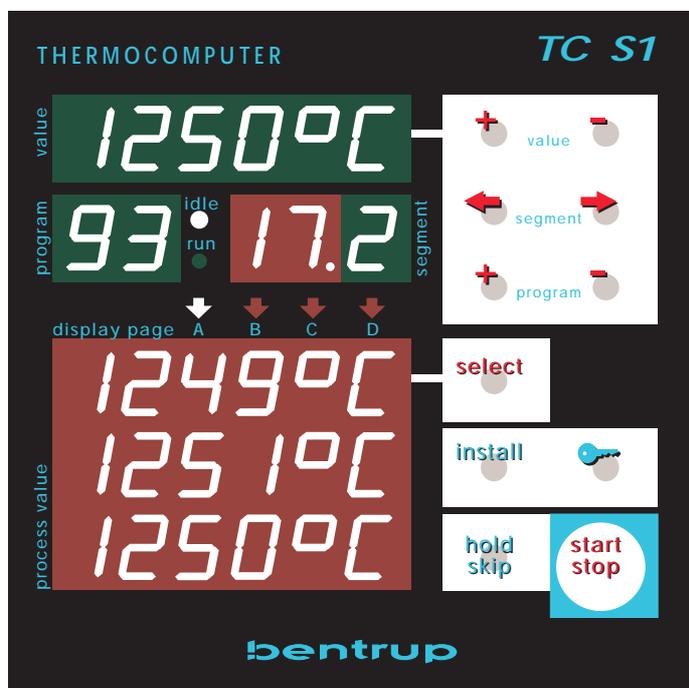


bentrup

Technical Manual



Universal Programmer

TC S1

(Version 6.XX)

1. General Information

These instructions apply to the TC-S1 Version 6. The configuration parameters determine all operation modes. This is for instance

- how many control zones and which control characteristic
- the definition of the input signals (e.g. thermocouples, mV-signals)
- the required output signals (e.g. servomotors, EVENTS)
- the required programme parameters (e.g. how many setpoints)
- the operation range of all parameters
- the type and appearance of any process parameters etc.

We configure the controller as far as possible according to the informations we got with the order, so only little adjustments are required. However, many adjustments (eg. graphic charts) are just a matter of taste and therefore can be changed according to the users requirements.

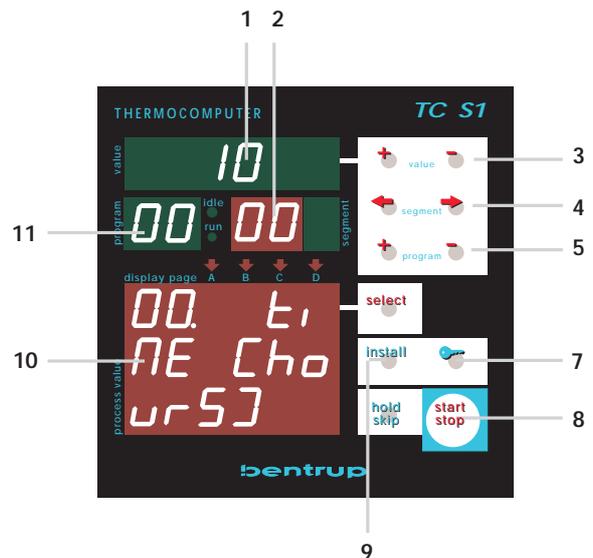
Attention: The high grade of flexibility causes that even very small changes might have very severe consequences. Therefore all changes must be done very carefully always considering the exact consequences as described.

2. How to enter / change the Configuration

After power up press the key(9) and hold it pressed. After 3 seconds the first parameter of the configuration appears (refer to the sketch).

Refer to enclosed blank configuration table showing the basic structure of the configuration. The entire configuration table consists of single pages (clock / calendar, misc. adjustments ..) each with one or more columns.

During the configuration, the meaning of some displays and keys is different: Display (11) reads the page number, display (2) the column and display (10) the parameter number and a short description of the parameter. Display (1) shows the actual value of the parameter; use keys (3) to adjust if required.



To step „down“ in each column use keys (8), use key (7) to step „up“. Use keys (4) to step through the columns (the value after the last valid column must be set to „end“. This also causes the controller to jump to the next page if you press key (4) „right“.

Use keys (5) to select the required pages.

To leave **and save** the configuration, press key (9) and hold it pressed until the display goes dark (display shows „save config“ and thereafter "save.ok" to confirm successful completion, otherwise it shows "save.Err"). If you want to leave the configuration without saving changes press key (9) and release it when display reads „saving config“.

3. General Information about the Configuration Pages

The configuration is very complex. Therefore we strongly recommend to configure the controller with the free bentrup Windows 95/NT WinConfig software. This makes configuration easy as well as gives you a better idea of how configuration structure works.

4. Naming Conventions

DO.....digital output (e.g. switching output)

DI.....digital input (e.g. status input)

AOanalog output (e.g. 0-10V output)

AIanalog input (e.g. measure input)

All inputs and outputs are followed by a number. The digit before the decimal point defines the unit used for this signal (0=controller, 1= first external unit of SYSBUS, etc.). The digit after the decimal point selects the individual input/output of this unit. Examples:

DO 0.2.....switching output #2 of the controller (formerly called "F2")

DO 1.7.....switching output #7 if the 1st e.g. SW808 on the SYSBUS

AI 0.0first analog input of the controller

AI 0.45th analog input of the controller

DI 2.4.....digital input #4 of a DIO808 on the SYSBUS

The configuration also defines which members on the SYSBUS are present and how they are assigned (incl. assignments of the numbers #1 to ...).

IN#.....INPUT, ie. usable process value (temperature, pressure etc.)

SP#.....SETPOINT, setpoints of the programme

CH#CHANNEL, control channel

OT#OUTPUT, definition of a control function (e.g. servomotor, alarm)

Please find following the explanation of each parameter:

<00> clock / calender

clock (hours) (0-23)

present time (hours) of the real time clock

clock (minutes) (0-59)

present time (minutes) of the real time clock

date (weekday) (MON - SUN)

present date (weekday) of the real time calendar (0=monday, 1=tuesday etc.)

date (day) (1-31)

present date (day) of the real time calendar

date (month) (1-12)

present date (month) of the real time calendar

date (year) (00-99)
present date (year) of the real time calendar

<01> misc. adjustments

max. segments # (1-99)

This determines the number of maximum programme segments. The larger this value, the less number of programmes you can save. The exact number of programmes can't be explained easily, because it also depends on the number and type of parameters per segment. The total size of the non-volatile programme memory is 16kB (EEPROM technology).

