

Notes

**STAFFORD**  
INSTRUMENTS

# ST501

## User Handbook



CE

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<http://www.stafford-inst.co.uk/docs/st501/user501.pdf>

See separate handbook for Installation Instructions    Issue: 2.01  
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# Quick Start Guide

## Quick Start Guide

Switch on & wait for <b>READY</b> display
To run a firing program set up previously press the <b>RUN/HALT</b> key
To stop the firing at any time press the <b>RUN/HALT</b> key again
To alter firing data at any time press the <b>SET</b> key to enter the setting menu
- to choose a program choose <b>SELECT PROGRAM</b> with the ➡ key ( <i>see page 9 for details</i> )
- to change the program's firing data choose <b>PROGRAM DATA</b> with the ➡ key ( <i>see page 15 for details</i> )
- to set up a delayed start for the firing choose <b>START DELAY</b> with the ➡ key ( <i>see page 10 for details</i> )
- to check the contents of the firing program choose <b>CHECK</b> with the ➡ key ( <i>see page 17 for details</i> )
To exit a menu at any time press the <b>SET</b> key

## Notes

# Adjusting While Firing

The program contents can be reviewed or altered and the program can be paused or advanced while the controller is firing by pressing the **SET** key while a firing is in progress.

## Program Pause/Resume



If **PAUSE** is selected with the **➔** key during ramping then ramping of the set-point will be paused and the kiln will indefinitely soak at the current set-point temperature. When **RESUME** is selected the ramp will continue.

If **PAUSE** is selected during soaking then the soak time will be indefinitely extended. When **RESUME** is selected the soak period will be terminated and the next segment (if any) will be executed.



During **PAUSE** one of the above running displays will be shown as a reminder that the ST501 program is paused.

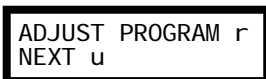
## Segment Advance



If **SEGMENT ADVANCE** is selected with the **➔** key during ramping then the ramp is terminated and the ST501 is forced into soak at the current kiln temperature for the soak time specified in the segment. If

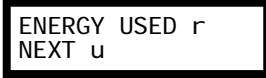
**SEGMENT ADVANCE** is selected during soaking then the next segment (if any) is executed. These changes are temporary and are not stored.

## Adjust Program



**ADJUST PROGRAM** enables review or editing of the currently executing program (from the currently executing segment onwards). Changes made are implemented as soon as the ST501 is returned to the running display. Any changes made are stored in the program.

## Energy Used



**ENERGY USED** shows the kiln energy used in kWh for the current firing to date.

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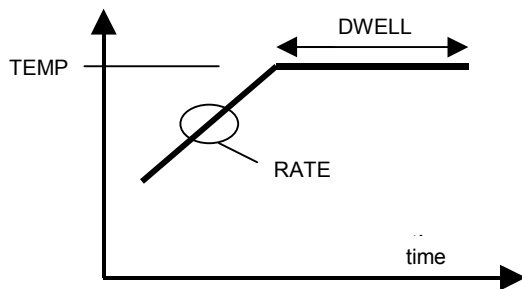
# Features

- ◆ Suitable for glass and ceramics
- ◆ Controlled ramps for heating & cooling
- ◆ 20 programs
- ◆ 30 segments per program
- ◆ 1 ramp + 1 dwell (soak) per segment
- ◆ Temperatures from 0 to 1310°C
- ◆ Dwell times up to 100 hours
- ◆ Ramp rates from 1 to 999°C/hour
- ◆ Delayed start facility (up to 100 hours)
- ◆ Program check facility
- ◆ Power failure recovery
- ◆ R,K,N & S type thermocouple selection
- ◆ Energy used display
- ◆ Program pause/resume
- ◆ Segment skip
- ◆ Program changeable while firing
- ◆ Optional internal over-temperature trip
- ◆ Optional multi-function auxiliary control relay

# Programs

## Program Segments

A program segment is a temperature ramp to a soak temperature followed by a dwell (soak) at this temperature.



A firing program on the ST501 comprises 1 to 30 segments.

