JUMO

MEASUREMENT AND CONTROL

JUMO DICON SM
Universal Compact Controller for industrial and process control

Housing to DIN 43 700
for flush panel mounting
Bezel 96 x 96 mm

B 70.3550

10.93/V 00085046

Operating Instructions

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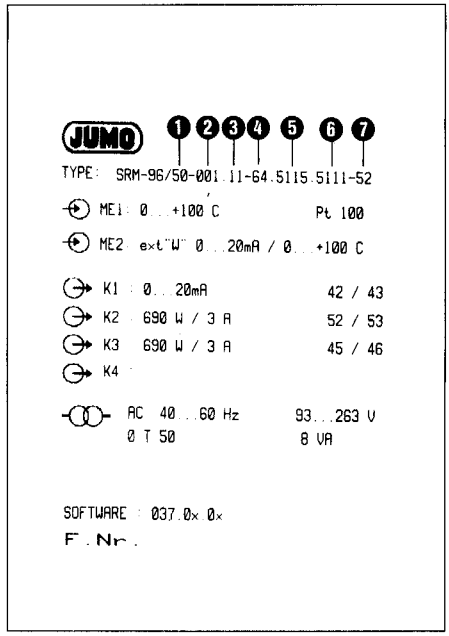
Note
All necessary settings and alterations are described in these Operating Instructions.
If, however, any difficulties should arise during start-up you are asked not to carry out any manipulations on the instrument which are not permitted.
You could endanger your rights under the instrument warranty. Please contact the nearest office or the factory.

1 DESCRIPTION

1.1 Type designation

The type label is affixed to the housing. The type designation contains all the factory settings such as controller function, signal inputs and extra Codes.
The mains supply must agree with the supply voltage stated on the label.



1 Controller function ..

Description

Single-setpoint controller with max. contact (relay de-energised for process above setpoint), feedback action can be configured[1]	10
Single-setpoint controller with min. contact (relay de-energised for process below setpoint), feedback action can be configured[1]	20
Double-setpoint controller, feedback action can be configured[1]	30
Modulating controller, feedback action can be configured[1]	40
Proportional controller, feedback action, output signal, characteristic can be configured[1]	50
Proportional controller with integral driver for motorised actuators[2]	80

[1] the factory settings are shown in the Parameter Table in Section 5.2.

2 Input 1 ...

Process

resistance thermometers in 3-wire circuit	
Pt 100	0 0 1
resistance transmitters	0 2 1
thermocouples	
Cu-Con T	0 3 9
Fe-Con J	0 4 0
Cu-Con U	0 4 1
Fe-Con L	0 4 2
NiCr-Ni K	0 4 3
Pt10Rh-Pt S	0 4 4
Pt13Rh-Pt R	0 4 5
Pt30Rh-Pt6Rh B	0 4 6
MoRe5-MoRe41	0 4 7
linearised transducers	
0 – 1 mA	0 5 1
0 – 20 mA	0 5 2
4 – 20 mA	0 5 3

2 Input 1 ...

Process (cont.)

linearised transducers	
0 – 50 mV	0 6 1
0 – 1 V	0 6 2
0 – 10 V	0 6 3
non-linearised transducers	
0 – 1 mA (range ... *)	1 . **
0 – 20 mA (range ... *)	2 . **
4 – 20 mA (range ... *)	3 . **
Special range (range ... *)	9 0 0
non-linearised transducers	
0 – 50 mV (range ... *)	4 . **
0 – 1 V (range ... *)	5 . **
0 – 10 V (range ... *)	6 . **
Special range (range ... *)	9 0 0

* specify range in full
** the two dots are replaced on the label by the last two digits of the transducer code, e.g.: 241: 2 means input 0 – 20 mA, 41 means linearisation to Cu-Con U.

❸ Input 2

. .

Function | |

not used	0 0
temperature difference input (sensor as input 1)	0 1
display of second process variable (sensor as input 1)	0 2
cold junction temperature (Pt 100 probe in 3-wire circuit)	0 3
heater current indication (0 – 20 mA, 50 Hz a.c.)	0 4
ratio input 0/4 – 20 mA, 0 – 10 V (sensor as input 1)	0 5
humidity input (psychrometric)	0 6
actuator retransmission with resistance transmitter	0 7
external setpoint	1 .
external setpoint with correction from the front	2 .
interference signal input	3 .

input signal:

0 – 20 mA	. 1
4 – 20 mA	. 2
0 – 10 V	. 3
0 – 1 V	. 4
0 – 50 mV	. 5
0 – 1 mA	. 6

❹ Output 1

6 .

Function of output | |

controller output y 6

Type of output

relay	1
0/5 V or 0/20 mA	2
semiconductor relay 1 A	3
0 – 20 mA	4
4 – 20 mA	5
–20/0/+20 mA	6
0 – 10 V	7
–10/0/+10 V	8
logic output, isolated 0/20 V* or 0/20 mA*	9

* standard setting;
different setting to be specified in full

❺ ❻ Outputs 2 and 3

. . . .

Functions of output | | | |

not used	0 0 0 0
process x (*)	1
setpoint w (*)	2
deviation xw (*)	3
second process variable (*)	4
limit comparator	5
controller output y	6

* range of values

Type of output

relay	1
0/5 V or 0/20 mA	2
semiconductor relay 1 A	3
0 – 20 mA	4
4 – 20 mA	5
–20/0/+20 mA	6
0 – 10 V	7
–10/0/+10 V	8
logic output, isolated 0/20 V* or 0/20 mA*	9

* standard setting;
different setting to be specified in full

Limit comparator function

no limit comparator	0 0
lk1 referred to input *	* 1
lk2 referred to input *	* 2
lk3 referred to input *	* 3
lk4 referred to input *	* 4
lk5 referred to input *	* 5
lk6 referred to input *	* 6
lk7 referred to input *	* 7
lk8 referred to input *	* 8

*=1 for input 1
*=2 for input 2

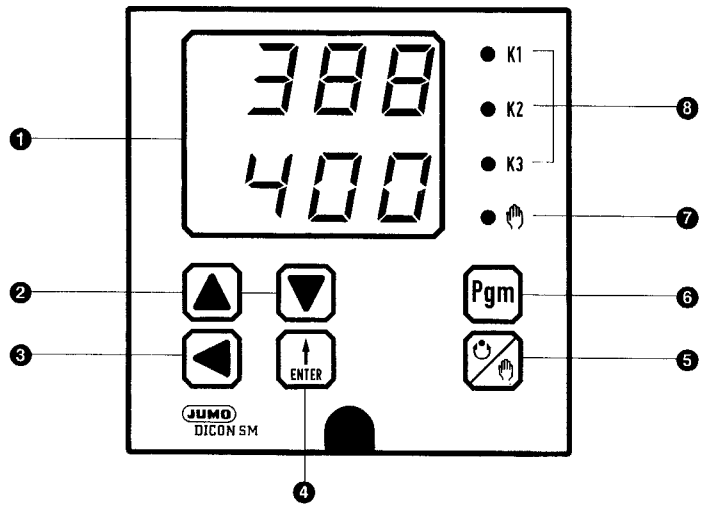
❼ Extra Codes

. .

Interface | |

V.24 (RS232C)	5 1
RS422/485	5 2
Ramp function with adjustable gradient and external stop	5 4
Construction to DIN 3440	5 6
Supply for 2-wire transmitter 20 V, 20 mA, isolated	5 8

1.2 Indications and controls



1 **Numerical display**
two 4-digit LED displays
for setpoint, process or
other process variables

2 **Increment and decrement keys**
for altering the
displayed value

3 **STEP key**
for selecting the
digit to be altered

4 **Enter key**
for entering the inputs

5 **Auto/manual key**
for changeover between manual
and automatic operation

6 **Programming key**
for parameter selection

7 **LED**
for manual operation

8 **LEDs**
status indication
for the outputs K1 to K3

1.3 Technical data

Controller for use with resistance thermometers

Input
Pt 100 in 3-wire circuit

Control range (°C or °F)
–199.9+850.0°C

Line balancing
not required with 3-wire circuit.
When using an existing resistance thermometer in 2-wire circuit it is necessary to provide line balancing. This can be done either at the configuration level or by means of an external line balancing resistor.
($R_{balance} = R_{line}$)

Controller for use with thermocouples

Input
Cu-Con U/T, Fe-Con L/J, NiCr-Ni K, Pt10Rh-Pt S, Pt13Rh-Pt R, Pt30Rh-Pt6Rh B or MoRe5-MoRe41 according to IEC or ISA

Control ranges

Cu-Con U –200 + 600°C	Fe-Con L –200 +1000°C
Cu-Con T –200 + 400°C	Fe-Con J –200 + 900°C
NiCr-Ni K –200 +1400°C	Pt10Rh-Pt S 0 +1800°C
Pt13Rh-Pt R 0 +1800°C	Pt30Rh-Pt6Rh B 0 +1820°C
MoRe5-MoRe41 0 +1990°C	

isolation of both inputs up to ±5 V

Temperature compensation
internal; external also available (can be configured)

Controller for use with linearised transducers with standard current or voltage signal

Input

0 – 1 mA	Ri = 50 Ω
0(4) – 20 mA	Ri = 2.5 Ω
0 – 50 mV	Ri = 100 kΩ min.
0 – 1 V	Ri = 50 kΩ
0 – 10 V	Ri = 500 kΩ

Control and display range
can be freely configured

Controller for use with non-linearised transducers with standard signal

Input
as for linearised transducers with standard signal

Control range
can be freely configured

Controller for use with resistance transmitters

Input
range: min. 0 – 30 Ω, max. 0 – 10 kΩ

Control range
can be freely configured

Current input for heater current
48–63 Hz a.c., 0–20 mA
for connection to a current converter

Outputs

3 outputs with the following possibilities are available which can be configured:

1 **Relay outputs with floating contact**
Rating: 690 W 3 A at 230 V 50 Hz, resistive load
Contact life:
approx. 10^6 operations at rated load

2 **Logic output**
0/5 V or 0/20 mA, Ri = 240 Ω

3 **Logic output**
isolated, 0/20 V* or 0/20 mA*
* adjustment range 4 – 20 V or 10 – 20 mA available to special order

4 **Semiconductor relay output**
220 V 50 Hz, 1 A, p.f. = 0.7 min.

5 **Analogue output (fully isolated)**

as selected	burden
0 – 20 mA	500Ω max.
4 – 20 mA	500Ω max.
–20/0/+20 mA	500Ω max.
0 – 10 V	500Ω min.
–10/0/+10 V	500Ω min.

Resolution D/A converter
13 bit

Accuracy of output signal
0.25% or better

6 **Supply for 2-wire transmitter**
20 V 20 mA. short-circuit protected, fully isolated

General controller data

Controller type
used as single-setpoint or double-setpoint controller, modulating or proportional controller, with integral control station for bump-free auto-manual changeover.
As proportional controller with integrated driver it can be used for operating motorised actuators.

A/D converter
resolution 15 bit

Measurement accuracy	Ambient temperature error
when used with resistance thermometers and resistance transmitters	
0.05% or better	0.01% max. per 10°C
when used with thermocouples within the working range	
0.25% or better	0.05% max. per 10°C
when used with linearised transducers with standard signal	
0.05% or better	0.05% max. per 10°C

These values include the linearisation tolerances.

Signal circuit monitor
(sensor break or short-circuit)
The outputs move to a defined value.

Data back-up
EEPROM

Supply
93 – 263 V a.c., 40 – 60 Hz or
17 – 44 V a.c., 40 – 60 Hz or
24 – 63 V d.c.

Loading
8 VA approx.

Electrical connection
through faston connectors to DIN 46 244/A, 4.8 x 0.8 mm

Permitted ambient temperature range
0 to 50°C

Permitted storage temperature range
–40 to +70°C

Climatic conditions
Class KWF to DIN 40 040,
rel. humidity not exceeding 75% annual mean, no condensation

Housing
aluminium extrusions, black anodised, with plug-in chassis (connected to ground)

Protection
to DIN 40 050
front IP54, rear IP20

Operating position
unrestricted

Interfaces
V.24 (RS232C) or RS422/485 (isolated from the remaining electronics). Device addresses (on RS422/485) can be configured.
Operation in communication mode.