Note: After changing this value (as well after a basic change in the programm table definition) all programmes must be reentered because of the required reorganisation of the memory.

lock programmes (0-1)

OFF=programme changes allowed

ON=programme changes locked

manual enable (0-1)

ON=MANUAL mode can be activated by pressing key "install"

OFF=MANUAL mode locked. Note: For safety reasons, the manual mode should be only enabled during commissioning or if the application really requires.

communication ID # (OFF resp 0-63)

This setting assigns the ID# to the unit used by the communication software (e.g. bentrup WinControl) for unique identification of this unit on the field bus

RS485 baudrate

data rate of the IO communication. NOTE: When using sysbus extension (e.g. SW808, DIO808) this value must set to 96000 resp. 115200 !

fctn. on pow.up. (0-3)

function on power up: 0=IDLE, 1 resp.2=automatic restart of the programme if a power breakdown occurred which was shorter than the corresponding parameter (see below).

1=time limit in seconds 2=time limit in minutes. 3=always automatic start (default: locked)

Following are the criterias for the power breakdown feature (**all** given criterias must be met):

..only if DO# (DOx.x)

programm is only continued, if the selected output was ON. If this output is controlled by an EVENT, you can select by programme the segments in which you like the controller to continue in case of power failure.

..only if t< min / sek. (01-60)

programme is only continued, if the duration of the power failure was less than t minutes resp. seconds (selection refer to parameter "fctn. on pow. up.")

dT input sel#.. (0-9)

programme is only continued, if the process value of the selected input do not drop more than a given value (see next parameter)

..only if dT<x (-9999 to +9999)

maximum allowed difference for function described above

p.time MIN:SEC (ON / OFF)

OFF: programme times entered as hours : minutes (appropriate for most applications)

ON: programme times entered as minutes : seconds (to control very fast processes)

<02> analog input

input mode (0=thermocouple, 1=linear, 2=Atmosphere, 3=resistor, 4=Flow)
kind of the input signal

signal source (AI x.x)
hardware source from which the signal is taken

mV range (0=50mV 1=20mV 2=8mV)
maximal signal value. A higher mV value causes a lower signal resolution.

average cycles (1-100)
on all values >1 the new acquired value is mixed with the former value. This is used for signal smoothing. Example: A value of 4 means that on each new conversion of the former value are taken. This compensates too strong changes of the input value.

units (0=°C 1=°F 2=°K 3=digits 4=mV 5=mA 6=O₂/CO 8=% 10=mbar)
unit of the process value

trim +/-% (+/-10%)
In certain applications it is required to compensate full scale errors that are caused by deviations of the installation. Example: Setting this parameter to "-5.0%" will cause the process value to be trimmed to 95°C instead of 100°C. Attention: This parameter should be used carefully. The real cause of the deviations should be cleared before using this compensation. Otherwise error in the reference measurements might cause wrong settings.

offset +/- val. (+/-10.0)
as above, but zero adjustments. On FLOW the resolution is 4 times higher.

min value (-9999 to +9999)
minimum value of the process value (e.g. -200°C on thermocouple NiCrNi)

max value (-9999 to +9999)
maximum value of the process value (e.g. +1280°C on thermocouple NiCrNi)

The following parameters are displayed depending on the type of "input mode":

thermocouple (0=S 1=R 2=K 3=J ..)
type of thermocouple

external CJC (OFF, IN#..)
selection of input if external cold junction compensation is used

signal type (0-50mV, 0-20mV,0-5V,0-10V,0-20mA,4-20mA,0-500Ohm 2/3 Leiter)
type of linear input signal

value at zeropoint (-9999 to +9999)
The value at zero reference input value. Example: A camera supplies 4-20mA in the range from 500°C to 1300°C: value at zeropoint = 500 (ie. „zeropoint“ refers to the lower range reference, 4mA in this example), value at fullscale = 1300

value at fullscale (-9999 to +9999)
see above

temp source (0-19)
selects the input number which represents the temperature of the atmosphere sensor

press. source (0-19)
select the input number which represents the over pressure of the reference air. This is used to supervise the reference air. Set to OFF if not used.

min. pressure (0-250)

minimum pressure limit. signal is classified INVALID if this minimum over pressure is subceeded (see above)

min CO temp (0-4000)

minimum temperature required for CO calculation. Attention: A minimum temperature of 900°C is recommended for reliable calculation.

type of gas (0-2)

type of the gas being used: 0=natural gas 1=propane 2=butane

resist.thermo (0=Pt100)

type of the thermo resistor

3rd wire input (AI x.x)

selection of the input for 3rd wire connection. The compensation of 4th wire error is done automatically, so 3 wire connection is as accurate as 4 wire technik. Set to OFF for 2 wire connection.

curr.res.trim (-10.0 to +10.0)

if required this parameter can be used to trim the measure current.

mV on max. flow (0-10000)

mV on maximum flow

media tmp.sens (0-19)

select the input which represents the media temperature. This value is used to compensate the flow signal over the media temperature range. Set OFF if not used.

media std. temp (0-100)

temperature that has been used as standadd temperature on venturi calculation

media prs.sens (0-19)

select the input which represents the media over pressure. This value is used to compensate the flow signal on all absolute pressure values. Set OFF if not used.

<03> digital input

input mode (CNT)

select the input mode. CNT selects event counting

signal source (DI x.x)

hardware source from which the signal is taken

units (0=°C 1=°F 2=°K 3=digits 4=mV 5=mA 6=O₂/CO 8=% 10=mbar)

unit of the process value

min value (-9999 to +9999)

minimum value of the process value

max value (-9999 to +9999)

maximum value of the process value

count unit x /

count unit /x

specifies the value to be added at each signal event. Example „count unit x/“ =1, „count unit /x“ = 20 -> 1/20 will be added at each signal event (positive edge)

<04> analog output

output mode # (PRZ, ANA)

PRC=direct output of a channel output (e.g. 0-100% -> 0-10V)

ANA=direct output of any process value (e.g. Setpoint) as 0-10V

destination # (AoO.O-Ao3.3)

The output information is directed to the specified output

The following parameters are displayed depending on "output mode":

channel source # (0-9)

This parameter selects the source of the information. When using the setting "MX../A" resp.