Segment temperatures are adjustable in the range 0 to 1310°C, ramp rates in the range 0 to 998°C/hour (+ full) & dwell times in the range 00:00 to 99:59 (hours:mins).

## Programs

There are 20 fully adjustable programs - numbered 01 to 20. 10 of the programs have been factory set to the sample programs shown in the table on page 6. These sample programs have been chosen to give safe repeatable results over a wide range of sizes, sections & clay types. These sample programs can be over-written or altered as required.

### Notes

*Both controlled heating & controlled cooling ramps are possible.*

*If the required heating rate is greater than maximum heating power can achieve then a controlled heating ramp will not be possible. The load will be heated at full power until the required temperature is reached. The ramp time will be extended as necessary.*

*If the required cooling rate is greater than the natural cooling rate of the load then controlled cooling will not be possible. The load will cool naturally with the heat set to zero power. The cooling ramp time will be extended as necessary.*

*All program data is retained when the controller is powered off.*

# Error Messages

These errors cause the controller to lock up with the indicated error displayed & heating power turned off. The power to the controller & the kiln should be turned off and the indicated fault rectified. An alarm buzzer (if fitted) will sound.

**ERROR 1  
NO KILN RESPONSE**

This indicates a kiln fault. There is insufficient heating capability. Possible problems are: the kiln door or lid may not be closed properly, a heater element may have failed, (on a 3 phase kiln) one of the power phases may be missing, the control relay or contactor has failed open or the thermocouple wiring is short circuit.

**ERROR 2  
THERMOCOUPLE O/C**

This indicates a broken thermocouple or a bad connection in the thermocouple circuit.

**ERROR 3  
T/C REVERSED**

A temperature of less than -40°C has been measured. This is interpreted as the thermocouple wiring being reversed.

**ERROR 4  
KILN RUN-AWAY**

This indicates an electrical fault in the control circuit. The temperature is rising when zero power is applied. Control contacts may have failed closed. **TURN OFF THE KILN!** If an auxiliary control relay configured as an over-temperature alarm is fitted its contacts will open.

**ERROR 5  
TEMP TOO HIGH**

This indicates that the kiln temperature has exceeded the highest programmed kiln temperature by at least 20°C

# Auxiliary Output Options

## General

The auxiliary control relay (if fitted) can be configured at the time of installation to have one of the following functions: Automatic damper control output, Event output or Set Point Alarm / Over-temperature output (see ST501 Installation Instructions for configuration details).

## Damper Control Output

SET DAMPER r NEXT u	If a damper control output is configured then this extra main menu item is available
○ → DAMPER CLOSES ABOVE <u>Q</u> 200°C ur	The damper closing temperature can be set with the ↑ & → keys.
○ → DAMPER OPENS BELOW <u>Q</u> 500°C ur	The damper opening temperature can be set with the ↑ & → keys.
○ → STORING . . .	This indicates that the damper control temperatures have been stored.

Prior to commencement of firing the damper will be open. The damper will close the first time that the kiln temperature exceeds the DAMPER CLOSES ABOVE temperature. It will remain closed until the kiln is naturally cooling at the end of a firing and the kiln temperature has fallen to below the DAMPER OPENS BELOW temperature.

## Event Output

PROG: 03 SEG: 01 RAMP EVENT <u>OFF</u> ur	PROG: 03 SEG: 01 SOAK EVENT <u>OFF</u> ur	If an event output is configured then these additional screens will appear during program data entry (after the segment dwell time screen). EVENT can be turned OFF or ON (using the ↑ key) in both the ramp and the soak portions of each segment. If EVENT is set to OFF the auxiliary relay contacts will be open during the indicated segment. If EVENT is ON the relay contacts will be closed. The relay contacts are open both prior to commencement of firing & during natural cooling at the end of a firing.
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## Error / Over-Temperature Output

The auxiliary relay contacts close at the start of a firing and open at the end of the firing. The contacts also open in the event of an error message being generated (see page 21). This output can be used to control a secondary heater contactor wired in series with the main heater contactor. This security feature will cut off kiln heating.

# Program Example (Glass)

The following program is a sample casting program for a lead glass plaster mould (medium size).

