Protronic PS

Process controller Protronic
Universal Controller

Manual

42/62-61 EN

Rev. 09

ABB

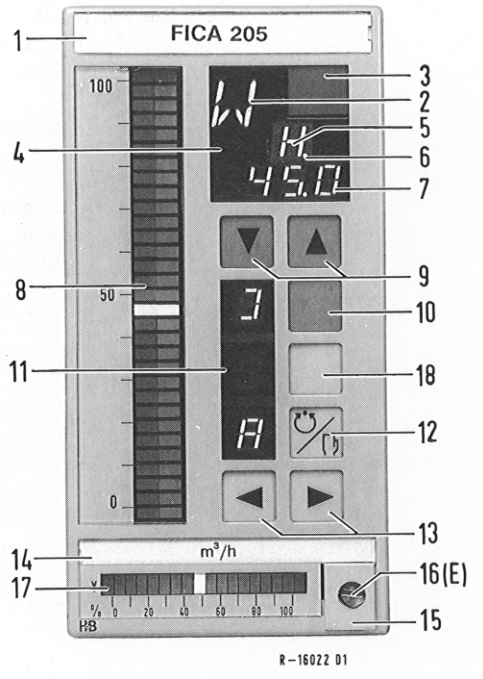

Fig. 28 Front view

1 Top legend plate
2 Code letter display
3 Selector switch for digital display
4 Digital display field
5 Index for code letters
6 Decimal point for 5, lights up when the variable displayed by 2 and 5 is
7 Four-digit display
8 Analog display: actual value red
set point green
9 "Raise/lower" keys for set point and parameter
10 Set point selection (I/E key) (can be disabled)
11 Status display
12 Manual/automatic transfer (Mode selector switch)
13 "Raise/lower" keys for output variable
14 Lower legend plate
15 Handle for removal
16 Module locking screw (E)
17 Output variable display
18 Multi-function key (F-key)

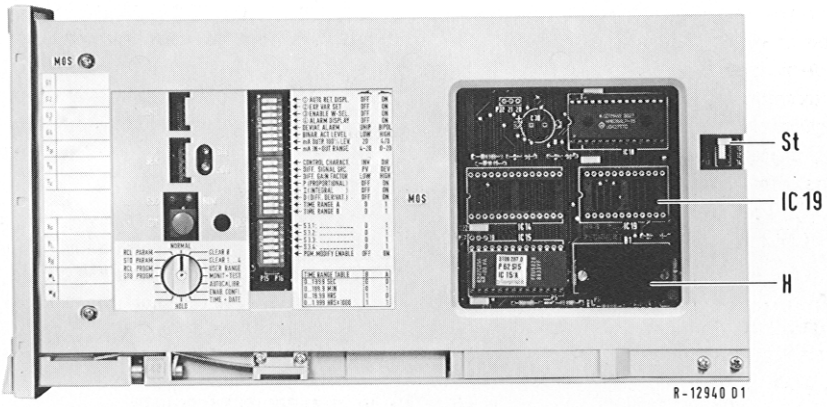

Fig. 29 Lateral view of the control electronics unit

H Battery
St Connector depending on EEPROM type
IC 19 Slot for E(E)PROM)

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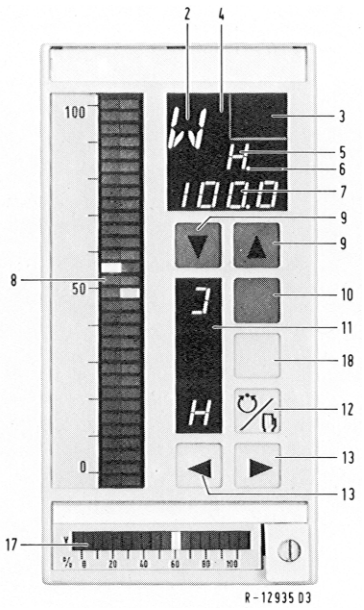
Protronic Control System
Universal Controller PS

DISPLAY AND MANUAL CONTROL ELEMENTS ON THE FRONT PANEL



2 Display of code letters for process variables
3 Selector switch for digital display
4 Digital display
5 Index to code letters
6 Decimal point for index (5), lights up when the variable displayed e. g. W_H is adjustable
7 Four-digit display
8 Analog display, actual value red set point green
9 "Raise/lower" keys for set point and alarm values
10 Set point transfer (can be disabled)
11 Status display
12 Manual/automatic transfer
13 "Raise/lower" keys for output variable Y or program set point
17 Output variable display
18 Multifunction key (F key) for switching to channel 1 or 2

Digital display and adjustments

In the digital display (4) a number of process variables can be represented with code letters and selected with switch (3) (see table below).

The variables with a point (6) can be changed with keys ▲/▼ (9).

In two-channel units all displays and adjustments are provided in duplicate.

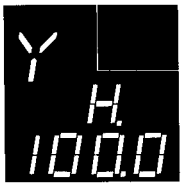
To distinguish between the channels, all displays for the second channel are shown with a point, e. g. X., W., $X._d$

The multifunction (F) key (18) is used for channel switchover.

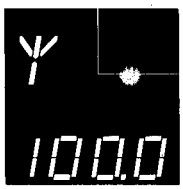
Display	Function
X	Actual value or reference variable for ratio
W	Set point (and ratio set point)
Y	Output variable
X_d	Control deviation (X – W)
D	Set point difference ($W_{ext.} - W_{int.}$)
G1	X alarm value MAX
G2	X alarm value MIN
G3	X_d alarm value MIN
G4	X_d alarm value MAX
V	Ratio (instantaneous)
X_2	Follow-up variable in ratio control

CONTROLLER OPERATING INSTRUCTIONS

Display of output signal Y



The output display (17) indicates the output variable. If a more precise readout is required, output variable y can be indicated on the digital display by actuating key (3).



If keys ◄ and ► are pressed simultaneously the output variable can be switched to the digital display for the duration of key depression.

Y corresponds to the controller output.

Set point adjustment

Key 10 can be used to select an internal set point or an external set point, provided transfer has not been disabled.

For **internal** set point the following display appears next to key 10:

For **external** set point:

Having selected "W" in the digital display by actuating key (3), the internal set point can be adjusted or the external set point displayed with keys ▲ and ▼.

Internal/external set point transfer

Transfer is effected by pressing key (10). As soon as the status display (11) next to key (10) stops flashing, the new operating mode is effective.

Before transferring from internal set point to an unknown external set point it is advisable to select the difference readout D = W_E — W_i in the digital display with key (3) and to check that transfer is permissible. The display is a percentage. A positive value indicates that the external set point value is higher than the current internal set point value. If transfer is effected with a difference existing between W_i and W_E, the effective set point approaches the external set point value at a rate of 6.25 digits per second.

Transfer from external set point to internal set point is automatically bumpless. The internal set point then corresponds to the last external set point value.

Auto/manual mode transfer

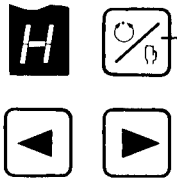
Operating mode transfer is automatically bumpless in both directions by depressing key (12). As soon as the status display (11) next to key (12) stops flashing the new operating mode is effective.

Manual operation of continuous controller

Adjusting the output signal y is always possible when the instrument is in the "manual" mode (H). A short depression of key ◄ or ► changes the output signal by + 0.1 % or − 0.1 %.

If one of the keys is held depressed the output signal will change with increasing speed.

Quick adjustment of output



If key 12 is pressed together with one of the two keys ◄ or ►, the output signal immediately changes in the required direction to − 2.4 % or 102.4 %.

Manual operation of three-position step controller

The servodrive is always adjustable when the controller is switched to "manual". The correction time is a function only of the run time of the drive.

In the delivery status, key ► acts on the "raise" output and key ◄ on the lower output.

The controller pulses are indicated by the illumination of single segments in the display next to the F key (18).

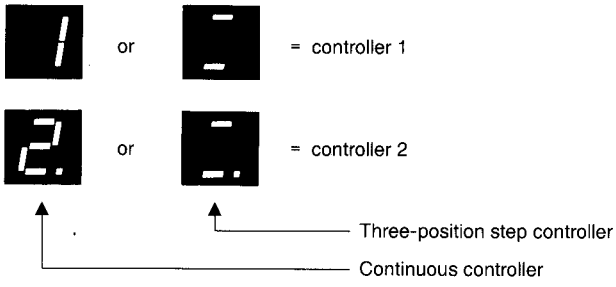
Manual operation of on/off controller

In the manual mode the on/off controller delivers a pulse train the mean value of which over time is displayed by the output meter (17). For manual operation the same instructions apply as for the continuous controller.

Manual operation of two-channel controller

The same rules apply to manual operation of two-channel controllers as for single-channel controllers.

The controller that can be operated at any one time is specified with the F key (18) and can be read off in the adjacent display field.



Channel identification

Manual operation of cascade controller

During commissioning the slave controller is first operated on its own.

The I/E key (10) has three possible positions:


= cascade is open


= cascade is closed


= external set point for master controller (usually disabled)

The master controller is always in the automatic mode. It cannot be switched to "manual". If an attempt is made to switch the master controller to "manual", the display transfers to controller 2 which then switches to "manual".

Manual operation is the same as for single-channel controllers via controller output 1.

Manual operation of override controller

The override controller can have continuous or step action output.

Controller 2 is always the master controller, controller 1 the override controller.

Using the I/E key (10) in interaction with the F key (18), an internal or external set point can be assigned to each controller.

The mode selector switch (12) only acts on the master controller, i. e. the override controller is always in the automatic mode.

Setting the alarm values

Having selected the alarm values on the digital display they can be changed with keys ▲ and ▼. The alarm values have the following functions:

G1 = max. alarm for X
G2 = min. alarm for X
G3 = min. alarm for X_d
G4 = max. alarm for X_d

If alarm values G3 and G4 are assigned to the amount of control deviation $|X_d|$, G3 must be set to negative values and G4 to positive values.

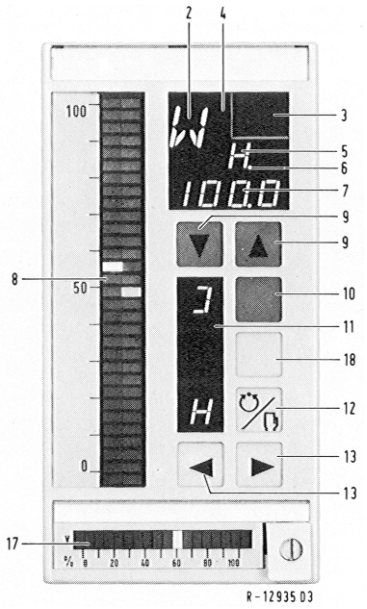
In two-channel controllers the following values are monitored in place of alarm values G3 and G4:

G.1 Max. alarm value of second channel for X.

G.2 Min. alarm value of second channel for X.

Protronic Control System
Programmer, Program Controller PS

DISPLAY AND MANUAL CONTROL ELEMENTS ON THE FRONT PANEL



2 Display of code letters for process variables
3 Selector switch for digital display
4 Digital display
5 Index to code letters
6 Decimal point for index (5), lights up when the variable displayed e. g. W_H is adjustable
7 Four-digit display
8 Analog display, actual value red set point green
9 "Raise/lower" keys for set point and alarm values
10 Set point transfer (can be disabled)
11 Status display
12 Manual/automatic transfer
13 "Raise/lower" keys for output variable Y or program set point
17 Output meter
18 Multifunction key (F key), e. g. to select programmer 1 or 2 or controller 1 or 2

Digital display and adjustments

In the digital display (4) a number of process variables can be represented with code letters and selected with switch (3) (see table below).

The variables with a point (6) can be changed with keys ▲/▼ (9).

In two-channel units all displays and adjustments are provided in duplicate.

To distinguish between the channels all displays on the second channel are shown with a point, e. g. X., W., $X._d$

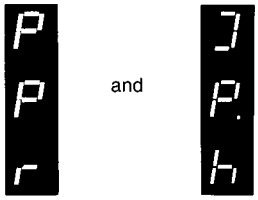
Channel switchover (control level switchover) is accomplished with key 18 (F key).

Display	Function
X	Actual value or reference variable for ratio
X_2	Follow-up variable for ratio
V	Ratio (instantaneous)
W	Set point (and ratio set point)
Y	Output variable
X_d	Control deviation (X – W)
N	No. of section currently being processed
G1	X alarm value MAX
G2	X alarm value MIN
T_u	The time elapsed in the section currently running
R	Loop counter: counts the repetitions

Programmer/program controller transfer

Transfer is accomplished with key (18).

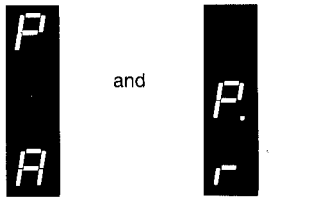
In two-channel programmers the display changes between



Channel 1 Channel 2

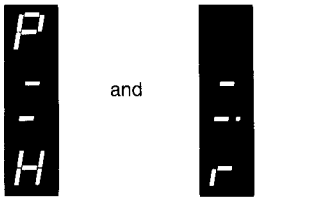
If a "J" appears in the status display, it is necessary to transfer to "P" with key (10).

In program controllers the display changes between



Channel 1 Channel 2

Continuous controller Programmer



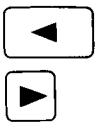
Channel 1 Channel 2

Step action controller Programmer

PROGRAMMER OPERATION

The following symbols are used for operation:

Operation for any length of time.



If two keys are to be operated simultaneously and if the sequence is significant, the adjacent symbols apply. Key ◄ must be pressed before key ► and held down.

Operating modes

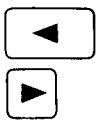
Manual operation of the programmer

Manual operation permits the following functions:

Stop

By switching the unit from one of the automatic modes to "manual", the program stops at the position reached.

Reset



The program is reset to the beginning and the repetition counter to zero by operating keys ◄ and ►.

Forwards

Moving forwards in the program irrespective of the time set with the aid of key ▶. The position in the program continues to change while this key is held.

Backwards

Key ◀ is used to shift the program against the sequence in time.

Jump forwards

By holding key ▶ down and simultaneously operating key (12) the program jumps to the next breakpoint (restart point).

Jump backwards

Conversely, the program jumps to the preceding breakpoint if key (12) is operated in addition to key ◀.

Automatic operation of the programmer

Automatic operation runs after key (10) is switched over.

Single run from program start to program end.

Repeated operation. At the end of the program it immediately starts again.

Fast forward. Irrespective of the time scale set, all sections are executed in 8 seconds.

Stop

Irrespective of the operating mode set, the program run is stopped by switching to "manual".

Set point transfer

Provided key 10 has not been disabled internally it can be used to transfer between a program set point "P" and a fixed set point "I". The value of "I" corresponds to the value of "P" at the instant of transfer.

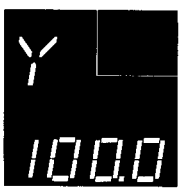
Having selected "W" in the digital display by actuating key (3), the fixed set point can be adjusted by actuating keys ▲ and ▼.

When transferring from "I" to "P" the set point jumps to the instantaneous program set point.

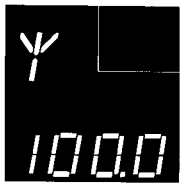
The mode of operation of the programmer (r, r., t, h) is not affected by the transfer.

CONTROLLER OPERATION

Display of output signal Y



The output meter (17) indicates the output variable. If a more precise readout is required, output variable Y can be indicated on the digital display by actuating key (3).



If keys ◀ and ▶ are pressed simultaneously the output variable can be switched to the digital display for the duration of key depression.

In the standard configuration Y corresponds to the controller output.

Auto/manual mode transfer

Operating mode transfer is automatically bumpless in both directions by depressing key (12). As soon as the status display (11) next to key (12) stops flashing the new operating mode is effective.

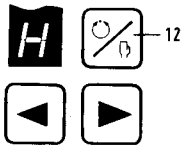
Manual operation of continuous controller

Adjusting the output signal

Adjusting the output signal is always possible when the instrument is in the "manual" mode (H). A short depression of key ◀ or ▶ changes the output signal by + 0.1 % or − 0.1 %.

If one of the keys is held depressed the output signal will change with increasing speed.

Quick adjustment of output



If key (12) is pressed together with one of the two keys ◀ or ▶, the output signal immediately changes in the required direction to − 2.4 % or 102.4 %.

Manual operation of three-position step controller

The servodrive is always adjustable when the controller is switched to "manual". The correction time is a function only of the run time of the drive.

In the delivery status, key ▶ acts on the "raise" output and key ◀ on the lower output.

The controller pulses are indicated by the illumination of individual segments in the display next to the F key (18).

Manual control of on/off controller

In the manual mode the on/off controller delivers a pulse train the mean value of which over time is indicated by the output meter (17). The same instructions apply to the manual mode as for the continuous controller.

Setting the alarm values

Having selected the alarm values on the digital display they can be changed with keys ▲ and ▼. The alarm values have the following functions:

G1 = max. alarm for X
G2 = min. alarm for X

Protronic Control System
Universal Controller PS
Selecting the Control Function

Preliminary remarks

This abridged operating instruction is extracted from Operating Manual 42/ 62-61 EN

which must be available, and familiarity with which is essential.

The numbering of the Sections, Figures and Tables has been retained for easy reference to the appropriate Section in the full Operating Manual.

4.3 Selecting the control function

4.3.1 Standard functions

The controllers PS can be software-configured as continuous or step action controllers.[1)]

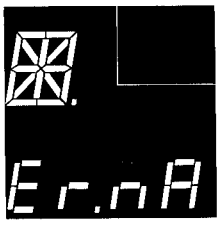
The status of the instrument can be monitored and changed as described in Section 9.4.1.

Table 6 shows the part of the request matrix that determines the software. The required function is defined with the aid of the table and entered with the auxiliary routine as described in 9.4.1.

With older software structures the entries must be made via monitor ME to addresses 87DA to 87DC.

If incorrect digits are entered in one or more addresses, the controller defaults to 31, 41, 51.

After the required data have been entered, switches 3, 4 and 5 must be temporarily set to the positions described in Table 7.



If one of these conditions is not met, the controller displays the message Er.nA (any decimal point visible is without significance).
Er.nA = Error: not accepted.
With this message the instrument reports that the desired change has not taken place. Before making another attempt with the switches in the correct position, the Er.nA message must be acknowledged with key 12.

4.3.2 Loading from the EPROM/EEPROM

The EEPROM must be plugged into socket St (above the battery, see Fig. 29).

The optionally available EEPROM usually contains special configurations, parameters and autocal data (see Section 13.5). The memory is large enough to store two or four (see Section 13.5) different programs.

If the EEPROM was loaded in a different instrument, the autocal data may not be transferred.

The required switch positions are shown in Table 7.

1) see Table 6 for further configuration possibilities

Switch	EPROM	EEPROM A	EEPROM B
S1/1	X	ON = Without autocal data OFF = With autocal data	
S1/2	X	ON	OFF
S1/3	ON	OFF	
S3/5	Write protection = ON		
S4	RCL PROGM		
S5	Press		
S4	RCL PARAM		
S5	Press		

Table 7 X = any

9.2 Calling test and auxiliary routines

The "MONIT + TEST" function is selected with switch S4 and activated with key S5.

Very different readouts may now appear in the digital display. What is displayed in detail depends on whether monitor routines used earlier were terminated correctly or not.

The flow diagram below shows what keys must be operated depending on the display.

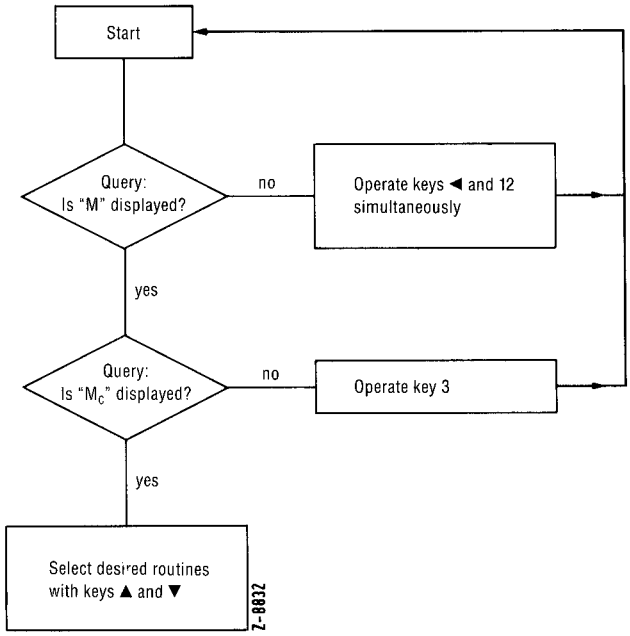
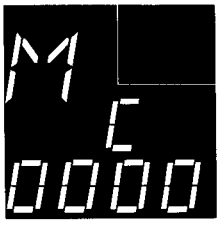


Fig. 40



Routine MC 00 . . is selected with keys ▲ and ▼.

Only the decimal digit at which the decimal point is positioned as cursor can be changed.

This cursor is moved by pressing key (10) and one of keys ▼ or ▲.

Key ▲ moves the cursor to the left, key ▼ to the right. The routine is activated by pressing keys ► and 12.

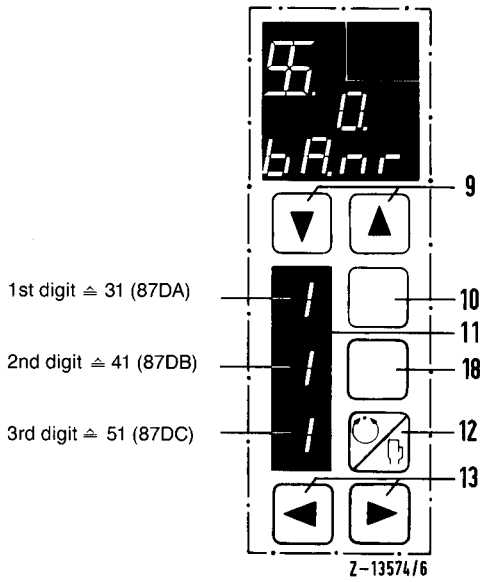
9.4.1 Display/change the request no. (B-Nr.) (address 10)

As described in Section 4.3.1, all the standard functions are stored in the EPROM (IC 15). Which of these functions is activated is specified by entering the request code in addresses 87DAH to 87DCH. Entry is facilitated with auxiliary routine MC 0010.

If this routine is called, the displays next to keys 10, 12 and 18 show the current function.

A new combination can be entered by operating these keys. The chosen function is loaded with S4 at RCL PROGM and RCL PARAM. S1/3 = ON.

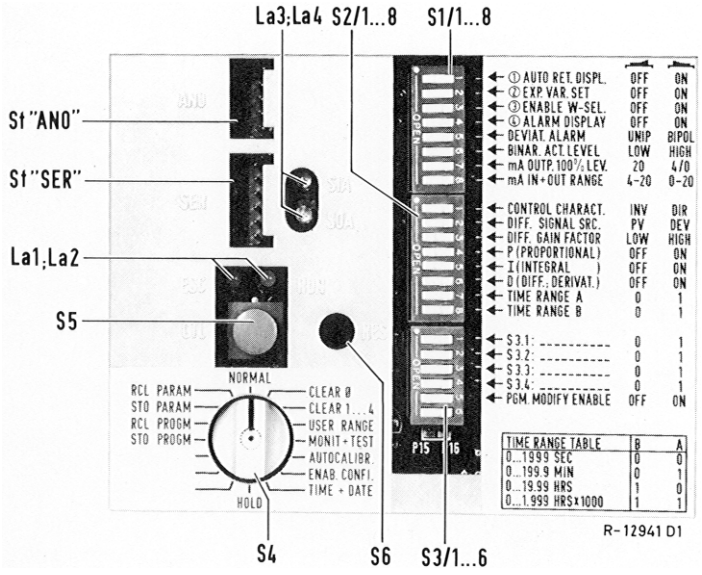
Note section 4.3.1!



After RCL PROGM and actuation of S5 the decimal points must be visible after the digits set.

3rd position: **Controller type**	
Single-channel, continuous including on/off action	1
Single-channel, three-position step action	2
Single-channel programmer	3
Two-channel, 2 x continuous including on/off action	4
Two-channel, 2 x three-position step action	5
Two-channel, continuous + three-position step action	6
Program controller with continuous and on/off output	7
Program controller with step action output	8
Two-channel programmer	9
Contents of 87DA 3	☐
4th position: **Input signal connection**	
Single-channel, fixed value/cascade	1
Single-channel, multi-component	2
Single-channel, ratio	3
Single-channel, extreme value selection	4
Two-channel, fixed value/cascade	5
Contents of 87DB 4	☐
5th position: **Channel logic**	
Only one channel or 1st and 2nd channel independent	1
Cascade (master controller = 1st channel)	2
Override control, min. selection	3
Override control, max. selection	4
Contents of 87DC 5	☐

Table 6 Extract from **controller PS** request matrix



Display and manual control elements of the processing electronics

Important Instructions for Your Safety!
Please read and observe!

Correct and safe operation *of the apparatus* calls for appropriate transportation and storage, expert installation and commissioning as well as correct operation and meticulous maintenance.

Only those persons conversant with the installation, commissioning, operation and maintenance of similar apparatuses and who the necessary qualifications are allowed to work on the apparatus.

Please take note of
- the contents of this Operating Manual,
- the safety regulations affixed to *the apparatus,*
- the safety regulations pertaining to the installation and operation of electrical systems,
- the safety regulations applicable when dealing with gases as well as
- the directives and guidelines on explosion protection.

The directives, norms and guidelines mentioned in this Operating Manual are applicable in the Federal Republic of Germany. When using *the apparatus* in other countries, please observe the national regulations prevailing in the respective country.

This apparatus has been designed and tested in accordance with DIN VDE 0411 Part 1, "Safety requirements for electronic measuring apparatuses", and has been supplied in a safe condition. In order to retain this condition and to ensure safe operation, the safety instructions in this Operating Manual bearing the headline "Caution" must be observed. Otherwise, persons can be endangered and *the apparatus* itself as well as other equipment and facilitis can be damaged

If the information in this Operating Manual should prove to be insufficient in any point, the Hartmann & Braun Service Department will be delighted to give you more information.