"MX../G" the output informations are taken from the atmosphere control mixer (1. parameter selects zone number)

channel char (0-5)

On "output mode 0": operating range of the output: 0=0% to +100% 1=+100% to 0% 2=0% to -100% 3=-100% to 0% 4=-100% to +100% 5=+100% to -100%

On "output mode 1": charakteristik of the servomotor: On non-linear servomotors the user can select a motor characteristic which is defined like described below. To select add "6" to the channel characteristic, ie. 0-5 linear motor (as above), 6-11 1st motor characteristic etc.)

outp. % on IDLE % (0-100)

the output supplies this value when the controller is in IDLE status.

outp. % on ERR % (0-100)

the output supplies this value when the controller or its assigned channel is in ERROR status.

min. output % (0-100)

Lower limit of the minimum output.

max. output % (0-100)

Upper limit of the maximum output.

outp. param. # (0-39)

the selected process value is send to the given output. Refer to example below.

lower base val. (-9999 to +9999)

defines the lower limit when setting the output to the process parameter

upper base val. (-9999 to +9999)

defines the upper limit when setting the output to the process parameter

Example: The setpoint #00 is given out as a 0-10V signal, 0°C=0V and 1300°C=10V: outp.

param #=0, lower base val.=0, upper base val.=1300.

<05> digital output

output configuration # (0-31)

number of the output

output mode # (0-4)

operation mode of the output:

PRC=direct output of a channel output to a pulsed/modulated relais or a logic or analog output (z.B. 0-20mA)

MOT=direct output of a channel output to a servomotor

LIM=output switching relating to a definable equation of setpoints / process values) (also called ALARM-functions)

PRC=switching according to a defined process status (e.g. IDLE, ERROR, HOLD, programme relay, power breakdown)

EVE=EVENT-outputs

SIG=puls-coded output of a programm table value (e.g. coded buzzer)

OUT=direct output of any process value (e.g. Setpoint as 0-10V signal)

CBM=to enter an AND / OR / XOR equation for logic on switching outputs

destination # (DO.O-AO3.3)

The output information is directed to the given output: Dx.x for digital resp. Ax.x for analog signals. Note: Some functions (like servomotors "+" and "-") require 2 outputs. On these output types the next logical output is assigned automatically with the "-" function. Example: Servomotor is directed to D1.0: D1.0="+", D1.1="-"...

The following parameters are displayed depending on "output mode":

channel source # (0-9)

This parameter selects the source of the information. When using the setting "MX../A" resp. "MX../G" the output informations are taken from the atmosphere control mixer (1. parameter selects zone number)

channel char (0-5)

On "output mode 0": operating range of the output: 0=0% to +100% 1=+100% to 0% 2=0% to -100% 3=-100% to 0% 4=-100% to +100% 5=+100% to -100%

On "output mode 1": charakteristik of the servomotor: On non-linear servomotors the user can select a motor characteristic which is defined like described below. To select add "6" to the channel characteristic, ie. 0-5 linear motor (as above), 6-11 1st motor characteristic etc.)

outp. % on IDLE % (0-100)

the output supplies this value when the controller is in IDLE status.

outp. % on ERR % (0-100)

the output supplies this value when the controller or its assigned channel is in ERROR status.

min. output % (0-100)

Lower limit of the minimum output.

max. output % (0-100)

Upper limit of the maximum output.

cyclus time (0-100)

Cyclus time of a switching output in seconds. High switching rates cause higher accuracy by also more stress to the components. Not required on analog and logic output boards.

travel time (0-999)

time in seconds required for the servomotor to move over the entire operating range.

delay time (1-99)

delay time in seconds when starting the motor.

update time (1-999)

time rate in seconds to actualize the servomotor. Small values cause higher accuracy but also more stress to the components. Typical value 20s.

hysteresis (0-100%)

Hysteresis on actuating the servomotor position. Small value = high accuracy but more stree to the components. Typical value 1% (or even 0%).

feedback input (0-19)

selects the input number of the position feedback: This input must hold the real position

information (the controller calculates the relative position using the following 2 parameters).

Note: Set parameter to OFF if not using this function.

feedback value (0-10000)

This value represents the 0% position of the servomotor

feedback input (IN0-19)

This value represents the 100% position of the servomotor

compare mode (0-3)

limit 1 # (0-59)

limit 2 # (0-59)

limit const (-9999 to +9999)

These parameters select the values used if the output operates as a limit comparator. The controller calculates the equation

$$"limit\ 1\ ?\ limit\ 2\ +\ limit\ const"$$

and sets the output to ON (=yes) or OFF (=no) accordingly. "?" is defined by the parameter compare mode: 0 >=, 1 <=, 2 "difference limit 1 - 2 less than limit const bzw. 3 .. more than limit const.

comp outp. IDLE (0-2)

During IDLE status of the controller, the result of the equation show above can be predefined: 1 stands for OFF, 2 for ON. When setting this parameter to 0 the equation will be calculated as usual.

comp outp. ERR (0-2)

as about, but in case of ERROR status of the controller.

process mode (0-8)

the output is activated when the selected condition is met: 0=active firing process, 1=running programme, 2=as beforem, but not during programme delay, 4=entire controller ERROR, 5=HOLD-mode, 6=OFF, 7=ON, 10/11/12=atmosphere mixer in AIR EXCESS/ STOICHO-METRIC/COOLING mode, 13=controller recovered from power breakdown

EVENT number# (0-16)

output of the EVENT number # during a running programme.

EVENT on IDLE# (0-1)

predefinition of the EVENT during IDLE 0=OFF 1=ON.

EVENT on ERR# (0-1)

predefinition of the EVENT during ERROR 0=OFF 1=ON.

table dat. src# (0-31)

column number from which the controller takes the value to set an digital output accordingly. as coded pulse: 0-9=continuous signal 0-9 seconds, 11-19=1-9 seconds pulsed signal 1/1 ratio, 21-29=1-9 seconds pulsed signal Ω ratio, 31-39 seconds pulsed signal 1/ ratio

outp. width (0-8)

defines the width the value is sent to the switching outputs. Example: If the application requires 3 switching outputs to be set according to a value defined in each segment set output width to 3. Assumed the destination is set to „do1.1“ the value in the programme table (which should be set as range 0 to 7) sets the outputs „do1.1“ to „do1.3“ according to the binary patten (eg. value = 5 = binary 1 0 1 = do1.1 ON, do1.2 OFF, do 1.3 ON). This function can be used for instance to initiate / select procedures on a PLC during programme run. NOTE: For typical ON/OFF control (resp. controlling a flap on the kiln) use the EVENT function (which is easier to handle).

