STAFFORD INSTRUMENTS

ST535C

Temperature Programmer Handbook

At a Glance

MAIN DISPLAY

RADIO ICON

PAUSED INDICATOR

KILN HEATING INDICATOR

SEGMENT DISPLAY

ZONE 1 ICON

ZONE 2 ICON

ZONE 3 ICON

EVENT INDICATORS

MIMIC DISPLAY

FIRING INDICATOR

START/STOP KEY

CONTROL KEYS

FUNCTION KEY

FUSE

MAINS SWITCH
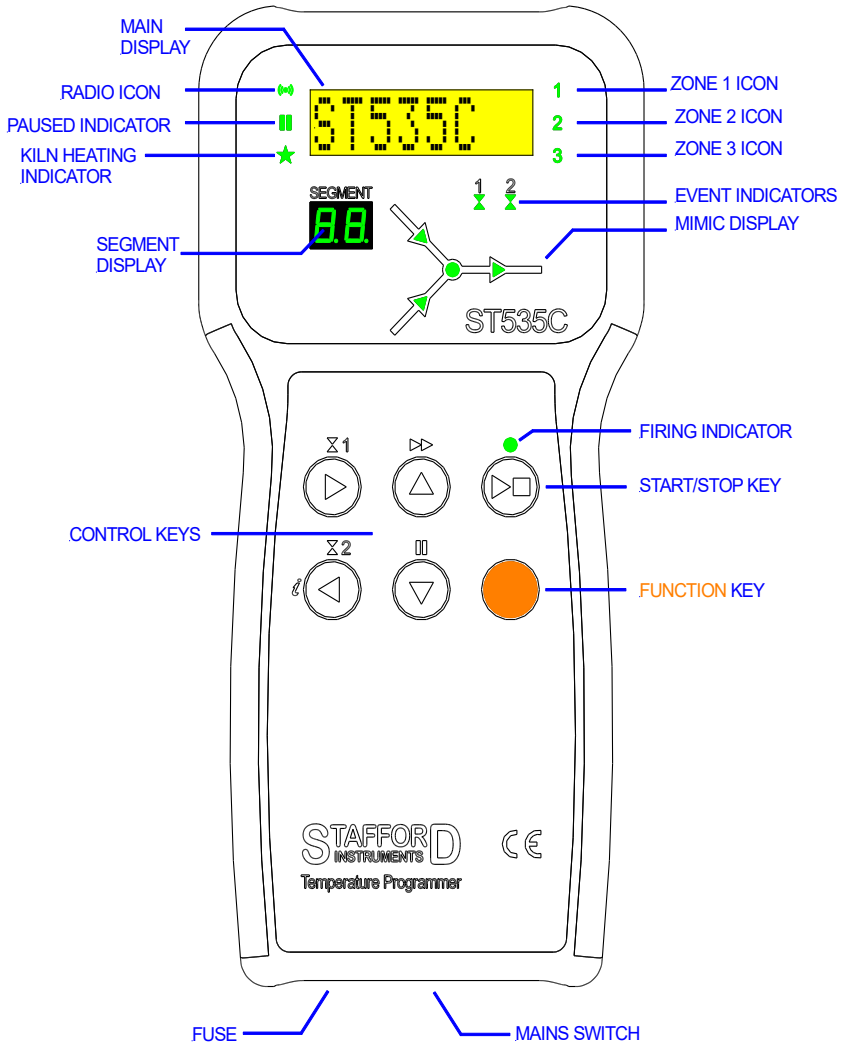
Quick Start Guide

Switch on & wait for kiln temperature display
To run a firing program set up previously press the ►■ key
To stop the firing at any time press the ►■ key again
To review firing data press the ► key to enter the programming mode
To change firing data press the ▲ & ▼ keys to change the displayed value
Use the ► key again as necessary to step to the next firing value or segment to be reviewed or changed
To mark the end of a program set a ramp rate to END with the ▼ key
To exit the programming mode either wait 20 seconds or press the ►■ key to start firing
If the keyboard is locked then press and hold down the function key for 5 seconds to unlock

Contents

Features

- Multi-zone (1,2 or 3 zones)
- 32 programs each with 32 segments
- 1 controlled heating / cooling ramp + soak per segment
- Soak periods up to 99 hours 59 mins
- Ramp rates from 0.1 to 999°/hour + FULL
- Ideal for glass or ceramics use
- Programs can be altered while firing
- Program pause and advance facilities
- Keyboard lockable
- Delayed start facility - up to 99 hours 59 mins
- Power failure recovery
- Energy used display
- Setpoint display
- Alarm buzzer & alarm relay output
- 2 Programmable control relay outputs
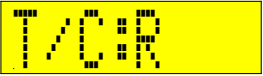- WiFi + USB datalogger option
- °C/°F operation

Turning On

ST535C

1. When turned on the ST535C performs a display test by lighting all of the display segments
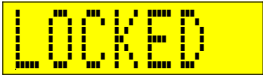2. and illuminating all of the front panel indicator
3. lamps.

F6.08

1. The version number of the software embedded
2. within the ST535C is now displayed. If you need technical support you might be asked for
3. this code together with the serial number.

T/C:R

1. Next displayed is the thermocouple type set-
2. ting. This should match the type of thermocouple fitted to the kiln and can be R, S, K or N
3. type (R,S,K,N).

20°C

1. The final display will show the kiln temperature. All other lamps (except the zone indicator lamp
2. for multi-zone kilns) should be off.
3.

LOCKED

1. If pressing any key causes LOCKED to appear
2. then the keyboard has been locked. This is an anti-tamper feature. Press the function key &
3. hold down for 5 seconds to unlock.

UNLOCKED

1. This now shows that the keyboard is UN-
2. LOCKED. To re-lock the keyboard press the function key & hold down for 5 seconds.
3.

If any mimic panel lamps are on then the ST535C is firing. To stop the firing press the ▶■ key.

32°C

1. During firing the star icon will light to show
2. when heating power is being applied to the
3. kiln.

SEGMENT **SEGMENT**

°C **°F**

Note: During power up the SEGMENT display shows the operating units (°C/°F) of the ST535C (Installer adjustable).

Programming

Cooling Ramp

Soak Period

Soak Temperature
(target temperature)

Heating Ramp

An ST535C firing segment comprises a ramp followed by a soak period. Two segments can be used for simple firing (biscuit firing for example) or several segments can be used per program for complex firing (crystal glazing or glass-making for example).

