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Supplementary documentation

Data Sheet 62-5.00 EN (Compilation of all the documentation pertinent to Protronic P controller system)

Data Sheet 62-5.11 EN

Important Instructions! They must be absolutely read and obeyed!

Correct and safe operation of the Process Controller Protronic PE 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 instruments and who possess the necessary qualifications are allowed to work on the instrument. They must be familiar with the contents of this Operating Manual, with the safety instructions inscribed on the unit as well as with the pertinent safety instructions governing the installation and operation of electrical systems.

This apparatus has been designed and tested in accordance with DIN VDE 0411, Part 1 (based on IEC Publication 348), "Safety Requirements for Electronic Measuring Apparatus", and has been supplied in a safe condition. The safety instructions in this Operating Manual bearing the headline "Caution" must be observed in order to retain the apparatus in a safe condition and to ensure safe operation. Noncompliance with the safety instructions can result in death, bodily injuries or in damage to the instrument itself or to other instruments and facilities.

If the information in this Operating Manual should prove to be insufficient in any point, please consult your Technical Branch Office, or a branch or representative of ABB.

The industrial standards and regulations (e.g. DIN, VDE, VDI) referred to in this Operating Manual are applicable in the Federal Republic of Germany. When using this device outside the Federal German jurisdiction, the relevant specifications, standards and regulations applicable in the country where the device is used must be observed.

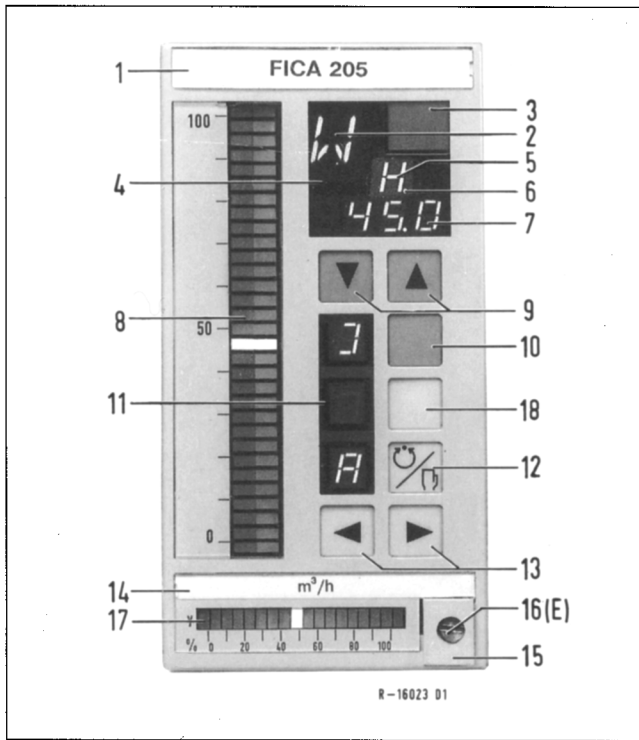


Fig. 1.1 Display and manual control elements on the front panel

- | | |
|---|--|
| <ul style="list-style-type: none"> 1 Top legend field 2 Code letter display 3 Selector switch for digital display 4 Digital display 5 Index for code letters 6 Decimal point for 5, lights up when the variable displayed in 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 ▼/▲ -keys) | <ul style="list-style-type: none"> 10 Set point selection (can be disabled) 11 Status display 12 Manual/automatic transfer (H/A -keys) 13 "Raise/lower" for output variable (◀/▶ -keys) 14 Scale factor plate, e.g. for dimension 15 Handle for removal 16 Slide-in unit lock (E) 17 Output variable display 18 Multifunctional key (F-key) |
|---|--|

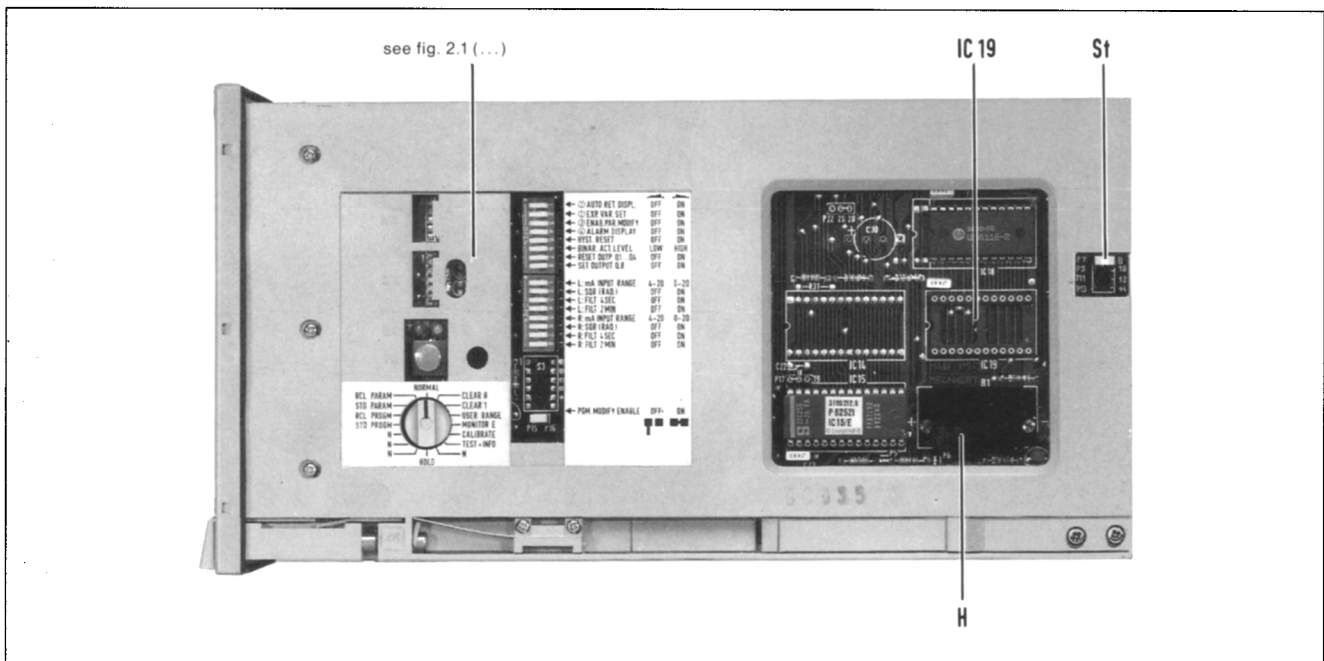


Fig. 1.2 Side view of control electronics, slide-in unit

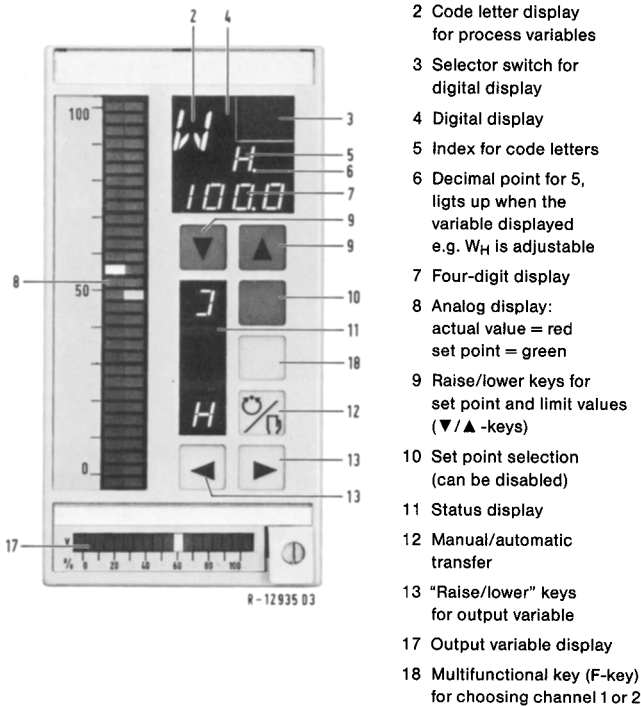
- H Battery
- IC 19 Location for EEPROM
- St Plug-in Jumper for write-protection

Operating the controller

Synopsis of Sections 2 and 3 of Operating Manual 42/62-60-7 EN

A synopsis of the most important operating procedures is given below. More detailed information is contained in the Chapter "Operation" of this Operating Manual.

DISPLAY AND MANUAL CONTROL ELEMENTS ON THE FRONT PANEL



- 2 Code letter display for process variables
- 3 Selector switch for digital display
- 4 Digital display
- 5 Index for code letters
- 6 Decimal point for 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 limit values (∇/\blacktriangle -keys)
- 10 Set point selection (can be disabled)
- 11 Status display
- 12 Manual/automatic transfer
- 13 "Raise/lower" keys for output variable
- 17 Output variable display
- 18 Multifunctional key (F-key) for choosing channel 1 or 2

Digital display and setting facilities

A number of process variables can be shown by means of identifying letters in the digital display field (4) and switched over with switch (3) (see following table).

Variables featuring a point (6) can be adjusted with keys $\blacktriangle/\blacktriangledown$ (9).

In the two-channel devices all displays and setting facilities are available in duplicate.

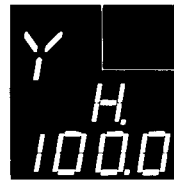
To distinguish between the channels all displays on the second channel are displayed with a point appended to them e.g. X_d , W_d , $X_{d,}$.

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

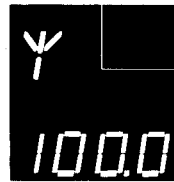
Display	Function
X	Actual value or reference variable with ratio
W	Setpoint (also ratio setpoint)
Y	Output variable
X_d	Control deviation ($X - W$)
D	Setpoint difference ($W_E - W_I$)
G1	X alarm value MAX
G2	X alarm value MIN
G3	X_d alarm value MIN
G4	X_d alarm value MAX

CONTROLLER OPERATING INSTRUCTIONS

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 \blacktriangle and \blacktriangledown 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:



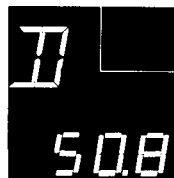
For **external** set point:



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 \blacktriangle and \blacktriangledown .

