bentrup

THERMOCOMPUTER *TC M2*

ACTIVE seg04 00:37:30	seg no.	time (h:m)	temp (°C)	atms (%)	E0 sta	E1 stp	E2 fan
	00	0:10	20	OFF	O	O	O
	01	1:00	500	OFF	O	O	O
	02	1:00	800	OFF	O	O	O
	03	2:00	1100	1.0O2	O	O	O
P# 12	>04	1:00	1100	1.5CO	O	O	O
	05	4:00	400	OFF	O	O	O

OTOO CHOO INOO	[--------+-] <- 78% +> 1100°C 78% 1101°C OK 1101	OTO1 CHO1 INO1	[---+------] <- 38% +> 1.50%CO 38% 1.55%CO OK 0.0001 % O2 1.5500 % CO	T/D Fxx	14:15 FRI 15.JAN 97
					00 01 02 03 04 05 06 07

7	8	9	+
4	5	6	−
1	2	3	CE
0	+/-	.	ENTER

+ select
☼
− install

↑ ← → ↓
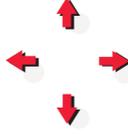
prog   hold
skip

🔑

start
stop

Operating Instructions

TC M2

General Informations

The TC-M2 is a very powerful control system. Due to the high system flexibility it is not possible to explain the TC-M2 in detail. The display and the functions vary depending how your TC-M2 has been set up. But the basic understanding of the front panel and the graphic screen will enable you to operate the TC-M2 in your application.

TC-M2 Front Panel
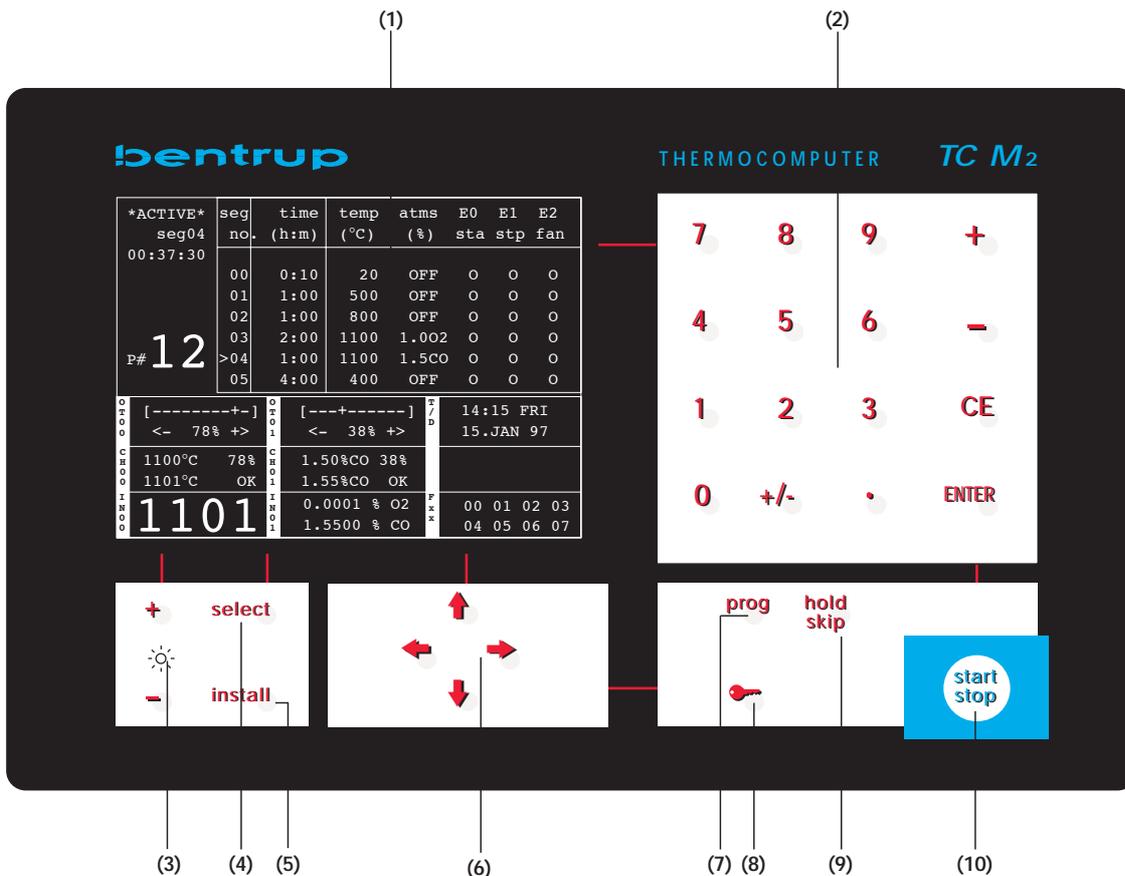
controller screen (1)