TECHNICAL DESCRIPTION

1 Application and Construction of the units

Protronic PS is a compact controller suitable for panel and rack installation. It is used for virtually all control tasks in the process industry. The interconnection of up to six input signals offers a large number of arithmetic functions and hence also allows the control of derived values.

On the output side the controller can be configured by software as a continuous controller, step action controller or on/off controller. A programmer or program controller can also be optionally configured.

Binary inputs and outputs allow many functions to be remote controlled.

The controllers can also be linked to higher-level systems via a serial interface.

For applications not included in the configurations offered by the manufacturer, provision is made for configuration by the customer.

Two analog displays with red and green luminous indicators enable easy recognition of measured and set point values, the control deviation and the margin of the controlled variable from the range limits, even from some distance away.

A four-digit numerical display is provided to permit precise readout of the measured values and adjustment of the set point and the control parameters.

The electronic potential isolation on the inputs permits unrestricted current signal connection even with grounded signal circuits.

2 Technical data

(Extract from Data Sheet 62–5.15 EN)

Input

Analog

6 times 0...20 mA/4...20 mA internal switch-over.
R_e = 50 Ω (built in to unit),
with electronic potential isolation.
Tolerated common-mode voltage ± 5 V.
Input circuits 5 and 6 are interrupted if the processing electronics are isolated from the case.

Voltage input

E1 to E4 at
0(2)...10 V; R_e 20 kΩ and 0(0.2)...1 V; R_e approx. 60 kΩ
E5 and E6 convertible to
0(0.2)...1 V; R_e approx. 60 kΩ.

Transmitter supply

Supply voltage 21 V, $I_{max.}$ 65 mA short-circuit proof,
also suitable for binary output supply.

Binary

1 binary input with respect to reference for forced trip to manual mode.
8 binary inputs for remote control
0 = open or 10...36 V
L = short circuit or −2...+3 V

Remote control

Binary inputs

To select and adjust set point, correction value (no correction value with step action controller), alarm values etc.

Adjustment time

100 % per minute for W, Y
1000 steps per minute (irrespective of decimal point position) for X_P, T_n etc.

Checkback signal for operating mode

by binary outputs.

Checkback signal for set values

Analog output A3
0(2)...10 V = 0...100.0 %
For X_P, T_n, T_v etc.:
0(2)...10 V for 0...1000 steps (setting over 1000 and under 0000 with decimal point in any position cannot be checked back).

Output

Analog

2 times 0...20 mA/4...20 mA, internal switch-over, linear correcting range 0...102 %. Above this approx. 105 % = approx. 21 mA, below this in 4...20 mA signal range approx. 3.5 mA.
Outputs 3 and 4
2 times 0...10 V, rated at 1 mA.

Permitted load on current outputs

0...750 Ω.

Effect of load

0.1 %/100 Ω.

Characteristic

Adjustable separately for automatic and manual.

Binary

Transistor outputs (open collector) with respect to reference (without electrical isolation) for max. 42 V, max. 50 mA, leakage current "off" 0.1 mA; surge-voltage proof for short durations up to 90 V, short-circuit proof for short durations via 10 Ω protective resistors.

Test jack

inside the instrument;
Outputs A1 and A2 each 0(1)...5 V, parallel to current outputs.
Outputs A3 and A4 each 0...10 V with respect to reference, rated at 1 mA.

Diagnostics

Self monitoring;
Binary output Q00:
Q00 = L: Unit in order (L = Output conducting)
Q00 = 0: Unit faulty or S4 = HOLD

Tape recorder interface

Facility for connecting commercially available "audio cassette units".

Output voltage

15 mV (peak-to-peak). Internal resistance approx. 100 Ω.

Input voltage

Max. 5 V (peak-to-peak). Internal resistance approx. 3 kΩ with input voltage less than 1 V (peak-to-peak).

Serial interface RS-422

Transmission type Balanced
Cable length max. 1200 m
Driver output
Without load ± 5 V
With load ± 1.5 V
Load 54 kΩ
Receiver
Input voltage − 7 to 12 V
Sensitivity + 200 mV
Resistance 12 kΩ
No potential separation.

Data and ranges

Display	Adjustment range display range	Factory setting (default value)	Function	Remarks
X	−0...100.8 %	−0...100.8 %	Actual value	−0 corresponds to X = appr.−5%*
W	0...100.0 %	0...100.0 %	Set point	*
Y	−2.4...102.4 % 0...100.0 %		Output variable	In manual mode (y ≧ 0 mA) In automatic mode
X_d	−100.0...100.0 %		Control deviation	$X_d = X - W$
D	−100.0...100.0 %		Set point difference	$D = W_{ext} - W_{int}$
G1 G2 G3 G4	−199.9...199.9 % −199.9...199.9 % −199.9...199.9 % −199.9...199.9 %	100.0 % 0.0 % −100.0 % 100.0 %	Alarm value max. Alarm value min. Alarm value min. Alarm value max.	* *
X_P	0...1850 %	100 %	Proportional range	Up to 1000 % in step action controller
T_n T_d	1...1999 1...1999	40 s 10 s	Integral action time Derivative action time	Time range depends on setting of switches S2/7 and S2/8
Y_0	−199.9...199.9 %	50.0	Operating point	Not in step action controller
H	0.5... 10.0 %	1.0 %	½ dead band	Only in step action controller
Y_L Y_H	−199.9...199.9 % −199.9...199.9 %	0.0 % 100.0 %	Min. output limit Max. output limit	
W_L W_H	−199.9...199.9 % −199.9...199.9 %	0.0 % 100.0 %	Min. set point limit Max. set point limit	* *
X_0 X_1	As X As X		Non-return pointer min. Non-return pointer max.	Resettable with CLEAR 0
V	−0...1999		Ratio actual value	
X_2	−1999...+1999	0...1000	denominator $K_3 \cdot E_3 + C_3$	
V_0 V_1	0...1999 0...1999	0000 1000	Lower-scale value analog Upper-scale value display	only rativ
$P_1...P_5$ $C_1...C_5$	0.0...100.0 % 0...1999		Amplitude values Time values	Programmer * See Section 7

Table 1

* See Section 4.7.2

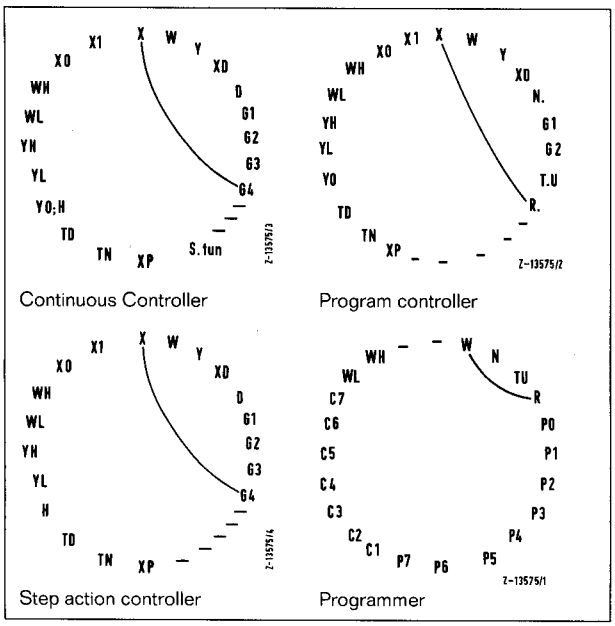


Fig. 2 Display loops

In two-channel controllers all displays and setting facilities are present in duplicate.

To permit the displays to be distinguished, all values for the second channel are shown with a point, e.g. X., W., X.d... .

In some instrument versions (software) the sequence, number and arrangement of the variables is different from Table 1.

All further variables used can be called up by simultaneously pressing key S5 (inside) and the display selector switch 3. It is recommended that a variable be set, initially in the small loop, which is as close as possible in the alphabet to the variable being sought. With key S5 depressed, the following setting possibilities are available:

Tipping display selector switch 3:
forwards in the alphabet

Holding display selector switch 3:
backwards in the alphabet.

Function of analog outputs in delivery status

	A1	A2	A3	A4
Single-channel K	Y1	W		
Single-channel D	20 mA	W		
Single-channel P	W	–		
Two-channel K	Y1	Y2		(E1) / (E3)
Two-channel D	20 mA	20 mA		(E1) / (E3)
Two-channel K/D	Y1	20 mA		(E1) / (E2)
Two-channel P+P	W1	W2		
Two-channel P+K	Y2	W1		
Two-channel P+D	20 mA	W1	–	
Cascade				(E1) / (E3)
K output	Y	W1		
D output	20 mA	W1		
Override control				(E1) / (E3)
K output	Y	W2		
D output	20 mA	W2		

Table 2

Function of binary outputs in delivery status

Channels	Controller			Programmer		
	1	2	Cascade	1	2	Program controller
Q 00	Output diagnostic L = in order					
Q 01 Q 02 Q 03 Q 04	G1 G2 G3 G4	G1 G2 G.1 G.2	G1 G2 G.1 G.2	B1 B2 B3 B4	B1 B2 B.1 B.2	B1 B2 G.1 G.2
Q 05 Q 06 Q 07 Q 08	Int.1 H1 Free Free	Int.1 H1 Int.2 H2	Ext.1 H2 o c	See Section 7		
	K	D		Z		
Q 09 Q 10 Q 11 Q 12	Free Free Free Free	Lower 2 Raise 2 Lower 1 Raise 1		2nd channel 1st channel		

Table 3

K	Continuous controller	Int.1	Feedback from 1st channel
D	Step action controller	Ext.1	Feedback from 1st channel
Z	On/off controller	o	Cascade is open
P	Programmer	c	Cascade is closed
H1	1st channel manual	Lower 2	Output 2, channel 2
H2	2nd channel manual	G	Alarm values
G./B.	Outputs of 2nd channel	B	Binary values of programmer

Power supply

Input-clocked switching power supply with electrical isolation. Can be plugged into case independently of processing electronics.

Also contains analog output circuit with memory and connection for service auto-manual unit.

Voltage ranges
220 VAC (187 ...264 VAC)
115 VAC (93.5...140 VAC)
24 VAC/DC (18...30 VDC and 20...27 VAC)
(Specifications for direct voltage include superimposed alternating voltage.)

Frequency range
Alternating voltage 48...400 Hz

Power consumption
16 VA, 9 W power dissipation

Fusing
Internal
220 V: G fuse link T0.2 C DIN 41662
115 V: G fuse link T0.315 C DIN 41662
24 V: G fuse link T1.25 C DIN 41662

Battery for RAM buffer
Type: VARTA (blue)
CR-1/3 NLF (3.4 V; LiCl)

Case and mounting

Mounting orientation
Vertically in vertical panel. Permissible inclination
-° to +30°

Electrical connections
Power supply
flat plugs A 6.3 mm × 0.8 mm or multi-pole connector (see Accessories)
Signal leads:
flat plugs DIN 46244
A 6.3 mm × 0.8 mm or A 2.8 mm × 0.8 mm
and pins 2.4 mm × 0.8 mm for Maxi-Termi-Point (MTP)
(clamp connection DIN 41611, Part 4)
Optionally:
Screw terminals as accessory
(fitted during wiring)

Degree of protection
Module in case IP40
Screw terminals, blade-type terminals and MTP IP00
Blade-type terminals with sleeve and power plug IP20 (DIN 40050)

Class of protection
I to VDE 0411

Insulation group
A to VDE 0110

Color
Front face and case pebble gray, RAL 7032

Weight
Module including power supply approx. 1.45 kg
Case 2.1 kg

Environmental capabilities

H&B climate group
2 (DIN 40040 KWF)

Ambient temperature
0...+50°C

Transportation and storage temperature
-25...+65°C

Relative humidity
75% annual average, short duration 95%

Condensation
None

Mechanical stress capabilities

Tested to
DIN 40046 Part 7 / IEC 68-2-27
DIN IEC 68 Part 2-6

Transport
Impact 30 g / 11 ms
Vibrations 2 g / ±10 mm / 3...150 Hz

During operation
Vibrations 2 g / ±10 mm / 3...150 Hz
acc. to seismic capability class II to DIN 40046 Part 55

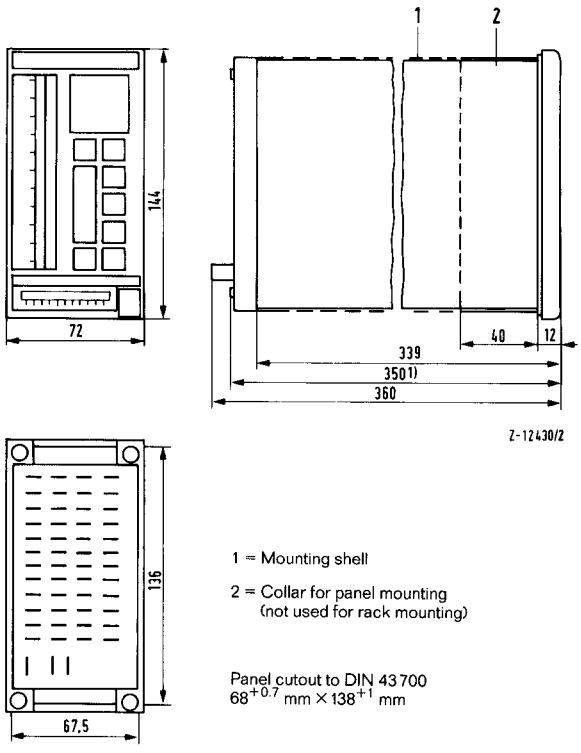


Fig. 1 Dimensional drawing (dimensions in mm)

[1] Plus panel thickness (max. 88 mm)

3 Mounting and connecting instructions

3.1 Selecting the installation site

The Protronic PS is suitable for panel and rack mounting. The case is protected to IP 40. The connections on the rear have the degrees of protection specified in the Technical Data.

An installation site must be selected where the values specified in the Technical Data are not exceeded.

3.2 Mounting the case

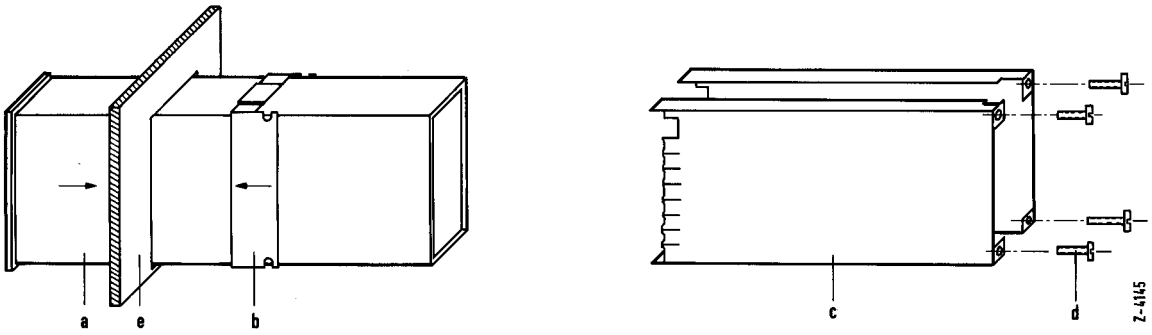


Fig. 3
a) Slide case into panel cutout (or rack field).
b) Slide collar (not used for rack mounting) over case.
c) Mount shells.
d) Fasten screws evenly and not too tight (approx. 5 Nm).
e) Panel or rack.

No additional support is required.

3.3 Installing the wiring

The signal lines and lines to the binary inputs must be laid separately from power lines.

When choosing and installing the conductor material, the regulations applicable in your country for the installation of power systems with rated voltages up to 1000 V (e. g. VDE 0100) must be observed.

3.4 Electrical connections

Connections are made with flat plugs A 6.3 mm × 0.8 mm or A 2.4 mm × 0.8 mm or Maxi-Termi-Point (MTP) to DIN 41611 Part 4. For ordering details for flat plugs and insulating sleeves see spare parts list.

A set of screw terminals is available as an accessory. If these terminals are used, first the terminal and then the plastic top are fitted over the connection during the wiring of the instrument. After inserting the wire, fitted with cable end sleeving, both wire and terminal are secured by tightening the screws.

3.4.1 Power supply

The protective ground connection must be made before any other connection.

For protection against electrostatic charges, a protective ground conductor is recommended even with a 24 V power supply.

The power supply must be connected via an external 2-pole switch.

Important

Before switching on the apparatus, make sure that the operating voltage stated on the power supply module rating plate is identical to the supply voltage.

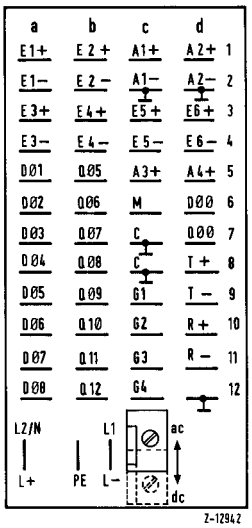
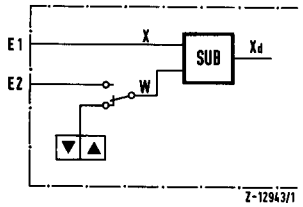


Fig. 4 Connection diagram

E1 to E6	Inputs 1 to 6
A1 to A4	Outputs 1 to 4
D1 to D8	Binary inputs 1 to 8
G1 to G4	Alarms 1 to 4 (= Q01 ... Q04)
Q05 to Q12	Binary outputs
D00	Forced manual mode input
Q00	Controller fault output
M	Transmitter supply
C	Instrument ground
T+; T−; R+; R−	Serial interface RS-422
Power supply	
L+, L−	Direct voltage connection
L2/N, PE, L1	Alternating voltage connection

3.4.2 Signal inputs

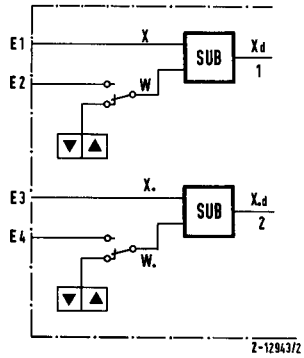
The input circuits outlined below are available in the instrument. Which input circuit is activated is determined by the software. The steps necessary to call up one of the control actions are described in Sections 4.3 and 11.2.



E = Input
X = Measured value
W = Set point
Xd = Control deviation

Xd = E1 – W

Fig. 5 Single-channel, fixed value/cascade

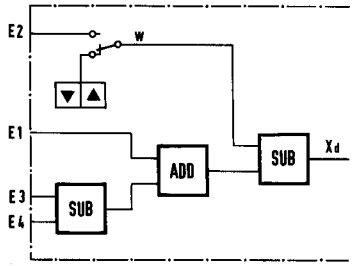


E = Input
X = Measured value
W = Set point
Xd = Control deviation

Xd = E1 – W and X.d = E2 – W.

Fig. 6 Two-channel, fixed value/cascade

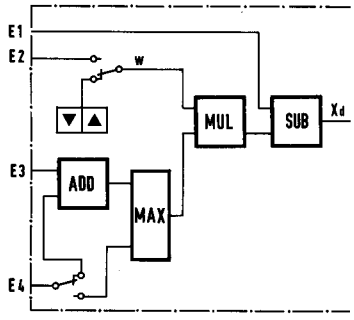
The values for the 2nd channel are always shown with a following point.



E = Input
W = Set point
Xd = Control deviation

Xd = E1 + (E3 – E4) – W

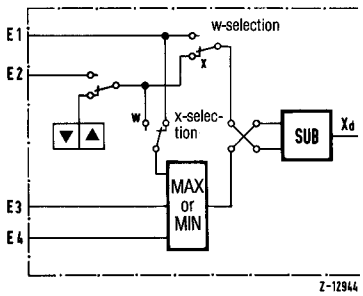
Fig. 7 Multi-component



E = Input
W = Set point
Xd = Control deviation

Xd = E1 – W (E3 ± E4) or can be switched over
Xd = E1 – W Max (E3, E4)

Fig. 8 Ratio



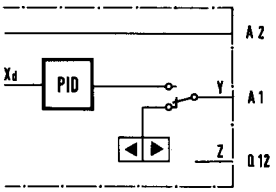
E = Input
W = Set point
Xd = Control deviation

Xd = Max/Min (E1, E3, E4) – W or can be switched over
Xd = E1 – Max/Min (E2, E3, E4)

Fig. 9 Extreme value selection

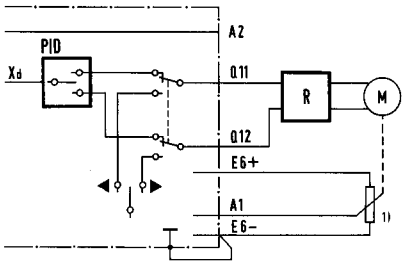
3.4.3 Type of control

The control actions provided in the instrument are described below. Which of these control actions is activated is determined by the configuration described in Sections 4.3 and 11.2.



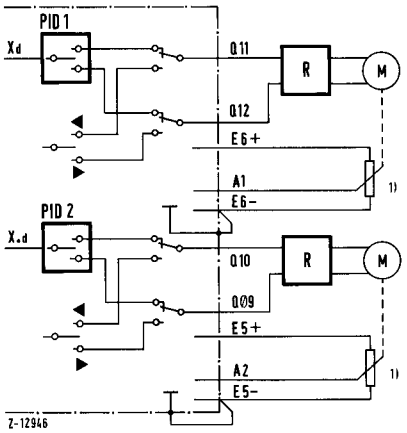
W = Set point
Xd = Control deviation
Y = Continuous output
Z = On/off output

Fig. 10 Single-channel continuous controller



W = Set point
Xd = Control deviation
R = Coupling relay
M = Motor

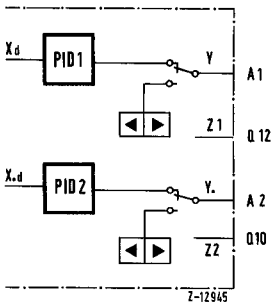
Fig. 11 Single-channel step action controller



Xd = Control deviation
R = Coupling relay
M = Motor

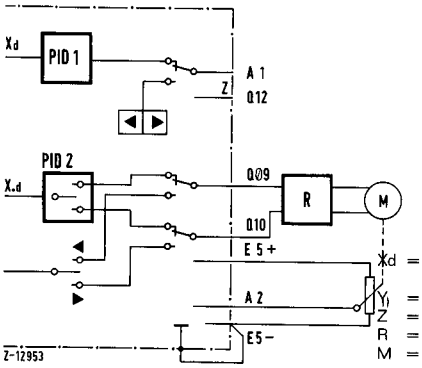
Fig. 12 Two-channel step action controller

[1] For current feedback signal the corresponding outputs (A1 or A2) are to be short-circuited (terminal c1 and c2 or terminal d1 and d2).



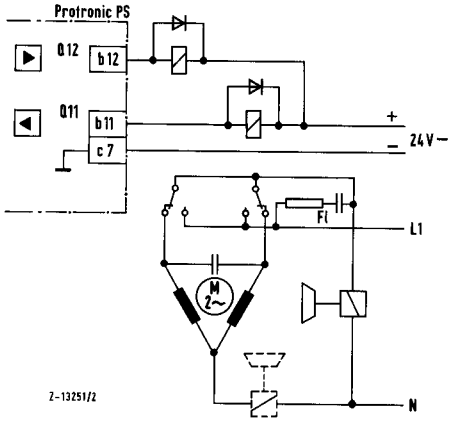
Xd = Control deviation
Y = Continuous output
Z = On/off output

Fig. 13 Two channel continuous controller



Xd = Control deviation
Yi = Continuous output
Z = On/off output
R = Coupling relay
M = Motor

Fig. 14 Continuous plus step action controller



FL = Sparking suppression is always recommended to prevent interference caused by sparking at switch contacts.

Fig. 17 Connection of a control motor via e.g. relay RHM 1003 (including diodes). Catalog No.: 86237-0-2304040

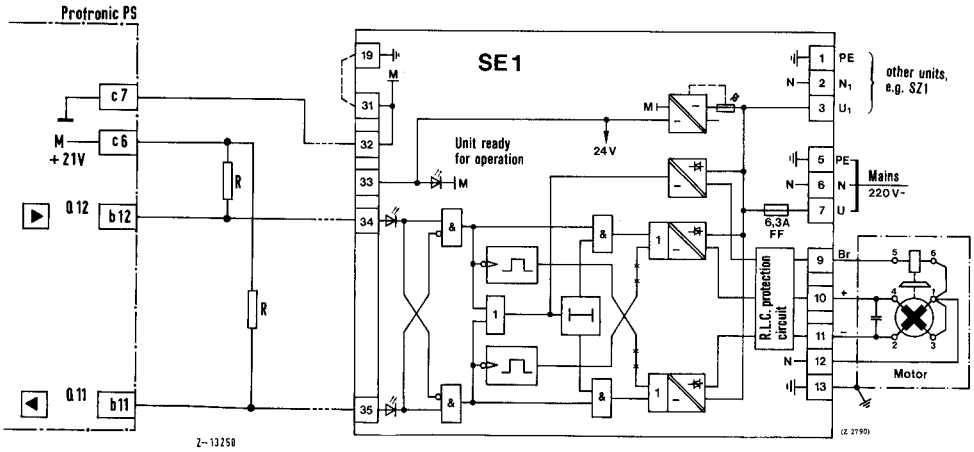


Fig. 15 Connection of a control motor via SE 1 with resistors

Resistors R must be mounted on the controller side as otherwise in the event of wire break the motor goes to an end position. The value C0 must be entered in address 873EH of the controller (see Section 11).
500 Ω ≦ R ≦ 1.5 kΩ

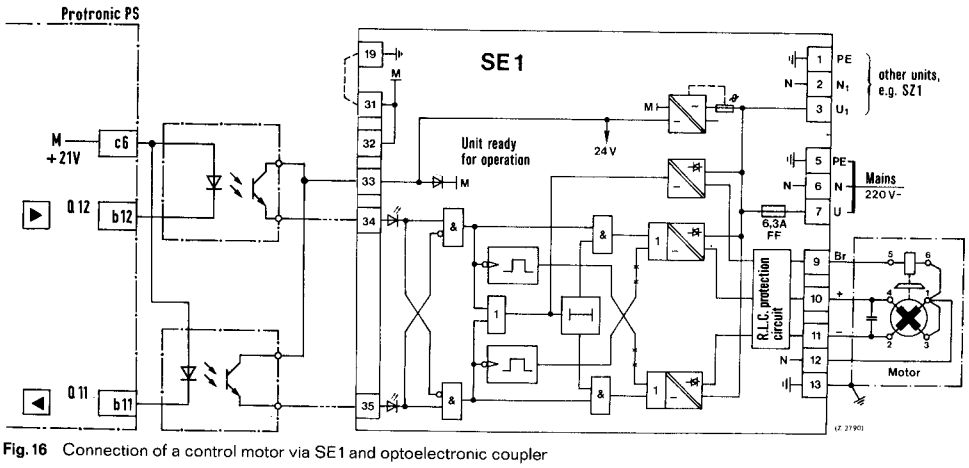


Fig. 16 Connection of a control motor via SE 1 and optoelectronic coupler

Electrical isolation and function reversal via optoelectronic coupler (Phoenix, Weidmueller etc.).
No modification is necessary in the controller.