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

H 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

H  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.

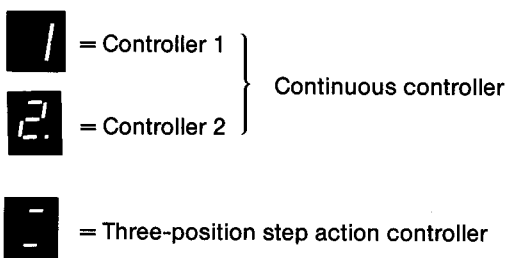
The control pulses are depicted by means of individual segments lighting up in the display beside the F key (18).



Manual operation of two-channel controllers

For manual operation the same rules apply to two-channel controllers and single-channel controllers.

The controller to be operated is determined via the F key (18) and can be read in the display field located beside it.

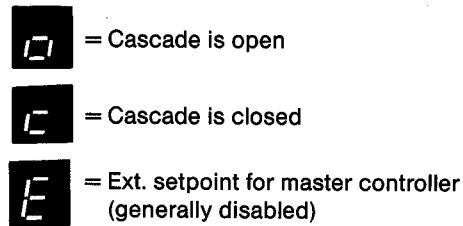


Designation of the channels

Manual operation of a cascade controller

During commissioning the slave controller is initially operated alone.

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



The master controller is always in the automatic mode and cannot be switched to "manual". If one endeavours to switch the master controller to "manual", the display switches to controller 2 which now goes to "manual".

Manual operation is effected as per specifications for single-channel controllers via controller output 1.

Manual operation of the override controller

The override controller may have a continuous or a step action output.

Controller 2 is always the master controller, controller 1 the override controller. An internal or external setpoint can be assigned to each controller with the I/O key (10) in conjunction with the F key (18). The mode selector switch (12) only affects the master controller, i.e. the override controller is always in the automatic mode.

Setting the alarm values

Having selected the various alarm values on the digital display, they may be modified with the keys ▲ and ▼. The alarm values perform the following function:



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

If the alarm values G3 and G4 are intended as the control deviation magnitude $|x_d|$, G3 must be set to negative values and G4 to positive values.

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

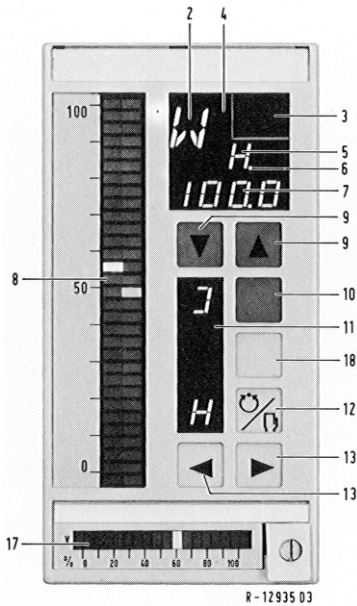
- G.1 Max. alarm value of the second channel for X.
- G.2 Min. alarm value of the second channel for X.

Operating the programmer and program controller

Synopsis of Sections 2 and 3.7/3.8 of Operating Manual 42/62-60-7 EN

A synopsis of the most important operating procedures is given below. More detailed information is contained in the Chapter "Operation" of this Operating Manual.

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 setpoint 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_2 , W_2 , X_{2d} .

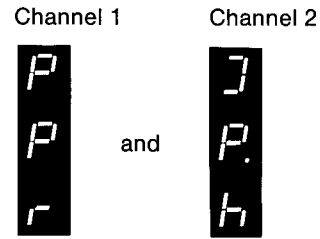
Channel switchover (control level switchover) is accomplished with key 18 (F key).

Display	Function
X	Actual value or reference variable with ratio
X_2	Secondary variable with ratio
V	Ratio (current)
W	Setpoint (also ratio setpoint)
Y	Output variable
X_d	Control deviation ($X - W$)
N	No. of currently processed section
G1	X alarm value MAX
G2	X alarm value MIN
T_u	The time expired in the currently active section
R	Loop counter; counts the repetitions

Programmer/program controller transfer

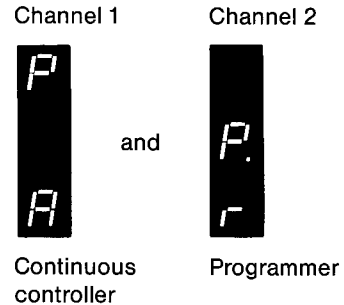
Transfer is accomplished with key (18).

In two-channel programmers the display changes between



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



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

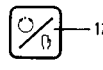
Adjusting the output signal



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%.



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

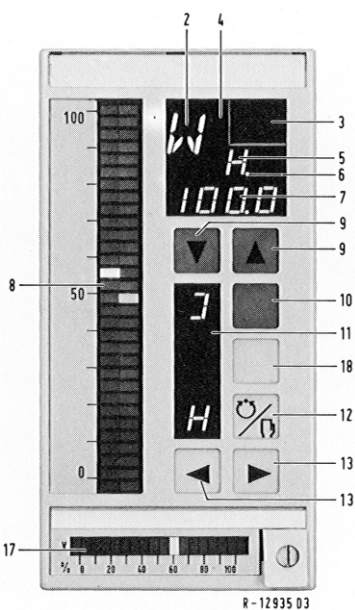
Operating of the stations

Synopsis of Sections 2 and 3 of Operating Manual 42/62-60-7 EN

A synopsis of the most important operating procedures is given below. More detailed information is contained in the Chapter "Operation" of this Operating Manual.

- Continuous manual station (HK)**
- Step output manual station (HS)**
- Set point station (SS)**
- Ratio station (VS)**
- Bias station (BS)**

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 or elapsed time of section
- 18 Multifunction key (F-key)

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).

Display	Function
X	Measured variable HK, HS, VS, BS Not in SS
Y	Controller output HK, HS Output variable VS, BS Not in SS
W	Set point SS Ratio factor VS Fixed value BS Not in HK, HS
D	Difference $W_E - W_I$ SS, VS, BS Not in HK, HS
G1	Alarm value max. measured variable HK, HS, VS, BS
G2	Alarm value min. measured variable HK, HS, VS, BS Not in SS

Display of output variable



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.

Y corresponds to the output variable.

Set point, ratio factor and fixed value adjustment



The process variable is selected on the digital display with key (3). The variable can be adjusted with keys ▲ raise and ▼ lower.

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 function:

- G1 = max. alarm value of measured variable
- G2 = min. alarm value of measured variable
- Not possible in HS

Internal/external set point, ratio factor, fixed value transfer (SS, VS, BS)

Provided transfer has not been disabled internally it is accomplished by pressing key 10. The operating mode is effective as soon as the display next to key 10 stops flashing.



= internal set point, ratio factor or fixed value



= external set point, ratio factor or fixed value

Before transferring from internal set point to an unknown external value 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 accomplished 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 (HK)

In the continuous manual station manual/automatic transfer is possible provided it is not disabled internally. In the automatic mode an external signal is connected to the output.



Operating mode transfer is automatically 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.

Continuous manual station (HK)

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%.



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%.



Step output manual station (HS)

If H is visible in the display next to key (12) the servodrive can be adjusted. The correction time is a function only of the run time of the drive.

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

Quick adjustment is not possible with step output.

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 = approx. -5%*
W	0...100.0%	0...100.0%	Set point	*
Y	-2.4...102.4% 0...100.0%		Output variable	In manual mode ($Y \geq 0$ mA) In automatic mode
D	-100.0...100.0%		Set point difference	$D = W_E - W_I$
G1	-199.9...199.9%	100.0%	Alarm value	*
G2	-199.9...199.9%	0.0%	Alarm value	*

* Other numerical ranges can be set.

Input and output assignment

	HK	HS	SS	VS	BS
E1	-	-	-	X	X
E2	Y_A	Y_R	W_E	W_E	W_E
A1	Y	20 mA	-	$E1 \cdot W$	$E1+/-W$
A2	-	-	W	W	W
Q00	Diagnosis				
Q01	G1	G1	-	G1	G1
Q02	G2	G2	-	G2	G2
Q03	-	Lower	-	-	-
Q04	H	Raise	-	-	-

E1, E2	Inputs 1 and 2
A1, A2	Outputs 1 and 2
Q00 - Q04	Binary outputs 0...04
W_E	External set point, ratio factor or bias
W	Current set point, ratio factor or bias
Y_R	Position feedback signal
Y	Controller output
Y_A	Controller output (automatic)
X	Input signal displayed as X with red pointer
G1, G2	Alarm values
H	Manual feedback signal

Field of application and unit construction 1 Installation

The Protronic PE process controller is used for the control functions fixed value and fixed value/cascade. Without modifying the hardware the PE controller can also be used as a step action controller for the control functions fixed value as a two-channel controller (cascade, override), as a programmer or as a manual station.

At the output is provided a continuous signal for the control of electro-pneumatic servo-drives or electrical power actuators.

Two analog displays with red and green luminous indicators enable the recognition of actual value and set point and the margin of the controlled variable from the range limits.

A four-digit numeric display is provided to permit precise readout and adjustment of measured value, set point and control parameters.

1.1 Selecting the mounting site

When selecting the mounting site bear in mind the permissible climatic and mechanical stipulations given in the Technical Data (see Appendix).

1.2 Mounting the unit case (Fig. 1.4)

1. Slide case into cutout (or rack field)
2. Slide collar over case (not for rack mounting)
3. Mount shell halves
4. Fasten screws evenly and not too tightly (approx. 0.3 Nm)

When mounting units featuring increased EMC make sure that the panel has the same potential as the grounding conductor and that a conducting contact exists via the fasteners between the case and panel.

