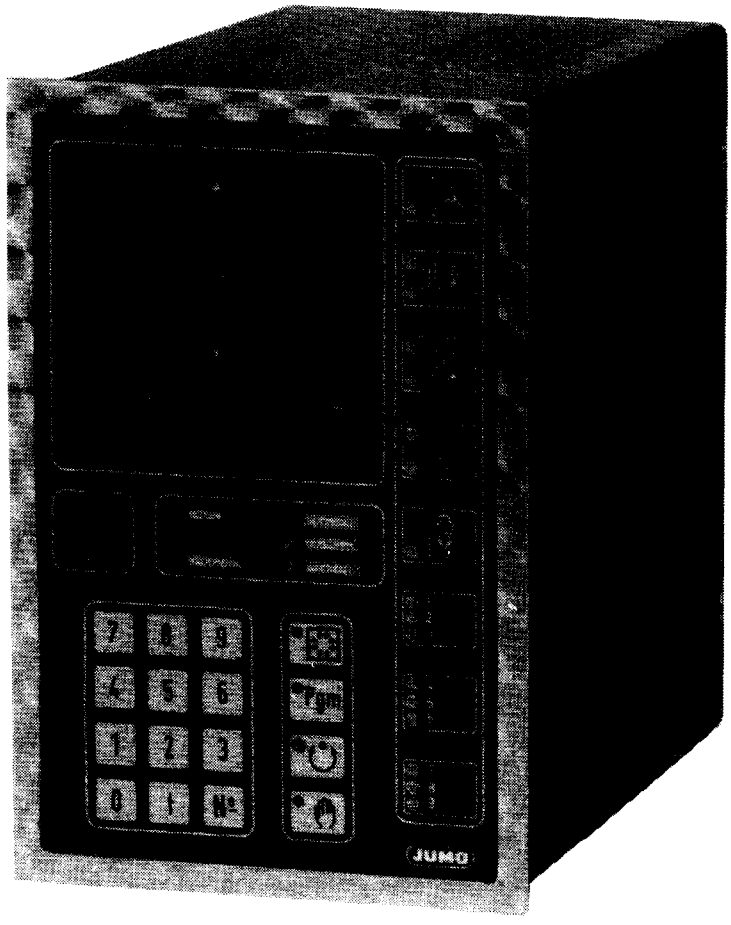
JUMO MEASUREMENT® AND CONTROL

Microprocessor Program Controller

Panel-mounting housing to DIN 43 700



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11.85/V

Operating Instructions

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1 DESCRIPTION

This self-monitoring microprocessor control unit has been specially developed to handle complicated control sequences in cooking and smoking chambers. Up to 100 different programs can be set up, stored, called up immediately, and modified as required. Each program consists of 6 time segments, e.g. heating, drying, smoking, cooking, washing, or baking.
The time for each segment of the program as well as the starting time for the complete program run can be selected up to a maximum of 99 h 59 min.
Each program segment carries the setpoints for the chamber temperature in °C, the relative humidity in % rH, the core temperature in °C and the time in hours and minutes. There is provision for operating up to 20 function channels during each phase of the process, for example ventilation, circulation, flaps etc.
On the display the user can see at a single glance all setpoints and actual values, the action of the function channels, the particular program selected, and the actual program time.
All program segments and function channels have illuminated fields on the front panel which can be fitted with interchangeable descriptions.
All pushbuttons for the entry of data are combined into a foil keypad with a clean lay-out. The keypad can be locked through an external signal to prevent unintentional or unauthorised interference with the programs.
The front panel is completely splashproof, scratch resistant and unaffected by acids; it is therefore easily cleaned.

1.1 Type designation

MPF-88
MPF Microprocessor controller for meat cooking and smoking
-88 bezel 192 x 288 mm depth 300 mm

1.2 Standard accessories

2 Mounting brackets
2 Control cables
1 Supply cable
1 Operating Instructions

1.3 Technical data

Programs

up to 100 complete programs can be stored

Program running time

up to 99 h 59 min

Program segments per program

6 segments, e.g. heating, drying, smoking, cooking, washing, and baking

Program segment indication

illuminated field for each segment, with interchangeable description

Display

bright 7-segment LED displays, 13 mm high, red, for all actual values and setpoints

-chamber temperature in °C	3 digits
-relative humidity in % rH	2 digits
-core temperature in °C	3 digits
-program time in h:min	4 digits
-number of selected program	2 digits

Action keys

membrane keys for
-manual operation
-automatic operation
-programming
-cleaning

Data keys

number keys 0 to 9

Selection of start time

through keypad up to 99 h 59 min

Temperature control

Control range

0+199°C

Sensing element

resistance thermometer Pt 100 in 3-wire circuit

Line adjustment

not required

Humidity control

Control range

0 to 100% rH
working range 10 to 100%rH

Sensing element

2 resistance thermometers Pt 100. The relative humidity is determined from the psychrometric difference between two Pt 100 resistance thermometers (wet and dry).
Air velocity 2 - 5 m/sec.
The reference temperature for humidity control is compensated for the actual chamber temperature.

Control action

on-off control with limit contact ws2 or limit comparator lk1 to lk6, alternatively double setpoint controller; selection by switches inside the instrument. Contact spacing ΔXk adjustable on a selector switch inside the instrument.

Control accuracy

± 0.5% on temperature
± 1.5% on humidity

Indication accuracy

± 0.5% on temperature
± 1.5% on humidity

Update rate

2/sec

Linearisation

fitted as standard

Linearity error

not exceeding 0.2%

Switching rate

can be selected internally

Feedback

PD, PID or PD/PID feedback selected internally.
Proportional band adjustable 0-24°C (0-24% rH)
Tv = 32, 64, 128 and 256 sec
Tn/Tv = 4.5

Output

relay 220 W 1 A at 220 V 50 Hz resistive load

External control inputs and outputs

Program lock

all keys are locked

Check routine

automatic self-test program before every program start

Fault indication

faults during the automatic program run are indicated immediately.

Display 01 = memory error (RAM)
Display 02 = internal transfer error
Display 03 = transfer error at serial output
Display 04 = battery voltage insufficient for data buffer
Display 08 = fault in serial port component
Display 13 = program memory fault

External start/stop

through floating contact

Data port

V24-RS 232 for reading in and reading out from and to external units, such as data printer or second programmer.
Transfer rate 2400 baud

Print-out format

a) Program print-out
all process values and setpoints are printed out. The data output takes place at the end of each program segment.

b) Protocol print-out
all setpoints are printed out. The data output takes place at the end of each program segment.

Data format

Intel-Hex

Diagnostic plug

for service testing, fitted as standard

Operating (function) channels

20 programmable function outputs

Operating action

8 relays with changeover contacts
12 relays with normally-open contacts

Contact rating

220 W 1 A at 220 V 50 Hz
resistive load

Data back-up

by lithium battery,
back-up time approx. 3 - 4 years,
automatic indication when battery is discharged

Action on mains supply failure

the program run is interrupted. When the supply is restored, the automatic program run continues if the difference between the actual chamber temperature before and after mains supply failure is less than 10%.
If the difference is greater than 10% the automatic program run remains interrupted.
The run can be continued or the program restarted from the beginning after pressing the cancellation key.

Ambient temperature error

0.02%/°C (chamber temperature)
0.1%/°C (rel. humidity)

Permitted ambient temperature range

0 to 50°C

Permitted storage temperature range

-10 to +70°C

Climatic conditions

Class KWF to DIN 40 040,
relative humidity not exceeding 75% annual mean,
no condensation

Protection

to DIN 40 050, front IP 65 waterproof (can be washed with free flowing water up to 70°C),
back IP 00

Mounting position

NL 90 to DIN 16 257
(vertical)