The ST535C ramps the kiln temperature at the required ramp rate until the kiln reaches the soak / target temperature. It then soaks (dwells) at the soak temperature for the soak period. It then runs the next segment until the end of the program is reached.
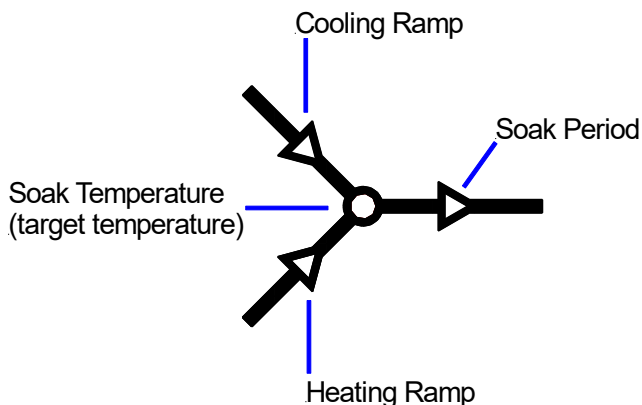
The ST535C is capable of both positive (heating) ramps and negative (cooling) ramps - as used in glassmaking for annealing. The type of ramp is clearly shown on the mimic display during firing.

The ramp rate is settable in the range 0.1 to 9.9°/hour then 10 to 999°/hour or FULL (full power) or END (end of program).

The soak / target temperature is settable over the range 0 to 1550°C (2822°F).

The soak period is settable over the range 00.00 (no soak) to 99 hours 59 mins.

Note: during soaking the ST535C display alternates every 15 seconds between kiln temperature and soak period remaining.

Altering a program

20°C
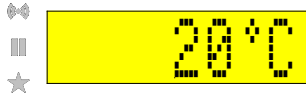
1 When not firing there are no indicators lit on
2 the mimic panel, the run indicator is off and
3 the display shows the current kiln temperature.

The controller settings can be reviewed by pressing the ► key.

PROG: 1

1 The first push of the ► key flashes the
2 program number display. The required firing
3 program can now be selected with the ▲ & ▼ keys.

Note: holding down the ▲ or ▼ keys causes rapid change of the displayed value.

150°C/HR

1 The next push of the ► key displays the ramp
2 rate in the range END, 0.1-9.9°/HR, 10-999°/HR
3 or FULL. This can be altered with the ▲ & ▼
keys. The heating ramp or the cooling ramp
indicator on the mimic panel will flash. END marks the end of the program. FULL
heats or cools as fast as possible.

600°C

1 The next push of the ► key displays the soak
2 temperature. This can be altered with the ▲
3 & ▼ keys. The soak temperature indicator
on the mimic panel will flash.

00:15

1 The next push of the ► key displays the soak
2 period in hours:minutes. This can be altered
3 in the range 00:00 to 99:59 with the ▲ & ▼
keys. The soak period indicator on the mimic
panel will flash.

SEGMENT

2 The next push of the ► key increments the segment number digit and
firing data for the next segment can be entered.

END

1 Program data entry is terminated if END is
2 selected for a ramp rate with the ▼ key. Pro-
3 gram data entry is also automatically terminat-
ed if the maximum number of segments have
been entered.

*Note 1: available ramp rate displays are: END, 0.1 … 999 & FULL. If END is shown but another segment is
required then push the ▲ key to obtain the required ramp rate (in the range 0.1°/hr to 999°/hr). If maximum
heating/cooling is required then push the ▲ key until FULL is displayed. To mark the end of the program push
the ▼ key until END is displayed.*

*Note 2: to exit programming without cycling through all of the above steps wait 20 seconds without pressing any
keys - the ST535C will revert to the idle display. Alternatively press the ►■ key to exit programming and to begin
firing immediately.*

*Note 3: the ◄ key can be used to reverse through the programming steps to correct errors or to exit programming
mode.*

ST535C Handbook

Temperature Display

This section only applies to multi-zone (2 or 3 zones) kilns. A single zone kiln will always show the temperature of zone 1 only.

1020°C

1 For a single zone kiln the zone icons are not
2 used and the temperature of zone 1 is always
3 displayed.

1020°C

1 For multi-zone kilns the temperature of each
2 zone can be displayed. Zone 1 is displayed by
3 default when the ST325 is powered on.

1018°C

1 To change the displayed zone press either the
2 ▲ or ▼ keys. The zone number icons will
3 change to show which zone temperature is being
displayed.

Control Relays

Control Relay Configuration

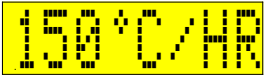The ST535C has 2 control relay outputs.
Control relay 1 can be configured as an event output, a damper control output or a fan control output.
Control relay 2 can be configured as an event output only.

See the Installation section for details about configuring the control relays.

Event Outputs

The control relays when configured as event outputs can be programmed to change state at the start of a ramp and also at the start of a soak period. Thus both ramp and soak events are possible. The event output is ON (relay contacts are closed) when the relevant event icon is lit. Prior to running a program both event outputs are OFF (relay contacts are open). The status of the event outputs is stored within the firing program.

150°C/HR

1 While displaying a ramp rate an event output can be
2 switched on or off by holding in the function key then
3 pressing either the ✕1 key or the ✕2 key. The event
output will be ON when the event icon is on.

00:15

1 While displaying a soak period the event output can
2 be switched on or off by holding in the function key
3 then pressing either the ✕1 key. The event output
will be ON when the event icon is on.

Damper Output

To enter the damper temperature configuration menu press the ► key and the ◄ key down together while the controller is not running a program (firing indicator not lit).

Note: in the sequence below if no key presses are detected within 30 seconds the ST535C will exit the menu and damper temperature changes will not be saved.

DAMPER:C

1. The damper close temperature prompt is
2. shown. Release the ► & ◄ keys.
3. **Press the ► key.**

150°C

1. The damper close temperature is now
2. shown. Adjust with the ▲ & ▼ keys (hold
3. down for acceleration).
   Press the ► key.

DAMPER:O

1. The damper open temperature prompt is
2. now shown.
3. **Press the ► key.**

300°C

1. The damper open temperature is now
2. shown. Adjust with the ▲ & ▼ keys (hold
3. down for acceleration)
   Press the ► key.

The instrument will now reset and the new damper control temperatures will be stored.

Note: in the sequence above it is important that the ► key is pressed a total of 4 times else changes will not be saved.

Damper Operation

Prior to firing the damper will be open. During firing, when the kiln reaches the damper close temperature, the damper will close. The event indicator ⏳1 will be on.

At the end of the firing and when the kiln has cooled naturally to the damper open temperature, the damper will open. The event indicator ⏳1 will be off.
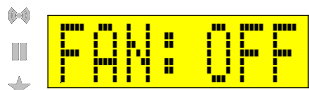
Fan Output

To enter the fan temperature configuration menu press the ▶ key and the ◀ key down together while the controller is not running a program (firing indicator not lit).

Note: in the sequence below if no key presses are detected within 30 seconds the ST535C will exit the menu and fan temperature changes will not be saved.