For further details see Operating Instructions D 97.560.2/565.2.

Limit comparators
The controller is provided with up to 2 limit comparators, depending on the model. The desired limit comparator function and the switching differential X_{Sd} are adjustable at the configuration level. The setpoint AL is adjusted at the parameter level.

Notes for controllers registered to DIN 3440:

On these controllers (registration No. TR 965 93) the factory set setpoint stop may not be adjusted. After inspection of the equipment the parameter and configuration level must be locked.

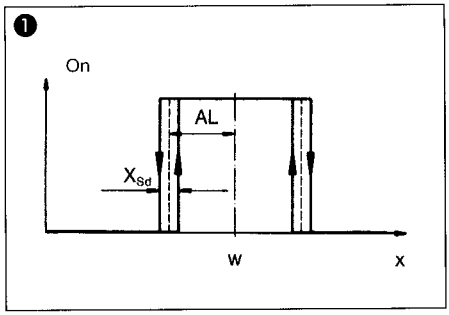
Suitable probes with DIN approval are listed in data-sheet 90.330.

1.4 Limit comparator functions

❶ Function Ik1

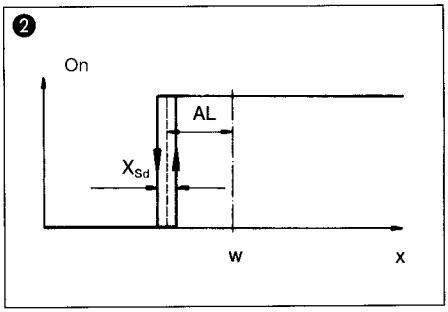
Window function: the relay is energised when the process is within a window about the setpoint W.

Example: W = 200°C, AL = 20, X_{Sd} = 10
Process value rising: relay switches on at 185°C and off at 225°C.
Process value falling: relay switches on at 215°C and off at 175°C.



❷ Function Ik2

as Ik1 but relay action reversed



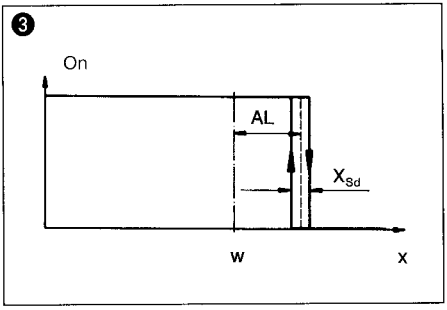
❸ Function Ik3

Low alarm:
the relay is de-energised when the process falls below the setpoint by the set amount.

Example: W = 200°C, AL = 20, X_{Sd} = 10
Process value rising: relay switches on at 185°C.
Process value falling: relay switches off at 175°C.

❹ Function Ik4

as Ik3 but relay action reversed



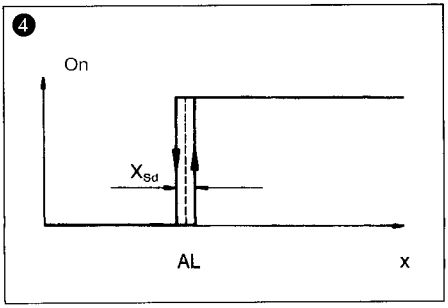
❺ Function Ik5

High alarm:
the relay is de-energised when the process rises above the setpoint by the set amount.

Example: W = 200°C, AL = 20, X_{Sd} = 10
Process value rising: relay switches off at 225°C.
Process value falling: relay switches on at 215°C.

❻ Function Ik6

as Ik5 but relay action reversed



❼ Function Ik7

Independent of the controller setpoint.
The relay is energised when the process value is above the alarm level AL.

Example: AL = 200, X_{Sd} = 10
Process value rising: relay switches on at 205°C.
Process value falling: relay switches off at 195°C.

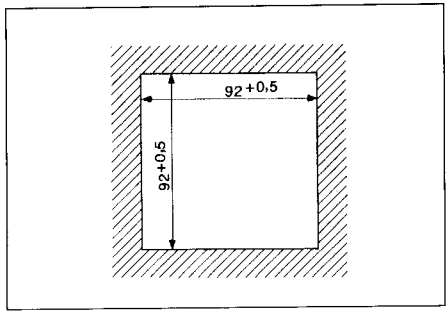
❽ Function Ik8

as Ik7 but relay action reversed

2 INSTALLATION

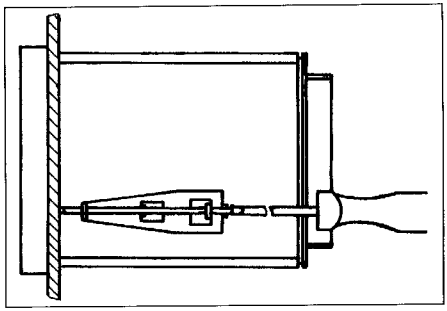
2.1 Location and climatic conditions

The instrument location should as far as possible be free from vibrations. Stray electro-magnetic fields, e.g. from motors, transformers etc., should be avoided. The ambient temperature at the instrument location should be between 0 and 50°C at a relative humidity not exceeding 75%. Corrosive atmosphere or fumes reduce the life of the controller.

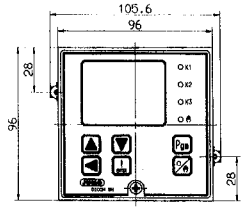


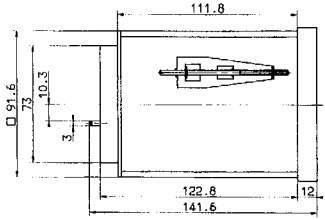
2.2 Fitting in position

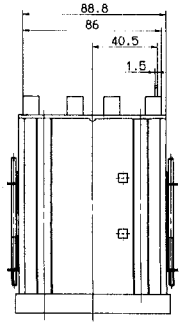
Insert the controller from the front into the panel cut-out. From the back of the panel hook the mounting brackets into the cut-outs in the sides of the housing. The flat bracket faces must lie against the housing. The brackets are then placed against the rear of the panel and tightened up evenly with a screwdriver.

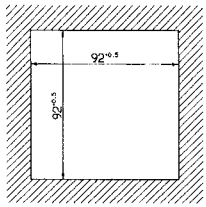


2.3 Dimensions





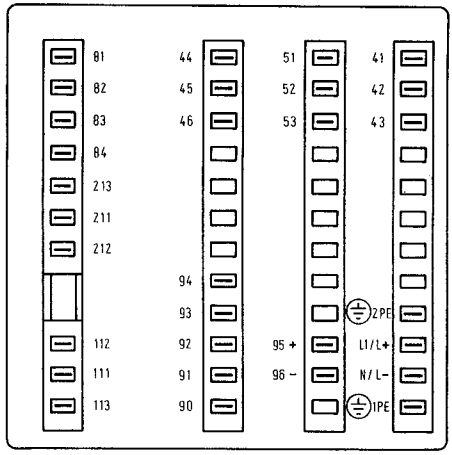




3 ELECTRICAL CONNECTION

The electrical connections are made in accordance with the connection diagram below. The choice of cable and the installation of the supply line must meet the requirements of VDE 0100 "Regulations on the Installation of Power Circuits with nominal voltages below 1000 V" or the appropriate local regulations.

Illustration on the right:
Rear view with faston connectors



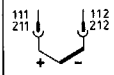
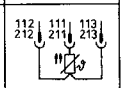
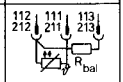
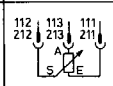
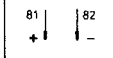
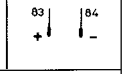
3.1 Connection diagram

Connection for		Terminals			
		Relay output*	Analogue output	SCR output**	Logic output 0/5 V or 0/20 V
Relay or semiconductor relay or logic outputs	K1	41 (O) n.c. (opening) 42 (P) common 43 (S) n.o. (closing)	42 – 43 +	42 43	42 – 43 +
	K2	51 (O) n.c. (opening) 52 (P) common 53 (S) n.o. (closing)	52 – 53 +	52 53	52 – 53 +
	K3	44 (O) n.c. (opening) 45 (P) common 46 (S) n.o. (closing)	45 – 46 +	45 46	45 – 46 +
Output 4		95 + 20 V 20 mA supply 96 – for 2-wire transmitter			
Supply as on label	AC/DC	L1 line N a.c. neutral 1PE ground 2PE screen		d.c. L + L –	

* contact protection circuit 22 nF 56 Ω between common and opening contact

** Varistor protection circuit 300 V

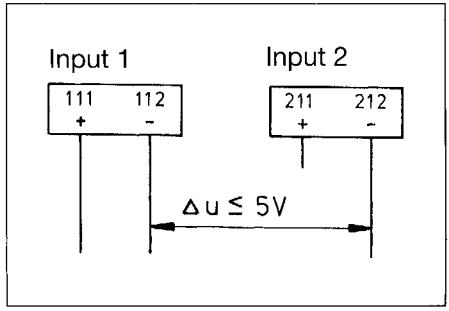
3 ELECTRICAL CONNECTION

Signal input	Terminals				
		Input			
		1	2		
Thermocouple		111 112	211 212	+ –	
Resistance thermometer in 3-wire circuit		111 112 113	211 212 213		
Resistance thermometer in 2-wire circuit		111 112 113	211 212 213	$R_{LAW} = R_{balance}$	
Standard signal voltage/current		111 112	211 212	+ –	
Resistance transmitter with 3-wire connection		112 111 113	212 211 213	S = slider E = end A = start	
External contact K1		81 82		+ 82 and 84 are – linked internally	
External contact K2		83 84		+ –	
Serial interface RS232 (V.24)	RxD	91		Received data (receiving line)	
	TxD	93		Transmitted data (transmitting line)	
	CTS	92		Clear to send (ready to send)	
	RTS	94		Request to send (switch on transmitter)	
	GND	90		Signal ground	
Serial interface RS422	A(+) B(–)	91 92		Received data (receiving pair)	
	A(+) B(–)	93 94		Transmitted data (transmitting pair)	
	GND	90		Signal ground	
Serial interface RS485	A(+) B(–)	93 94		Transmitted/received data (transmitting/receiving pair)	
	GND	90		Signal ground	

3 ELECTRICAL CONNECTION

3.2 Important notes on installation

- The choice of cable, the installation, and the connection to the supply must meet the requirements of VDE 0100 "Regulations on the Installation of Power Circuits with nominal voltages below 1000 V" or the appropriate local regulations.
- Work inside the unit must only be carried out to the extent described and, like the electrical connection, only by qualified technicians.
- The unit must be isolated on both line and neutral from the supply when there may be contact with live components during work.
- A current limiting resistance interrupts the supply circuit in case of a short-circuit. The external fuse of the supply should not exceed a value of 1 A (slow). In order to avoid welding of the contacts in the output relay in case of an external short-circuit in the load circuit, the latter has to be fused according to the maximum relay current [1].
- There must be no magnetic or electrical fields in the neighbourhood of the instrument, e.g. due to transformers, radio telephones, or electrostatic discharges.
- Inductive loads (relays, solenoid valves etc.) should not be installed near the instrument and should be fitted with RC modules for interference suppression.
- In case of a very "noisy" supply (e.g. thyristor controls) the instrument should be fed through an isolating transformer.
- Supply fluctuations are permitted only within the limits of the voltage range indicated [1].
- When using several analogue inputs, the potential difference of the negative connections must not exceed 5 V!