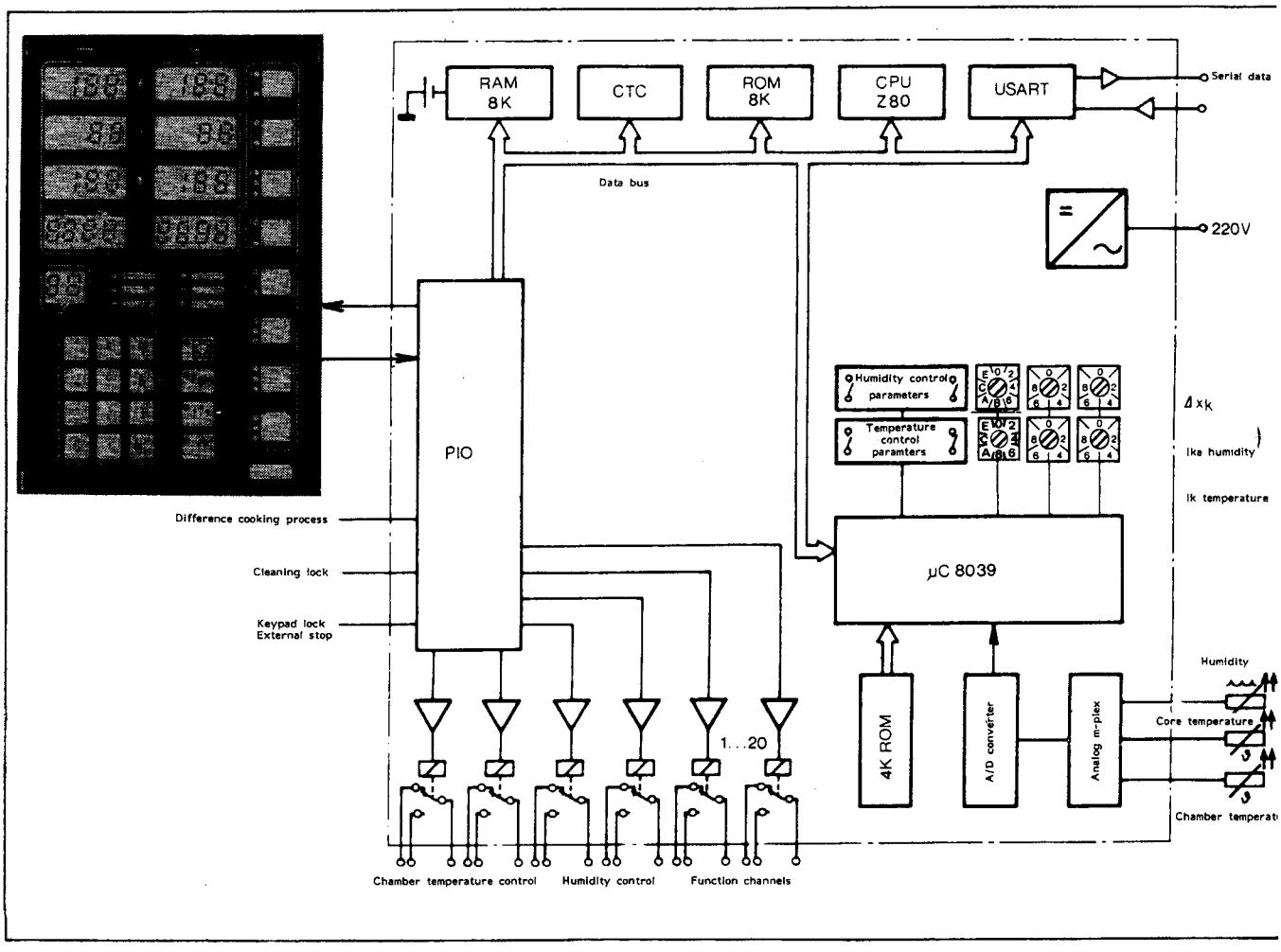
Weight

approx. 6.5 kg

Supply

220V +10% -15%,
48-60 Hz

1.4 Block diagram

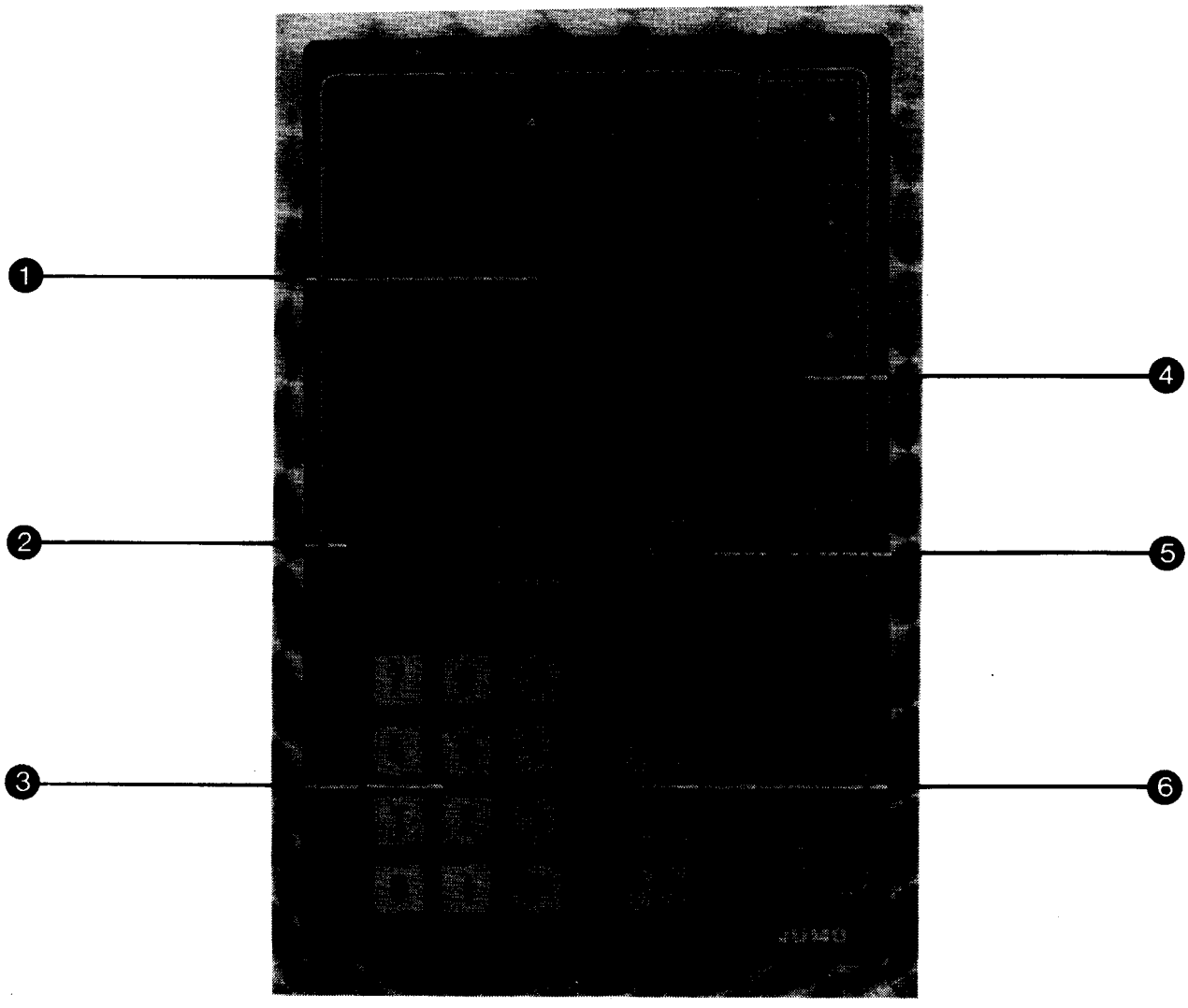


1.5 Operation

The MPF-88 operates digitally with two microprocessors (Z80 and 8039).
The program sequence is controlled by the Z80 while the 8039 handles the DDC controller with its parameters.
The analog signals chamber temperature, core temperature and relative humidity are converted to voltage signals, passed through the analog multiplexer to the analog-digital converter and then digitised.
The parameters control action, switching rate, switching differential, limit comparator action, setpoint etc. can be selected by rotary or DIL switches.
External actions such as difference cooking process, stop etc., as well as the relay outputs for the function channels, which are switched through power drivers, are operated through the PIO (Peripheral input/output).
The RAM (read-in/read-out memory) is backed-up by a lithium battery in case of mains failure.
A V24-RS232 data port is provided for data transfer to and from an external data unit, such as printer or secondary programmer.
The various modules are supplied from a secondary switched power supply.

2 DESIGN FEATURES

2.1 Indications and controls on the front panel



1. Display of all setpoints and actual process values
2. Display of program number
3. Number keys
4. Display of all control functions
5. Program segment indication
6. Operation keys

Please fold out this page for reference during the next sections!

❶ Display of all setpoints and actual process values

Display I

Display II Chamber temperature (°C

Display III

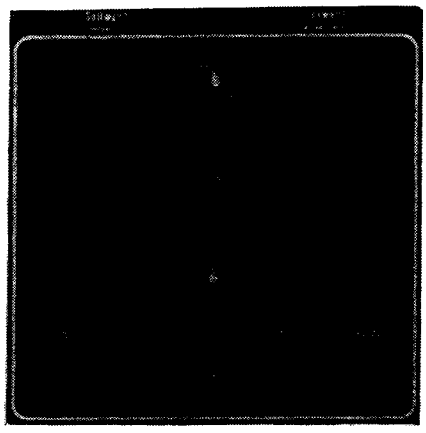
Display IV Relative humidity (% rH)

Display V

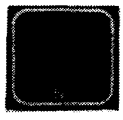
Display VI Core temperature (°C)

Display VII

Display VIII Elapsed time (h/min)

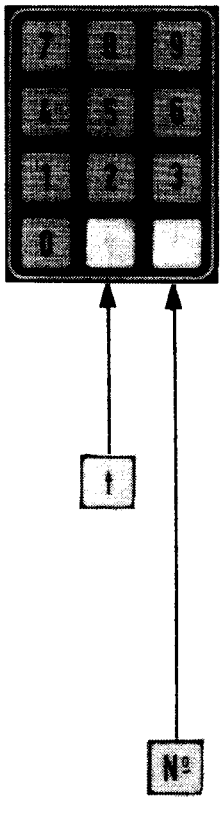


❷ Display of program number



Number of program selected (00 to 99)

❸ Number keypad



Number keys

for setpoint selection of chamber and core temperature, relative air humidity, control functions and to select program number

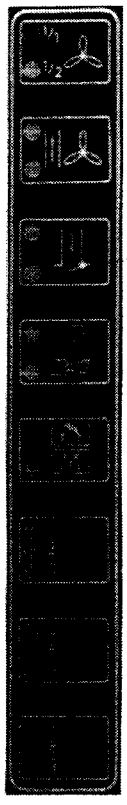
Data input

"arrow" key for transferring the selected setpoints into the memory

Program selection

after pressing this key the required program (00 to 99) can be selected with the number keys

❹ Function operation display (example)



1 2 Relay contacts "fan"

3 4 Relay contacts "vent"

5 6 7 Relay contacts "air supply"

8 Relay contact "wash"

9 Relay contact "alarm"

10 Relay contact "smoke"

11 Relay contact "vent"

Relay contacts (spare)

15 16 17 Relay contacts (spare)

18 19 20 Relay contacts (spare)

Note:

The two displays ❹ and ❺ can be changed after removing the front panel, see Section 3.6

❺ Program segment display

Each program consists of 6 time segments which follow each other.
The program segment in operation is indicated by an LED.

❻ Function keys

Cleaning program

This key controls the cleaning program which can be blocked by an external contact.

Programming

This key starts the programming of all setpoints and times; program runs and control functions can be programmed.

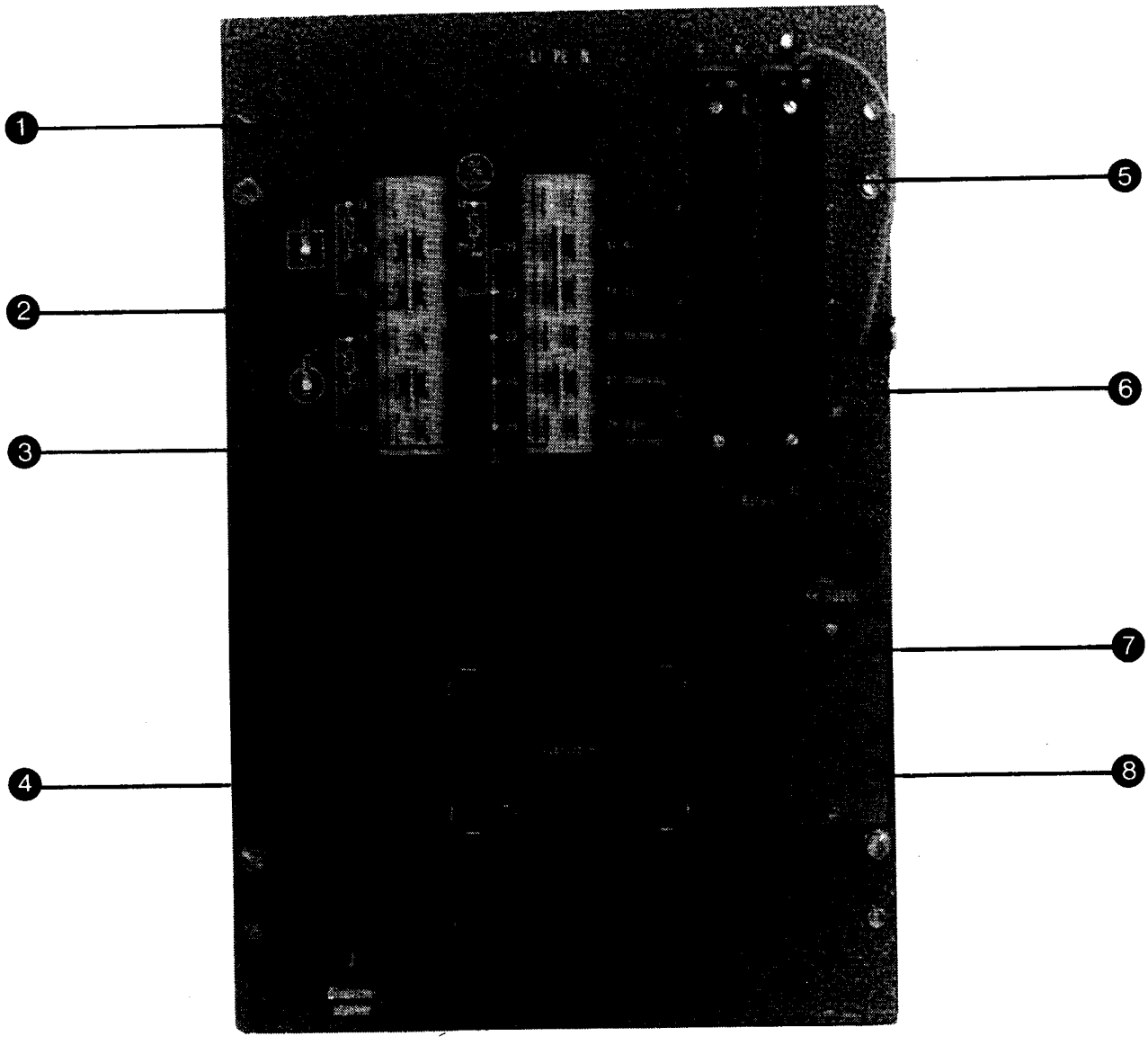
Auto run

The automatic program run is started with this key.

Manual operation

Pressing this key stops the automatic program run.
Any new setpoints are held in the working memory, the program memory remains unchanged.
On restarting the program the change in the working memory is cancelled.

2.2. Rear view



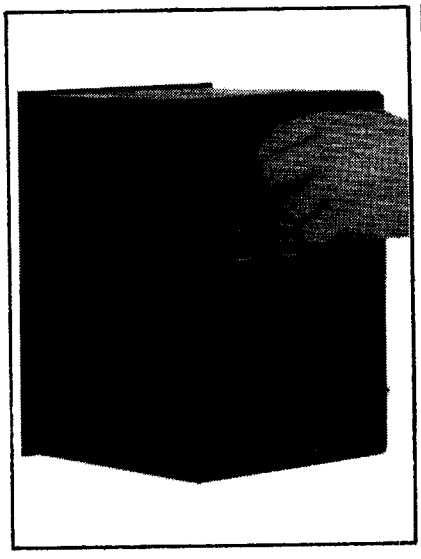
1. Mains terminals
2. Signal inputs
3. Data port and external inputs
4. Diagnostic plug
5. Connector I - relay outputs
6. Connector II - relay outputs
7. Battery
8. Rating label

3 ADJUSTMENTS INSIDE THE INSTRUMENT

These controls are accessible after removing the front panel.
The chassis is taken out of the housing as follows:

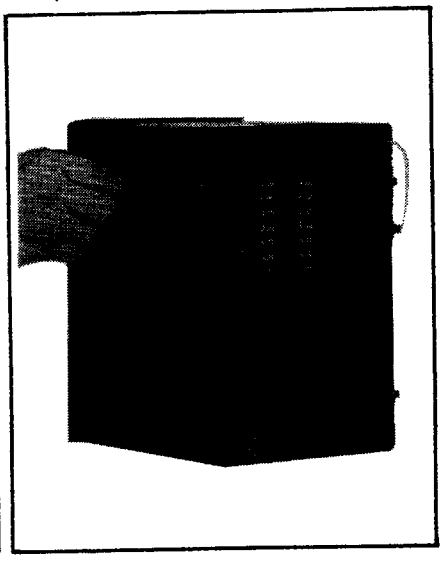
Before working inside the instrument always switch off the mains supply!

Step 1



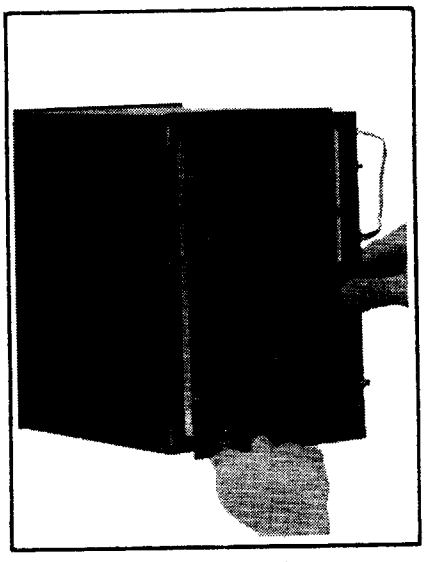
Release the 4 retainers on the back panel by a few turns anti-clockwise.

Step 2



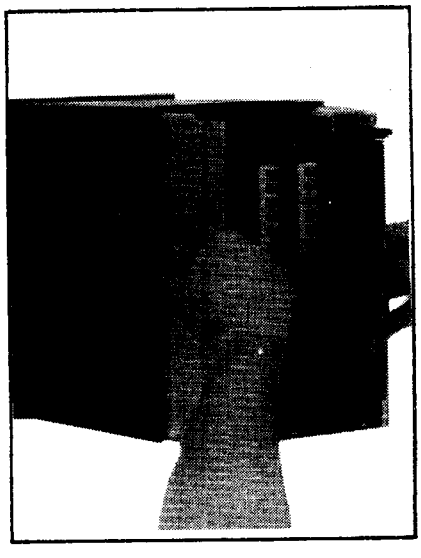
Unscrew the 4 retaining screws at the left and right of the housing.