When entering „0“ as output width, the table value causes a pulsed signal output typically

used for a buzzer to indicate programme status as the user requests: 0-9=continuous signal 0-9 seconds, 11-19=1-9 seconds pulsed signal 1/1 ratio, 21-29=1-9 seconds pulsed signal Ω ratio, 31-39 seconds pulsed signal 1/ ratio

combinat. type# (OR / NOR / AND / NAND / XOR / XNOR)

The result of the specified digital outputs is calculated using this logic formula:

OR: output ON if **any** of the listed „do“ is ON / **NOR:** output OFF if **any** ...

AND: output ON if **all** of the listed „do“ are ON / **NAND:** output OFF if **all** ...

XOR: output ON if **an odd number** of the listed „do“ are ON / **XNOR:** output OFF if ..

1. DOxx sel. to

8. DOxx sel. (OFF, do0.0 to do3.7)

digital outputs used for the logic formula

Example: Your application requires the digital output „do0.4“ to be activated whenon of 3 limits are exceeded: First define the 3 limits in „digital outputs“ as required and set for instance „do3.0“ to „do 3.2“ as the destination. These outputs need not to be physically implemented if you dont need the individual switching output. Then define another digital output as „CMB“ and set „destination“ to the digital output „do0.4“ and list the previos defined destinations „do3.0“, „do3.1“, „do3.2“ in the following lines.

<06> programme table

All parameters required for programm run (time, setpoints, EVENTS etc.) and the range and units for each parameter are defined on this page. The number of parameters defined for each segment (and of course the maximum number of segments) defines the maximum number of programmes available (the less parameters per segment, the more programmes). The first value (column) must be defined as time !

table configuration # (0-9)

number of the programme column

value type # (0-9)

0=time 1=VAL-L large value in the max. range of +/-10000 2=VAL-S small value max. +/-127

4=EVENT (ON / OFF) 5=atmosphere value

lower time lim. (-100 to -2)

lower limit of the time: -2=“END”, lower values allow programme chaining (e.g. -5 = PROG no. 1 to 3 can be selected to be chained)

upper time lim. (10 to 5999)

upper limit for the time values in minutes

designator ref. (ASCII character)

up to 3 characters to assign a user definable designator to each columns (e.g. Z1 for zone 1)

value unit

unit of the value / column

lower val. lim. (depending on type, +/-10000 or +/-127)

lower limit of the programme parameter

upper val. lim. (je nach value type +/-10000 or +/-127)

upper limit of the programme parameter. To be used to limit the maximum user adjustable temperature e.g. 1320°C as max. temperature.

EVENT number (0-31)

number of the EVENT. This number is to identify the particular EVENT. You are free to assign the numbers, just make sure to use the same number in the output configuration to access.

atmosphere cde. (6)

presently not used

<07> process flow setup

During a firing many unusual events might happen. The following adjustments allow you to adapt the controllers reaction on process problems like a broken thermocouple, kiln heat up problems etc.

process control mode (0)

presently not used

monitor ch (ch00 to ch09 or range ch00 to ch..)

Only the channels specified here are monitored for process problems. This setting allows to include only the channel(s) which are important for the process. Either a single channel can be selected (e.g. on single zone kilns) or a range of channels (e.g. ch00 to ch02 on a 3 zone kiln). A range is entered as „minus“ channel (e.g. „- ch02“ for the previous example)

temp match ‰ # (0.0 to 100.0 ppm)

An uncontrolled ramp (SKIP) the end of the segment is determined by match of actual temperature and final segment temperature. Since the controller slows down temperature move at the end to avoid over/undershoot it might take some time to finally reach the temperature although it is not required by the process. This parameter allows to specify a window to earlier complete the segment. Example: 2.0‰ from 1320°C (max. channel temperature) = 2.64°C, SKIP segment ends at 997.4°C on final temp. of 1000°C

number of matches (1 to 250)

An uncontrolled ramp (SKIP) is completed only if the temperature matched the specified number of cycles. The check is done each 0.5 seconds. This is used to avoid leaving the segment if the temperature only overshoots for a short time. Example: The setting of 6 lets the controller to complete the current segment if the temperature matched for at least 3 seconds

time in ramps (keep, update)

If the temperature of the pilot input (IN00) is higher than the start temperature of the ramp the time of the ramp can be either kept or reduced accordingly. Example: Segment 0 is 0°C, segment 1 in 2 hours to 500°C. If the kiln temperature is 250°C on starting the firing, the setting „update“ causes the time to be reduced to 1 hour (causing a setpoint of 250°C)

end of SKP seg (disr, wait, infin)

An uncontrolled ramp (SKIP) usually is only completed if the actual temperature reached the final ramp temperature. The setting „disr“ causes the controller to disregard the temperature, ie. to leave a SKIP segment immediately. „infi“ causes the controller to wait for temperature match infinite. „wait“ causes the controller to wait for temperature match, but maximum for the specified time (see next parameter). Especially on multi zone kilns we recommend to use the „wait“ setting at a time of e.g. 10 minutes. Otherwise a lock situation might encounter where for instance in a cooling SKIP, the thermocouple of zone 2 has a little deviation and therefore zone 2 is heated 4°C higher; if the heat fluctuates to zone 1 this zone will never cool down as far enough. The time begins to count if the first zone starts to control. If the time is elapsed the segment is finished disregarding the temperature of the zones matches.

max wait (sec) (0 to 9999 seconds)
wait time in seconds for the function previously specified

act.on CH unco (disr, wait->break, wait->continue, break)

In a controlled ramp it might happen that the kiln temperature can not follow the requested increase although the controller asks for maximum heating (resp. the requested decrease in a cooling segment). The setting „disr“ lets the controller to disregard this situation. „wait->break“ causes the controller to *hold* the firing to give the kiln temperature time to catch up. If the kiln couldn't catch up within the specified time (see next parameter) the firing is interrupted (break). „wait->cont“ also enters *hold* but - after the time has elapsed - continues the firing disregarding the temperature. The setting „break“ causing an immediate break if the temperature can not follow. The *hold* mode (same as *hold* used during programme run) can also be released manually by pressing the hold skip button.

max hold (sec) (0 to 9999 seconds)
wait time in seconds for the function previously specified

act.on error (disr, wait->break)

If any error in the control channels happens (e.g. overtemperature because of break of thermocouple) the reaction of the controller can be adjusted. „disr“ lets the controller to disregard this event and to continue the process with the remaining channels. „wait->break“ causes the controller to *hold* for a specified time (see next parameter). This time can be used to notify the user (e.g. by a process alarm of the controller) and to fix the problem. When the time is elapsed the firing is terminated. Set time to „0“ if the process is to be finished after channel error immediately.