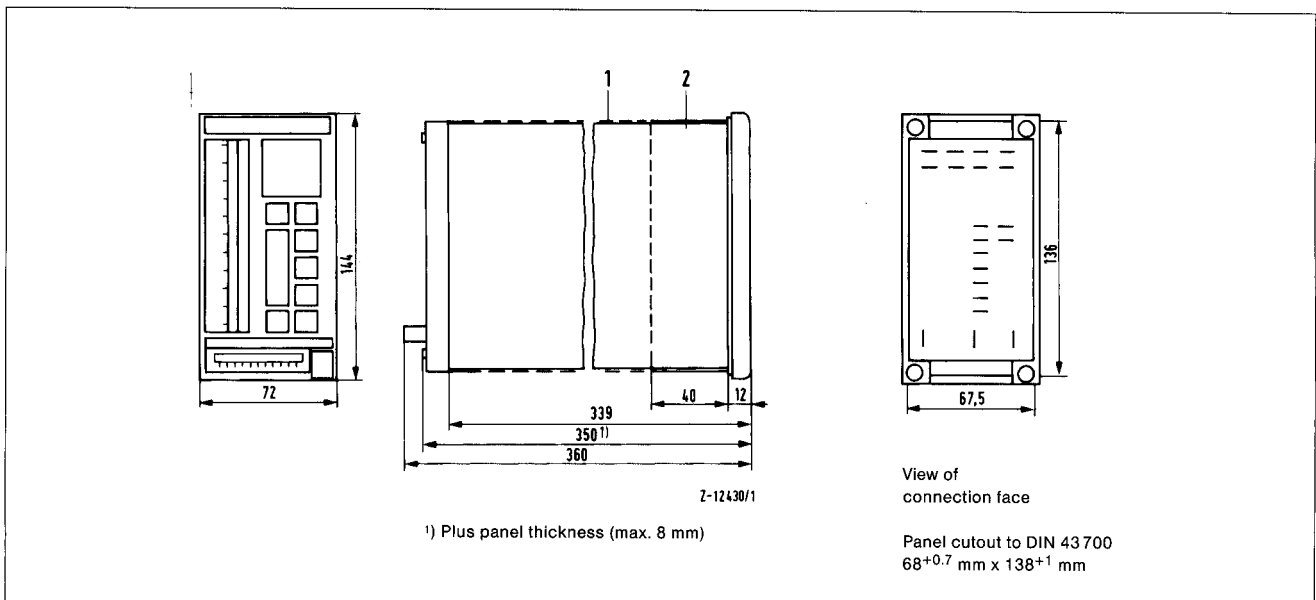


Fig. 1.3 Dimensional drawing (dimensions in mm)

1 = Mounting shell

2 = Collar for panel mounting
(not used for rack mounting)

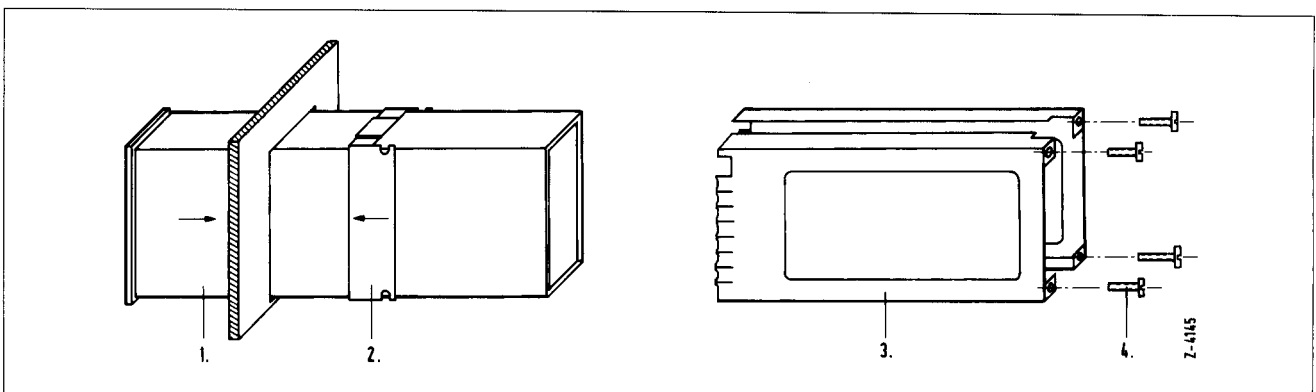


Fig. 1.4 Panel in rack mounting

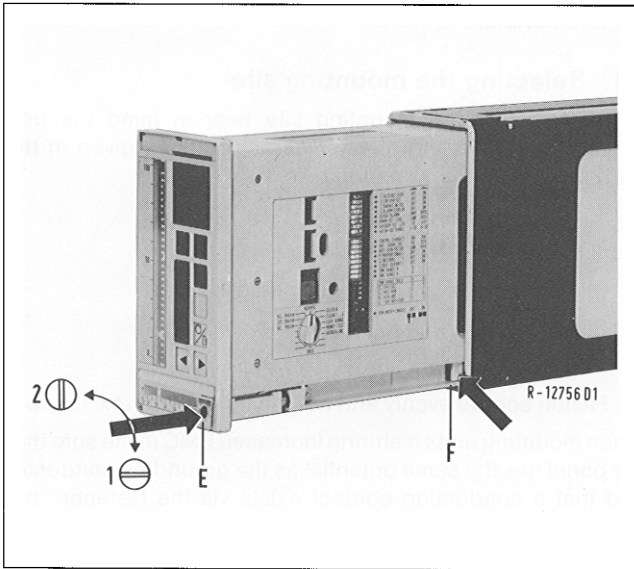


Fig. 1.5 Removal from the case

1.3 Connection and release of chassis, power supply module and case

(see Figs. 1.5 and 1.6)

Insertion into case slide-in unit for control electronics

1. Pull out flexible ribbon with plug (C) from case.
2. Insert power supply module (B) along the left case wall (D).
3. Insert plug (C) into socket plug (C1) at the mother board (A) and close locking lever
4. Insert modules completely into case and turn locking screw (E) clockwise.

Removal from the case

Warning!

If the controller has to remain in operation, follow the safety prescriptions acc. to Section 6.1 strictly.

1. Unlock locking screw (E).
2. Withdraw unit from the case as far as the limit stop.
3. Push limit stop (F) to the back and pull the module control electronics completely out of the case.
4. Open locking lever at socket (C1) and remove plug.

Legend to the Figs. 1.5 and 1.6

- A Slide-in unit for control electronics
- B Power supply units
- C Flexible ribbon cable with connector
- C1 Plug-in socket
- D Case
- E Slide-in unit locking screw
 - 1 Lock
 - 2 Unlock
- F Slide-in unit limit stop
- G Dimmer for brightness adjustment
 - Dimmer A Analog display
 - Dimmer B Digital display

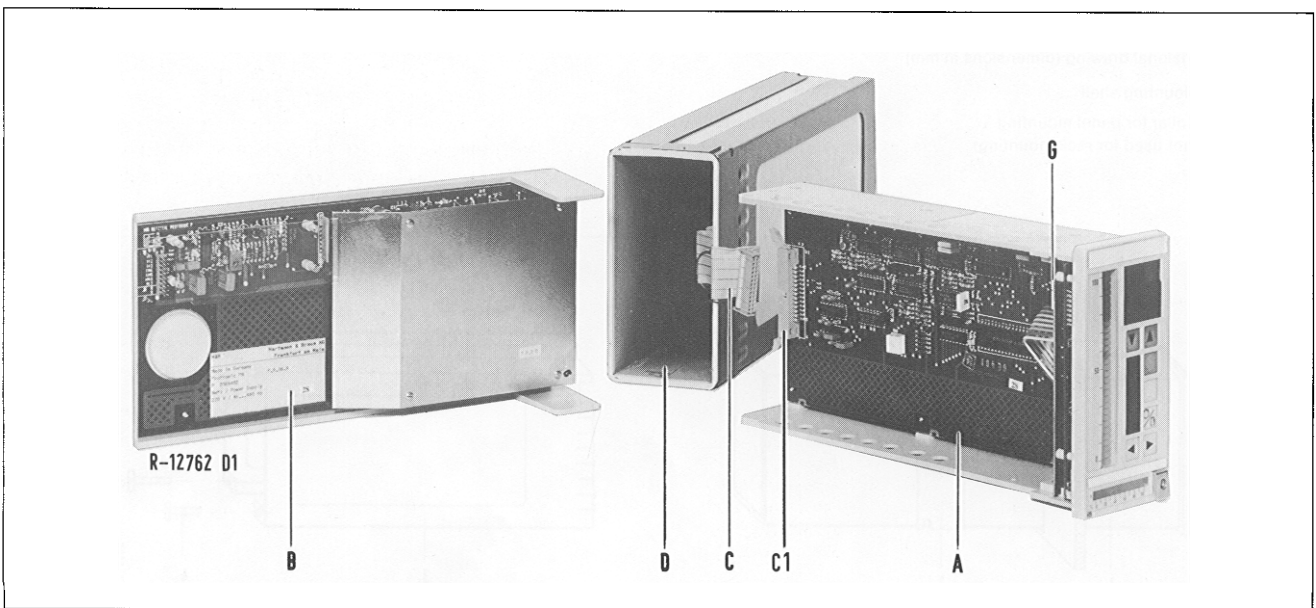


Fig. 1.6 Subdivision into modules

1.4 Connecting the unit

When selecting and installing the connecting cables please observe the regulations for electric power installations with nominal operating voltages up to 1000 V (DIN VDE 0100) or the respective local regulations.

As a protection against electric shocks connect the protective earth terminal (⊕) to a protective earth (PE) before any other connection is made.

The grounding conductor is also used to divert HF interferences. Hence provision should be made for it also with a power supply of 24 V (DC or AC).

It must be possible to switch off the power supply at two poles.

Connections are made with tab connectors A 6.3 x 0.8 mm or A 2.4 mm x 0.8 mm to DIN 46422 or pins 2.4 x 0.8 to DIN 41611 (see "Accessories and Spare Parts" in appendix).

Screw terminals (cat. No. 60604-4-0366627; each with 23 pcs.) are available optionally.

