

Notes



# ST316

## User Handbook



## ST316 Temperature Programmer

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Further copies of this handbook may be found at <http://www.stafford-inst.co.uk/docs/st316/user316.pdf>

# At A Glance

CONTROL KEYS (5)

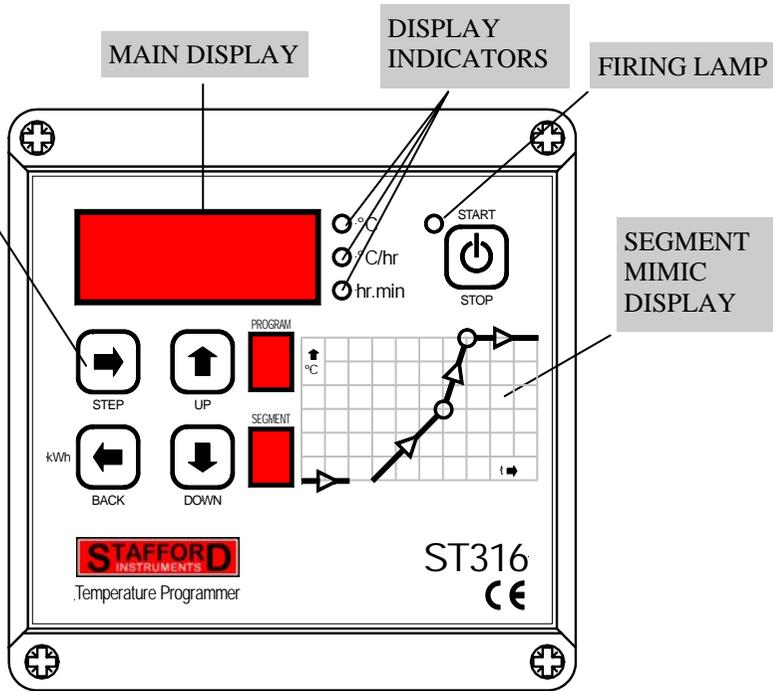
MAIN DISPLAY

DISPLAY INDICATORS

FIRING LAMP

SEGMENT MIMIC DISPLAY

At A Glance



SOAK TEMPERATURE LAMP

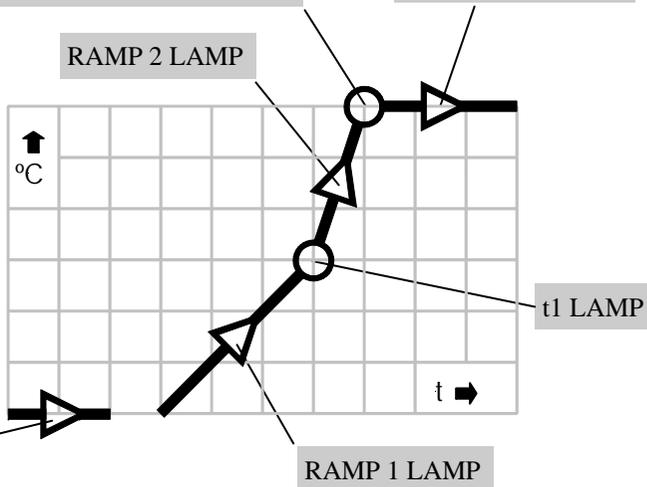
SOAK TIME LAMP

RAMP 2 LAMP

t1 LAMP

DELAYED START LAMP

RAMP 1 LAMP



Notes

# Other Features

## Energy Used Display

Pressing the **◀** button at any time shows the amount of electrical energy used in kW hours. If pressed during a firing it shows the energy used so far. After a firing it shows the total energy used for that firing. 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 into the ST316—see installation handbook.

## Keyboard Lock Facility

The keys on the ST316 can be locked so that pressing them has no effect. This is an anti-tamper feature used to ensure that the operation of the ST316 or the program data cannot be altered by un-authorized people. The ST316 can be locked when it is idle (not firing) or while it is firing. It cannot be locked while it is being programmed.

|       |                                     |   |
|-------|-------------------------------------|---|
| 1.200 | <input checked="" type="radio"/> °C | If the left-hand decimal point in the display is lit then the ST316 is locked. Press and hold in both the <b>↑</b> & <b>↓</b> keys for 5 seconds to unlock the ST316. |
|       | <input type="radio"/> °C/hr         |   |
|       | <input type="radio"/> hr.min        |   |

|      |                              |   |
|------|------------------------------|---|
| 1200 | <input type="radio"/> °C     | If the left-hand decimal point in the display is not lit then the ST316 is not locked. Press and hold in both the <b>↑</b> & <b>↓</b> keys for 5 seconds to lock the ST316. |
|      | <input type="radio"/> °C/hr  |   |
|      | <input type="radio"/> hr.min |   |

## Power Failure Recovery

If power fails during firing then the ST316 recovers as follows:-  
 For power failure during start delay the ST316 commences firing immediately when power returns. For power failure during ramp 1 or ramp 2 the ST316 goes back into the ramp it was previously executing. For power failure during soaking the ST316 ramps back up to soak temperature at ramp rate 2 then applies the full soak period. This recovery scheme can be disabled if required (see installation handbook) - the ST316 will then lock up with **FRL** displayed and kiln off in the event of power failure.