max hold (sec) 0 to 9999 seconds
wait time in seconds for the function previously specified

<08> programme setpoint

setpoint type (0=CONstant, 1=MODulated over time, 2=CHA Cascade)

depending on the application the setpoint during each segment has to be constant (e.g. a flap position) or has to be modulated over the time (e.g. to create a ramp). The cascade mode is required to install chained control loops: This can be used e.g. to optimize the temperature equalization of a very slow probe to the ambient kiln temperature. For details refer to the parameter description of this feature.

tab. source TA# (column of the prog. table, TA00=Zeit, TA01=1.Wert, ...)
the setpoint calculation is based on the selected column of the programme table

offset src SP# (as above, resp. "end" for "no offset")

the selected setpoint (which must have been defined in a previous page number) is added to the actual calculated setpoint. This is used e.g. to create a setpoint with an offset specified in the programme table. Typically this is used for the temperature of multizone kilns (to define offset of the zones referred to the master zone)

idle setpoint (-9999 to +9999)
setpoint on IDLE status. Typically 0°C.

error setpoint (-9999 to +9999)
setpoint on during fatal error. Typically 0°C.

based on SP# (0-9)
calculation base setpoint number for the cascade feature

-
- charg.ctrl.CH#** (0-9)
number of the control channel, which controls programme setpoint and probe temperature
- max. temp. diff** (-9999 to +9999)
maximum allowed difference of temperature between probe temperature and kiln ambient temperature (- setpoint)
- max envir. temp** (-9999 to +9999)
maximum absolute setpoint of the kiln ambient

typical example of a cascade control:

Two control channels are operated as a cascade: The 1st channel is used as usual, ie. setpoint created out of the programme and probe temperature as actual. The output signal of this channel controls the setpoint (ambient) temperature of the kiln (in the given limits) which is defined here. This setpoint and the actual kiln temperature is fed to the 2nd control channel to drive the heating elements of the kiln. On multizone kilns, this setpoint is simply used on all channels. Note for PID parameter settings: The P-value of the 1st control channel must be large enough because it determines how fast the kiln ambient temperature is decreased when the probe achieves the setpoint. Consider the heat capacity ratio between the probe and the kiln. The D-value should be set to zero, the I-value must be large enough to avoid oscillations which can be caused easily due to the complex structure. Select "-100 to +100%" as the output characteristic and "prop. shift" = 0. The parameters of the 2nd control channel are tuned as normal.

<09> control channel

- ctrl. algorithm** (0 to 4.)
Select the type of control channel depending on your application:
0=PID-algorithm
1=PID-algorithm with conditional activation (by output)
2=D-hysteresis algorithm with adjustable deadband (for pulsed gas burners)
3=direct P-control (no control function!)
- setpoint chn #** (SP0-19)
selection of the setpoint to control
- input chn #** (IN00-19)
selection of the process input to control
- power % on err** (0-100)
output value when a channel error occurs (e.g. overflow)
- maximum value** (-9999 to +9999)
maximum value of process input. If this value is exceeded the channel will switch off permanently in the over status (OVR) for safety reasons. To clear this error, press start/stop twice to re-start. Set this value a little bit higher as the maximum to allow a little overshooting.
- grdnt check s** (0=OFF, or 1-9999 seconds)
this gradient check is used for safety reasons. It prevents the unit from damage if the feedback

signal (e.g. the thermocouple) is missing or shorted. The check is only performed on maximum output (typically +100%) and monitors the process value for a given increase. The channel checks at the given time rate (in seconds) the minimum required difference (see next parameter). If the conditions are not met, the channel will switch off permanently and enter the GRD (gradient) error. Reset by re-starting the programme. Set to 0 to lock checking.

grdnt chk dif (-9999 to +9999)
minimum required increase at +100%, see above.

ctrl charact (0-1)
control characteristic of the channel:
0=standard 0 to 100%
1=inverted, 100% to 0%
2=standard -100% to +100%
3=inverted, +100 to -100 %

The following parameters are shown depending on the control algorithm:

prop. band % (0.0-1000.0%)
PID-control parameter "proportional band" in % of the maximum value

integral time (0-9999)
PID-control parameter "integral time" in seconds (0=OFF)

derivat. time (0-9999)
PID-control parameter "derivative time" in seconds (0=OFF)

prop. shift (0-3)
x/4 of the proportional band are set equal to the setpoint. Example: The parameter 1 sets 1/4 of the proportional band above the setpoint and therefore ensures fastest temperature achieving on typical applications with very small tendency to overshoot.

+ **activat. DO x.x**
the output command "+" (heating) is only given if the selected digital output DO x.x is active. If not, the control channel enters the OFF status temporarily. For explanation see below.

- **activat. DO x.x**
the output command "-" (cooling) is only given if the selected digital output DO x.x is active. If not, the control channel enters the OFF status temporarily. This features are used to avoid a control signal is given during the function is not available on the kiln. Example: When the burners of a kiln are switched off, a "heating" command is suppressed to avoid gradient error or channel "wind up". In this example select the EVENT output used for burner activation resp. the cooling bit to activate the corresponding channel functions.

hyster. units (0.0-999.9)
switching hysteresis in units of the process value. A small value results in a higher accuracy but causes higher switching rates. A large value causes less accuracy but larger oscillations of the process value.

min. ON time (0-200)
minimum time for output activation in seconds. This is used to avoid very short switching pulses, which might cause error e.g. for certain types of gas burners.

min. OFF time (0-200)
minimum time for output deactivation. Application as above.

lower val. base (-9999 to +9999)
defines the lower value when using direct control (0%)

upper val. base (-9999 to +9999)
defines the upper value when using direct control (100%)

<10> infobox

The user can determine which process information he likes to be displayed. Up to 27 so called infoboxes can be defined. Depending on controller type, the values were displayed in sets of 3 (TC-S1) resp. 9 (TC-M2) values.

infobox type # (0-7)
type of displayed value:
SPACE=empty
VAL=showing a single value
VAL-B=as above, but big letters without comma/unit (ensures long range legibility on TCM1)
VALx2=as 1, but displays double values (eg. atmosphere O2 and CO). On TC-S1, this mode shows the 2nd value (CO in the example), the 1st value must be shown by type VAL display.
CHAN=status display of a control channel
DO=status display (ON / OFF) of digital outputs DOx.x
AO=status display (0-100%) of analog outputs AO x.x
SM=position/movements display of a selected servomotor
STAT=general status information (0=realtime clock / calender)
DI=status information (ON / OFF) digital Inputs DI x.x
AI=status information (0-100%) analoger Inputs AI x.x
MISC=miscellaneous informations (0/1=atmosphere mixer status)
FLWRT=flow volume ratio (not on TC-S1)
Kwh=summarized energy consumption kwh
FLW=summarized flow (calculation of gas consumption)