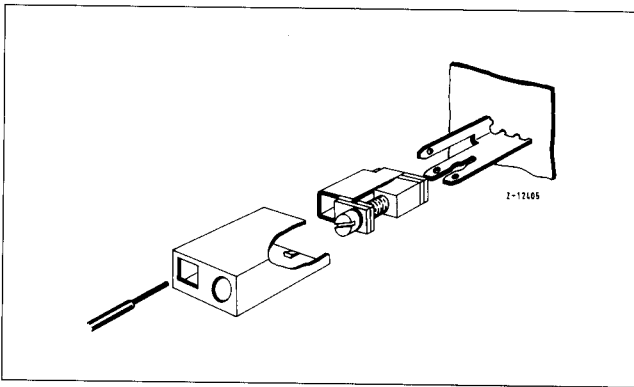


Fig. 1.7 Mounting the screw terminals

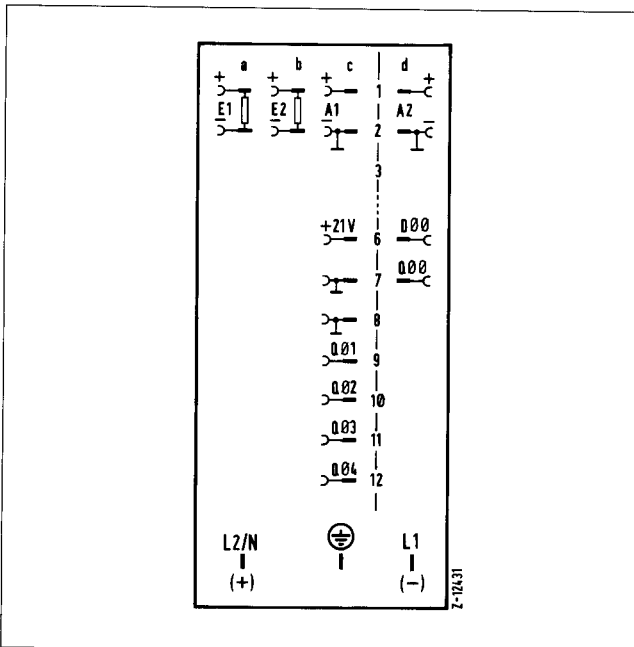


Fig. 1.8 Connection diagram
 E1 = X = controlled variable
 E2 = WE = external set point
 A1 = Y = output variable
 D = binary input
 Q = binary output
 D00 = forced manual mode
 Q00 = instrument fault
 L1; L2/N Power supply AC
 +; - Power supply DC
 ⊕ Protective earth connector

2 Commissioning

This apparatus shall be only operated when built in.

Caution!

Before switching on, make sure that the operating voltage given on the rating plate of the mains slide-in unit corresponds to the voltage of the power supply.

2.1 Display and manual control elements

Note

In the text which follows frequent reference is made to the display and manual control elements on the front panel as well as to the switches and keys located on the side of the control electronics slide-in unit.

The front view as well as the entire view of the operating side of the control electronics slide-in unit are reproduced on the front fold-out page (Fig. 1.1).

All display and manual control elements of control electronics slide-in unit are illustrated together with function specifications on the back fold-out page (Fig. 2.1).

It is recommended that these pages be opened out while reading the Operating Manual.

For the sake of brevity, in the following text the adjustment keys on the front panel are designated by their imprinted symbol (▼, ▲, ◀, ▶) or by a letter or a figure in parentheses identical with the reference numbers of Fig. 1.1.

The letters have the following meaning:

A = Automatic

H = Manual

H/A key = Key imprint

I/E = (10)

F key (multifunction key) = (18)



2.2 Setting the signal ranges

Switch	Position	Function
S 1/8	4 - 20 0 - 20	Signal range 4...20 mA Signal range 0...20 mA

These settings apply to all mA inputs and outputs. More information is given in the Configuration Instructions 42/62-63 EN.

2.3 Physical display

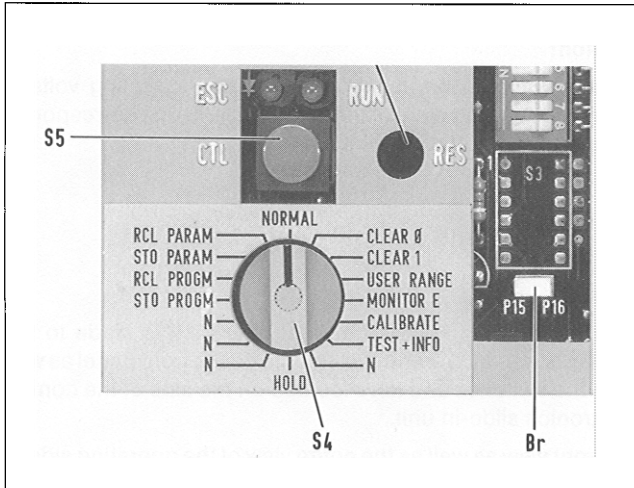


Fig. 2.2

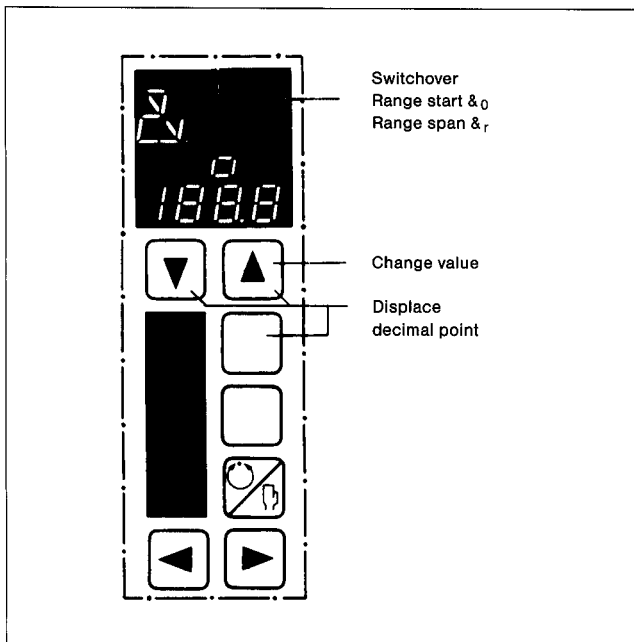


Fig. 2.3 User range

Apart from the display 0...100%, the physical display of a measured value is also possible.

1. Place jumper Br (see Fig. 2.2) horizontally, thus canceling the write protection.
2. Set switch S4 to position **USER RANGE**
3. Tip key S5, the code $\&_0$ range start or $\&_r$ range span (can be switched with key 3) appears on the digital display.
4. Move the decimal point to the position to be modified **simultaneously** with key 10 and ∇ or \blacktriangle .
5. Set desired values values with ∇ or \blacktriangle
6. Turn switch S4 to **NORMAL** position
7. Tip key S5

The display range is valid for X, W, G1, G2, WH, WL, X0, X1, for both channels if applicable.

2.4 Manual characteristic

2.4.1 Continuous controller

Switch	Position	Function
S 1/7	20	Key: \blacktriangleright Output increases to 20 mA Display to 100 %
	4/0	Key: \blacktriangleright Output decreases to 4/0 mA Display increases to 100 %

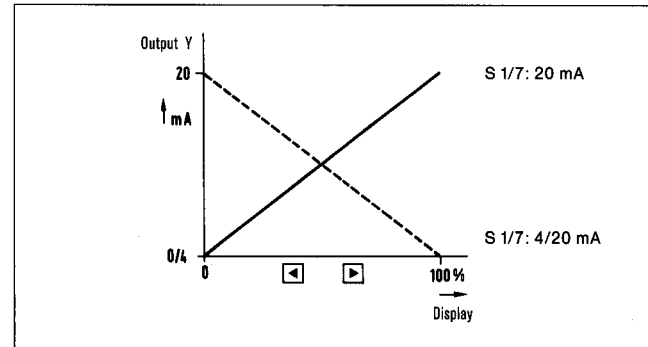


Fig. 2.4 Characteristic

2.4.2 Step action controller

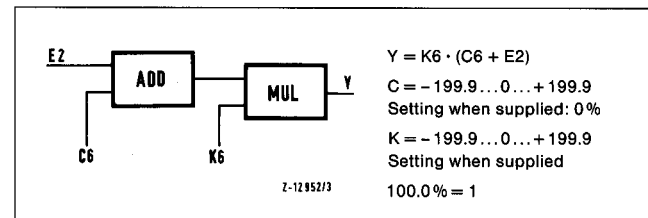


Fig. 2.5 Input weighting

The manual characteristic is determined by means of the wiring method used, with the result that on actuating the key \blacktriangleright the positioning signal behind the drive increases. The display Y depends on the wiring, the position feedback signal and the position of switch S 1/7.

The output variable display 0...100 % is adapted to the current correcting range using the setting values K6 and C6. These settings are called in the digital display by **simultaneously** pressing key S5 and key S.

The adjustment is performed by first moving the drive to the zero position and then by adjusting the output variable display (17) to $Y = 0.0\%$ with C6.

Then repeat the adjustment with K6 for $Y = 100\%$ at the end position.

2.4.3 Three-point positioner

The three-point positioner is a special form of the step action controller. Its controlled variable is the output variable which has been reported back.

2.5 Automatic characteristic

Switch	Position	Function
S 2/1	INV	Falling output signal with increasing controlled variable
	DIR	Increasing output signal with increasing controlled variable

2.6 Parameter definition

In the large or small loop the following values are shown on the digital in accordance with the setting of switch S 1/2.