# Quick Start Guide

|  |
|--|
| Switch on & wait for kiln temperature display  |
| To run a firing program set up previously press the <b>START/STOP</b> key                                      |
| To stop the firing at any time press the <b>START/STOP</b> key again   |
| To review firing data press the <b>➡</b> key to enter the programming menu                                     |
| To change firing data press the <b>↑</b> & <b>↓</b> keys to change the displayed value                         |
| Use the <b>➡</b> key again as necessary to index to the next firing value or segment to be reviewed or changed |
| To mark the end of a program set a ramp rate to <i>End</i> with the <b>↓</b> key                               |
| To exit the programming menu either wait 10 seconds or press the <b>START/STOP</b> key to start firing         |
| If the keyboard is locked then press the <b>↑</b> & <b>↓</b> keys together & hold down for 5 seconds to unlock |

# Contents

At A Glance..... 2  
 Quick Start Guide..... 3  
 Contents..... 4  
 Features ..... 4  
 Turning On ..... 5  
 Programming ..... 6  
 Firing ..... 9  
 Cooling ..... 13  
 Adjusting While Firing..... 14  
 Error Messages ..... 16  
 Other Features ..... 18

# Features

- 9 programs each with up to 9 segments
- 2 controlled heating / cooling ramps + soak per segment
- Soak times up to 99 hours 59 mins
- Ramp rates from 1 to 999°C/hour + full
- Suitable for ceramics and glass use
- Programs can be altered while firing
- Program pause/un-pause + segment advance facilities
- Keyboard lockable
- Delayed start facility - up to 99 hours 59 mins
- Power failure recovery
- Energy used display
- Alarm buzzer & optional alarm output



- °C
- °C/hr
- hr.min

Error 7. Maximum room temperature exceeded. The internal temperature of the ST316 has exceeded an installer selectable (30—70°C) limit.

Possible causes are: room vent fan failure, ventilation grills blocked, kiln room too small, damper or bung left open

These error messages cause the ST316 to terminate the firing with all the keys locked. **An alarm buzzer sounds once per second.**

### SWITCH KILN OFF!

To reset the ST316 turn off the power to the instrument and have the fault investigated by your installer or kiln service engineer to rectify the fault.

*Note: these 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—such as the Stafford Instruments ST101.*

*Technical note: any error message will cause the auxiliary alarm relay (if fitted) to open—see installation handbook for details.*

# Error Messages



- °C
- °C/hr
- hr.min

Error 1. The kiln temperature is not increasing as required. The kiln has been on full power for 1 hour but the kiln temperature has not risen by at least 8°C.

Possible causes are: kiln door or lid not closed properly, heater element failure, elements too old, power phase failure, contactor failure or thermocouple short-circuit.



- °C
- °C/hr
- hr.min

Error 2. Thermocouple or thermocouple wiring open circuit. Get thermocouple and wiring checked. Have thermocouple replaced if necessary.



- °C
- °C/hr
- hr.min

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



- °C
- °C/hr
- hr.min

Error 4. Kiln temperature too high. The kiln has been on zero power for 30 minutes but the kiln temperature has not fallen by at least 1°C

Possible causes are: contactor failure or thermocouple connection intermittent or high resistance.



- °C
- °C/hr
- hr.min

Error 5. Kiln temperature overshoot. The kiln temperature exceeds the desired temperature by at least 10°C / 20°C (installer selectable).



- °C
- °C/hr
- hr.min

Error 6. Maximum firing time exceeded. The length of the current firing has exceeded an installer selectable (10—999 hours) limit.

# Turning On



When turned on the ST316 performs a display test by briefly illuminating all of the display digits and all of the front panel lamps.



The version number of the software embedded within the ST316 is now displayed. If you ever need technical support you will be asked for this code together with the ST316's serial number.

Next displayed is the thermocouple type to which the ST316 is set. This thermocouple type setting should match the type of thermocouple fitted to the kiln and can be R, S, K or N type.



'R' type thermocouple



'S' type thermocouple



'K' type thermocouple



'N' type thermocouple



- °C
- °C/hr
- hr.min

The final display should show the kiln temperature (20°C shown here) with the '°C' indicator on. All other lamps should be off.



- °C
- °C/hr
- hr.min

If the left-hand decimal point is on then the keyboard is locked. This is an anti-tamper feature. Press the **▲** & **▼** keys together & hold down for 5 seconds to unlock.