For detailed explanation see below.

value input keypad (2)

The value at the current cursor position can be increased or decreased using the keys „+"
resp. „-". Alternatively, the value can be entered using the digit keys. „CE" clears the
value, „enter" accepts the value and proceeds the cursor to the next position. If a value is
outside its allowed range, the cursor remains at its position resp. the value is changed. On
entering a time, enter the hours followed by „." and the minutes.

brightness control (3)

The brightness of the TC-M2 display can be adjusted to obtain optimum reading in various
enviroments.

select (4)

Select further value display. Pressing this key switches to the further information windows
(each window shows 9 process values) and information graphs. The exact type, appearance
and sequence is defined in the configuration.

enter manual mode / enter installation (5)

By pressing this key the outputs of the TC-M2 can be operated manually (only if this mode
is enabled in the configuration). On the upper left corner of the display the output can be
monitored. Change the values by using the keys „+" and „-" of the keypad (2). Step to the
next output using the coursor keys. To leave manual mode press key "install" again. The
manual mode is very helpful to setup the kiln. Every output can be operated manually.

When pressing this key for 3 seconds the TC-M2 interrupts operation and enters the
installation (=configuration) menu. For details refer to the "Technical manual".

cursor control (6)

The cursor can be moved within the program table to select the value to be changed. The
cursor is shown as a bright box coming up when you press any of the cursor keys.

insert / delete segment feature (6)

To enter segments easily, the TC-M2 provides a feature to insert or to delete a segment in
an existing program. To insert a segment at the present cursor, simply press the key ⬅
followed by ➡. All segments behind the present cusor position will be moved up.
To delete the segment at the present cursor, press the key ➡ followed by the key ⬅. The
present segment is deleted and the segments behind are moved down.
To remember the key sequences easily, simply keep the symbol of the 2nd key in mind:

➡ means shift the segments forwards (=insert)

⬅ means shift the segments backwards (=delete)

programme select (7)

Each temperature curve is saved as a programme; the programme keys are used to select the required programme number. Press key (7) and select programme by the keypad (2) and then press key (7) again. The maximum number of programmes depends on the number of values per segment and the number of segments.

Important note: Segment No. 00 is only to define the initial value of the programme variables, e.g. to define the start point of a temperature ramp. The time of segment 00 can be used as a programme delay. If the programme should start right away, set time of segment 00 to 00:00 (=SKIP).

keyboard lock (8)

By pressing this key for 3 seconds a little key appears in the process display. This indicates locked status means that the complete keyboard is locked and therefore unauthorized adjustment of the values is prohibited. Key (4) remains operable to call up process values.

skip / hold feature (9)

This feature allows direct control during a firing process:

Pressing the "hold" key causes the controller to enter / to exit the "HOLD" state (see process window reading "HOLD"). The hold state causes the controller to wait at the actual temperature and to stop the time count. The actual setpoint values will be used for control until the hold state is cancelled by pressing the "hold" key again. Refer also to pre-programmed hold feature described later on.

Pressing this key for 3 seconds initiates the skip function causing the TC-M2 immediately to skip to the next segment during a firing, disregarding the actual temperature / time requirements. This allows manual control of the firing process.

program start / stop (10)

After the program has been entered the process is started by pressing the key "start/stop". The TC-M2 starts with segment number zero of the actual selected programme. Pressing the skey "start/stop" again stops the program. Check the process control window (see below) for present state.