FAN: ON
1 The fan start temperature prompt is shown.
2 Release the ▶ & ◀ keys.
3 **Press the ▶ key.**

200°C
1 The fan start temperature is now shown.
2 Adjust with the ▲ & ▼ keys (hold down for acceleration).
3 **Press the ▶ key.**

FAN: OFF
1 The fan stop temperature prompt is now shown.
2
3 **Press the ▶ key.**

700°C
1 The fan stop temperature is now shown.
2 Adjust with the ▲ & ▼ keys (hold down for acceleration)
3 **Press the ▶ key.**

The instrument will now reset and the new fan control temperatures will be stored.

Note: in the sequence above it is important that the ▶ key is pressed a total of 4 times else changes will not be saved.

Fan Operation

Prior to firing the fan will be off. During firing the fan will start when the kiln temperature has risen to the fan start temperature.

The fan will remain on until the kiln temperature has risen to the fan stop temperature. The fan then turns off and remains off.

The event indicator ⧗1 is turned on while the fan is running.

Firing

To start a firing press the ►■ key. The firing indicator lamp will flash.

With the firing indicator flashing an optional start delay up to 99 hours: 59 minutes can be entered with the ▲ & ▼ keys.

After 10 seconds, or immediately if the ►■ key is pressed again, the firing will commence and the firing indicator lamp will remain lit.

To stop the firing prematurely at any time press the ►■ key again. The firing indicator lamp will go out.

Hint: it is good practice to check that the program is correct by pressing the ► key & checking the program number & program contents before pressing the ►■ key to start a firing. It is also a good idea to have a written record of the contents of the firing programs kept and displayed near the kiln especially if there is more than one user of the kiln.

Note: during ramping the ST535C will perform either controlled heating or controlled cooling - as indicated on the mimic display. During soaking the ST535C display alternates every 15 seconds between kiln temperature and soak period remaining. At the end of each segment the segment number display will be incremented.

Information: The ST535C operates by calculating the amount of energy required by the kiln every 30 seconds (installer adjustable). If for example 40% of full energy is required to maintain a particular ramp rate or a particular soak temperature then the ST535C will apply heating power to the kiln for 12 seconds every 30 seconds. The kiln heating indicator will light for 12 seconds every 30 seconds. If the kiln has a contactor then a loud click will be heard both when the kiln heating indicator lights up and when it goes out. If full heating power is required then the kiln heating indicator will remain lit. If full cooling is required the kiln heating indicator will remain off.

Cooling

Upon completion of firing the ST535C lights all lamps on the mimic display and the kiln is allowed to cool naturally.

While the kiln temperature is above 40°C the display alternates every 5 seconds between the kiln temperature and HOT.

When the kiln has cooled to less than 40°C the display alternates every 5 seconds between the kiln temperature and END.

To return the ST535C back to idle condition ready for the next firing press the ►■ key (or turn off the power to the instrument).

Operating Notes

Kiln too slow

If the ST535C is programmed to heat the kiln at a faster rate than the kiln is capable of then the ST535C will turn on full power then wait until the kiln temperature has risen to the correct temperature before proceeding to the next ramp or soak segment.

Likewise if the ST535C is programmed to cool the kiln at a faster rate than the kiln is capable of then the ST535C will apply zero power then wait until the kiln has cooled to the correct temperature before proceeding to the next ramp or soak segment.

Heating & Cooling Ramps

The ST535C is capable of controlled ramps for both heating and cooling. The type of ramp required is determined by comparing the required soak temperature to the soak temperature in the previous segment and is shown on the mimic display.

►■ Key Operation

If the ►■ key is pressed during a firing then the firing will be halted (not paused). Pressing the ►■ key again will cause the ST535C to restart the firing from the beginning. The ST535C will look at the current kiln temperature and if this is greater than the required soak temperature then the ST535C will automatically *cool* from current temperature to the soak temperature. This may not be what is desired so the ►■ key should only be used to halt the firing in an emergency.

The program can be paused or program data can be changed while the controller is firing. This is a better option than using the ►■ key. The program advance feature is however available to recover quickly from ►■ key operation if required (see "Adjusting While Firing" section).

Memory

All programs & necessary data are remembered when the ST535C is turned off. In the event of power failure during firing the ST535C will automatically resume firing when power is returned (this feature can be disabled: see installation section).

Delayed Start

By default the delayed start time period is initialised to 00:00 for each firing. The ST535C can however be configured to remember the delayed start time period (see Installation section).

Adjusting While Firing

Firing values can be adjusted while the ST535C is firing. Also there are program pause and program advance features that are particularly useful for glass work.

Adjusting Firing Values

While firing operate the ► key to select the required parameter as shown by a flashing lamp on the mimic display. The firing value is shown on the main display and can now be adjusted with the ▲ & ▼ keys in the usual way. The contents of the current segment or any segment still to be executed can be changed. Firing will still carry on as normal while these changes are being made. The ST535C will return to its normal running display 20 seconds after key presses cease (or immediately after END is displayed).

Changes made to programs in this way are stored and are used for subsequent firings.

Program Advance Facility

While firing press and hold down the function key then press the ▲ key to obtain the ▶▶ (advance) function. The ST535C will sound a short beep and the executing program will immediately advance one step as indicated by lamps on the mimic panel. The effect of this is as follows:-

If ramping then the ST535C will switch to soak at the current kiln temperature. If soaking then the ST535C will advance to the next segment if any, or else it will end the firing.

Changes made to the operation of the ST535C in this way are temporary and are not stored.

Program Pause Facility

While firing press and hold down the function key then press the ▼ key to obtain the ❙❙ (pause) function. The ST535C will sound a short beep and the executing program will pause at the current kiln temperature. The pause indicator (❙❙) will light. To release the pause repeat the above action.

While paused, the kiln temperature display will alternate periodically with a scrolling PAUSED display and a beep will be sounded.
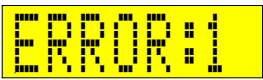
WARNING - PROGRAM PAUSE
The program pause facility should be used with care. Program execution is suspended and the kiln will be held at its current temperature. If left too long at high temperatures kiln damage could result. Pause will automatically release after an Installer-defined time period (default: 2 hours - see Installation section).

Error Messages
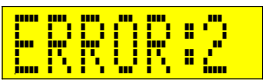
If the ST535C detects a problem the buzzer will sound and an error message will be displayed. This error message will alternate with a display of kiln temperature. The segment number display will show where the error occurred.

To obtain more information on the error press the ◄ key. The first press will display the maximum temperature reached in the firing. The second press will display the length of time that the error has been present. The buzzer will mute.

ERROR:1 — Heating error. The kiln temperature is not increasing as required. The kiln has been on full power for 60 minutes but the temperature has not increased by at least 2°C.