1) For current feedback signal the corresponding outputs (A1 or A2) are to be short-circuited (terminal c1 and c2 or terminal d1 and d2).

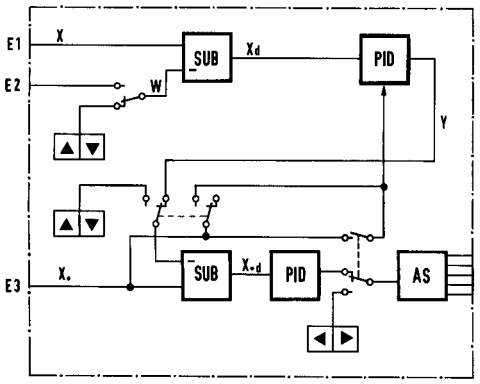


Fig. 18 Cascade control

Controller 1 = Master controller
Controller 2 = Slave controller
Controller output = Output 1 (see Fig. 11 and 12 resp.)
Position feedback signal ES

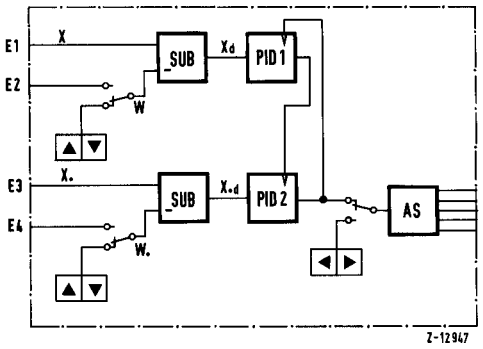


Fig. 19 Override control

Master controller = Controller 2
Override controller = Controller 1
Controller output = Output 1 (see Fig. 11 or 12)
Position feedback signal ES

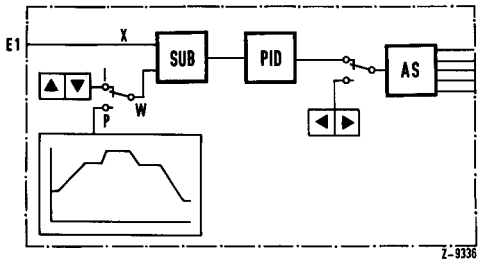


Fig. 20 Program controll

Channel 1 = Control
Channel 2 = Programmer
Controller output = Output 1 (see Fig. 11 or 12)

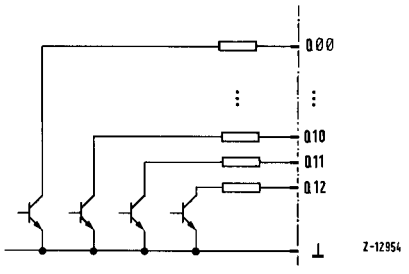


Bild 21 Connection diagram for binary outputs

3.4.4 Remote control

For programmer and program controller see also section 7.7.

Many of the controller functions can be remote controlled.

Manual/automatic key (12)

DEC = Decoder circuit for inputs D05 to D07. The variable to be adjusted is selected via these inputs and adjusted via D03 and D04. The new value is reported back via A3. Rate of adjustment 100 %/60 s.

Yr = Feedback signal. Forces the controller output (for K, D and Z) to the value of input E5.

D00 = A pulse sets the controller to forced manual mode. Switching back to automatic only with key 12 or D02.

D02 = The negative slope of a pulse switches the operating mode one position further. Only "manual" is reported back. Other checkback signals are configurable.

D01 = As D02, but for internal/external (I/E-) switching.

Pulse duration for 2-channel unit D00, D01, D02 and D00
≧ 200 ms

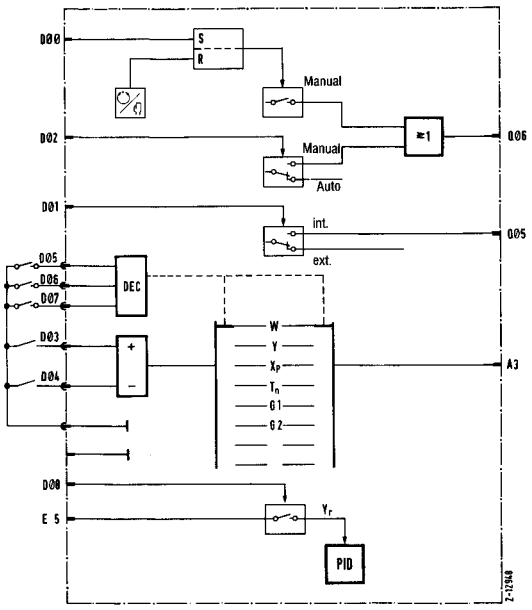


Fig. 22 Remote control of controller

	W	Y	G1	G2	Xp	Tn	WL	WH
D05	0	1	0	1	0	1	0	1
D06	0	0	1	1	0	0	1	1
D07	0	0	0	0	1	1	1	1

Table 4 Remote control of single-channel units

D08 = External feedback. If D08 = 1, the controller output tracks the value of E5. In step action controllers E5 is compared with the position feedback signal.

	W	Y	G1	G2	W.	Y.	G.1	G.2
D05	0	1	0	1	0	1	0	1
D06	0	0	1	1	0	0	1	1
D07	0	0	0	0	1	1	1	1

Table 5 Remote control of two-channel units without channel logic

If D07 = "1", D01 and D02 also act on channel 2. D00 always acts on both channels.

In cascade control, D01 switches between

"o" = cascade open
"c" = cascade closed
"E" = "c" + master controller with external set point if E is enabled (see 4.4.5).

All analog values of Table 4 can be adjusted except Y (of the master controller or override controller).

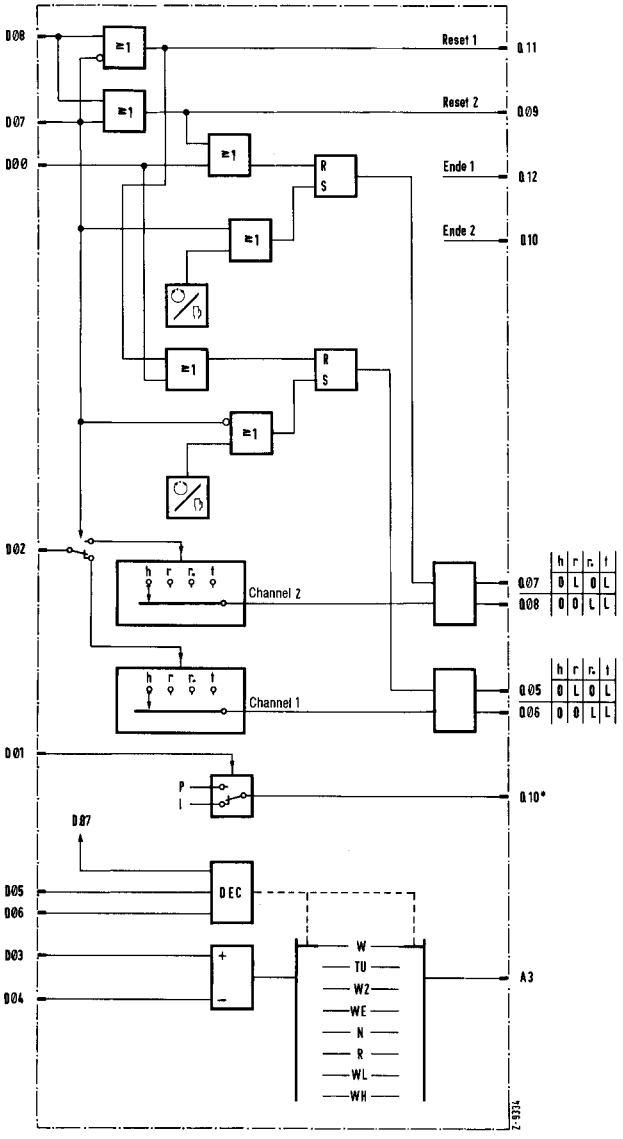


Fig. 23 Remote control of programmer

D00 = Forced "stop" for both channels
D07 = 0 : Channel 1 1 : Channel 2
D01 = Cyclic switchover P/I
D02 = Cyclic switchover h, r, r., t
D03 = Raise } rate of adjustment 100 %/60 s.
D04 = Lower }

Single-channel programmer

	W	TU	W2	WE	N	R	WL	WH
D05	0	1	0	1	0	1	0	1
D06	0	0	1	1	0	0	1	1
D07	0	0	0	0	1	1	1	1

Two-channel programmer

	W	TU	W2	WE	W.	T.U	W.2	W.E
D05	0	1	0	1	0	1	0	1
D06	0	0	1	1	0	0	1	1
D07	0	0	0	0	1	1	1	1

Program controller

	W	Y	G1	G2	W.	T.U	W.2	W.E
D05	0	1	0	1	0	1	0	1
D06	0	0	1	1	0	0	1	1
D07	0	0	0	0	1	1	1	1

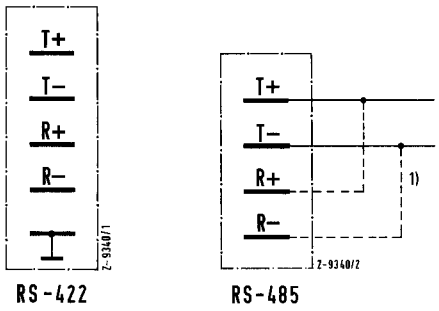
W.2 = 20 × N. W.E = 20 × R.

D08 = Reset (channel depends on D07)

3.4.5 Serial interface

The electrical data for the serial interface are specified in the Technical Data.

The software required in the higher-level system is described in the Operating Manual 42/62-64-.... ("Serial Interface")

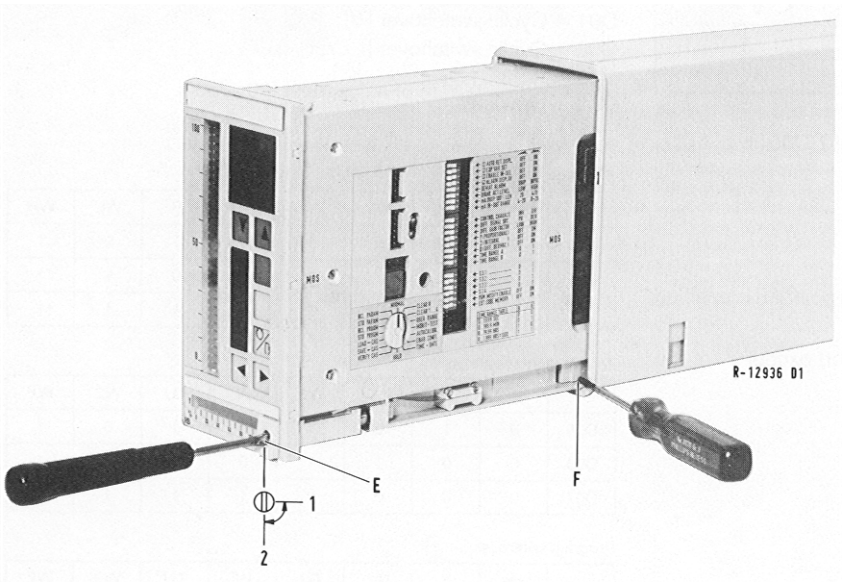


1) with one unit only

Fig. 24 Serial interface

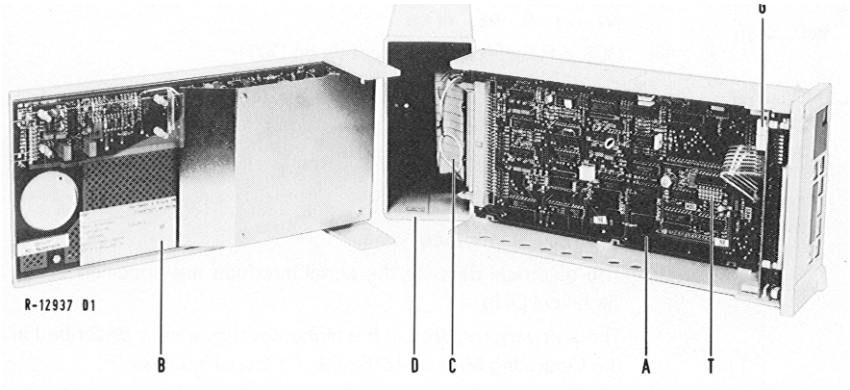
T+, T– = Controller transmission lines
R+, R– = Controller receive lines

3.5 Connection and release of chassis, power supply unit and case



E Module locking screw
1 lock
2 unlock
F Module catch

Fig. 25 Withdrawing the module



A Control electronics
B Power supply unit
C Flexible ribbon cable with connector
D Case
G Potentiometer for brightness adjustment
Printed circuit-board imprint
A = analog display
B = digital display
T Printed circuit board real-time clock

Fig. 26 Division into subassemblies

Insertion into case

- Pull out ribbon cable and connector from case.
- Insert power supply unit along the left case wall.
- Open locking lever at socket (C.1) of control electronics. Connect plug and close locking lever.
- Insert instrument completely into case and turn lock "E" (Fig. 25) clockwise.

Removal from the case

- Unlock the instrument (turn locking screw (E) counterclockwise).
- Withdraw instrument from the case as far as the limit stop.
- Release catch (F) with a screwdriver.

Important

If the instrument is in operation, read Section 14 before disconnecting the control electronics.

- Remove instrument completely.
- Open locking lever at socket and remove plug (C).
- Position plug on case so that it does not slide into the case.

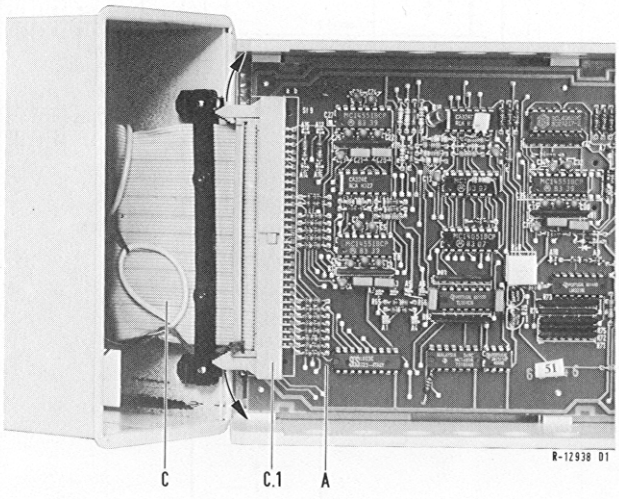


Fig. 27 Connection between electronics and case

A Control electronics
C Ribbon cable with plug
C.1 Plug-in socket

4 Commissioning

This apparatus shall be used only when built in. Before switching on the apparatus make sure that it is set to the voltage of the power supply.

4.1 Display and manual control elements on the front panel

Note:

In the following text, frequent reference is made to the manual control elements presented here. To avoid having to leaf back frequently to locate diagrams, the front view, display and control elements (figs. 28 and 30) are reproduced on the back fold-out page 38.

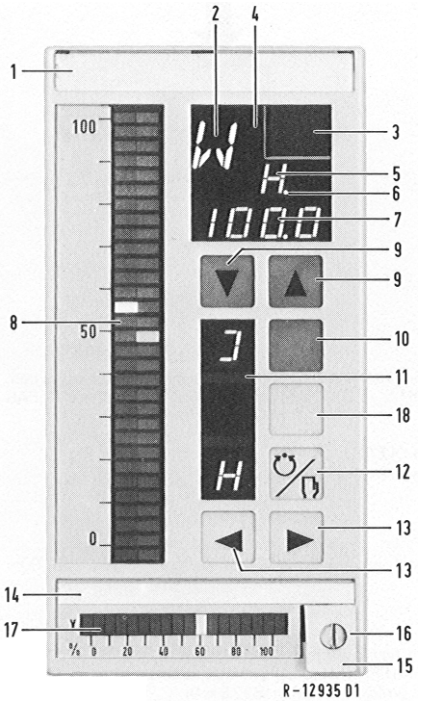


Fig. 28 Front view

1 Top legend plate
2 Code letter display
3 Selector switch for digital display
4 Digital display field
5 Index for code letters
6 Decimal point for 5, lights up when the variable displayed by 2 and 5 is adjustable
7 Four-digit display
8 Analog display: actual value red
set point green
9 "Raise/lower" keys for set point and parameter
10 Set point selection (I/E key) (can be disabled)
11 Status display
12 Manual/automatic transfer (Mode selector switch)
13 "Raise/lower" keys for output variable
14 Lower legend plate
15 Handle for removal
16 Module locking screw (E)
17 Output variable display
18 Multi-function key (F-key)

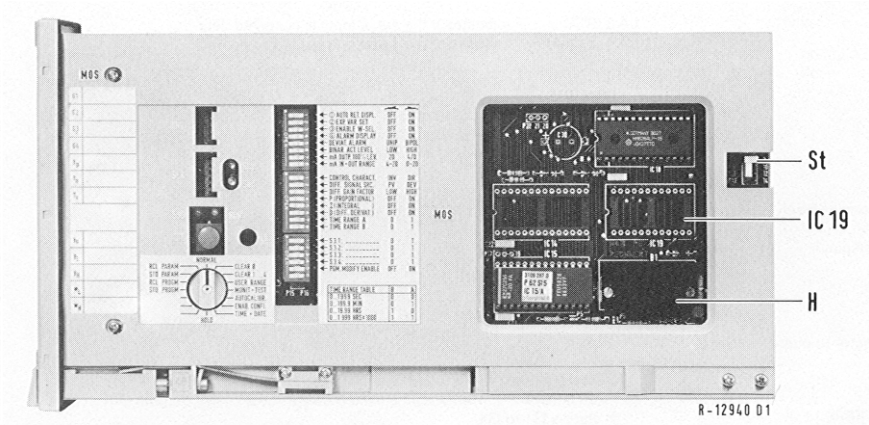


Fig. 29 Lateral view of the control electronics unit

H Battery
St Connector depending on EEPROM type
IC 19 Slot for E(E)PROM)

4.2 Internal display and manual control elements

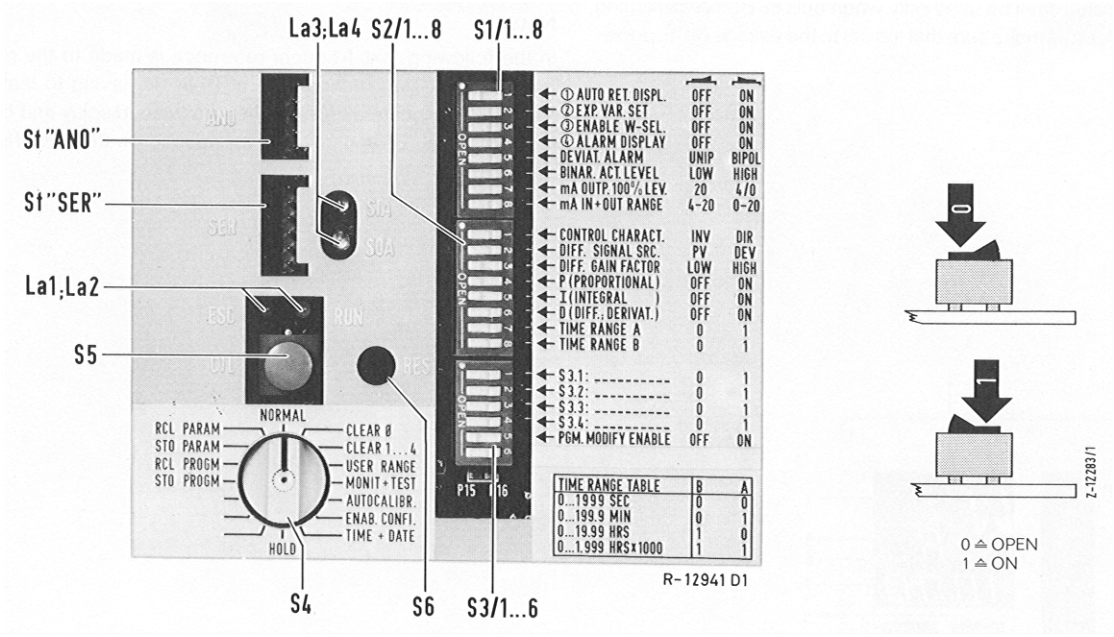


Fig. 30 Display and manual control elements of the control electronics unit

Switch S1/...,
Functions

1	Digital display returns automatically to "x"	no[1]	yes
2	Parameters are displayed	no[1]	yes
3	Internal/external selector switch enabled	no[1]	yes
4	Alarm value exceeded is indicated by the red actual value indicator flashing	no[1]	yes
5	Alarm values 3 and 4	UNIP[1]	BIPOL
	UNIP = Control deviation −100...+100 % adjustable		
	BIPOL = Amount of control deviation 0...100 % adjustable		
6	LOW = quiescent current, HIGH = operating current signalling[2]	LOW[1],	HIGH
7	Y = 100 % corresponds to	20[1]	0/4 mA
8	Input and output (mA)[5]	4-20[1]	0-20

Switch S2/...,
Functions

1	Control characteristic	reverse[1]	direct
2	Differentiation of	PV = x[1]	DEV = x_w
3	Differential gain	$V_D = 1$	$V_D = 4$[1]
4	P action (proportional)	no	yes[1]
5	I action (integral)	no	yes[1]
6	D action (derivative)	no[1]	yes
7 and 8	Time range according to table 11.		

Switch S3/...,
Functions

1, 2, 3 } Dependent on the input function, see Sections 3.4 and 4.3
4 Unused = freely configurable

5	Write protection[3]	on	off
6	Ext. code memory[4] (IC 13)	off	on

Switch S4/...
Functions

NORMAL	= Normal operating position
CLEAR 0	= Reset non-return pointers
CLEAR 1...4	= CLEAR 1 as CLEAR 0 for channel 2, otherwise freely configurable (see below)
USER RANGE	= Set the physical readout for the digital display
MONIT+TEST	= Test routines and configuration
AUTOCAL	= Calibration of inputs and outputs
ENAB. KONFI	= Enable configurator
TIME + DATE	= Read and set date and time (option)
HOLD	= Disconnect processing electronics, transfer to output memory of power supply unit
RCL PARAM	= Recall saved parameters
STO PARAM	= Store parameters
RCL PROGM	= Enter the configuration contained in the EPROM (without parameters)
STO PROGM	= Store the configuration in EEPROM (option), see 4.3.3
LOAD CAS	= Load configuration data from cassette
SAVE CAS	= Store configuration data on cassette
VERIFY CAS	= Test configuration data stored on cassette

Function CLEAR 1...4

CLEAR 2 to 4 can be used to reset functions configured in the unit, such as the non-return pointers. Switches S1/2 to S1/4 are used to select which of the CLEAR functions is to be activated.
Procedure:

- Switch S4 to position CLEAR 1...4
- Select the desired function by setting S1/... to "ON"
- Operate key S5

Key S5 (CTL)

Individual operating modes will only be activated if in addition to turning S4, S5 (CTL) is also operated.

Key S6 (RES)

When S6 is pressed three times within a second while holding down S5, the configuration data contained in EPROM including default parameters are transferred to RAM = Reset, if the write protection is open (S3 / 5 = 0).

If an EEPROM is present, loading is done from the EEPROM if the configuration data in the EEPROM have a priority code (see 4.3.3).

LEDs La 1...4

The LEDs La 1, La 2 indicate the present operating status:
green LED only: pure control/manual operation = NORMAL
red LED only: HOLD

If other tasks are being processed in parallel with the control function, red and green alternate at different time intervals.
The frequency does not correspond to actual time conditions.
The green LED begins to flash at 5 Hz if the position of S4 does not coincide with the actual operating mode.

LA 3 (SIA)	indicates if the serial input is received data.
LA 4 (SOA)	indicates if the serial output is sending data.

Connectors (St)

ANO	Analog outputs A1 to A4 from top to bottom. Lowest connection: ground.
SER	Connection for tape recorder or configurator.

[1] Delivery status.
[2] From software status 16/85 the switch only affects binary outputs Q01 to Q04 = alarms G1 to G4.
[3] See 4.8.1 for function of write protection facility.
[4] From mid-1985 a microprocessor with integral ROM will preferably be used in the Protronic P. In this case switch S3/6 must be in the "OFF" position.
[5] See section 4.5.2.4 for three-position step action controller and signal range 4...20 mA.

4.3 Selecting the control function

4.3.1 Standard functions

The universal controller can be software-configured as a continuous or step action controller.

The status of the instrument can be monitored and changed as described in Section 9.4.1.

Table 6 shows the part of the request matrix that determines the software. The required function is defined with the aid of the table and entered with the auxiliary routine as described in 9.4.1.

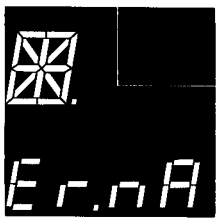
In older software structures the entries must be made via monitor ME to addresses 87DA to 87DC.

