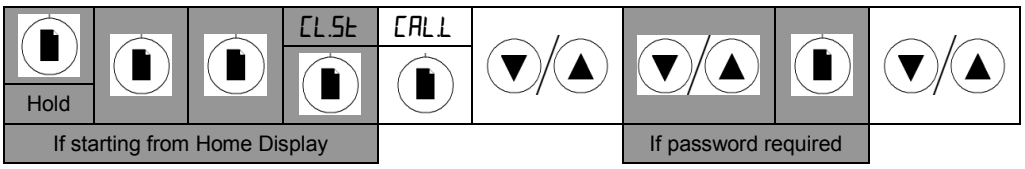
Once the C.CL 1 has been selected as the customer calibration type, it is possible to start from the Home display and go to OFS.t directly and enter the password at this point when the calibration adjustment is required again.

8.3 Dual Point Calibration - C.CL2

Dual point calibration uses two offset values at two corresponding temperatures to progressively change the calibration as the temperature increases or decreases. This is a more accurate representation of how the temperature difference will occur.

Caution! *- Do not make CAL.L and CAL.H the same value as the controller will not work correctly and could cause your furnace or oven to overheat.*

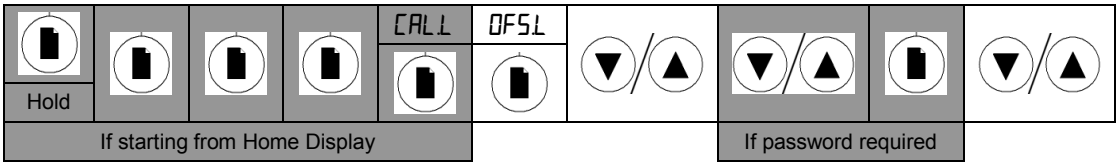
8.4 Changing the Calibration, Low Temperature – CAL.L



Starting from CL.St after C.CL2 has been selected.
Press the *Page* key until CAL.L shows on the display.
Press the *Up* or *Down arrow* key to display the current calibration low temperature.
Press the *Up* or *Down arrow* key to change the temperature value.
The value will then be stored without any further input.

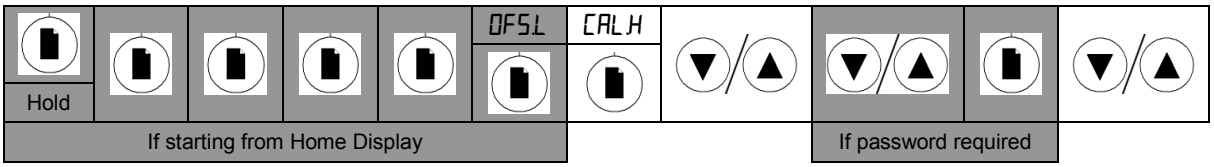
Once C.CL2 has been selected as the customer calibration type, it is possible to start from the Home display and go to CAL.L directly (or any of the other settings in C.CL2) and enter the password at this point when calibration adjustment is required again.

8.5 Changing the Calibration, Low Temperature Offset - OFS.L



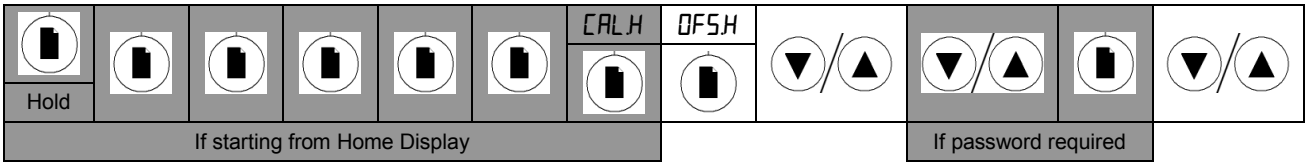
OFS.L follows on from CAL.L when the *Page* key is pressed.
Press the *Up* or *Down arrow* key to display the current calibration low offset.
Press the *Up* or *Down arrow* key to alter the low offset value.
The value will then be stored without any further input.

8.6 Changing the Calibration, High Temperature – CAL.H



CAL.H follows on from OFS.L when the *Page* key is pressed.
Press the *Up* or *Down arrow* key to display the current calibration high temperature.
Press the *Up* or *Down arrow* key to change the temperature value.
The value will then be stored without any further input.

8.7 Changing the Calibration, High Temperature Offset - OFS.H



OFS.H follows on from CAL.H when the *Page* key is pressed.
Press the *Up* or *Down arrow* key to display the current calibration high offset.
Press the *Up* or *Down arrow* key to alter the high offset value.
The value will then be stored without any further input.

9 Overtemperature protection

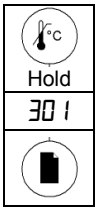
Overtemperature protection is an option on the 301 controller. An independent control circuit and temperature sensor provide the over temperature protection.

There are two reasons for overtemperature protection:
1. To prevent the material being used in a furnace or oven from over-heating.
2. To give an extra safety system to prevent the furnace or oven from heating in the event of a fault.