Possible causes: kiln door or lid not closed properly or door switch faulty or needs adjusting. Heater element open circuit or elements too old. Electrical power phase failure or contactor failure.

ERROR:2 — Thermocouple or thermocouple wiring open circuit. Get thermocouple and wiring checked. Replace thermocouple if necessary.

ERROR:3 — Thermocouple reversed (kiln temperature apparently less than -40°C). This is an installation fault. Get wiring checked.

ERROR:4 — Cooling error. The kiln has been on zero power for 30 minutes but the kiln temperature has not fallen by at least 1°C.

Possible causes: contactor failure (contacts welded?) or thermocouple connection intermittent or high resistance.

ERROR:5 — Kiln temperature overshoot. The kiln temperature exceeds the desired temperature by a preset limit.

ERROR:6 — Maximum firing time exceeded. The length of the firing has exceeded an installer selectable limit.

ERROR:7 — Maximum room temperature exceeded. The internal temperature of the ST535C has exceeded an installer selectable limit.

Possible causes: kiln room vent fan failure, kiln room too small, ventilation grills blocked, damper or bung left open, controller mounted too close to kiln.
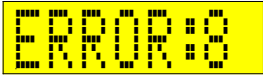
ERROR:8 — Internal data conversion circuit (ADC) error.

ERROR:S — Maximum allowable differential temperature between zones exceeded. The temperature of zone 2 or zone 3 has varied from zone 1 by an installer selectable limit.

All these error messages cause the ST535C to terminate the firing. The alarm buzzer will sound once per second. To reset the ST535C turn off the power to the instrument and have the fault investigated and rectified by your installer or kiln service engineer.

Note: these error messages are provided to detect kiln faults and so offer some protection to the kiln.

Technical note: these error messages will cause the alarm relay to open.

Firing Program Errors
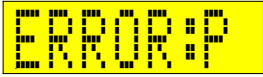
ERROR:P — Program Error. This error message is displayed if a potential error is detected within the firing program when the ▶■ key is pressed to start a firing. The alarm buzzer will sound 3 times and the segment display will show the suspect segment number. To clear this error press the ▶ key. The ST535C will now enter programming mode to allow the suspect program to be viewed and altered if necessary. If a fault is found then correct it. If no fault is found then press the ▶■ key again to force the firing program to start. A potential programming error is defined as a very low ramp rate to a very low temperature. Such a programming fault might cause very long firing times with potential kiln damage.
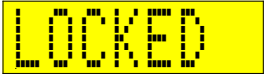
Other Features

Energy Used & Setpoint Displays

12.5KWH

1 Press and hold down the function key then
2 press the ◄ key at any time to show the amount of electrical energy used in kWh.
3 During a firing the energy used so far is shown. After a firing the total energy used for the firing is shown. This information is stored while power is off and is only reset to zero when a new firing is started. If the value displayed is always 0.0 then the kiln power rating has not been configured - see Installation section.

Operating the ◄ key a second time shows the current set-point (the temperature which the ST535C is currently trying to achieve).

Keyboard Lock Facility

The keys on the ST535C can be locked so that pressing them has no effect. This is an anti-tamper feature used to ensure that the operation of the ST535C or the program data cannot be altered by un-authorised people. The ST535C can be locked when it is idle (not firing) or while it is firing. It cannot be locked while it is being programmed.

LOCKED

UNLOCKED

1 Press and hold the function key down for 5
2 seconds to lock or to unlock.

Power Failure Recovery

If power fails during firing then the ST535C recovers as follows:-
For power failure during start delay the ST535C times off the remaining start delay when power returns. For power failure during ramping the ST535C continues the ramp it was previously executing. For power failure during soaking the ST535C ramps back up to soak temperature at the correct ramp rate then applies the remaining soak period. This recovery scheme can be disabled if required (see Installation section) - the ST535C will then lock up with FAIL displayed and kiln off in the event of power failure.

Sample Glass Programs

The ST535C is provided pre-programmed with the glass firing programs below. These programs may be modified as required.

Program No.	Program Description	Seg 1 Ramp Rate °C/hr	Seg 1 Soak Temp °C	Seg 1 Soak Time hr:mn	Seg 2 Ramp Rate °C/hr	Seg 2 Soak Temp °C	Seg 2 Soak Time hr:mn	Seg 3 Ramp Rate °C/hr	Seg 3 Soak Temp °C	Seg 3 Soak Time hr:mn	Seg 4 Ramp Rate °C/hr	Seg 4 Soak Temp °C	Seg 4 Soak Time hr:mn	Seg 5 Ramp Rate °C/hr
1	4-6mm Float Glass Fuse	150	538	00:10	FULL	840	00:20	FULL	538	00:45	182	427	00:15	END
2	4-6mm Float Glass Slump	538	538	00:00	FULL	824	00:20	FULL	538	00:15	182	427	00:00	END
3	6mm Bullseye™ Fuse	222	677	00:30	333	795	00:10	FULL	482	01:00	83	371	00:01	END
4	6mm Bullseye™ Slump	167	640	00:10	FULL	482	01:00	56	371	00:01	END	-	-	-
5	6mm Spectrum System 96™ Fuse	200	500	00:00	FULL	804	00:12	FULL	540	00:40	150	510	00:20	END
6	6mm Spectrum System 96™ Slump	155	704	00:20	FULL	540	01:30	FULL	510	00:10	26	371	00:00	END
7	Bottle Firing Cycle	170	510	00:00	250	780	00:10	FULL	510	01:00	70	400	00:30	END
8	Low Stain	200	570	00:10	FULL	516	00:30	100	300	00:00	END	-	-	-
9	High Stain	200	665	00:10	FULL	550	00:20	FULL	516	00:30	100	300	00:00	END

Sample Ceramics Programs

The ST535C is provided pre-programmed with the ceramics firing programs below. These programs may be modified or over-written as required.