3rd position: **Controller type**	
Single-channel, continuous including on/off action	1
Single-channel, three-position step action	2
Single-channel, programmer	3
Two-channel, 2 × continuous including on/off action	4
Two-channel, 2 × three-position step action	5
Two-channel, continuous + three-position step action	6
Program controller with continuous and on/off output	7
Program controller with step action output	8
Two-channel programmer	9
Contents of 87DA 3	
4th position: **Input signal connection**	
Single-channel, fixed value/cascade	1
Single-channel, multi-component	2
Single-channel, ratio	3
Single-channel, extreme value selection	4
Two-channel, fixed value/cascade	5
Contents of 87DB 4	
5th position: **Channel logic**	
Only one channel or 1st and 2nd channel independent	1
Cascade (master controller = 1st channel)	2
Override control, min. selection	3
Override control, max. selection	4
Contents of 87DC 5	

Table 6 Extract from the request matrix

If incorrect digits are entered in one or more addresses, the controller defaults to 31, 41, 51.

After the required data have been entered, the following switches 3, 4 and 5 must be temporarily set to the positions described in Table 7.



If one of these conditions is not met, the controller displays the message ErnA (any decimal point visible is without significance).

Er.nA = **Er**ror: **n**ot **a**ccepted.

With this message the instrument reports that the desired change has not taken place. Before making another attempt with the switches in the correct position, the ErnA message must be acknowledged with key 12.

4.3.2 Loading from the EEPROM

The EEPROM must be plugged into socket 19 (above the battery, see Fig. 29).

The optionally available EEPROM usually contains special configurations, parameters and autocal data (see Section 13.5). The memory is large enough to store two or four (see Section 13.5) different programs at the same time.

If the EEPROM was loaded in a different instrument, the autocal data may not be transferred.

The required switch positions are shown in Table 7.

Switch	EPROM	EEPROM A	EEPROM B
S1/1	×	ON = Without autocal data OFF = With autocal data	
S1/2	×	ON	OFF
S1/3	ON	OFF	
S3/5	Write protection = ON		
S4	RCL PROGM		
S5	Press		
S4	RCL PARAM		
S5	Press		

Table 7 × = any

4.3.3 Storing configurations in an EEPROM [1)]

Switch	EEPROM A	EEPROM B
S4	STO PARAM	
S5	Press	
S1/1	ON = Without autocal data OFF = With autocal data	
S1/2	ON	OFF
S1/3	OFF = Priority	
S4	STO PROGM	
S5	Press	

Table 8 × = any

Before storing configurations, check that the plug-in jumpers St (Table 26 and Fig. 29) are correctly inserted. If these jumpers are withdrawn or only plugged in at one side, the EEPROM is write protected.

If S1/3 is set to "OFF" during storing, the stored configuration is given a priority code and automatically reloaded in the event of a RESET. It should therefore contain the parameters. (STO PARAM before saving). If several configurations are stored in this way, the one stored last with S1/3 OFF is loaded.

If it is planned to use the EEPROM in other instruments too, the autocal data should not be stored.

The required switch positions are shown in Table 8.

4.3.4 Reinitialization

If the operating status is not clear and no improvement can be obtained with RCL PROGM and RCL PARAM, a reinitialization is recommended. Reinitialization is brought about by pressing key S5 three times within a second with key S6 held down.

The controller initially attempts to load from EEPROM the configuration with priority code. If no such configuration is available, the function defined in addresses 87DA to 87DC is loaded.

The controller goes to manual. The parameters last set are still effective. The continuous controller output goes to 0%. Er.00 appears in the digital display.

4.4 Manual operation

The controller is operational immediately after switching on the power supply.

If the instrument was previously operational and the back-up battery continuously connected and serviceable, the instrument returns to the operating condition from which it was switched off. It will contain the last valid parameters.

4.4.1 Manual operation of continuous controller

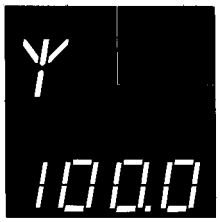
4.4.1.1 Output characteristic

In the delivery status, pressing key ▶ causes the output signal to increase at the same time as the output display (17) moves to the right.

Switching over S1/7 results in a decreasing output signal when key ▶ is operated. The luminous indicator however continues moving to the right. This ensures that, irrespective of the direction of action of the actuator, a connected valve is opened when pressing key ▶, or closed when pressing key ◀.

4.4.1.2 Output signal display

The output meter (17) displays the output variable with a resolution of approx. 6 %. If a more precise readout is required, operating key 3 causes the output variable y to be switched to the digital display and shown with a resolution of 0.1 %.



For fast information on the precise output value, simultaneous operation of keys ◀ and ▶ switches the output variable to the digital display for the duration of the key operation.

In the standard configuration corresponds to the controller output.

Flashing of the cursor indicates a control circuit break or overload.

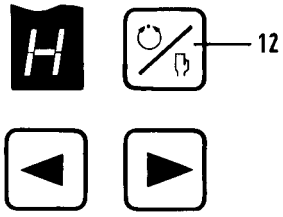
If the write protection is set, the controller displays Er.nA.

4.4.1.3 Adjusting the output signal

Adjusting the output signal is always possible when the instrument is in the "manual" mode (H). A short depression of key ◀ or ▶ changes the output signal by + 0.1 % or − 0.1 %.

If one of the keys is held depressed the output signal will change with increasing speed.

4.4.1.4 Quick adjustment of output



If key 12 is pressed together with one of the two keys ◀ or ▶, the output signal immediately changes in the required direction to − 2.4 % = 0 or 3.5 mA or 102.4 % = approx. 20.6 mA.

4.4.1.5 Control deviation display

The control deviation X − W is displayed as X_d.

4.4.2 Manual operation of step action controller

4.4.2.1 Output characteristic

In the delivery status, key ▶ acts on output Q12 (increase) and key ◀ on output Q11 (decrease).

The motor must be connected to these outputs according to the desired characteristic.

4.4.2.2 Display of final control element position

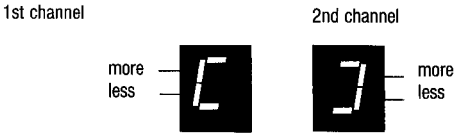
The position of the drive must be reported back with a potentiometer or a position pickup that delivers a current signal.

If a potentiometer is used, it is possible to specify by means of suitable wiring or with switch S1/7 whether, when key ▶ is pressed, the position display will change to larger or smaller values.

If a current feedback signal is used, the display 100 % can be assigned to a feedback signal of 0(4) mA or 20 mA with switch S1/7.

4.4.2.3 Display of control pulses

In the display next to the F-key the control pulses are displayed by illuminated single segments.



4.4.2.4 Matching the position display to the correcting range

In signal range 4...20 mA (determined by switch S1/8) and when using a potentiometer feedback signal, the corresponding controller input (E5 or E6) must be configured via a control code change (in the monitor ME870B) for the signal range 0...20 mA. The following table fixes the signal range of inputs 1...4 at 4...20 mA. The signal range of inputs 5 and 6 must be determined acc. to the table, depending on the type of controller (see 3.4.3).

Contents in address 870B	Input 5	Input 6
80	4...20 mA	4...20 mA
90	0...20 mA	4...20 mA
A0	4...20 mA	0...20 mA
B0	0...20 mA	0...20 mA

Matching the 0...100 % position display to the present correcting range is effected for potentiometer and current feedback signalling with the aid of settings K6 and C6. These settings are selected by simultaneously pressing keys S5 (internal) and 3. It is advisable initially to set a variable in the small loop as close as possible in the alphabet to the variable sought. With key S5 depressed the following adjustments are possible:

Key 3 tapped: forwards in the alphabet
Key 3 held: backwards in the alphabet

Procedure:

Adjust C6 = 0, K6 = 100.0
First the drive is brought to the two end positions one after the other, and Y is read from the digital display for both positions.

From the readout values:

Y_a = value at end position 0 %
Y_e = value at end position 100 %

K6 and C6 can now be calculated, as follows:

$$C6 = -Y_a \qquad K6 = \frac{10000}{Y_e - Y_a}$$

For the second channel C.6 and K.6 are used to adjust the position display.

Adjustment can be performed without calculation by first moving the drive to the zero position and adjusting the position display (17) with C6 (C.6) in such a way that illumination is transferred from the first to the second LED just at that point.

The adjustment must then be repeated in the end position with K6 (K.6).

The setting uncertainty obtainable by this method is less than 0.5 %.

4.4.2.5 Adjusting the servodrive

The servodrive is always adjustable when the controller is switched to manual. The correction time depends only on the run time of the drive.

Quick adjustment is not possible.

4.4.3 Manual operation of on/off controller

In the manual mode the on/off controller delivers a pulse train the mean value of which over time is displayed by the position indicator (17). For manual operation the same instructions apply as for the continuous controller.

If a display of the output signal is required acc. to 4.4.2.3 at the controller it is necessary to enter value "00" at address 8730 (see Section 11).

The switching frequency depends on the duty cycle and achieves its maximum at an output of 50 %. In the delivery status the controller switches 6 times a minute with a duty cycle of 50 %. For a different switching frequency the addresses mentioned in the table below must be changed.

$\frac{n}{min}$	Addresses channel 1 84AC Addresses channel 2 84AD Contents	Contents Address 8740
1 2	78 = 2 min	7D = 12.5 % 3F = 6.3 %
3 4 5	77 = 25 s	C8 = 20.0 % 96 = 15.0 % 78 = 12.0 %
6 7 8 9 10 12 15 20 25 30 39 50 60	**76** = 10 s	**FA** = 25.0 % D6 = 21.4 % BC = 18.7 % A7 = 16.7 % 96 = 15.0 % 7D = 12.5 % 64 = 10.0 % 4B = 7.5 % 3C = 6.0 % 32 = 5.0 % 26 = 3.8 % 1E = 3.0 % 19 = 2.5 %

Table 9

Individual switching times can be calculated as follows:

On time $t_{on} = \frac{H(8740) \cdot T(84AC)}{(1-y) \cdot 100\,\%}$

Off time $t_{off} = \frac{H(8740) \cdot T(84AC)}{y \cdot 100\,\%}$

Cycle time $t_z = \frac{H(8740) \cdot T(84AC)}{y \cdot (1-y) \cdot 100\,\%}$

Max. cycle time $F_{max} = \frac{H(8740) \cdot T(84AC)}{25.0\,\%}$

T = Time constant of the integrator used
H = Hysteresis of the comparator used, see Table 9.

4.4.4 Manual operation of two-channel controller

The same rules apply to manual operation of two-channel controllers as for single-channel controllers.

The controller that can be operated at any one time is specified with the F-key (18) and can be read off in the adjacent display field (11).

The second character applies to the step action controller

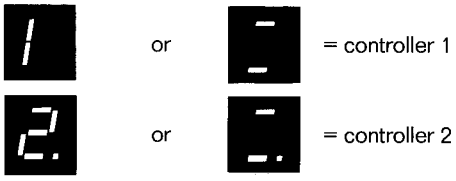


Fig. 31 Channel identification

4.4.5 Manual operation of cascade controller

During commissioning the slave controller is first operated on its own. The I/E-key (10) has three possible positions:


= cascade is open


= cascade is closed


= external set point for master controller (only accessible after changing the contents of address 877BH from 03 to 07).

The F-key can be used to switch between master controller and slave controller. The displays shown next to the F-key are described in 4.4.4.

The master controller is always in the automatic mode. It cannot be switched to "manual". If an attempt is made to switch the master controller to "manual", the display transfers to controller 2 which then switches to "manual".

Manual operation is the same as for single-channel controllers via controller output 1.

If channel 1 is selected in the manual mode, a flashing "A" indicates the continuing manual mode.

4.4.6 Manual operation of override controller

The override controller can have continuous or step action output. In the step action controller a position feedback signal is necessary for the limitation.

Controller 2 is always the master controller, controller 1 the override controller.

Using the I/E-key (10) in interaction with the F-key (18), an internal or external set point can be assigned to each controller. The mode selector switch (12) only acts on the master controller, i.e. the override controller is always in the automatic mode.

If channel 1 is selected in the manual mode, a flashing "A" indicates the continuing manual mode.

Commissioning starts with the master controller.

4.5 Set point adjustment

When the controller is switched on it reverts to the operating mode from which it was switched off.

4.5.1 Internal set point

If the internal set point is not active, I/E-key (10) can be used to transfer to "I" if this is not disabled with switch S1/3.

If this is the case, the block must first be removed (see Fig. 30).

After selecting "W" in the digital display by operating key 3, the set point value can be adjusted with keys ▼ and ▲. A brief key depression alters the last (right hand) digit of the set point by +1 or −1. If the key is held depressed, the set point value changes with increasing speed.

The internal set point can be adjusted by remote control at any time without being selected in the digital display.

If a numerical range of more than approx. 2500 digits is set (see Section 4.8), the smallest possible set point adjustment is in some cases 2 digits due to rounding.

4.5.2 External set point

The controller is to operate permanently as a slave controller. Transfer to internal set point is to be inhibited.

The controller is switched to "E" = external set point with key 10, and key 10 is then disabled with switch S1/3. Set point adjustment is performed solely with a continuous signal via terminals b1(+) and b2(−).

4.5.3 Internal/external set point transfer

Transfer is effected by pressing key 10. As soon as the display next to key 10 stops flashing, the new operating mode is effective.

Before transferring from internal set point to an unknown external set point it is advisable to set the difference readout $D = W_E - W_i$ in the digital display with key 3 and to check that transfer is permissible. The display is in percent. A positive value indicates that the external set point value is higher than the current internal set point value.

If a transfer takes place with a difference existing between w_i and w_e, the effective set point approaches the external set point value at a rate of 6.25 digits per second.

Transfer from external set point to internal set point is automatic and bumpless. The internal set point then corresponds to the last external set point value.

4.6 Auto/manual mode transfer

The operating mode transfer is automatic and bumpless in both directions by depressing key 12.

As soon as the status display next to key 12 stops flashing the new operating mode is effective.

Auto/manual transfer is also bumpless with I action switched off. Transfer is effected according to an E-Function with a time constant that can be set with parameter T_n which is unused in this mode.

4.7 Matching the controller to the controlled system

Important.

The values to be set in the following paragraphs could be lost during a battery change (see Section 10).

Adjustment of the control parameters is only possible if switch S1/2 is in the "ON" position. By operating key 3 on the front panel the parameters can be transferred to the digital display and then adjusted with keys ▼ and ▲.

4.7.1 Write protection

4.7.1.1 Write protection for the RAM area

The write protection feature protects the configuration and the USER RANGE settings against inadvertent deletion with "RCL PROGM".

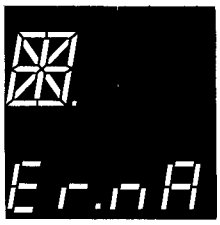
USER RANGE settings and configuration data are entered directly to the protected area.

Once values have been established for the parameters, these can be written to the write protected area of RAM and thus saved, by turning switch S4 to the "STO PARAM" position and then pressing key S5. Switch S3/5 in Fig. 30 operates the write protection. If the switch is in the "OFF" position, the effective parameters can be altered but not stored.

The stored parameters can be recalled via function "RCL PARAM" with a subsequent depression of S5.

4.7.1.2 Write protection for the EEPROM

If the plug-in jumpers at the EEPROM are withdrawn or only inserted on one side, the EEPROM is write protected. See Sections 4.3.3 and 13.5.



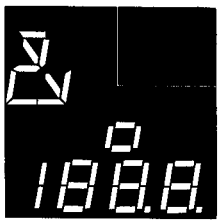
If an attempt is made to write to the protected area with write protection switched on, the controller displays the message Er.nA (any decimal point visible is without significance).

This display must be acknowledged with key 12 before a new attempt can be made with write protection switched off.

4.7.2 Adjusting the digital display

Note write protection status!

In the delivery status the digital display shows 0 to 100.0 (%) for 0(4)...20 mA. A physical display can be set for a selected number of variables. In two-channel instruments the selected range applies to both channels.



If a physical display is required for linear signals, proceed as follows:

With switch S3/5 in position "on" = write protection off, turn switch S4 to "USER RANGE" and operate key S5 (inside the instrument). An identification symbol "&" appears on the digital display with the index o or r.

"o" represents start of range, "r" end of range. Adjustment is effected with keys ▲ and ▼. The digit to be changed is indicated by the decimal point which acts as cursor. The cursor is moved to the required digit by simultaneously pressing key 10 and one of keys ▲ or ▼.

By operating key 3 the second value to be set is called up and set in the same way.

Before returning switch S4 from "USER RANGE" to "NORMAL" the decimal point must be put in the required position. After the change-over and operation of key S5 the display range is stored in the battery-backed RAM (note write protection).

The actual value, set point (internal and external) and alarm values are then displayed exclusively in the fixed numerical range. They are recognizable by the extreme right decimal point flashing at intervals of one second.

All other values are displayed as a percentage or in the selected time units.

4.7.3 Changing the scale

The scale of the analog display (8) can be changed without opening the instrument. Insert a small screwdriver into the slot provided at the bottom narrow edge of the scale and lift out the scale. The new scale is inserted bottom part first, then bending the scale outwards slightly in the middle, push top part of scale in.

Adjustment is not necessary.

4.7.4 Legends on front panel

To open the legend field:

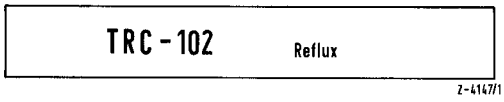
Insert a small screwdriver in the cutout at the narrow side of the transparent cover and lift out the cover.

The self adhesive strips of cardboard available as accessories should be used as base for the inscription (see spare parts, Section 15).

a) **Top legend field**
(Control loop identification and dimension)
Size: 66 mm × 9 mm

Using mixed lettering with character height 4.5 mm (width approx. 2.6 mm) and character height 2.5 mm (width approx. 1.5 mm), the following possibilities arise:

Example



Z-4147/1

Fig. 32

Height	Number of letters											
4.5 mm	0	3	4	5	6	8	10	12	15	18	20	25
2.5 mm	44	37	35	33	31	28	24	21	16	11	7	0

Table 10 Character height and number of characters

Intermediate values can be calculated as follows:

N = Number of large letters (4.5 mm)
n = Number of small letters (2.5 mm)

$$n = \frac{66 - (N+1)\,2.6}{1.5} \quad \text{or} \quad N = \frac{66 - 1.5\,n}{2.6} - 1$$

Inserting the legend strip:
Having stuck in the paper strip, insert transparent cover on the left, bend it slightly, and engage it on the right hand side while pushing to the left.

b) **Lower legend field**

Size: 66 mm × 5 mm

With a character height of 2.5 mm and width 1.5 mm, 44 letters can be used.

4.7.5 Brightness of displays

The brightness of the analog and digital displays can be adjusted separately with a potentiometer each on the rear of the front module (accessible from the left with the instrument opened; see Fig. 26).

The potentiometers are identified on the pcb as follows:

Dimmer A: Brightness adjustment of analog displays
Dimmer B: Brightness adjustment of digital displays including status displays.

5 Hints on optimization

In order to determine the most suitable settings we suggest referring to the literature. The rules of thumb mentioned there normally bring satisfactory control results.

Apart from this possibility, the PS units as from the software status 3.0 (IC 15, see Section 9.4.8) have a function for automatically setting the control parameters.

This function can be used for a large number of processes and is described in detail in Technical Information 30/62–1290 XA (see Section 18, Appendix) [1]

The control algorithm corresponds to the parallel structure with the following transient response:

$$F = \frac{1}{X_P}\left(1 + \frac{p \cdot T_d}{1 + p \cdot T_d / V_d} + \frac{1}{p \cdot T_n}\right)$$

5.1 Proportional range

The proportional range can be adjusted in steps of 1% from 1 to 1850%. (In the step action controller, values greater than 1000% count as 1000%).

If a pure I-controller is required, the P-action can be switched off with S2/4.

In the step action controller the effective proportional range X_p* depends on the effective run time T_y of the servodrive.

$$X_p^* = X_p \frac{T_y}{60\,s}$$

5.2 Integral action time

The time range is set with switches S2/7 and S2/8.

S2/7	S2/8	Time ranges
0	0	0...1999 s*
1	0	0...199.9 min
0	1	0...19.99 h
1	1	0...1.999 × 1000 h

Table 11 Time ranges
* Delivery status

The setting 0 (with any decimal point position) means T = 150 ms.

Without checking the switch positions, the selected time range is quickly recognized from the position of the decimal point.

If I-action is not required, it can be switched off with switch S2/5.

[1] also available as a separate document

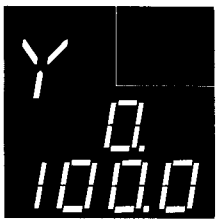
5.3 Derivative action time

For the derivative action time the same time ranges are valid as for the integral action time. Since "T_v" cannot be displayed, it is displayed as "T_d".

The derivative gain can be selected with switch S2/3. The higher value is normally the correct one.

Switch S2/2 determines whether the controlled variable or the control deviation should be differentiated. If D-action is not required, it can be switched off with S2/6.

5.4 Operating point (not in step action controller)



With I-action switched off and constant set point, it is advisable to set the operating point in order to keep the "steady-state offset" as small as possible.

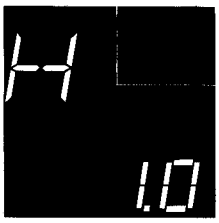
Values between 0...100.0% are useful. If I-action is activated, the value of "Y_0" is of no significance.

If P-, I- and D-action are switched off, the output signal goes to the value Y_0.

5.5 Control characteristic

The characteristic of the controller is determined by the position of switch 2/1. Position "INV" means a falling output signal (y falls from 100% to 0%) for a rising controlled variable. Whether the output signal (measured in mA) rises or falls depends on switch 1/7. (See Section 4.5.1.1).

5.6 Dead band



The step action controller has an adjustable dead band the value of which can be altered by selecting the letter H. This dead band is only effective for the P-channel. I-action acts within this band up to an inner dead band of ± 0.1%.

Where measured signals are unsteady it is advisable to set relatively large values for H. This reduces the proportional access without diminishing the obtainable control accuracy.

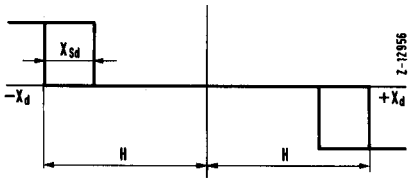
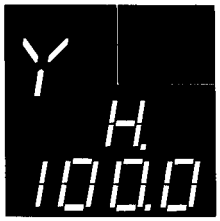


Fig. 33 Dead band of step action controller

5.7 Output limits



For certain applications it is necessary to limit the output signal.

After selecting Y_H and Y_L on the digital display, they can be altered with keys ▲ and ▼.

Y_H = upper limit
Y_L = lower limit

In the continuous controller, if the lower limit is set above the upper limit, the output signal is equal to the upper output limit.

The output limits are only effective in the automatic mode and can be passed over in manual operation.

If an output signal outside the output limits is set in the manual mode, it jumps to the output limit on transfer from manual to automatic in the continuous controller.

In the step action controller the final control element is only moved to the set area if an appropriate control deviation is present. In this application the position feedback signal is included in the control (limitation).

External control of the output limits is available. Its implementation necessitates intervention in the configuration. Further details are given in the Configuration Manual (42/62-63-...).

5.8 Limitation of set point range

The adjustment range for the set point can be limited for both the internal and the external set point.

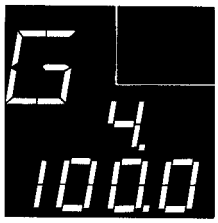
After selecting W_H and W_L on the digital display they can be altered with keys ▲ and ▼.

W_H = upper limit
W_L = lower limit

If W_H is smaller than W_L, W_H becomes the effective set point.

5.9 Setting the alarms

After selecting the individual alarms on the digital display, they can be adjusted with keys ▲ and ▼. The alarms have the following functions:



G1 = Max. alarm for X
G2 = Min. alarm for X
G3 = Min. alarm for X_d
G4 = Max. alarm for X_d

Switches S1/5 and S1/6 are used to determine the switching behavior of the alarm values.

S1/5 determines for both G3 and G4 whether the error signal is monitored with prefix sign "UNIP" or without prefix sign "BIPOL" $=|X_d|$. In switch position "BIPOL", G3 must be set to negative values and G4 to positive values.

Setting for unused alarms if the visual display is to be used:

G1 . . . . . 100.0 %
G2 . . . . . 0.0 %
G3 UNIP . . . . . −100.0 %
BIPOL . . . . . −100.0 %
G4 . . . . . 100.0 %

Quiescent or operating current signalling is selected with switch S1/6. With quiescent current signalling the output transistors have high impedance if the alarm value is exceeded. This coincides with the behavior in the event of power failure.

In two-channel controllers, in place of alarm values G3 and G4 the following values are monitored:

G.1 Max. alarm value of second channel for X.
G.2 Min. alarm value of second channel for X.

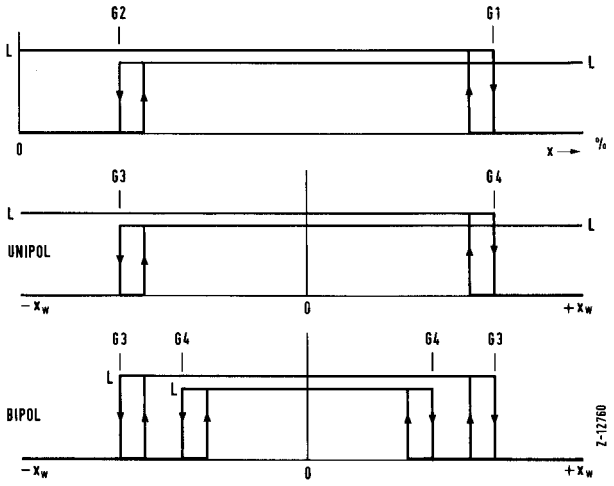


Fig. 34 Characteristics of the alarm
Quiescent current signalling
L = Output transistor is conductive

5.10 Non-return pointer

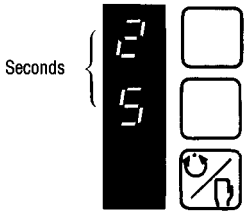
Two "non-return pointers" are coupled with the measured variable; these retain the maximum value x_1 and the minimum value x_0 within any measuring period. They can be indicated on the digital display if the parameter display is enabled with S1/2.

The non-return pointers are reset to the instantaneous value of x by operating key S5 with switch S4 in position CLEAR 0 (for channel 2 with CLEAR 1).

5.11 Setting the real-time clock

To set and read the real-time clock, switch S4 must be turned to position "TIME + DATE" and key S5 pressed.