9.1 Overtemperature (O/T) Home Display

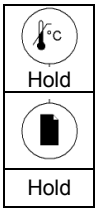
When the Overtemperature key is pressed and held the O/T Home display is shown.
The Home display shows what the overtemperature limit value is.

9.1.1 Finding the O/T Home Display from the O/T Home Menu



Press and hold the *Overtemperature* Key.
Press the *Page* key until the O/T limit value shows on the display

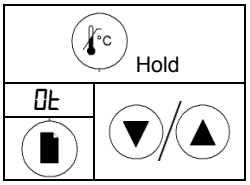
9.1.2 Finding the O/T Home Display from the O/T Setup Menu



Press and hold the *Overtemperature* key
Press and hold the *Page* key for 1.5 seconds.

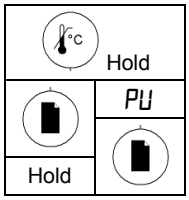
9.2 Changing the Overtemperature Limit

Note: If protection of the sample being processed is required, the overtemperature limit is normally set 15°C above the temperature setpoint of the controller. If protection of the furnace or oven is required, the overtemperature limit is normally set 15°C above the maximum setpoint of the furnace or oven.



Start at the Home display.
Press and hold the *Overtemperature* key.
Press the *Page* key until OE shows on the display.
Use the *Up* and *Down arrow* keys to change the offset value– a single press shows the current setting. To alter either keep pressed or press again.
The value will then be stored without any further input.

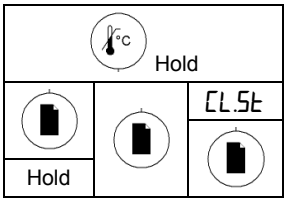
9.3 Checking the Overtemperature sensor temperature



Starting at the Home display.
Press and hold the Overtemperature key.
Press and hold the *Page* key for 1.5 sec.
PU is displayed for 1 second, followed by the overtemperature sensor value for 3 seconds; this sequence is then repeated.

9.4 Overtemperature Protection Calibration

The overtemperature protection circuit can be calibrated in the same way as can the main controller. However, this is not normally necessary as the level of accuracy required for overtemperature protection is not as critical as it is for the main control temperature.



Starting at the Home display.
Press and hold the Overtemperature key.
Press and hold the *Page* key for 1.5 sec.
Press the *Page* key until CL.SE is displayed.
Now follow the procedure in section 8

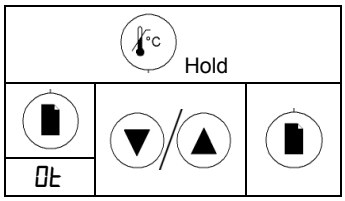
9.5 Overtemperature Activation

When an overtemperature circuit is fitted and is operating, the overtemperature indicator is green. When the temperature of the furnace or oven goes above the overtemperature limit, the overtemperature circuit activates. The power supply to the heating elements is cut and the overtemperature indicator changes to flashing red.

Pressing the Overtemperature key shows OLL in the display to say that the overtemperature has been triggered.

The reason for the overtemperature activation should Hold then be investigated; an incorrect setting in the overtemperature limit is often the cause. When you are satisfied with the reason for the overtemperature activation it can be reset.

9.6 Resetting Overtemperature Activation



Starting at the Home display press and hold the Overtemperature key; OLL is displayed.
Press the *Page* key; OL is displayed and the red indicator stops flashing.
Press the *Up* or *Down arrow* key to check the overtemperature limit value.
Press the *Up* or *Down arrow* key to alter the value if necessary.
Press the *Page* key to return to the overtemperature home display.
The overtemperature has now been reset
When the temperature falls below the overtemperature limit, the indicator changes back to green.
When the PV falls below the temperature setpoint, the furnace/oven starts to heat again.

10 RS232 Communication

The 301 controller can be supplied with the capability to communicate with other devices via an RS232 link. If this option has been ordered, the furnace or oven will be supplied with a 9 pin 'D' socket for connecting to an external device. Plugging this into a computer will allow the controller to be accessed from that computer. The computer must have appropriate communication software installed such as Eurotherm's 'i-Tools'

