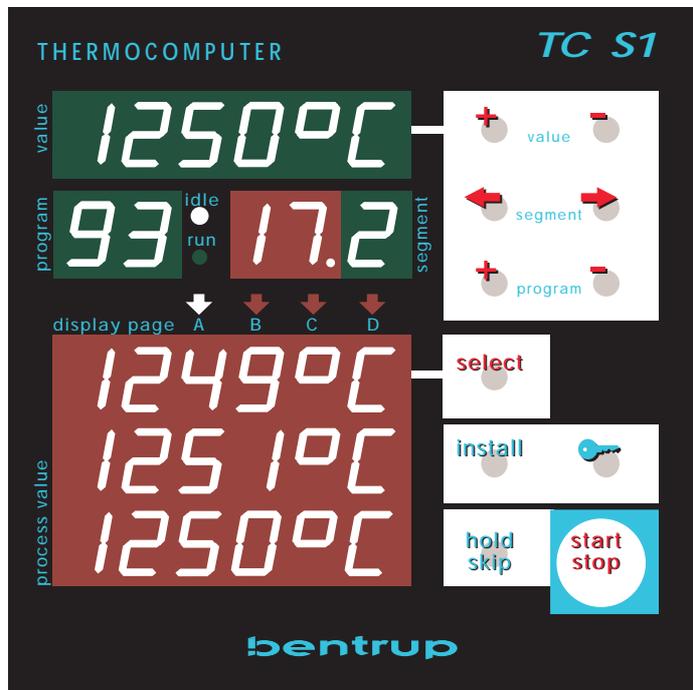


# bentrup



# Operating Instructions

## Universal Programmer TC S1

## Front Panel / Brief Description

(1) programme parameter resp. remaining segment time display

(2) segment number display: actual programme segment resp. segment to be changed (blinking). The green digit counts the parameters per segment (.0=time .1=temperature ...)

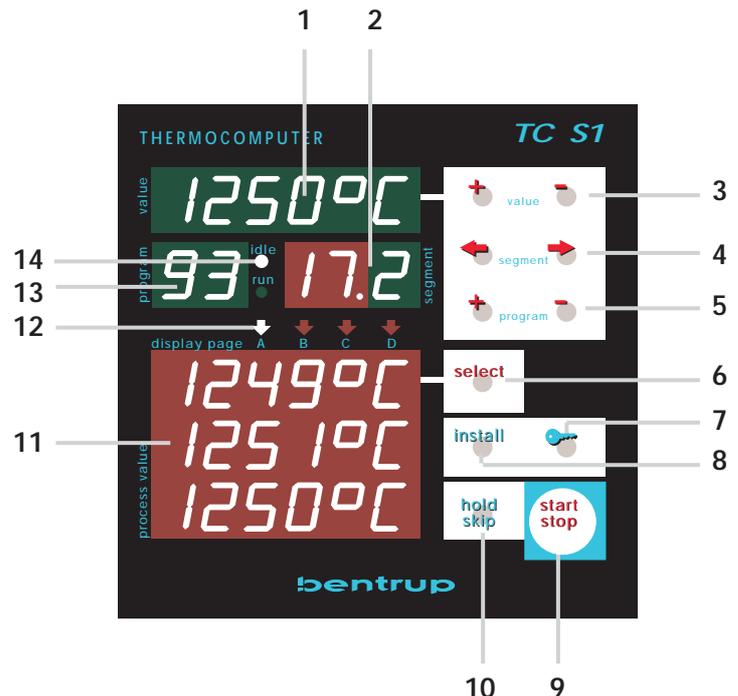
(3) key to change programme values: If a programme value is shown on display (1) change this value by using these keys. For larger value changes, simply press the corresponding key *and hold it pressed*.

(4) key to enter a programme: To enter a new programme or to check / change the values of the actually selected programme, select the segment number by these keys (segment display (2) is **blinking**) showing the actual segment. Each segment consist of a time first and then one or more programme parameters. Change the displayed value if required using keys (3).

(5) key programme, (13) display of actual programme selected: Select the desired programme by using these keys. Each pressing of a key selects the next resp. previous programme. Hold key pressed for large changes. The maximum number of programmes depends on the configuration. In most applications the maximum of 99 programmes is available.