Program Number	Program Name	Seg 1 Ramp Rate °C/hr	Seg 1 Soak Temp °C	Seg 1 Soak Time hr:mn	Seg 2 Ramp Rate °C/hr	Seg 2 Soak Temp °C	Seg 2 Soak Time hr:mn	Seg 3 Ramp Rate °C/hr
11	Slow Bisque	60	600	00:00	FULL	1000	00:00	END
12	Normal Bisque	100	600	00:00	FULL	1000	00:00	END
13	High Bisque	100	600	00:00	FULL	1140	00:00	END
14	Brush-on Earthenware Glaze 1000°C (Cone 6)	100	300	00:00	FULL	1000	00:00	END
15	Standard Earthenware Glaze 1100°C	100	300	00:00	FULL	1100	00:00	END
16	Earthenware High Temperature Glaze 1140°C	100	300	00:00	FULL	1140	00:00	END
17	Mid-Range Stoneware Glaze 1200°C	100	300	00:00	FULL	1200	00:00	END
18	Standard Stoneware Glaze 1260°C (see note)	100	300	00:00	FULL	1235	00:00	END
19	Onglaze 780°C	100	400	00:00	FULL	780	00:00	END
20	Lustre 750°C	100	400	00:00	FULL	750	00:00	END

Note
It has been found that a kiln controller will give greater heat work as the temperature increases. Therefore to achieve a stoneware firing of cone 8-9 we suggest setting the final soak temperature to 1235°C. A slight adjustment can then be made after the first firing. It should be remembered that kiln controllers are indicators of temperature and the effects of faster or slower firings may cause extreme variations in the end result. This is known within ceramics as "heatwork". Cones are measures of heatwork and it is strongly recommended that cones are always used in conjunction with a kiln controller to appreciate the differences between heatwork and temperature indicated by the controller. Stoneware firings will also demonstrate the greatest potential differences between heatwork and indicated temperature.

WiFi & USB Datalogging Option

This option (if fitted) allows for remote monitoring, datalogging and program loading by WiFi. It also has a USB connector to give local data logging, configuration and maintenance by USB FLASH memory "thumb" drive.
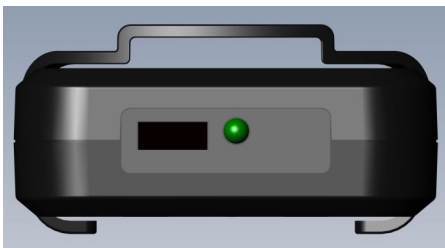
The radio icon lamp on the front panel flashes when the ST535C is paired to a WiFi network and is sending or receiving information.

WiFi Configuration

To access the controller over an internet connection go to www.staffordinstruments.co.uk then click on the "MY CONTROLLER" link. Follow the on-screen instructions. One or more controllers can be registered to a user account. If you haven't already done so then you will first need to create a user account then register your controller.

USB Functions

The main USB function is to provide a time stamped datalogging facility. The log files created are in CSV format which can be read directly into a Microsoft Excel spreadsheet. User program data and or configuration data can also be read into the controller. Controller firmware updates are also possible.

The USB socket and associated green "Drive Mounted" LED are mounted on the top panel of the controller. A dust plug is provided for when a USB drive is not fitted.

FLASH Memory Drive Specification
These can be either USB1, USB2 or USB3 drives (USB3 drives have a blue insulator). The drives must be formatted as FAT32 or FAT16 (not NTFS or ExFAT). The module has been tested with several makes of drive up to size 256Gbytes. If the green LED next to the USB connector illuminates then the inserted FLASH drive is acceptable.

The drive can be inserted at any time (with the controller either on or off). It can also be removed at any time - but preferably not while the controller is writing data to the drive. The green LED will turn off when the drive is removed.

Time of day Clock Function
This datalogger module incorporates an accurate battery backed date and time of day clock. It compensates for leap years. It does not automatically compensate for daylight saving in summer and winter. This clock is used to time stamp data within the datalogger files. It is also used to date and time stamp the actual file. Note: the date and time stamp of the file is the time the file was last written to (not the time when the file was first created). The (replaceable) clock battery (CR1632) is sized to last at least 10 years.

Clock Adjustment

With the controller turned on and not firing: press and hold down the ◄ (left) key for 5 seconds.

You are now in date setting mode. The date is shown in YY.MM.DD format (2020.05.28 illustrated):-

20.05
28

Navigate to the flashing digit with the ► or ◄ key. Change the flashing digit with the ▲ ▼ keys. Move onto the next digit with the ► key.

Move to the time setting mode by pressing the ► key from the flashing day display. The time is now shown in HH.MM.SS format (09:15:20 illustrated):-

09.15
20

Navigate to the flashing digit with the ► or ◄ key. Change the flashing digit with the ▲ ▼ keys. Move onto the next digit with the ► key. Leave the time setting mode either by waiting 15 seconds or by pressing the ► key from the flashing seconds display.

Datalogging

Datalogging commences when a firing is started. Datalogging finishes when the firing is complete and when the kiln has cooled to 100°C. A file: LOGnnn.CSV is created on the FLASH drive. The first file to be created will be LOG000.CSV. Subsequent firings will generate LOG001.CSV … up to LOG999.CSV. Only 1000 log files are allowed. It is best to move the LOG files to another storage disk after just a few firings—because it takes about 1 second to index each existing file on disk before a new file can be created. So for example if there are files LOG000.CSV to LOG100.CSV on disk there would be a delay of just over 100 seconds before LOG101.CSV could be created and logging could be commenced.

The files created are in "Comma Separated Variable" (CSV) ASCII format and can be directly imported into Microsoft Excel Spreadsheets.

Logging Interval

This can be adjusted over the range 5 to 300 seconds (default 60 seconds) using parameter P50 with the controller in configuration mode. Please see the Installation Instructions section of this document for details.

Log File Format

This is illustrated on page 23 of this document.

LOGnnn.CSV file format

Year	Month	Day	Hour	Min	Sec	Z1 Temp	Z1 Setpoint	Z2 Temp	Z2 Setpoint	Z3 Temp	Z3 Setpoint	Ambient Temp	Program	Segment	Event 1	Event 2	Status
2021	2	11	17	44	47	22.9	24.9	22.9	24.9	22.9	24.9	22.9	1	1	0	0	HEATING RAMP
2021	2	11	17	45	47	22.9	26.9	22.9	26.9	22.9	26.9	23	1	1	0	0	HEATING RAMP
2021	2	11	17	46	47	23.8	28.9	23.8	28.9	23.8	28.9	23.1	1	1	0	0	HEATING RAMP
2021	2	11	17	47	47	25.1	30.9	25.1	30.9	25.1	30.9	23.1	1	1	0	0	HEATING RAMP
2021	2	11	17	48	47	26.9	32.9	26.9	32.9	26.9	32.9	23.1	1	1	0	0	HEATING RAMP
2021	2	11	17	49	47	28.9	34.9	28.9	34.9	28.9	34.9	23.1	1	1	0	0	HEATING RAMP
2021	2	11	17	50	47	32.2	36.9	32.2	36.9	32.2	36.9	23.1	1	1	0	0	HEATING RAMP
2021	2	11	17	51	47	36.8	38.9	36.8	38.9	36.8	38.9	23.1	1	1	0	0	HEATING RAMP
2021	2	11	17	52	47	40.5	40.9	40.5	40.9	40.5	40.9	23.2	1	1	0	0	HEATING RAMP

Note

The "Event" field shows "1" when the event relay is energised.
For damper operation this indicates damper closed
For fan operation this indicates fan on
For event operation this indicates event active
In all cases the event icon on the front panel will be illuminated

The "Event" field shows "0" when the event relay is de-energised.
The event icon on the front panel will be off.