Following parameters are required depending on "infobox mode":

display value # (0-52)
select the value to display

dspl.big val. # (0-52)
select the value to display

dspl. 2x val. # (0-52)
select the double-value to display

channel info # (0-9)
select the channel which status info to be displayed

DO output # (0-3)
select the digital outputs (8 bits) to display

AO output # (0-2)
select the analog outputs to display

step. mot.info # (0-31)
reserved

power calc. CH# (-CH.. to CH..)
CH: the energy of the selected channel CH.. is summarized
-CH: the energy of the selected channels CH00 up to incl. -CH.. is summarized

power rating kw (0-250)

kw pickup of the channel (on CH..) resp. the total power pickup of all zones (-CH..)

<11> infograph (not used on TC-S1)

graph type # (0-4)

type of graph:

0=time axis with segments

1=process value (setpoints, actual temperatures)

2=channel output

3=status of the digital outputs

4=status of the analog outputs

time scale # (0-18)

data recording speed. The width of one window corresponds on 1=2.5 min, 2=5min, 3=10min, 4=20min, 5=40min, 6=1h, 7=2h, 8=4h, 9=8h, 10=16h, 11=1 day, 12=2 days, 13=4 days, 14=8 days, 15=16 days, 16=1 months, 17=2 months, 18=3 months.

vertic. scale # (1-10)

vertical size of the graphic. 1=10% of the total window height, 2=20% etc. On some graphic types (e.g. digital outputs) the height of the graphic is determined automatically by the number of data.

Note: If the vertical space allows, a graph is show together with the preceding chart if they are defined with the same value of "time scale".

The following parameters are shown depending on "graph type":

time axis type#

reserved

graph lower lim# (-9999 to +9999)

lower value limit of the chart

graph upper lim# (-9999 to +9999)

upper value limit of the chart

1. to 4. graph val# (0-39)

chart graphs to be shown (max. 4)

ch range # (0 to 2)

display range of the chart: 0=0 to +100%, 1=-100 to 0%, 2=-100 to +100%

1. to 4. graph CH# (0-9)

chart graphs to be shown (max. 4)

1. to 8. graph DO# (0-19)

chart graphs of the digital output to be shown (max. 8)

1. to 4. graph AO# (0-5)

chart graphs of the analog output to be shown (max. 4)

<12> systembus

The systembus is used to extend the inputs / outputs of the controller. The following types of extension modules are available:

SW808 relais switching output (8 outputs 250V/8A)

DIO808 discrete digital input/output (8 inputs/8 outputs 0.5A 24VDC)
AI812 generic use analog inputs (12 channels)
IF804 analog outputs (4 channels)

The bidirectional data interchange is done via the systembus. The configuration page assigns the input/output ports (DI/DO/AI/AOx.x) to the modules connected to the systembus. Each configuration page defines one systembus type and the port number assigned to. Example: A SW808 to output DO1 and a DIO808 to output DO2 and to read DI1 is connected (in this physical order) to the controller. Set systembus #00 to "SW808"/"DO1" and systembus #01 to "DIO808"/"DO2"/"DI1". With this settings, the outputs DO1.0 to DO1.7 switch the SW808 ports 0 to 7; the outputs DO2.0 to 2.7/ resp. inputs DI1.0 to 1.7 are served by the DIO808.

client type (ASETUP, NONE, SW808, DIO808, AI812, IF804)

Enter the type of extension module. To read the presently connected members automatically on initial setup, enter "ASETUP" on the first page. This causes the controller on next entering of the configuration to read the units automatically. You only have to enter the assignment of the inputs / outputs manually.

data src. / ... data dst

source (data source) bzw. destination (data destination) of the member

<13> virtual input

Virtual inputs enable you to setup very flexible control features. A virtual input is assigned to real inputs (IN#..) depending on predefinable conditions. Example: Virtual input #IV00 can be defined to represent the lowest value of the real inputs #IN00, #IN01, #IN02. The possible functions are listed below:

virtual input conf. # (0-9)

number of the virtual input

select type # (0-3)

type of value calculation: 0/AVG=average of the given inputs 1/MIN=minimum value ...
2/MAX=maximum value... 3/SEL=selection depending on digital outputs

input A, B, C, D # (0-9)

selection of the 1st, 2nd, 3rd, 4th input. OFF stands for unused input.

value offset A,B,C,D (-9999 to +9999)

this value is added to the corresponding input value before the calculation is done. This allows e.g. for the minimum value selection a selection depending on a given offset.

output sel A. # (do0.0 to do3.7)

The status of the selected digital output switches the virtual input to the input A (DOx.x=0) of input B (DOx.x=1).

output sel B. # (do0.0 to do3.7)

The status of the selected digital output switches the virtual input to the input A/B (DOx.x=0) of input C/D (DOx.x=1). **Note: In other words, the two switching outputs select one of the 4 inputs: 0/0=A 1/0=B 0/1=C 1/1=D.**

<14> motor characteristic

For the servomotor function the used can enter the characteristic of a nonlinear servomotors

(refer to chapter "outputs"). This tables are selected by entering there table number +1 as the characteristic. For every requested output value the user can enter the corresponding motor position. The other values are created by interpolation.

<15> atmosph. mix. setup

<16> atmosph. mix. adj.

This setup is only required if your controller operates a gas kilns with direct servomotor control of air and gas. In this configuration, the controller operates to do the entire temperature and atmosphere control (controlled oxygen or/and carbonmonoxide). For detailed informations about this configuration please ask us for sepearate technical description. The mixer can control up to 3 temperature zones (1 atmosphere zone).