TC-M2 Basic Display

(1) (2)   (3)

```
*ACTIVE* seg    time   temp  atms   E0  E1  E2
    seg04 no.  (h:m)   (°C)   (%)   sta stp fan
00:37:30
          00   0:10     20   OFF    O   O   O
          01   1:00    500   OFF    O   O   O
          02   1:00    800   OFF    O   O   O
       03   2:00   1100  1.0O2  O   O   O
P# 12  >04   1:00   1100  1.5CO  O   O   O
          05   4:00    400   OFF    O   O   O
```

```
O          O              T
T [--------+-] T  [---+------]  /   14:15 FRI
O          O   0              D
O <-  78% +>   1  <-  38% +>       15.JAN 97
O          1

C          C
H 1100°C    78% H  1.50%CO 38%
O          O
O 1101°C    OK  1  1.55%CO   OK
O          1

I          I
N          N   0.0001 % O2   F   00 01 02 03
O 1101     O                 x
O          1   1.5500 % CO   x   04 05 06 07
O          1
```

(4)   (5)

Above is the typical information of the TC-M2 graphic display during normal operation.

status window (1)

In this area the TC-M2 displays important status information if available.

process window (2)

This windows shows the actual state of the controller:

* * IDLE * *	controller is idle, ie. no program started, no process running
* ACTIVE *	program active, firing has been started
* * HOLD * *	program active, but in hold mode (for explanation see above)
* MANUAL *	controller in manual mode
seg.. / fnshd	segment number being processed presently, "fnshd" = finished, ie. program completed successfully
00:00:00	time remaining until end of segment

programme table window (3)

This table shows the present selected programme. Each segment is defined as a time followed by one or more programme setpoints, EVENTS etc. The type, number and appearance of the values is defined by the configuration. The configuration also defines whether the program values are connected as "RAMPs". This is usually done for temperature values only, eg. segment 03 in our example shows "reach 1100°C in 2:00 hours. For more information refer to the configuration.

The words in the headline of the table can also be configured. This enables the user to have individual designators on the display ensuring easy understandable operation.

To enter more segments / values resp. the program window scrolls if you move the cursor to the corresponding values. Entering a new value is done by moving to the "END" mark in the time column and changing it to the time of the new segment. "SKIP" stands for "no time" =0:00; a "HOLD" in this column causes the controller to enter the HOLD mode if this segment is reached. This can be used if for example manual access of the process is required. An alarm signal can be configured to inform the operator.

programme number (4)

The number of the present program is displayed.

information windows (5)

During a firing process there are many process variables, input / output channels, parameters, states etc. inside the TC-M2 that might be of interest. The configuration determines which values are displayed. 9 windows are shown simultaneously (refer to inverse numbering 1-9) each displaying a value (or a set of values) according to the configuration.

The revers lighted legend on the left hand side of the box shows the type of window:
"OT#.": Status of output #: On servomotors, the present position and movement +/- is displayed.
"CH#": Status of channel #: The control channel # is shown with its setpoint (upper value), actual (lower value), resulting control value (in %). Additionally, the current state of this control channel is shown (OFF, OK=normal operation, OVR=off due to overflow of input values, GRD=off due to gradient error occured).
"IN#": display of value(s). The selected value is shown.
"T/D": time / date information
"do": current ON/OFF status of the control outputs xx
"ao": current value of the analog outputs