Step 3



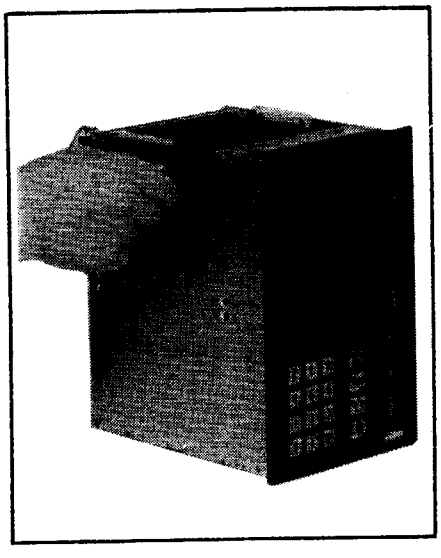
Remove back panel.

Step 4



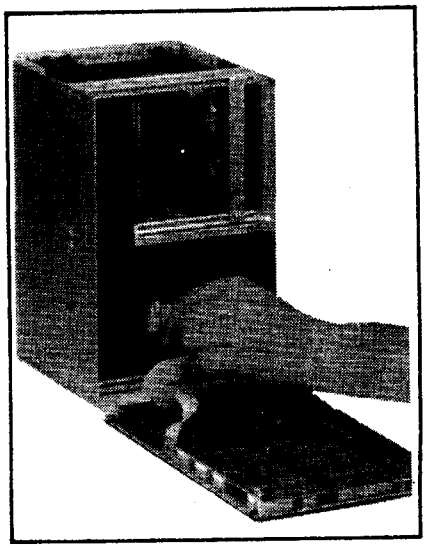
Pull the chassis out of the housing towards the back.

Step 5



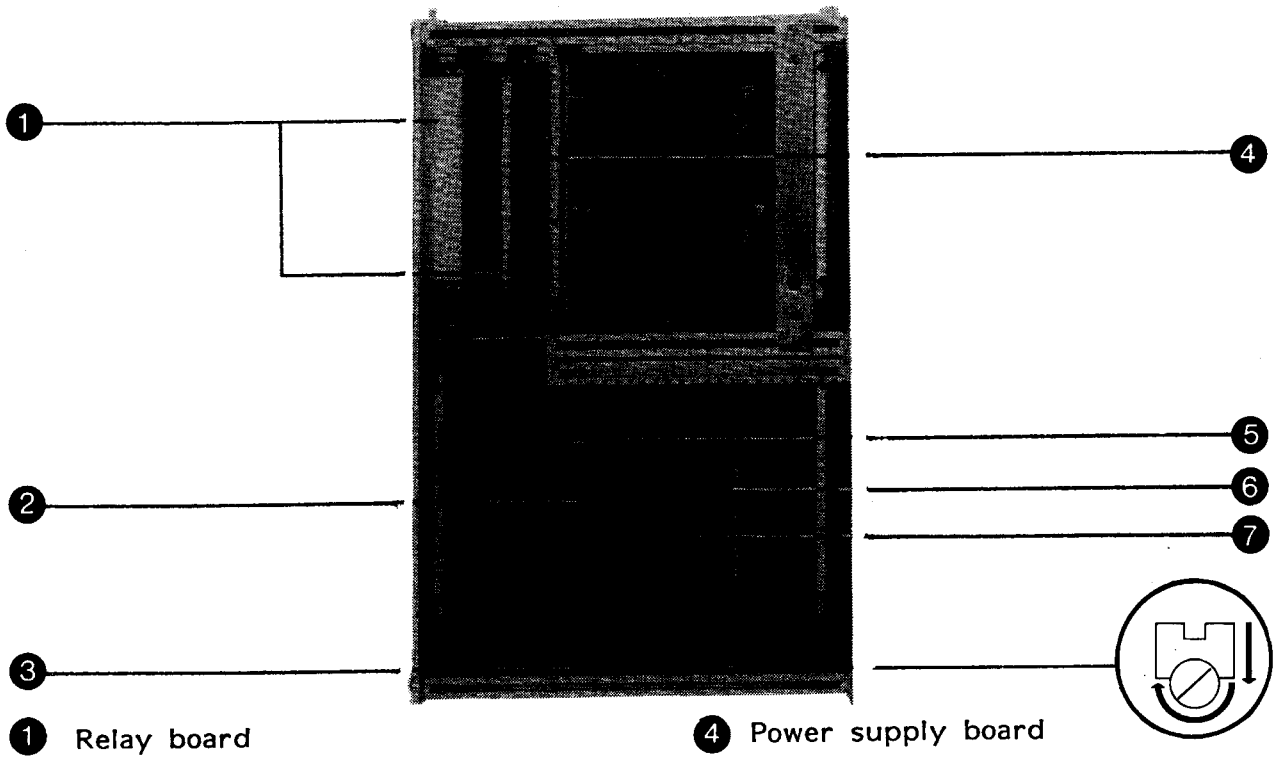
Unscrew the 4 screws on the left and right of the chassis.

Step 6



Remove the front panel towards the front.
Pull off the connection plug to the chassis.

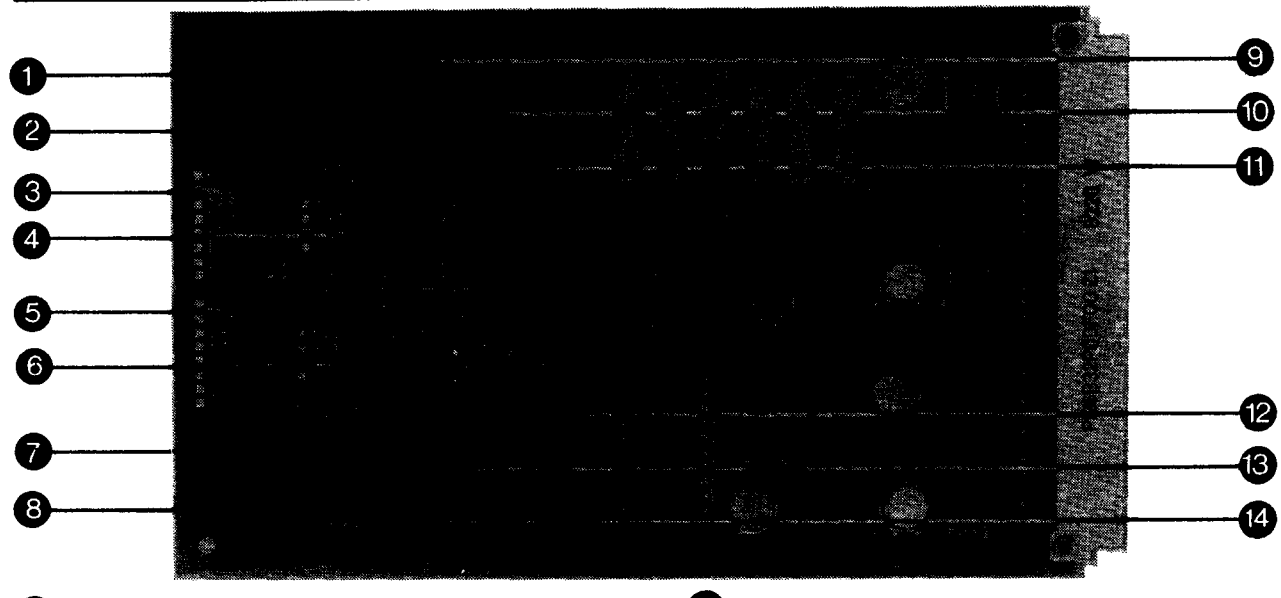
Instrument chassis without front panel



1. Relay board
2. CPU board
3. Retainers
4. Power supply board
5. Memory board
6. Analog board
7. Controller board

The switches are located on the memory board 5 and the analog board 6 . The required board can be pulled out forward after screwing in the locking screw and depressing the retainer 3 .

3.1 Adjustments on the analog board



1. Selector +XpT
2. Selector -XpT
3. Selector T1
4. Selector T2
5. Selector F1
6. Selector F2
7. Selector +XpF
8. Selector -XpF
9. Selector IkT x 1
10. Selector IkT x 10
11. Selector IkT x 100 and Δ Xk
12. Selector IkF x 1
13. Selector IkF x 10
14. Selector IkF x 100 and Δ Xk

3.1.1 Selecting the switching differential Xd °C(%rH) and the switching rate fs (min-1)

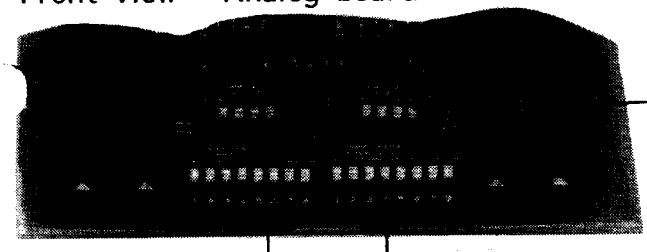
The parameters Xd, Xp and fs are interdependent.

With Xd fixed the switching differential remains constant when the Xp range is altered. The switching rate is altered by Xp.

When selecting Xd proportional to Xp the switching rate is constant irrespective of the selected Xp range.
The switching rate is calculated from factor K (0.5, 1, 2, 4), using the

formula $fs = \frac{4}{Tv \cdot K}$ (this applies for 50% ON time and Xp larger than Xd)

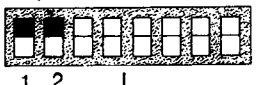
Front view - Analog board



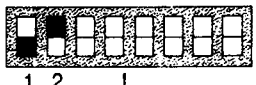
T1 (F1)	K Xd	0,5 1	1 2	2 4	4 8	Tv(s),Tn = Tv·4 32	64	28	256	Xp single-sided	Xp symmetrical	Controller O	S	PD/ PID	PD	PID	PD/ PID
1		○	x	○	x												
2		○	○	x	x												
3						○	x	○	x								
4						○	○	x	x								
5										○	x						
6												○	x				
7														○	x	○	x
8														○	○	x	x

T1 = Temperature

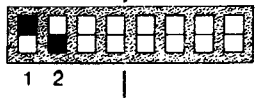
F1 = Humidity



1 2



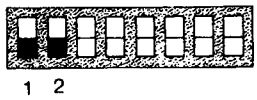
1 2



1 2

Tv = 64 sec

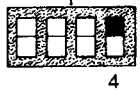
factory setting



1 2

T2 (F2)	Ik 1	2	3	4	5	6	ws2 O	ws2 S	Xd fixed	Xd prop Xp
1	○	x	○	x	○	x	○	x		
2	○	○	x	x	○	○	x	x		
3	○	○	○	○	x	x	x	x		
4									○	x

T2 = Temperature



4

F2 = Humidity

4

Xd fixed

Xd = 1°C(0.1°C)

$f_s = \frac{Xp}{Xd \cdot Tv \cdot 4}$

Xd = 2°C(0.2°C)

$f_s = \frac{Xp}{Xd \cdot Tv \cdot 4}$

Xd = 4°C(0.4°C)

$f_s = \frac{Xp}{Xd \cdot Tv \cdot 4}$

Xd = 8°C(0.8°C)

$f_s = \frac{Xp}{Xd \cdot Tv \cdot 4}$

Xd proportional Xp

factory setting

$Xd = 0.5 \cdot \frac{Xp}{16}$

$f_s = \frac{4}{Tv \cdot 0.5}$

$Xd = 1 \cdot \frac{Xp}{16}$

$f_s = \frac{4}{Tv \cdot 1}$

$Xd = 2 \cdot \frac{Xp}{16}$

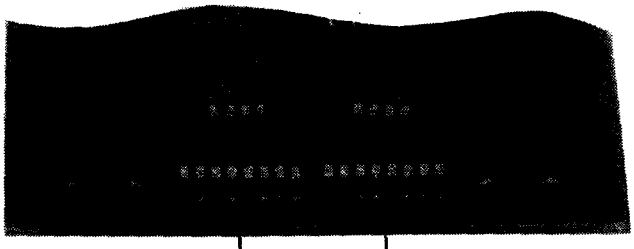
$f_s = \frac{4}{Tv \cdot 2}$

$Xd = 4 \cdot \frac{Xp}{16}$

$f_s = \frac{4}{Tv \cdot 4}$

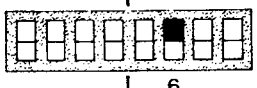
3.1.2 Choice of relay action (n.c. = O; n.o. = S)

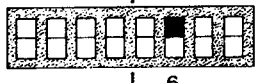
Front view - Analog board



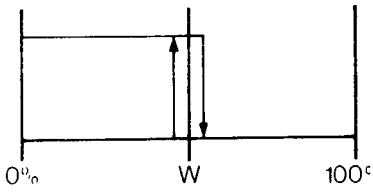
Temperature controller DIL switch T1

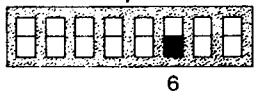
Humidity controller DIL switch F1

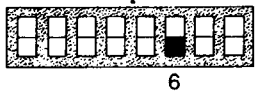




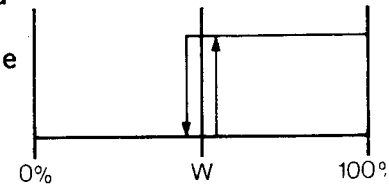
Relay action O
for heating systems
Relay de-energised
above setpoint
factory setting