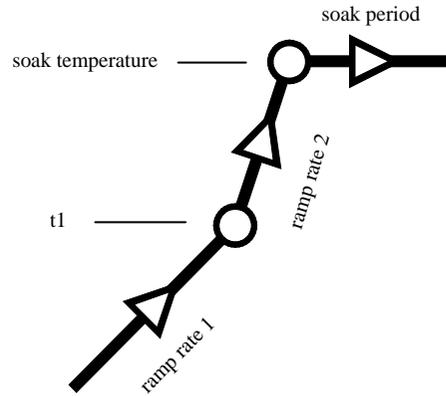


- °C
- °C/hr
- hr.min

If any mimic panel lamps are on then the ST316 is firing. Press the START/STOP key to stop the firing. During firing the right-hand decimal point will light to show when the kiln is heating.

# Programming

## A firing segment



An ST316 firing segment comprises 2 ramps followed by a soak period. A single segment can be used for simple firing (biscuit firing for example) or up to 9 segments can be used per program for complex firing (crystal glazing or glass-making for example).

The ST316 ramps the kiln temperature at ramp rate 1 until the kiln reaches temperature  $t_1$ . It then ramps the kiln temperature to the soak temperature at ramp rate 2. It then soaks (dwells) at the soak temperature for the soak time. It then runs the next segment until the end of the program is reached.

The ST316 is capable of both positive (heating) ramps and negative (cooling) ramps—as used in glassmaking for annealing.

Ramp rate 1 & ramp rate 2 are settable in the range 1°C/hour to 999°C/hour or *FULL* (full power) or *END* (end of program).

$t_1$  & the soak temperature are settable over the range 0 to 1320°C.

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

**Note: during soaking the ST316 display alternates every 5 seconds between kiln temperature and soak time remaining.**

## Program Pause Facility

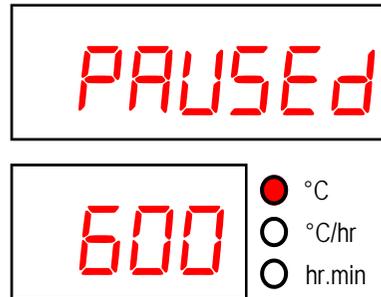
While firing press and hold down the  $\downarrow$  key for about 4 seconds. The ST316 will pause the executing program. To un-pause the program press and hold down the the  $\downarrow$  key again for about 4 seconds. The effects of pausing are as follows:-

If paused during a ramp the kiln temperature will be held (soaked) *indefinitely* at the current kiln temperature. The ramp will continue when un-pause is selected.

If paused during a soak then the soak time will be *extended indefinitely*. The remainder of the soak period will be resumed when un-pause is selected.

Segment advance ( $\uparrow$  key held down for about 4 seconds) can also be used to terminate the pause. This will advance the segment and will immediately terminate a paused soak—advancing to the next segment (if any).

Changes made to the operation of the ST316 in this way are temporary and are not stored.



As a warning during pause a double beep is sounded every 10 seconds, the display scrolls *PAUSED* for 5 seconds then shows the kiln temperature for 5 seconds.

### **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 indefinitely.*

*If left too long at high temperatures kiln damage could result.*

# Adjusting While Firing

Firing values can be adjusted while the ST316 is firing. Also there are program pause/un-pause and segment 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 ST316 will return to its normal running display 10 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.

## Segment Advance Facility

While firing press and hold down the **⬆** key for about 4 seconds. The ST316 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 a start delay is currently executing then the ST316 will terminate this and start firing immediately.

If ramp 1 is currently executing then the ST316 will switch to ramp 2 using ramp rate 2 from the current kiln temperature.

If ramp 2 is currently executing then the ST316 will switch to soak at the current kiln temperature.

If currently soaking then the ST316 will advance to the next segment if any, or else it will end the firing.

Changes made to the operation of the ST316 in this way are temporary and are not stored.

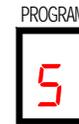
## Altering a program

When the ST316 is not firing there are no lamps lit on the mimic panel, the run lamp is off and the display shows the kiln temperature with the °C indicator lit.



If the left-hand decimal point is on then the keyboard is locked. Press the **⬆** & **⬇** keys together & hold down for 5 seconds to unlock.

The controller settings can be reviewed by pressing the **➡** key.



The first push of the **➡** key flashes the program number display. This can be altered from 1 to 9 with the **⬆** & **⬇** keys.

*Note: holding down the **⬆** or **⬇** keys causes rapid change of the displayed value.*



The next push of the **➡** key displays the start delay time in the range 00.00 to 99.59 (99 hours 59 mins). This can be altered with the **⬆** & **⬇** keys. The DELAYED START lamp on the mimic display will flash.