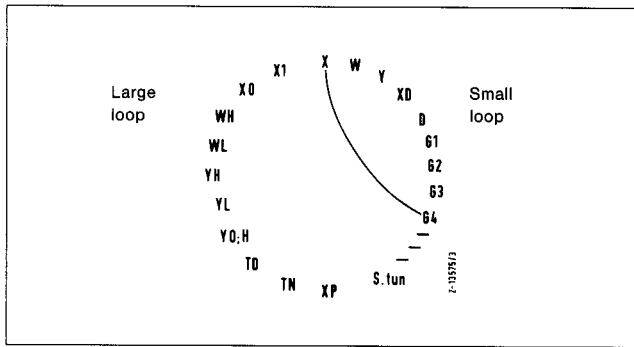


Fig. 2.6 Display loop

Switch	Position	Function
S 1/2	OFF	Small display loop
	ON	Large display loop

XP Proportional range 1 ... 1850 %
In the step action controller, the effective proportional range X_P^* is a function of the effective run time T_y of the servodrive:

$$X_P^* = \frac{T_y}{60s} \cdot X_P$$

TN Integral action time

TD Derivate action time $T_n, T_d = 0$ corresponds to 0.1 s.

The time range is selected with the keys S 2/7 and S 2/8.

S 2/7	S 2/8	Time ranges
0	0	0 ... 1999 s ¹
1	0	0 ... 1999.9 min
0	1	0 ... 19.99 h
1	1	0 ... 1.999 · 1000 h

The differentiation and derivative gain are determined with switches S2/2 or S2/3.

Switch	Position	Function
S 2/2	PV	Differentiation of the controlled variable X
	DEV	Differentiation of the controlled deviation X_w
S 2/3	LOW	Derivative gain $V_D = 1$
	HIGH	Derivative gain $V_D = 4^1$

¹ Delivery status

Y0 Operating point (not in step action controller)
 Y_0 is at 50 % for the PI(D) controller.

H Dead band (with the step action controller)
The dead band applies only to the P channel. The component I is also active within this band up to an internal dead band of ± 0.1 %.
The positioning limits are effective only in automatic operation and can be overranged in manual operation.

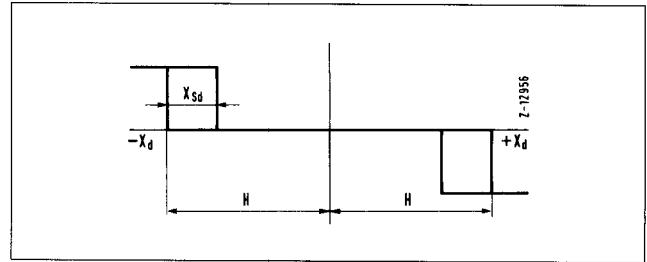


Fig. 2.7 Dead band of the step action controller

YL Lower limit, output variable
YL must be $< Y$ in step action controllers without feedback signal.

YH Upper limit, output variable

WL Lower limit, setpoint

WH Upper limit, setpoint

X0 Minimum value X, non-return pointer reset with CLEAR 0 (1)

X1 Maximum value X, non-return pointer reset with CLEAR 0 (1)

2.7 Alarm values

Switch	Position	Function
S 1/5	UNIP	G3, G4 with sign
	BIPOI	G3, G4 without sign
S 1/6	LOW	Quiescent current signalling
	HIGH	Operating current signalling

G1 Max. alarm value X

G2 Min. alarm value X

G3 Min. alarm value X_d

G4 Max. alarm value X_d

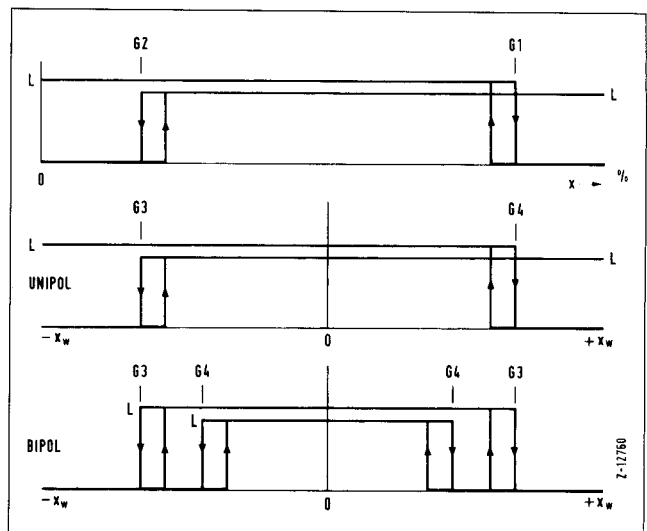


Fig. 2.8 Quiescent current signalling
L = output transistor has low impedance (conducting)

2.8 Self-parameter definition

The function "self-parameter" definition is disabled in devices with the following standard configurations:

- Cascade
- Override
- All control functions with the input signal connections "multicomponents" and "ratio".

The self-parameter definition is only activated for the channel displayed.

Preparation:

Bring the control loop manually to the vicinity of the envisaged operating point (setpoint).

The self-parameter definition can only be selected in the large display loop (key 3, enable with key S 1/2).

Display	Meaning
S.tun	Flashes in display 7 Start: Press ▼ and ▲ simultaneously
d.St.P	Flashes in display 7

Initial self-parameter definition:

1. From display <d.St.P> within 3 s, parameters acc. to Table 2.1
2. Select with key 3
3. Adjust with ▼ or ▲

Display	Meaning	Preset to							
T _r	Scanning interval	0.4 s							
	<table border="1"> <thead> <tr> <th>Switch</th> <th>Position</th> <th>Function</th> </tr> </thead> <tbody> <tr> <td>S2/8</td> <td>0</td> <td>0.4 .. 51.2 min</td> </tr> <tr> <td>S2/8</td> <td>1</td> <td>1.8 ... 14.4 h</td> </tr> </tbody> </table> <p>Select T_r such that after the control jump a noticeable change can be seen in the controlled variable (5-10%) within T_r.</p>		Switch	Position	Function	S2/8	0	0.4 .. 51.2 min	S2/8
Switch	Position	Function							
S2/8	0	0.4 .. 51.2 min							
S2/8	1	1.8 ... 14.4 h							
n	Number or repeats	1							
F _p	Parameter factor for X _p , T _n , T _d	100%							
b _n	Tolerance band for superimposed ripple	0.5%							
'P _H	Maximum value for X _p	1850							
'P _L	Minimum value for X _p	0							
'n _H	Maximum value for T _n	1999							
'n _L	Minimum value for T _n	0							
'd _H	Maximum value for T _d	1999							
'd _L	Minimum value for T _d	0							
e _H	Maximum value for analog inputs	100%							
e _L	Minimum value for analog inputs	0%							

Display	Meaning
Δ Y	Flashes in display 7 Modification of value (▼ or ▲) and sign (key 10) possible
Sc. 00 ... Sc. FF	is effected at scanning rate

The mean values of the control parameters are presented in the display for manual transfer (key 10).

Display	Meaning
'P ₋	Average X _p value
'n ₋	Average T _n value
'd ₋	Average T _d value

■ Abort: Key 3 and 18 **jointly** or S 5

Error messages

Display	Meaning
Er.tA	Amplitude too low
Er.tC	Controller structure neither PI nor PID
Er.tE	Alarm value for input signal infringed
Er.tF	Curve form of the step response cannot be analyzed
Er.ti	Wrong controller characteristic
Er.tP	Inconsistent parameter input
Er.tr	Time range neither xxxx s nor xx.xx h
Er.tS	Write protection impeded, parameter transfer
Er.tt	Scanning time range too small
Er.tt.	Scanning time range too big
Er.ty	Correction amplitude (y + Δy) > 100% or < 0%

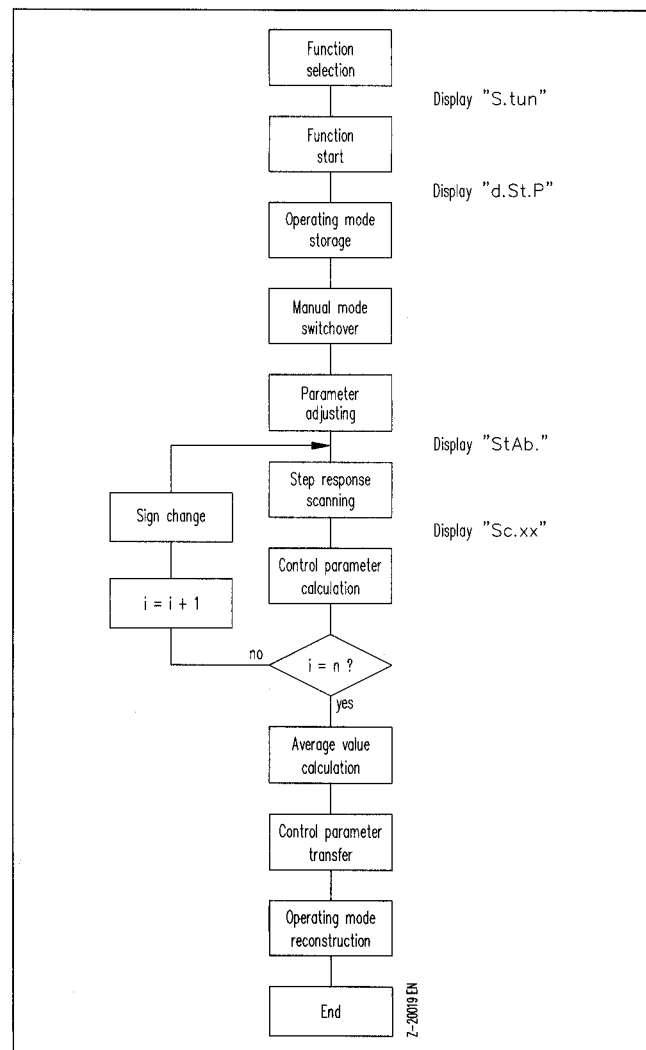
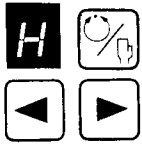


Fig. 2.9 Sequence diagram of the selftune function

3 Operation

3.1 Manual operation



The output signal Y can always be adjusted if the device is in the **manual** mode.

