

**bentrup**

TC 405/30



# Operating Instructions

## Brief Instructions

To

- start a fixed programme (e.g. no.5)

use this key



5



- start a personal programme (e.g. no.3)

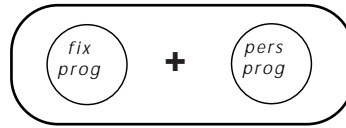


0

3



- save a personal programme (e.g. as no.1)



0

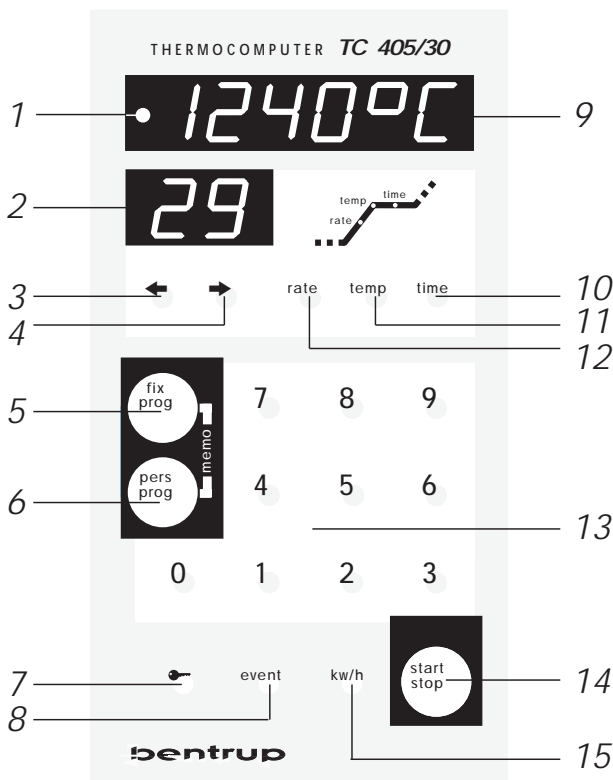
1

- to lock the controller



about 3 seconds

## Controllers Panel



- 1 indicator kiln on/off (power relay)
- 2 segment display
- 3 key "previous segment" ("HOLD" during a running programme)
- 4 key "next segment"
- 5 key for calling up fixed programmes
- 6 key for calling up personal programmes
- 7 key for locking the controller
- 8 key for event control output
- 9 display
- 10 key for adjusting the dwell
- 11 key for adjusting the temperature
- 12 key for adjusting the ramp
- 13 numeric keyboard
- 14 start/stop key
- 15 key for calling up the power consumption (and for installation parameters)

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## General Information

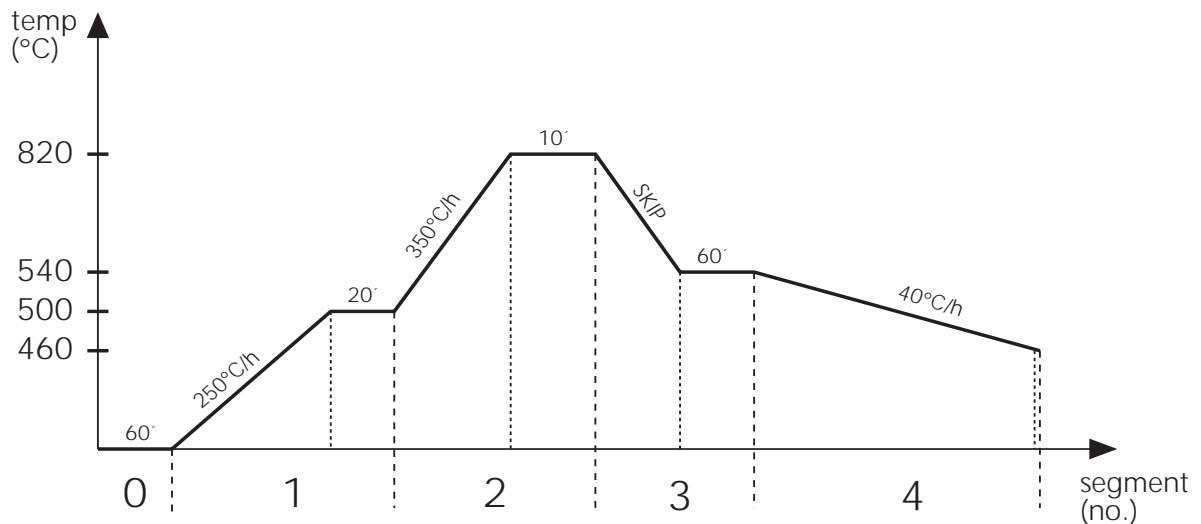
Your brand new bentrup TC405/30 represents the latest technology in kiln controls concerning safety, precision and features available today. The TC405/30 is one of the most popular controls available.