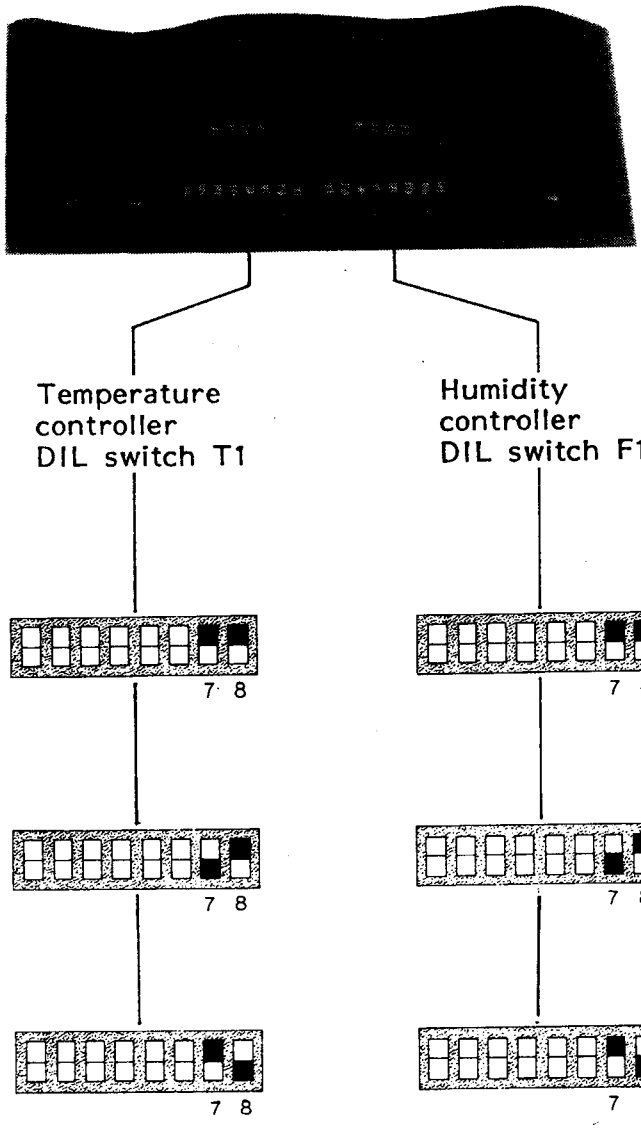
Relay action S
for cooling systems
Relay de-energised
below setpoint
With this action the
feedback is auto-
matically inverted.



3.2 Feedback setting

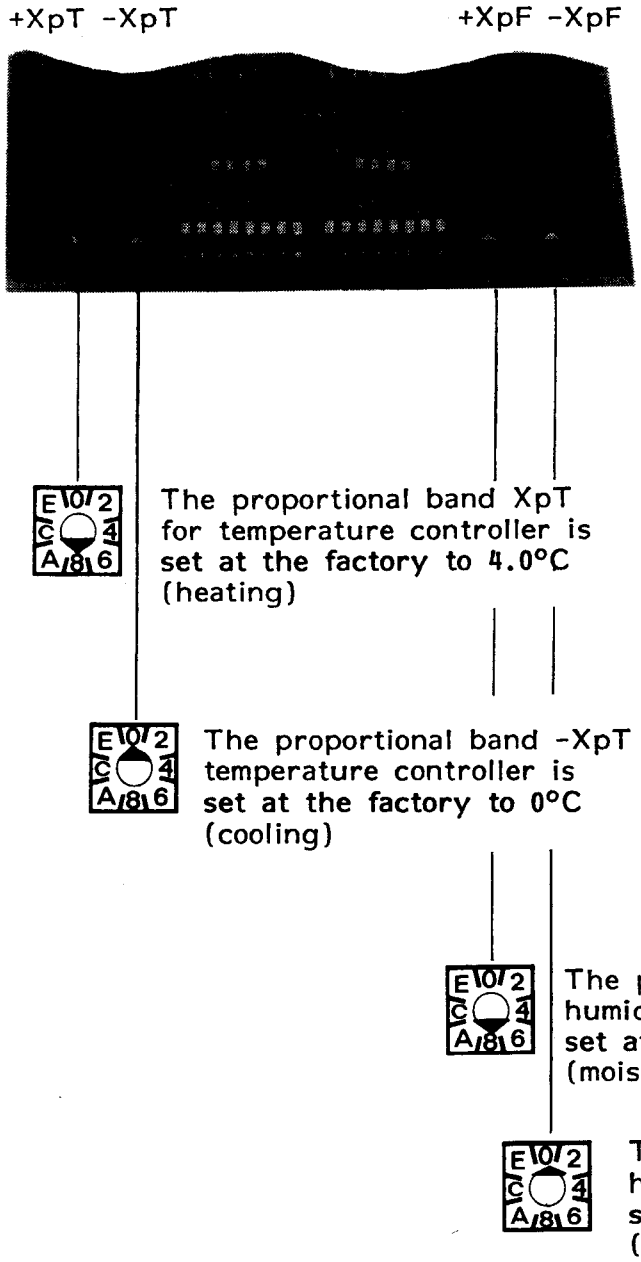
3.2.1 Selecting the feedback (PD, PID or PD/PID action)

Front view - Analog board



3.2.2 Selecting the proportional band Xp [°C(% rH)]

Front view - Analog board

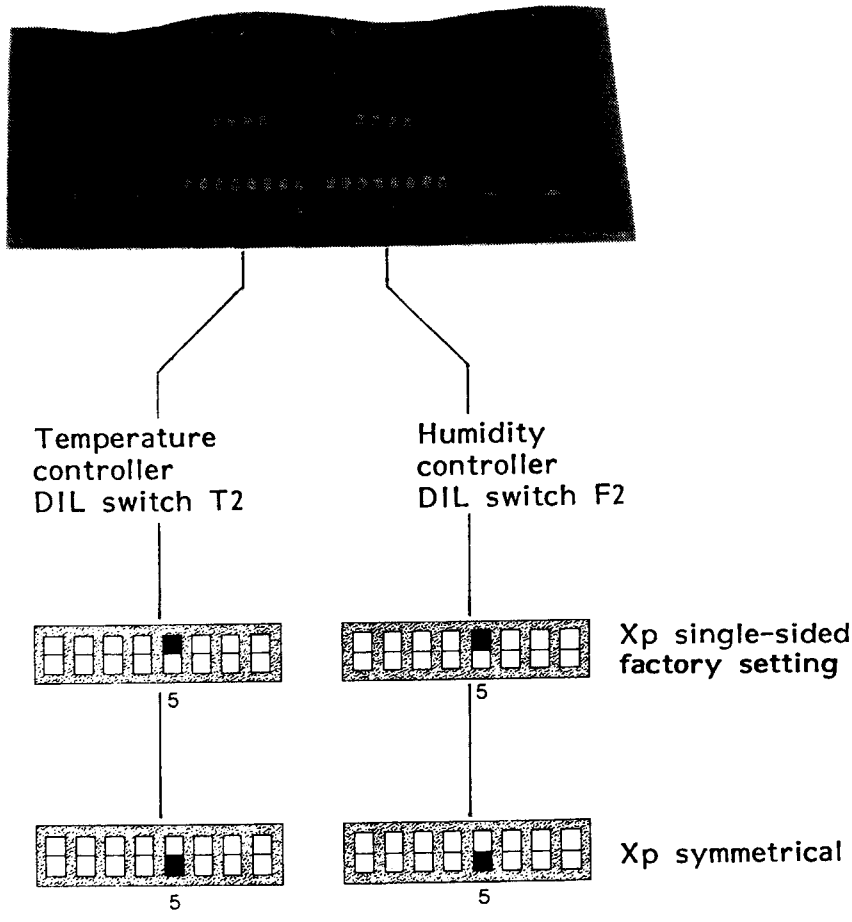


The proportional bands XpT (°C) (temperature) and XpF(%) (humidity) with single-setpoint controllers and ±XpT(°C) and ±XpF(%) with double setpoint controllers are selected on separate 16-position switches as table below:

Switch position	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Proportional band °C(%)	0	0.4	0.8	1.2	1.6	2.0	2.4	3.2	4.0	5	6	8	11	14	18	24

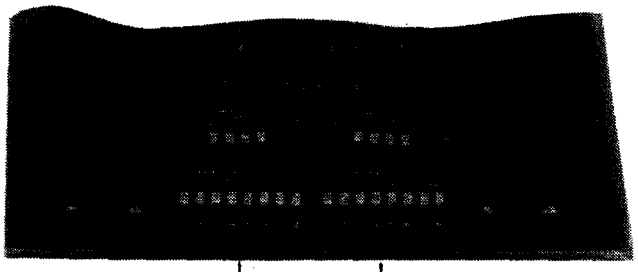
3.2.3 Selecting the proportional band setting Xp (symmetrical/single-sided)

Front view - Analog board



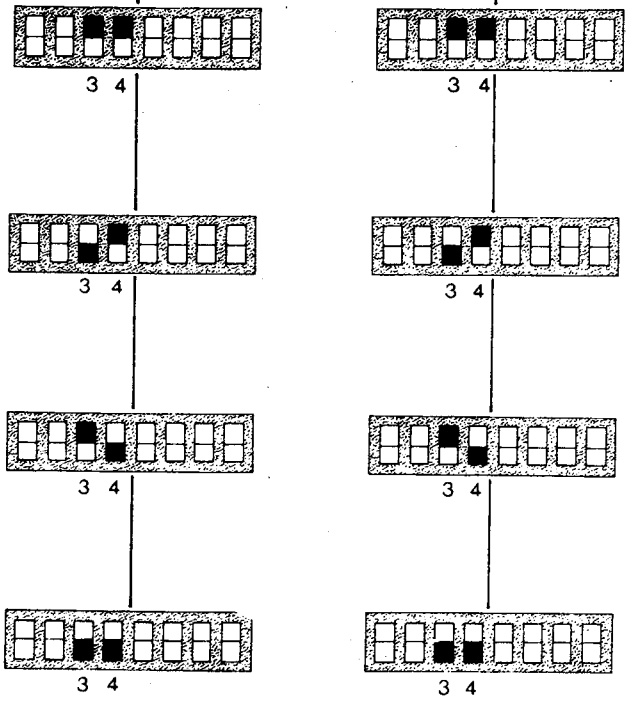
3.2.4 Selecting the time parameters Tv and Tn (sec)

Front view - Analog board



Temperature controller DIL switch T1

Humidity controller DIL switch F1



Tv = 32 sec Tn = 128 sec

Tv = 64 sec Tn = 256 sec
factory setting

Tv = 128 sec Tn = 512 sec

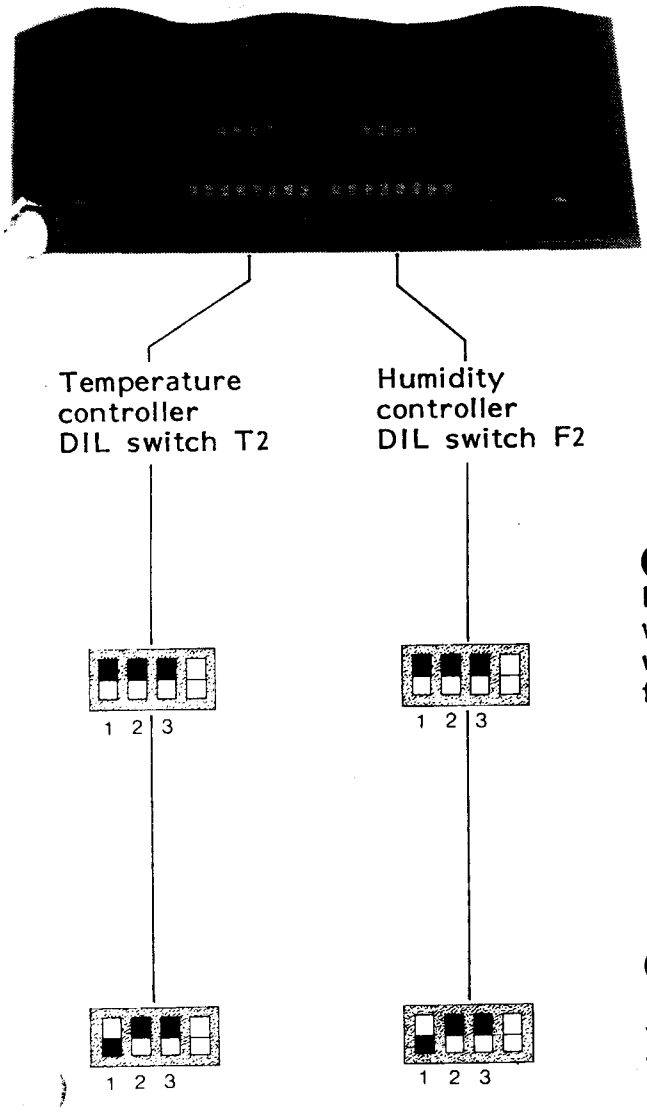
Tv = 256 sec Tn = 1024 sec

$Tn = 4 \cdot Tv$

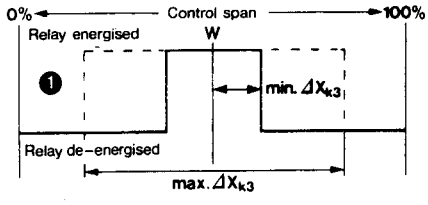
3.3 Alarm contacts (limit contacts)