TC-M2 Graphic Display

Above listet graphic curvesare typical examples. The exact type and arrangement is defined

```
1100°C
0. IN00
   IN02


   0°C

1.  SEG        2              3        4
   TIME    07:00    09:00   11:00   13:00   15:00

   100%
2. CH00
   CH01
    0%


3. A01

   A00


4.  F02
    F01
    F00
```
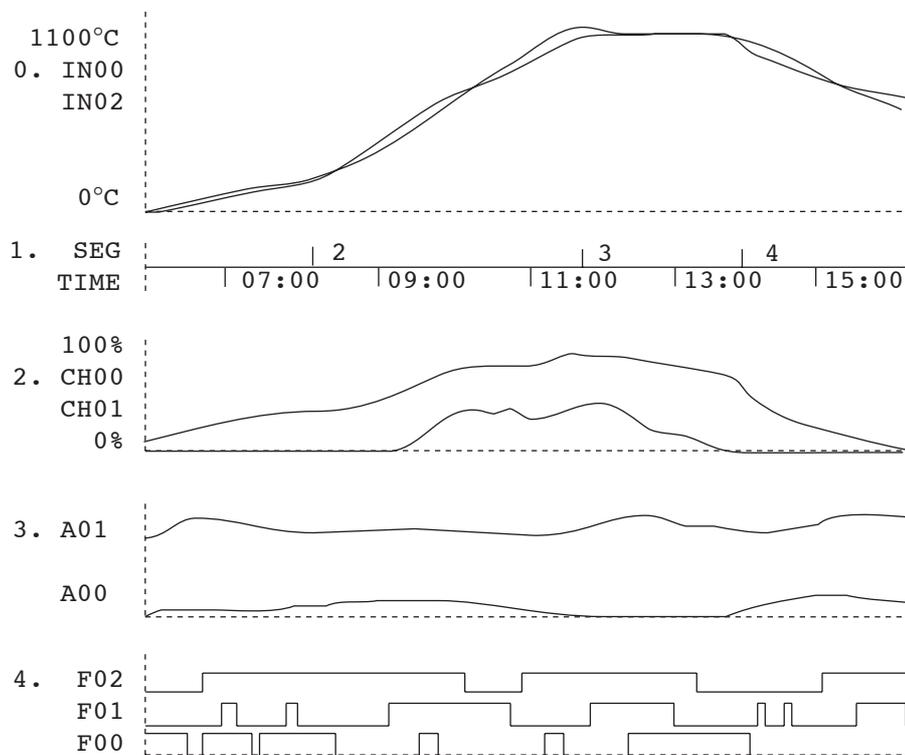
in the configuration. Following the explanation of the examples:

0. Graphic showing the input values IN00 and IN00. A setpoint can be shown as well.

1. time axis: This graph shows the segment changes and the real time of the graph

2. channel information: The output signal of the channel is shown.

3. analog output: The direct value of the analog output(s) is shown.

4. control output: This graphic illustrates the ON/OFF switching of the selected outputs. Attention: Depending on the time scale, very short switching pulses may get lost in the illustration for technical reasons.

Appendix: Error Messages

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

The Error Message appears in window (1).

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

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

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

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

Error A1: error on sensor input
The control channel shuts down because of an error on the sensor input (e.g. overflow). Error is latched until next firing is started. Possible causes:

- thermocouple or compensating wire interrupted

- maximum temperature has been exceeded

- thermocouple polarized wrong (temperature reading „under")

Error A2: programme run skipped and brought to a controlled end
The user defined limits during a programme run have been exceeded and therefore the programme run skipped to the cooling section of the actual firing programme. The limits for this event can be defined in the „digital output" section of the configuration, process mode 18.

Error A3: policeman activated

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

Error A4: temperature increase on full power too low

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

- mains fuse / phase broken, heating elements broken

- heating elements too old (on high temperatures)

- short circuit on thermocouple or compensating wire

- contactor broken (check after operating for some time !)

Error A5: kiln does not follow programmed temperature increase

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

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

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

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

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

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

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

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

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

Error B1: firing process continued after controller restart

Controller continued after a reset.

Error B2: firing process after power breakdown continued

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

Error B3: firing process interrupted after power breakdown

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

B3.1: programme break has been requested by configuration settings
B3.2: programme break because corresponding digital output was off
B3.3: programme break because maximum power breakdown time elapsed
B3.4: programme break because maximum temperature drop exceeded

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

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

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

Error B6: AUTOTUNE in progress

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

Error B7: Failure during AUTOTUNE firing: channel error occured

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

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

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

Error B9: AUTOTUNE firing finished successfully

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

Error C1: System failure: analog digital converter failed

Internal error. Contact bentrup customer service for support.