(6) key select, (11) process value display, (12) page indicator: The most important 3 process parameters (e.g. the 3 actual temperatures of a 3 zone kiln) are displayed in window (11). To call up further process parameters (like setpoints, control channel output etc.) press key select. The exact type and sequence of these extra parameters is defined in the installation. Indicator (12) shows which „page“ is currently shown.

(7) key lock / unlock the keyboard: During a programme run, you can protect the controller against unauthorized use by locking the keyboard. If the keyboard is locked, the user can only call up process values by pressing key (6). Locking is done by pressing the key and holding it pressed for about 3 seconds (decimal point in the display (3) means locked keyboard). To unlock, press key (7) and hold it pressed for about 3 seconds again.



**(8) key install:** Pressing this key for 3 seconds enters installation. The installation is to adapt the TC-S1 to your individual application. Refer to the "Technical Operating Manual" for details.

**(9) start / stop key, (14) programme run indicator:** To start the selected programme, press key start / stop. The indicator (14) changes from IDLE to RUN indicating a running programme. To stop a programme, press start / stop again (indicator (14) changes back to IDLE). This interrupts controller operation.

**(10) key hold:** holds programme run, TC-S1 keeps controlling. This is used e.g. to hold programme run at the current setpoint in a ramp. During a hold the programme run indicator (14) shows both indicators RUN and IDLE

**key skip:** pressing this key and holding it for 3 seconds causes an immediate skip to the next segment during a programme run (disregarding whether the actual segment was completed).

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## General Information

Your brand new bentrup TC S1 represents the latest technology in kiln control concerning safety, precision and features available today. The TC S1 is one of the most powerful controllers of its size on the market. It incorporates a multichannel design with a complex system structure. The technical manual describes the powerful and very flexible function which can be used in your application.

Before operating your new TC S1 please read the manual carefully. This familiarizes you quickly with the numerous features of the TC S1.

Please also refer to the safety advice of your kiln manufacturer. Make sure that the control is placed at a safe distance from the kiln and is not exposed to direct heat or radiation from the kiln.

## Basic Operation

The microprocessor controller TC S1 gives you an exact and reproducible control of your kiln. One firing curve is called a programme; a programme is split down into single segments. Each segment is defined as time and temperature. Following example A shows a simple temperature curve:

### Example A: Typical Temperature Curve for Drying (simple application)

segment no.	time	temperature	comments
0	SKIP	20°C	immediate start at 20°C
1	2:00	150°C	slow temperature increase: within 2:00 hours up to 150°C
2	0:30	150°C	maintaining 30 minutes the temperature of 150°C
3	1:00	50°C	temperature decrease: within 1:00 hour down to 50°C
4	END		

Each segment consists of the time and the temperature to reach during this segment. A dwell (soak) is done simply by entering the same temperature as in the segment before (see segment 2 in example A).

"SKIP" (entered as a time) means the controller will make the segment as short as possible. If you enter

SKIP in segment 1 of example A, the controller will do an uncontrolled heat up to 150°C. In segment 0, SKIP means that the controller will start the programme right away.

### Note

segment 0 is always required ! Even if you don't want to delay the programme start, you have to enter segment 0 because it defines the starting temperature (20°C in the example).

In many applications, the controller controls not only one temperature of a system. Depending on your application, it might be desirable to control additional functions like

- the temperature of a 2nd kiln zone
- the damper / flap of a kiln
- an external signal to be activated in a particular segment (e.g. buzzer) etc.

Please find following example B the programme for a kiln with 3 temperature zones and one damper:

### Example B: Typical Temperature Curve for Drying, 3 zone kiln with damper

seg.	time	temp.	zone 2	zone 3	damper	comments
0	SKIP	20°C	0°C	0°C	CLOSED	immediate start at 20°C, damper closed
1	2:00	150°C	0°C	0°C	CLOSED	ramp to 150°C, all 3 zones equal, damper closed
2	0:30	150°C	+5°C	-5°C	CLOSED	dwelt at 150°C, 2nd zone at 155°C, 3rd zone 145°C
3	SKIP	20°C	0°C	0°C	OPEN	uncontrolled cooling, damper opened
4	END					

Compared to the example A, now additionally to time and temperature further parameters are required in each segment.