Before operating your new control TC405/30 please read the manual carefully. This makes you familiar quickly with the numerous features of the TC405/30.

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.

The microprocessor controller TC405/30 allows an exact and reproducible control of your kiln. The course of a firing is shown in a figure which is seperated in up to 30 segments.

One segment always consists of a ramp (i.e. heat up or cooling) to a certain temperature followed by a dwell at this temperature. **Example:**



segment	function
0	delay start (60 min.)
1	heating up at 250°C/h to 500°C with 20 min dwell
2	heating up at 350°C/h to 820°C with 10 min dwell
3	cooling at maximum speed (SKIP) to 540°C with 60 min dwell
4	cooling at 40°C/h to 460°C, 0 min (=no) dwell

**Summarized, for every segment the following values have to be entered:**

**rate** temperature increase (or decrease resp.) in °C per hour (\*). The value **"SKIP"**, i.e. uncontrolled achieving of the final temperature with maximum speed is selected by entering "9999". The setting **"end"** (enter "0") means end of programme, i.e. on reaching this segment the firing is finished.

**temp** final temperature of the ramp and therefore dwell temperature

**time** dwell time at this temperature ("0" stands for no dwell, "9999" (display "hold") sets the control in the infinite hold mode; see chapter "direct control")

(\*) formerly, a ramp has been defined by the **time** to reach the final temperature. If you are used to this way of entering the speed **indirectly**, you can change the TC405/30 to this mode by setting the parameter no. 3 to "1" (refer to chapter "setting the parameters" on page 28).

*Note: The time to heat up is entered using the key "rate", the dwell by using the key "time"*

## Fixed programmes

## Personal programmes

Often used curves are already in series - saved as fixed programmes in the controller. Anyway you are able to save 9 individual curves - personal programmes which let you consider your experience and special wishes. Both fixed and personal programmes are called up simply by pressing the corresponding keys (5) or (6) resp.

A seldom used curve can also be used without saving it as a programme. In this case use all the necessary values (see "creating a new curve") and then press the "start/stop" key. If a curve is put in like this it will be lost after firing.

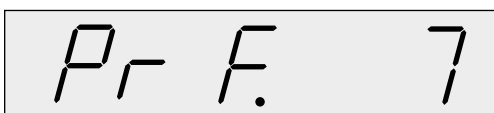
## Calling up a fixed programme

The following a list of the fixed programmes in the controller:

programme	temp	no.	rate <sub>1</sub>	temp <sub>1</sub>	time <sub>1</sub>	rate <sub>2</sub>	temp <sub>2</sub>	time <sub>2</sub>
drying	150°C	4	30°C/h	150°C	20'	end		
biscuit	800°C	5	100°C/h	600°C	0'	SKIP	800°C	10'
biscuit	900°C	6	100°C/h	550°C	0'	SKIP	900°C	10'
glaze	1060°C	7	180°C/h	400°C	0'	SKIP	1060°C	30'
glaze	1200°C	8	180°C/h	400°C	0'	SKIP	1200°C	30'
glaze	1250°C	9	180°C/h	400°C	0'	SKIP	1250°C	30'



7



To start e.g. a glaze firing with a temperature of 1060°C you can use fix programme no.7.

Turn on the controller. After a short self test the display will show the actual kiln temperature. Press the key "fix prog" (5) followed by key no."7" on the numeric keyboard (13). The display shows the selected fix programme.