PROG: <u>20</u> 880°C Cur		
PROG: 20 SEG: 01 TEMP 400°C ur	PROG: 20 SEG: 01 RATE 50°C/HR ur	PROG: 20 SEG: 01 DWELL 00:00 ur
PROG: 20 SEG: 02 TEMP 880°C ur	PROG: 20 SEG: 02 RATE 150°C/HR ur	PROG: 20 SEG: 02 DWELL 00:00 ur
PROG: 20 SEG: 03 TEMP 850°C ur	PROG: 20 SEG: 03 RATE 10°C/HR ur	PROG: 20 SEG: 03 DWELL 05:00 ur
PROG: 20 SEG: 04 TEMP 500°C ur	PROG: 20 SEG: 04 RATE 200°C/HR ur	PROG: 20 SEG: 04 DWELL 00:00 ur
PROG: 20 SEG: 05 TEMP 440°C ur	PROG: 20 SEG: 05 RATE 10°C/HR ur	PROG: 20 SEG: 05 DWELL 04:00 ur
PROG: 20 SEG: 06 TEMP 250°C ur	PROG: 20 SEG: 06 RATE 20°C/HR ur	PROG: 20 SEG: 06 DWELL 00:00 ur
PROG: 20 SEG: 07 TEMP 0000°C ur	PROG: <u>20</u> 880°C Cur	

1. Heats at 50°C/hour from room temperature to 400°C with a soak time of zero.
2. Heats at 150°C/hour to 880°C with a soak time of zero.
3. Cools at 10°C/hour to 850°C where it soaks for 5 hours 0 minutes.
4. Cools at 200°C/hour to 500°C with a soak time of zero.
5. Cools at 10°C/hour to 440°C where it soaks for 4 hours 0 minutes.
6. Cools at 20°C/hour to 250°C with a soak time of zero.
7. Cools naturally at the end of the program.

## Sample Programs

No	Name	Seg 1	Seg 2	Seg 3
01	Low Biscuit	TEMP: 200°C RATE: 30°C/hr DWELL: 00:00	TEMP: 600°C RATE: 70°C/hr DWELL: 00:00	TEMP: 960°C RATE: 999°C/hr DWELL: 00:15
02	Normal Biscuit	TEMP: 200°C RATE: 30°C/hr DWELL: 00:00	TEMP: 600°C RATE: 70°C/hr DWELL: 00:00	TEMP: 1000°C RATE: 999°C/hr DWELL: 00:15
03	High Biscuit	TEMP: 200°C RATE: 30°C/hr DWELL: 00:00	TEMP: 600°C RATE: 70°C/hr DWELL: 00:00	TEMP: 1160°C RATE: 999°C/hr DWELL: 00:15
04	Earthenware Low Temperature Glaze	TEMP: 150°C RATE: 30°C/hr DWELL: 00:00	TEMP: 600°C RATE: 90°C/hr DWELL: 00:00	TEMP: 960°C RATE: 999°C/hr DWELL: 00:30
05	Earthenware Mid Temperature Glaze	TEMP: 150°C RATE: 30°C/hr DWELL: 00:00	TEMP: 600°C RATE: 90°C/hr DWELL: 00:00	TEMP: 1040°C RATE: 999°C/hr DWELL: 00:30
06	Earthenware High Temperature Glaze	TEMP: 150°C RATE: 30°C/hr DWELL: 00:00	TEMP: 600°C RATE: 90°C/hr DWELL: 00:00	TEMP: 1140°C RATE: 999°C/hr DWELL: 00:30
07	Stoneware Glaze	TEMP: 150°C RATE: 30°C/hr DWELL: 00:00	TEMP: 600°C RATE: 90°C/hr DWELL: 00:00	TEMP: 1250°C RATE: 999°C/hr DWELL: 00:30
08	On Glaze Enamel	TEMP: 150°C RATE: 30°C/hr DWELL: 00:00	TEMP: 600°C RATE: 90°C/hr DWELL: 00:00	TEMP: 780°C RATE: 999°C/hr DWELL: 00:30
09	Heavy Sculpture	TEMP: 150°C RATE: 20°C/hr DWELL: 00:30	TEMP: 300°C RATE: 50°C/hr DWELL: 00:30	TEMP: 1000°C RATE: 70°C/hr DWELL: 00:30
10	Lustre	TEMP: 150°C RATE: 30°C/hr DWELL: 00:00	TEMP: 600°C RATE: 90°C/hr DWELL: 00:00	TEMP: 750°C RATE: 999°C/hr DWELL: 00:00

### Notes

Earthenware High Temperature Glaze is also suitable for Stoneware Low Temperature Glaze.