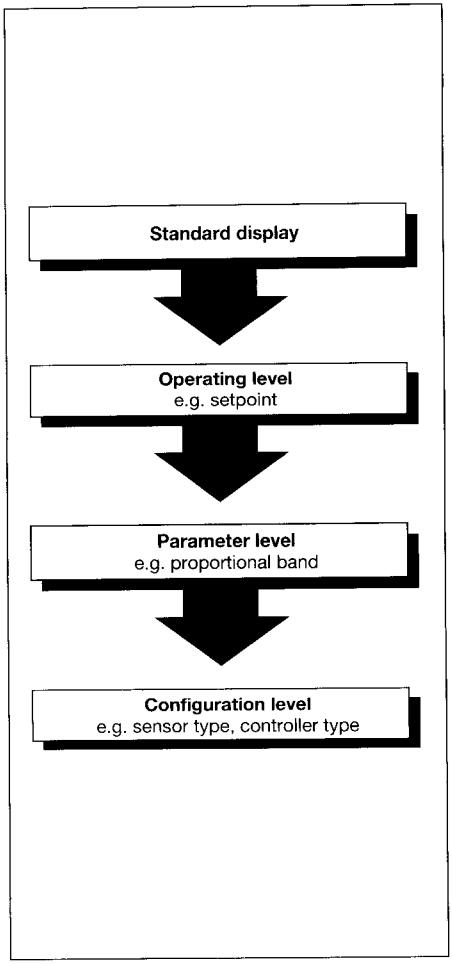
- Input, output and supply lines should be run separately and not parallel to each other.
- Screened and twisted cables should be used for sensor and interface lines. Do not run them close to current-carrying components or cables. The screen should only be grounded at one end at the controller (terminal 2PE).
- Ground the instrument to the ground line at terminal 1PE. This line should have the same cross-section as the supply lines. Run the ground lines to a common grounding point in a star-shaped layout, and connect this grounding point to the supply ground conductor. Do not loop the ground lines, i.e. do not run them from one instrument to the next.
- Do not connect any further loads to the supply terminals of the instrument.
- The instrument is not suitable for installation in areas subject to explosion hazard.
- In addition to faulty installation, it is possible for incorrect settings on the controller (setpoint, data of parameter and configuration level, alterations inside the unit) to interfere with correct operation of the controlled process or cause damage. It is therefore important to provide always safety features independent of the controller, e.g. overpressure valves or temperature limiters/monitors, and ensure that setting is possible only by qualified technical personnel. Please observe the appropriate safety requirements in this connection. Adaptation (self-optimisation) cannot be expected to handle all possible control loops and unstable parameter configurations are theoretically possible. The process value reached should therefore be checked for its stability.

1) see Technical Data

4 OPERATION

4.1 Levels and inhibits

For clearer identification of the large number of possible actions the controller parameters are arranged on three distinct level:
- operating level
- parameter level
- configuration level.



Operating level/Standard display

The two displays show process value and setpoint. The setpoint can be altered. It is also possible to change over to manual operation. With appropriate configuration (see Section 6.3) it is possible to display other variables, e.g. controller output or second process variable.

Parameter level

At this level the controller is adjusted to suit the process. The individual parameters are displayed sequentially as value and symbol. Only those parameters are indicated which correspond to the particular controller model (see Section 5.2).

Configuration level

This level serves to alter the controller to suit the particular application. The control is out of action. The factory setting can be changed at any time. The integral card recognition system ensures that the controller indicates only those parameters which correspond to the existing hardware.

Internal switches determine whether the controller operates with the factory-set configuration data when the supply is switched on, or whether the data input by the user are used (see Section 8).

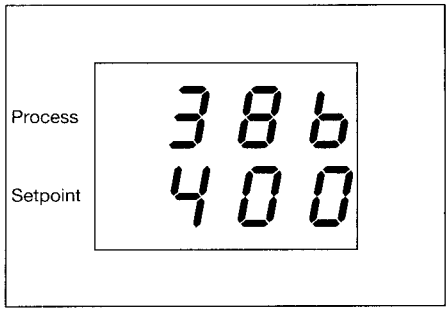
The three levels can be inhibited with internal switches (see Section 8).

Level	Inhibit
Operating level	access possible
Parameter level	access possible
Configuration level	factory-inhibited

4.2 Standard display

The upper display shows the actual value, the lower display shows the setpoint.

Other data can be shown in the standard display if required, see Section 6.3 Code C 312. These data can also be called up and displayed with the "Pgm" key.



4.3 Changing setpoint

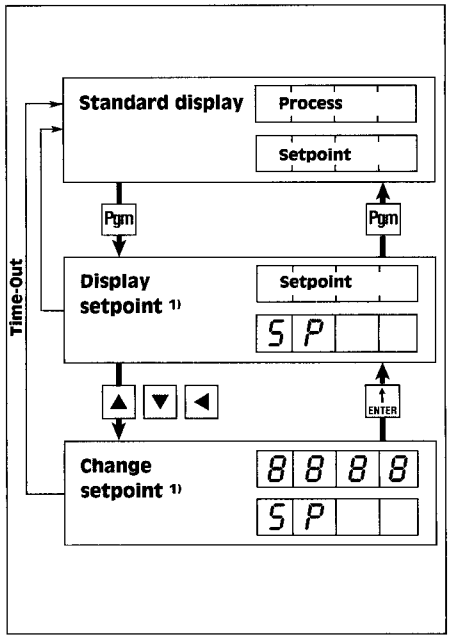
In the standard display the process is shown in the upper display and the setpoint in the lower display. After pressing the "Pgm" key the upper display shows the setpoint and the lower display the parameter name "SP" (setpoint).

The setpoint can be changed with the "Increment", "Decrement" and "STEP" keys. After one of these keys has been operated the parameter name "SP" is flashing.

Enter the value with the "ENTER" key. Further parameters can be displayed by pressing the "Pgm" key or the controller returns to the standard display.

If there is no input for 30 sec the controller returns automatically to the standard display (time-out).

The "Time-Out" parameter can be altered under Code C 518, see Section 6.3.



1) In the sub-directory Sd03 of configuration table Code C 313 it is possible to include 1 or 3 additional setpoints at the operating level.

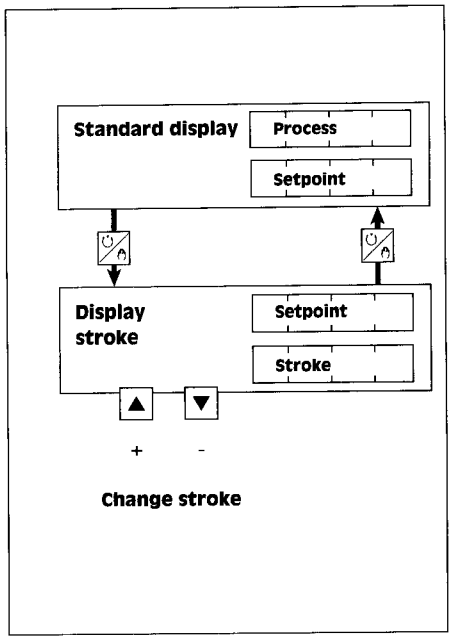
4.4 Manual operation

The controller is supplied with manual operation inhibited. This operating mode becomes accessible with the internal switch S 201.3 (see Section 8).

Manual operation is not possible if the proportional bands (Pb.1 or Pb.2) are zero.

The control loop is opened by pressing the auto/manual key. The two displays show the process and the current controller output. The output is changed with the increment or decrement keys within the range 0 – 100% (–100 to +100%). On the modulating controller the actuator opens or closes continuously while the key remains depressed.
After a break in the supply it is possible that the control output does not have the latest value since this is stored only one minute after the last alteration.

Manual operation is terminated with the "Auto/Manual" key.

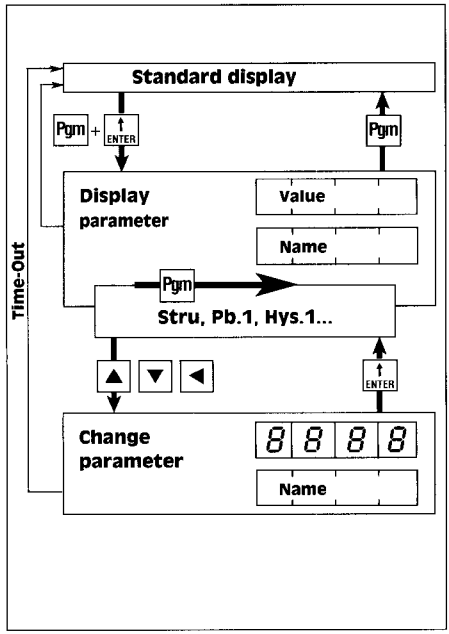


5 PARAMETER LEVEL

The parameter level is reached by pressing the keys "Pgm" and "ENTER" simultaneously.

5.1 Displaying and altering parameters

The parameters are called up in sequence with the "Pgm" key. The parameters of the individual controller versions are listed in Section 5.2.
After the last parameter the controller automatically returns to the standard display. When one of the keys "Increment", "Decrement" or "STEP" is pressed for changing the parameter, the parameter name (e.g. Pb.1, Hys.1) is flashing in the lower display. After the changed value has been entered with "ENTER", further parameters are displayed with "Pgm".
In case of an incorrect input the upper display flashes the minimum or maximum permitted value.



5.2 Parameter table

Single-setpoint controller

Parameter	Symbol	Feedback structure none*	P	I	PD	PI	PID	Adjustment range	Factory setting	Notes
Feedback structure	**Stru**	–	■	■	■	■	■	**P, I, PD, PI, PID**	**PID**	**applies to analogue outputs. For switching outputs the structure changes: P→PD, PI→PID, PID→PD/PID, PD→PDD, I→PI**
Proportional band 1 Xp 1	Pb.1	0	■	–	■	■	■	0 – 9999 digit	0 digit	*Pb.1=0 means no feedback
Derivative time Tv	**d.t**	–	–	–	■	–	■	**1 – 9999 sec**	**80 sec**	
Reset time Tn	r.t	–	–	■	–	■	■	1 – 9999 sec	350 sec	
Cycle time	**Cy.1**	■	■	■	■	■	■	**0 – 99.9 sec**	**20.0 sec**	**only with switching outputs. The cycle time should be selected so that the energy supply is virtually continuous without excessive demands on the switching device.**
Differential Xd 1	Hys.1	■	–	–	–	–	–	0 – 999 digit	1 digit	
Working point	**Y.0**	■	■	■	■	■	■	**0 – 100%**	**0%**	**on P and PD controllers: y=Y.0 at x=w. With feedback switched off: Y.0 = 0%, switch-off point = setpoint; Y.0 = 100%, switch-on point = setpoint**
Output limitation Max. output	Y.1	–	■	■	■	■	■	0 – 100%	100%	
Output limitation Min. output	**Y.2**	–	■	■	■	■	■	**0 – 100%**	**0%**	
Ramp slope	rA.Sd	■	■	■	■	■	■	0 – 999 digit	0 digit	only if configured
Setpoint first Ik	**AL.1**	■	■	■	■	■	■	**–1999 to +9999 digit**	**0 digit**	**only if configured**
Setpoint second Ik	AL.2	■	■	■	■	■	■	–1999 to +9999 digit	0 digit	only if configured
Fuzzy intensity	**Fc1**	–	–	–	–	■	■	**0 – 100%**	**0%**	**see Section 9.10 "Fuzzy Logic"**
Fuzzy parameter adjustment	Fc2	–	–	–	–	■	■	1.0 – 10.0%	3.0%	see Section 9.10: "Fuzzy Logic"
Time constant of digital filter	**dF**	■	■	■	■	■	■	**0.0 – 99.9 sec**	**0.6 sec**	

■ = adjustable

– = no input possible

5.2 Parameter table

Double-setpoint controller (also with analogue outputs)