To start the firing process press key "start stop" (14). By using the "start stop" key again you can interrupt and continue with your programme.

The flashing decimalpoint on the right side of the display "value" indicates that a firing process is running.

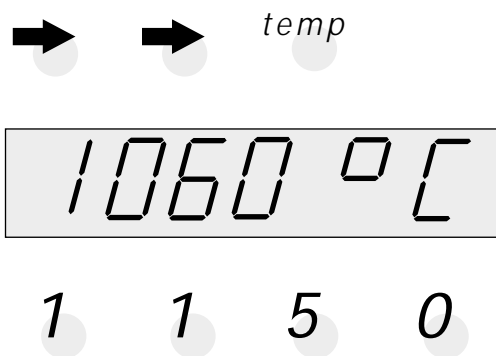
An "E" in display (2) indicates that the firing was finished successfully

## Calling up a personal programme

Entering a personal programme can be done in two different ways:

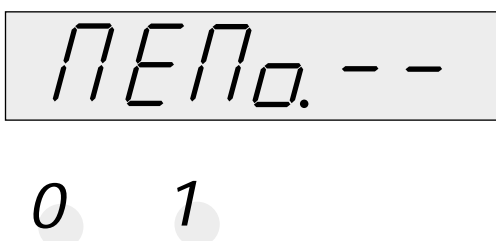
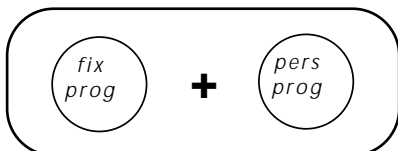
### 1. Variation of a fixed programme

You may need a programme, which is almost the same as the fixed programme no. 7, but with a firing temperature of 1150°C. This changed programme is to be stored as personal programme no 1 for future use.



First call up fixed programme no.7 as described in the previous chapter. Now change the temperature value of the second firing segment by pressing the key "next segment" (4) until the segment display (2) shows the value 2. After using the "temp" key the programmed temperature of the segment (1060°C) is shown. With the numeric keyboard you can enter the new value (1150°C).

If required you can change the other values of this segment (ramp and dwell) in the same way, i.e. select them using the keys "rate" or "time" resp. and enter the new value by the numeric keyboard (13).



To store this new programme as personal programme no.1 press the keys "fix prog" and "pers prog" simultaneously.

The display tells you as in the illustration "MEMO" to enter the desired programme number. Use the keys "0" and "1" of the numeric keyboard (depending on the configuration the controller can store up to 84 personal programmes. Therefore it is necessary to enter the programme number as two digits always). The programming is now finished. By using the "start stop" key you can start this programme right away.

If you want to call up this programme later on use keys "pers prog" followed by "0" and "1".

rate 1 5 0

150 °r

temp 7 7 0

770 °C

time 1 0

10' t



etc.

SKIP °r

End. °r

hold. 't

## 2. Entering new values

You can also define a firing curve by entering all the values without calling up a fixed or personal programme. Entering for every segment, ramp, final temperature and dwell time one after the other. Use the key (4) to step to the next segment. Depending on the configuration setting up to 30 segments are available.

### Note

After selecting a segment the ramp is always displayed first.

You can only skip to the next segment if the previous segment has been entered (ramp and temperature required); this prevents the user from skipping a segment unintentional

Other than this, the sequence of entering the values is as you like. Step to the desired segment using the keys (3) or (4) resp. and display or alter the value after selecting it by the keys (10), (11) or (12).

### Attention

Make sure that the ramp after the last segment used is set to "end" (enter value "0" to select this). This signals the control during the firing process that the end of the programme is reached.

With the key "start stop" you can start the programme right away. To store the programme as a personal programme for future use refer to the section above.

### Summary of the special values

If a value of "9999" is entered in a ramp (display reads "SKIP") the controller causes the kiln to fire at maximum speed (i.e. maximum heating or cooling resp.)