3.3.1 Limit comparator lk1 and lk2 with adjustable window

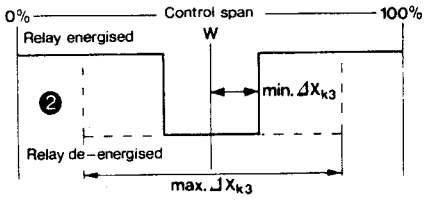
Front view - Analog board



❶ lk1
Relay energised when process within window factory setting

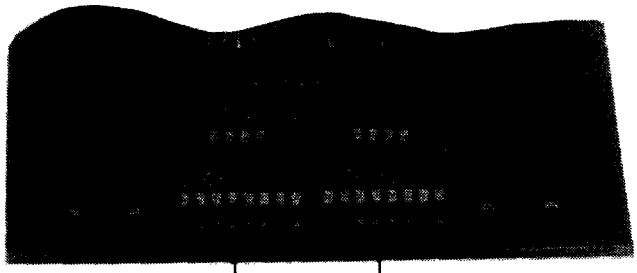


❷ lk2
Relay de-energised when process within window



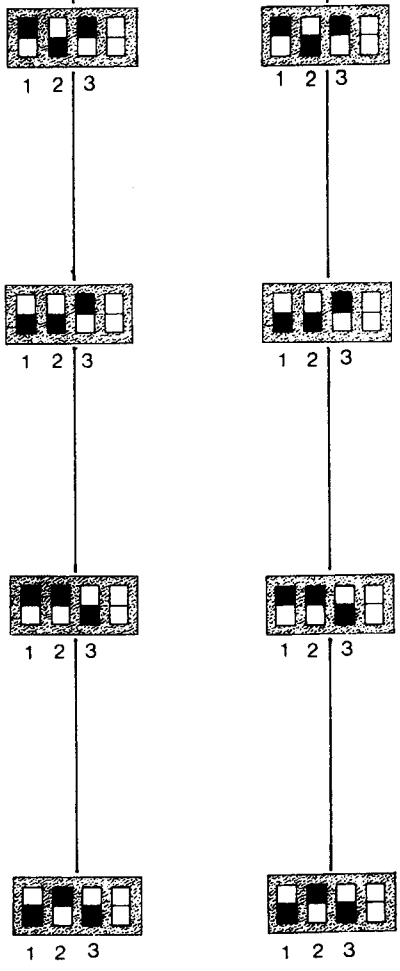
3.3.2 Limit comparator lk3 to lk6 as advance or follow-on contact

Front view - Analog board

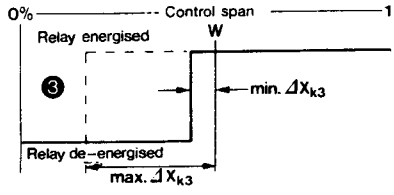


Temperature controller DIL switch T2

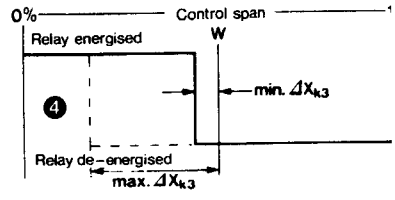
Humidity controller DIL switch F2



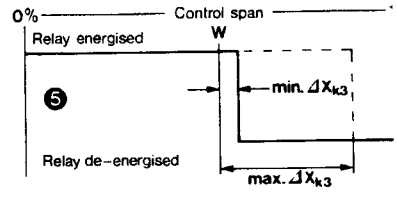
❸ lk3
low alarm contact only
(advance contact)
Relay energised above setpoint



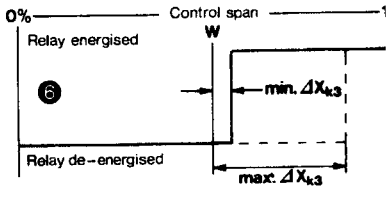
❹ lk4
low alarm contact only
(advance contact)
Relay de-energised above setpoint



❺ lk5
high alarm contact only
(follow-on contact)
Relay energised below setpoint

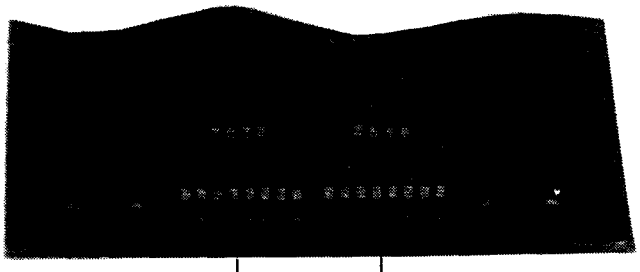


❻ lk6
high alarm contact only
(follow-on contact)
Relay de-energised below setpoint



3.3.3 Alarm contact ws2 over the full control span

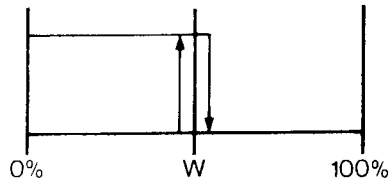
Front view - Analog board



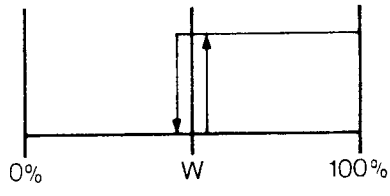
Temperature controller DIL switch T2

Humidity controller DIL switch F2

Relay action O
for heating
Relay de-energised
above setpoint

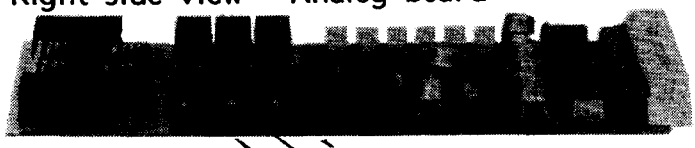


Relay action S
for cooling
Relay de-energised
below setpoint
With this action
the feedback is
automatically
inverted.



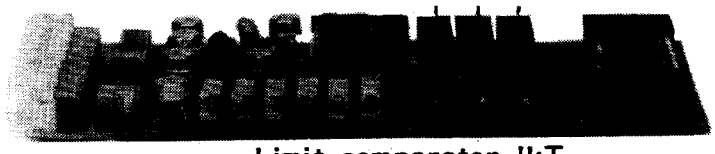
3.3.4 Selecting window width ⊿Xk3 [°C(% rH)] on Ik1 and Ik2

Right side view - Analog board

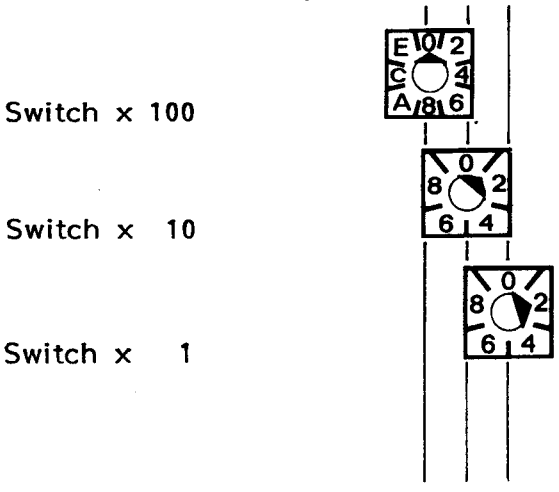


Limit comparator IkF -
Humidity controller

Left side view - Analog board



Limit comparator IkT -
Temperature controller



These switches to the left and righ on the analog board select the window width of the limit comparato for the temperature and humidity controller within the range 0 - 99°C (% rH).

Example:

Required window: ⊿Xk3 = 24°C (% r
Setting is for half the width = 12°C

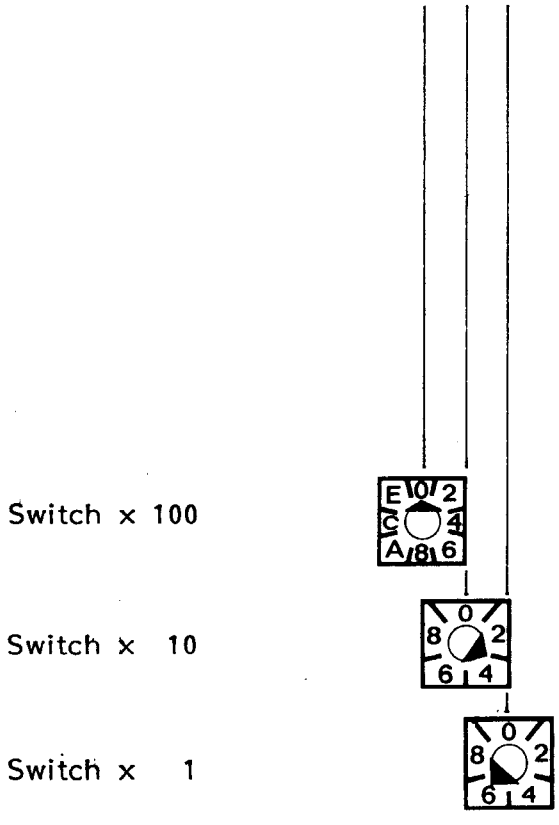
Switch x 100 on 0

Switch x 10 on 1

Switch x 1 on 2

0 = factory setting

3.3.5 Selecting the contact spacing ⊿Xk3 [°C(% rH)] on Ik3 to Ik6



These switches to the left and righ on the analog board select the contact spacing of the limit comparator for the temperature controller and humidity controller within the range 0 - 99°C (% rH).

Example:

Required contact spacing:
⊿Xk3 = 36°C(% rH)
The total contact spacing is selected

Switch x 100 on 0

Switch x 10 on 3

Switch x 1 on 6

0 = factory setting

3.3.6 Selecting the setpoint for alarm contact ws2 [°C(% rH)]

Right side view - Analog board

Limit comparator IkF -
Humidity controller

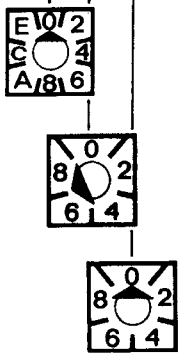
These switches to the left and right on the analog board select the setpoint for alarm contact ws2 for the temperature controller and humidity controller over the full control span.

Left side view - Analog board

Limit comparator IkT -
Temperature controller

Example:

Range: 0+200°C (0 to 100% rH)
Required setting: 70°C (% rH)



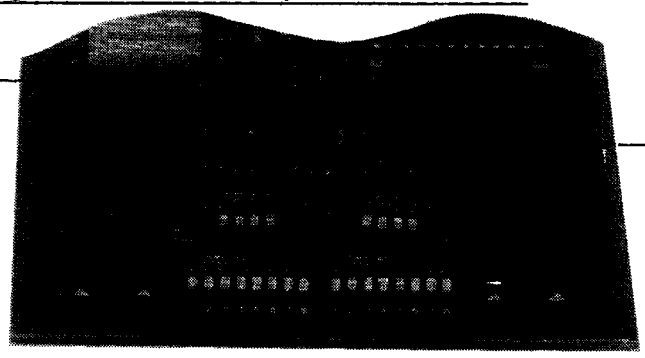
Switch x 100 — Switch x 100 on 0

Switch x 10 — Switch x 10 on 7

Switch x 1 — Switch x 1 on 0

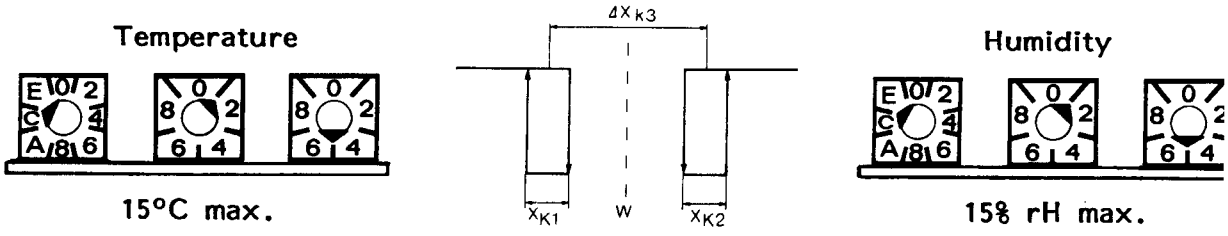
0 = factory setting

3.4 Setting the alarm contacts Ik1 to Ik6 (ws2) and the contact spacing ⊿Xk (double setpoint controller)



Position 0...1 — Limit comparator Ik1 to Ik6 or alarm contact ws2. This switch selects the contact spacing ⊿Xk.

Position D — Contact spacing ⊿Xk for double setpoint controller. The contact spacing ⊿Xk can be selected within the range 1 to 15°C (% rH).



On the limit comparators Ik1 and Ik2 the setting is only half the window width!

Example:

Right side view - Analog board

Limit comparator IkF - Humidity controller

Required window ⊿Xk3 = 24% rH
Setting is half the width

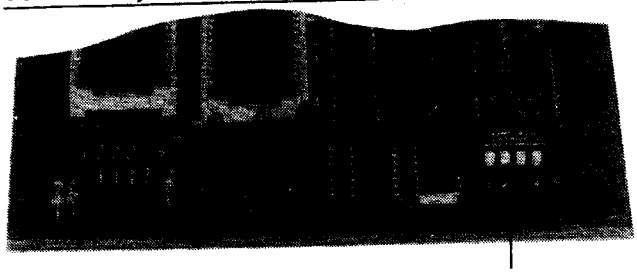
Switch x 100 — Switch x 100 on 0

Switch x 10 — Switch x 10 on 1

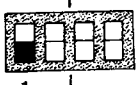
Switch x 1 — Switch x 1 on 2

0 = factory setting

3.5 Adjustments on the memory board



3.5.1 Clearing the entire memory

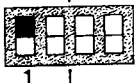


With the contact closed, all programs in the memory can be cancelled.

