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TC 505

Operating Instructions

THERMOCOMPUTER *TC 505*

Z1
Z2
Z3

$1250°C.$

00.12

▷h.min
▸°C
▸°C/h
▸°F
▸°F/h

tmp$_2$

tmp$_1$

t$_0$ rmp1   t$_1$ rmp2   t$_2$ rmp3

prog	7	8	9
	1050°C	1180°C	1250°C
memo	4	5	6
	150°C	800°C	900°C
0	1	2	3
hold	event 1	event 2	

shift   select   start stop

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Brief Instructions

start a programme (e.g. no. 15)

prog   **1**   event 1   **5**   start stop

save the current firing curve as a programme (e.g. no. 9)

memo   **0**   hold   **9**

to lock the controller

   (about 3 seconds)

Controllers Panel

1   zone # currently displayed
2   indicator „ controller keypad locked"
3   read / change final firing temperature
4   read / change 1st dwell temperature
5   read / change programme delay
6   read / change 1st heat up ramp
7   read / change 1st dwell time
8   calling up a programme
9   saving a programme
10 key to lock the controllers keypad
11 shift key
12 display for kiln temperatures etc.
13 unit of the process of programme value displayed in (12)
14 process value or programm value on entering programmes
15 grafical scheme of the firing curve
16 read / change cooling ramp
17 read / change dwell time
18 read / change 2nd heatup up ramp
19 keypad for entering values
20 key to start and to stop a firing
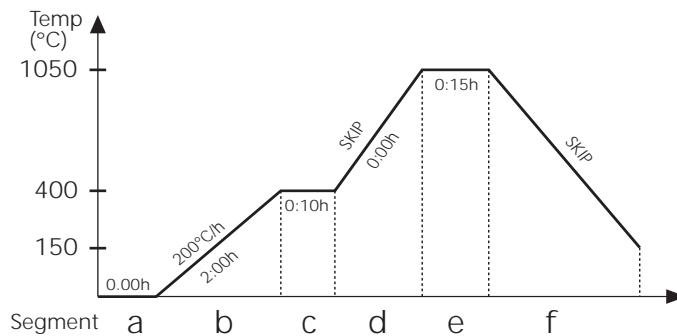21 calling up additional values displayed in (12) and entering configuration

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Contents

General Information

Your TC505 is the choice of the professionals in the bentrup controller family TC500. These controllers use the latest technology available and incorporate many features which haven´t been available on kiln controls before. Appearing as a controller easy to use, it is a highly sophisticated instrument with a totally configurable control design allowing adaption to almost all applications (for details see Appendix C). Reading through this manual quickly familiarizes you with the numerous features of the TC505.

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

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The microprocessor controller TC505 allows an exact and reproduceable control of your kiln. The sketch below shows a firing curve of the TC505. Each firing curve consists of the segments (a) to (f). **Example:**

Temp (°C)

```
1050 ─                          ┌─0:15h─┐
                                │       │
                         SKIP   │       │   SKIP
                        0.00h   │       │
 400 ─         ┌─0:10h─┘        │       │
 150 ─      200°C/h             │       │
    0.00h  2.00h                │       │
Segment  a    b    c    d    e       f
```

programme delay (a):

t_0

The controller waits for the time set before the actual firing is started. This can be used to take advantage of off peak electricity. In the example no programme delay is entered.

heating up to 1st dwell (b):

rmp1

The kiln heats up at the set rate. The rate is entered as degrees centigrade per hour (you can confi-gure to enter as time of you prefer, see appendix C).

1st dwell at set time and temperature (c):

t_1

After reaching the temperature the kiln remains for set time. The time is entered as hours / minutes.

heating up to 2nd dwell (d):

rmp2

The kiln heats up at the set rate to the firing temperature. The example shows SKIP which stands for heating at maximum power (ie. uncontrolled).

dwell at final temperature (e):

t_2

The kiln temperature remains at the final temperature for the set time this may be that all fired goods are entirely heated through.

**cooling or programme end (f):**

rmp3

After completing the dwell the kiln is cooled either controlled (e.g. 200°C/h) or uncontrolled (SKIP) as shown in the example. The TC505 finishes control in this cooling ramp at 150°C showing „End" in display (14) for successful completion.