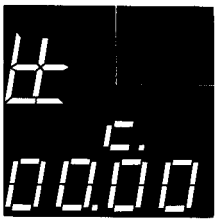
In the digital display "tt" is shown with various indices. Transfer between the various functions is accomplished with key ▲ with key 3 held down.



"r":

time display. Hours and minutes in the digital display, seconds next to keys 10 and 18.

If these two display fields are not illuminated, the digital display shows the day and month. (No automatic date switch is available.)



"c":

the time or date can be set. The date, hours and minutes are adjusted with keys ▲ and ▼. The decimal point indicates the currently adjustable digit. The clock is started by simultaneously pressing keys 10 and 12.

"1." or "2.":

Two time markers (date, hours, minutes) can be set (switching clock); these are monitored by the controller, enabling switching functions to be triggered at a predetermined moment.

The date, hours and minutes are set with keys ▲ and ▼. The decimal point indicates the currently adjustable digit. The date is not taken into consideration (daily reporting) in the condition as delivered. The date cannot be set.

The inclusion of switching functions triggered by the time markers is described in the Configuration Manual.

The real-time clock is a plug-in printed circuit board (also for retro-fitting, see Sparte Parts List) and is installed in the pcb control electronics (see Fig. 25).

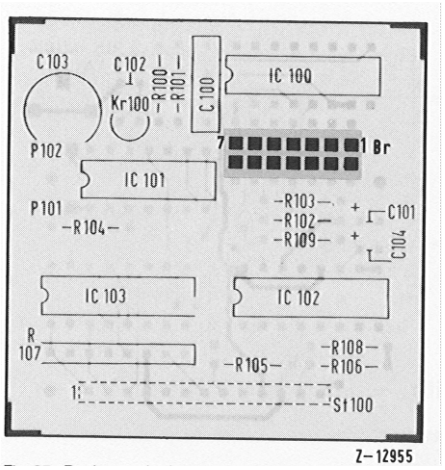
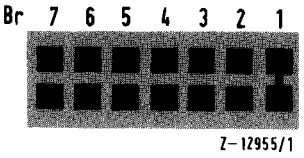


Fig. 35 Real-time clock – setting the running reserve

The running reserve of the real-time clock in the event of power failure can be set with jumpers (Br) 1 to 7.

The running reserve should always be as small as possible taking into account the back-up battery.

(Delivery status: 1 day ≙ jumper 1).

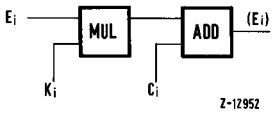


Jumper	Running reserve
1	approx. 1 day
2	approx. 2 days
3	approx. 4 days
4	approx.. 8 days
5	approx. 16 days
6	approx. 32 days
7	approx. 64 days

Table 12 Running reserve of real-time clock
Br = jumper

6 Setting the input circuits

All analog inputs are weightable. Inputs E1 to E4 have the following structure:



$(E_i) = (E_i \cdot K_i) + C_i$ [1]

Fig. 36 Input weighting

In the sections below, (Ei) is written in place of the full weighting equation Ei · Ki + Ci

C = −199.9...0...+199.9 %
Delivery setting 0 %
K = −199.9...0...+199.9 %
Delivery setting 100.0 % = 1

Variables C1 to C6 and K1 to K6 are set with the aid of the digital display.

These settings are selected by simultaneously pressing keys S5 (internal) and 3. It is advisable first to set a variable in the small loop as close as possible in the alphabet to the variable sought. With key S5 held down the following adjustments are possible:

Tipping key 3: forwards in the alphabet
Holding key 3: backwards in the alphabet

6.1 Single-channel fixed value/cascade

The circuit and the inputs used are described in Section 3.4.2.1. The following transfers[1] can be effected with switches S3/..:

S3/1	Output 2
0	(E1)
1	W or (E2)*

* depends on setting of switch I/E (10)

S3/2	X display
0	E1
1	(E1)

(E_n) = weighted input

6.2 Two-channel fixed value/cascade

The circuit and the inputs used are described in Section 3.4.2.

S3/1	Output 3
0	(E1)
1	W1 or (E2)*

S3/2	Output 4
0	(E3)
1	W2 or (E4)*

* depends on setting of switch I/E (10)
(E_n) = weighted input

Weighting Channel 1: E1 C1; K1
E2 C2; K2

Channel 2: E3 C.1; K.1
E4 C.2; K.2

6.3 Multi-component

The structure is described in Section 3.4.2.3.

All inputs are weightable.

The following transfers can be effected with switches S3/..:

The control deviation is formed according to the following formula:

Xd = (E1) + [(E3) - (E4)] - W

S3/1	Output 2
0	(E2) or W*
1	(E1)

* depends on setting of switch I/E (10)

S3/2	X display
0	(E1)
1	(E1) + (E3) - (E4)

S3/3	D action
0	(E1)
1	(E3) - (E4)

(E_n) = weighted input

6.4 Ratio

If the ratio is controlled externally it is necessary to check whether K2 is set to 199.9.

All inputs are weightable. The input weighting of input E1, C1 is used to set the air excess required for gas mixture control.

The instrument has an **electrical** ratio range from 0...2. The transmitters should normally be set up so that this electrical ratio is adhered to. In special cases the ratio range can be extended by weighting the inputs.

For the analog displays the readout range can be limited within the range 0 to 2 with the adjustable variables

V0 = lower range value and
V1 = upper range value.

The range of adjustment is determined by WL and WH.

The **physical** ratio range required by the process (including the transmitter ratio) can be displayed by setting "USER RANGE" (see Section 4.7.2). For this purpose the physical ratios associated with the electrical ratios 0 and 1 must be determined and then entered in the USER RANGE.

Switches S3/.. have the following functions:

S3/1	S3/2	Output 2
0	0	Actual value ratio
1	0	Set point ratio
x	1	Min ([E1]/Vset, [E4])

(E_n) = weighted input
x = any

S3/2 = 1 (on) activates the max. selection between inputs E3 and E4 (see 3.4.2).

6.5 Extreme value selection

All inputs are weightable.

In the version for minimum selection, for an unused input C must be set to >100.0 % (K remains = 1). This input then becomes 100 % and is eliminated from the minimum selection.

Switches S3/.. have the following functions:

S3/1	Function
0	Selection from X
1	Selection from W

S3/2	Function
0	Max. selection
1	Min. selection

7 Programmer

7.1 Setting the programs

After the programmer/controller has been called up and activated as described in Sections 4.3.1 and 9.4.1, the program values can be set.

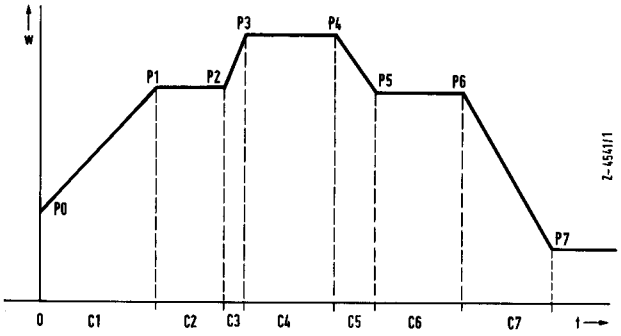


Fig. 37 Example of program

The preconfigured programs have 7 program sections. This means that a maximum of 8 amplitude values and 7 time values must be entered.

In the single and two-channel programmers the variables are contained in the large loop which can be made accessible with switch S1/2.

In the program controllers the variables P.0 to P.7 and C.1 to C.7 are accessible by simultaneously pressing keys S5 and 3 (see also 4.4.2.4).

The amplitude values can be set as follows:

Programmer:
Single-channel: USER RANGE
Two-channel: USER RANGE, if the range is the same for both channels,
otherwise 0...100.0 %
Program controller: 0...100.0 %. The effective set point is displayed in the USER RANGE selected for the controller.

The following rules apply to the time setting:

The distance between breakpoints is entered. The range of adjustment is between the figures 0 and 19.99. The time scale is determined by the position of the decimal point. The time scale set at the factory is the "hours" scale. The decimal point can be shifted and thus the time scale altered, separately for each section, via monitor MC 001C (see Section 9.4.9).

The time scales are as follows:

0.....xxx.x Minutes
1.....xx.xx Hours
2.....x.xxx times 1000 hours
3.....xxxx Seconds.

[1] The changeover switched is omitted as from 3/86.
Until September 1985 the sequence of Ci and Ki were reversed. The input weighting was accordingly: (Ei) = (Ei + Ci) · Ki.
This sequence is still valid for position feedback in step action controllers.
[2] The switchover output 2 is omitted as from 3/86.

To simplify the adjustment it is advisable to work out the following table:

No.	Amplitude			Time	
		Value	%		Value
0	P0			-	-
1	P1			C1	
2	P2			C2	
3	P3			C3	
4	P4			C4	
5	P5			C5	
6	P6			C6	
7	P7			C7	

Table 12

7.1.1 Programming program loops

It is possible to jump back automatically from the program end to any restart point in the program. The number of the restart point to be returned to must be entered via monitor ME at address 8736H (channel 1) and 8737H (channel 2) (Section 11). The number of repetitions is counted in variable "R".

7.2 Programming the binary outputs

There is no auxiliary routine available for programming the binary outputs. The necessary data must be entered via monitor ME (see Section 11).

Operation codes are thereby changed. With no knowledge of the details it is possible to define the functions of the binary outputs in the following way:

The binary outputs that are to be activated (conducting) are defined separately for each section.

A numeral must be entered in the configuration for each section. This is determined from the sum of the significances of the activated outputs.

The activated outputs have the following significance:

Number of channels	1	2
No output	0	0
Output 1 (Q01)	1	1
Output 2 (Q02)	2	2
Output 3 (Q03)	4	1
Output 4 (Q04)	8	2

The sum arrived at is converted to a hex number.

Decimal	0	1	2	3	4	5	6	7
Hex.	0	1	2	3	4	5	6	7

Decimal	8	9	10	11	12	13	14	15
Hex:	8	9	A	B	C	D	E	F

Example: Outputs 1, 3 and 4 are to be activated. For this section the resulting sum is decimal 13 = Hex D.

A value must be determined in this way for each section and inserted in the tables 13...15 below in place of the letter "y". (These tables only apply to standard configurations).

Section	Address ---	Q04 8	Q03 4	Q02 2	Q01 1	Contents
1	844A					Fy
2	844C					Fy
3	844E					Fy
4	8450					Fy
5	8452					Fy
6	8454					Fy
7	8456					Fy

Table 13 For single-channel programmers

Section	Address ---	Q04 0	Q03 0	Q02 2	Q01 1	Contents
1	844A	0	0			Fy
2	844C	0	0			Fy
3	844E	0	0			Fy
4	8450	0	0			Fy
5	8452	0	0			Fy
6	8454	0	0			Fy
7	8456	0	0			Fy

Table 14 For two-channel programmer (1st channel)

Section	Address ---	Q04 2	Q03 1	Q02 0	Q01 0	Contents
1	844B			0	0	Fy
2	844D			0	0	Fy
3	844F			0	0	Fy
4	8451			0	0	Fy
5	8453			0	0	Fy
6	8455			0	0	Fy
7	8457			0	0	Fy

Table 15 For two-channel programmer (2nd channel) and program controller

The columns containing "0" are not usable in the standard configuration for the respective channel.

7.3 Displays

In the instruments used as programmers only, the following values are shown in the digital display:

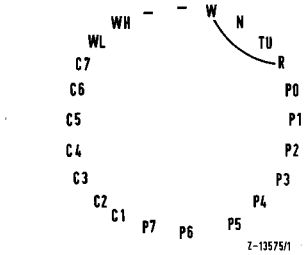


Fig. 38 Display loops of programmer

W = Set point
N = Number of section currently being processed
TU = The time elapsed in the section currently running (0...100 % of the time C set for the section)
R = Loop counter (repetition counter), counts the repetitions
C. = Time settings
P. = Amplitude settings

In the program controllers only the small display loop changes in comparison with the controllers (Table 1).

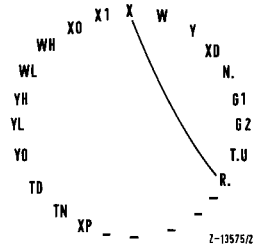


Fig. 39 Display loops of program controllers

The settings for C.1 to C.7 and P.0 to P.7 are called up by simultaneously pressing key S5 (internal) and key 3 (see also 4.4.2.4).

7.4 Storing and calling programs

7.4.1 Storing

The values set for a program can only be stored if they are transferred to the write protectable memory area after setting "STO PARAM".

Up to 2 · 16 programs, each with 7 sections, can be stored in the optionally available EEPROM (Section 13.5).

If one or more programs has more than 7 sections (= special configuration), fewer programs can accordingly be stored. Each memory sector can accommodate the data for seven sections of a program. Sectors that are only partially used cannot be used for other programs.

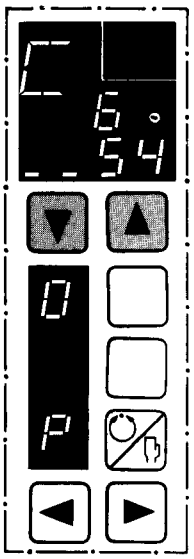
The auxiliary routine MC 0012 permits program data to be stored.

After this routine has been called as described in Section 9.4, the display shown here appears, for example.

The variable which is now visible is coincidental. However, when placing in memory, the first variable to be saved C1 or C.1 must be set. It is possible to select a variable which precedes the C variable in the alphetic sequence, e.g. A4.

The variables are adjusted with keys ▼▲ further activation of key 3 effects a more rapid progression.

Call up the corresponding channel with key 12:



C_6 = Any variable. The first variable which is to be stored must be set.
54 = Its hex address
0 = Memory sector selected can be altered with key 10 (0...F)
P = Programmer data, first channel
P. = Programmer data, second channel
E = Without significance for the programmer

P for single-channel programmer or 1st channel in two-channel programmer

P. for 2nd channel in two-channel programmer or in a program controller.

The following keys must be pressed to store:

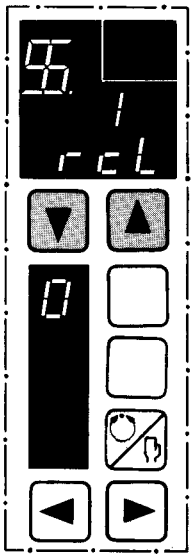
Switch	EEPROM	
	Area A	Area B
S4	STO PARAM	
S5	Press	
S1/2	ON	OFF
Key 10	0 to F select a free sector	
S4	STO PROGM	
S5	Press	

Table 16

After pressing key S5, the display shows which variable is currently being stored.

The storage procedure is completed when the sector display appears incremented by 1 with a point. If other program data are to be stored for the same program it is sufficient to press S5 once more. If no more data are to be stored the instrument displays "Er.nA" after S5 is pressed. This message must be acknowledged with key 12.

7.4.2 Calling stored programs



Auxiliary routine MC 0011 enables stored programs to be called up. After the routine has been activated as described in Section 9.4, the instrument shows the adjacent display. Key 10 is used to select the sector in which the program or program section to be loaded was stored.

The following keys must be operated to accomplish loading:

Switch	EEPROM	
	Area A	Area B
S1/2	ON	OFF
Key 10	0 to F select a desired sector	
S4	RCL PROGM	
S5	Press	
S4	RCL PARAM	
S5	Press	

Table 17

The loading procedure is completed when the sector display appears incremented by 1 with a point. If other program sections are to be loaded, it is sufficient to press key S5 if the section(s) to be loaded is (are) stored in the next sector.

After a program has been loaded, a RESET (see 7.6.1) must be carried out.

7.4.3 Calling stored programs via remote control inputs

Calling up of stored programs via the binary inputs is possible from software state 35.86 (IC15 with index as from H) together with a special IC14.

If the instrument was ordered with suppl. No. 410, the IC14 is included. For retrofitting the IC14 can also be supplied separately (see section 17).

The stored programs must all be of the same length – up to 7 sections. If certain programs require less sections, the time C.. of the sections not required should be set to "0".

Program	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D03	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
D04	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
D05	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
D06	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
D07	selects area A or B in the EEPROM															
D08	copies the program selected with D03 to D06 into the working memory (RAM)															

Table 18

Table 18 shows the switches that must be closed for calling up a program.

D07 = 1 Calling up from area A of E(E)PROM
D07 = 0 Calling up from area B of E(E)PROM

With a positive flank (transition from 0 to 1) on D08 the program selected each with D03 to D07 is loaded, provided that the write protection of the RAM is open.

S3/5 = ON

Note:
Actuate D08 in the programm controller only in operating mode "manual".

In case of a reset forced by the controller or by actuating keys S5 and S6, the program corresponding to the state of the binary inputs D03 to D07 is automatically loaded, provided that the write protection is open.

The variable /U8 contains the number of the program loaded.

1xx for area A
2xx for area B

The variable can be called up by actuating key 3 and S5 in the digital display. With a special configuration the variable /U8 can also be set into the small display loop. This special configuration, however, then occupies one of the memory areas (A or B) of the E(E)PROM.

7.5 Operation

The following symbols are used for operation:

Operation for any length of time.

If two keys are to be operated simultaneously and if the sequence is significant, the adjacent symbols apply. Key ◀ must be pressed before key ▶ and held down.

7.6 Operating modes

7.6.1 Manual operation

Manual operation permits the following functions:

Stop

By switching the unit from one of the automatic modes to manual, the program stops at the position reached.

Reset

The program is reset to the beginning and the repetition counter to zero by operating keys ◀ and ▶.

Forwards

Moving forwards in the program irrespective of the time set with the aid of key ▶. The position in the program continues to change while this key is held.

Backwards

Key ◀ is used to shift the program against the sequence in time.

Jump forwards

By holding key ▶ down and simultaneously operating key (12) the program jumps to the next breakpoint (restart point).

Backwards

In contrast, the program jumps to the preceding breakpoint if key (12) is operated in addition to key ◀.

Start

Takes place by switching over from "h" to r, r. or t.

7.6.2 Automatic operation

The program runs if mode "h" is not switched on.

Single run from program start to program end.

Repeated operation. At the end of the program it immediately starts again until the unit is switched over to manual.

A breakpoint at which the repetitions are to commence can be specified in addresses 8736H (channel 1) and 8737H (channel 2).

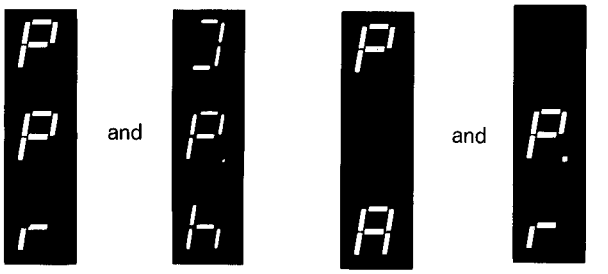
Fast forward. Irrespective of the time scale set, all sections are run through in 8 seconds, in each case.

Stop

Irrespective of the operating mode set, the program run is stopped by switching to "manual".

7.6.3 Set point transfer

In program controllers the display alternates between:



Channel 1 Channel 2 Channel 1 Channel 2

Continuous controller

Step action controller

If key 10 has been enabled with switch S1/3 it can be used to transfer between a program set point "P" and a fixed set point "I". The value of "I" corresponds to the value of "P" at the instant of transfer.

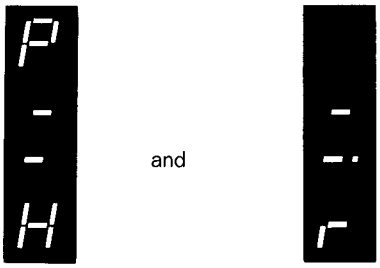
When transferring from "I" to "P" the set point jumps to the instantaneous program set point.

The mode of operation of the programmer (r, r., t, h) is not affected by the transfer.

7.6.4 Channel transfer

Transfer between channels is effected with F-key 18.

In two-channel programmers the display alternates between:



Channel 1 Channel 2

7.7 Remote control

7.7.1 Single and two-channel programmer

D00 Switches both channels to "h" and switches the channel over.

D07≙0 Binary inputs D01 to D06 and D08 serve the 1st channel.

D07≙1 Binary inputs D01 to D06 and D08 serve the 2nd channel.

D02 Cyclic switching between operating modes r, r., t, h.

Checkback signal:

	Q05 (Q07)	Q06 (Q08)
r	L	0
r.	0	L
t	L	L
h	0	0

L = Output is conductive.

Program end Q12 (Q10)

Information in () applies to the second channel.

D01 Cyclic switching between I and P.
P : Q10 = 0
I : Q10 = L
Checkback signal omitted in two-channel programmers.

D03 + D04 Common "Start" if the operating mode is not "h". If the programmer is set to "h", it starts automatically when the operating mode is switched over.

D03 "raise"

D04 "lower"

	W	TU	W2	WE	N	R	WL	WH
D05	0	1	0	1	0	1	0	1
D06	0	0	1	1	0	0	1	1
D07	0	0	0	0	1	1	1	1

Table 19 Remote control of single-channel instruments

	W	TU	W2	WE	W.	T.U	W.2	W.E
D05	0	1	0	1	0	1	0	1
D06	0	0	1	1	0	0	1	1
D07	0	0	0	0	1	1	1	1

W.2 = 20 × N. W.E = 20 × R.

Table 20 Remote control of two-channel instruments

WH and WL are adjustable for both channels in every operating mode, W only in "h" and "internal" and TU only in "h".

In all operating modes the value selected is switched to output A3. Display 100.0 % ≙ 10 V. For W2 and WE the following applied:

W2 ≙ N/5 in volts

WE ≙ R/5 in volts

D08 Reset and manual

Checkback signal: Q11 ≙ 1 for 1st channel

Q09 ≙ 1 for 2nd channel.

7.7.2 Remote control of program controller

D00 Switches both channels to manual and switches over to the next channel.

<table>
<tr><td></td><td colspan="4">D07 ≙ 0</td><td colspan="4">D07 ≙ 1</td></tr>
<tr><td>D01</td><td colspan="4">Cyclic switching of</td><td colspan="4">Cyclic switching of</td></tr>
<tr><td></td><td colspan="4">Set point:
I = internal
P = program
Checkback signal:
I : Q05 ≙ L
P : Q05 ≙ 0</td><td colspan="4">Controller/programmer</td></tr>
<tr><td>D02</td><td colspan="4">Manual/Automatic
Checkback signal

H : Q06 ≙ L
A : Q06 ≙ 0</td><td colspan="4">r, r., t, h
Checkback signal

r Q07 = L, Q08 = 0
r. Q07 = 0, Q08 = L
t Q07 = L, Q08 = L
h Q07 = 0, Q08 = 0</td></tr>
<tr><td></td><td>W</td><td>Y</td><td>G1</td><td>G2</td><td>W.</td><td>T.U</td><td>W.2</td><td>W.E</td></tr>
<tr><td>D05</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>D06</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>D07</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>D08</td><td colspan="4">Manual channel 1</td><td colspan="4">Reset
Checkback signal:
Q09 ≙ L (conductive)</td></tr>
</table>

Program end Q10 = 1

Table 21

8 Signal display on the front panel

8.1 Alarms

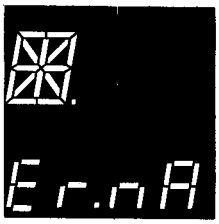
If switch S1/4 is in the "ON" position, exceeding or falling below an alarm value is indicated by flashing of the red actual value indicator.

If S1/4 is switched to "OFF" the alarm display is suppressed.

8.2 Self-monitoring messages

8.2.1 Battery monitoring

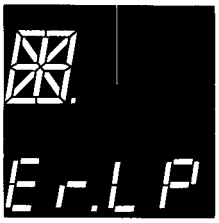
If the battery voltage is too low, the message Er.bA (**e**rror **b**attery) is displayed for 2 seconds within 4 seconds.



If this display occurs, the instrument remains functional. The battery should however be changed before a supply failure occurs (see Section 10.1).

Acknowledgement is not possible.

8.2.2 Power supply monitoring

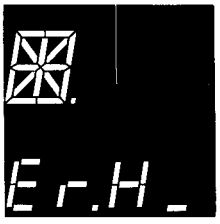


If the instrument is operating on power below the permitted tolerance, the warning ErLP (error low power) appears for 2 seconds within 16 seconds.

Because the controller is no longer guaranteed to function in this situation, output signals y and w are held at their last value and do not change while the voltage is low.

The set point w and the output variable y can be set during this time but are not processed until the power supply has returned to its tolerance range.

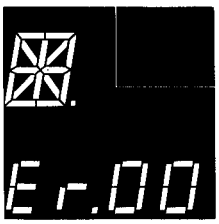
8.2.3 Hardware monitoring



If one of the faults in Table 22 (except errors Er.bA and Er.EC) is diagnosed, the controller sets output Q00 and displays this as hardware fault Er.H_.

The error message is cancelled in every test cycle and reset if the fault is still present. The output signal is therefore not constant.

8.2.4 Software monitoring



If the controller diagnoses an error during processing, it first attempts to restart the program several times. If this is not successful the program is reloaded from the EPROM or EEPROM (see 4.3.3). This in turn will only succeed if write protection is not set.

After loading (reinitialization) the controller displays the message Er.00 and goes to "manual".

If the write protection is set, the controller displays Er.nA.

8.2.5 Other messages

Other messages can also be configured. For further details see the Configuration Manual. The freely configured messages can be acknowledged with keys ▲ and ▼.

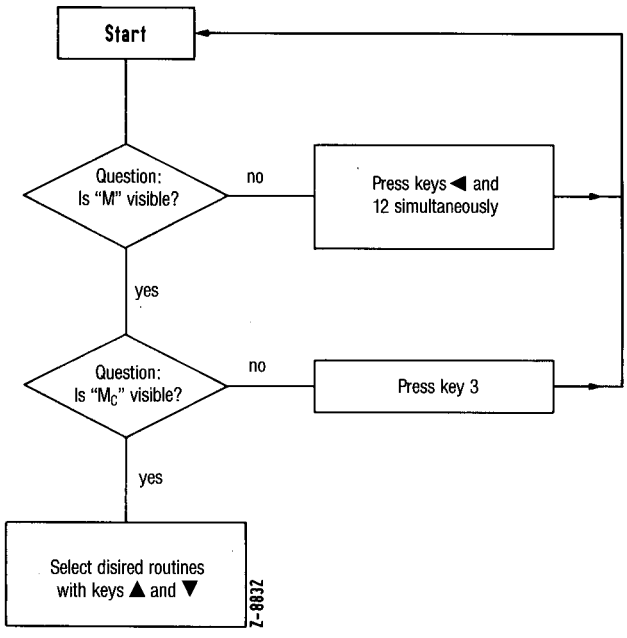


Fig. 40

9 Testing and auxiliary routines

The instrument contains test routines which assist testing in case of a defect. During the entire test run the controller remains in the operating mode previously set, e.g. automatic.