Continuous controller



1. Slow modification by **tipping** ◀ or ▶
 - Quick modification by **holding** ◀ or ▶
 - Quick adjustment to 0% by **holding** ◀ and **tipping** H/A
 - Quick adjustment to 100% by **holding** ▶ and **tipping** H/A
2. Display of the current value by **holding** ◀ and ▶



Step action controller



- Raise: Tip ▶ (output Q04)
- Lower: Tip ◀ (output Q03)

The control pulses are shown in the status display (11).

The positioning speed is constant and depends on the drive.

3.2 Setpoint adjustment



1. Select the setpoint W in the identifying letter field (2) using key 3.



2. Change the internal setpoint by **tipping** ▼ or ▲



3. Select E = External (input E2) by **tipping** the I/E key (10). (not with the step action controller)

On switching over from **Internal** to **External** observe **D**; $D = W_E - W_I$.

Switchover E → I is bumpless

3.3 Automatic operation

Switchover is bumpless in both directions.



- Switchover from manual to automatic and vice versa by **tipping** H/A. The new mode is not active until the status display (11) stops flashing.

3.4 Two-channel controller

The same rules apply for the two-channel controller as for the single-channel controller.

- Select channel with the F key (18)
Channel display 1 or 2 via status display (11).



= Controller 1



= Controller 2

} Continuous controller



= Three-position step action controller

3.5 Cascade controller

- Switchover between master controller and slave controller with = F key (18)

The master controller (channel 1) is always in automatic operation.

Switchover to manual only affects the slave controller (channel 2) which is immediately displayed.

If switchover to channel 1 is effected in manual operation the flashing A indicates the continuation of the manual mode.



Controller 1, master controller
(always in automatic)



Controller 2, slave controller



Cascade open



Cascade closed

3.6 Override controller

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

- With the I/E key (10) in conjunction with the F key (18) an internal or external setpoint can be assigned to each controller.

The mode selector switch (12) only affects the master controller.

If switchover to channel 1 is effected in manual operation the flashing A indicates the continuation of the manual operation.

3.7 Programmer

3.7.1 Setting the program

The preconfigured programs have 7 program sections, i.e. a maximum of 8 amplitude values and 7 time values must be entered.

The amplitude values can be set in the User Range.

The distance between the kink points is given for each time adjustment.

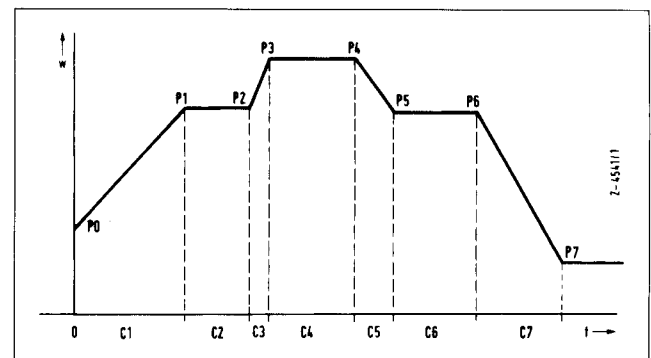


Fig. 3.1 Example of a program

The time scale can be changed via the auxiliary routine MC 001C (see Section 5.2).

The following applies:

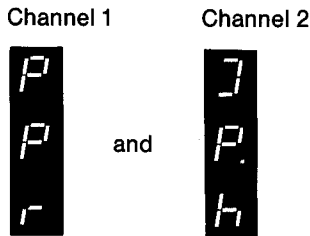
- 0 xxx.x Minutes
- 1 xx.xx Hours
- 2 x.xxx times 1000 hours
- 3 xxxx Seconds

Program Section 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

3.7.2 Channel switchover

Switchover is effected with key (18).

In the case of two-channel programmers the display switches between



If a "J" appears in the status display, switch over to "P" with key (10).

3.7.3 Displays

The following values are shown in the digital display field (4) for the programmer:

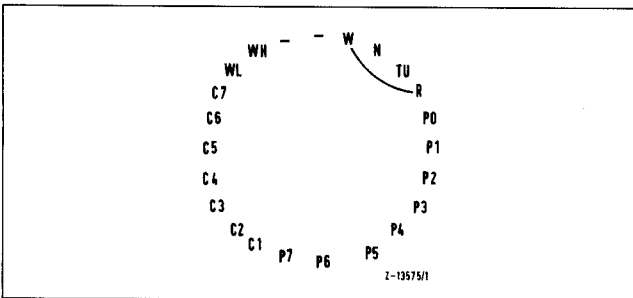


Fig. 3.2 Display loops of the programmer

- W Setpoint
- N Number of the currently processed section
- TU The time expired in the current section (0... 100% corresponding to the time C_x set for the section)
- R Loop counter (repeat counter)
- C_ Time settings
- P_ Amplitude settings

3.7.4 Operation



Tip program setpoint (10)

Internal

- Switchover P → J Last program setpoint
- Switchover J → P Current program setpoint

Channel switchover Tip F key (18)



Channel 1



Channel 2



Single run

Tip H/A

Repeat operation

Quick forward

Stop

In the STOP mode (manual):

- Reset: Hold ◀ and ▶
- Forwards: Tip ▶
- Backwards: Tip ◀
- Jump forwards: Hold ▶ and tip (12) (next restart point)
- Jump backwards: Hold ◀ and tip (12)

3.8 Program controller

Deviations vis-à-vis controller or programmer.

3.8.1 Displays

With program controllers only the small display loop changes as compared to controllers.

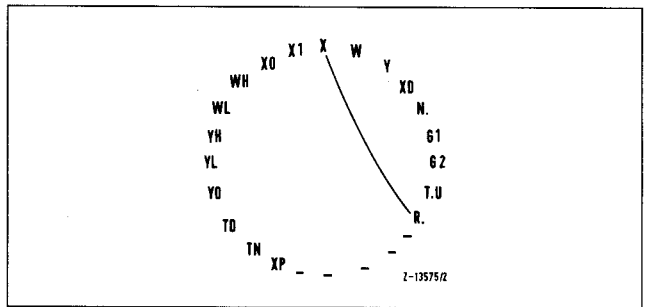


Fig. 3.3 Display loops of the program controller

- Call setting for C.1 to C.7 and P.0 to P.7: **Simultaneous** actuation of key S5 (in the control electronics slide-in unit) and of the displays selector switch (3) P... is displayed in %.
- Temporary display in Unser Range by **simultaneous** actuation of ▼ and ▲.

3.8.2 Channel switchover

- Channel switchover is effected with the F key (18)



Channel 1
Program controller

Channel 2
Programmer

3.9 Stations without control algorithm

3.9.1 Station displays

Indication	Function	Short designation
X	Measured variable	HK,HS,VS,BS
Y	Controller output	HK,HS
	Output variable	VS,BS
W	Setpoint	SS
	Ratio factor	VS
	Fixed value	BS
D	Difference ($W_E - W_I$)	SS,HS,VS,BS
G1	Alarm value, max. measured variable	HK,HS,VS,BS
G1	Alarm value, min. measured variable	HK,HS,VS,BS

Description

Manual station, continuous (HK)

Operation of the manual station with continuous output corresponds to the function manual operation with the continuous controller.

The setpoint display is switched off.

The manual/automatic transfer is disabled via switch S 1/3 (on the control electronics slide-in unit) on delivery. If this transfer is enabled, the signal applied to input 2 is switched to the output when switching over to automatic mode.

Manual station, step action output (HS)

The operation corresponds to the function manual operation of a step action controller.

Set point station (SS)

The set point is set as in the controller mode and is indicated by the green luminous cursor and in the digital display.

After enabling with switch S 1/3 it is possible to switch over to an external set point.

The signal applied to input 2 is switched to the output.

Ratio station (VS)

With the ratio station it is possible to multiply the measured variable (red cursor) with a ratio factor ($Y = X \cdot W$).

The ratio factor W is indicated via the green cursor and in the digital display. By enabling with switch S 1/3 an external value can also be used.

Bias station (BS)

With the bias station it is possible to add a fixed value to the measured variable (X) ($Y = E1 \pm W$).

The sign can be changed with the switch S 2/2.

By enabling with switch S 1/3 an external value can also be used.

3.9.2 Function of the inputs and outputs

	Station designation				
	HK	HS	SS	VS	BS
E1	-	-	-	X	X
E2	Y_A	Y_R	W_E	W_E	W_E
A1	Y	20 mA	-	$E1 \cdot W$	$E1 \pm W$
A2	-	-	W	W	W
Q00	Diagnosis				
Q01	G1	G1	-	G1	G1
Q02	G2	G2	-	G2	G2
Q03	-	Lower	-	-	-
Q04	H	Raise	-	-	-

A1; A2 Outputs 1 and 2

E1; E2 Inputs 1 and 2

G1; G2 Alarm values

H Manual feedback signal

Q00...Q04 Binary outputs 0...4

W_E External set point; ratio factor or bias

X Input signal displayed as X with red cursor

Y Controller output

Y_A Controller output (automatic)

Y_R Position feedback signal

4 Self-monitoring reports

Battery monitoring

If the battery voltage is too low, the message **Er.bA** is displayed (Error battery).

If this message appears the instrument remains capable of operation. However, the battery must soon be changed (see section 6.2).

Power supply monitoring

If the instrument is operating on power below the permitted tolerance (see Technical Data), the warning **Er.LP** (Error low power) appears. The Y displays flashes.

As 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 permitted tolerance range.

Hardware monitoring

If one of the following faults is diagnosed in the instrument during self-monitoring

Er.PU }
Er.CO }
Er.C5 } (see Section 5.3)
Er.EL }
Er.I1 }

the controller sets output Q00 to "low" and displays this as hardware fault **Er.H.**

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. This will only succeed if write protection is not set. After loading (re-initialization) the controller displays the message **Er.00** and goes to "manual".

The error message is acknowledged by operating key H/A.

Write protection

If one attempts to write data onto the protected area while the write protection (jumper Br) is switched on, the controller reports **Er.nA**. This message must be acknowledged with H/A before making a new attempt with the write protection switched off (jumper Br horizontal).