Key [•Pgm] → Key [N°] → Key [6]

As long as the contact is closed, the programmer does not respond to a mains failure.

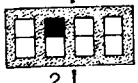
factory setting



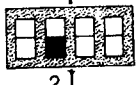
With the contact open, memory clearance is out of action. The programmer responds to mains failure.
It is essential that the switch is always in this position during operation!

3.5.2 Locking the keypad and external stop

factory setting



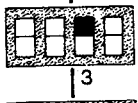
In this switch position, with external contact 28 to 29 closed, all keypad functions are blocked.



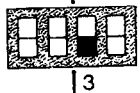
In this switch position, with external contact 28 to 29 closed, the time base of the instrument is stopped, see Section 7.4 - external start/stop. Display 5 flashes the corresponding program segment.

3.5.3 Blocking the control functions

factory setting



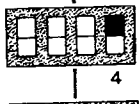
In this switch position all function cannels can be programmed.



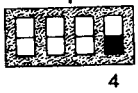
In this switch position the function cannels cannot be programmed.

3.5.4 Blocking the operation mode Pgm

factory setting



In this switch position all functions can be programmed.



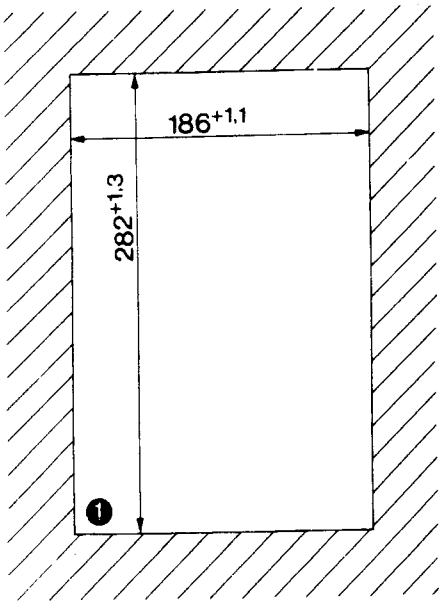
In this switch position programming is prevented
(Operates up to key [1], then no further action).

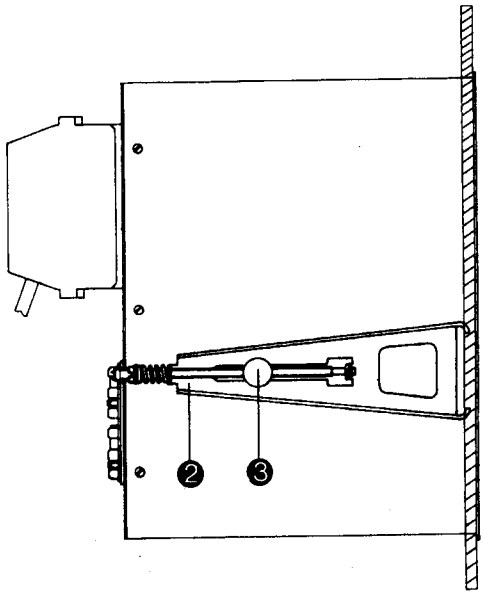
4 INSTALLATION

The program controller is intended for panel mounting. The location should be as free as possible from vibrations. Stray electromagnetic fields, e.g. from motors, transformers etc., should be avoided.
Correct operation of the program controller is ensured in the ambient range 0 to 50°C at a relative humidity up to 75%.

4.1 Fitting in position

Insert the program controller from the front into the panel cut-out ❶
From the back of the panel insert the two brackets ❷ into the cutouts ❸ at the sides. The flat bracket faces must be against the housing.
Tighten up evenly with a screwdriver.





4.2 Electrical connection

The electrical connections to the program controller are made according to the connection diagram, Section 15, page 40. When connecting the instrument to the mains supply, the requirements of VDE 0100 "Regulations on the design of power installations with mains voltages below 1000V" or the corresponding local requirements have to be observed.

Please note the following:

- an isolating switch and a fuse have to be provided for every instrument
- on supplies affected by interference (e.g. thyristor controls) the instrument should be connected through an isolating transformer
- all probe and alarm lines should be run separately from the control and power supply lines (separate and independent cable ducts)
- provide star-circuit wiring including protective ground connection
- screened probe and alarm lines must only be grounded at the electronic instrument
- where possible arange physical separation between electronic instruments and contactors
- provide an RC circuit at contactors and solenoid valves, as these items are a common source of interference. All the manufacturers are aware of this problem and offer suitable RC circuits in their programme
- do not connect any control circuits (relays, contactors) to the mains terminals of the instrument
- mains fluctuations are only permitted within the stated tolerances

5 STARTING UP

Please fold out page 5, Section 2, for reference during the next sections of the Operating Instructions!

The unit leaves the factory without any program, i.e. all setpoints and function channels are on "0". The user can transfer programs into the unit through a data port (V24 RS 232) from a second unit which has already been programmed (see Section 12).

5.1 Setting up a program

This example is intended to explain in detail the information interchange between operator and program controller, from data input to display, taking each step at a time.

Step	Entry	Key	Display	Signal lamp
1	Programming	Pgm	field ❷ flashes 00	Pgm
2	Reference number of program, e.g. 12	1 2	field ❷ flashes 12	Pgm
3	Enter program reference number	↵	field ❷ has steady display 12 field ❺ RÖTEN (heating) display I flashes 000* and requests entry of chamber temperature setpoint	Pgm
4	Setpoint e.g. 100°C	1 0 0	display I flashes 100	Pgm
5	Enter setpoint	↵	display I has steady display 100 field ❺ RÖTEN (heating) display III flashes 00 and requests entry of relative humidity setpoint	Pgm
6	Setpoint e.g. 75% rH	7 5	display III flashes 75	Pgm
7	Enter setpoint	↵	display III has steady display 75 field ❺ RÖTEN (heating) display V flashes 000 and requests entry of core temperature setpoint	Pgm

continue as in Section 5.1.1 or 5.1.2

* If the instrument has already been programmed, the flashing display shows the programmed setpoint.

5.1.1 Program step-on by core temperature

If a core temperature setpoint greater than 0 has been selected the segment time is automatically set at zero. The program steps on after the programmed setpoint has been reached.

Step	Entry	Key	Display	Signal lamp
8	Setpoint, e.g. 80°C	8 0	display V flashes 080	Pgm
9	Enter setpoint	1	display V has steady display 080	Pgm
			field ❺ RÖTEN (heating)	Pgm
			display VII has steady display 00:00	
			the first signal lamp in field ❹ flashes and requests entry of control function	

The core temperature should always be 2 to 5°C below the chamber temperature as otherwise the program step-on is delayed.

5.1.2 Program step-on by time

If a core temperature setpoint of 0 has been selected the program steps on after the programmed segment time has elapsed.

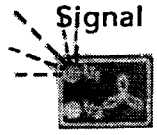
			display VII flashes 00:00 and requests entry of time	Pgm
10	Time e.g. 2 h : 50 min	2 5 0	display VII flashes 02:50	Pgm
11	Enter time	1	display VII has steady display 02:50	Pgm
			the first signal lamp in field ❹ flashes and requests entry of control function	

Note:

If chamber temperature setpoint 000 has been programmed for any segment (heating, drying etc.) this program segment is omitted immediately, and also during the automatic run.
If relative humidity setpoint 00 is programmed, the humidity controller is out of action.

5.2 Programming the function channels

A total of 20 function channels can be programmed for each program segment. The instrument contains 8 relays with changeover contacts and 12 relays with closing contacts. The relay actions for each control channel are entered with the number keys 0 or 1.
If 0 is entered the relay is de-energised.
If 1 is entered the relay is energised.

Step	Entry	Key	Display	Signal lamp
12	Relay state e.g. 1	1	_ _ _ _	

Immediately after this entry the sequence moves to the next relay.

Pressing 1 omits this next relay,

the previous relay action remains unchanged.

13	Relay state e.g. 1	1	_ _ _ _	

14-31 Continue programming until all function channels have been programmed. The program controller then switches automatically to the next program segment.

field ❺ TROCKNEN (drying)

display I flashes 000
and requests entry of
chamber temperature setpoint

32 The next program segments RÄUCHERN, KOCHEN, DUSCHEN and BACKEN (smoke, cook, wash and bake) and their functions are programmed in the same sequence as described above (steps 4 to 31). After the last function in the final program segment BACKEN (bake) has been entered all the displays go dark; the programming of program No. 12 is now completed.

6 PROGRAM CHECK

Press key [Nº]

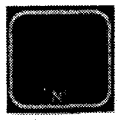
Field ❷ flashes 00

Select the desired program number (in this example 12) on the keypad

and press [↑]

Field ❺ RÖTEN (heat) lights up

All entries for this program segment are now being displayed:

Display I		Setpoint of chamber temperature (100°C in this examp
Display III		Setpoint of relative humidity (75% rH in this example)
Display V		Setpoint of core temperature (80°C in this example, Section 5.1.1)
Display VII		Time of program segment (2h:50 min in this example, Section 5.1.2)
Field 2		Reference number of selected program (12 in this example)
Field 4		Operation of the 20 function channels

Press key [↑]

All entries for the segment TROCKNEN (dry) are now being displayed

Continue pressing [↑] until the entries for program segment BACKEN

(bake) are displayed

Press [↑] again, all displays go out - the program check is completed

6.1 Program correction before program start

6.1.1 Correction of program setpoints

Example: Changing the time for segment TROCKNEN (dry)

Press key [№]

Field ❷ flashes 00

Select program number on keypad (12 in this example)

Press [↑]

Field ❺ RÖTEN (heat) lights up

All entries for this program segment are displayed

Press [↑]

Field ❺ TROCKNEN (dry) lights up

All entries for this program segment are displayed

Press [*Pgm]

Display I (chamber temperature setpoint) flashes

press [↑]

The chamber temperature setpoint is entered unchanged

Display III (relative humidity setpoint) flashes

Press [↑]

The relative humidity setpoint is entered unchanged

Display V (core temperature setpoint) flashes

Press [↑]

The core temperature setpoint is entered unchanged

Display VII (time) flashes

Select the desired new setpoint on the keypad

Press [↑]

The new time setting is entered

Press [*Pgm] * - program correction is terminated

* If function channels have to be corrected, do not press [*Pgm] but continue according to Section 6.1.2 (see also Manual key, Section 7.5).

6.1.2 Correction of control functions

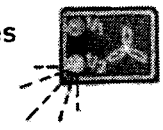
Example: Changing the second function channel

The first signal lamp in field ❹ (function channel) flashes

Press ↑

The relay action of the first function channel remains unchanged.

The second signal lamp in field ❹ (function channel) flashes



Enter 0 or 1

Press *Pgm - program correction is completed

Proceed similarly for other program segments or function channels (see also Manual key, Section 7.5).

7 PROGRAM RUN

Press key *

Select the reference number of the program on the keypad

Press ↑

7.1 Programming a hold time

Display VII flashes 00:00 - ready for programming a hold time

If a hold time is entered, the program starts when the hold time has elapsed.

7.2 Program start

If no hold time is selected the program run starts immediately when key ↑ is pressed.

After the program start field ❶ displays all process values and setpoints for the segment RÖTEN (heat).

The program moves on to the next segments:

- if a core temperature has been programmed:
  after reaching the programmed setpoint;

  or

- if a time has been programmed:
  after this time has elapsed.

7.3 Program end

The end of the program is indicated by the relay output with the hooter symbol (relay 9); the contact closes for 5 minutes. All displays are off, only the lignal lamps of key  and function channel  are alight.

7.4 External start/stop

External start

The DIL switch 2 on the memory must be closed for this mode of operation, as described in Section 3.5.2.

Close the external contact 28 to 29

Press 

Field ❷ flashes 00

Select the reference number of the program on the keypad

Press 

Signal lamp RÖTEN (heat) flashes

The program run starts on opening the external contact 28 to 29

External stop

Close the external contact 28 to 29.
The running time is stopped.
The display of the appropriate program segment flashes.

7.5 Manual key

Pressing key  prevents the move to the next segment by core temperature or time; the running time is stopped.

7.6 Loop programming
(linking several programs together)

Press 

Field ❷ flashes 00

Select the program reference number on the keypad

Press 

The first program is entered

Field ❷ flashes 00

Select the next program on the keypad

Up to 10 programs can be linked together in this way.

The programs must be entered in sequence with increasing numbers, e.g. 07, 08, 09, 10

After the last number has been entered

press 

Program start as described in Section 7.2

7.7 Fault indication

Faults in the course of a program run are indicated on the displays. The LEDs in the relay keys flash and the hooter sounds in 1-second bursts. Display IX indicates the fault as a 2-digit code.

01 = memory fault (RAM)

02 = transfer fault µPZ80 to µP8048

03 = transfer fault at the serial data port

04 = battery voltage insufficient for RAM back-up

08 = fault in serial data port component

13 = program memory fault

During a fault all keys are out of action with the exception of key 

The fault is acknowledged by pressing key 

8 PROGRAM CORRECTION DURING RUN

Key  has been pressed, program is running

Press 

Press 

Chamber temperature setpoint display in field I flashes

If the chamber temperature setpoint has to be changed, select the new value on the keypad.