9.1 Self diagnosis

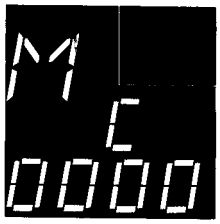
The controller tests the hardware and software cyclically and in the event of an error sets output Q00 from "high" to "low" level (transistor has high impedance). Q00 is also set acc. to Table 22 (exceptions: Er.bA and Er.EC) for "Hold" and in the event of a fault.

9.2 Calling test and auxiliary routines

The "MONIT+TEST" function is selected with switch S4 and activated with key S5.

Very different readouts may now appear in the digital display. What is displayed in detail depends on whether monitor routines used earlier were terminated correctly or not.

The flow diagram (Fig. 40) shows what keys must be operated depending on the display.

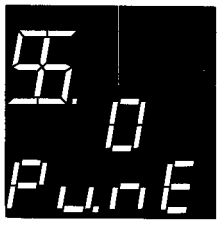


Routine MC00.. is selected with keys ▲ and ▼.

Only the decimal digit at which the decimal point is positioned as cursor can be changed initially.

This cursor is moved by pressing key (10) and one of key ▼ or ▲.

Key ▲ moves the cursor to the left, key ▼ to the right. The routine is activated by pressing keys ▶ and 12.



The symbol  = self test then appears in the digital display with an index that corresponds to the number of the test section selected.

The four-digit display shows a statement on the particular test section.

"..nE" = ...no Error
"Er.." = Error in...

To test quickly for an error, after activating the first test routine, it is possible to switch through to any error present by simultaneously operating ▶ and ◀.

The individual diagnostic routines are switched off by simultaneously pressing keys ◀ and 12.

9.3 Self-test routines

Address	Function	No error	Error
M_C 0000	Processor	PU.nE	Er.PU
M_C 0001	EPROM 1 (0000H-0FFFH)	C0.nE	Er.C0
M_C 0002	EPROM 2 (6000H-7FFFH)	C7.nE	Er.C7
M_C 0003	EPROM 3 (4000H-5FFFH)	C5.nE	Er.C5
M_C 0004	RAM area 1	EL.nE	Er.EL
M_C 0005	RAM area 2*	EC.nE	Er.EC
M_C 0006	Battery	bA.nE	Er.bA
M_C 0007	Transmitter supply 21 V	UG.nE	Er.UG
M_C 0008	Interface module 1	I1.nE	Er.I1
M_C 0009	Interface module 2	I2.nE	Er.I2
M_C 000A	Output monitoring	Au.nE	Er.Au
M_C 000B	Inputs less than 0 %	LE.nE	Er.LE
M_C 000C	Undefined op-codes	SC.nE	Er.SC
M_C 000D	Op-codes in area	S5.nE	Er.S5
M_C 000E	Clock module	rt.nE	Er.rt
M_C 000F	EEPROM Test		

Table 22 Self-test routines

* If write protection is switched on, error message "Er.EC" will be displayed even if no error is present since the test is prevented by the write protection.

Error message "Er.rt" also appears if no real-time clock is built in.

9.3.1 EEPROM test

Various EEPROMs or an erased EPROM can be used in the controller. Depending on the type used, one of routines A to C must be activated for processing and testing the EEPROM contents. EPROM (D) is not testable (see Section 13.5).

Routine A for type: 52B13
Routine B for type: X2816A
Routine C for type: 2816
Routine D for type: 2732A (EPROM)

Compatible types from other manufacturers can be used instead of the types named. The appropriate test routine must then be selected.

Routine C presupposes that code area 0 is stored in the microprocessor's ROM and no external EPROM (IC 13) is used. If this test ist attempted without these conditions being met, the controller displays the message ErnA (= no access). This message must be acknowledged with key 12.

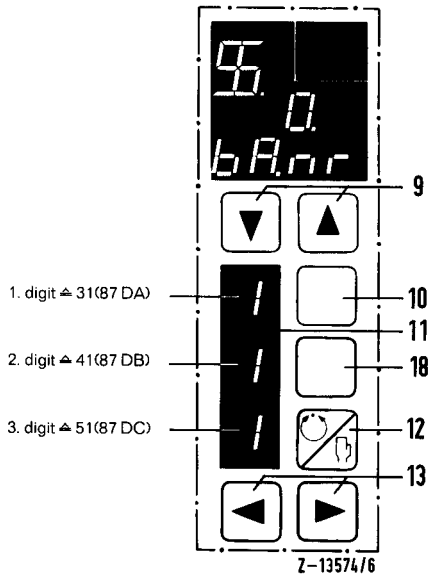
Self-test routine 0F is started in the same way as all other routines. C000 appears in the digital display. The individual subroutines can be selected with key 10. The routine selected is started by operating key ▲ and terminated by pressing key 12. The test lasts for up to 1.5 minutes. The numerals shown in the digital display indicate the address currently being tested.

9.4 Auxiliary routines

Address	Function	Explanation in Section
10	Display/change request no.	9.4.1
11	See programmer	7.4.2
12	See programmer	7.4.1
13	Table values TAO	9.4.2
14	Controller address at bus	9.4.3
15	Baud rate	9.4.4
16	Cycles per second	9.4.5
17	Switch test	9.4.6
18	Binary inputs	9.4.7
19	Status of EPROM C0	9.4.8
1A	Status of EPROM IC 14	9.4.8
1B	Status of EPROM IC 15	9.4.8
1C	Variables list	9.4.9
1D	Configuration data	9.4.10
1E	Auto-manual unit test	9.4.11
1F	Watch-dog test	9.4.12

Table 23 Auxiliary routines

9.4.1 Display/change the request no. – address 10



As described in Section 4.3.1, all the standard functions are stored in the EPROM (IC 15). Which of these functions is activated is specified by entering the request code in addresses 87DAH to 87DCH. Entry is facilitaed with auxiliary routine MC 0010.

If this routine is called, the status display next to keys 10, 12, and 18 show the current function.

A new combination can be entered by operating these keys. The chosen function is loaded with S4 at RCL PROGM and RCL PARAM. S1/3 = ON. Note Section 4.3.1!

3rd position: **Controller type**

Single-channel, continuous including on/off action	1
Single-channel, three-position step action	2
Single-channel, programmer	3
Two-channel, 2 × continuous including on/off action	4
Two-channel, 2 × three-position step action	5
Two-channel, continuous + three-position step action	6
Program controller with continuous and on/off output	7
Program controller with step action output	8
Two-channel programmer	9
Contents of 87DA	3

4th position: **Input signal connection**

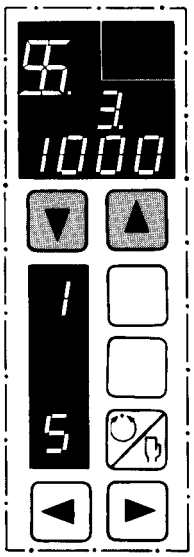
Single-channel, fixed value/cascade	1
Single-channel, multi-component	2
Single-channel, ratio	3
Single-channel, extreme value selection	4
Two-channel, fixed value/cascade	5
Contents of 87DB	4

5th position: **Channel logic**

Only one channel or 1st and 2nd channel independent	1
Cascade (master controller = 1st channel)	2
Override control, min. selection	3
Override control, max. selection	4
Contents of 87DC	5

Table 24 Extract from the request matrix

9.4.2 Table values TAO – address 13

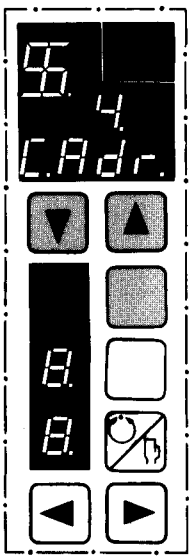


The values of the freely configurable linearization function are readily entered with auxiliary routine MC 0013. After the routine has been called, the digital shows the value set for the restart point displayed. The number of the restart point displayed can be read next to keys 10 and 12 and changed with key 12.

The value itself is set with keys ▲ and ▼

By means of configurations at the desired position the linearization function TAO must be incorporated in the process.

9.4.3 Controller address at serial bus - address 14



To operate the controller at a serial bus, an individual controller address is required. The choosen address is displayed in the status display and can be changed with the keys 10 and 18. Besides the already known Protronic P-protocol, now[1] a protocol with telegram formats similar to those of the PROFIBUS is alternativly available. This protocol supports paralell operation of Protronic (PS2) instruments with single controller Digitric P at a common bus with a single driver software. With the ▾-key, you can switch the display above between "C.Adr." (old protocol) and "P.Adr." (new protocol).

1 since version index E; code 33.90.4.0

9.4.4 Baud rate - address 15

In this test routine the baud rate set can be read, and altered if write protection is open.

The following baud rates can be set by operating key ▲:

300, 600, 1200, 2400, 4800, 10420; 20833 baud.

Other baud rates can be set via monitor address 8703. See Operating Manual "Protronic PS Serial Interface".

9.4.5 Cycles per second - address 16

The number shown in the digital display indicates the number of cycles per second. This number fluctuates somewhat since not all self-test routines are processed in each cycle. The cycle time can be calculated as follows:

$$T(ms) = \frac{1000}{\text{displayed value}}$$

9.4.6 Switch test - address 17

This test program enables testing of all internal switches except S4, S5, S3/5 and S3/6.

The number shown in the digital display represents switches S1 and S2. During the test it is sufficient to observe whether the digital display changes when S1 or S2 is operated.

The displayed number is made up as shown below:

0 = open/off 1 = closed/on

Switch S1 8765 4321	Switch S2 8765 4321	Display
0000 0000	0000 0000	0000
0000 0001	0000 0000	0100
0000 0010	0000 0000	0200
0000 0100	0000 0000	0400
0000 1000	0000 0000	0800
0001 0000	0000 0000	1000
0010 0000	0000 0000	2000
0100 0000	0000 0000	4000
1000 0000	0000 0000	8000
0000 0000	0000 0001	0001
0000 0000	0000 0010	0002
0000 0000	0000 0100	0004
0000 0000	0000 1000	0008
0000 0000	0001 0000	0010
0000 0000	0010 0000	0020
0000 0000	0100 0000	0040
0000 0000	1000 0000	0080

Table 25 Switch test

The top four switches of S3 are represented on the display next to key 10. If this display changes when the switch is operated, this indicates that the switch is functioning correctly. The number is made up as follows:

Switch 3: S3/1 = ON: value = 0001 (decimal 1)
S3/2 = ON: value = 0010 (decimal 2)
S3/3 = ON: value = 0100 (decimal 4)
S3/4 = ON: value = 1000 (decimal 8)

Switches S3/5 and S3/6 cannot be tested in this way.

If several switches are in the "on" position, the values shown in the "display" column are added. Please note that these are "hexadecimal" numbers in which numbers 0 to 9 have their known values and letters A to F represent numbers 10 to 15. For example 1111 1100 1001 0011 is FC93.

If switch S4 is turned clockwise starting at the "HOLD" position, the display next to key 12 shows the numbers 0 to F if the switch is operating correctly in all positions.

9.4.7 Binary inputs - address 18

In this test routine the current status of the binary inputs is shown. The switching status is represented graphically in the two left hand positions and as a sum of hexadecimal numbers in the two right hand positions of the digital display.

An active input (logical 1) is shown as an illuminated segment. Fig. 41 shows which segment represents which input.

The dots adjacent to the segments for the inputs 1 and 7 are lit when the binary input D00 = 1.

Fig. 41 Assignment of display segments to binary inputs

For the summation in the right hand display the inputs have the following significance:

Input D0:	00H	Input D5:	10H
D1:	01H	D6:	20H
D2:	02H	D7:	40H
D3:	04H	D8:	80H
D4:	08H		

9.4.8 EPROM identifier - address 19 to 1B

Routine 19 reproduces the software status of address area 0000 to 0FFF. In the case of older unit the manufacture date of the software is stored in the format "calendar week.year" e.g. "22.84". This memory area can be either in a separate EPROM (IC 13) or in the microprocessor itself.

Depending on the components used, the switch S 3/6 must be switched accordingly.

In the PS2 units of new manufacture (as from mid-December 1988) there is no plug-in socket for the IC 13, hence the switch S 3/6 function is omitted.

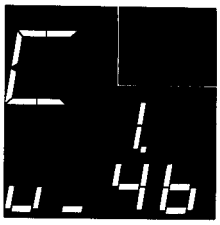
[1] Only PS as from version 3.x
[2] Not PS

Routines 1A and 1B show the status off EPROMs IC 14 (= code area 3) and IC 15 (= code area 5).

IC 14 is not usually present. The controller then displays the message no.IC.

9.4.9 Variables list – address 1C

The instrument shows the variable names possible in the system.



It is possible to page through this list by pressing keys ▲ or ▼. If key 3 is pressed in addition, paging is automatic.

In the 3rd and 4th positions of the digital display, the hexadecimal code of the displayed variable is given.

In the first position, the letter "u" shows when a variable is not used.

Whether a variable can be changed is indicated by a point after the index. The changeability can be switched on and off with key 10.

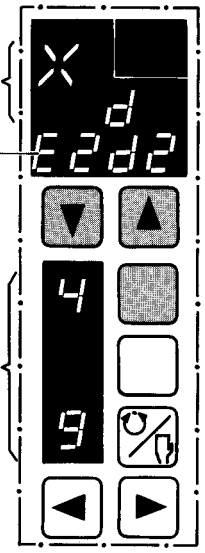
Next to key 12 the decimal point position of the respective displayed variable can be set by pressing key ▶, if it is defined with FIX, FLX, PW./PT. and not displayed in the USER RANGE. The significance is as follows:

0.....xxx.x
1.....xx.xx
2.....x.xxx
3.....xxxx

9.4.10 Configuration data – address 1D

The display consists of four different parts:

1. Name of displayed variable e.g. X_d
2. First component (source 1) E2 ≙ X
   Second component (source 2) d2 ≙ W
3. Linking the two sources e.g. "49" ≙ "–".



By operating key 10 the hexadecimal code of the displayed variable can be displayed temporarily.

Switching over from one variable to the next is effected by operating key ▲ or ▼. If key 3 is operated in addition, switching over is automatic.

9.4.11 Auto-manual unit test – address 1E

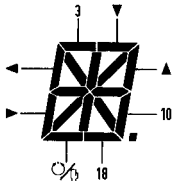
The "auto-manual unit test" allows testing of all display and operating functions on the front of the instrument.

Repeated operation of one of keys ▲ or ▼ results in all LEDs and all luminous segments of the displays being driven. If key 3 is pressed in addition, switching over is automatic.

The following luminous text is visible in the digital display:

"Protronic PS xx.xx xx"

Fields xx.xx xx here identify the software status of address area 4000 to 5FFF (see also addresses 19 to 1B).



Pressing one of the keys will cause one segment of the 16-segment display to be extinguished.

During the test it is sufficient to note whether a segment is extinguished when a key is operated.

The surrounding indicators serve as visual indicator or information on the current special function of the instrument.

9.4.12 Watch-dog test – address 1F

This test shows the longest time after which a fault in the instrument is detected. The time constant is determined by analog components and can therefore vary in individual instruments from approx. 65 to 130 ms.

The time constant typical for the instrument must however be virtually the same.

10 Maintenance

No maintenance is required apart from changing the battery (see 8.2.1).

10.1 Changing the battery

The battery may be changed during operation. The instrument must be withdrawn past the limit stop and removed from the case.

The battery is situated in the second chassis cutout at the bottom rear (see Fig. 29). After removing the two fastening screws the used battery can be replaced with a new one of the same type. The coding pins ensure correct polarity. If the mains supply is maintained during the battery change, all values in RAM are retained.

Another way of changing the battery is by first removing the module. If the battery is already discharged, the data stored in RAM are lost. However if the battery is weak but still operational, it is possible to avoid a data loss by connecting the instrument on site to the supply of a spare instrument.

The procedure is as follows:

- Switch instrument to "Manual" and set a correction value which is not critical for the controlled system.

- Switch controller to "HOLD" with S4 and activate this function with S5. The controller signals "HOLD" in the digital display. The control cycle is now interrupted and the correction values y and y. are "frozen" in the analog output memories. (Drift rate 1% per min).
- The processing electronics can now be withdrawn and disconnected from the case.
- Change the battery.
- Reassemble the instrument in the reverse order.
- Change from "HOLD" to "NORMAL". The controller will accept the last available values in the memories as soon as key 5 is operated.
  The controller remains at manual.
- If during this time the instrument was without both battery and power supply, the parameters, USER RANGE and any modifications will have to be re-entered.

11 Changing the configuration

Configuration of the Protronic PS controller is described in detail in the Configuration Manual 42/62-63-...

Changing the configuration is described in this manual only to the extent that is necessary for entering the functions described in the preceding sections.

It is assumed that the configurator is not available.

11.1 Selecting a memory address

Turn switch S4 to "MONIT+TEST" and operate key S5. Very different displays may now appear in the digital display. What is displayed in detail depends on whether monitor routines used earlier were terminated correctly or not.

The flow diagram below shows what keys should be operated depending on the display.

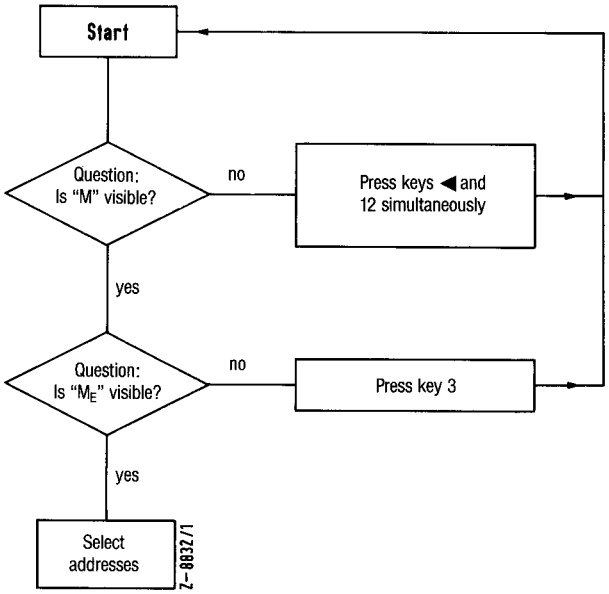


Fig. 42 Flow diagram for setting memory addresses

The address is selected with keys ▲ and ▼. Only those digits can be altered at which the decimal point is located as cursor. This cursor is moved by pressing key 10 and one of keys ▲ or ▼. Key ▲ moves the cursor to the left, while key ▼ moves it to the right.

11.2 Changing the memory contents

The display fields next to keys 10 and 12 show the current contents (value) of the selected addresses, read from top to bottom.

The displayed value can be increased with key ▶ and decreased with key ◀. Here too the value can only be changed in the field in which the cursor is visible. In this case the cursor is moved by operating key 10 while pressing one of keys ◀ or ▶.

If the contents of one of the two display fields is altered with key ◀ or ▶, both fields begin to flash. The flashing indicates that the previous value can be recalled by pressing key 10, and the new value can be confirmed and thus written to memory by pressing key 12. If key 12 is operated, the flashing stops. When writing the data to memory, the entry for each address field must be confirmed separately.

If the desired hexadecimal number is visible in both display fields without flashing, it is possible to switch over to the next address and there enter the next hex number.

Each entry is effective in the instrument as soon as the flashing is acknowledged with key 12. This may temporarily give rise to irrational command sequences during entry. The configuration therefore cannot be tested and evaluated until entry is complete.

This routine is terminated by turning switch S4 to "NORMAL" and operating key S5.

12 Calibration

Inputs and outputs can be calibrated per software to a certain degree.

This function is only required after a complete loss of data after a defective battery simultaneously with a power failure or after replacing components in the analog part of the inputs/outputs.

If a power supply unit is replaced an error of approx. 1% may occur at the outputs (the accuracy of the inputs is not affected by replacing the power supply unit).

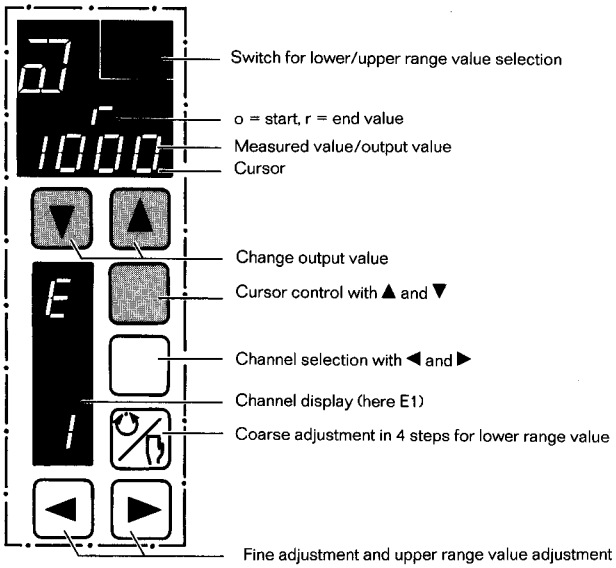
During calibration, reference signals must be supplied to the instrument and the output values must be measured. The control loop must therefore be managed during this time by a different unit e.g. a service auto-manual unit (see Section 13).

The following additional equipment is required:

1. Highly accurate current source e.g. Kompavi 10
2. Highly accurate ammeter e.g. Kompavi 10

Procedure:

■ Set switch S4 to AUTOCAL position and operate switch S5. The controller will now display the following:



Simultaneous operation of keys ◀ and ▶ sets the correction values of the selected input or output to 0. If key S5 is pressed simultaneously in addition, the correction values of all inputs and outputs are set to 0.

■ **Calibrating the inputs**

1. Select the input channel to be calibrated.
2. Switch to lower range value.
3. Set signal range 0...20 mA.
4. Inject 1.000 mA at the relevant input.
5. Set coarse adjustment to a value as close as possible above 0050, then fine adjustment. The decimal point position is immaterial. 0050 should be read as 5.0%.
6. Repeat from 3. with signal range 4...20 mA. Inject 4.000 mA, display 0000.
7. Switch display to upper range value.
8. Inject 19.999 or 20.00 mA (19.999 is more precise than 20.00).
9. Fine adjustment as near as possible to 1000 = 100.0%.
10. Switch to signal range 0...20 mA and if necessary take the mean between 0...20 mA and 4...20 mA.

■ **Calibrating the outputs**

1. Set display to lower range value.
2. Select output channel.
3. Set signal range 0...20 mA.
4. Set display to 0050 = 5.0%.
5. Measure output current externally; it should be approx. 1 mA.
6. Set coarse adjustment as close as possible below or at 1.000 mA. Then fine adjustment to 1.000 mA.
7. Repeat from 3. with signal range 4...20 mA. Setting 0000, output 4.000 mA.
8. Switch display to upper range value.
9. Set display to 1000.
10. Measure output current externally; value should be approx. 20 mA.
11. Fine adjustment to 19.999 (20.00) mA.
12. Switch over to signal range 0...20 mA and if necessary take the mean between 0...20 mA and 4...20 mA.

Note

1. Calibration is possible at other measuring points besides 0 and 100%.
2. If only one signal range is required (0...20 mA or 4...20 mA), calibration of the other range may be omitted.

13 Service function

13.1 Service auto-manual unit

If the processing electronics are disconnected from the control loop due to a fault or for any other reason, the output signals from outputs 1 and 2 initially remain at the last value. Since these values are stored in analog form, a maximum drift rate of 1% per minute occurs.

This storing of values allows the processing electronics to be removed and a replacement unit subsequently connected without hindrance by the former. The service auto-manual unit can serve as the replacement unit.

13.2 Exchange controller for controller

Controller 1 is the unit to be replaced
Controller 2 is the replacement unit

1. Switch controller 1 to manual and set a non-critical value. Make a note of set parameters.
2. Set switch S4 of controller 1 to "HOLD" and operate key 5.
3. Remove controller 1 from case and disconnect flexible connection.
4. Set switch S4 of controller 2 to "HOLD" (operating key S5 is ineffective without power supply), therefore:
5. While connecting controller 2, keep its key S5 depressed. Irrespective of the operating mode at the time controller 2 was switched off, it is now in "HOLD".
6. Turn switch S4 to "NORMAL" and confirm with S5. The instrument goes to manual mode and contains the parameters which were set at the time of switching off.
7. Adjust parameters and operating mode if necessary.

Operating instructions for service auto-manual unit

- Key at top left:
  Transfer of display:
  x1 = Controller input 1 (x)
  x2 = Controller input 2 (w_e)
  y1 = Output 1
  y2 = Output 2
- Key at top right:
  Transfer of display format
  LZ% = Percentage display of 4 – 20 mA signal range
  DZ% = Percentage display of 0 – 20 mA signal range
  mA = Display in mA
- Left hand switch: Operating mode
  1 = Instrument is in operation. If a controller is connected at the same time it has no access.
  N = Normal operation
  0 = Auto-manual unit has no access
- Potentiometer 1 = Potentiometer to set controller output-y1
  2 = Potentiometer to set controller output y2
- LEDs Adjustment of potentiometers to present output values in switch position "0" so that all LEDs are off.
- Transfer output values with potentiometer 1 and, if required, potentiometer 2.
- Switch to "N" or "1".

The service auto-manual unit is now operational. The output values can be set with the auto-manual unit. Lay ribbon cable in controller case and plug service auto-manual unit into case.

Important

Do not pull the service auto-manual unit as this might disconnect the power supply unit from the case.