Calling up a Programme

You can save up to 29 firing curves in your TC505 as programmes. The programme numbers 1 to 6 are factory set and cannot be altered. Please find the values of these 6 programmes below:

prog #	t0 (min)	rmp1(°C/h)	tmp.1 (°C)	t1(min)	rmp2(°C/h)	tmp.2 (°C)	t2(min)	rmp3 (°C/h)
01	0	30	150	10	skip	150	10	skip
02	0	100	600	0	skip	800	10	skip
03	0	100	550	0	skip	900	10	skip
04	0	180	400	0	skip	1050	30	skip
05	0	180	400	0	skip	1180	30	skip
06	0	180	400	0	skip	1250	30	skip
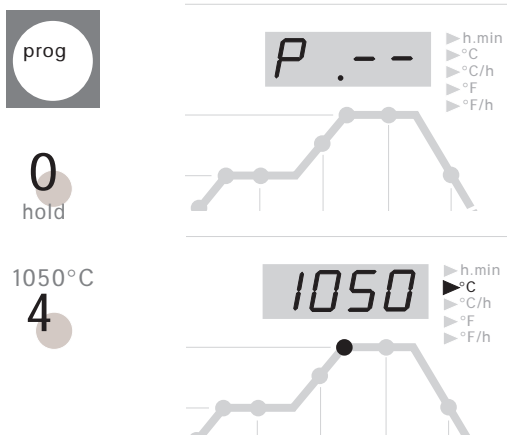
The following example demonstrates how to call up programme number 04 and to start the firing:

After turning on the TC505 display (14) is empty. Pressing key (8) the controller display appears as shown on the left.

Now enter „0" and „4" on the keypad (19). Note that the programme number must always be entered as a 2 digit number. The TC505 prompts entering a valid programme number by showing the maximum temperature of the selected programme on display (14).

Starting a Firing

Press key (20) to start the firing. From now on the current segment of the firing lights up in the firing curve (15). Display (14) reads the current setpoint, display (12) the temperature inside the kiln.

Note

The flashing decimal point on the right hand side of display (12) always indicates a running programme.

If a **programme** value (rather than a setpoint) is shown in display (14) the corresponding section of firing curve (15) is **flashing**.

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Displays during the Firing

By default during a firing the current programme setpoint is shown on display (14). On heat up ramps this setpoint counts upwards according to the programmed rate. Every 15 seconds display (14) flashes the maximum temperature of the currently selected firing. This allows you to double check the most important value of the firing without pressing any keys.
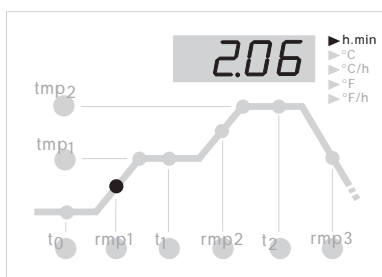

Pressing key (11) followed by key (21) changes the display (14) to the remaining time in the current segment. On ramps the estimated time is calculated whilst on dwells the entered time counts backwards. In general the reading shows hours / minutes; if the time is less than 1 hour the indication is in minutes / seconds (unit display (13) „h.min" is blinking).

After 15 seconds or when pressing key (10) followed by key (20) again the the display (14) switches back to the programme setpoint.

During a programme delay always the remaining time until the programme starts is always shown.

Watching the firing curve (15) allows you to see how your TC505 processes the firing curve segment by segment. The programme is completed if the kiln temperature reaches 150°C in the cooling segment (f).
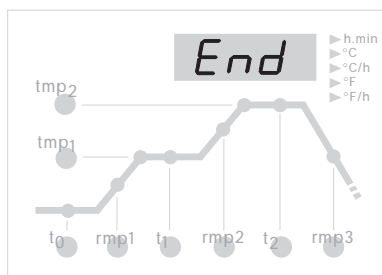
„End" on display (14) comfirms successful completion of the firing process (as depicted on the left).

Entering and Checking a Firing Curve

rmp1
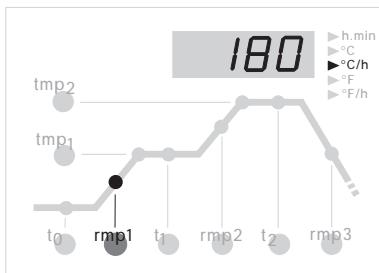
You can check the values of a firing curve at anytime even during programme run. If you want to change a value you have to stop the firing by pressing the key (20).

For instance to check the heat up ramp press key (6). Display (14) reads the current value for the heat up speed. The unit of the value (in this example degree centigrade per hour) is shown in (13). The corresponding segment (b) of the firing curve (15) lights up.

To change this value simply enter a new value by using the keypad (19). If you enter a value that is outside the allowed range the controller rejects by showing „- - - -". If this is the case simply enter the correct value.

tmp₂
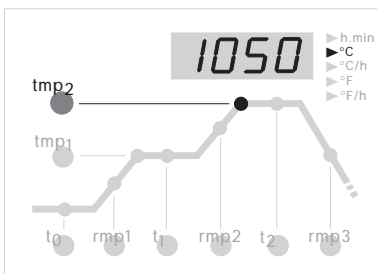
For instance to check the final temperature press key (3). As described before, the current value is shown in display (14) and the corresponding section (d) of the firing curve (15) lights up.