Press 

Setpoint % rH in field III flashes etc.

After the changes have been made, press key 

The program now continues automatically with the changed setpoints.

When starting the program again all setpoints in the working memory are cancelled!

9 CLEANING PROGRAM

The cleaning program is started through a separate key  which is interlocked with an external contact (27 to 29).

Example:

Program blocked by phote-electric cell in the chamber if the carriage has been pushed in.

9.1 Programming the cleaning program

Press 

Field ❷ flashes 00

Press 

Field ❷ goes out

Set up the program as described in Section 5.1 and 5.2

9.2 Starting the cleaning program

Press 

Field ❷ flashes 00

Press 

Display VII flashes 00:00 and requests programming of hold time.
If a time is programmed, cleaning starts after this time has elapsed.

If no hold time is programmed, the program can be started immediately by pressing key  when the external interlock contact 27 to 29 is open-circuit. With the contact closed the LED in key  flashes.

10 CONTROL

10.1 Chamber temperature (°C)

Single setpoint controller with limit comparator lk1 to lk6 or alarm contact ws2
Double setpoint controller for heating and cooling
Parameter selection by rotary switch on board ⑥ inside the instrument:
(see Section 3)

- Setpoint ws2 or lk1 to lk6:	3 digits 0 - 199°C
- Proportional band Xp:	in 16 steps
- Double setpoint controller, contact spacing:	Xk = 1 - 15°C

The following can be selected by DIL switches:
(see Section 3)

- Switching rate fs:	0.25, 1, 2, 15 operations per minute
- Delay time Tv:	32, 64, 128, 256 sec; Tn = 4 Tv
- Switching differential Xd:	0.1, 0.2, 0.4, 0.8°C
- Feedback:	PD, PID or PD/PID action
- Control action:	O (open on rise), S (open on fall)
- Limit comparator:	lk1 to lk6
- Feedback:	Xp symmetrical or single-sided
- Alarm contact ws:	O, S

On probe failure the corresponding display flashes,

the relay with the hooter sign  closes repeatedly for 1 sec.

The control functions are out of action. All control and relay outputs

are interrupted; switch off with key 

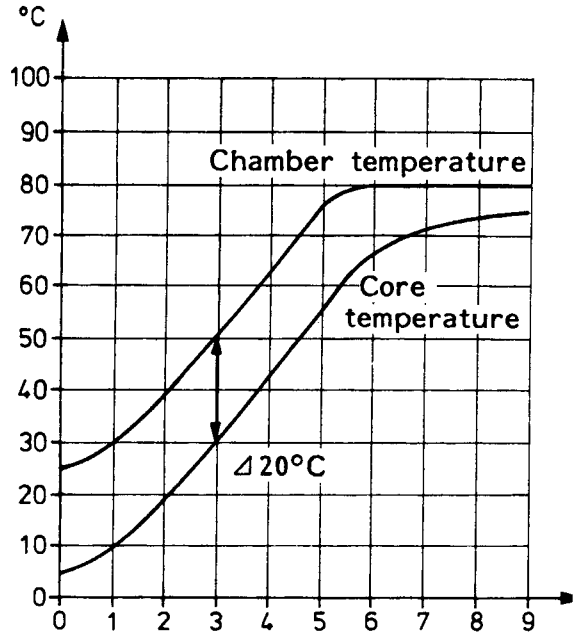
10.2 Core temperature (°C)

The core temperature controller is linked in through the software and has no direct output. When the actual value has reached the selected core temperature setpoint the system moves on to the next program segment.

10.3 Difference cooking process

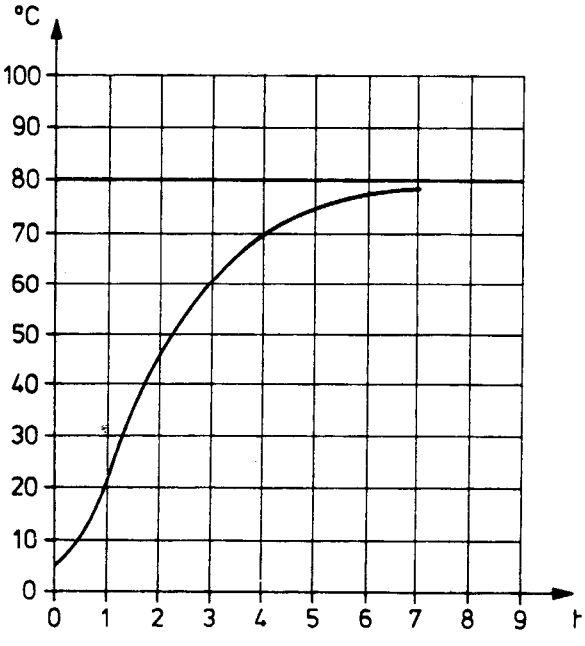
An external input (floating contact 19 to 29) is used to start the difference cooking process.

The chamber temperature setpoint is set 20°C above the actual core temperature and increases continuously until the chamber temperature setting is reached. The core temperature continues to rise to the programmed core temperature setpoint, and the instrument then moves to the next program segment.



Difference cooking process

If no core temperature has been programmed, the difference cooking process is out of action.



Chamber temperature control with fixed setpoint

10.4 Relative humidity (% rH)

The relative humidity is sensed with two Pt 100 resistance thermometer probes (dry and wet bulb) using the psychrometer principle (air flow 2 - 5 m/sec). The relative humidity is calculated from the partial water vapour and displayed directly in % rH.

The reference temperature for humidity control is compensated for the actual operating temperature.

The control range is 0 to 99% rH at an ambient temperature of 10 to 100°C.

The controller operates as:

- on-off single setpoint controller with limit comparator lk1 to lk6 or alarm contact ws2, and all the adjustment parameters as in Section 10.1 chamber temperature (%rH instead of °C)
  or
- double setpoint controller with symmetrically adjustable contact spacing (see Section 3.4) and ± Xp separately adjustable. The contact spacing can be selected in 15 steps with switch ⊿XkF.

11 FUNCTION CHANNELS

20 programmable relays, rating 1 A at 220 V/50Hz resistive load. 8 relays with floating changeover contact and 12 relays with floating closing contact.

Electrical connections are through the two cables (supplied) using a 32-pin connector.

Programming of the function channels can be blocked by an internal switch (see Section 3.5.3).

12 DATA OUTPUT (DATA PORT)

Serial data port with fixed baud rate (2400 baud) for linking to a data printer or a second program controller.
All setpoints are printed out at the end of each program segment; data format: Intel-Hex.

12.1 Programming the serial data port

Press [•Pgm]

Field ❷ flashes 00

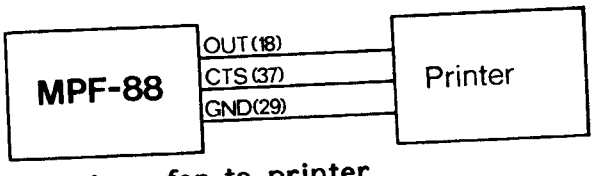
Enter the program reference number on the keypad

Press [№]

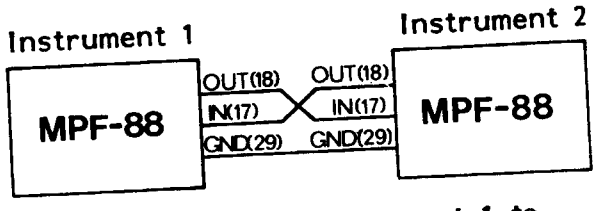
On pressing key [7] the selected program is output at the serial data port

On pressing key [8] the selected program is output in Intel-Hex data format (e.g. to a second program controller)

On pressing key [9] a program is read in (e.g. from a second program controller) and stored in the program memory

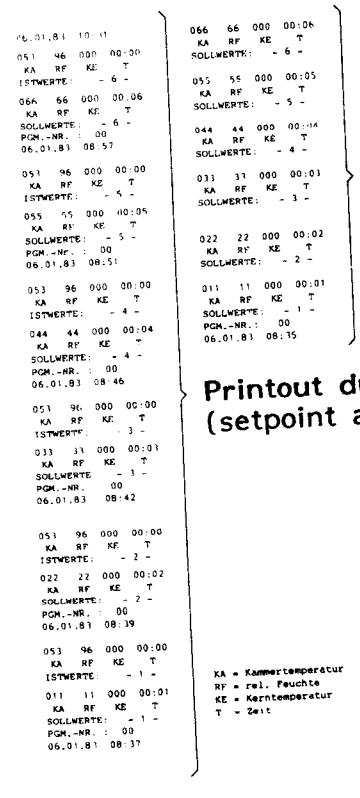


Data transfer to printer



Data transfer from instrument 1 to instrument 2

Program instrument 2 with Pgm 9.
Display on instrument 2 shows 00.
Program instrument 1 with Pgm 8.
Display on instrument 2 goes out after approx. 1 sec.
Data transfer is completed.



Printout with Pgm 7 (setpoints)

Printout during program run (setpoint and process values)

13 DATA BACK-UP

The data in the memory are backed-up by a lithium battery which is housed in a battery box (Section 2.2.7) in the back of the housing.
The battery life is 3 - 5 years.
Falling-off of the battery voltage causes the signal lamps in the 4 function keys ❻ to flash.
Field ❷ flashes 04.

To cancel the alarm press key  ,

the unit continues to work normally.
Battery capacity is sufficient for another 2 - 5 months.
Change the battery!

14 MAINS FAILURE

In case of mains supply failure the automatic program run is interrupted immediately.

When the mains supply is restored the automatic program is continued if the difference between the actual chamber temperatures before and after the mains failure is less than 10%.
If the difference exceeds 10% the automatic program run remains interrupted,

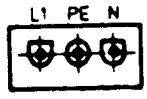
the LEDs function channel  and  flash, relay 9 is energised.

Press key  to continue or restart program run.

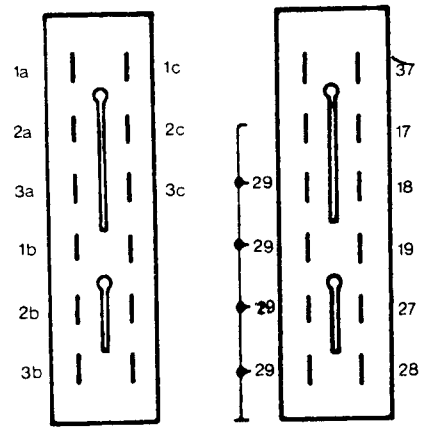
15 CONNECTION DIAGRAM

Mains connection

Supply see rating label	L1 line PE ground N neutral

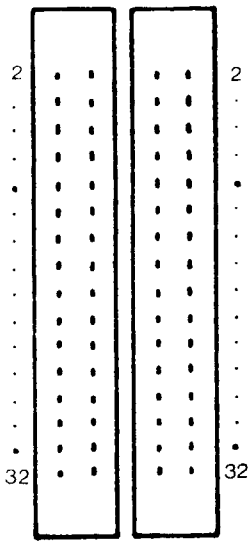


Connectors

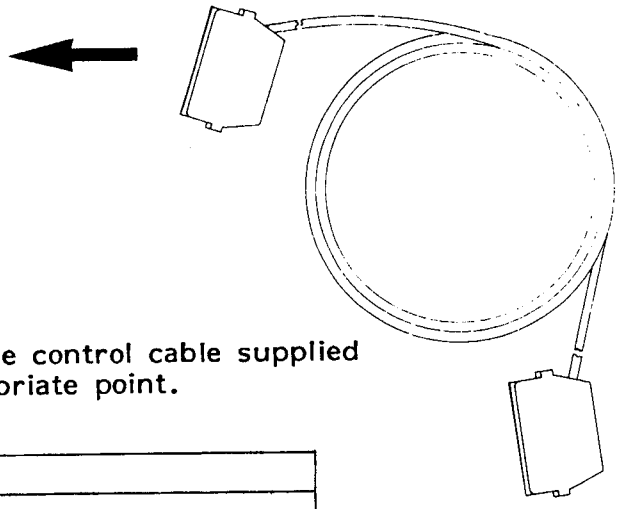


Connectors	
Detail	Connection
Chamber resistance thermometer	1a 2a 3a
Core resistance thermometer	1b 2b 3b
Humidity resistance thermometer	1c 2c 3c
Serial data port V 24 Rx	17 29 IN
Serial data port V 24 Tx	18 29 OUT
Serial data port V 24	37 Clear to send
Difference cooking process	19 29
Cleaning program interlock	27 29
Keypad lock	28 29 see Section 3.5.2
External stop	28 29 see Section 3.5.2

Connector I

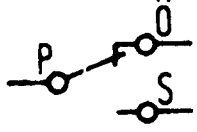


Connector II



Please cut the control cable supplied at the appropriate point.