Alarm values

Overshooting of an alarm value is indicated by the flashing of a red cursor.

Enable with S 1/4 (control electronics slide-in unit).

Output variable

Flashing of the output variable display (17) points to an interruption of the control circuit or to a fault in the vicinity of the output DA converter.

5 Test routines and auxiliary routines

The instrument contains test routines which assist testing in case of a fault.

During the entire test run the controller remains in the operating mode previously set.

The controller tests 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 likewise set to "low" with "Hold" and if an error exists acc. to Section 5.3 (with the exception of Er.bA and Er.EC).

5.1 Calling

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

The flow chart below shows which keys must be operated in accordance with the display.

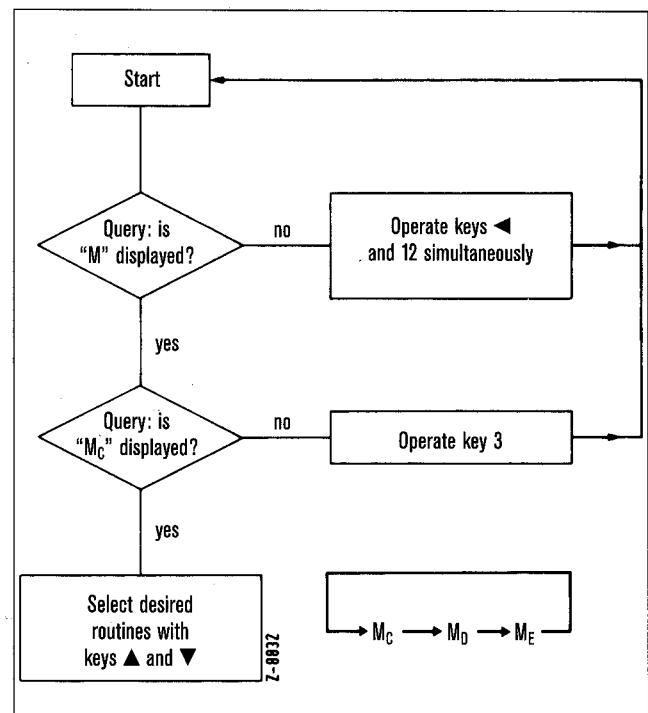


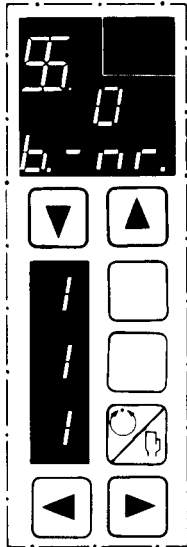
Fig. 5.1 Flow chart for calling test and auxiliary routines

1. Select routine M_C 00.. with \blacktriangledown or \blacktriangle . Only the decimal digit at which the decimal point is positioned as cursor can be changed.
2. Move cursor by **holding** (10) and **tipping** \blacktriangledown (to the right) or \blacktriangle (to the left).
3. Activate the routine with \blacktriangleright and (12).

5.2 Auxiliary routines

Address	Function	Explanation in Section
M _C 0010	Display or modification of the controller function	5.2.1
M _C 0011	Programmer: Call programs	5.2.2
M _C 0012	Store programs	5.2.3
M _C 0013	Table values TAO	5.2.2
M _C 001C	Variable list	7.2.3

5.2.1 Displaying or modifying the controller type M_C 0010



All standard functions are stored in the EPROM IC 15.

If the auxiliary routine M_C 0010 is called the status display shows (11) the current function read from top to bottom.

The function can be modified with the keys 10, 18, 12.

Controller type/function	No.
Single-channel	
Continuous	100
Three-position step action	200
Two-channel	
Continuous ³	010
Cascade interconnection:	
Master controller,	
continuous slave controller ³	020
Override min. selection:	
Continuous master and slave controllers ³	030
Override max. selection:	
Continuous master and slave controllers ³	040
Time-schedule controller	
Continuous, fixed value ³	050
Continuous, ratio ³	060
Time-scheduler	
Single-channel	300
Two-channel ³	070
Manual station	
Continuous ¹	400
Step action output ¹	500
Setpoint station¹	600
Ratio station¹	700
Bias station¹	800
Three-point positioner²	900

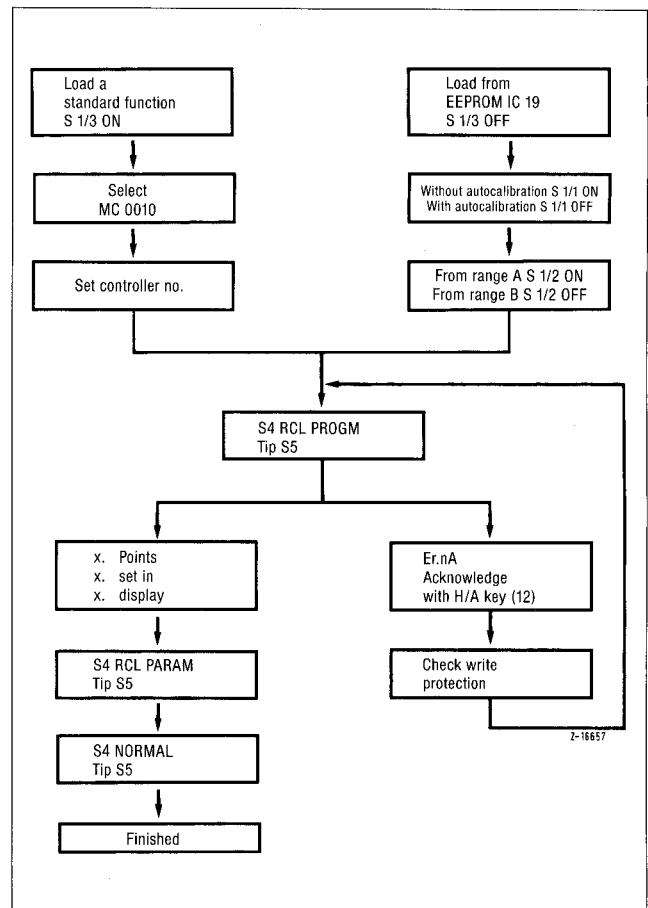


Fig. 5.2 Loading a standard function

Write protection

The write protection facility protects the configuration and the User Range settings against inadvertent overwriting with RCL PROG.

The plug-in jumper Br acts as write protection (see Fig. 2.1).

If the jumper is open (fitted vertically) the parameters can be changed but cannot be stored in the protected areas.

¹ As per software dated April 1986

² As per software dated April 1987

³ As per software dated April 1991

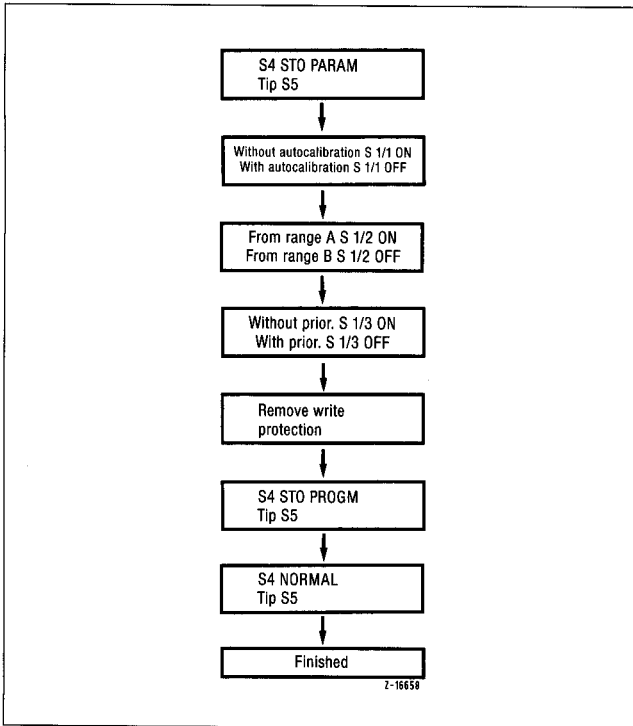


Fig. 5.3 Storing configurations in the EEPROM (IC 19)

5.2.2 Programmer

Call programs M_C0011

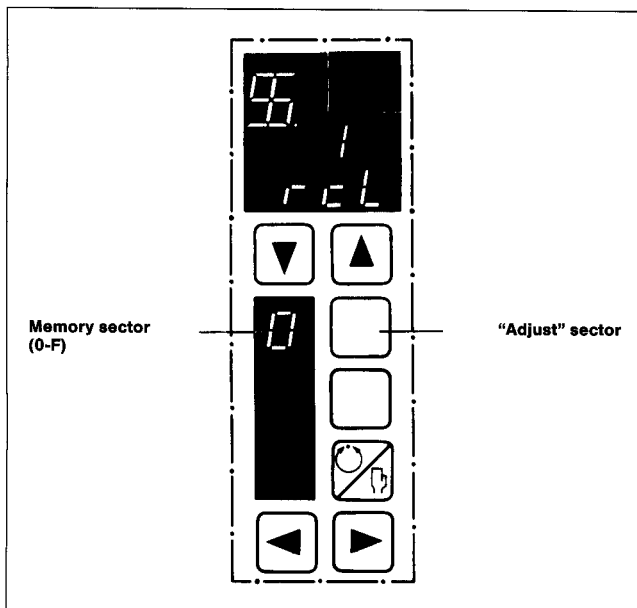


Fig. 5.4

The following operational steps must be taken for loading:

Switch or key	Range A	EEPROM	Range B
S1/2	ON		OFF
10	0...F Selection of the desired sector		
S4	RCL PROGM		
S5	Actuate		
S4	RCL PARAM		
S5	Actuate		

The loading procedure has been completed if the sector display increases by 1 and is displayed with a point.

- If other program parts are to be loaded, press key 5 if the program part(s) still to be loaded has (have) been stored in the next sector.
- Effect RESET after loading a program (see Section 3.7.3).

Storing programs M_C 0012

The set values of a program can only be stored if they have been transferred to the protectable area, after being set.