### Note

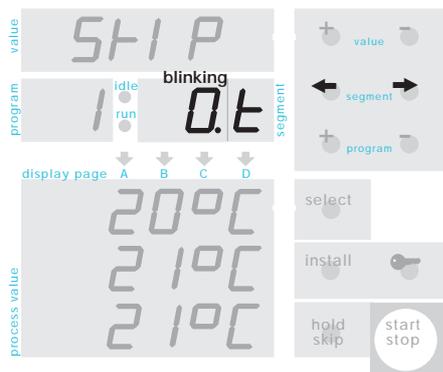
The above examples are typical only and reference should be made to kiln, clay and/or glaze manufacturer with regard to venting and cooling.

## Entering a programme

We are going to enter the example A as programme number 1.

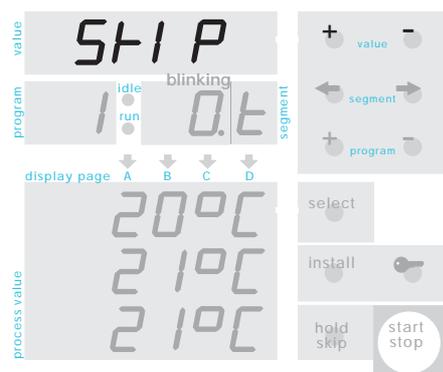
### Note

As mentioned before, the exact number of parameters to be entered for each segment varies depending on your application. Your system manufacturer has adapted the TC S1 to your application. Therefore the following sequence might be different than shown. Refer to table of appendix A.



After power up, the TC S1 has selected programme number 1 automatically. Use the keys (4) to select the time of segment 0 (display (2) shows blinking „0.t“). Refer to the sketch shown on the left.

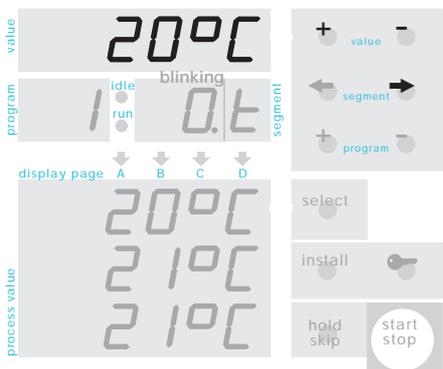
The display (1) shows the present value for time in segment 0.



Now, use the keys (3) to change the time as required. SKIP is shown instead of time 0:00, so you must count down the time to get to SKIP. When you have completed this, the display will appear as shown.

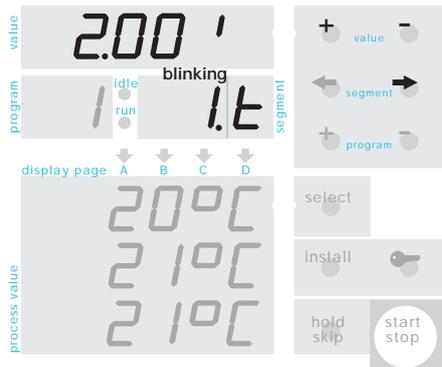
You have now entered the time of segment 0, SKIP.

Note that the controller switches back from input mode if you don't press any keys for 15 seconds. However, all changes made are kept.



To enter the temperature 20°C in this segment, press the right hand side key (4) once and then change the displayed value to 20°C using the keys (3) again.

You have now completed segment 0. Time is SKIP, temperature 20°C. See next page to continue.



Now, enter the values for segment 1. Press the key (4) to the right hand side key once to step to the next segment (display (2) shows segment number 2).

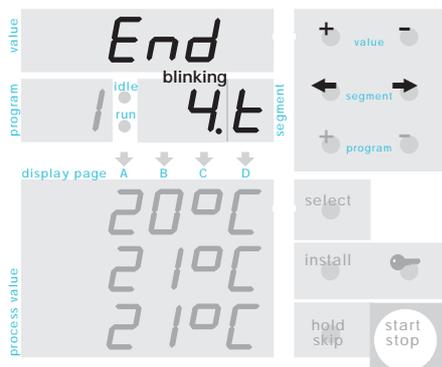
### Note

If your TC S1 is configured for additional parameters per segment (as in example B), these are entered before moving to segment 1.