13.3 Exchange controller for service auto-manual unit

- Disconnect controller as described in 13.2 (1. ... 3).
- Remove ribbon cable from service auto-manual unit and connect it initially without the service auto-manual unit to the power supply pcb. The yellow side must face the auto-manual unit.
- Turn switch of auto-manual unit to "0".
- Connect auto-manual unit, making sure the connector is not twisted but plugs in easily.

13.4 Exchange service auto-manual unit for controller

- Switch service auto-manual unit to "0".
- Remove connection from service auto-manual unit.
- Remove connection from power supply unit.
- Connect controller as described in 13.2 (5. to 7).

13.5 Retrofitting an EEPROM

The EEPROM is simple to retrofit. Various EEPROM types can be used.

a) For microprocessor 8031 with separate EEPROM (IC 13 in top left socket).
Possible EEPROMs: 52B13 and X2816A

b) For microprocessor 8051 with integral ROM (top left socket is free).

EEPROM	52B13; X1816A; 2816
EPROM	2732A

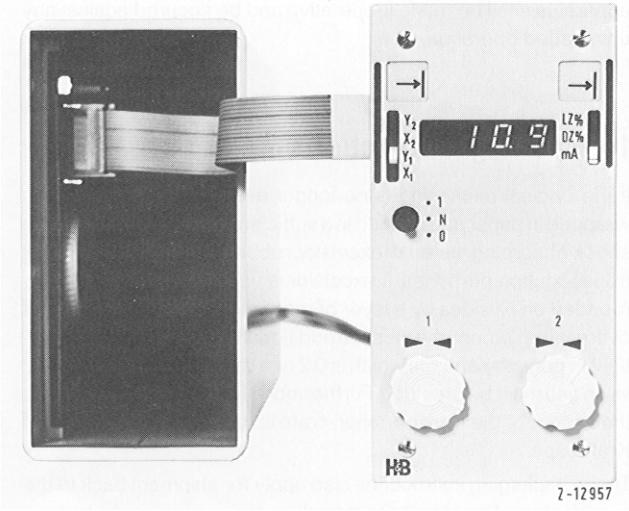


Fig. 43 Service auto-manual unit

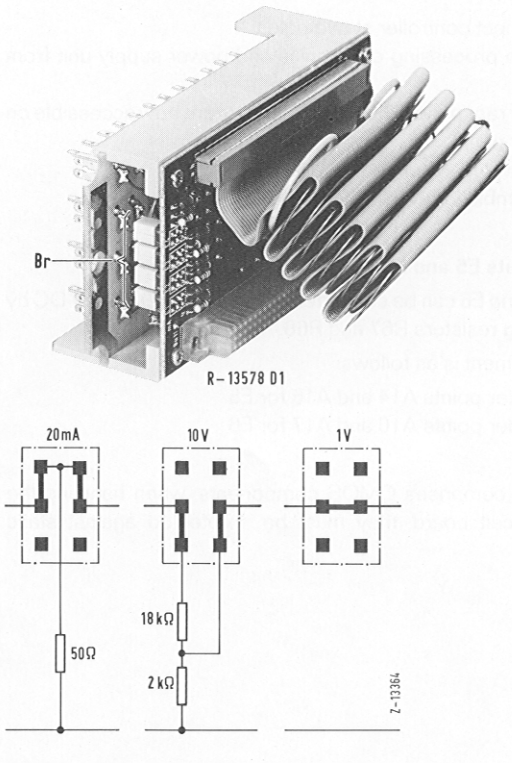


Fig. 44 Position and arrangement of plugged jumpers

Replacement or retrofitting of an EEPROM or an EPROM must be effected when the instrument is voltage-free.

When fitting the IC pay attention to the correct mounting direction (concordance between the code at the base and IC).

To activate the different EEPROMs the appropriate processing routines must be linked in to self-test routine 0F and plug-in jumpers inserted in the chassis cutout at the end of the module (St in Fig. 29).

Type	Routine	Plug-in jumpers	Program
52B13	A		2
X2816A	B		2
2816	C		2
2732A EPROM	D	 Br*	4

Table 26 Possible EEPROMs

 = Jumper with function
= Jumper without function (= parked)

* Without jumper Br programs A1 and B1, with jumper Br programs A0 and B0 are accessible with switch S1/2 (see Section 4.3.2).

13.6 Conversion to voltage input

13.6.1 Inputs 1 to 4

Inputs E1 to E4 can be converted by means of plug-in jumpers to
0(0.2)...1 V DC or
0 (2)...10 V DC.

Procedure:

- Disconnect controller at two poles.
- Remove processing electronics and power supply unit from case.
- Take off rear panel. The plug-in jumpers are now accessible on the rear panel.
- Transfer plug-in jumpers.
- Reassemble in reverse order.

13.6.2 Inputs E5 and E6

Inputs E5 and E6 can be converted to the range 0(0.2)...1 V DC by unsoldering resistors R67 and R68.

The assignment is as follows:

R67 at solder points A14 and A15 for E5
R68 at solder points A16 and A17 for E6

Caution!

The circuit comprises CMOS components; when handling the printed circuit board, they must be protected against static charges.

14 Identifying an instrument

Equipment without special configuration

Identification	see section
1. Connection of power supply. Observe voltage	3
2. Switch S4 MONITOR + TEST, press S5	Fig. 30
3. Call up routine MC 0010 and start	9.4
4. Read Catalog-No. and compare with table 6	9.4.1 4.3.1

Setting of desired functions is accomplished according to Section 4.3.2.

Equipment with special configuration

Equipment with special configuration is fitted with an EPROM in the factory (IC 19 above the battery), see Fig. 29.

The configuration based on the special configuration can generally be ascertained via the monitor MC 0010 (see above). Details are to be derived from the documentation compiled for the special configuration. Special configurations installed in the factory are allotted a code number in the addresses 8702H (LB) and 8705H (HB). These numbers permit a retracing of the configuration.

15 Information and warnings

Any interruption of the protective conductor inside or outside the apparatus or disconnection of the protective ground terminal is likely to make the apparatus dangerous. Intentional interruption is prohibited.

When the apparatus is connected to its supply, terminals may be live, and the opening of covers or removal of parts (execpt those to which access can be gained by hand) is likely to expose live parts.

The apparatus shall be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance or repair (see Section 10.1 for battery replacement).

Any adjustment, maintenance and repair of the opened apparatus under voltage shall be avoided as far as possible and, if inevitable, shall be carried out by a person who is aware of the hazard involved.

Capacitors inside the apparatus may still be charged even if the apparatus has been disconnected from all voltage sources.

Whenever it is likely that the protection has been impaired, the apparatus shall be made inoperative and be secured against any unintended operation.

16 Packing instructions

If the original packaging is no longer available, the unit is to be wrapped in paper and packed in a sufficiently large crate lined with shock-absorbing material (excelsior, rubberized hair or the like) for transportation purposes. If excelsior is used, the unit is to be surrounded on all sides by a layer of more than 15 cm. In the case of overseas shipment, the must be additionally welded so as to be airtight in polyethylene foil which is 0.2 mm thick. A drying agent (e.g. silica gel) must be provided. Furthermore, for this type of shipment, the interior of the transportation crate is to be lined with a layer of Kraft paper.

These packaging instructions also apply for shipment back to the manufacturer (recalibration, repair).

17 Accessories and spare parts list

Accessories	Catalog No.(B-Nr.)
Power plug	62403-4-0098852
Insulating sleeve (plastic)	92195-4-0454484
Flat plugs (0.5...1 mm^2)	92195-4-0542681
Flat plugs (0.75...2.5 mm^2)	92195-4-0538045
15 flat plugs with sleeve	60604-4-0801243

The component parts listed in the following Data Sheet 62-5.90 EN can be obtained as **spare parts** from the spare parts service of the device manufacturer.

In order to avoid delays and enquiries, the following ordering information

- designation
- order number (B-No.)

should be given when ordering spare parts.

Furthermore, whenever ordering spare parts or making complaints, the manufacturing and order numbers given on the rating plate are to be stated.

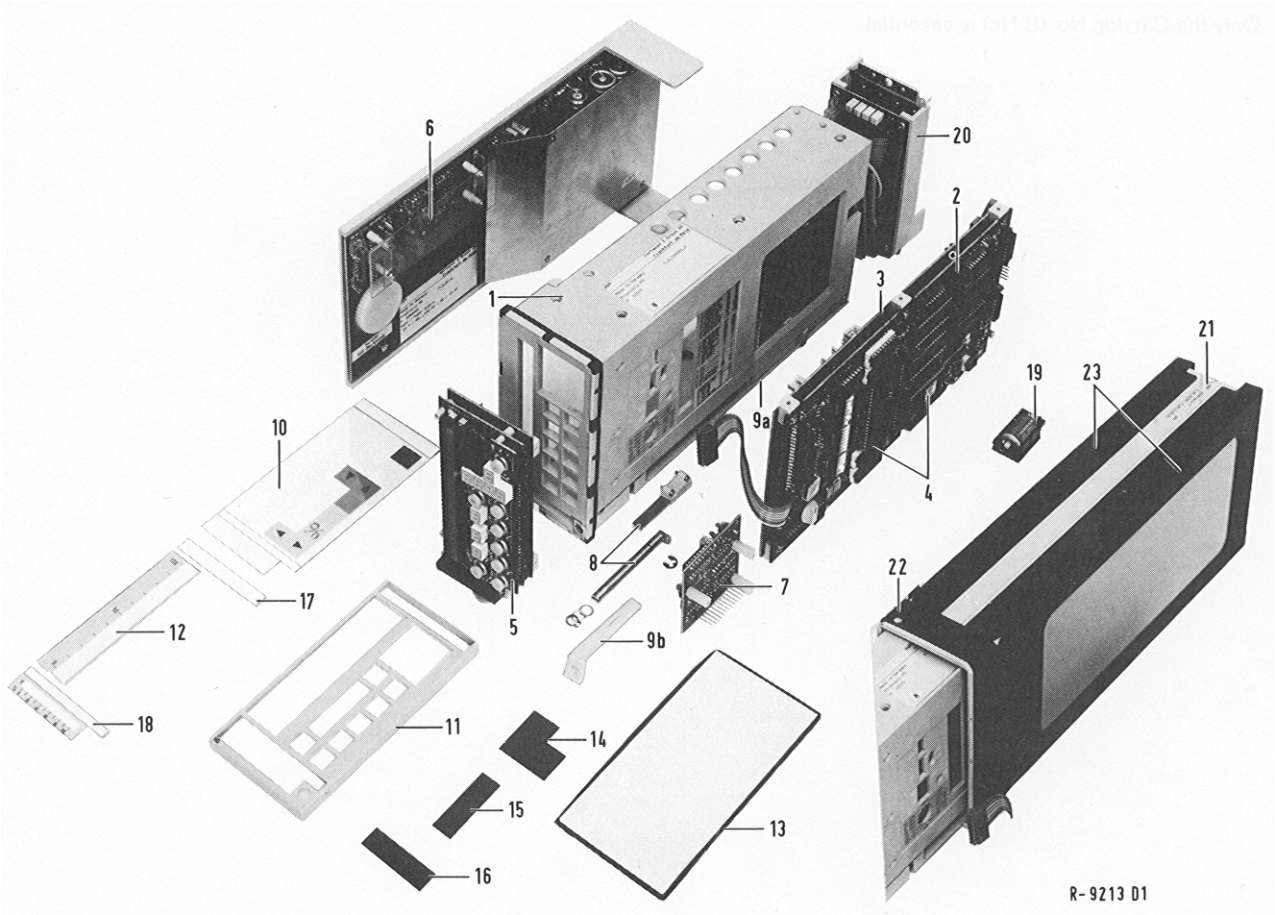
The Data Sheet 62-5.90 EN can be obtained separately from the device manufacturer.

All spare parts sales are handled by means of EDP. Thus, the sales are subject to the laws of automatic data processing in the order designation (= Gegenstand / object) of the order confirmation, of the shipping note and of the bill. Verbal deviations in the correspondence of the manufacturer are therefore possible.

Only the Catalog No. (B-Nr.) is essential.

Protronic P.

Spare Parts



Note:
The components numbered in the illustration are listed under the same number in the spare parts list.

Spare parts

		PE	PS	PA	Catalog No.	Price	Delivery time
1	Chassis	X	X		62504-4-0366412		
	Chassis			X	62504-4-0366413		
2	Microprocessor circuit board	X		X	62504-4-0342423		
	(processor part with 11 MHz quartz) without program storage		X		62504-4-0342429		
	(processor part with 12 MHz quartz) without program storage		X		62504-4-0366478		
3	Input/output circuit board	X		X	62504-4-0366488		
	Process interface with RS-422/RS-485		X		62504-4-0366251		
4	Microprocessor 8051 containing IC 13	X	X	X	62504-4-0366246		
	Program storage (EPROM) IC 15 (for processor part 11 MHz quartz)		X		62504-5-3100287		
	Program storage (EPROM) IC 15 (for processor part 12 MHz quartz)		X		62504-4-3100215		
	Program storage (EPROM) IC 15	X			62504-4-3100219		
				X	62504-5-3100212		
	Additional program storage for programmer IC 14		X		62504-4-3100229		
	Additional program storage programmer IC 14 Contronic P coupling		X		62515-4-0342471		
	Program storage (EPROM) without program	X	X		94083-4-0873094		
	Plug-in jumpers (also write protection)	X	X	X	62504-4-0806610		
5	Control/display electronics	X			62504-4-0366462		
			X		62504-4-0366463		
				X	62504-4-0368412		
6	Power supply 220 V	X	X	X	62504-4-0366482		
	115 V	X	X	X	62504-4-0366483		
	24 V	X	X	X	62504-4-0366484		
	Fuses 220 V T 0.2 A	X	X	X	94082-4-0865951		
	115 V T 0.315 A	X	X	X	94083-4-0865953		
	24 V T 1.25 A	X	X	X	94082-4-0804335		
	Fuse holder	X	X	X	94083-4-0805729		
7	Real-time clock		X		62504-4-0368405		
8	Locking bar	X	X	X	62504-4-0366235		
	Block with spring	X	X	X	62504-4-0366217		
9	Stop catch	X	X	X	62504-4-0366426		
	Handle	X	X	X	62504-4-0366669		
10	Film	X	X		62504-4-0366421		
				X	62504-4-0368406		
11	Mask	X	X		62504-4-0366416		
				X	62504-4-0366417		
12	Scale 0...100 linear	X	X	X	62504-4-0366497		
	Blank scale	X	X	X	62504-4-0366422/380		
	Special scale	X	X	X	62504-4-0366422/383/384		
13	Sealing ring	X	X		62504-4-0366428		
14	Filter	X	X		62504-4-0366434		
15	W-F-Y filter	X	X		62504-4-0366433		
16	Filter			X	62504-4-0368407		
17	Cover	X	X	X	42105-4-0456699		
18	Cover	X	X	X	62504-4-0366419		
	Cover			X	42105-4-0456700		

Spare parts

		PE	PS	PA	Catalog No.	Price	Delivery time
19	Battery with holder	X	X	X	62504-4-0368479		
	Capicitor (Elko-Radial)	X	X	X	62504-4-0741433		
	Paper sheet for legend fields	X	X	X	62504-4-0366222		
	Cable for controller/cassette unit		X		62504-4-0366350		

Case		Universal PS	Standard PE/PA	Catalog No.	Price	Delivery time
20	Terminal board with ribbon cable	X		62504-4-0366231		
			X	62504-4-0366230		
21	Case body	X	X	62504-4-0366401		
22	Spacer	X	X	62504-4-0366405		
23	Mounting shell	X	X	62504-4-0366404		
	Set of screw terminals	X	X	60604-4-0366627		

Service auto-manual unit	Catalog No.
16-pole connection cable	62504-4-0368473
Mask	62504-4-0381748
Film	62504-4-0368466

Configurator	
Case	62504-4-0368437
Keyboard film	62504-4-0368442
Connection cable to controller	62504-4-0368457
NiCad battery	94083-4-0873679
Power supply	94083-4-0873641
Positioning bar	62504-4-0366349
On/off switch	94083-4-0870542
Box	62505-4-0368486
Lid insert	62504-4-0366210
Base insert	62504-4-0366211
EPROM IC 4	62504-5-3100204
EPROM IC 5	62504-5-3100205
RAM IC 6 and IC 7	94083-4-0873108

This sign [ ] means: complete Suppl. No. with further specifications.

◇

Selbsteinstellung von Regelparametern

1 Grundlagen

Der zweikanalige Kompaktregler Protronic PS besitzt eine Funktion zur selbsttätigen Einstellung der Regelparameter (Self-tune-Funktion). Der Oberbegriff für diese Funktionen ist „Adaptive Regelung".

In der VDI/VDE-Richtlinie 3685 Blatt 1 (Entwurf) werden Begriffe und Merkmale adaptiver Regelsysteme festgelegt. Die in dieser Richtlinie verwendeten Definitionen für die Grundstruktur eines adaptiven Regelsystems sind in Bild 1 schematisch dargestellt; sie werden nachfolgend erläutert:

Die **Identifikation** ermittelt die Eigenschaften eines Systems oder Teilsystems als Grundlage für den Entscheidungsprozeß.

Der **Entscheidungsprozeß** vergleicht die durch die Identifikation erhaltenen Informationen nach vorgegebenen Kriterien mit gewünschten Eigenschaften und entscheidet, ob bzw. wie der Regelalgorithmus anzupassen ist.

Die **Modifikation** realisiert die Ergebnisse des Entscheidungsprozesses (z.B. Berechnung der Parameter).

Das **Überwachungssystem** überwacht und koordiniert die Funktion der Teilsysteme und/oder des Gesamtsystems. Es erkennt Fehler und leitet entsprechende Maßnahmen ein.

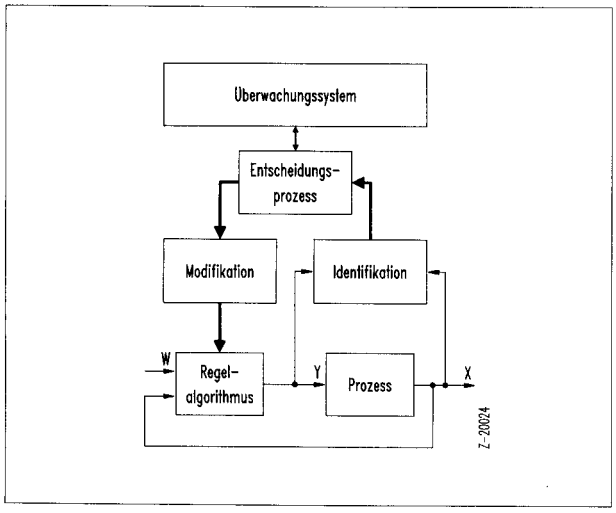


Bild 1 Grundstruktur eines adaptiven Regelsystems

Self-setting of control parameters

1 Basis

The two-channel compact controller Protronic PS is equipped with a function for automatic setting of the control parameters (self-tune function). The generic term for these functions is "adaptive control".

The definitions and features of adaptive control systems are stipulated in the VDI/VDE Guideline 3685 part 1 (draft). The definitions for the basic structure of an adaptive control system used in this guideline are illustrated in Fig. 1 and are explained as follows:

The **identification** determines the features of a system or subsystem as a basis for the decision process.

The **decision process** compares information gathered via the identification with desired features, according to stipulated criteria, and decides if and how the control algorithm should be adapted.

The **modification** implements the results of the decision process (e.g. parameter calculation).

The **monitoring system** monitors and coordinates the function of the subsystems and/or of the overall system. It recognizes errors and takes appropriate measures.

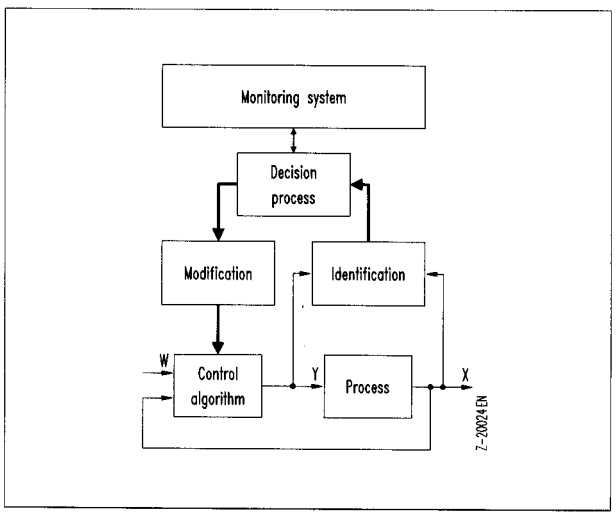


Fig. 1 Basic structure of an adaptive control system

2 Verfahren

Die Self-tune-Funktion wird vom Bediener gestartet. Der Regler kann sich in den Betriebsarten Hand oder Automatik befinden. In jedem Fall wird vor der Identifikation selbständig die Betriebsart Hand erzwungen. Die Identifikation erfolgt damit gesteuert im offenen Regelkreis, indem die Sprungantwort nach einer entsprechenden Anregung aufgenommen wird. Auf die explizite Modellbildung der Regelstrecke wird dabei verzichtet.

Mit Hilfe bestimmter Zeitkennwerte der Sprungantwort wird die Regelstrecke klassifiziert, und die Regelparameter werden berechnet. Die Parameter (PI oder PID) werden der zuvor festgelegten Regelstrecke ohne Überprüfung eines Gütemaßes zugeordnet.

Die Optimierungsstrategie zielt auf ein gutes Störverhalten gemäß ITAE-Kriterium[1] mit zusätzlicher Phasenrandreserve. Sie liefert bei Regelstrecken mit Ausgleich und aperiodischem Übergang fast immer ein gutes und stabiles Regelverhalten.

Sekundäre Parameter wie Tote Zone H und schaltzeitbestimmende Kontrollcodes für Dreipunkt- und Zweipunktregelung werden nicht beeinflußt; sie müssen im Einzelfall vorab passend zu den Eigenschaften des Regelkreises gewählt werden. Die werkseitig eingestellten Werte sind jedoch für die Mehrzahl der üblichen Regelstrecken geeignet.

2 Procedure

The self-tune function is started by the operator, the controller being in the modes manual or automatic. In all cases manual mode is automatically forced before identification. Thus identification takes place controlled in the open control loop by recording the step response after an appropriate excitation. Here attention is not paid to explicit model formation of the controlled system.

The controlled system is classified and the control parameters are calculated by means of certain time codes of the step response. The parameters (PI or PID) are assigned to the controlled system, which has already been determined, without verification of a quality criterion.

The optimization strategy aims at good response to disturbances in compliance with the ITAE criterion[1] with additional phase margin reserve. It nearly always provides good, stable control behaviour in controlled systems with compensation and aperiodic transition.

Secondary parameters such as Dead Zone H and control codes governing switching times for three-position and two-position control are not affected. They must be selected in advance in the individual case corresponding to the features of the control loop. However, the factory settings are suitable for most of the normal controlled systems.

3 Bedienung und Ablauf

3.1 Anwahl der Funktion

Die Self-tune-Funktion kann nur angewählt werden, wenn in der Anzeigeschleife die Variable ohne Namen (Hex-Adresse 00) eingetragen ist. Werkseitig ist diese Variable nach den Grenzwerten eingetragen. Die große Anzeigeschleife muß freigegeben sein (Schalter S1/2 auf ON). Mit dem Kontrollcode 8718 (siehe Abschnitt 3.5) kann festgelegt werden, ob die Funktion anwählbar sein soll.

Die Funktion kann in Geräten mit den B-Nrn. 111, 211, 451, 551, 651, 711 und 811 aktiviert werden (siehe Gebrauchsanweisung 42/62-61, Abschnitte 4.3.1 und 9.4.1). In zweikanaligen Geräten wird sie für den Kanal aufgerufen, der momentan bedient wird (Anzeige neben der Taste 18). Sie liefert die Regelparameter für einen PI- oder einen PID-Regler (abhängig von der Stellung des Schalters S2/6 oder dem Inhalt des entsprechenden Kontrollcodes).

Die Taste 3 wird solange gedrückt, bis in der Digitalanzeige 7 der Text „S.tun" für Self-tune erscheint (siehe Bild 2). Das Blinken der Anzeige zeigt an, daß die Funktion noch nicht aktiviert ist und daß jetzt die weiteren Variablen in der großen Anzeigeschleife angewählt werden können.

1 ITAE = Integral of time multiplied absolute value of error (Zeitbewertete betragslineare Regelfläche)

3 Operation and sequence

3.1 Selection of the function

The self-tune function can be selected only if the variable without a name (hex address 00) has been entered in the display loop. This variable is entered behind the alarm values when the units are first delivered. The large display loop must be enabled (switch S1/2 to ON). Control code 8718 (see Section 3.5) can be used to define whether the function is to be selectable.

The function can be activated in instruments with request nos. 111, 211, 451, 551, 651, 711 and 811 (see Operating Instructions 42/62-61, Sections 4.3.1 and 9.4.1). In two-channel instruments it is called up for the channel currently being operated (display beside key 18) and furnishes the control parameters for a PI or PID controller (according to the position of switch S2/6 or the content of the appropriate control code).

Key 3 is pressed until the text "S.tun" for self-tune appears in digital display 7 (see Fig. 2). Flashing of the display indicates that the function has not yet been activated and that the other variables in the large display loop can now be selected.

1 ITAE = Integral of time multiplied absolute value of error

3.2 Start der Funktion

Um die Parameterdefinition zu beginnen, müssen die Tasten ▼ und ▲ gleichzeitig gedrückt werden, während die Anzeige „S.tun" blinkt. Die aktuelle Betriebsart wird gespeichert und der Regler schaltet in die Betriebsart „Hand".

Solange die Anzeige „d.St.P." blinkt, kann der Bediener die Parameter der Funktion in der Anzeigeschleife 1 anwählen und ändern (siehe Bild 4 und Abschnitt 4). Kurzes Drücken der Taste 3 schaltet von oben nach unten und längeres Drücken von unten nach oben. Zum Abschluß muß der Parameter Δy angewählt werden.

Wird kein Parameter angewählt, so schaltet die Funktion selbsttätig auf Δy. Solange die Anzeige „Δy" blinkt, kann der Bediener die Stellsprung-Amplitude ändern.