Parameter	Symbol	Feedback structure						Adjustment range	Factory setting	Notes
		none*	P	I	PD	PI	PID			
Feedback structure	**Stru**	–	■	■	■	■	■	**P, PI, PID, PD, I**	**PID**	**applies to analogue outputs. For switching outputs the structure changes: P ➝ PD, PI ➝ PID, PID ➝ PD/PID, PD ➝ PDD, I ➝ PI**
Proportional band 1 Xp 1	Pb.1	0	■	–	■	■	■	0 – 9999 digit	0 digit	*Pb.1=0 means no feedback
Proportional band 2 Xp 2	**Pb.2**	**0**	■	–	■	■	■	**0 – 9999 digit**	**0 digit**	***Pb.2=0 means no feedback**
Derivative time Tv	d.t	–	–	–	■	–	■	1 – 9999 sec	80 sec	
Reset time Tn	**r.t**	–	–	■	–	■	■	**1 – 9999 sec**	**350 sec**	
Cycle time output 1	Cy.1	■	■	■	■	■	■	0 – 99.9 sec	20.0 sec	only with switching outputs. The cycle time should be selected so that the energy supply is virtually continuous without excessive demands on the switching device.
Cycle time output 2	**Cy.2**	■	■	■	■	■	■	**0 – 99.9 sec**	**20.0 sec**	
Contact spacing XSh	db.	■	■	■	■	■	■	0 – 999 digit	0 digit	
Differential Xd1	**Hys.1**	■	–	–	–	–	–	**0 – 999 digit**	**1 digit**	
Differential Xd2	Hys.2	■	–	–	–	–	–	0 – 999 digit	1 digit	
Working point	**Y.0**	■	■	■	■	■	■	**-100 to +100%**	**0%**	**on P and PD controllers: y=Y.0 at x=w. With feedback switched off: Y.0 = 0%, switch-off point = setpoint; Y.0 = 100%, switch-on point = setpoint**
Output limitation Max. output	Y.1	–	■	■	■	■	■	0 – 100%	100%	
Output limitation Min. output	**Y.2**	–	■	■	■	■	■	**-100 to 0%**	**-100%**	
Ramp slope	rA.Sd	■	■	■	■	■	■	0 – 999 digit	0 digit	only if configured
Setpoint second Ik	**AL.2**	■	■	■	■	■	■	**-1999 to +9999 digit**	**0 digit**	**only if configured**
Fuzzy intensity	Fc1	–	–	–	–	■	■	0 – 100%	0%	see Section 9.10 "Fuzzy Logic"
Fuzzy parameter adjustment	**Fc2**	–	–	–	–	■	■	**1.0 – 10.0%**	**3.0%**	**see Section 9.10: "Fuzzy Logic"**
Time constant of digital filter	dF	■	■	■	■	■	■	0.0 – 99.9 sec	0.6 sec	

■ = adjustable

– = no input possible

5.2 Parameter table

Modulating controller and proportional controller with integral driver for motor actuators

Parameter	Symbol	Feedback structure none*	P	I	PD	PI	PID	Adjustment range	Factory setting	Notes
Feedback structure on modulating controller:	**Stru**	**–**	■	■	■	■	■	**P, PI, PID, PD, I**	**PID**	
		■	–	–	–	■	■			
Proportional band 1 Xp 1 on modulating controller:	Pb.1	0	■	–	■	■	■	0 – 9999 digit	0 digit	*Pb.1=0 means no feedback
		–	■	–	■	■	■	1 – 9999 digit		
Derivative time Tv	**d.t**	**–**	**–**	**–**	■	**–**	■	**1 – 9999 sec**	**80 sec**	**on modulating controllers Tv = Tn/4.5**
Reset time Tn	r.t	–	–	■	–	■	■	1 – 9999 sec	350 sec	
Contact spacing Xsh	**db**	■	■	■	■	■	■	**0 – 999 digit**	**0 digit**	
Differential	Hys.1	■	–	–	–	–	–	0 – 999 digit	1 digit	only on modulating controller
Actuator time	**t.t**	**–**	■	■	■	■	■	**15 – 3000 sec**	**60 sec**	
Working point on modulating controller	Y.0	–	■	■	■	■	■	0 – 100%	0%	
		■	–	–	–	■	■			stroke retransmission must be connected
Output limitation max. output on modulating controller	**Y.1**	**–**	■	■	■	■	■	**0 – 100%**	**100%**	**Y.1 > Y.2**
		■	–	–	–	■	■			**stroke retransmission must be connected**
Output limitation min. output on modulating controller	Y.2	–	■	■	■	■	■	0 – 100%	0%	Y.2 < Y.1
		■	–	–	–	■	■			stroke retransmission must be connected
Ramp slope	**rA.Sd**	■	■	■	■	■	■	**0 – 999 digit**	**0 digit**	**only if configured**
Setpoint second lk	AL.2	■	■	■	■	■	■	-1999 to +9999 digit	0 digit	only if configured
Fuzzy intensity	**Fc1**	**–**	**–**	**–**	**–**	■	■	**0 – 100%**	**0%**	**see Section 9.10 "Fuzzy Logic"**
Fuzzy parameter adjustment	Fc2	–	–	–	–	■	■	1.0 – 10.0%	3.0%	see Section 9.10: "Fuzzy Logic"
Time constant of digital filter	**dF**	■	■	■	■	■	■	**0.0 – 99.9 sec**	**0.6 sec**	

■ = adjustable

– = no input possible

5.2 Parameter table

Proportional controller

Parameter	Symbol	Feedback structure P	I	PD	PI	PID	Adjustment range	Factory setting	Notes
Feedback structure	**Stru**	■	■	■	■	■	**PI, I, PD, PI, PID**	**PID**	
Proportional band	Pb.1	■	–	■	■	■	0 – 9999 digit	1 digit	Pb.1 always >0
Derivative time Tv	**d.t**	–	–	■	–	■	**1 – 9999 sec**	**80 sec**	
Reset time Tn	r.t	–	■	–	■	■	1 – 9999 sec	350 sec	
Working point	**Y.0**	■	■	■	■	■	**0 – 100%**	**0%**	**on P and PD controllers: y=Y.0 at x=w**
Output limitation max. output	Y.1	■	■	■	■	■	0 – 100%	100%	
Output limitation min. output	**Y.2**	■	■	■	■	■	**0 – 100 %**	**0%**	
Ramp slope	rA.Sd	■	■	■	■	■	0 – 999 digit	0 digit	only if configured
Setpoint first Ik	**AL.1**	■	■	■	■	■	**-1999 to +9999 digit**	**0 digit**	**only if configured**
Setpoint second Ik	AL.2	■	■	■	■	■	-1999 to +9999 digit	0 digit	only if configured
Fuzzy intensity	**Fc1**	–	–	–	■	■	**0 – 100%**	**0%**	**see Section 9.10 "Fuzzy Logic"**
Fuzzy parameter adjustment	Fc2	–	–	–	■	■	1.0 – 10.0%	3.0%	see Section 9.10: "Fuzzy Logic"
Time constant of digital filter	**dF**	■	■	■	■	■	**0.0 – 99.9 sec**	**0.6 sec**	

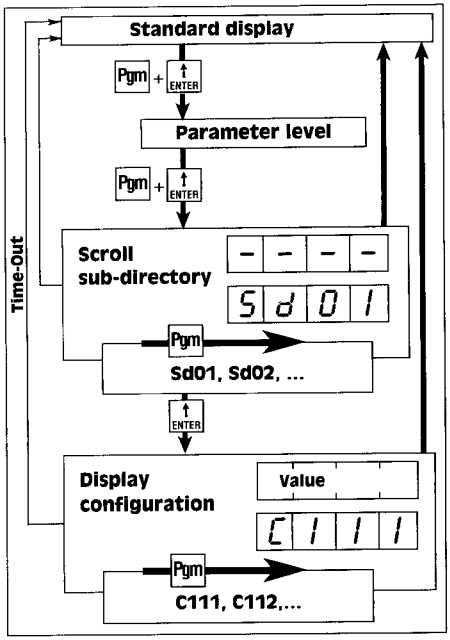
■ = adjustable

– = no input possible

6 CONFIGURATION LEVEL

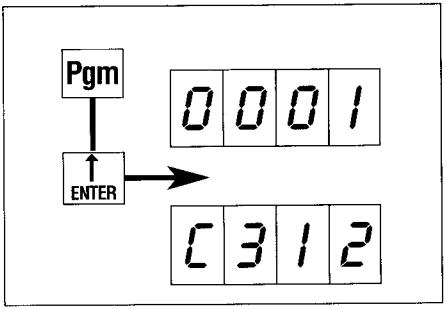
6.1 Displaying configuration data

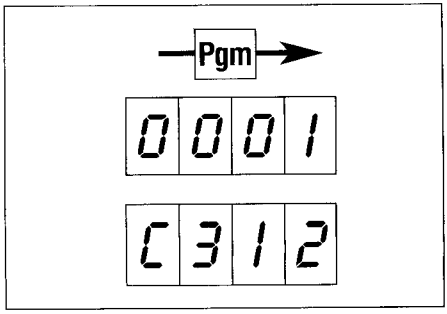
The configuration level can only be accessed from the parameter level.
The configuration data are divided into seven sub-directories Sd01 – 07.
The step "Scroll sub-directory" permits rapid location of a configuration code.



An example:

Which function is set under Code C 312 at the configuration level?
Scroll with key "Pgm" to sub-directory Sd03; after pressing "ENTER" the display shows the configuration code "C 311". Pressing "Pgm" again causes this to change to "C 312". The display is as shown alongside. As seen from the configuration table, the figure 1 in the upper display means "display setpoint". After pressing "Pgm" all the codes of the sub-directory Sd03 appear in sequence; this is followed by scrolling through the subsequent sub-directories.





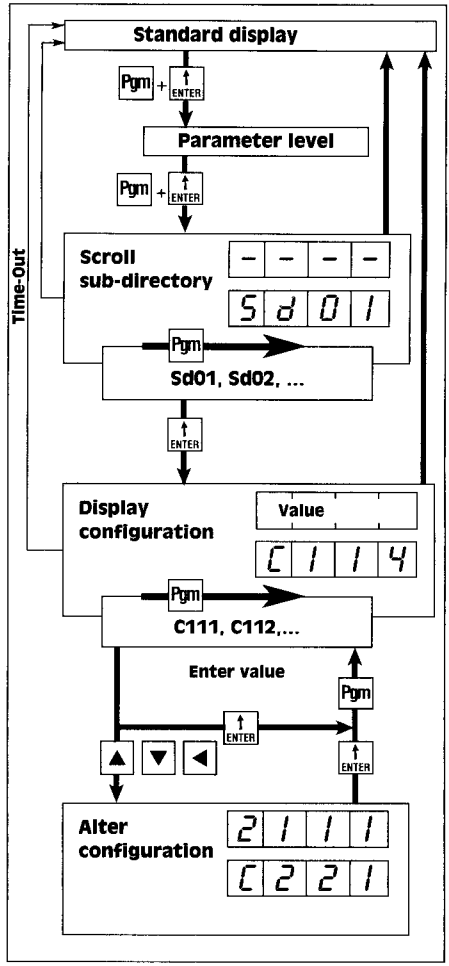
6.2 Altering configuration data

Access to the configuration level is only possible after inhibition of the level has been cancelled and the data transfer of the factory-set parameters has been switched off (see Section 8).

Many changes in configuration data also require adjustment of other parameters. If, for example, the control action is changed from double-setpoint controller to single-setpoint controller, the feedback structure, proportional band etc. must also be set again. If a parameter were to be omitted this would result in an undesirable or faulty control action. The controller is therefore provided with operator guidance which only permits return to the operating level or standard display after all the necessary alterations have been made completely and logically.

Following an incorrect input the upper display flashes and requests correction of the input. Every unintentional alteration of a configuration parameter may result in alterations to other parameters. The status as supplied from the factory can always be restored by reading in the factory-set parameters.

Call up configuration parameter, alter it if required, and enter the input with "ENTER". After pressing "Pgm" the next parameter to be altered is displayed. Flashing of both displays indicates that operator guidance is activated. The value shown in the upper display is either entered with "ENTER" or a new value is input. After all the necessary parameters have been altered or confirmed the controller returns to the standard display.