Change the displayed value to 2.00 hours using keys (3). Hold the key pressed for large value changes.

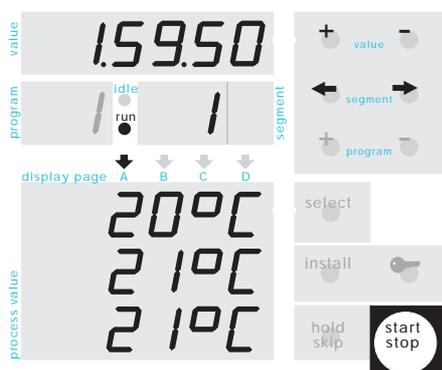
Press the key (4) again to enter the temperature for segment 1. Change the value to 150°C using keys (3).

Enter the further parameters in the same manner. Always step to the next parameter using key (4) after you have changed the programme values accordingly.



After completion of 3rd segment set the 4th segment time to END (decrease time value down, beyond SKIP). This tells the controller on programme run that the end of the process is reached.

You can review and change all values at anytime by using the keys (4). So you can step through the entire programme and check and if required change the values in any sequence.



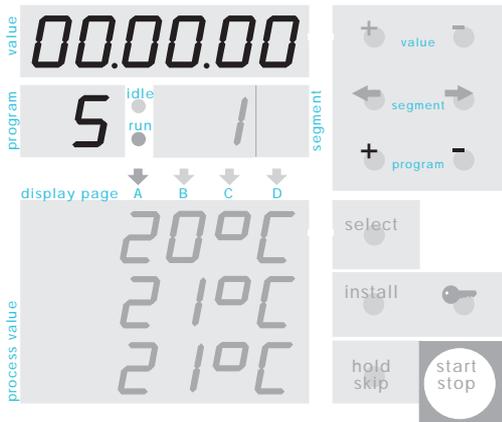
To start the process simply press key (9). The indicator (14) changes from IDLE to RUN indicating a running programme. The display (1) now counts backwards the time left in the actual segment which is shown on display (2) (not blinking).

The displays (11) show the actual process parameters (like kiln temperatures, depending on application).

To stop the firing press key (9) again (indicator (14) reads IDLE). If you press key (9) again the programme is continued. Refer to a later section how to restart the programme completely from the beginning.

When the firing has completed successfully, the display (2) shows an "E" (for End).

## Programmes



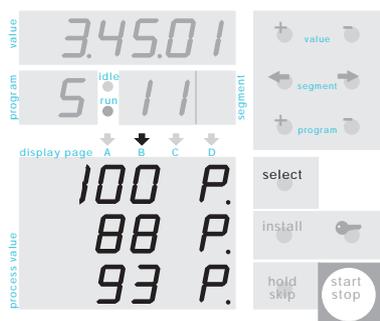
Up to 99 firing curves can be saved in your controller. To enter a firing curve as programme number 5 for instance, press key (5) multiple times until display (13) shows programme number 5. Enter the programme values as described in the previous example. The programme is saved automatically after a few seconds or after programme start.

To call up a programme already entered, press key (5) multiple times until display (13) shows the desired programme number. Press the key (9) and the programme run commences.

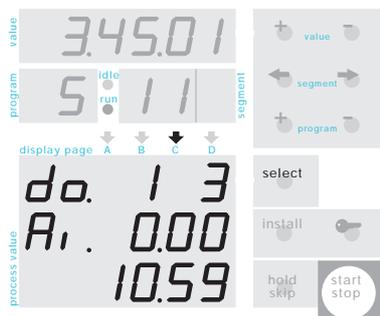
## Additional Displays



The display (11) is used to show all different kind of process values like actual kiln temperatures, setpoints, channel output / status, analog input / output status, digital input / output status. The 3 lines of display (11) show one process value each. Press the key (6) to switch to the next set of 3 process values. The indicator (12) shows which set of process values is currently displayed (A, B, C, D). The system manufacturer has adapted the TC-S1 to your application (refer to the Technical Manual for details).