To change this value proceed as described before.

All values of the firing curve can be checked and - if required - changed as described. The sequence of checking or changing is free. Only keep in mind always stop a firing if you intend to change a programme.

On delays of more than 15 seconds the display (14) returns to the current programme setpoint. Select the segment to change again if you wish.

The Value SKIP

rmp2

9
9
9
9
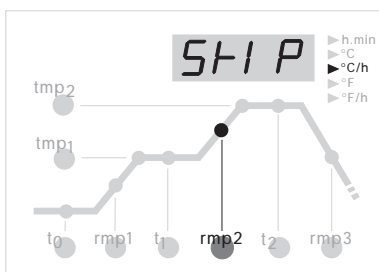
On most firings the customer wants to heat up the kiln as fast as possible from 1st dwell temperature to final temperature. This is done by entering the value „SKIP" on segment (d).

Press key (18) to select segment (d). Now press the digit key „9" on the keypad (19) 4 times. TC505 shows „SKIP" on display (14) as depicted on the left.

This option can be used on all ramps (i.e. segments (b), (d) and (f).

Saving Programmes

You can save up to 29 programmes in your TC505. Once a firing curve has been saved as a programme it can be called up easily to be modified, saved again or simply used by starting the firing.
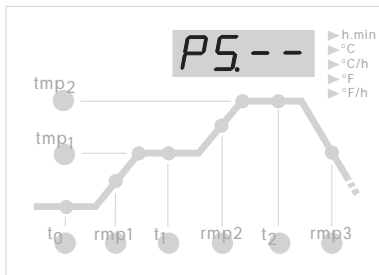
To save a firing curve that has been entered before as e.g. programme number 25 proceed with the following steps: Press key (8). The display (14) asks for the programme number as shown on the left („**p**rogramme **s**ave"). Now enter the programme number „25".

Please note that a programme number must always be entered as a two digit number (e.g. „0" and „9" for programme no 9).

After successfully saving the current firing curve the display (14) reads the final temperature of the programme (or the current firing). If the display shows „PS.- -" you have tried to enter an invalid programme number which has been rejected by the controller.

The first 6 programmes are factory set and cannot be changed. This ensures that you always have a set of 6 standard firing curves available. The values of these programme number 1 to 6 were listet on page no. 5.

The programmes number 7 to 29 can be set according to your requirements as described previously. You can change and update them as often as you wish.

Working with Programmes

Presuming you frequently need a firing curve which is the same as preset programme no. 5 but with a final temperature of 1195°C and 20 minutes dwell. This programme is to be saved as no. 15.

Call up programme no. 5 and change the final temperature (1195°C) and dwell (20 min). Now save the firing curve as programme no. 15.

> **Note**
> The progamme number **must always** be entered as a 2 digit number. Example: Enter „05" for programme no. 5

Displaying the Kiln Temperature

Display (12) shows continuously all values of the current process such as actual kiln temperature, heating power (in %), status of the control outputs etc. All values are shown in sequence by pressing key (21).

The TC505 is available in a version for multizone kilns. The indicator (1) points to the zone the value refers to. For details about multizone kilns please check out the „Technical Manual TC500 Series Controller" available on *http://www.bentrup.de.*

The sequence of the process values can be determined in the configuration. By default the values shown in display (12) by pressing key (21) are as follows:

Z1◄
Z2◄
Z3◄
●◄

$24°C.$

Z1◄
Z2◄
Z3◄
●◄

$ouEr$

Z1◄
Z2◄
Z3◄
●◄

$undEr$

Z1◄
Z2◄
Z3◄
●◄

$inuAL$

Actual Kiln Temperature

The actual temperature of the kiln is shown. On multizone kilns the temperatures are shown zone by zone pressing key (21). Zone no# refer to indicator (1).

„**over**": no sensor (thermocouple) connected, sensor broken, sensor wiring broken or adjusted sensor temperature exceeded

„**under**": sensor or wiring polarized bad. On switching poles check color codes ! A wiring switched at both ends (!) can NOT be determined by the controller and will cause overfiring !

„**invalid**": signal acquisition bad, error on determining cold junction temperature or controllers data acquisition defect.

Z1◄
Z2◄
Z3◄
●◄

$27 P$

Z1◄
Z2◄
Z3◄
●◄

$ch. oFF$

Z1◄
Z2◄
Z3◄
●◄

$ch. our$

Z1◄
Z2◄
Z3◄
●◄

$ch. Grd$

Actual kiln heating in percent

On kilns switching ON / OFF only the percentage is represented by the on/off duty (e.g. 50% means 15 seconds on and 15 seconds off).

„**channel off**": currently no control process, for instance during programme delay or programme not started.

„**channel over**": control channel has been switched off due to error of corresponding signal input (e.g. „over" on input). Automatic reset when starting a programme.