6.3 Configuration Tables

Sd01	Inputs		8	8	8	8
C 111	Sensor type input 1	Pt 100				1
		Thermocouple (int. CJTC)				2
		Thermocouple (ext. cold junction)				3
		0 – 50 mV				4
		0 – 20 mA/4 – 20 mA				5
		0 – 1 mA/0.2 – 1 mA				6
		0 – 10 V/2 – 10 V (0 – 1 V)				7
		Resistance transmitter				8
	Changeover °C/°F input 1	Temperature °C	0			
		Temperature °F	1			
	Linearisation input 1	linear –1999+9999 digit		0	0	
		Pt 100 – 200+ 850°C		0	1	
		Fe-Con L – 200+1000°C		0	2	
		NiCr-Ni K – 200+1400°C		0	3	
		PtRh-Pt S 0+1800°C		0	4	
		PtRh-Pt R 0+1800°C		0	5	
		PtRh-Pt B 0+1820°C		0	6	
		Cu-Con U – 200+ 600°C		0	7	
		MoRe5-MoRe41 0+1990°C		0	8	
		Cu-Con T – 200+ 400°C		0	9	
		Fe-Con J – 200+ 900°C		1	0	
C 112	Decimal place	no decimal place				0
		one decimal place				1
		two decimal places				2
C 113	Selection input signal 1	0 – 20 mA/0 – 1 mA/0 – 10 V				0
		4 – 20 mA/0.2 – 1 mA/2 – 10 V				1
C 114	Start of display input 1	Assigning the display to a particular standard signal or resistance transmitter signal	X	X	X	X
C 115	End of display input 1		X	X	X	X
C 116	External cold junction temperature	Value range 0 – 100°C		X	X	X
C 121	Sensor type input 2	not used				0
		Pt 100				1
		Thermocouple (int. CJTC)				2
		Thermocouple (ext. cold junction)				3
		0 – 50 mV				4
		0 – 20 mA/4 – 20 mA				5
		0 – 1 mA/0.2 – 1 mA				6
		0 – 10 V/2 – 10 V (0 – 1 V)				7
		Resistance transmitter				8
	Function	no function	0	0	0	
		External setpoint	0	0	1	
		External setpoint with correction from the front	0	0	2	
		External disturbance	0	0	3	
		Stroke retransmission with resistance transmitter	0	0	4	
		Reference value for ratio control	0	0	5	
		Reference temperature for temperature difference measurement	0	0	6	
		Display of second process variable	0	0	7	
		Reference temperature for humidity	0	0	8	
		Heater current display	0	0	9	9
		Temperature of external cold junction (Pt 100)	0	1	0	1

Sd01	Inputs		8	8	8	8
C 123	Changeover input signal 2	0 – 20 mA/0 – 1 mA/0 – 10 V 4 – 20 mA/0.2 – 1 mA/2 – 10 V				0 1
C 124	Start of display input 2	Assigning the display to a particular standard signal or resistance transmitter signal	X	X	X	X
C 125	End of display		X	X	X	X

X Input within range of values

Sd02	Outputs		8	8	8	8
C 211	Output 1 Mode	not used Switching output Analogue output, dead zero (e.g. 0 – 20 mA) Analogue output, live zero (e.g. 4 – 20 mA)				0 1 2 3
	Function	Controller output (falling characteristic) Controller output (rising characteristic) Double-setpoint output (falling characteristic) Modulating controller (falling characteristic) Proportional controller with integral actuator driver (falling characteristic)	1 1 1 1 1	0 0 0 0 0	1 2 3 4 5	
C 221	Output 2 Mode	not used switching output Analogue output, dead zero (e.g. 0 – 20 mA) Analogue output, live zero (e.g. 4 – 20 mA)				0 1 2 3
	Function	no function Double-setpoint output (rising characteristic) Modulating controller (rising characteristic) Proportional controller with integral actuator driver (rising characteristic)	0 1 1 1	0 0 0 0	0 3 4 5	
		Limit comparator function Ik1 Limit comparator function Ik2 Limit comparator function Ik3 Limit comparator function Ik4 Limit comparator function Ik5 Limit comparator function Ik6 Limit comparator function Ik7 Limit comparator function Ik8 * = 1 for input 1 * = 2 for input 2	2 2 2 2 2 2 2 2	* * * * * * * *	1 2 3 4 5 6 7 8	
		Process x Setpoint w Deviation xw Second process variable	3 3 3 3	0 0 0 0	1 2 3 4	
C 222	Signal start output 2	range –1999 to +9999 digit	X	X	X	X
C 223	Signal end output 2	range –1999 to +9999 digit	X	X	X	X
C 224	Switching differential of limit comparators (Ik)	range X_{Sd} = 0 to 999.9 digit	X	X	X	X

Sd02	Outputs		8	8	8	8
C 231	Output 3					
	Mode	not used				0
		Switching output				1
		Analogue output, dead zero (e.g. 0 – 20 mA)				2
		Analogue output, live zero (e.g. 4 – 20 mA)				3
	Function	Limit comparator function lk1	2	*	1	
		Limit comparator function lk2	2	*	2	
		Limit comparator function lk3	2	*	3	
		Limit comparator function lk4	2	*	4	
		Limit comparator function lk5	2	*	5	
		Limit comparator function lk6	2	*	6	
		Limit comparator function lk7	2	*	7	
		Limit comparator function lk8	2	*	8	
		* = 1 for input 1				
		* = 2 for input 2				
		Process x	3	0	1	
		Setpoint w	3	0	2	
		Deviation xw	3	0	3	
		Second process variable	3	0	4	
C 232	Signal start output 3	range –1999 to +9999 digit	X	X	X	X
C 233	Signal end output 3	range –1999 to +9999 digit	X	X	X	X
C 234	Switching differential of limit comparators (lk)	range X_{Sd} = 0 to 999.9 digit	X	X	X	X

X Input within range of values

Sd03	Extra Codes		8	8	8	8
C 311	Self-optimisation	Self-optimisation not possible				0
		Self-optimisation possible				1
	Limit comparator reference value with active ramp function	Ramp setpoint (Ik output 3)			0	
		End of ramp (Ik output 3)			1	
		Ramp setpoint (Ik output 2)		0		
		End of ramp (Ik output 2)		1		
		Ramp function off	0			
		Ramp function on (°C/min)	1			
		Ramp function on (°C/h)	2			
		Ramp function on (°C/day)	3			
C 312	Lower display	no display				0
		Setpoint (end of ramp)				1
		Ramp setpoint				2
		Stroke				3
		Input 2				4
	Upper display on ratio, humidity and temperature difference controller					
		Ratio, humidity(%), difference			0	
		Actual value (slave)			1	
C 313	Supply frequency filter	50 Hz (to minimise effect	0			
		60 Hz of mains-borne interference)	1			
	Logic inputs[1] input 1	not used			0	
		Keyboard inhibit			1	
		Manual operation inhibit			2	
		Manual operation on/off			3	
		Address for additional setpoints[2]			4	
		Start self-optimisation			5	
		External stop on ramp function			6	
	input 2	not used				0
		Keyboard inhibit				1
		Manual operation inhibit				2
		Manual operation on/off				3
		Address for additional setpoints[2]				4
		Start self-optimisation				5
		External stop on ramp function				6

[1] If both inputs are configured identically, the function is on both inputs.
[2] If both inputs are configured "4", a total of 4 setpoints can be addressed.
If C 121 is configured for external setpoint (with correction from the front), the setpoint address 0 is the external setpoint.

Sd04	Interface		8	8	8	8
C 411	Type of interface (cannot be programmed)	Interface off RS232 RS422/485				0 1 2
C 412	Data format	no parity parity odd parity even				0 1 2
		1 stop bit 2 stop bits			1 2	
		7 data bits 8 data bits		7 8		
		9600 baud 4800 baud 2400 baud 1200 baud 600 baud 300 baud 150 baud	0 1 2 3 4 5 6			
C 413	Special function	Terminal mode off Terminal mode on				0 1
		End-of-line character CR End-of-line character CR/LF			0 1	
C 414	Device address	Range 0 to 31 digit			X	X

X input within range of values

Sd05	Special functions		8	8	8	8
C 511	Setpoint limit start of setpoint	Range –1999 to + 9999 digit	X	X	X	X
C 512	Setpoint limit end of setpoint	Range –1999 to + 9999 digit	X	X	X	X
C 513	Min. ON-time of relay 1[1]	Range 0 to 99.9 sec Normal setting: 0 sec	X	X	X	X
C 514	Min. ON-time of relay 2	Range 0 to 99.9 sec Normal setting: 0 sec	X	X	X	X
C 515	Function on overrange or underrange (Output 1):					
	on single- or double-setpoint or proportional controller:	Any output between –100 and +100% current output retained on sensor break or short-circuit		X 1	X 0	X 1
	on modulating controller:	K1 on. K2 off K1 off, K2 on K1 off, K2 off The controller changes to manual operation		1 1	0 0	0 0 1
C 516	Function on overrange or underrange (output 2): If output 2 is a limit comparator, then:	Any output between 0 and +100% K2 off K2 on	 0 0	X 0 0	X 0 0	X 0 1
C 517	Function on overrange or underrange (output 3) If output 3 is a limit comparator, then:	Any output between 0 and +100% K3 off K3 on	 0 0	X 0 0	X 0 0	X 0 1
C 518	Time-out	Range 15 – 100 sec	X	X	X	X

[1] Minimum switch-on time, e.g. on burner controls (not with modulating controller)
X Input within range of values

Sd06	**Process value correction and adjustment of start and end with resistance transmitter or standard signal input**					
C 611	Correction of process value to user specification	X0 Offset input 1		X	X	X	X
C 612	(see Section 9.2) or calibration of resistance transmitter or standard signal input	X1 Gain input 1		X	X	X	X
C 621		X0 Offset input 2		X	X	X	X
C 622	(see Section 9.4)	X1 Gain input 2		X	X	X	X

	Measured values for programmed display					
C 613	Cannot be programmed, values are only indicated	X0 Input 1	0	X	X	X	X
C 614		X1 Input 1	1	X	X	X	X
C 623		X0 Input 2	0	X	X	X	X
C 624		X1 Input 2	1	X	X	X	X

X Input within range of values

Sd07	Software version, hardware recognition, (not programmable)		8	8	8	8
C 700	Version	Hardware version Software version	X	X	X	X
C 701	Extra codes	Ramp function, humidity and ratio controller cannot be configured can be configured	0 1			
C 702	Hardware recognition Interface	 not fitted RS232 RS422/485	 0 1 2			
	Range card input 1	 Pt 100, thermocouple, 0 – 50 mV 0 – 20 mA 0 – 1 mA 0 – 10 V Resistance transmitter			 0 1 2 3 4	
	Range card input 2	 Pt 100, thermocouple, 0 – 50 mV 0 – 20 mA 0 – 1 mA 0 – 10 V Resistance transmitter Heater current display				 0 1 2 3 4 5
C 703	Hardware recognition Output 1	 not fitted switching analogue		 0 1 2		
	Output 2	not fitted switching analogue			 0 1 2	
	Output 3	not fitted switching analogue				 0 1 2

7 ACTION ON FAULTS

7.1 Error messages

Er 11*:

There is a fault in the processor sequence but the watchdog (internal monitoring device) was not activated.

Remedy:
Cancel the error message by switching the supply off and on again.

Er 30:

Incorrect process value correction.
X0 = X1 or X1 = 0 has been entered.

Remedy:
The error message can be cancelled by pressing any key.
The parameters X0 and X1 are automatically set to standard settings, i.e the incorrect input is ignored. Repeat the process value correction if necessary.

Er 40:

The display capacity is exceeded.

Remedy:
The number of decimal places (see C 112) has to be reduced; in case of programmable parameters press the step, increment or decrement key.

* In case of this fault the inputs are switched off

7.2 Action on supply failure

After supply failure the controller returns to the standard display. An exception is the configuration level; here the configuration is re-started.

7.3 Action on overrange or underrange (also sensor break or short-circuit)

If the configuration included retention of the latest output setting (see C 515), the controller switches automatically to manual operation on sensor break or short-circuit. This presumes that this is not inhibited by switches, logic inputs etc. The LED for manual input is alight.

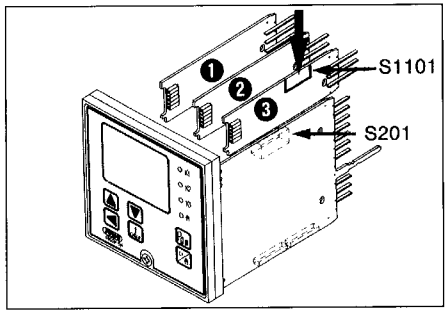
The changeover takes place on:

- sensor break or short-circuit
- overrange
- underrange

Manual operation is inhibited only if feedback is switched off (Xp = 0).
The LED for manual operation is then flashing.