Stoneware Glaze is also suitable for Porcelain.

On Glaze Enamel is also suitable for some enamelling work.

Heavy Sculpture is also suitable for Terracotta.

## Firing Displays

HEATING RAMP r  
KI LN TEMP 147°C

This shows that the controller is executing a positive (heating) ramp

COOLING RAMP r  
KI LN TEMP 1007°C

This shows that the controller is performing a negative (cooling) ramp

SOAKING r  
KI LN TEMP 880°C

This shows that the controller is soaking at a constant temperature

COOLING... HOT!  
KI LN TEMP 172°C

The firing program is finished & the load is cooling naturally

COOL  
KI LN TEMP 96°C

The load has cooled to less than 100°C

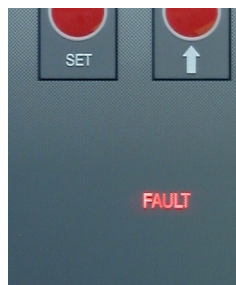
READY  
KI LN TEMP 32°C

The load has cooled to less than 40°C

Every minute during firing status information is sequentially displayed on the top line of the display.

This status display can be repeated at any time during firing by pressing the **➡** key

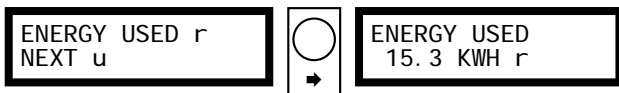
## Trip



If the optional over-temperature trip module is installed a red FAULT lamp illuminates when an over-temperature error condition occurs. The trip turns off heating power. Turn off mains power to the kiln & controller & investigate the cause of the error. The trip is automatically reset by removal of the mains supply to the controller. If the fault is still present the trip will operate again about 5 seconds after re-powering the controller.

## Energy Used

From the READY display the energy used during the previous firing can be obtained. Press the **SET** key to enter the setting menu, then press the **↑** key as required to navigate to the ENERGY USED item.



Choose the ENERGY USED item on the menu with the **→** key. Return to the menu or the READY display with the **SET** key.

## Power Failure Handling

In the event of power failure followed by power restoration, the instrument takes recovery actions to avoid a firing being aborted. The recovery action taken depends on where the instrument had reached in the firing sequence prior to power failure as detailed below:-

Before Power Failure	After Power Failure
In READY mode	In READY mode
Timing delayed start	Immediate start as if the end of delay time reached
Ramping approaching soak temperature	Ramp will be restarted at the previous ramp rate from the present temperature
Soaking	Temperature will be ramped at the previous ramp rate to the soak temperature. The full soak period will then be re-applied
Cooling after firing complete	Cooling continues

## Operation

### Running a program

The image shows a digital display with two lines of text: 'READY' on the top line and 'KI LN TEMP 21°C' on the bottom line.



To start a firing program press the **RUN/HALT** key when the READY screen is displayed.

The program that will be run is the currently selected program. This currently selected

program is stored in continuous memory & so is not lost when the power is turned off. See note 1.

### Halting a program

The image shows a digital display with two lines of text: 'HEATING RAMP. r' on the top line and 'KI LN TEMP 72°C' on the bottom line.



To abort a firing press the **RUN/HALT** key while the ST501 is firing. The **READY**

screen will again be displayed & the load will

cool naturally. See note 2.

### Firing Status

The image shows a digital display with two lines of text: 'HEATING RAMP. r' on the top line and 'KI LN TEMP 72°C' on the bottom line.



During firing status information is displayed on the top line of the display at 1 minute intervals. This gives a sequential display of the program & segment currently being executed together with other status information.

The **→** key can be used to obtain this status information display at any time while firing.