Entering the value "0" in a ramp ("end") signals the control to end the programme

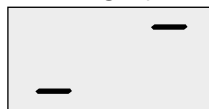
Adjusting the time to "9999" in a dwell (display reads "hold") causes the controller to enter the hold mode

## Displays

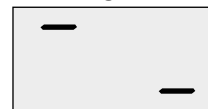
During the firing process the display (9) always shows the kiln temperature and display (2) shows the actual firing segment. Every 15 seconds special information is displayed (flashing):

- display (9) shows the maximum temperature of the actual programme
- display (2) shows one of the following symbols:

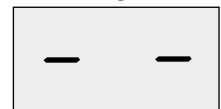
heating up



cooling



dwelling



## Direct control

In certain applications it may be useful to take direct control of the firing process (e.g. for glass fusing) Therefore you have 2 functions (**only while programme is running**):



### 1. Immediate skipping to the next segment

The user sees that the time in the actual segment is too long which means the controller should have continued with the next segment. By pressing the button "next segment" (4) the controller will skip to the next segment immediately. If a ramp presently processed the control skips to the final temperature and continues with the dwell (if applicable).



### 2. "Hold" in the actual segment

The user sees that the goods need more time than the duration of the segment provides. By using the key "previous segment" (3) you can set the controller to hold mode: The holding times can be extended; in addition the given temperature during the ramps stays constant (the setpoint is no longer driven up or down). The hold mode is indicated by ".h" in the display.



### Caution

The controller stays in this hold mode until the key (3) is pressed again



## Checking the programme values

To check the values of a programme step through the programme segments with the keys (3) and (4). The ramp of every segment will be shown first; press the key temp (11) or time (10) to display the temperature or the dwell time resp.

The shown values can be overwritten anytime. If the programme has been started it first has to be interrupted and after the check / change restarted again (by pressing the "start stop" key).

### Note

Calling up the actual **setpoint temperature** is very helpful if the kiln seems not to operate properly. With the setpoint temperature you can check easily whether this is caused by an error in entering the programme or a problem in the kiln itself.

Following values can be displayed during a **running programme** without interrupting the firing:

- the actual setpoint temperature can be called up by pressing the key "rate" (display (2) reads "SP" for "Setpoint")
- the final (and dwell) temperature of the actual segment is displayed pressing the key "temp" (display (2) reads "SF" for "Setpoint Final")
- to display the time left in a dwell press key "time"

After 2 seconds the display is automatically reverts back to the actual kiln temperature.

### Power consumption

Anytime during a firing process you can ask for the power consumption (since starting of a programme) by pressing the key "total kwh" (15).

Make sure that the kiln's power is programmed (refer to appendix "setting the parameters"). Otherwise the controller is unable to calculate the power consumption and will display "0".

kw/h

## Locking the controller



1.060 °C

To prevent the TC405/30 from unauthorized usage press the "key button" (5) for about 3 seconds and you will see a decimal point in the left part of the display. The TC405/30 is now locked.

To unlock the TC405/30 press the key (5) for 3 seconds again until the indicator goes off.

## Further hints

### Reaction to a breakdown of the power supply

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. The way of reacting to a breakdown can also be changed (refer to "Setting the parameters", parameter no. 4).

### Actual length of the segments

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.

### Maximum values

ramps (rate) .....1-9998°C/h and "SKIP"  
temperatures (temp).....20°C-max. temperature  
dwell (time).....0-9998 min and "hold"  
resolution on ramps .....0.19°C/h  
(when ramps defined by time)

## Appendix

### Second control output

The controller TC405/30 is available with an optional second control output that can be used for different applications:

- **EVENT control**

By using the EVENT control function you can switch any external events (e.g. aeration flaps for uncontrolled cooling, a signal on any segment of the firing etc.). The EVENT ON/OFF status for this control output is predefined by the user for each segment on entering the curve.

To activate this control output select the desired segment using keys (3) or (4). Then press the

"EVENT"-key. The display (9) shows the actual status (ON/OFF). By pressing any key of the numeric keyboard (13) you can change ON/OFF.

While saving a programme as a personal programme the output modes are also stored.