The sketches on the left hand side show an example for a three zone kiln: Page (A) reads the actual temperature of each zone, page (B) the control output (in % heating / cooling) resp. channel status and page (C) reads information like the status of the output relays, 2nd line an analog input value and 3rd line the actual time.



Check the table in appendix B where your system manufacturer has entered the sequence according to the configuration.

## Special Displays



on. E4

When operating the TC S1, you will sometimes encounter messages with a special meaning. Please find below the exact appearance and what they mean.

When entering a programme, sometimes ON / OFF information is required (e.g. damper OPEN / CLOSE). This is defined by EVENTS. The example shows event number 4 presently set to ON.



ouEr

"over": The actual value (e.g. kiln temperature) has overrun, ie. is out of bounds. Usually, this points to an open input (no sensor connected or sensor resp. circuit is open)



undEr

"under": as above, but value underrun. Check the defined boundaries in the input configuration.



i n u A L

"inval": as above, but value invalid. Means the TC S1 was unable to create this value because of missing data. Check cross-referenced inputs and configuration.



ch. oFF

"ch.off": Control channel is off. This means that no programme is running or the control channel is inactive at the moment (e.g. in conditional PID mode).



ch. Grd

"ch.grd": Control channel cancelled operation due to gradient check failed. The TC S1 found that the unit connected to this channel (e.g. kiln) could not comply to the minimum heat up requested by the channel configuration. Auto-Reset on next start.



ch. ovr

"ch.ovr": Control channel cancelled operation due to assigned input value failed. The channels remain in this mode for safety reasons until next restart of the programme.



APPL.Err

"Appl.Error": Application Error. This is a user definable error message which appears blinking on the display (1). The exact meaning depends on the configuration, usually this message is used to point to a problem in one of the control channels.

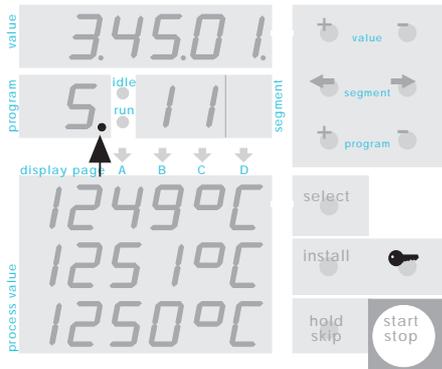


Err 3.FE

"Err.<x.y>": Internal Error. x / y points to the cause of the problem. Ask your system manufacturer for assistance or refer to the Technical Manual.

or other code

## Keyboard Locking



To avoid unauthorized use, you can lock the keyboard of the controller after the programme is started. Only the key (6) is still operable to call up values.

To lock the keyboard, press the key (7) and hold it pressed for 3 seconds until the decimal point in window (13) appears. Unlocking is done in the same way.

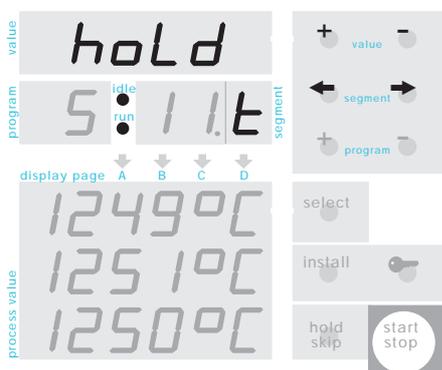
## Immediate Segment Skip

Sometimes it is required to skip to the next segment during a programme run immediately. The TC S1 provides this feature by pressing and holding key (10) for 3 seconds. The TC S1 will skip immediately to the next programme segment.

## Restarting a Programme

When selecting a programme, it always starts from the beginning, ie. from segment 0. If you had to interrupt the firing in a later segment and would like to restart from the beginning, simply recall the programme by pressing the key (5) + and thereafter key (5)- .

## Programme HOLD



The hold mode is to freeze the present programme status during a process, ie. to stay at the present setpoint (and segment) as well as to hold the timer (in a dwell). The hold mode can be initiated in two ways:

To initiate the hold **manually** during a running programme, press the key (10). Both indicators (14) IDLE and RUN are on indicating programme hold.

To initiate the hold **automatically**, set the time of the corresponding segment to "HOLD". If the firing reaches this segment, the controller will enter hold (both indicators (14) IDLE and RUN on).