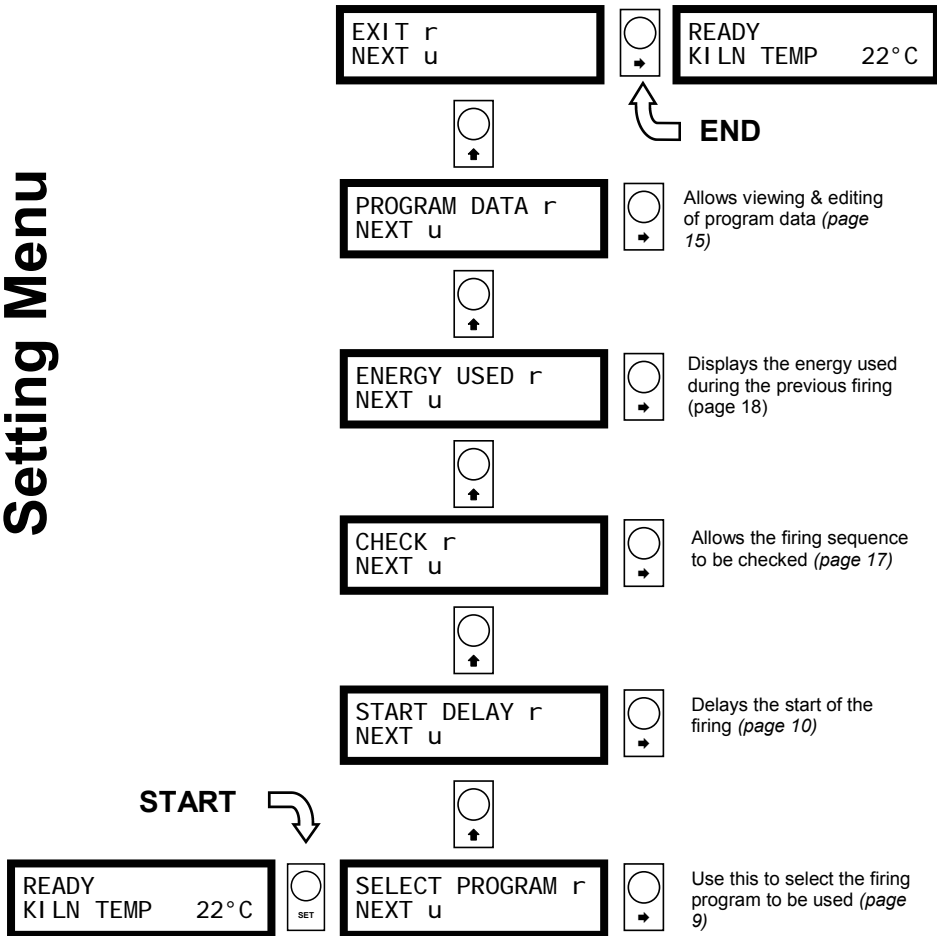
#### Notes

1. Firing will commence immediately if the **START DELAY** is set to 00:00 otherwise the start of firing will be delayed - see page 10.
2. If the kiln temperature is more than 40°C when the firing is aborted then a temperature warning will be displayed. Press the **RUN/HALT** key again to obtain a READY display.
3. The ST501 operates by calculating the amount of energy required by the kiln every 30 seconds. If for example 40% of full energy is required to maintain a particular ramp rate or a particular soak temperature then the ST501 will apply heating power to the kiln for 12 seconds every 30 seconds. The kiln contactor will be heard (loud click) to energise every 30 seconds then to de-energise 12 seconds later. If full heating power is required then the contactor will remain continuously energised. If full cooling is required then the contactor will remain continuously de-energised.

# Setting Menu

Prior to firing, the parameters of the ST501 can be set up by pressing the **SET** key when **READY** is displayed. This enters a setting menu. To exit this menu press the **SET** key again.