Analogue output

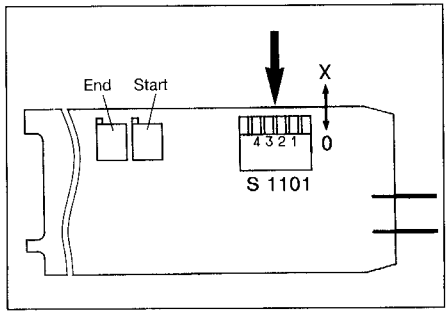
The output signal is set on DIL switches. The change-over between 0 – 20 mA and 4 – 20 mA and between 0 – 10 V and 2 – 10 V is made through the software and is described in Section 6.3 (sub-directory Sd02). The controller is supplied fully calibrated. If a different output signal is selected on the switches S1101.1 – S1101.4, a slight re-adjustment of the output signal with the "start" and "end" trimmers may be required.



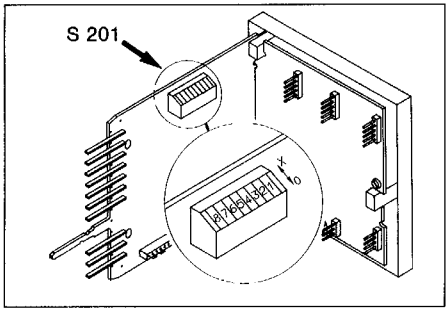
Analogue output ❶ ❷ ❸

Switch Signal	S1101.1	S1101.2	S1101.3	S1101.4
0(2) – 10 V	o	x	x	o
–10 to +10 V	x	x	x	o
0(4) – 20 mA	o	o	o	x
–20 to +20 mA	x	o	o	x

o = Signal x = on



8 INTERNAL ADJUSTMENTS



Switch position X means switch down (towards card) Switch S201.7 is provided for service use only and is set to 0 at the factory; it must not be moved! Switch S.201.8 is without function.

Level inhibits

Inhibited levels	S201.	
	S201.1	S201.2
Operating level (only call-up permitted) Parameter level Configuration level	o	x
Parameter level Configuration level	x	o
Configuration level	o	o
No inhibit	x	x

All levels are inhibited; no access to the parameter and configuration levels. Process variables of the operating level can be called up but cannot be changed.

No access possible

No access possible

All levels can be accessed.

Manual operation

Manual operation is inhibited at the factory. Switch S201.3 must be set to x when using the control station.

Manual operation	S201.3
Inhibited	o
Not inhibited	x

x = on
o = off
: factory setting

Input filter

Digital filter for smoothing the input signal; time constant 1.4 sec.

Input filter	201.4
on	o
off	x

Data read-in

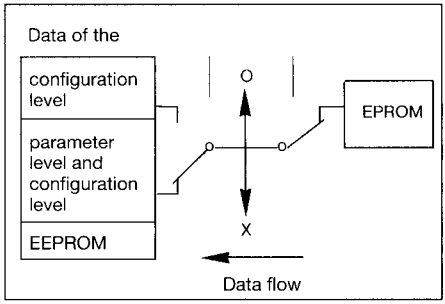
Configuration data and parameter data are read from the EPROM into the working memory (RAM) when S201.5 is set to o and S201.6 set to x. This means the parameters can be called up but cannot be changed.

As supplied from the factory (S201.5 and S201.6 set to o) only the parameter data can be changed.

With S201.5 set to x the data transfer is switched off and the controller can be re-programmed without restriction.

The basic status as supplied from the factory can be restored if S201.5 is set to o and S201.6 set to x.

	S201	
Factory data	S201.5	S201.6
yes	o	
no	x	
Read into:		
configuration level		o
configuration level and parameter level		x

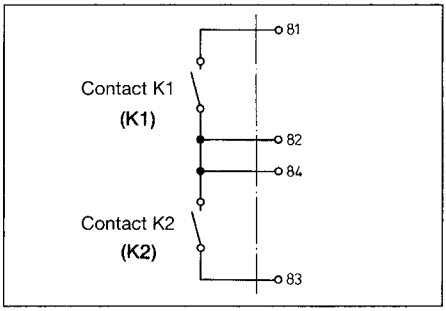


o = off
x = on
: standard setting

9.1 Functions of the logic inputs

The following functions can be realised through floating contacts. The required function is selected under configuration code C 313.

1 Start of self-optimisation
2 Changeover manual/automatic operation (internal switch S201.3 on x)
3 Manual operation inhibited
4 Keys inhibited
5 External stop on ramp function
6 Selection of additional internal setpoints



Selection of additional internal setpoints

Up to 4 internal setpoints can be used which can be selected by external floating contacts (configuration C 313).

The additional setpoints are set at the operating level (see Section 4.3); the current setpoint is displayed on operating the "Pgm" key. The lower display shows "SP". A total of 5 setpoints are thus displayed at the operating level, of which "SP" is always identical with one of the additional 4 setpoints.

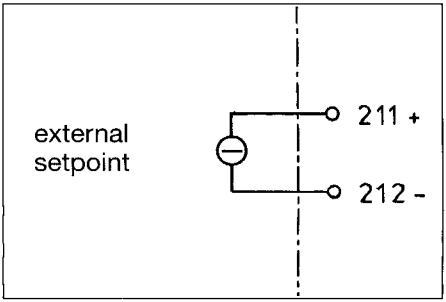
Depending on the switch position (K1, K2) the current setpoint "SP" is equal to "SP1", "SP2", "SP3" or "SP4".

Example:
If setpoint "SP" is programmed in switch position K1 = 0 and K2 = 1, then "SP" equals "SP3".

	K1	K2
Setpoint 1:	0	0
Setpoint 2:	1	0
Setpoint 3:	0	1
Setpoint 4:	1	1

External setpoint selection

The external setpoint is set as proportional current 0(4) – 20 mA or voltage 0 – 10 V (configuration C 121). Further internal setpoints can be selected by external contacts (see Table above). The external setpoint is then "SP1".



External setpoint selection with setpoint correction from the front

It is a necessary requirement that the value 002X has been programmed in C 121 (X = input 4 – 7), and that in addition C 313 has been configured as 0044. Otherwise the setpoint can be overwritten by a value but the correction value cannot be called up.
Setting the correction:
Press "Pgm" once, the current setpoint "SP" is displayed. This can be overwritten and entered with the ENTER key. "SP1" then shows the correction value as entered. "SP2 – 4" remain unchanged.

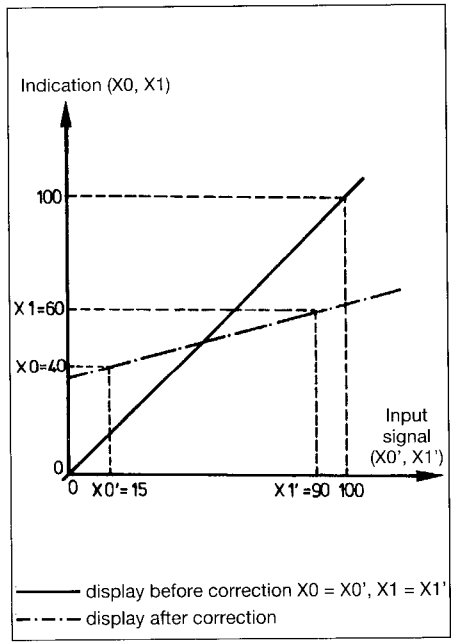
9.2 Correction of process indication to customer specification

A process indication differing from the desired or real value can be corrected with the keys. This is useful, for example, in order to match the indication of several instruments or to compensate for the resistance of the sensor cable. Two values are input, the intermediate values are interpolated or extrapolated by the controller.
The corrections should be performed near the start and end of the range to provide a sufficiently large spacing between X0' and X1'.

Example:
When the process value is 15 the indication should be 40.
When the process value is 90 the indication should be 60.

Programming:
With a process value of 15, 40 is programmed in parameter X0
(C 611/C 621). The complete graph is thereby raised by 25 (15 + 25 = 40).
The original value 90 is thereby also increased by 25 to 115.
The second correction by means of X1 must therefore take place at 115 (90 + 25 = 115).
At the process value of 115, 60 is programmed in parameter X1
(C 612/C 622).
After this correction by means of X0 and X1, the settings in channel 1 are e.g. C 611 for X0 40
C 613 for X0' 15
C 612 for X1 60
C 614 for X1' 90

To restore the base status X0 must equal X1. First X1 and then X0 is programmed to the same value. The error message Er 30 appears and can be cancelled with any key. In this way X0 and X0' are set to 0 and X1 and X1' to 1.



9.3 Controller with ramp function

It is possible to set a rising or a falling ramp function.

WR = ramp setpoint (instantaneous setpoint)
SP = final value of ramp
rA.Sd = slope of ramp
t_x = instant of change

On reaching the end of the ramp WR equals SP.
The selected setpoint "SP" is the final value of the ramp which is to be reached at the programmed slope "rA.Sd". The standard display shows the current setpoint.

Significance of the setpoint for the limit comparators

The settings of the limit comparators Ik1 to Ik6 during the ramp function refer to the ramp setpoint or the final value of the ramp (see configuration table in Section 7.3).

Significance of the setpoint for the analogue output

If output 2 or 3 is a setpoint output, this output then represents the value of the current setpoint (WR).

Settings

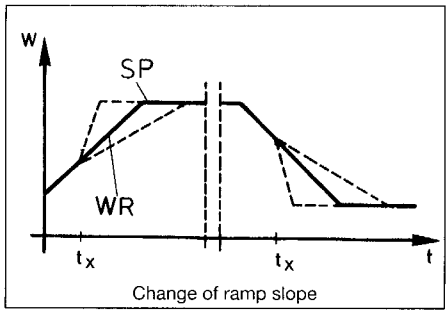
Parameter	Level
Ramp function	Configuration level Code C 311
SP	Operating level
rA.Sd	Parameter level

Action after configuration

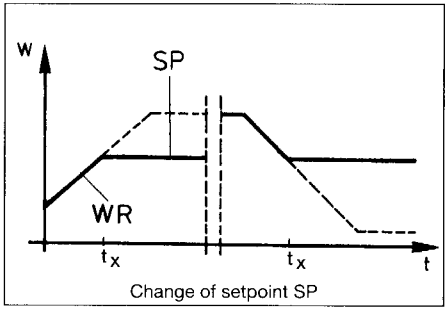
On starting configuration the ramp function is interrupted. The outputs become inactive; the actual value can change. When configuration has been completed the controller accepts the actual value measured at that time as the ramp setpoint and continues the ramp function.

Start of ramp function

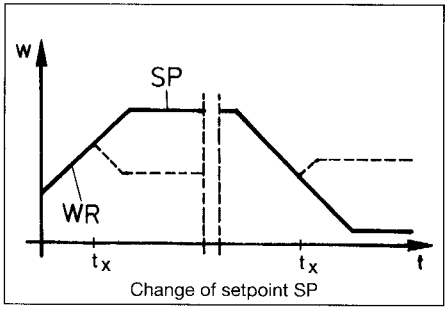
As soon as the supply is switched on, the current process value is taken as the ramp setpoint WR and the setpoint changes in accordance with the selected gradient until the final value SP is reached. Self-optimisation is not possible while the ramp is activated.



Change of ramp slope



Change of setpoint SP



Change of setpoint SP

Action on supply failure, sensor short-circuit and sensor break

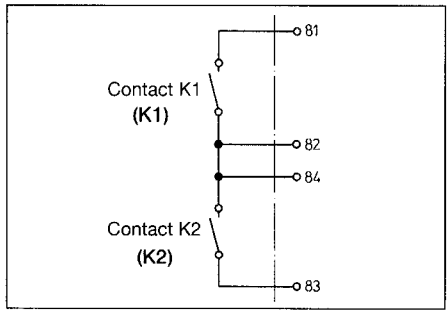
If the supply fails the ramp function is interrupted; the outputs become inactive; the process value can change. When the supply is restored the controller accepts the process value measured at that time as the ramp setpoint and continues the ramp function with the selected parameters.