- **drive for security power relay**

If your kiln is equipped with a second power relay for safety reasons this control output can be used. The TC405/30 will de-activate this output if the kiln's temperature exceeds the setpoint 20°C or more (see also error message F2 code 2)

- **cooling control output**

If your kiln is fitted with a cooling unit (e.g. fan), your TC405/30 can be used for controlled cooling segments. This active cooling is linear and therefore not limited to the natural cooling speed of the kiln.

- **pilot flame (gas kiln)**

In this mode the control output is pre-programmed to perform automatic ON/OFF-function of a gas kiln's pilot flame

- **signal on end-of-firing**

The control output will be activated when the firing is finished. Can be used as a "READY" message.

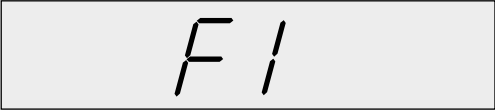
- **temperature range signal**

The control output will be activated in a preadjusted range (eg 600°C to 1100°C).

The operation mode of this additional control output is defined in the parameter list (see below)

## Error messages

The integrated microprocessor inside your TC405/30 performs continuous checking of the firing process. In case of any malfunction the display will show an error message pointing to the problem. The display (2) reads the segment number in which the problem occurred. Following is a description of the possible error messages:

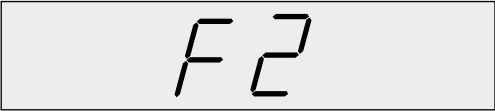


F1

**The kiln doesn't follow the required temperature increase**

This clearly points to a kiln problem ! Possible cause:

- broken fuse, a power phase failed
- the door (lid) contact is open
- a heating element is broken
- the heating elements are too old (esp.with high firing temperatures)
- the thermocouple has a short circuit
- a problem with the power relay / contactor



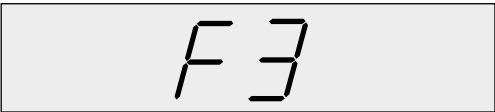
F2

**Problem on temperature acquisition**

The controller continuously checks the validity of the measured temperature values during the firing process. If any problem occurs an error message is given. The right part of the display shows a number which defines the error:

- 1- acquired temperature too high
- 2- safety power relay was activated
- 3- measured temperature flacking (contact problem)

If this error message occurs refer to your dealer.

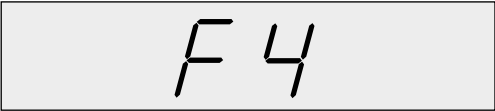


F3

**Thermocouple or thermocouple circuit defect**

Possible cause:

- thermocouple broken
- thermocouple wiring bad
- contacts of the connecting plug bad



F4

**Impossible values on data acquisition**

Possible cause:

- thermocouple polarized bad
- thermocouple temperature less than -15°C



F5

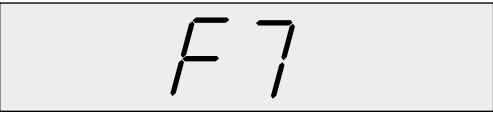
**No programme values are loaded**

An attempt has been made to start a programme with no values entered.

A rectangular LCD display showing the text "F6" in a stylized, seven-segment font.

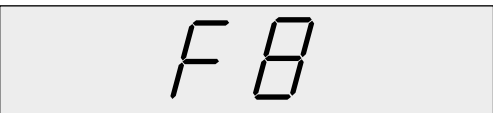
## Temperature out of range (too high)

A temperature value of the curve is too high. The corresponding segment number is also displayed. Re-enter correct value and then start programme.

A rectangular LCD display showing the text "F7" in a stylized, seven-segment font.

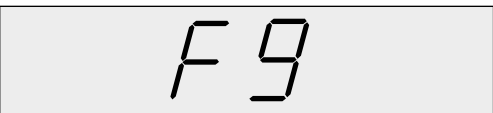
## Temperature out of range (too low)

as above, but temperature is too low (has to be higher or equal to 20°C).

A rectangular LCD display showing the text "F8" in a stylized, seven-segment font.

## Error detected during power-up self check

On every power-up the controller performs a self check. If an error is detected the controller shows F8 (ROM error) or F9 (hardware error). Please contact your local dealer.