„**channel gradient error**": For safety reasons TC505 checks the temperature increase of the kiln during **full power heating**. When dropping below 3°C per 15min this error message appears. Typical causes: *heating elements too old or broken, one phase of mains supply missing or missing by contactor failure, short circuit of thermocouple or wiring.* Not a defect of the controller !

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status of the control outputs

Any activated outputs are shown by their number (example shows all 4 outputs active). The function of an output is determined by the configuration.

process errors

Any process errors during the firing. On the left hand side an „E" is shown followed by an error code if applies (example shows code „A4"). Refer to appendix A for a complete listing and explanation of all errors.

Power consumption since programme start

Displays the total power consumption since last programme start. The TC505 calculates this value by adding up the heating cycles. Make sure that the kiln power rating is properly set in the configuration (see appendix C, parameter 1).

Operation time of the heating elements

The TC505 adds up the net operation times of the heating elements (ie. only the duration where they were actually under power) since programme start. This allows you to check the load of the kiln or the efficiency of the heating elements.

Total operation time of heating elements

As before but time is added up to a total value to check lifetime of the heating elements. Very useful feature to proove warranty claims as well as getting an impression about how intensive a kiln has been used. For safety reasons reset to zero only by manufacturer.

Realtime clock display: day of week and time

Your TC505 is also available with a real time clock (optional, can be installed at anytime) for automatic commencing programmes. If your TC505 is fitted with this option this display is shown to check current day of week and time (hours / minutes).

Locking the Controller

The prevent the TC505 from unauthorized usage you can lock the keypad by pressing the key (10) for about 3 seconds. The indicator (2) shows the TC505 is now locked. If the controller is locked you can for instance only call up values but not start or interrupt a firing.

To unlock the controller press and hold key (10) again until the indicator (2) goes off.

Power Failure

In case 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. If the kiln temperature has dropped more than 50°C since the power failure happened the firing is interrupted (an error messages comes up - see appendix A).

Actual Duration of a Segment

In theory a ramp takes exactly the time which is programmed. However, if at the beginning of a ramp the actual kiln is higher than the initial ramp temperature the time is adjusted accordingly. Example: Ramp in 2 hours up to 500°C. If the kiln is already at 250°C the time is set to 1 hour only. This also ensures that the setpoint starts at the kiln temperature. The ramp is finished when the time has elapsed.

Kiln can not follow the Ramp

What happens if the kiln temperature is unable to keep up with the programmed temperature increase? Example: Ramp asks in 1 hour to 1000°C. Your TC505 handles this situation as best as possible (only if parameter #9 is set to 0 or 1): When the heating power reaches 100% (and therefore there is no control any more) the ramp time (or setpoint) is held (display (14) flashes „hold"). When the kiln temperature has caught up the time continues automatically.

To avoid a firing process locking itself because of lack of kiln power in a ramp an automatic continuation is performed.

By using the function „hold" you can also manually release the ramp „hold" (press shift + key 0, see below).

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Uncontrolled Ramps (SKIP)

On uncontrolled ramps the TC505 stays in the segment until the final temperature is reached. On multizone kilns the TC505 waits for all zones. To avoid the process locking itself because of heat-shift between the zones, there is a complex algorithm which realizes this situation and causes a step to the next segment.

Interruption of the firing on Errors

On severe errors (like a broken sensor etc.) the TC505 interrupts the process and shows an error message.

Hold Process

The TC505 provides you with the feature to hold the process manually. Press key (11) followed by the digit key „0" (hold). Display (14) shows flashing „hold" and the firing process is held **until the key (11) followd by key „0" is pressed again**.
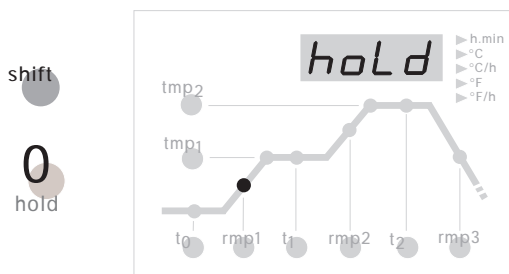
A „hold" causes the programme to remain at the setpoint in a controlled (!) ramp by holding the time. In a dwell the time is also held infinitely.

Heating / Cooling Segments entered as Time

Your TC505 provides you with the option of entering the heating and cooling ramps as time (hours / minutes) rather then degrees centigrade per hour (°C/h). Some people are still more used to these values although they are a leftover from controllers used in the past. Your ceramic is interested in the temperature gradient and not in the time required for it !
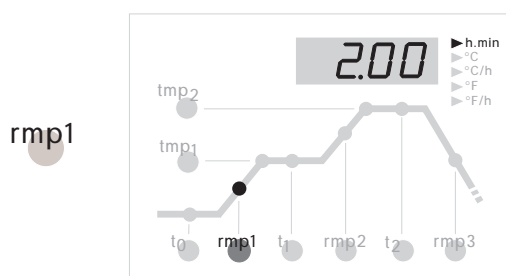
In the example given on page 4 enter 2 hours (instead of 200°C/h) in segment (b). Enter a time of „0.00" to programme uncontrolled heating / cooling (SKIP).