To release the hold, you have to press the key (10) again (indicator (14) shows RUN only).

This feature should be used carefully to avoid the firing unintentionally holding "forever". But combined with an EVENTS buzzer, this feature can be very helpful if user access is required on a firing process.

## **Reaction to a Power Breakdown**

In the event of a power breakdown the firing process is interrupted. After power is established again the firing process is continued from that point at which it was interrupted. The decision whether to resume programme run or not can be depended from time, process values or also EVENTS. Refer to the configuration for details.

## **Actual length of the Segments**

Usually, on firing a programme segment is finished when the temperature of this segment is matched. If the kiln is unable to reach the temperature in the given time the segment will be extended accordingly. A detailed adaption is also possible. Refer to the configuration for details.

## **Any further functions required ?**

The TC S1 is one of the most flexible and powerful instruments of its class. The configuration keeps many hundreds of functions available which covers most requests. Whatever you need in your application, you will find the answer in the configuration. The configuration is described in a separate booklet.

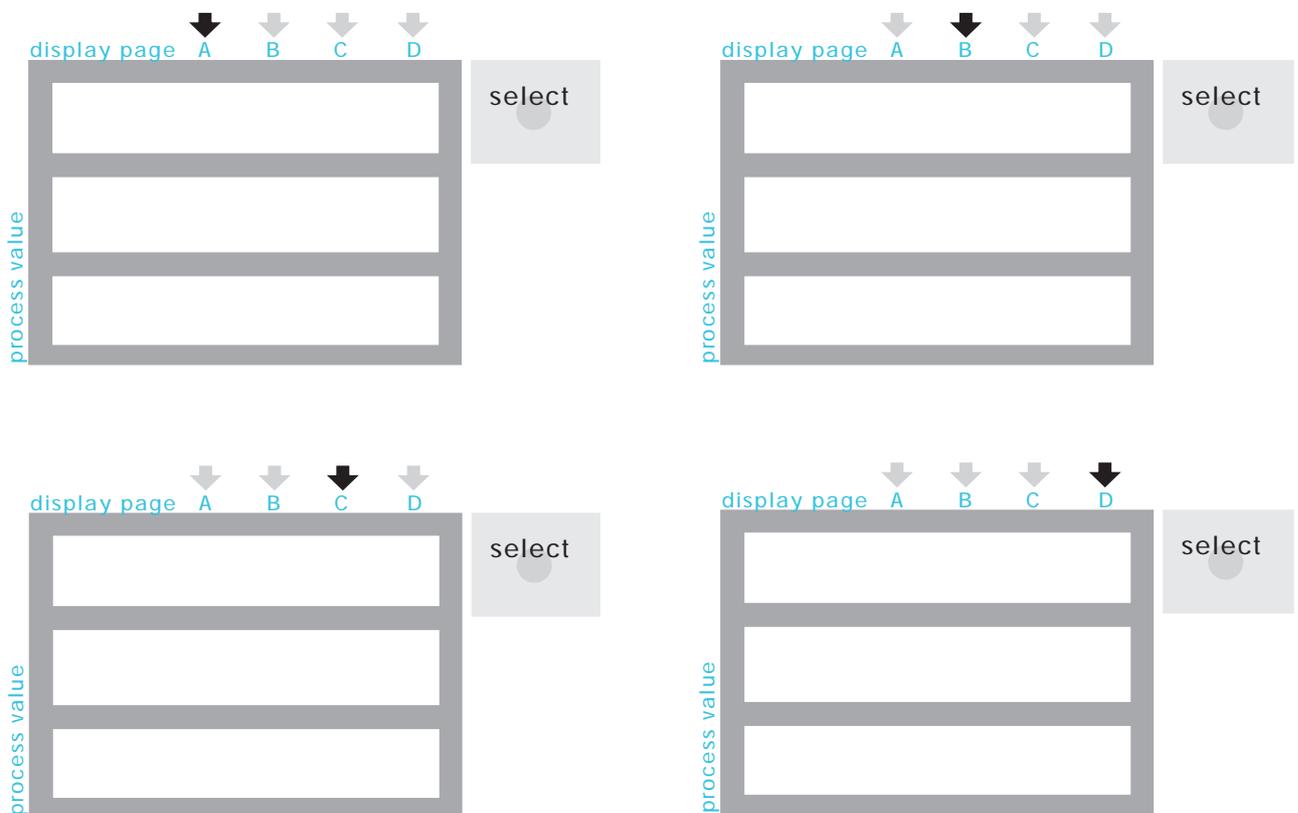
For the first time, it might be a little bit difficult to understand all the possibilities. So we are glad to support you, just let us know what functions you require to change or to add.