A rectangular LCD display showing the text "F9" in a stylized, seven-segment font.

## Self-tune feature

Your controller TC405/30 provides a feature for automatic adjustment of the control parameters. Therefore the controller does a special firing. During this firing the controller will learn the kiln and its reaction and will calculate the control parameters (PID) that fit the best. On delivery the controller is configured with standard parameters that provide excellent results for a very wide range of kilns, so this self-tune firing is not really required.

To start self-tune firing, turn on the controller **while pressing** the key "total kwh". Release the key when the controller comes up with "no err" message on the display. Then use key "fix-prog" (5). The controller now shows the final temperature of this self-tune-curve. This temperature should be about half of the maximum temperature of the kiln. If required, overwrite displayed value by using the numeric keyboard. Then press "start stop" to start self-tune-firing process.

Depending on the kilns speed this process can take up to several hours. When the self-tune-process is complete the "A" (for adjust) on display (2) goes out.

## Setting the parameters

Because your TC405/30 can be used in a wide range of applications some operating parameters of the controller are adjustable. Please refer to following parameter list:

par.-no.	description	default	unit
0	power of kiln	0,0	kWh
1	printer-rate	0	cm/h
2	maximum number of segments	20	-
3	definition of the ramps (0=°C/h 1=min)	0	-
4	reaction on power breakdown	1	-
5	type of thermocouple(0=Pt10, 1=Pt13, 2=Ni)*		-
6	maximum temperature of the kiln*	1320	°C
7	proportionalband	2.0	%
8	integral time	200	s
9	minimum time for ON cycles	0	s
10	minimum time for OFF cycles	0	s
11	derivative time	10	s
12	cyclus time (or hysteresis resp., 1.0°C)	30	s
13	function of the 2nd control output (optional)	1	-
14	cooling control: cyclus time (hysteresis)	50	s
15	cooling control: overlap	80	%
16	heating elements operation hours counter*	0.0	h
17	disable error message F1 (heat up check)	0	-
18	version code of the internal software*	6.0	-

*\* for changing these values additional manufacturer code is required*

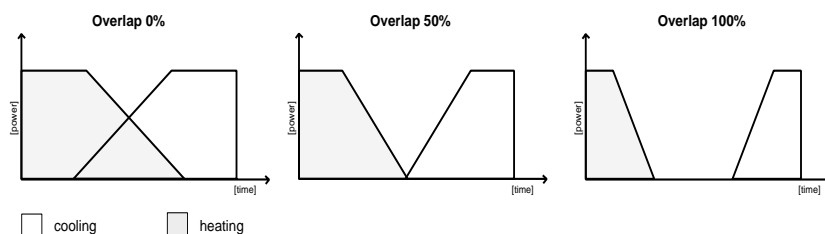
To change the parameters the controller first has to be switched in the parameter mode: Turn on the controller while pressing key "total kwh" (15). When the controller shows the kilns temperature press the key (15) again and hold it down for about 3 seconds til the display (9) switches to the first parameter of the above list. Display (2) shows the parameter no. and display (9) the actual value. Use the numeric keyboard for changing the value.

By pressing the key "total kwh" (15) you can go step by step through the parameter list. After having finished all entries escape the parameter mode by pressing the key "total kwh" (15) until the display goes off. The controller comes up in normal operation mode a few seconds later.

**Note:** Depending on the controllers version and adjustment of the TC405/30 some parameters are skipped automatically (=parameter is not valid for the actual operation mode). See parameter no. in display (2) to avoid confusion on entering the parameters.