Appendix C explains how to change the controllers configuration (set parameter 11 to „time").

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Appendix A
Error Messages
of the TC505

Certain errors (like power breakdown, break of sensor, kiln problem etc.) found by the controller are processed accordingly. Important errors are show immediately on display (12) by a unique code number (see example on the left hand side showing code „A4"). All error messages are recorded by the controller for post analyzation (see appendix B).

```
Z1
Z2     E      A4
Z3
```

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 A3

policeman activated

When exceeding the maximum programme temperature by 20°C or more the integrated policeman shuts down the kiln using the safety contactor (applies only if your kiln is fitted with a safety contactor). This prevents your kiln from overfiring in case the main contactor stucks in the ON position for instance.

Possible causes for over temperature:

• kiln contactor stuck in ON position

• a contact of the contactor has melted together

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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

Other then error 4 bad programme values are the cause for this message. Firing is not interrupted ! Message comes up only if enabled in the configuration (appendix C, parameter 9).

Error A8

ramp has been continued automatically

If the temperature increase does not follow the programme the ramp is held on (see section „Kiln can not follow the Ramp"). If the controllers finds the kiln unable to catch up with the temperature the firing is continued and this message is shown for 1 minute.

Error A9

SKIP ramp has been interrupted

In an uncontrolled ramp 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 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 (e.g. **B3.4** = temperature dropped too much).

If this error message comes 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 C1, C2 C3, C4

internal problem

Technical assistance required (C1 signal acquisition broken, C2 signal acqusition not within precision limits, C3 systembus communication error, C4 systembus configuration setup mismatch).

Error D1, D2 D3, D4, D5

hardware error

Technical assistance required (D1 processor fault, D2 RAM error, D3 bus error, D4 configuration memory error, D5 calibration data invalid).

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Appendix B
Data- and Error Log

IYour controller TC505 is fitted with a data and error log. All data and errors of the entire firing are recorded continuously by the TC505. Such features have not been known on this type of controller until now! Don´t waste time watching a firing to discover an error (and of course miss the most important moment anyway !)

Data Log

The data log records all important process values (kiln temperature(s), setpoint, control outputs, times) once a minute. The data log holds the last 36 hours which can be inspected by the user. The recording takes place automatically in the background (no matter whether a firing is started or not). After turning off the controller all data is lost.

Error Log

The error log records values only if certain errors happen (for instance all errors decribed in Appendix A). The last 50 errors are recorded (including all details (temperatures etc.) like in the data log). This allows quick and efficient error tracking and trouble shooting. The error log is permanent so it is not lost when turning off the controller.

Data log as well as error log record the same set of process data. These are the actual kiln temperature and kiln heating (on multizone kilns from all zones), the setpoint temperature, remaining time in segment, segment number, status of the control outputs as well as process information.

If your controller is fitted with the optional real time clock the date / time when the data or error took place is also recorded. This allows finding the error of interest quickly and enables efficient reconstruction of the problem.

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Calling up the Data Log
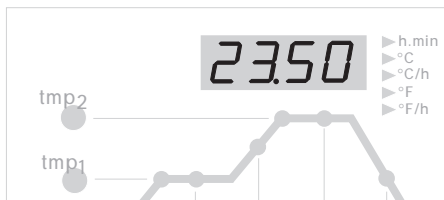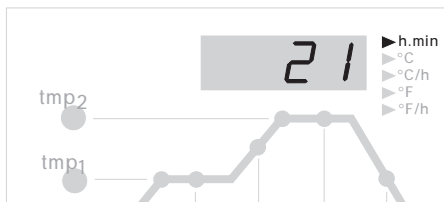
To view the data logged since last power up proceed as follows: Press key **shift** (11) followed by **memo** (9). This can be done at anytime also during programme run without interrupting the programme.

Display (12) reads „L" (for „Log") followed by the log number. All other displays show the same value as in normal operation (i.e. setpoint temperature, segment number etc.). As well all other process values can be displayed pressing key select (21). Calling up the remaining time instead of setpoint temperature using the keys shift (11) followed by select (21) can be done the same way as in normal operation display.

Additionally the time and date (only if TC505 is fitted with the real time clock, see appendix D; if not display of elapsed time since last power up) is displayed (see example display on the left hand side). To indicate log display other than normal operation display a programme run is shown as a continuously (and not blinking) decimal point in display (12).