## Appendix B: Process Value Display (11)

### Sequence of Process Values Called up by the Select Key (6)

The type and meaning of values which are displayed by pressing the select key (6) depends on your application. These have been set by your system manufacturer accordingly. The following table shows which values are displayed and what they mean (fill in explanation (like „zone 1 temp“) in the empty boxes):



Comments:

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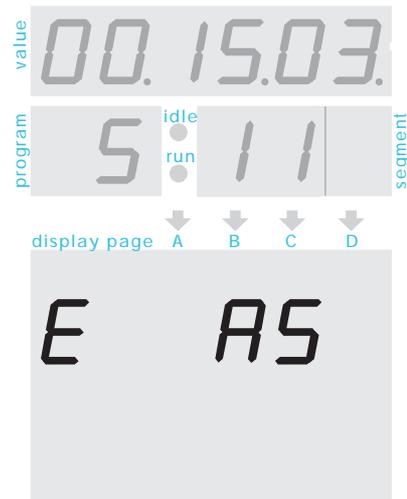
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## Appendix C: Error Messages

Certain errors (like power breakdown, break of sensor, kiln problem etc.) found by the controller are processed accordingly. Important errors are show immediately on the display by a unique code number (see example on the right hand side showing code „A5“).

Some error messages contain an additional code providing further details of the error cause (e.g. „E D4.2“).

All error messages are recorded by the controller for post analyzation (see appendix B).



The error codes are divided into operation or control problems (codes A ..), power breakdown (code B ..), internal problems (code C ..) and hardware problems (code D ..).

Following is a complete listing and explanation of all possible error messages:

### Error A1: error on sensor input

The control channel shuts down because of an error on the sensor input (e.g. overflow). Error is latched until next firing is started. Possible causes:

- thermocouple or compensating wire interrupted
- maximum temperature has been exceeded
- thermocouple polarized wrong (temperature reading „under“)

### Error A2: programme run skipped and brought to a controlled end

The user defined limits during a programme run have been exceeded and therefore the programme run skipped to the cooling section of the actual firing programme. The limits for this event can be defined in the „digital output“ section of the configuration, process mode 18.

## **Error A3: policeman activated**

The policeman of the controller has caused the programme to stop operation because of an overtemperature.

## **Error A4: temperature increase on full power too low**

The error message **clearly points out a problem of the kiln**. Possible causes:

- mains fuse / phase broken, heating elements broken
- heating elements too old (on high temperatures)
- short circuit on thermocouple or compensating wire
- contactor broken (check after operating for some time !)

## **Error A5: kiln does not follow programmed temperature increase**

If the kiln can not follow the programmed temperature increase in a ramp the controller holds the programme to enable the temperature to catch up again. Depending on the configuration of the controller the programme hold is entered if one (resp. all) control channels operate at full power for a certain time. Keep in mind that in a multizone kiln the controller can not equalize temperature once one of the zones is running on full power or zero power. Therefore the controller enters hold mode to avoid loss of accuracy. Refer to the following error message to understand the possible options after the programme has entered the hold.

## **Error A6: controller has quit programme hold after temperature caught up**

After a programme hold has been entered (see Error A5) the controller tries to catch up with the temperature. If the temperature is back into controllable range the programme hold is finished and the programme run continued. To inform the operator this error message is displayed for 1 minute. This message is for information rather than an error message.

## **Error A7: programme run finished due to failure in catching up with the temperature**

If the kiln temperature does not catch up within the configured time the controller finishes programme run if configured to do so. This error message informs the operator about this cause.