Status Field within Log File
The Status field within the log file format can show the following:-
"DELAYING",
"HEATING RAMP",
"HEATING RAMP PAUSED",
"COOLING RAMP",
"COOLING RAMP PAUSED",
"SOAKING",
"SOAKING PAUSED",
"COOLING",
"COOL",
"ERROR" + error number (0 to 9),
"POWER FAILED",
"PAIRING"

CONFIG.TXT
This file (if it exists on the drive) will be read only when the controller is powered up.
So insert the drive while the controller is not powered. Then apply power to the controller.
This file changes the controller configuration using the following file format (one item per line):-
Configuration Parameter Number,Configuration Parameter Value
So for example to change the controller settings for a datalogger sample interval of 60 seconds, with "K" type thermocouple, with a maximum user temperature of 1050°C and with a kiln power rating of 3.0kW:-

The contents of CONFIG.TXT would be:-

50,60
0,0
2,1050
14,30

Note: out of range values will not be stored (ignored).
Note: refer to the Installation Section for a full list of configuration parameters.

It is best to store this file on a separate drive and remove it from the controller after use. In this way unnecessary re-configuring is avoided the next time the controller is powered on. This drive can be used to re-configure multiple controllers.

Controller Firmware Updates
If you have created an account via the "MY CONTROLLER" link on our website then by logging onto your account you will be informed if there is a firmware update available. Follow the on screen instructions.

PROGRAMS.TXT
This file (if it exists on the drive) will be read only when the controller is powered up. So insert the drive while the controller is not powered. Then apply power to the controller.

This file changes the contents of the user programs using the following file format (one segment per line):-

Program number,segment number,ramp rate,temperature,soak time,event flag

So for example to put a simple firing program in program location 7 such as:-

Segment 1:	50°C/hr to 120°C then soak 60 minutes
Segment 2:	150°C/hr to 600°C then soak 0 minutes
Segment 3:	FULL to 1250°C then soak 15 minutes
Segment 4:	End

The contents of PROGRAMS.TXT would be:-

7,1,500,120,60,0
7,2,1500,600,0,0
7,3,10000,1250,15,0
7,4,0,0,0,0

Notes:-
(1)   Out of range values will not be stored.
(2)   Ramp rates are stored with a resolution of 0.1°C/hour so for a ramp rate of 50°C/hour enter 500 and for a ramp rate of say 9.7°C/hour enter 97.
(3)   Full power is specified by a ramp rate of 10000
(4)   Program end is specified by a ramp rate of 0
(5)   The last line of the program should have "0,0,0,0" (as shown above) to mark the end of the program.
(6)   The "event flag" item on the end of each program line can have the value 0 to 15 and should be set as follows:-

Event flag	Event flag (binary)	Soak event 2	Ramp event 2	Soak event 1	Ramp event 1
0	0000	OFF	OFF	OFF	OFF
1	0001	OFF	OFF	OFF	ON
2	0010	OFF	OFF	ON	OFF
3	0011	OFF	OFF	ON	ON
4	0100	OFF	ON	OFF	OFF
5	0101	OFF	ON	OFF	ON
6	0110	OFF	ON	ON	OFF
7	0111	OFF	ON	ON	ON
8	1000	ON	OFF	OFF	OFF
9	1001	ON	OFF	OFF	ON
10	1010	ON	OFF	ON	OFF
11	1011	ON	OFF	ON	ON
12	1100	ON	ON	OFF	OFF
13	1101	ON	ON	OFF	ON
14	1110	ON	ON	ON	OFF
15	1111	ON	ON	ON	ON

Installation

DISCONNECT BEFORE REMOVING COVER (NO USER SERVICEABLE PARTS INSIDE)

<u>WARNING</u>

ISOLATE KILN & PROGRAMMER FROM ELECTRICAL SUPPLY BEFORE ATTEMPTING INSTALLATION OR REPAIR WORK

Installer Information

Installation Category: II
Pollution Class: 2

100-240V ~ 50/60HZ 1.0A

Fuse: 3.15A Anti-surge
20mm ceramic HRC

IP50

CE

UK
CA
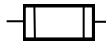
EMC

To meet Electromagnetic Compatibility requirements the controller lead should not exceed 3.0m in length.

This instrument is designed for use mainly in Domestic, Commercial & Light Industrial environments where electromagnetic interference may cause a loss of accuracy of the displayed temperature reading of up to 3°C. Specified accuracy will be restored when the interference is removed.

Mounting

Mounting Location

Mount the instrument on a suitable vertical surface which will not get hot. Choose a position where the instrument is not exposed to direct heat from the kiln - especially when the kiln door or lid is open.

Wall Mounting Bracket

This is a 'holster' style ABS moulded bracket which can be attached with 2 screws. The bracket mounting holes are spaced 100mm. The instrument can be removed from this bracket for in-hand programming if required. Spare wall brackets are available from Stafford Instruments Ltd. - our part number: X00210.

Contactor Coil Suppression

The coil of each kiln contactor *should be suppressed* with an RC suppressor. RC suppressors must be connected directly across the coil terminals on each contactor. Suitable proprietary RC suppressors are often available from contactor manufacturers as add-on blocks.

A suitable RC suppressor with insulated wire leads (fly leads) is the Okaya Electric XEB1201B. These are available from Stafford Instruments Ltd. - our part number: X00104.

Han12Q	CPC14	CPC19	Han15D		
11	1	1	B5	Thermocouple Z1 +ve	ORANGE
12	2	2	C5	Thermocouple Z1 -ve	WHITE
-	3	3	B4	Thermocouple Z2 +ve	ORANGE
-	4	4	C4	Thermocouple Z2 -ve	WHITE
-	5	5	A4	Thermocouple Z3 +ve	ORANGE
-	6	6	A5	Thermocouple Z3 -ve	WHITE
5	8	8	A1	Mains Supply (L)	BROWN
6	9	9	B1	Mains Supply (N)	BLUE
7	13	13	C3	Control Output Neutral (N)	BLACK
1	14	14	A2	Heating Control Output (L) Z1	WHITE/BLACK
-	7	7	B2	Heating Control Output (L) Z2	YELLOW/BLACK
-	10	10	C2	Heating Control Output (L) Z3	ORANGE/BLACK
2	12	12	C1	Safety Control Output (L)	YELLOW
3	-	15	A3	Event 1 Control Output (L)	GREY
4	-	16	B3	Event 2 Control Output (L)	PINK
-	11	11	Shell	Earth	GREEN/YELLOW
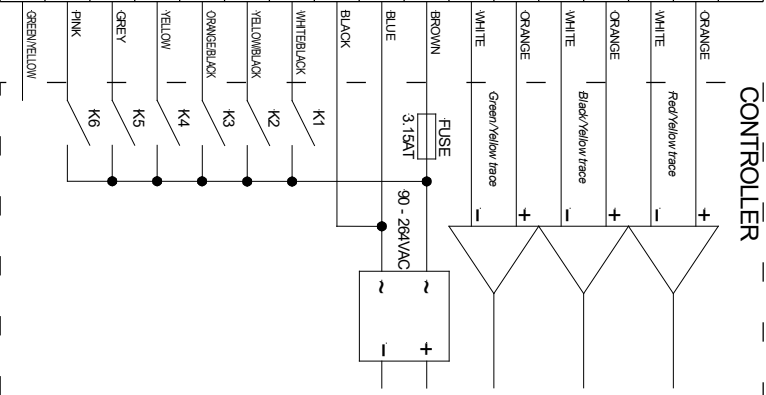
Connecting Leads