Action during manual operation

During manual operation the automatic control is discontinued. The process value is continuously accepted as the ramp setpoint. On changing to automatic operation the ramp function continues with the set parameters.

External stop

In the configuration parameter C 313 it is possible to configure an external input (K1 or K2) as external stop. Closing the external contact holds up the ramp function, opening the external contact continues the ramp function. When an external stop is recognised, the lower display in the standard display mode flashes for the duration of the external stop.
There is no provision for a stop through a key function; this can however be achieved in practice by programming rA.Sd = 0 from the keys or the serial interface. When stopped by the interface the lower display does not flash.



9.4 Calibration of resistance transmitter input or standard signal input

Calibration of the start and end values in sub-directory Sd06, Code C 611/C 621 and C 612/C 622. There is provision for connecting up resistance transmitters of 0 – 30Ω min. and 0 – 10 kΩ max. When connecting up the resistance transmitter the controller adjusts itself automatically to the start and end values. Fine adjustment may be necessary if the slider of the resistance transmitter cannot be set to zero.
Calibration of start value:
Set resistance transmitter to start position. Select Code C 611/C 621. Input 0% and press "ENTER" key.

Calibration of end value:
Set resistance transmitter to end position. Select Code C 612/C 622. Input 100% and press "ENTER" key.

9.5 Humidity control

Function: relative humidity is measured according to the psychrometric principle. The measurement is independent of reference temperature.
Input 1 (Pt100) – wet temperature
Input 2 (Pt100) – dry temperature
The humidity controller only operates when the dry temperature is within the range 0 – 100°C and when relative humidity calculated from the corresponding wet temperature is between 0% and 100% rH.
Display: the upper display shows the relative humidity in % or the master temperature (dry temperature).
All controller types can be configured.
The process output also shows 0 – 100% rH.

9.6 Ratio control

The instrument operates as ratio controller with two current, voltage, or resistance transmitter inputs in any combination, with the ratio adjustable between 0.01 and 99.9.
In the base status the ratio can be displayed (see configuration level sub-directory Sd03).
Process values and setpoints are indicated with two decimal places.

9.7 Proportional controller with integral driver for motorised actuators

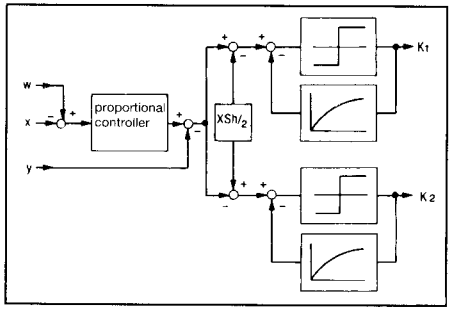
The analogue controller output signal is compared with the stroke feedback from the actuator.

The deviation of the output signal is fed to a switching double-setpoint controller with PD feedback which controls clockwise and anticlockwise rotation of the actuator.

The control gain of the double-setpoint controller is proportional to TO/TL (TO = sampling time, TL = actuator stroke time).

The derivative time of the double-setpoint controller serves to compensate for parasitic smoothing time constants within the controller.

With pronounced run-on (poor braking action) of the actuator motor it is possible to avoid juddering of the actuator by increasing X_{Sh} (parameter db.). The stroke retransmission must be connected up.



9.8 Compensation of external disturbance

The disturbance signal 0/4 – 20 mA or 0 – 10 V is fed into the controller through input 2. The disturbance acts on the controller output. If the proportional bands (Pb.1 or Pb.2) are zero the external disturbance compensation is out of action.
In case of additive disturbance compensation the output is changed by a certain amount corresponding to the disturbance signal.
With multiplying disturbance compensation the controller output is multiplied by the disturbance signal. Multiplying disturbance compensation is not possible on modulating controllers and on driver controllers with position feedback.
The effect of the disturbance can be set at the configuration level Sd01, Code C 124 and C 125, within the range of e.g. -100 to +100%.

Example of additive disturbance compensation:
Disturbance signal 0 – 20 mA = 0 – 50% (C 124 = 0, C 125 = 50), i.e. when the disturbance signal is 10 mA the current output signal is increased by 25%.

On the modulating controller the change is applied to the actuator stroke time. Example:

Actuator stroke time 100 sec, disturbance signal 0 – 20 mA = 0 – 100%, i.e. when the disturbance signal is 10 mA the relay K1 remains energised 50 sec longer, the actuator is opened further.

Example of multiplying disturbance compensation:
Disturbance signal 0 – 10 V,
C 124 = 100, C 125 = 250
If the disturbance signal is 0 V the controller output is not affected (100%).
If the disturbance signal is 10 V the controller output is multiplied by the factor 2.5 (250%).

9.9 Heater current indication

Using a current converter (output signal 0 – 20 mA a.c. 48 – 63 Hz) the second input of the SRM-96 can be used as current measurement input, e.g. for monitoring heater currents. The indication range can be set in C 124 and C 125.

The measurement always takes place when the heating contact is closed. The previous value is held until the next measurement. The heater current can be monitored by a limit comparator (lk1 – 8 referred to input 2).

9.10 Fuzzy logic

In addition to the usual algorithms for the various controller structures, the controller software also includes a fuzzy logic* software module. This can be used to improve both the control and the disturbance response of the controller.

When the fuzzy module is activated (Fc1 > 0) the output y consists of the controller output and the output signal of the fuzzy module. The parameter Fc1 determines the intensity of the fuzzy signal.
0% = no effect; 100% = large effect

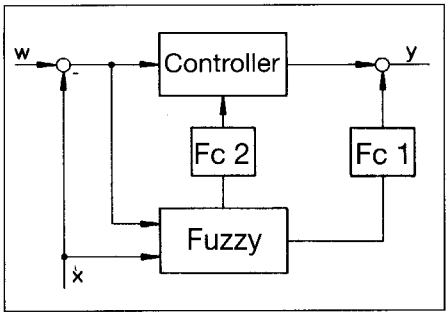
If the fuzzy module makes corrections in the controller output y, the controller parameters are simultaneously modified during the correction. After the correction the controller parameters return to the original settings.

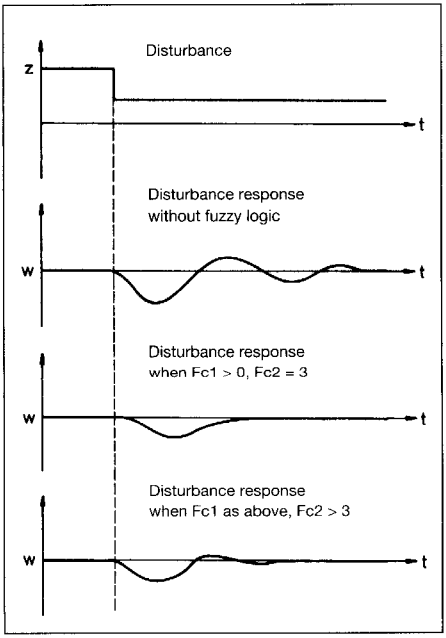
The parameter Fc2 can be used to vary the influence on the controller parameters.

1 = no change
10 = large changes

Following the factory setting or after self-optimisation the fuzzy module is inactive. When self-optimisation has been completed the control action can be further improved by changing Fc1 and/or Fc2.
Initial settings should be Fc1 = 50%, Fc2 = 3.

Action	Response
Fc1 ↑	disturbance amplitude reduced, settling time is increased
Fc1 ↓	disturbance amplitude is increased, settling time is reduced
Fc2 ↑	settling time is reduced
Fc2 ↓	settling time is increased





* see also JUMO Publication A 386

10 OPTIMISATION

Optimum adjustment means:
1. Good start-up action, i.e. start-up curve as steep as possible without overshoot.

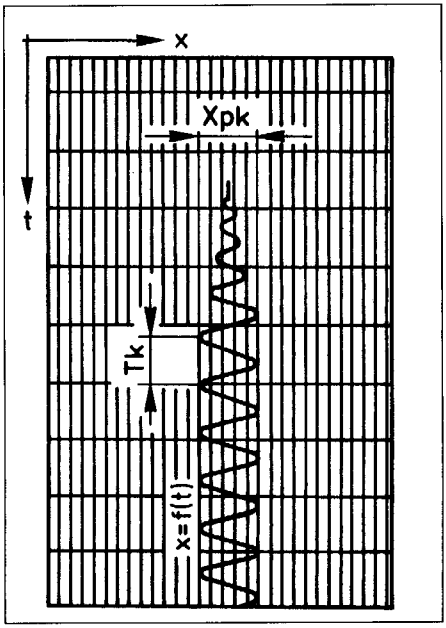
2. Good disturbance and control correction, i.e. to ensure rapid control action without oscillation in case of an external disturbance or if the setpoint is changed.

When precise process characteristics are available the control parameters for a defined operating point can be determined precisely by an involved mathematical procedure. In practice, however, precise characteristics of the process loop are rarely available, and practical adjustment criteria have therefore been developed empirically which have proved satisfactory.

Even here the assumed conditions (e.g. sudden changes of disturbance or setpoint at the loop input) are in most cases only approximately correct so that the results obtained have to be considered as a rough indication. In practice it is useful to record a curve of the process variable under operating conditions and to ascertain the optimum setting by stepwise changes of one parameter at a time. A base setting for controllers with PID action, based on measured parameter values, can be obtained by the procedures described below.

The automatic adjustment of the controller parameters with built-in self-optimisation or tuning (see instrument label) is described on page 43.

Oscillation method according to ZIEGLER and NICHOLS for <u>proportional controllers:</u>



This method applies to control loops which can be rendered unstable for brief periods (T_g/T_u greater than 3). The controller is operated initially with the following settings:

- set proportional controllers to P action,
  $T_n = \infty$, $T_v = 0$

- then set Xp on maximum (on double-setpoint controllers X_{p1} and X_{p2} on maximum).

Now slowly reduce the proportional band X_p to try determining the stability limit at which the process performs oscillations of constant amplitude.

This test gives:

a) X_{pk} (amplitude of the oscillations)

b) T_k (oscillation period)
Index k: critical

The approximate optimum settings are then:

$X_p = 1.7\ X_{pk}$

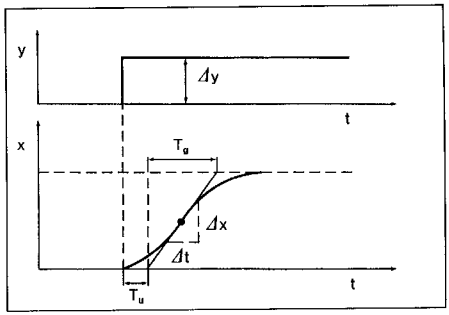
$T_n = 0.5\ T_k$

$T_v = \dfrac{T_n}{4.5}$

For <u>switching controllers</u> it is possible to obtain approximately similar satisfactory results by cutting out the feedback ($X_p = 0$) and setting the differential to minimum.

Compared with proportional controllers the oscillation amplitude produced is twice as large. The value for X_{pk} is divided by two and the parameters can then be calculated from the above formulae.

Another possibility for determining the parameters is to evaluate vmax. This value is determined during a setpoint step. This setpoint step should be located in the centre of the controller working range. vmax is determined graphically from the transfer function which is available as a recording or can be obtained from a table of temperatures.



Example: calculation of the control parameters for a controller with PID action

measured values: Tu = 30 sec
Δt = 180 sec
Δx = 90 °C

$$v_{max} = \frac{\Delta x}{\Delta t} = \frac{90°C}{180\ sec} = 0.5\ °C/sec$$

$$X_p = 0.83 \cdot v_{max} \cdot T_u$$

$$X_p = 0.83 \cdot \frac{0.5°C}{sec} \cdot 30\ sec = 12.5\ °C$$

$$T_n = 2\ T_u$$

$$T_n = 2 \cdot 30\ sec = 60\ sec$$

$$T_v = \frac{T_n}{4.5}$$

$$T_v = \frac{60\ sec}{4.5} = 13.3\ sec$$

Note:

During the optimisation procedure and in particular during changes in the controller parameters it is possible to reach conditions which must not be allowed to appear during normal operation.
It is advisable to monitor the process continuously during this period in order to avoid any consequential damage.