Error C2: System failure: analog digital converter became unreliable

Internal error. Contact bentrup customer service for support.

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

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

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

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

Error C5: PLC failure

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

Error C6: Any member of the control chain has failed

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

Error D1: Hardware error: CPU failure

Internal error. Contact bentrup customer service for support.

Error D2: Hardware error: Data RAM failure

Internal error. Contact bentrup customer service for support.

Error D3: Hardware error: Internal I2C bus failure

Internal error. Contact bentrup customer service for support.

Error D4: Hardware error: Internal I2C device failure

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

Error D5: Calibration data invalid

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

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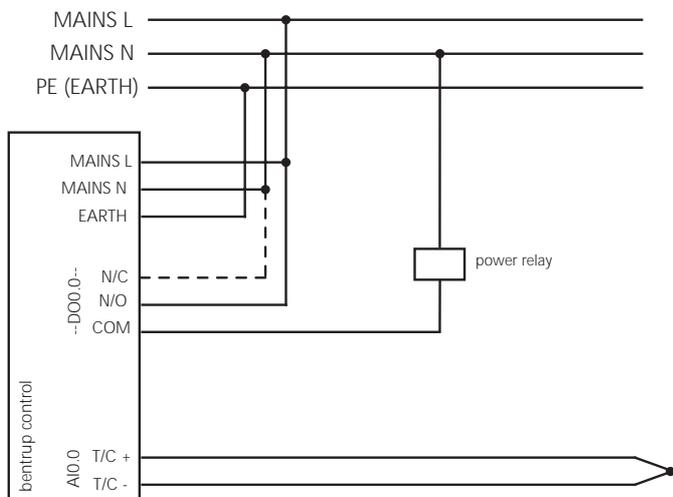
MAINS L

MAINS N

PE (EARTH)

MAINS L

MAINS N

EARTH

N/C

N/O   DO0.0

COM

power relay

AI0.0 T/C +

T/C -

bentrup control

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
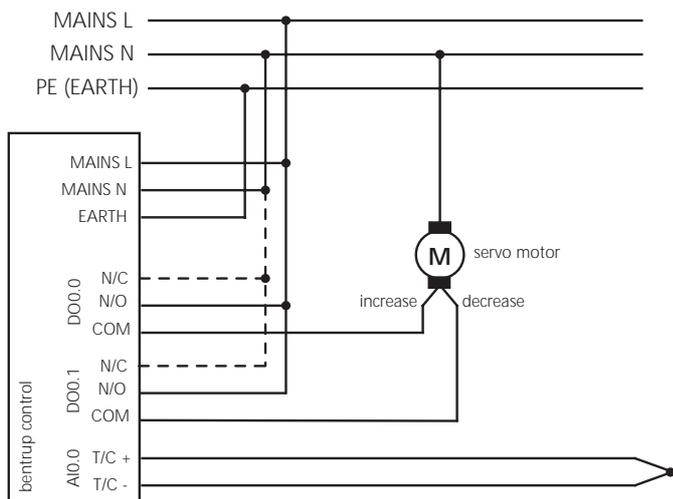
MAINS L

MAINS N

PE (EARTH)

MAINS L

MAINS N

EARTH

N/C

N/O   DO0.0

COM

M   servo motor

increase   decrease

N/C

N/O   DO0.1

COM

AI0.0 T/C +

T/C -

bentrup control

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)

schematic diagrams for typical applications

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

MAINS L

MAINS N

PE (EARTH)

MAINS L

MAINS N

EARTH

FO

N/C

N/O

COM

power relay zone 1

RXTX+

RXTX-

T/C +

T/C -

thermocouple zone 1

TC804/5

MAINS L

MAINS N

EARTH

FO

N/C

N/O

COM

power relay zone 2

RXTX+

RXTX-

T/C +

T/C -

thermocouple zone 2

TC802Z

MAINS L

MAINS N

EARTH

FO

N/C

N/O

COM

power relay zone 3

RXTX+

RXTX-

T/C +

T/C -

thermocouple zone 3

TC804/5

to further
bentrup units