## **Error A8: controller continued programme operation although temperature did not catch up**

If the temperature increase does not follow the programme the ramp is held on (see error messages before). If the controller finds the kiln unable to catch up with the temperature the firing is continued and this message is shown for 1 minute. The configuration settings determine whether programme run is interrupted (Error A7) or continued (Error A8) if the temperature did not catch up during the configurable waiting time.

## **Error A9: temperature match at the end of a ramp or skip segment disregarded**

In a ramp or skip segment the controller tries to match all zone temperatures to the requested final value. If the controller found the kiln unable to achieve this it continues to the next section. In this case the error message A9 is shown for 1 minute to inform the user.

## **Error B1: firing process continued after controller restart**

Controller continued after a reset.

## **Error B2: firing process after power breakdown continued**

After re-establishing power supply the firing process has been continued.

## **Error B3: firing process interrupted after power breakdown**

After re-establishing power supply the firing process has been interrupted due to e.g. kiln temperature has dropped too much. If there is a digit shown after the comma it gives further information about the cause. The following options can be displayed:

**B3.1:** programme break has been requested by configuration settings

**B3.2:** programme break because corresponding digital output was off

**B3.3:** programme break because maximum power breakdown time elapsed

**B3.4:** programme break because maximum temperature drop exceeded

If one of these error messages come up right after turning on the controller by the mains switch you can disregard. It just means that the controller has been turned off last time when the firing had not been totally completed. Simply continue working by entering a programme.

## **Error B5: Failure during AUTOTUNE firing: type of control algorithm can not be tuned**

Only control channels configured as PID and C-PID can be auto tuned.

## **Error B6: AUTOTUNE in progress**

During the autotune process this message is shown. This is for information rather than an error message.

## **Error B7: Failure during AUTOTUNE firing: channel error occurred**

Autotune quit because of error of one of the channels to be auto tuned.

## **Error B8: Failure after AUTOTUNE: parameters found to be unusable**

After the autotune is completed the controller judges the resulting parameters. If the result is found to be wrong, extreme or just unlikely the controller does not save the parameters and shows this error message.

## **Error B9: AUTOTUNE firing finished successfully**

This message is shown for operator information that the autotune was successful and the resulting parameters have been stored in the configuration. You can inspect the results by entering the configuration and manually stepping through the configuration.

## **Error C1: System failure: analog digital converter failed**

Internal error. Contact bentrup customer service for support.

## **Error C2: System failure: analog digital converter became unreliable**

Internal error. Contact bentrup customer service for support.

## **Error C3: Systembus failure: system communication (SW808, DIO 808 etc.) interrupted**

The bentrup extensions (switching extensions SW808, digital input / output DIO808, analog input AIM4, analog output AO808 etc.) are connected via a serial communication bus to the controller. If this communication fails this error message is shown. Check the terminating plug, all plugs, contacts, power supplies of the extensions etc.

## **Error C4: Systembus setup failure: Configuration setup does not match actual chain**

Configuration setup does not match the actual number, position and type of the actual physical units. Use the AUTOSETUP feature of the controller to read the chain if you find it difficult to determine the units physically connected. The secondary code (e.g. „E C4.3“ shows the position of the mismatch unit).

## **Error C5: PLC failure**

The controller can be fitted with an optional PLC (programmable logic control). This very useful option enables you to download any kind of functions and networks to expand your controller to any kind of functionality far beyond the functions of the controller itself. Error C5 is shown if any part of the PLC functionality fails. Please refer to the separate PLC manual for details.

## **Error C6: Any member of the control chain has failed**

If your controller is working in a master / slave configuration this error message is shown on the master to point out an error in any slave device.

## **Error D1: Hardware error: CPU failure**

Internal error. Contact bentrup customer service for support.

## **Error D2: Hardware error: Data RAM failure**

Internal error. Contact bentrup customer service for support.

## **Error D3: Hardware error: Internal I2C bus failure**

Internal error. Contact bentrup customer service for support.

## **Error D4: Hardware error: Internal I2C device failure**

Internal error. Contact bentrup customer service for support. Error D4.0: Setup unknown, D4.1: configuration memory error, D4.2 real time clock inop, D4.3 programme memory too small, D4.4 log memory too small, D4.5 PLC memory too small

## **Error D5: Calibration data invalid**

Calibration data checksum error or invalid. Contact bentrup customer service for support.