The ST535C is fitted with a 3m connecting lead and plug. The plug will be a Han12Q, Han15d, CPC14 or CPC19. For kilns requiring either 1 or 2 event outputs then either the Han12Q, Han15DX or CPC19 connector is used.

It is important to check the wiring of the kiln connector for compatibility prior to connecting the ST535C - to prevent possible damage either to the kiln or the controller!

Han15DX plug
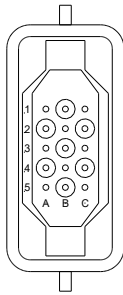
View on pins

Han12Q plug
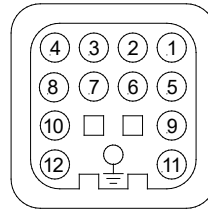
View on pins

CPC14 plug
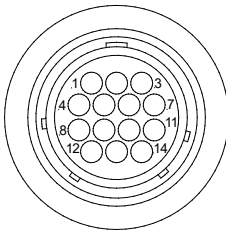
View on pins

CPC19 plug
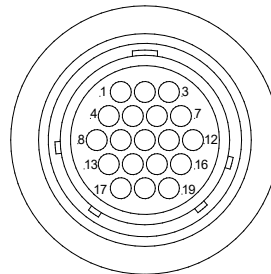
View on pins

Zone Allocation

Zone 1 is the main control zone and it is normal to allocate this zone to the bottom of a multi-zone kiln. Zone 2 is a slave zone and should be allocated to the middle zone of a 3-zone kiln or the top zone of a 2-zone kiln. Zone 3 is also a slave zone and is allocated to the top zone of a 3-zone kiln.
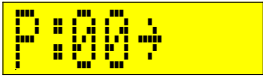
Configuring

To enter configuration mode power down the ST535C. Press and hold down both the ►■ key & the function key while powering up the ST535C.

T/C:R

1 When the thermocouple type is displayed
2 release the ►■ key.
3

P:00→

1 The first setup parameter number is now dis-
2 played (flashing 00). Refer to the code tables
3 overleaf for a description of the available con-
figurable parameters.

P:02→

1 Change the parameter number with the ▲
2 & ▼ keys. To display the parameter value
3 press the ► key.

1320

1 The parameter value can now be altered with
2 the ▲ & ▼ keys. To select another
3 parameter press the ► key.

Pressing both the ►■ key & the function key at any time causes the config-uration parameters to be stored. The instrument will then reboot.

TIMEOUT!

1 *Note: in the above sequence if no key presses*
2 *are detected for 30 seconds the instrument will*
3 *time out and exit configuration mode **without**
saving any changes. The buzzer will sound for
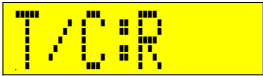3 seconds*

ERROR MESSAGES
Certain error messages can be disabled by the use of configuration parameters. Error messages should normally be left enabled. Error messages should only be disabled as a short term measure - to diagnose kiln problems for example.

The alarm output contact closes at the start of a firing and opens when the firing is complete. If an error message is generated the firing is terminated, the alarm buzzer sounds and the alarm output contact opens. This output is usually used to drive a secondary (policeman) contactor to isolate power to the kiln elements.

Error messages are provided to detect kiln faults and so offer some protection to the kiln. For increased protection the use of a heat fuse or other independent over-temperature trip is recommended. For maximum protection an independ-ent thermocouple, trip & heater contactor circuit should be used.

Note: Power fail recovery may need to be disabled if un-attended firing is not allowed.

Setup Parameters (0 - 31)

No.	Function	Min.	Max.	Default	Notes
0	Thermocouple type	0	3	2	0=K, 1=N, 2=R, 3=S
1	Error 1 enable	0	1	1	0=disabled, 1=enabled
2	Max. user temperature	100	1550	1320	°C
3	Display brightness	0	15	7	0=dim, 15=bright
4	Error 4 enable	0	1	1	0=disabled, 1=enabled
5	Error 5 enable	0	1	0	0=disabled, 1=enabled
6	Error 6 firing hours trip	10	1000	1000	1000=disabled
7	Room temperature trip	30	71	50	°C. 71=disabled
8	Power fail recovery enable	0	1	1	0=disabled,1=enabled
9	Paused time limit (hours)	1	11	2	11=disabled
11	Proportional band (zone 1)	1	999	55	°C
12	Integral time (zone 1)	0	9999	200	Seconds, 0=disabled
13	Differential time (zone 1)	0	999	10	Seconds, 0=disabled
14	Kiln element power (zone 1)	0	9999	0	1 unit = 0.1kW
19	Error 9 differential temperature trip	0	99	0	°C. 0=disabled
20	Set point offset (zone 2)	-99	99	0	°C
21	Proportional band (zone 2)	1	999	5	°C
22	Integral time (zone 2)	0	9999	0	Seconds, 0=disabled
23	Differential time (zone 2)	0	999	0	Seconds, 0=disabled
24	Kiln element power (zone 2)	0	9999	0	1 unit = 0.1kW
30	Set point offset (zone 3)	-99	99	0	°C
31	Proportional band (zone 3)	1	999	5	°C

Note: The setup parameters shown thus are freely adjustable. The other setup parameters might be password protected - contact supplier.