Die Funktion prüft den Parametersatz auf Plausibilität. Unstimmigkeiten werden mit der Fehlermeldung „Er.tP" angezeigt (siehe Abschnitt 5); in diesem Fall muß der Bediener die Parameter korrigieren.

3.2 Start of the function

To start the parameter definition run, the keys ▼ and ▲ must be pressed simultaneously, with the display "S.tun" flashing. The actual operating mode is stored and the controller switches to the manual mode.

As long as the display "d.St.P" continues to flash, the operator can select and modify the parameters of the function in display loop 1 (see Fig. 4 and Section 4). Brief pressing of key 3 switches from top to bottom, longer pressing from bottom to top. The parameter Δy must be selected last.

If no parameter is selected, the function switches automatically to Δy. As long as the display "Δy" flashes, the operator can change the amplitude of the step of the manipulated variable.

The parameter set is checked for reasonableness. Inconsistencies are shown by the error message "Er.tP" (see Section 5); here the parameters must be corrected by the operator.

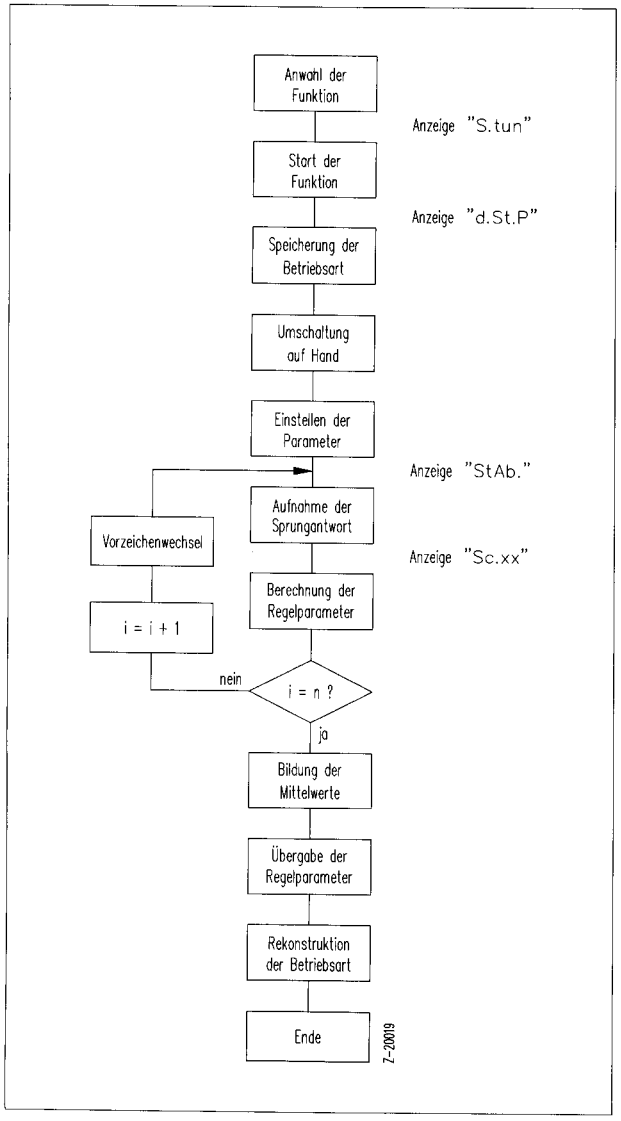


Bild 2 Ablauf der Self-tune-Funktion

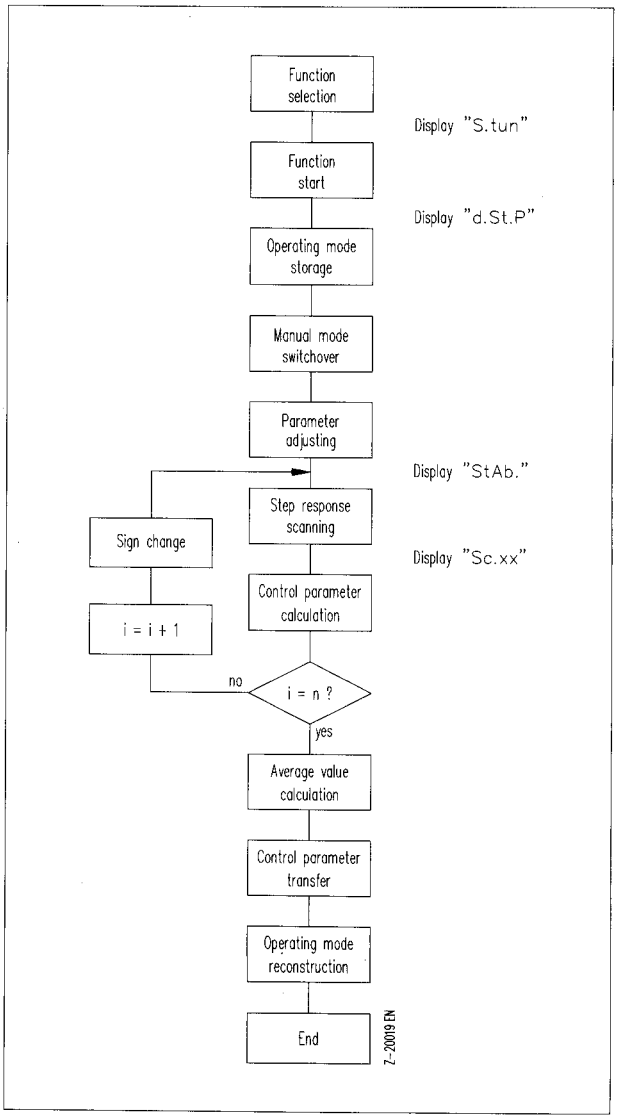


Fig. 2 Sequence of the self-tune function

3.3 Ermittlung der Regelparameter

Ist der Parametersatz plausibel, erscheint in der Anzeige der Text „StAb." für Stabilisierungsphase. Durch Überprüfen des aktuellen Istwert-Eingangs (E1 für Kanal 1, E3 für Kanal 2) auf Beharrungszustand wird sichergestellt, daß alle Einschwingvorgänge im nun offenen Regelkreis abgeklungen sind.

Die rote Istwert-Anzeige (8) blinkt mit 2,5 Hz, wenn der aktuelle Istwert-Eingang sich nicht im Beharrungszustand befindet und während der Abtastung der Sprungantwort.

Nach Erreichen des Beharrungszustandes führt die Funktion einen Stellsprung Δy mit den eingestellten Werten für Betrag und Richtung durch. Die Regelabweichung x_d wird innerhalb des festgelegten Zeitbereichs T_r mit dem entsprechenden Takt abgetastet (siehe Bild 3). Der Abtast-Takt läuft in der Anzeige „Sc.xx" neben den blinkenden Zeichen „Sc." in Hex-Ziffern von 00 bis FF durch.

Die Funktion speichert die Abtastwerte in einer Tabelle. Ist die Tabelle vor Erreichen der Endlage gefüllt, so wird sie auf die Hälfte komprimiert und in verdoppeltem Abtast-Takt erneut gefüllt. Dieser Vorgang wird so oft wiederholt, bis entweder eine stabile Endlage oder der größtmögliche Abtast-Takt erreicht ist. Im ersten Fall werden die Regelparameter berechnet; im zweiten Fall wird das Verfahren mit der Fehlermeldung „Er.tt" abgebrochen (siehe Abschnitt 5).

Die Aufnahme der Sprungantwort kann mehrmals wiederholt werden. Dabei werden die bereits ermittelten Regelparameter gespeichert, und nach der letzten Wiederholung werden die Mittelwerte der Regelparameter gebildet.

3.3 Determination of the control parameters

If the parameter set is reasonable, the text "StAb." for stabilization phase appears in the display. Checking the steady-state condition of the current actual value input (E1 for channel 1, E3 for channel 2) guarantees that the open control loop is now free of all transient effects.

The red actual value display (8) flashes with 2.5 Hz when the current actual value input is not in the steady-state condition and during the scanning of the step response.

On reaching the steady-state condition the function carries out a step of the manipulated variable Δy with the set values for magnitude and direction. The control deviation x_d is scanned at the corresponding rate within the defined time range T_r (see Fig. 3). The scanning rate appears in hex figures from 00 to FF in the display "Sc.xx" beside the flashing characters "Sc.".

The function records the scanning values in a table. If the table is full before the end position is reached it is compressed to half its size and refilled at double the scanning rate. This procedure is repeated until either a stable end position or the maximum scanning rate is reached. The control parameters are calculated in the first case; in the second case the procedure is aborted with the error message "Er.tt" (see Section 5).

Recording of the step response can be repeated several times, with the control parameters already determined being stored and the average values of the control parameters always being calculated after the last repeat.

3.4 Übergabe der Regelparameter

Die Funktion übergibt die Mittelwerte der Regelparameter wahlweise (Kontrollcode 8718, siehe Abschnitt 3.5) direkt an den Regelalgorithmus oder bietet sie in der Anzeige zur manuellen Übergabe an. Angezeigt werden der mittlere XP-Wert 'P_, der mittlere Tn-Wert 'n_ und der mittlere Td-Wert 'd_.

3.4 Transfer of the control parameters

The function either transfers the average values of the control parameters directly into the control algorithm or offers them in the display for manual transfer (depending on control code 8718, see Section 3.5). The average XP value 'P_, the average Tn value 'n_ and the average Td value 'd_ are displayed.

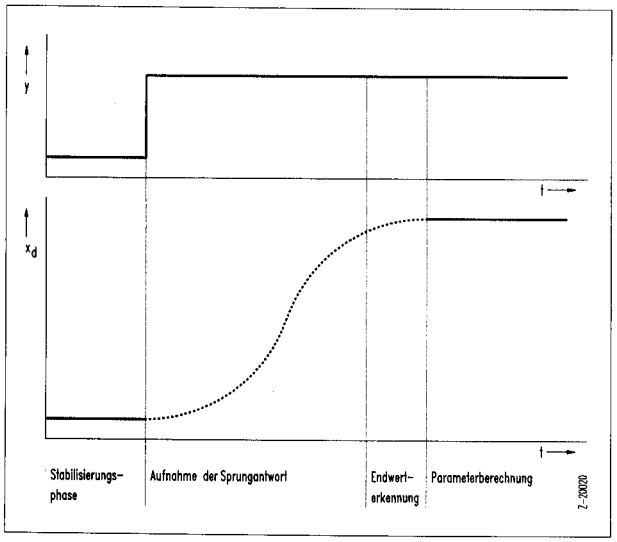


Bild 3 Abtastung der Sprungantwort

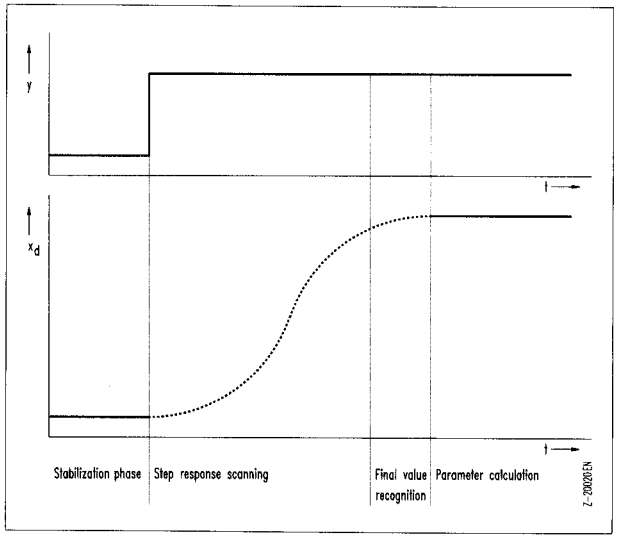


Fig. 3 Scanning of the step response

Der Bediener kann die ermittelten Regelparameter zu einem beliebigen Zeitpunkt überprüfen, z.B. wenn sie automatisch übergeben worden sind. Hierzu wird die Self-tune-Funktion angewählt; aus der Anzeige „d.St.P" kann dann durch längeres Drücken der Taste 3 in die Anzeigeschleife 2 gesprungen werden.

Für die Interpretation der Regelparameter muß die Reglerstruktur bekannt sein:

$$F_{kontinuierlich} = \frac{1}{XP}\left(1 + \frac{1}{Tn \cdot p} + \frac{Td \cdot p}{1 + Td/Vd \cdot p}\right)$$

$$F_{Schrittregler} = \frac{1}{XP}\left(1 + \frac{Td \cdot p}{1 + Td/Vd \cdot p}\right)\left(1 + \frac{1}{Tn \cdot p}\right)$$

Damit entsprechen die ermittelten Regelparameter XP, Tn und Td für den kontinuierlichen Regler direkt den in DIN 19226 definierten Größen Proportionalbereich, Nachstellzeit und Vorhaltzeit.

Für den Schrittregler müssen sie mit dem Interaction-Faktor I = (1 + Td/Tn) umgerechnet werden:
Proportionalbereich = XP / I
Nachstellzeit = Tn · I
Vorhaltzeit = Td / I

The operator can check the determined control parameters at any time, for instance in the case of automatic transfer. The self-tune function is selected for this purpose; by pressing key 3 for a longer time it is possible to proceed from the display "d.St.P" to display loop 2.

The controller structure must be known to interpret the control parameters:

$$F_{continuous} = \frac{1}{XP}\left(1 + \frac{1}{Tn \cdot p} + \frac{Td \cdot p}{1 + Td/Vd \cdot p}\right)$$

$$F_{step\ controller} = \frac{1}{XP}\left(1 + \frac{Td \cdot p}{1 + Td/Vd \cdot p}\right)\left(1 + \frac{1}{Tn \cdot p}\right)$$

Thus for the continuous controller, the determined control parameters correspond directly to the quantities proportional range, integral action time and derivative action time defined in DIN 19226.

For the step action controller, they must be converted using the interaction factor I = (1 + Td/Tn) into:
Proportional range = XP / I
Integral action time = Tn · I
Derivative action time = Td / I

3.5 Abbruch der Funktion

Der Funktionsablauf kann jederzeit durch gleichzeitiges Drücken der Tasten 3 und 18 oder der Taste CTL (S5) abgebrochen werden.

3.5 Abortion of the function

The function sequence may be aborted at all times by simultaneously pressing keys 3 and 18 or key CTL (S5).

3.6 Kontrollcode 8718

Mit dem Kontrollcode 8718 wird festgelegt,
- ob nach Erreichen des eingestellten Zeitbereich-Wertes T_r der Abtasttakt verdoppelt oder der Abtastvorgang abgebrochen werden soll,
- ob die Regelparameter automatisch oder manuell an den Regelalgorithmus übergeben werden sollen und
- ob die Fehlermeldungen zur Signalisierung auf den Binärausgang Q00 verknüpft werden sollen.

8718								
Bit	7	6	5	4	3	2	1	0
Inhalt	1	1	1	1	1	1	1	1
Hex	F				F			

(werkseitig eingestellt)

Bit 0 = 1: Automatische Verdoppelung des Abtast-Zeitbereichs T_r
= 0: Abbruch nach Erreichen von T_r
Bit 1 = 1: Manuelle Übergabe der Regelparameter
= 0: Automatische Übergabe der Regelparameter
Bit 2 = 1: Keine Verknüpfung der Fehlermeldungen auf den Ausgang Q00
= 0: Verknüpfung der Fehlermeldungen „Er.tx" auf den Ausgang Q00 (siehe Abschnitt 5)
Bit 7 = 1: Self-tune-Funktion kann angewählt werden
= 0: Self-tune-Funktion kann nicht angewählt werden

3.6 Control Code 8718

Control code 8718 is used to specify
- whether the scanning rate is to be doubled or the scanning procedure aborted on reaching the set time range value T_r
- whether the control parameters are to be transferred into the control algorithm automatically or manually and
- whether the error messages are to be connected to the binary output Q00 for signalling.

8718								
Bit	7	6	5	4	3	2	1	0
Cont.	1	1	1	1	1	1	1	1
Hex	F				F			

(factory setting)

Bit 0 = 1: Automatic doubling of the scanning time range T_r
= 0: Abortion on reaching T_r
Bit 1 = 1: Manual transfer of the control parameters
= 0: Automatic transfer of the control parameters
Bit 2 = 1: No connection of the error messages to output Q00
= 0: Connection of the error messages "Er.tx" to output Q00 (see Section 5)
Bit 7 = 1: Self-tune function can be selected
= 0: Self-tune function cannot be selected

4 Einstellung der Parameter

Der Bediener kann die folgenden Parameter mit den Tasten ▼ und ▲ ändern:

T_r Abtast-Zeitbereich:
Abhängig von der Wahl des Zeitbereichs für die Reglerzeitkonstanten (mit Schalter S2/8 oder entsprechendem Kontrollcode)

Abtast-Zeitbereich	Abtast-Takt
0.4 min	0.1 s
0.8 min	0.2 s
1.6 min	0.4 s
3.2 min	0.8 s
6.4 min	1.6 s
12.8 min	3.2 s
25.6 min	6.4 s
51.2 min	12.8 s
1.80 h	25.6 s
3.60 h	51.2 s
7.20 h	102.4 s
14.40 h	204.8 s

Der Abtast-Zeitbereich wird nicht automatisch von 51.2 Minuten auf 1.8 Stunden erhöht. Werkseitig ist kein Wert eingestellt. Der Abtast-Zeitbereich (und damit der Abtast-Takt) muß passend zur Strecke gewählt werden: Abschätzen der vom Prozeß benötigten Zeit, um von einem stabilen Zustand in einen anderen zu gelangen (siehe punktierte Linie in Bild 3), und danach Einstellen des nächstkleineren Abtast-Zeitbereichs.

n Anzahl der Wiederholungen:
1...8, werkseitig eingestellt: 2

F_P Parameterfaktor für XP, Tn, Td:
75.0...199.9 %, werkseitig eingestellt: 100.0 %
Werte > 100.0 % ergeben eine sanftere und stabilere Regelung.

b_n Toleranzband für überlagerten Ripple (maßgebend für das Kriterium „Beharrungszustand erreicht"):
0.3...3.0 %, werkseitig eingestellt: 0.5 % = ± 0.25 %

'P_H Maximalwert für XP:
0...1850, werkseitig eingestellt: 1850

'P_L Minimalwert für XP:
0...1850, werkseitig eingestellt: 3

'n_H Maximalwert für Tn:
0...1999, werkseitig eingestellt: 1999

'n_L Minimalwert für Tn:
0...1999, werkseitig eingestellt: 1

'd_H Maximalwert für Td:
0...1999, werkseitig eingestellt: 1999

'd_L Minimalwert für Td:
0...1999, werkseitig eingestellt: 0

$\overline{e}_H$ Maximalwert für Analogeingang /E1 oder /E3:
199.9...199.9 %, werkseitig eingestellt: 100.0 %

4 Parameter setting

The operator can change the following parameters with keys ▼ and ▲:

T_r Scanning time range:
Dependent on selection of the time range for the controller time constants (with switch S2/8 or appropriate control code)

Scanning time range	Scanning rate
0.4 min	0.1 s
0.8 min	0.2 s
1.6 min	0.4 s
3.2 min	0.8 s
6.4 min	1.6 s
12.8 min	3.2 s
25.6 min	6.4 s
51.2 min	12.8 s
1.80 h	25.6 s
3.60 h	51.2 s
7.20 h	102.4 s
14.40 h	204.8 s

The scanning time range is not automatically increased from 51.2 minutes to 1.8 hours. No value is set in the factory. The time range (and thus the scanning rate) must be chosen in accordance with the system: Estimate the time the process needs to come from one stable state to another one (see dotted line in Fig. 3) and then set the next lower scanning time range.

n Number of repeats:
1...8, factory setting: 2

F_P Parameter factor for XP, Tn, Td:
75.0...199.9 %, factory setting: 100.0 %
Values > 100.0 % assure a more gentle and stable control.

b_n Tolerance band for superimposed ripple (decisive for the criterion "steady-state condition reached"):
0.3...3.0 %, factory setting: 0.5 % = ± 0.25 %

'P_H Maximum value for XP:
0...1850, factory setting: 1850

'P_L Minimum value for XP:
0...1850, factory setting: 3

'n_H Maximum value for Tn:
0...1999, factory setting: 1999

'n_L Minimum value for Tn:
0...1999, factory setting: 1

'd_H Maximum value for Td:
0...1999, factory setting: 1999

'd_L Minimum value for Td:
0...1999, factory setting: 0

$\overline{e}_H$ Maximum value for analog input /E1 or /E3:
-199.9...199.9 %, factory setting: 100.0 %

$\bar{e}_L$ Minimalwert für Analogeingang /E1 oder /E3:
-199.9...199.9 %, werkseitig eingestellt: 0.0 %

Δy Stellsprung-Amplitude:
-199.9...199.9 %, werkseitig eingestellt: 20.0 %
Werte > 100 % sind nicht sinnvoll. Das Vorzeichen wird bei jedem Ablauf automatisch umgeschaltet; es kann durch Drücken der Taste 10 direkt umgeschaltet werden, wenn Δy angewählt ist.

Wird während der Anzeige „d.St.P" die Taste 10 gedrückt, übernimmt die Funktion die werkseitig eingestellten Parameter; ansonsten arbeitet sie mit den Parameterwerten des letzten Self-tune-Laufs.

$\bar{e}_L$ Minimum value for analog input /E1 or /E3:
-199.9...199.9 %, factory setting: 0.0 %

Δy Amplitude of the step of the manipulated variable:
-199.9...199.9 %, factory setting: 20.0 %
Values > 100 % have no meaning. The preceding sign is automatically switched over for each run; it can be switched over directly by activating key 10, when Δy is selected.

If key 10 is pressed when the display "d.St.P" appears, the function uses the parameters set in the factory. Otherwise it operates with the parameter values of the last self-tune run.

5 Fehlermeldungen

Die Self-tune-Funktion gibt die in der folgenden Tabelle aufgelisteten Fehlermeldungen aus. Die Fehlermeldungen werden mit der Taste 3 quittiert. Anschließend sind die erforderlichen Korrekturen durchzuführen; bei den mit * gekennzeichneten Meldungen ist dies durch Betätigen des entsprechenden Schalters bzw. durch Ändern des entsprechenden Kontrollcode-Inhalts möglich. Die Funktion muß neu gestartet werden.

Er.tA		Amplitude zu gering (Regelabweichung < 7.5 %)
Er.tC	*	Reglerstruktur nicht PI oder PID
Er.tE		Grenzwert für Eingangssignal verletzt
Er.tF		Kurvenform der Sprungantwort nicht analysierbar
Er.ti	*	Regelcharakteristik falsch
Er.tP		Parametereingabe unstimmig
Er.tr	*	Zeitbereich nicht xxxx s oder xx.xx h
Er.tS	*	Schreibschutz verhindert Parameterübergabe
Er.tt		Abtast-Zeitbereich zu klein
Er.tt.		Abtast-Zeitbereich zu groß
Er.ty		Stellampitude (y + Δy) > 100 % oder < 0 %

5 Error messages

The self-tune function issues the error messages listed in the following table. The error messages are acknowledged with key 3. Then necessary corrections should be made. In the case of messages marked with * this is effected by actuating the corresponding switch or by changing the appropriate control code content. The function must be started up again.

Er.tA		Amplitude too low (control deviation < 7.5 %)
Er.tC	*	Controller structure not PI or PID
Er.tE		Alarm value for input signal infringed
Er.tF		Curve form of step response cannot be analysed
Er.ti	*	Control characteristic incorrect
Er.tP		Parameter entry inconsistent
Er.tr	*	Time range not xxxx s or xx.xx h
Er.tS	*	Write protection prevents parameter transfer
Er.tt		Scanning time range too small
Er.tt.		Scanning time range too large
Er.ty		Amplitude of the manipulated variable (y + Δy) > 100 % or < 0 %

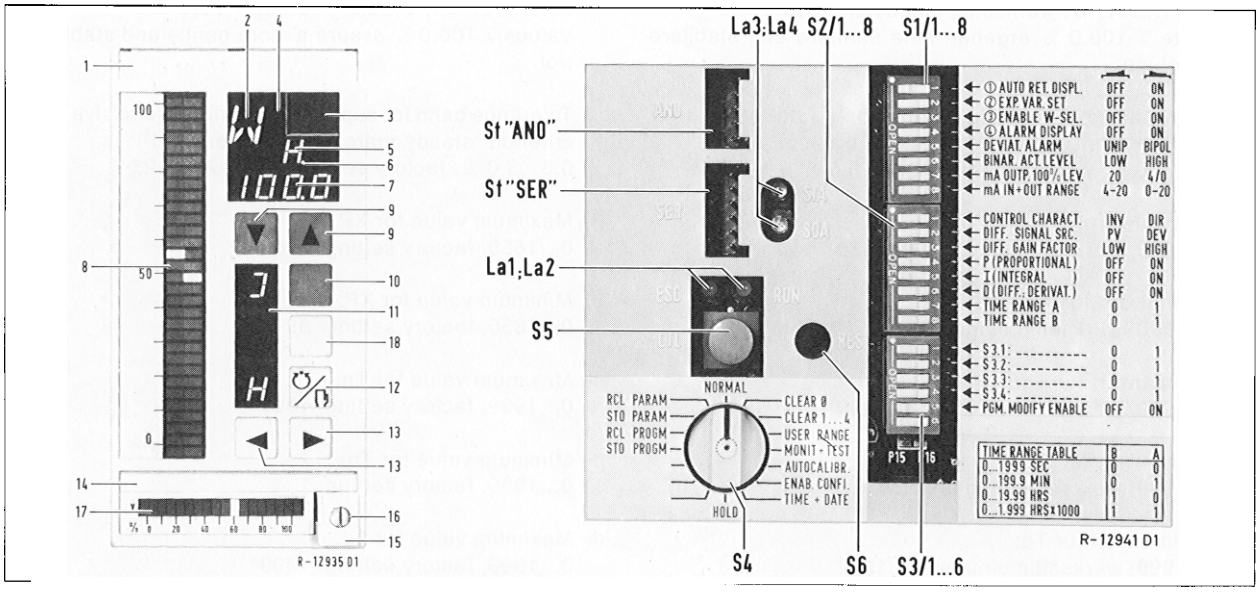


Bild 5 Frontansicht und Anzeige-/Bedienelemente

Fig. 5 Front view and display/manual control elements

Subject to technical changes.

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