Setting Menu

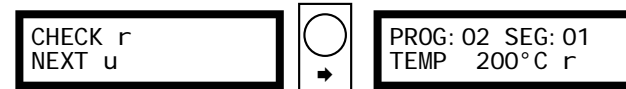


**Note**  
To exit the menu system at any time press the **SET** key a number of times until **READY** is displayed.

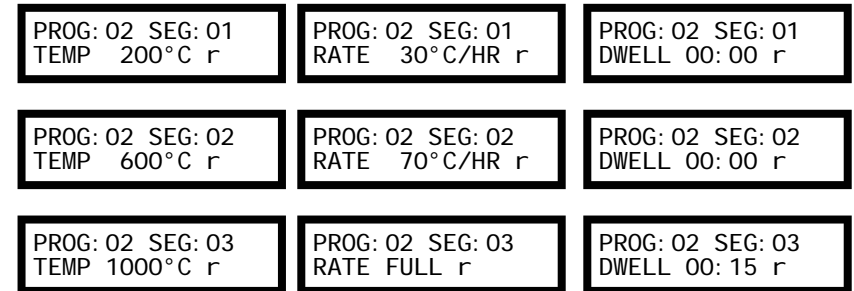
# Check Facility

It is recommended that the program contents be checked prior to firing by using this facility. Each segment of the program can be sequentially stepped through to check that the desired program has been selected & that it has been correctly programmed.

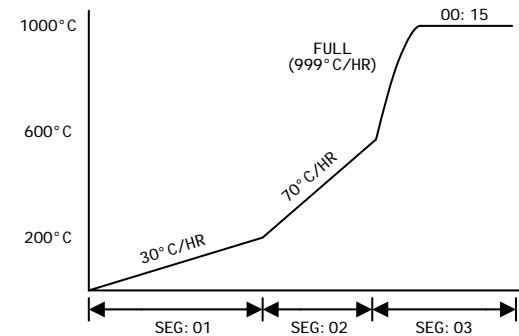
From the **READY** display press the **SET** key to enter the setting menu, then press the **↑** key as required to navigate to the **CHECK** menu item.



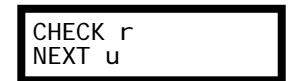
The **→** key can now be used to step through each segment of the program as shown in this (biscuit firing) example:-



Check Facility



The next push of the **→** key returns to the **CHECK** menu because the end of the program has been reached.





PROG: 01 SEG: 02  
TEMP 0000°C ur

The temperature entry screen for segment 2 is now displayed.

Program data entry continues either until data for segment 30 (the last segment) is selected with the  $\rightarrow$  key or until 0000 is selected as a segment temperature with the  $\rightarrow$  key.

STORING . . .

The display now indicates that the program data is being stored.

PROG: 01 960°C ur

The program data select screen now appears again allowing another program to be selected for editing. See note 1.

If a mistake is made during data entry press the SET key as many times as required to reverse through the program data entry system.

**Notes**

1. The temperature shown on the top line of the display is that of the highest temperature segment in the program.

# Program Selection

READY  
KI LN TEMP 21°C



SELECT PROGRAM r  
NEXT u

To select a firing program press the SET key while the READY screen is displayed. This enters the setting menu. Choose the SELECT PROGRAM item on this menu with the  $\rightarrow$  key.



PROG: 12 1000°C ur

A flashing cursor will appear at the program number position. The temperature shown on the top line of the display is that of the highest temperature segment in the program.

Use the  $\uparrow$  key to increment the display to the required program number then select this with the  $\rightarrow$  key.

STORING . . .

The display now indicates that the program selected is being stored.

SELECT PROGRAM r  
NEXT u



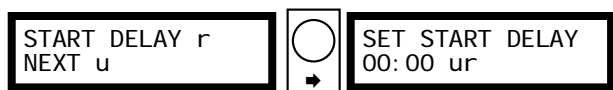
READY  
KI LN TEMP 21°C

After storing, the SELECT PROGRAM item on the setting menu is again displayed. The setting menu can be quitted by pressing the SET key to return to the READY display.

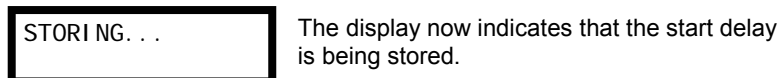
# Start Delay

This feature enables the start of firing to be delayed - to enable firing overnight for example - possibly on low-tariff electricity. To disable this feature set the start delay to 00: 00.