To call up the further values which have been recorded minute by minute the digit keys „0" to „3" are misused. Press key „2" to show next recording, press „3" to step back to previous recording. Keeping the key pressed to step through the logs automatically. Pressing key „0" shows the 1st, „3" the last record.

After 15 seconds without pressing any keys the display changes back to normal and the current value are shown. Alternatively press keys shift (11) followed by memo (9) to return to normal display.

Note

The controller records the set of values every 60 seconds. If there is for instance a short switching in between two recordings it can not be seen in the data log of course.

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Calling up the Error Log

To call up the error log press key **shift** (11) followed by key **prog** (8). This can be done at anytime without interrupting the programme.

Z1◄
Z2◄
Z3◄
⚷◄

E   2

Display (12) shows „E" (stands for „Error") followed by the error #. You can read out about the last 50 errors.

Note
The error that happened last (and so the most current error) has the lowest number and is shown first

The kind of display, the apperance, the options to call up the values etc. are absolutely identical as described before for the data log.

The error log records in seqence all previous errors. The log can only be purged by the manufacturer and is very efficient and essential to track up problems in kiln or controller.

Z1◄
Z2◄
Z3◄
⚷◄

E   – –

If the error log is empty the display reads „- -" (see display shown on the left hand side). This applies to an empty data log as well.

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Appendix C
Configuration

Because your TC505 can be used in a wide range of applications some operating parameters of the controller are adjustable. Usually if there were any adjustments required they already have been done by your supplier. Please refer to following parameter list If you are interested in details:

par.-no.	description	default	unit
1	power of kiln	0,0	kWh
2	< reserved >	0	cm/h
3	type of thermocouple (S, R, K, J)		-
4	maximum temperature of the kiln	1320	°C
5	proportionalband	2.0	%
6	integral time	200	s
7	derivative time	10	s
8	cyclus time (or hysteresis resp., 1.0°C)	30	s
9	reaction on heat up problems	1	-
10	number of kiln zones	1	-
11	enter ramps as gradient (°C/h) or time (h.min)	grad	grad/time
12	function of the 1st additional control output	1	-
<13>	function of the 2nd additional control output	0	-
<14>	function of the 3rd additional control output	0	-

Warning !

Failure in setting up the parameter might easily cause damage to kiln and firing goods. It is the users responsibility to decide whether the changes made are proper and safe. If you are in doubt do not adjust the parameters !

Some adjustments are blocked for safety reasons (e.g. changing the type of thermocouple from S/R to J/K or vice versa).

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Explanation of the parameters (see # in brackets for parameter number)

power rating (1)
Power rating of the kiln. This value is only used for calculating the power consumption.

thermocouple code (3)
Type of thermocouple: S=PtRh10%-Pt, R=PtRh13%-Pt, K=NiCr-Ni, J=FeCu-Ni. Change from S/R to J/K and vice versa are locked for safety and technical reasons.

maximum temperature of the kiln (4)
maximum adjustable temperature. **Please make sure that this limit never exceeds the maximum temperature allowed for the kiln !**

proportional band (5), integral time (6), derivative time (7)
These so called control parameters adapt the controller to the heating characteristics of the kiln. The default parameters ensure excellent results since they are continuously adapted by the permanent auto tune feature of the controller.

cycle time (8)
Determines the number of switching cycles of the contactor. Frequent switching reduces lifetime of the controller. On the other hand long switching cycles cause unsteady heating of the kiln. The default value of 30 seconds has been found a good compromise for almost all applications.

reaction on problems heating up the kiln (9)
setting 0 the controller entirely reacts on all delays on heating up in ramps. The time counter in controlled ramps is held („hold") if **one** zone gets up to full power. This setting ensures that even on multizone kilns if there is a lack of power the temperature in all zones is equalized as best as possible. With this setting the actual time required for a ramp might be much longer than programmed because the controller enters „hold" cycles frequently.

setting 1 (default) as setting 0 but time is only stopped if **all** zones are on full power. This ensure that during a heat up ramp the kiln power of all zones is used although the temperature in some zones is not totally equalized. On single zone kilns setting 0 and 1 come to the same result !

setting 2 the controller only checks the increase in temperature on full power heating. As long as a certain increase in temperature is found (min 3°C per 15 minutes) the firing is continued.

setting 3 the controller does not check for any heating of the kiln. This setting should only be used if **required by the application** (e.g. if the kiln must be opened frequently during the firing) because operation safety gets lost. On this setting for instance a short circuit on the thermocouple can not be found by the controller and would cause the kiln to overfire.

number of heating zones (10)

The TC505 is available as 2 and 3 control zone unit. This parameter sets the actual number of control zone used. More than one control zone require a kiln designed accordingly (one thermocouple per zone, one contactor per zone). The temperature distribution on a multizone kiln is greatly improved !

enter ramps as gradient (°C/h) or time (h.min) (11)

On the TC505 you can can enter the speed on a heating or cooling ramp either as degrees centigrade per hour (°C/h) or as time (hours / minutes) whatever your preference is.

function of the 1st / 2nd / 3rd additional control output (13) ff.