Connector		Connector	
Chamber Relay Xk1	a2 S wh c2 O wh-gr a4 P br	Relay 10	a2 S wh c2 O wh-gr a4 P br
Chamber Relay Xk2	c4 S br-gr* a6 O gn c6 P wh-pk	Relay 11	c4 S br-gr* a6 O gn c6 P wh-pk
Humidity Relay Xk1	a8 S ye c8 O br-pk* a10 P gr	Relay 12	a8 S ye c8 O br-pk* a10 P gr
Humidity Relay Xk2	c10 S wh-bl a12 O pk c12 P br-bl	Relay 13	c10 S wh-bl c12 O pk c12 P br-bl
Relay 1	a14 S bl c14 O wh-rd a16 P rd	Relay 14	a14 S bl c14 O wh-rd a16 P rd
Relay 2	c16 S br-rd a18 O bk c18 P wh-bk	Relay 15	c16 S br-rd a18 O bk c18 P wh-bk
Relay 3	a20 S vio c20 P br-bk	Relay 16	a20 S vio c20 P br-bk
Relay 4	a22 S gr-pk c22 P gn-gr*	Relay 17	a22 S gr-pk c22 P gn-gr*
Relay 5	a24 S bl-rd* c24 P ye-gr	Relay 18	a24 S bl-rd* c24 P ye-gr
Relay 6	a26 S wh-gn c26 P gn-pk*	Relay 19	a26 S wh-gn c26 P gn-pk*
Relay 7	a28 S br-gn c28 P ye-pk	Relay 20	a28 S br-gn c28 P ye-pk
Relay 8	a30 S wh-ye c30 P gn-bl		
Relay 9	a32 S br-ye* c32 P ye-bl		



S = closing
0 = open
P = common

* also in reverse ratio

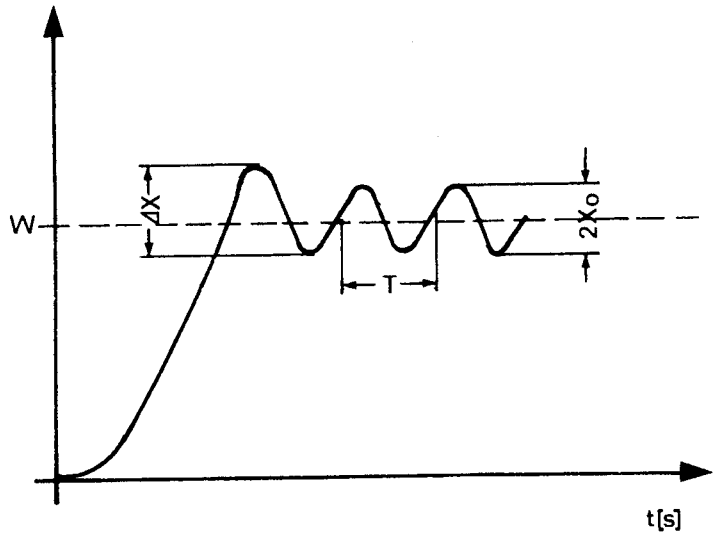
16 MATCHING THE CONTROLLER PARAMETERS TO THE PROCESS (OPTIMISATION)

The purpose of the optimisation is to find the control parameters giving the smallest possible deviation, a satisfactory damping of the control action and a stabilisation time which is not excessively long.

16.1 Determining process characteristics by the oscillation method

This method applies to processes which may be rendered unstable for a brief period. Tg and Tu = less than 3

The controller is operated first without feedback. The Xp switch inside the instrument is set to 0. The parameters Tn and Tv are then also ineffective. The process is recorded until it performs undamped oscillations of constant amplitude. From the amplitude 2 • X0 and the time T the individual parameters can be established according to empirical rules.



Feedback	Xp	Tn	Tv	Note
PD action	$2 \cdot X0$	--	$\frac{T}{16}$	permanent offset
PD/PID action	$\frac{\Delta X \cdot 5}{20}$	--	$0.15 \cdot T$	----------

The values for Tn and Tv can be adjusted inside the controller to match them to the calculated values (see Section 3.2.4).

16.2 Adjustment according to the process characteristics

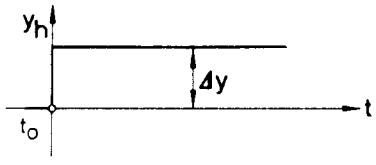
It is not always possible to render the process unstable for a brief period. An alternative method is therefore based on the process data. Using the transfer function (response to a sudden change in controller setting) the following data are determined:

Ks = process transfer coefficient

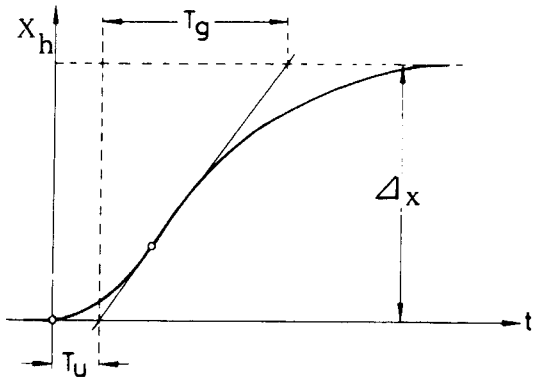
$$Ks = \frac{\Delta x}{\Delta y} = \frac{\text{output signal change}}{\text{input signal change}}$$

Tu = delay time and Tg = time constant

To determine the transfer function, the input of the process is suddenly changed at time t_o by an amount Δy within the adjustment range Yh (e.g. 10% of Yh).



The result is a transfer function with values for Δx, Δy, Tu and Tg, where Tu and Tg are obtained in minutes, Δy in % of the adjustment range Yh and Δx in % of the control range Xh. t_o is the instant when the transfer function starts.



The controller is then adjusted according to the empirical rule for processes with saturation as follows:

$$Kp = 1.2 \cdot \frac{1}{Ks} \cdot \frac{Tg}{Tu}$$

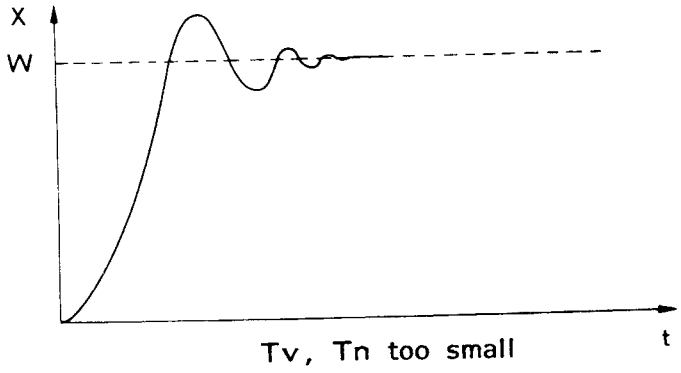
$$Tn = 2 \cdot Tu$$

$$Tv = 0.44 \cdot Tu$$

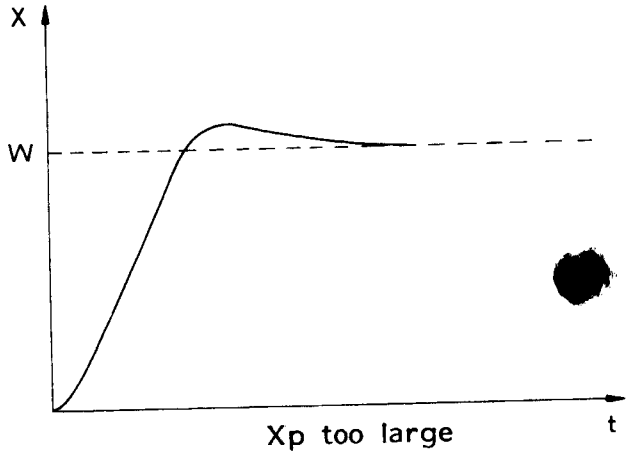
$$Xp = 0.83 \cdot Ks \cdot \frac{Tu}{Xh} \cdot 100\%$$

16.3 Checking the optimisation

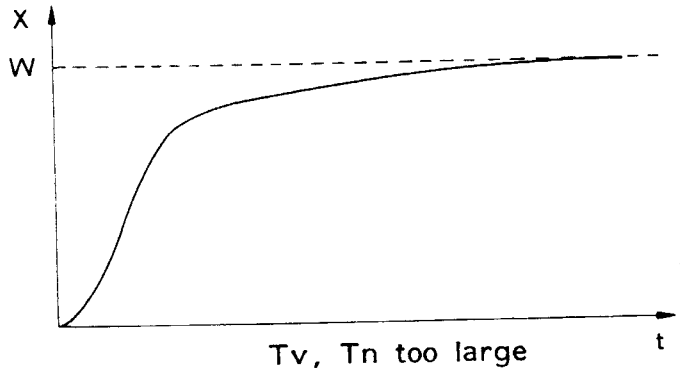
The optimum adjustment of the controller to the process can be checked by recording a process transfer function.
The diagrams below indicate possible incorrect adjustments and the correction required.



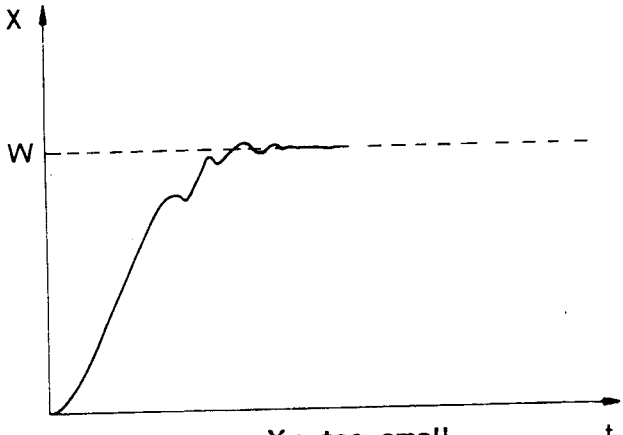
Tv, Tn too small



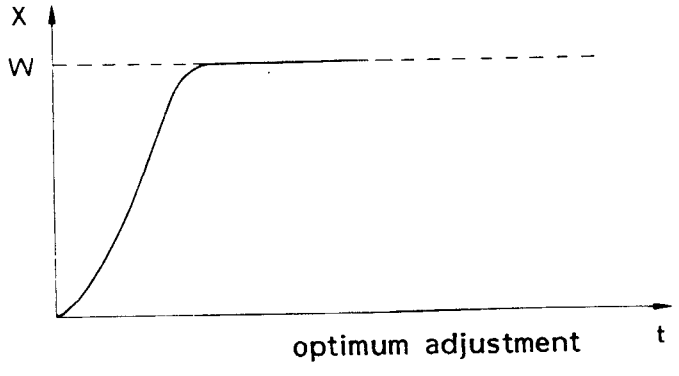
Xp too large



Tv, Tn too large

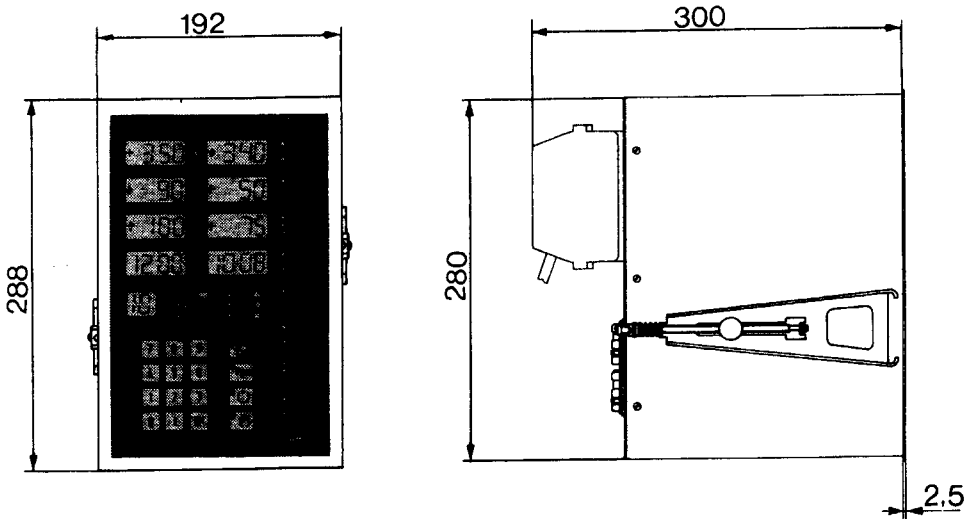


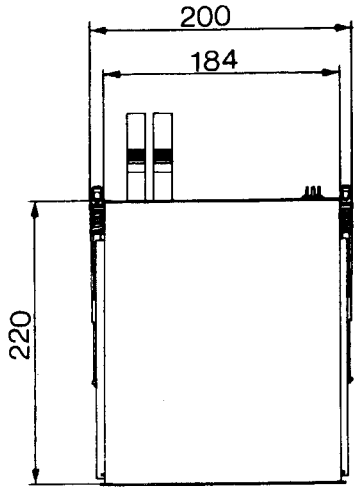
Xp too small

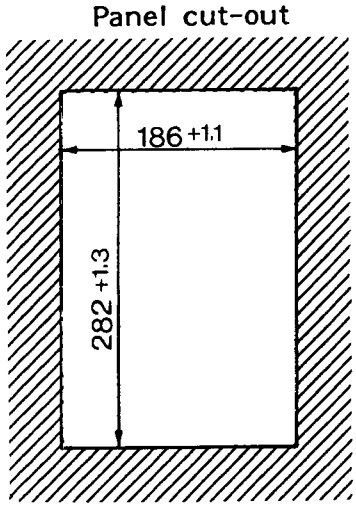


optimum adjustment

17 DIMENSIONS







mm	inch	mm	inch	mm	inch
2.5	0.10	192	7.56	$282^{+1.3}$	$11.10^{+0.05}$
184	7.24	200	7.87	288	11.33
$186^{+1.1}$	$7.32^{0.04}$	220	8.66	300	11.81

18 MAINTENANCE AND SERVICING

The microprocessor program controller requires no maintenance.

If the instrument becomes faulty please return it to the supplier with full details of the fault.

The staff of our Technical Offices, Subsidiaries and Agencies are available at all times for advice and to service our instruments.

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