From the READY display press the **SET** key to enter the setting menu, then press the **↑** key as required to navigate to the START DELAY menu item.

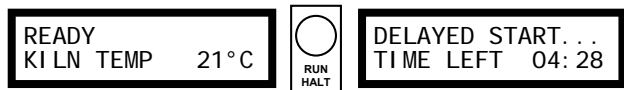


Choose the START DELAY item on the menu with the **→** key. Set the required delay in the range 00: 00 to 99: 59 (hours:mins) with the **↑** & **→** keys. Select this with the **→** key.



After storing, the START DELAY item on the setting menu is again displayed. Press the **SET** key to return to the READY display.

If a non-zero start delay time is set then a timer screen will be shown when the **RUN/HALT** key is pressed. This counts down once per minute & the firing commences when the time left is 00: 00.

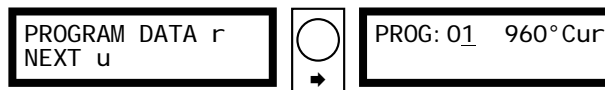


Start Delay

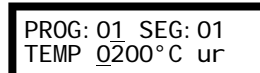
# Program Data

The firing data in the programs can be viewed & changed as often as necessary. The data is stored in non-volatile memory and so is not lost when the power is turned off.

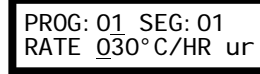
From the READY display press the **SET** key to enter the setting menu, then press the **↑** key as required to navigate to the PROGRAM DATA menu item.



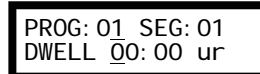
A flashing cursor will appear at the program number position. The program number initially shown is the currently selected program. *See note 1.* Use the **↑** key to increment the display to the required program number then select this with the **→** key.



The segment temperature for segment 1 is displayed. With the aid of a flashing cursor this can be changed as necessary in the range 0 to 1310°C with the **↑** & **→** keys. Select the temperature with the **→** key.



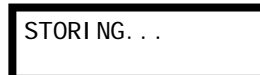
The ramp rate to reach segment 1's temperature is now displayed. This can be entered in the range 1 to 999°C/hour with the **↑** & **→** keys. *See note 2.* Select the ramp rate with the **→** key.



The dwell (soak) time for segment 1 is now displayed. This can be changed in the range 00:00 to 99:59 hours:mins with the **↑** & **→** keys. Select the dwell time with the **→** key.



PROG: 01 SEG: 01 SOAK EVENT OFFur *these screens only appear if an auxiliary relay is fitted & is configured as an event relay*



## Notes

1. The temperature shown on the top line of the display is that of the highest temperature segment in the program.
2. A ramp rate of 999°C/hour is treated as a requirement for full power for positive ramps or zero power for negative ramps – the actual ramp rate achieved will depend on the performance of the kiln.
3. Use the **SET** key to terminate program data entry at any time.

Program Data

# Program Record Sheet

<b>Program No.</b>		Date:	
Operator:		Time:	
<u>Comments</u>			
Segment Number	Temperature °C	Ramp Rate °C/hour	Dwell (Soak) hours:mins
1			
2			
3			
4			
5			
6			
7			
8			
9			

# Program Record Sheet

<b>Program No.</b>		Date:	
Operator:		Time:	
<u>Comments</u>			
Segment Number	Temperature °C	Ramp Rate °C/hour	Dwell (Soak) hours:mins
1			
2			
3			
4			
5			
6			
7			
8			
9			

# Program Record Sheet

<b>Program No.</b>		Date:	
Operator:		Time:	
<u>Comments</u>			
Segment Number	Temperature °C	Ramp Rate °C/hour	Dwell (Soak) hours:mins
1			
2			
3			
4			
5			
6			
7			
8			
9			

# Program Record Sheet

<b>Program No.</b>		Date:	
Operator:		Time:	
<u>Comments</u>			
Segment Number	Temperature °C	Ramp Rate °C/hour	Dwell (Soak) hours:mins
1			
2			
3			
4			
5			
6			
7			
8			
9			