The TC505 can be fitted with up to 4 control outputs. On single zone kilns therefore up to 3 additional control outputs are available. The function of these additional control outputs can be set to one of the following options each:

0 - control output OFF (no function)

1 - output for safety contactor: ON during programme run, OFF if overtemperatur is found

2 - EVENT: output is programmed to ON of OFF for each half (ramp and dwell) of a segment. Up to 2 outputs can be configured as EVENT. After configuration use keys **event1** or **event2** to enter „0" (=OFF) or „1" („ON") on every segment (actually for ramp and for dwell). During programme run the control outputs are switched to ON or OFF accordingly. This feature is used to control cooling flaps or a chimney for instance.

3 - ON during programme run

4 - ON during programme run as before, but not during programme delay

5 - ON when programme is completed

(further options on request)

Parameters (13) and (14) appear only depending on installed extensions of the controller and number of zones used (ie. according to the number of available control outputs).

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Calling up the Configuration

Press key **select** (21) and hold it pressed for about 3 seconds. The TC505 enters configuration showing the first parameter of the list explained before. Display (12) shows the parameter number while display (14) shows the current value.
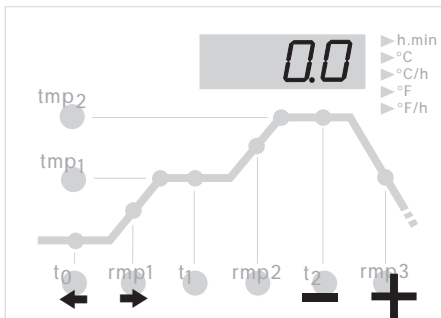
Use keys (5) and (6) to step through the parameterlist explained before. To change a parameter use keypad (18). Note a number of parameters can also be altered by using the keys **t2** (17) and **rmp3** (16). Key (10) is used as decimal point (e.g. to enter the kilns power rating).

To leave the configuration press and hold the key (21) for 3 seconds. If you have altered any parameters and you would like to keep them permanently, hold key **select** (21) until the display as shown on the left hand side appears („Save okay"). This special requirement avoids unintentional parameter change.

Large Parameter List

The parameter list described earlier is kept simple and compact to make changes understandable. Parameter changes allow the adaption of the TC505 to almost all applications. However, many functions of the TC505 are hidden using this parameter list.

The **large parameter list** includes more than 2000 parameters and allows totally free configuration of the entire controller design. Zonewise control channel configuration, servo motor control, analog outputs and many features more can be configured.

The large parameter list is selected by setting a jumper inside the TC505. Configuring the large parameter list on TC505 is either done over the keyboard or by using our Microsoft Windows based software bentrup WinConfig (only on TC505 fitted with data link - see appendix D).

For further details please check the „Technical Manual TC500 Series Controllers". This manual - as well as WinConfig - can be downloaded as PDF file on our homepage *http://www.bentrup.de* free of charge.

Appendix D
Weekly Switching Clock

The TC505 is available with weekly switching clock. This optional feature allows you to commence programmes at a preset time or day of week (e.g. commence programme 2 on Monday at 01:00 ó clock). You can enter up to 7 switching jobs. By over lapping switching jobs functions for instance automatic reducing temperature at night time become possible on continuous kilns (heat up kilns weekdays at 7 AM heat up to 1200°C and bring back temperature at 5 PM down to 900°C.
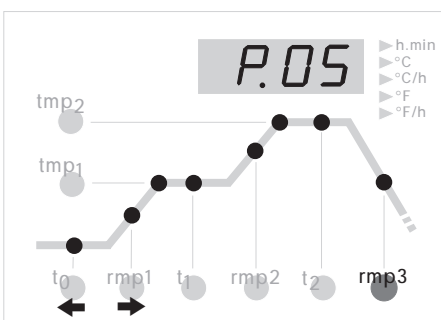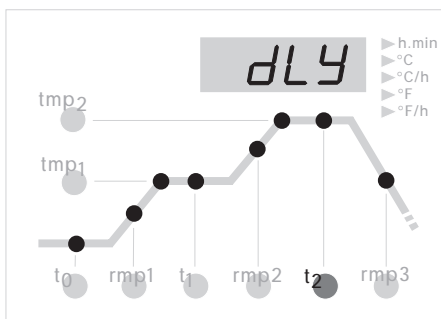
By pressing and holding key (8) the TC505 changes to the mode of entering weekly switching jobs (all segments of the firing curve (15) light up to indicate clock switching jobs). Use the keys (16), (17) and (18) to enter the jobs:

Press key (18) to enter the time (e.g. 23:30). All times are entered in 24h format. To supress the job enter „off" instead of a time (to do so press keys (11) and „0"). As on entering programmes the last job must be set to „end". The last switching job must be set to „end" (press key (11) followed by digit key „3").