**➡** then displays ramp rate 1 in the range 1 to 999°C/hr or *FULL* or *End*. This can be altered with the **⬆** & **⬇** keys. RAMP 1 lamp on the mimic display will flash.



**➡** then displays temperature t1 in the range 0 to 1320°C. This can be altered with the **⬆** & **⬇** keys. The t1 lamp on the mimic display will flash.



**➡** then displays ramp rate 2 in the range 1 to 399°C/hr or *FULL* or *End*. This can be altered with the **⬆** & **⬇** keys. The RAMP 2 lamp on the mimic display will flash.



**➡** then displays the soak temperature in the range 0 to 1320°C. This can be altered with the **⬆** & **⬇** keys. The SOAK TEMPERATURE lamp on the mimic display will flash.



- °C
- °C/hr
- hr.min

The next push of the  $\rightarrow$  key displays the soak time in the range 00.00 to 99.59 (99 hours 59 mins). This can be altered with the  $\uparrow$  &  $\downarrow$  keys. The SOAK TIME LAMP on the mimic display will flash.



A further push of the  $\rightarrow$  key increments the segment display digit and firing data for the next segment can be entered.



- °C
- °C/hr
- hr.min

Data entry is terminated if *End* is selected with the  $\downarrow$  key for either ramp rate 1 or ramp rate 2. Data entry is also automatically terminated if 9 segments have been entered.

*Note: available ramp rate displays are: End, 1 ... 999 & FULL. If End is shown but another segment is required then push the  $\uparrow$  key to obtain the required ramp rate (in the range 1°C/hr to 999°C/hr). If full power is required then push the  $\uparrow$  key until FULL is displayed.*

*Note: to exit programming without cycling through all of the above steps wait 10 seconds without pressing any keys—the ST316 will revert to the idle display. Alternatively press the START/STOP key to exit programming and to begin firing immediately.*

*Note: the  $\leftarrow$  key can be used to reverse through the programming steps to correct errors or exit programming mode.*

# Cooling

Upon completion of firing the ST316 lights all lamps on the mimic display and the kiln is allowed to cool naturally.



- °C
- °C/hr
- hr.min



- °C
- °C/hr
- hr.min

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



- °C
- °C/hr
- hr.min



- °C
- °C/hr
- hr.min

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 ST316 back to idle condition ready for the next firing press the START/STOP key (or turn off the power to the instrument).

## Operating Notes

### Kiln too slow

If the ST316 is programmed to heat the kiln at a faster rate than the kiln is capable of then the ST316 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 ST316 is programmed to cool the kiln at a faster rate than the kiln is capable of then the ST316 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 ST316 is capable of controlled ramps for both heating and cooling. If the soak temperature is set lower than t1 for example then ramp 2 will automatically become a *negative* (cooling) ramp.

### STOP key operation

If the START/STOP key is pressed during a firing then the firing will be halted (not paused). Pressing the START/STOP key again will cause the ST316 to restart the firing from the beginning. The ST316 will look at the current kiln temperature and if this is greater than temperature t1 then the ST316 will automatically *cool* from current temperature to t1 at ramp rate 1. This may not be what is desired so the STOP 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 (see page 14). This is a better option than using the STOP key. The segment advance feature (see page 14) is however available to recover quickly from STOP key operation if required.

### Memory

All programs & necessary data are remembered when the ST316 is turned off. In the event of power failure during firing the ST316 will automatically resume firing when power is returned (this feature can be disabled: see installation handbook).

### Delayed Start

The delayed start time period is set to 00.00 when the ST316 is turned on.

## Firing

To start a firing press the START/STOP key. The RUN lamp will light. To stop the firing prematurely press the START/STOP key again.

**Hint:** it is good practice to check that the program is correct by pressing the  $\blacktriangleright$  key & checking the program number & program contents before pressing the START/STOP key to start a firing.



If the left-hand decimal point is on then the keyboard is locked & the ST316 will not respond to the START/STOP key. Press the  $\uparrow$  &  $\downarrow$  keys together & hold down for 5 seconds to unlock.



If a delayed start has been set then pressing the START/STOP key causes a time delay to start. The time remaining is shown on the display—this counts down once per minute. The DELAYED START lamp on the mimic panel will light. The centre decimal point will flash once per second.



If no delayed start has been set (00.00) then pressing the START/STOP key causes firing to commence immediately. The RAMP 1 lamp on the mimic panel will light. If kiln heating is required then the right-hand decimal point on the display will light while heating power is being applied to the kiln.

**Information:** The ST316 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 ST316 will apply heating power to the kiln for 12 seconds every 30 seconds. The right-hand decimal point in the display will light for 12 seconds every 30 seconds. If the kiln has a contactor then a loud click will be heard both when the decimal point lights up and when it goes out. If full heating power is required then the decimal point will remain lit. If full cooling is required then the decimal point will remain off.