The atmosphere has 3 basic operating modes: AIR EXCESS FIRING, ATMOSPHERE CONTROLLED FIRING (controlled O₂ / CO) and COOLING. You can operate the controller either as atmosphere control (air / gas ratio is calculated by the cumbustion parameter field) or as an atmosphere control loop (as above but with on-line adaption of the parameter field by considering the continuous oxygen / carbonmonoxide feedback signal)

Control Signal for AIR and GAS depending on the Mixer Operation Mode:

| mode | AIR | GAS |
|-----------------------|---------------------|-------------------|
| AIR EXCESS | 100% | as power required |
| ATMOSPHERE CONTROLLED | as power required | as amount of air |
| COOLING | as cooling required | 0% |

The pages "atmosphere control mixer setup" defines the assignement of the required informations, the page "atmosphere control mixer adjustments" defines the combustion parameters field.

atmosphere SP# (0-19)

selection of the setpoint representing the atmosphere

atmosphere IN# (0-19)

selection of the input representing the actual setpoint

cooling act. DOx.x

selection of the digital output activating the cooling mode. The mixer needs this information to enter COOLING mode. The other modes are identified by the atmosphere setpoint.

temp. ctrl. .. CH# .. (0-10)

selection of the temperature control channel for up to 3 zones (set the unused zones to OFF)

air flow .. IN# .. (0-19)

selection of the input which represents the present amount of air

gas flow .. IN# .. (0-19)

selection of the input which represents the present amount of gas

max.% gas air X (30-100)

parameter to limit the maximum amount of air during the AIR EXCESS MODE. Can be used e.g. to set 4% O₂ on maximum power.

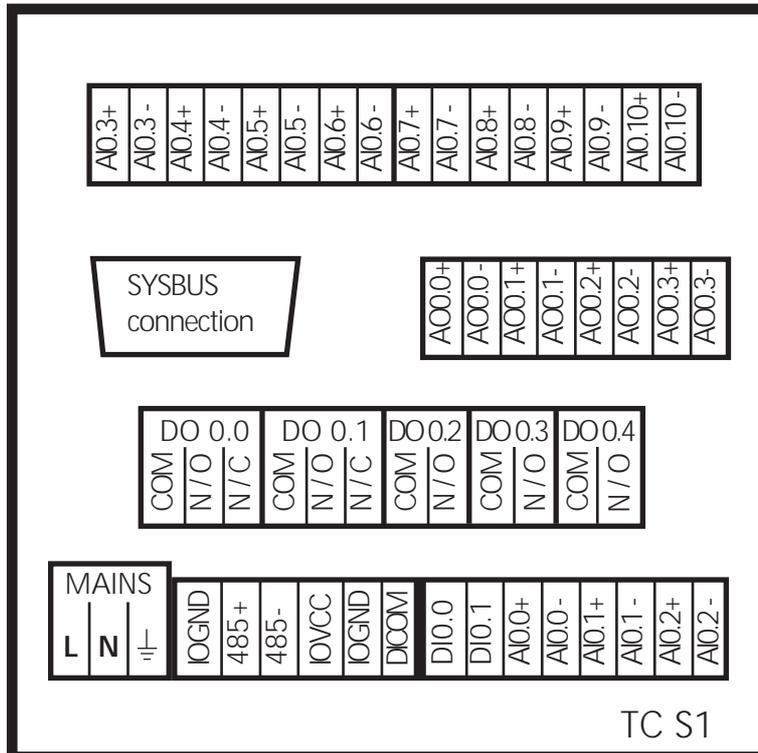
air / gas @ 4%O₂ (5-100)

volume ratio air / gas on n=1.2 (ie. 4% O₂)

- fact. for x.x%** (0.5-1.0)
factor respecting to n=1.2 on combustion aiming for x.x%O₂
- corr.each +100°K** (0.5-2.0)
factor as above for each +100°K higher temperature
- PWR corr @ CO %** (0-100%)
the combustion formula assumes an essential stronger temperature increase on reduction.
The grade of anticipation is defined by this parameter (100% = double power on 0.5% CO)
- max.ratio mod. %** (0-50%)
maximum modulation by the control loop of the combustion ratio
- atms.intergral (10-1000)**
integral time for the atmosphere control loop
- atms. dev. eval (0.5 to 2.0)**
the actual deviation is powered by this value before adding to the integral

5.0. Controller Electrical Connections

Back View



5.1. Electrical Connections

MAINS L / N, Earth:

Power supply 220V 50/60Hz (ca. 6 VA), Filter Ground (!)

IOVCC / IOGND

outlet of the controllers IO power supply, max load 100mA. Can be used for small applications to avoid an external power supply. Don't connect this circuit to any external power supply, ground etc. ! Severe damage might happen !

DI COM, DI0.0, DI0.1

Digital inputs, e.g. for external switches. Voltage input level 5V to 24V. DI COM is common rail for both digital inputs. IOVCC and IOGND can be used in small applications (connect DI COM to IO GND and make contact between e.g. DI 0.0 and IO VCC).

DO0.0 to 0.4

Digital Switching outputs: COM=common, N/O=normal open, N/C=normal closed. Max. contact load max. 4A / 250V.

AI0.0 to AI0.11

Analog inputs, e.g. for thermocouples, thermoresistors etc. Voltage input range configurable for all standard signals (see next chapters)

AO0.0 to AO0.3

Analog Voltage (or Current) output. Used to drive e.g. thyristors or to output any other controller information for further use (e.g. temperature output).

SYSBUS MASTER

SUB-D9 female socket to link further bentrup SYSTEMBUS units (like additional relay outputs, digital input / output, Analog input / output etc.) to the controller. For details refer to the manual coming with the SYSTEMBUS unit.

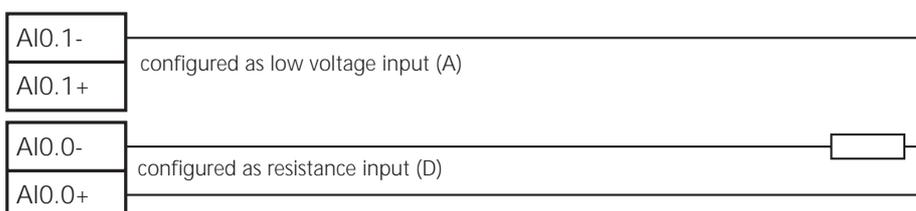
RS485 + / -

communication bus for configuration of the controller, bentrup WinControl etc.

5.2. Connecting a Pt100 as 3 - wires

For improved accuracy of resistance sensor as Pt100 use the following setup. Note that the input configuration must be adapted accordingly. The controller compensates automatically for the entire cable resistance (ie. no 4 wire setup required).

Pt100 3-wire setup

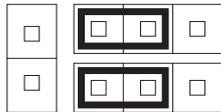


Note: Any input can be configured for Pt100 3-wire. The following input number is assumed to operate as the 3rd wire input. If you do not intend to connect the Pt100 with 3-wires, you have to change the configuration to 2-wire setup.