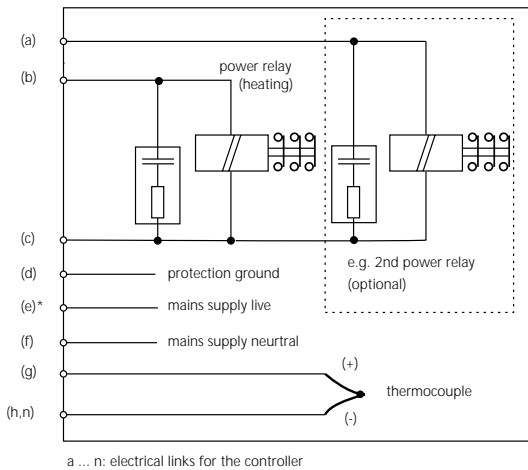
## par.-no. description

- 0 power rating of the kiln. This value is only used for calculating the power consumption.
- 1 applies only if the controller is equipped with an optional printer output. Parameter determines the length of the printout in cm per hour. Maximum length is 60 cm/h
- 2 maximum number of adjustable segments. This also defines the maximum number of personal programmes (max.pers. Prog. = 330 divided by maximum number of segments)
- 3 type of value for ramps: 0=enter in °C per hour. 1=enter the time in minutes to reach the final temperature of the ramp.
- 4 reaction on power breakdown: Firing process is continued after power breakdown ... 0=in no case. 1=only when power breakdown was less than 20 min. 2=always.
- 5 type of thermocouple. Locked to avoid unauthorized change.
- 6 maximum allowed temperature of the kiln. For changing additional code required.
- 7,8,11 control parameters; automatic adjustment can be done by calling up the self-tune-function (see previous section of this manual). Changing these values without detailed knowledge of the meaning can cause worse results in firing accuracy. By entering 0.0% as proportional band the controller works as D-control with hysteresis.
- 9,10 in some applications (e.g. gas kilns) it may be required to limit the minimum time of ON cycles or the minimum time between two ON cycles (= minimum OFF time).
- 12 determines the cyclus time of the control output. A short cyclus times ensures smooth heating but reduces the lifetime of the power relay. A long cyclus time can result in temperature oscillations. A typical value for proper operation is 30 sec. In D-control operation mode (par.4=0.0%) this parameter determines the hysteresis in °C
- 13 selects the operation mode of the (optional) 2nd control output: 0=OFF, 1=drive for security power relay, 2=EVENT-control, 3=drive for pilot-flame (gas kiln), 4=like 3 but also active during t0, 5=signal on programme finish, 6=cooling control, 7=temperature alarms (ranges). For further details see section "second output" on page 25 of this manual
- 14,15 only if 2nd output is in cooling operation mode: par.no. 14 corresponds to par.no. 12 of the heat control; par.no. 15 is the overlap value that determines the relation between heating and cooling output: 0% overlap lets the cooling output activate when the kiln doesn't heat with full power; 50% lets the cooling output starting to activate when the kiln is not heated any longer. 100% increases the gap between heat and cool function to one proportional band. A typical value is 80%. Refer to figure below.
- 16 total operation time of the the kilns heating elements. All heating cycles of the kiln will be summarized allowing to check the lifetime of the heating elements. For resetting to zero additional code required
- 17 disable error message F1: For certain applications it might be required to suppress the checking of the kilns heating. "1" disables checking; disable **only** if really required !
- 18 version code of the internal software (present version 6.0, value read only)



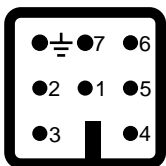
## Technical Informations

### Schematic of a Kiln

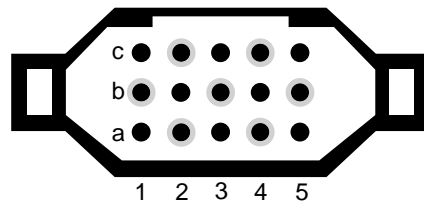


### Pin assignment

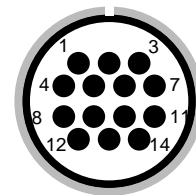
#### HAN 7 D



#### HAN 15 D



#### CPC14



connect.	function	HAN7D	HAN15D	CPC14
a	second control output (live)	7	C3	12
b	control output power relay (live)	6	A3	14
c	neutral for both control outputs	1	B3	13
d	protection earth *	⊕	PE clamp	11
e	mains supply live	5	A1	8
f	mains supply neutral	2	B1	9
g	thermocouple +	3	B5	1
h	thermocouple - (type S, R)	4	C5	2
n	thermocouple - (type K, J)	4	A5	3

\* protection earth should be connected !

### Important Note

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