10.1 RS232 Communication Addressing:

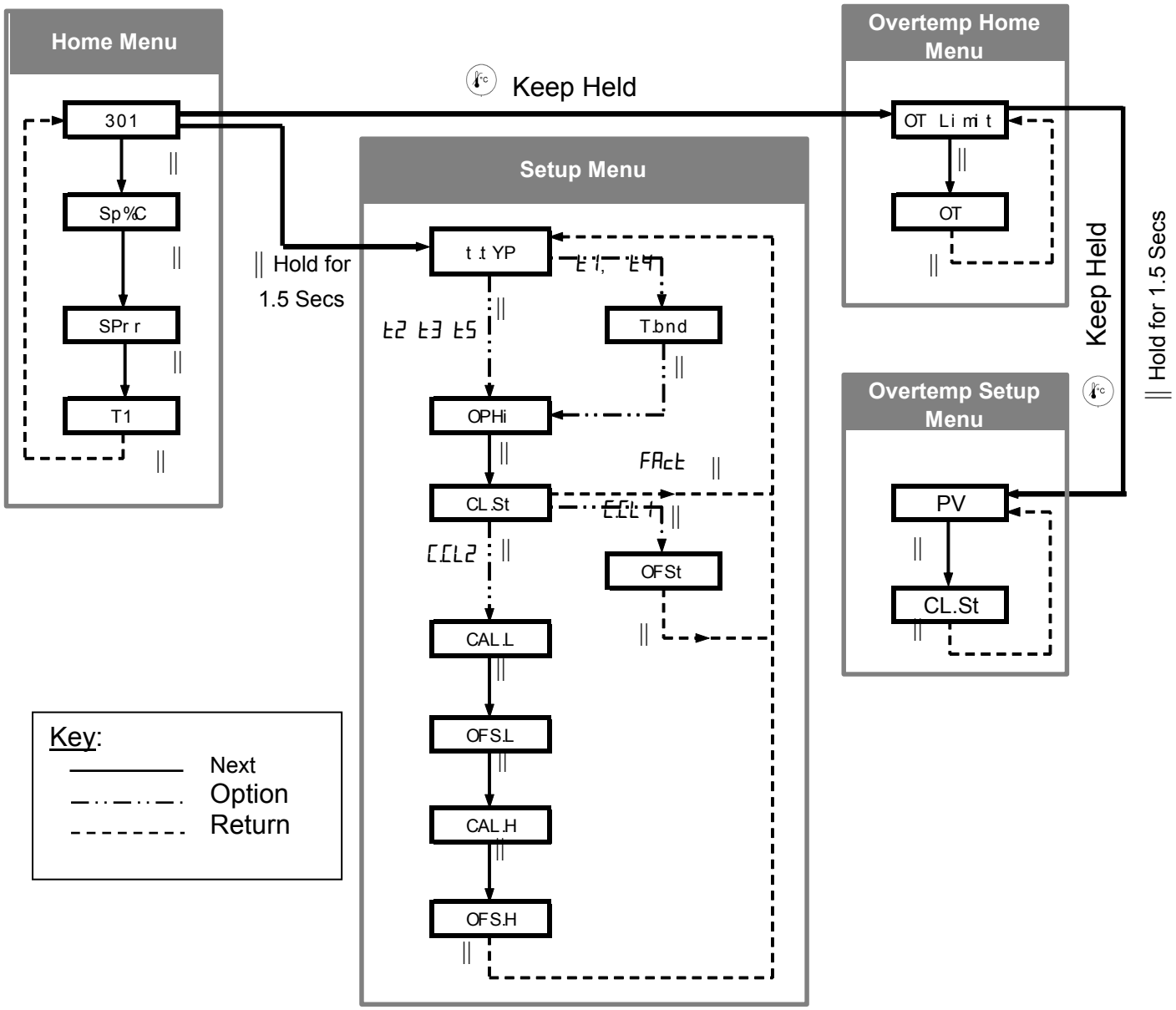
Modbus Address (Main)	=	**2**
Modbus Address (O/Temp)	=	**3**
Baud Rate	=	**9600**
Byte Format	=	**8**

10.2 RS232 Communication Cables

Connecting the furnace or oven to a computer is done via a “straight” cable as follows:

Furnace end of cable male 9-pin		RS232 Cable: furnace to PC	Computer end of cable female 9-pin	
Rx	3	———————	3	Tx
Tx	2	———————	2	Rx
Com	5	———————	5	Com

11 Navigation Diagrams



12 Controller Fault

12.1 Fault Code Diagnostic Table

Error Code	Explanation	Actions
5.br	Temperature sensor failure	Check all terminal connections between the temperature sensor (thermocouple) and temperature controller (301). It is recommended to loosen then tighten the screws in the terminal blocks in case the connections are oxidised. If this does not correct the error then replace the furnace or oven temperature sensor (thermocouple).
oooo	Input over range	
-ooo	Input under range	
E - followed by numerical code	Controller error	Turn the furnace or oven off and back on to see if this clears the error. If not contact Carbolite Engineering Services – (see back cover)

13 Glossary of Terms

Process Value (PV)	The actual temperature of the furnace or oven.	°C
Setpoint (SP)	The target temperature the furnace or oven is trying to reach.	°C
Setpoint Ramp Rate	The speed at which the furnace or oven is allowed to heat up or cool down.	°C/Min
Element	The heating device used in the furnace or oven.	-
Thermocouple	The temperature measuring device used in the furnace or oven.	-
PID	Proportional Integral Derivative: the control system used by the controller.	-
Overtemperature (O/T)	The condition which a furnace or oven may enter if part of the main control circuit fails.	-
Overtemperature Protection	A system to prevent the product or process being damaged if it has gone into an overtemperature condition.	-
Furnace or Oven	This refers to the product purchased from Carbolite Gero.	-

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

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