Now press key (17) to select the day of week. Further to the normal weekday selections monday to friday the TC505 accepts „daily", „weekday" and „weekend". All settings are entered as abbreviation (0-mon, 1-tue, 2-wed, 3-thu, 4-fri, 5-sat, 6-sun, 7-dly, 8-w/d, 9-w/e).

After pressing key (16) enter the number of the programme to be commenced when time is reached. Enter „0" as programme number to stop a programme. This feature can be used to stop a programme at a certain time or day of week.

To enter next switching job enter key (6); key (5) brings you to the previous job.

After 15 seconds not pressing any keys the TC505 quits the mode of entering switching jobs and returns to normal operation. All switching jobs are processed repeatedly until suppressed on setting them to „off" manually.

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Appendix E
Communication Link

The TC505 is available with a communication link for operation on Windows based PCs using a serial link (controller is directly connected to a serial PC port) or an industrial standard RS422/485 fieldbus. The signals are electrically isolated for safe and proper operation.

This feature allows full access to all process parameters, programmes, configuration and controller operation. A complete remote control of the TC505 becomes possible. Follwing are some typical applications:

- check and modify configuration using bentrup WinConfig (utility free of charge)

- connect the TC505 to your own software using the published data protocol

- connect the TC505 to your own software using windows DDE (simple commands like „START"; bentrup DDE fieldbus driver software required)

- state of the art software bentrup WinControl for visualization, data acquisition and recording, managing firing programmes and configuration

A detailed description of the options including the definitions of the communication protocol can be found on our homepage *http://www.bentrup.de.*

Appendix F
Checking Installed Options

On pressing key **select** (21) on power up the TC505 shows its hardware release as well as any installed options. The codes shown on the display have the following meanings:

- number of control channels *
- number of switching outputs*
- number of analog outputs *
- real time clock installed yes / no
- large programm memory installed yes / no
- hardware release code

* The actual number can be less, please check with the code on the controllers type label following the type of thermocouple (e.g. TC505-S-14- .. stands for 1 zone / 4 switching outputs)

Appendix F
Electrical Connections

Important Note

The specifications given are only an example. The electrical connections are made to our customers request and sometimes differ from the specifications shown on this page.Please double check the required information with the files of your kiln manufacturer

All bentrup controllers for either more than 1 zone or more than 2 outputs are fitted with the HAN15DX plug described on a seperate sheet.
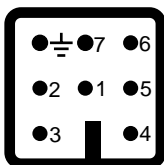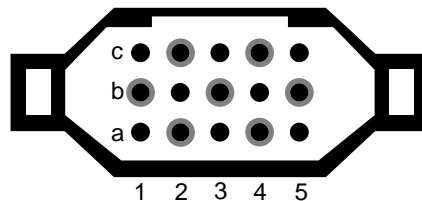
Simplified Schematic of a Kiln
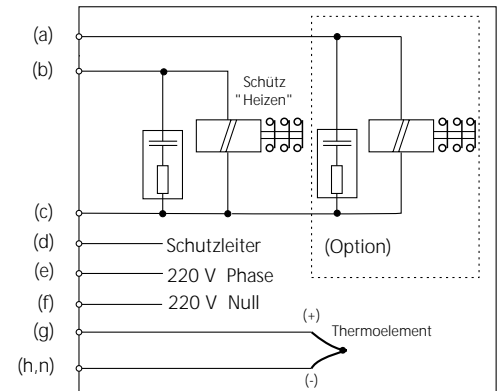
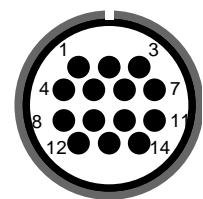a...n: Anschlüsse für Regelanlage

Pin Assignements

HAN7Da   HAN15Da   CPC14a

pin no.	function	HAN7Da	HAN15Da	CPC14a
a	additional control output	7	C3	12
b	control output (live)	6	A3	14
c	control output (neutral)	1	B3	13
d	earth ground *		earth clamp	11
e	mains supply (live)	5	A1	8
f	mains supply (neutral)	2	B1	9
g	thermocouple +	3	B5	1
h	thermocouple - (PtRh-Pt)	4	C5	2
n	thermocouple - (NiCr-Ni)	4	A5	3

* earth ground **must** be connected!

Important Note: Please compare type of thermocouple used in the kiln with the controllers thermocouple input marked on the back of the controller. Mismatch can cause severe damage of kiln and contents !