Controller structure	Setting
P	$X_p = v_{max} \cdot T_u$
PI	$X_p = 1.2\ v_{max} \cdot T_u$
PD	$X_p = 0.83\ v_{max} \cdot T_u$ $T_v = 0.25\ T_u$
PID	$X_p = 0.83\ v_{max} \cdot T_u$ $T_n = 2\ T_u$ $T_v = \frac{T_n}{4.5}$
PD/PID	$X_p = 0.4\ v_{max} \cdot T_u$ $T_n = 2\ T_u$ $T_v = \frac{T_n}{4.5}$

$\frac{T_g}{T_u}$ more than 10: satisfactory control

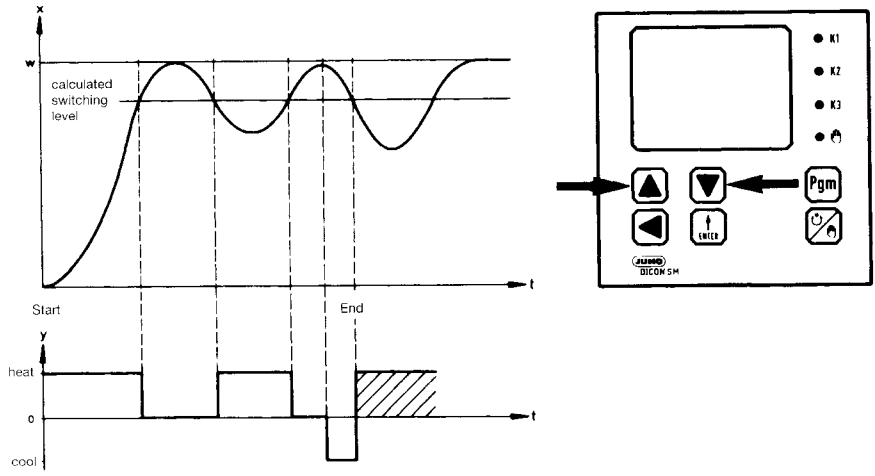
$\frac{T_g}{T_u}$ from 10 to 3: just controllable

$\frac{T_g}{T_u}$ less than 3: difficult to control

Explanation of abbreviations:

v_{max}	max. rate of rise
T_g	response time
T_u	delay time
X_p	proportional band
T_n	reset time
T_v	derivative time
y	controller output
t	time

10.1 Self-optimisation



The controller is supplied as standard with self-optimisation (referred to below as SO) of the controller parameters.
A method developed by JUMO is being used to evaluate the reaction of the process to certain changes in the controller output. The controller parameters calculated include Xp1, T_n, T_v, Cy1, and dF. On double-setpoint controllers the calculation includes also the controller parameters Xp2 (separate from Xp1) and Cy2 (Cy2 = Cy1). The fuzzy parameters Fc1 and Fc2 are set to standard values after SO.

All parameters can be called up at the parameter level and also amended. The changes should however not exceed ±20% of the values determined during SO.

After completion of SO, further improvement in the controller results can be achieved by varying Fc1 and/or Fc2 (see Section 9.10).

SO is initiated by pressing the increment and decrement keys simultaneously. During SO the lower display flashes the word "tunE".

SO can be started from any actual value. It always produces enforced oscillations close to the setpoint.

Depending on the process, SO may take some time (approx. 10 times the delay time of the process).

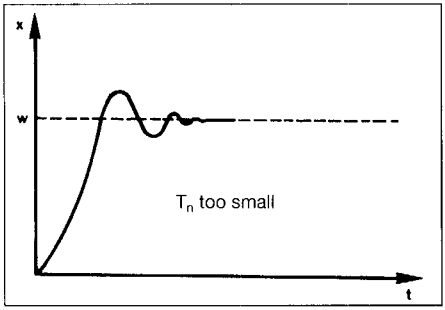
After completion or abort of SO the lower display shows again the setpoint.

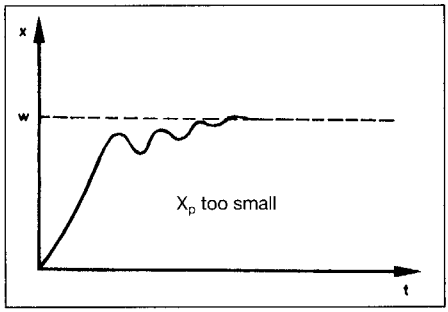
The optimisation process can be aborted at any time using the step key.

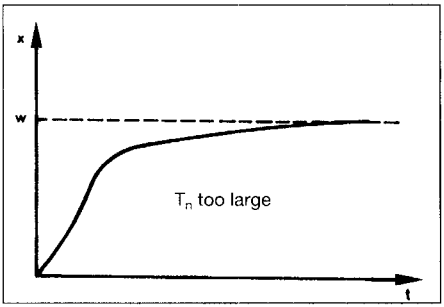
10.2 Checking the optimisation with PID action

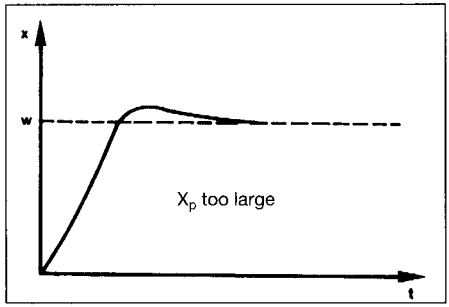
The optimum adjustment of the controller to the process can be checked by recording a start-up with closed control loop.

The diagrams below indicate possible incorrect adjustments and the correction required.

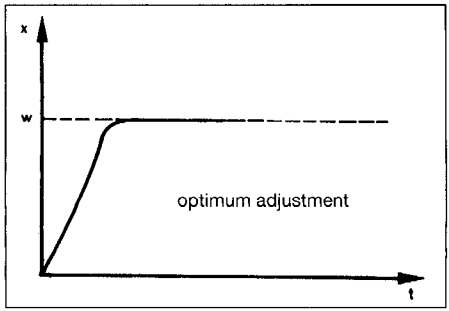








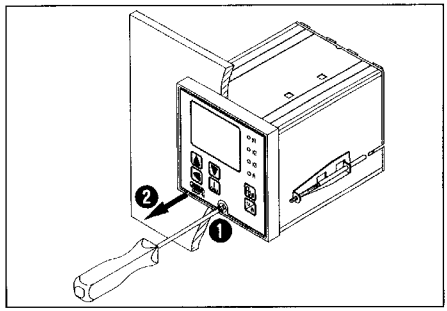
This shows that increased X_p and increased Tn both result in a more stable and more sluggish control action.
Smaller X_p or T_n produces a less damped control action.



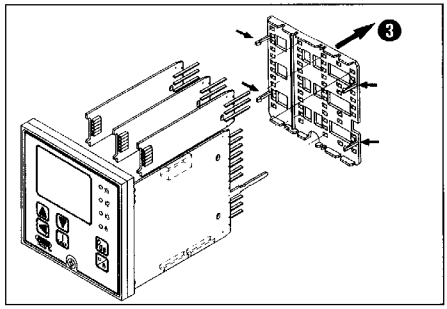
11 RETROFITTING OF CARDS

In case the controller functions have to be enhanced or modified a variety of retrofit cards are available.
They are summarised at the end of this section and can be ordered individually.
The operations to change the cards will now be described.

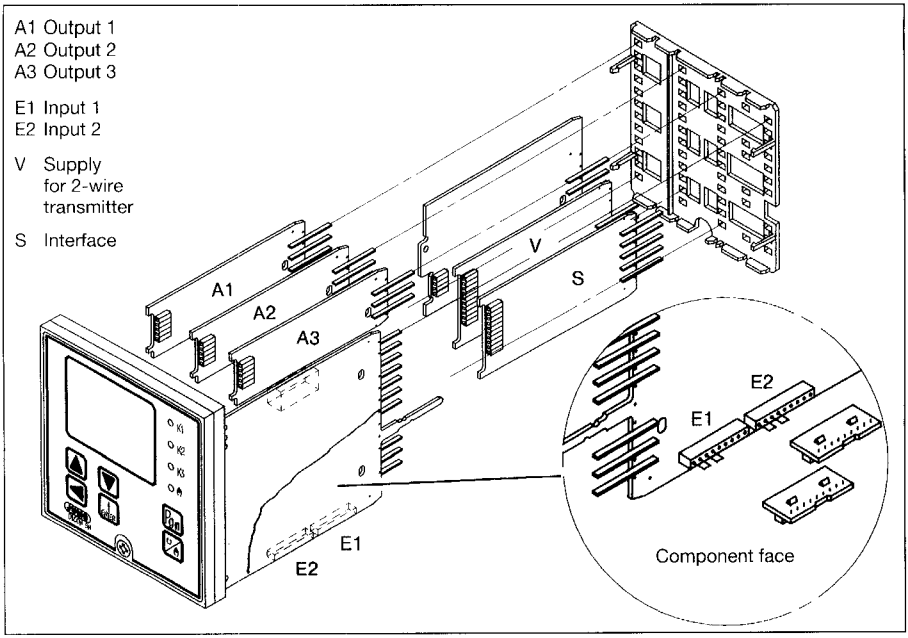
❶ Release the fixing screw
❷ Pull out the chassis



❸ Lift the clips at the back and pull off the back panel



11 RETROFITTING OF CARDS



List of retrofit cards

Description		Plug-in position	Order No.
Interface RS422/485		S	91964
Interface RS232		S	91965
Input card for standard current signal (solder face towards DIL switch)	0(4) – 20 mA 0 – 1 mA	E1, E2 E1, E2	91309 91310
Input card for standard voltage signal (solder face towards DIL switch)	0 – 10 V 0 – 1 V	E1, E2 E1, E2	91312 91313
Input card for resistance transmitter		E1, E2	91311
Input card for heater current monitoring	0 – 20 mA a.c.	E2	91314
Semiconductor relay output		A1, A2, A3	91967
Relay output Logic output Logic output, isolated,	 0/5 V or 0/20 mA 0/20 V or 0/20 mA	A1, A2, A3 A1, A2, A3 A1, A2, A3	91968 91975 91963
Analogue output (current/voltage selection)		A1, A2, A3	91970
Voltage supply for 2-wire transmitter		V	91966
Wire link for resistance thermometer and thermocouple input (please order 2 off per input)		E1, E2	66989

The input cards for current and voltage signal, resistance transmitter and heater current monitoring must be fitted with the connector downwards (towards the edge of the board)

12 APPENDIX

12.1 Table of settings for parameter and configuration data

As a guide for later changes in the controller data the appropriate parameter and configuration data can be entered here.

Some of the parameters may be omitted depending on the controller model.

Configuration data

Sd01	C 111				
	C 112				
	C 113				
	C 114				
	C 115				
	C 116				
	C 121				
	C 123				
	C 124				
	C 125				
Sd02	C 211				
	C 221				
	C 222				
	C 223				
	C 224				
	C 231				
	C 232				
	C 233				
	C 234				
Sd03	C 311				
	C 312				
	C 313				
Sd04	C 411				
	C 412				
	C 413				
	C 414				
Sd05	C 511				
	C 512				
	C 513				
	C 514				
	C 515				
	C 516				
	C 517				
	C 518				
Sd06	C 611				
	C 612				
	C 621				
	C 622				
Sd07	C 701				

Parameter data

Feedback structure	**Stru**				
Proportional band	Pb.1				
Proportional band	**Pb.2**				
Derivative time	d.t				
Reset time	**r.t**				
Cycle time	Cy.1				
Cycle time	**Cy.2**				
Contact spacing	db.				
Differential	**Hys.1**				
Differential	Hys.2				
Actuator time	**t.t**				
Working point	Y.0				
Max. output	**Y.1**				
Min. output	Y.2				
Ramp slope	**rA.Sd**				
Setpoint first lk	AL.1				
Setpoint second lk	**AL.2**				
Fuzzy intensity	Fc1				
Fuzzy parameter adj.	**Fc2**				
Dig. filter time const.	dF				

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