Setup Parameters (32 - 63)

No.	Function	Min.	Max.	Default	Notes
32	Integral time (zone 3)	0	9999	0	Seconds, 0=disabled
33	Differential time (zone 3)	0	999	0	Seconds, 0=disabled
34	Kiln element power (zone 3)	0	9999	0	1 unit = 0.1kW
40	Number of zones	1	3	3	
41	Control Strategy	0	1	1	0=differential, 1=absolute
42	Not used	0	1	0	0=disabled, 1=enabled
43	Engineer lockup on error	0	1	0	0=disabled, 1=enabled
44	Control cycle time	5	120	30	Seconds
45	Event1 / Damper / Fan relay function	0	3	0	0=disabled, 1=event, 2=damper, 3=fan
46	Remember start delay	0	1	0	0=forget, 1=remember
47	Skip start delay after power failure	0	1	0	0=resume delay, 1=skip delay
48	Reset to factory defaults	0	1	0	1=reset
49	Event2 / Forced cooling relay function	0	2	0	0=disabled, 1=event2 2=forced cooling
50	USB Datalogging sample rate	5	300	60	seconds
51	USB Datalogging string format	0	1	1	0=short form 1= long form
55	Disable setup password protection	0	1	1	0=enabled, 1=disabled
60	Operating units °C/°F	0	1	0	0=°C, 1=°F

Note: The setup parameters shown thus are freely adjustable. The other setup parameters might be password protected - contact supplier.

Configuration Notes

Parameter	Note

Parameter **Note**

19 — **Differential Trip (Error 9):** This is the temperature differential allowed between zones during firing. This trip is only active when zone 1 (the master zone) is above 600°C. If either zone 2 or zone 3 temperature deviates from zone 1 temperature by ± the selected amount then ERROR 9 will occur after a short hold-off delay. Units are °C.

20 — **Setpoint offset for zone 2:** This is added to the current temperature of zone 1 (for control strategy = differential), or is added to the setpoint defined by the user program (for control strategy = absolute). Ignored for single zone kilns. Units are °C.

22 — **PID I for zone 2:** This is set to 0 by default to disable the integral action, which will cause zone 2 to achieve a slightly lower temperature than the setpoint. This can be corrected either by setting a value of (say) 400 for this parameter (at the risk of possible interaction between zones), or, by setting a positive value for parameter no. 20 (setpoint offset).

30 — **Setpoint offset for zone 3:** This is added to the current temperature of zone 1 (for control strategy = differential), or is added to the setpoint defined by the user program (for control strategy = absolute). Ignored for single or 2 zone kilns. Units are °C.

32 — **PID I for zone 3:** This is set to 0 by default to disable the integral action, which will cause zone 3 to achieve a slightly lower temperature than the setpoint. This can be corrected either by setting a value of (say) 400 for this parameter (at the risk of possible interaction between zones), or, by setting a positive value for parameter no. 30 (setpoint offset).

40 — **Zones:** Zone 1 is the master zone which should be allocated to the slowest zone, usually the bottom zone in a kiln.

41 — **Control strategy:** Absolute control strategy is the default. With this strategy all the zones follow the same user programmed set point. Differential control strategy is also available. With this strategy the setpoint for zone 1 is as defined by the user program but the setpoint for zones 2 & 3 is the currently achieved actual temperature of zone 1. This strategy ensures that zones 2 & 3 are always able to follow zone 1 (the slowest zone). Control strategy is ignored for single zone kilns.

43 — **Engineer lock-up on error:** If this feature is enabled then errors cannot be cleared by cycling the power to the controller i.e: cannot be cleared by the user. This forces an engineer call out to determine the cause of the error and a repair to be implemented.

45 — **Relay Output1:** this is a programmable event1/damper/fan output. If set to event mode then this output is controlled by the user program to open or close at the start of each ramp and to open or close at the start of each soak. If set to damper or fan mode then the user is able to enter damper open & close temperatures or fan on and off temperatures.

46 — **Remember start delay:** By default this feature is disabled and the controller sets the initial value for start delay to 00:00. If enabled the controller remembers the user entered start delay from the previous firing (useful for repetitive overnight firings). In either case the actual start delay can be edited by the user.

47 — **Skip start delay after power failure:** By default this feature is disabled and in the event of a power failure while executing the start delay the controller times off the remainder of the start delay when power is restored. If enabled the controller immediately starts firing when the power is restored. Note: the controller does not contain a real time clock and so does not know how long the power has been off.

49 — **Relay Output2:** this is event 2 output. This output is controlled by the user program to open or close at the start of each ramp and to open or close at the start of each soak.

60 — **Operating Units °C/°F:** When units are changed the controller will reload its default set of programs (in either °C or °F units as required). *Warning! - this will over-write any existing programs!*

Notes

Notes

Characteristics

Electrical

Power supply
Voltage range: 90 - 264VAC
Frequency: 50/60Hz
Power: Controller 4VA (max)
           Switched outputs 125VA

Fuse: 3.15A slow-blow HRC
        20mm x 5mm ceramic

Control Relays (6)
Contact type: SPST NO
Switched Line voltage O/P @500mA max
(for contactor driving)

Thermocouple
R,S,K & N type.

Lead & Connector
3m flexible grey polyurethane lead fitted with either Han12Q, Han15d, CPC14 or CPC19 connector.

Environmental

Operating temperature range: -10°C to +55°C
Storage temperature range: -10ºC to +55ºC

Error Handling

Thermocouple failure detection
Thermocouple reversal detection
Heater failure detection
Kiln over-temperature detection
Room over-temperature detection
Lock-up on error facility
Firing run time hours limiter
User program check
Alarm buzzer

Other

Keyboard lock facility & indication
Kiln heating indicator
Program running indicator
Displayed zone number indication
Energy used display

Wall Bracket

Material: ABS flame retardant UL 94V-0
Colour: Dark Grey RAL7012
Fixing slot centres (vertical): 100mm
Fixing slot size: 8mm x 4mm

Temperature

Temperature setting
Range: 0 to 1550ºC (R/S) 0 to 1250°C (K/N)
Resolution: 1º

Control Accuracy
P.I.D. Control
Reading accuracy: ±0.25% FSD ±1 digit

Time

Start delay range: 00:00 to 99hr 59min
Soak time range: 00:00 to 99hr 59min
Resolution: 1 min

Ramps

Ramp rate: 0.1 to 9.9°/hour then
10 to 999°/hour or full power
Ramps can be heating or cooling

Enclosure

Material: ABS flame retardant UL 94V-0
Sealing: IP51
Size: 100/86mm(W), 210mm(L), 32mm(D)
Colour: Black/Dark Grey
(RAL9011/RAL7012)

Weight

Instrument + wall bracket + cable: 0.841kg (max)

Packaging

Packaged size: 320 x 230 x 75mm
Packaged weight: 1.025kg (max)

CE UKCA This instrument complies with Council Directive 89/336/EC (EMC) & Council Directive 2006/95/EC (safety)

Council Directives 2002/96/EC & 2003/108/EC
The crossed out bin symbol, placed on this product, reminds you of the need to dispose of the product properly at the end of its life. Electrical & Electronic Equipment should never be disposed of with general waste but must be separately collected for proper treatment. In this way you will assist in the recovery, recycling & reuse of many of the materials used in this product.