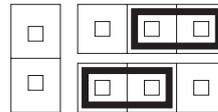
5.3. Adapting the inputs for different input signals

The controller inputs are configurable for different signal types. Set the requested signal type in the „analog input“ configuration; additionally check whether the jumper settings on the main board fit the signal type. :

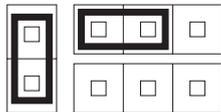
A: low voltage input (thermocpl. etc.)



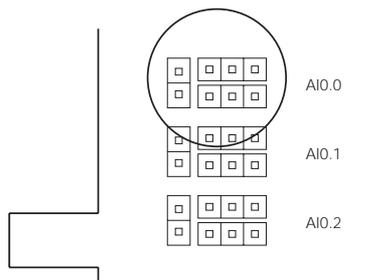
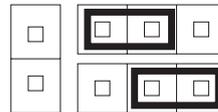
B: voltage input (0-5V/10V)



C: current input (0 / 4-20mA)

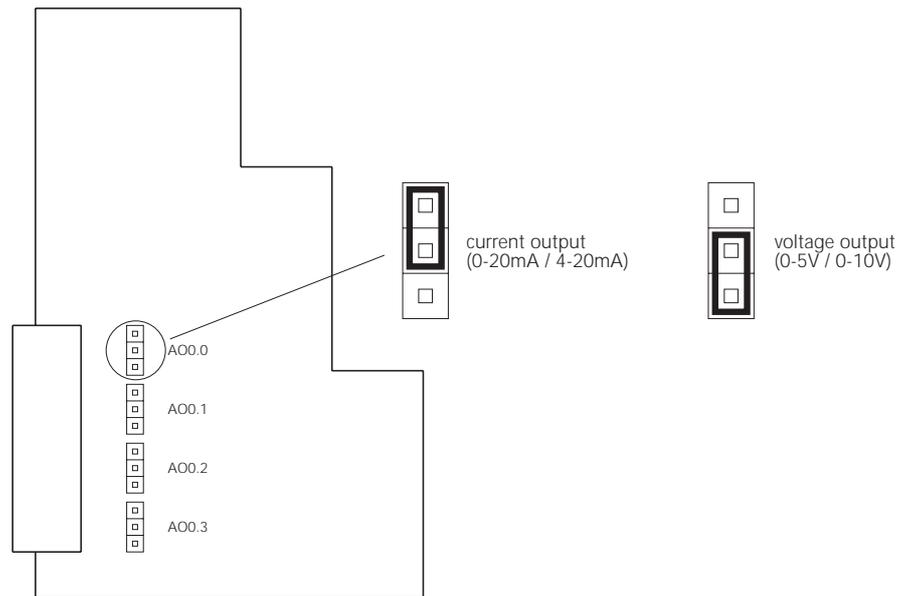


D: resistance input (Pt100 etc.)



5.4. Adjusting the signal of the analog outputs

The optional analog output board provides 4 channels of configurable output signal. The signal type is configured in the section „analog output“ in the configuration. However, the basic selection of „voltage“ or „current“ must be done additionally by setting the jumpers according to the following sketch:



5.5. Wiring for a RS485 connection to a standard serial port

In most applications where only 1 unit is connected to one computer port and the distances are small (e.g. for configuring the controller via the bentrup software), we offer a passive converter cable. This cable is fitted with a 9-pole SUBD plug (for standard RS232C PC ports) and the PHOENIX plug for the TC-M2/S1:

5.6. Maximum Cable Distances

The IEEE standards define the maximum cable distances. For exact details and definitions, please refer to the corresponding publications of the IEEE.

As a general rule of thumb, the following distances are not critical in typical industrial environments:

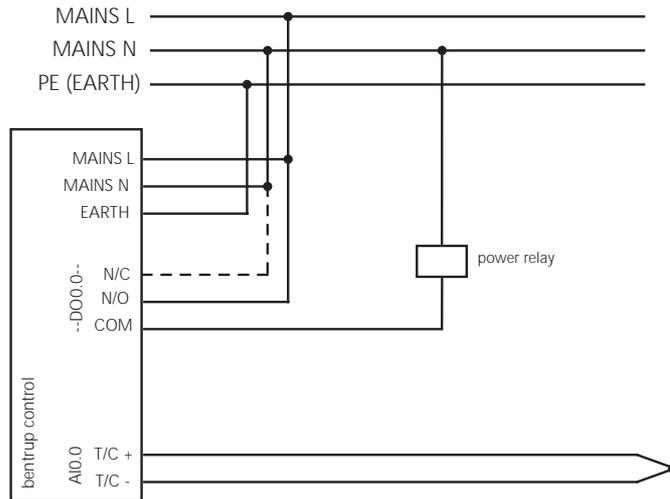
RS232 100 m @ 38400 Baud

RS485 1 km @ 38400 Baud

Always use shielded cables (for RS485 twisted pair) properly grounded !

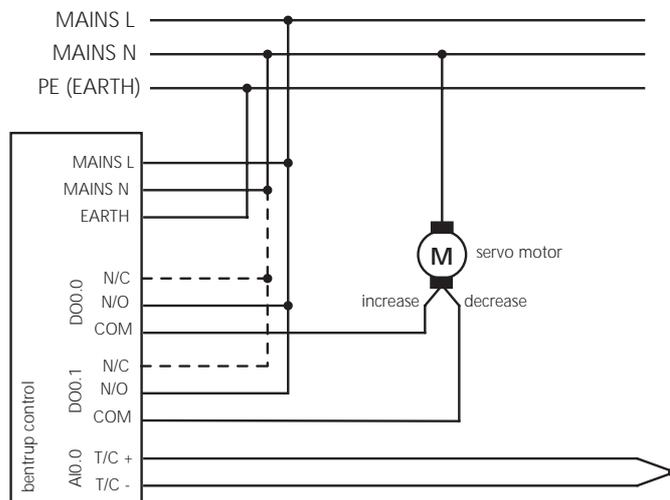
Typical Examples Schematics

bentrup control on a 1 zone kiln
(DO0.0 configured as relay output)



dashed line: only required if relay is very current sensitive
(supresses RC-bridge current on OFF state; for solid state relays change RC-bridge-jumper inside the controller)

bentrup control on a 1 zone kiln
(DO0.0 / DO0.1 configured as servomotor output)



dashed line: only required if relay is very current sensitive
(supresses RC-bridge current on OFF state; for solid state relays change RC-bridge-jumper inside the controller)

bentrup control on a 3 zone kiln (for details refer to previous schematics)