A maximum of twice 16 programs, each with 17 sections, can be stored in the EEPROM, i.e. the data of 7 sections can be stored in each memory sector.

If the program features more than 7 sections fewer programs can be stored accordingly. Sectors which have only been partially utilized cannot be used for other programs.

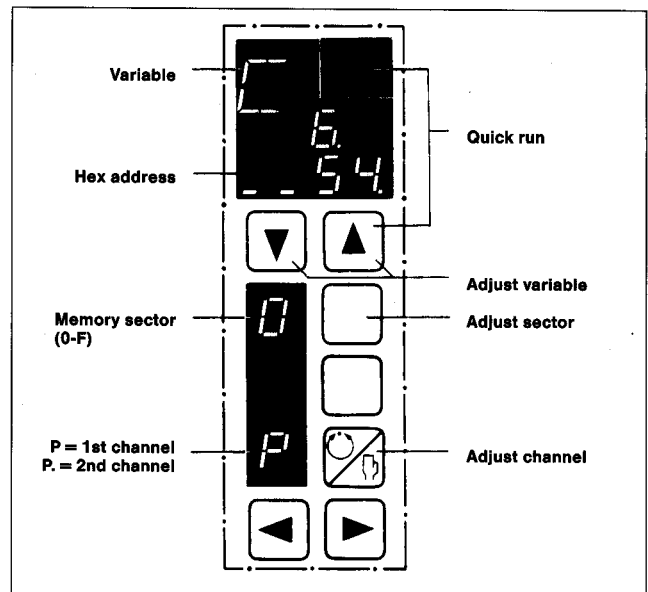


Fig. 5.5

The following operational steps must be taken for storing:

Switch or key	Range A	EEPROM	Range B
S4	STO PARAM		
S5	Actuate		
S1/2	ON		OFF
10	0...F Select an unoccupied sector		
S4	STO PROGRM		
S5	Actuate		

Now the variable currently stored is displayed in the digital display (4).

The saving process has been completed when the sector display increases by 1 and is displayed with a point.

- If other program data of the same program are to be stored, actuate key S5.
- If no further data are to be stored, the device reports "Er.nA" after pressing S5.
- Acknowledge message with key 12.

5.2.3 Table values TAO M_C 0013

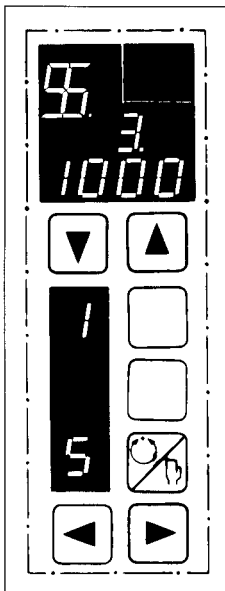


Fig. 5.6

The linearization function TAO can be used in special configurations.

- The digital display shows the value set for the restart point.
- The number of the restart point is read from the status display (11) and modified with key (12).
- The value itself is set with ◀ and ▶.

5.2.4 Variable list M_C 001C

The variable names which are possible are shown in the digital display.

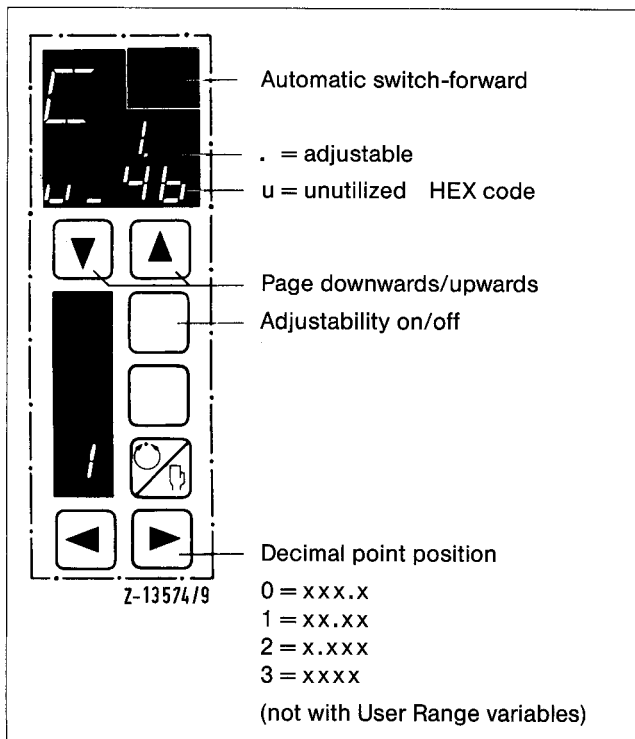


Fig. 5.7

5.3 Test routines

Adress	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 (2000H-3FFFH)	C3.nE	Er.C3
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 ¹	EC.nE	Er.EC
M _C 0006	Battery check	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 000A	Output monitor	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 000F	EEPROM (see Section 3.1)	FC.nE	Er.FC

¹ If the write protection is switched on an error message "Er-EC" ensues without an error being actually present, as a check is hindered by the write protection.

Address	Function	Explanation in
M _C 0016	Cycles per second	5.3.2
M _C 0017	Switch test	5.3.3
M _C 0018	Binary inputs	5.3.4
M _C 0019	Status EPROM C0	5.3.5
M _C 001B	Status EPROM IC 15	5.3.5
M _C 001D	Configuration data	5.3.6
M _C 001E	Auto-manual unit test	5.3.7
M _C 001F	Watch dog test	5.3.8

For a quicker check, after activation of the first test routine one can switch forward to any existing error by **simultaneously** pressing ◀ and ▶ (M_C 0000 to M_C 000F).

The diagnostic routines are switched off by **simultaneously** pressing ◀ and (12).

5.3.1 EEPROM test M_C 000F

C000 appears in the digital display after calling the test routine.

The test lasts about 1.5 minutes. The figures shown in the digital display indicate the address being currently checked.

- Start with ▲
- Abort with key (12).

5.3.2 Cycles per second M_C 0016

The number shown in the digital display shows the number of cycles per second. This number fluctuates somewhat as not all self-test routines are run in every cycle.

The cycle time is calculated as follows:

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

5.3.3 Switch test M_C 0017

This test program permits testing of all internal switches.

- Actuate S1 or S2 acc. to Table 5.3
Observe change in the digital display (7)
- Turn switch S4 clockwise, beginning at the "HOLD" position.
The figures 0 to F are shown in the status display (11) (HEX).

Switch S1 8765 4321	Switch 2 8765 4321	Display ¹
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

¹ 1 = On; 0 = Off

5.3.4 Binary inputs M_C 0018



If the decimal points illustrated are visible, the input D00 is logical 1.

5.3.5 EPROM identifier M_C 0019/1A/1B

Routine M_C 0019 reproduces the software status of address area 0000 to 0FFF.

The production date of the software is stored in the format "calendarweek.year", e.g. "22.84".

The routine M_C 001B shows the status of IC 15.

Note

Module IC 14 is not present. The controller reports **no.IC** for the routine M_C 001A.

5.3.6 Configuration data M_C 001d

e.g.

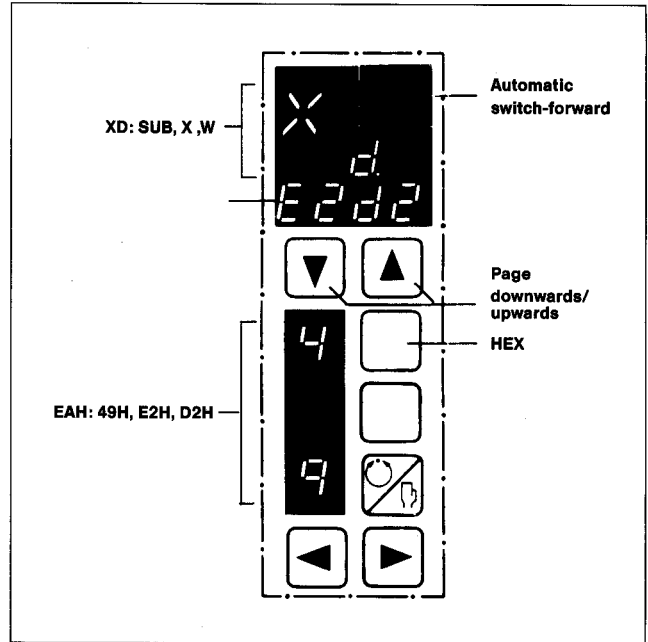


Fig. 5.8

5.3.7 Auto-manual unit test M_C 001E

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

- Operation of one of keys ▼ or ▲ results in all LEDs and all luminous segments of the displays being driven in succession.
- If key (3) is pressed in addition, switch-forward is automatic.

The following luminous text is visible in the digital display:

„Protronic PE xx.xx.x.x“.

The last field shows the date of software.

- Pressing the keys illustrated nearby causes the assigned segment of the 16-segment display to extinguish. During the test it suffices to observe whether one segment extinguishes at a key press.

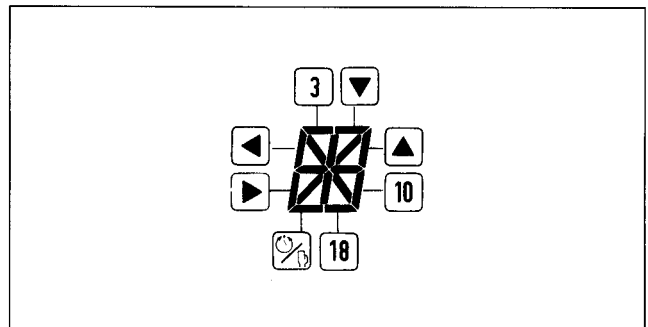


Fig. 5.9

5.3.8 Watchdog M_C 001F

This routine shows the longest time after which a fault is detected in the instrument. The time constant is determined by analog components and can therefore vary between individual instruments from approx. 65 to 130 ms. However, the time constant of an instrument must almost be constant.

5.4 Changing the software

The controller Protronic PE contains in its memory all functional modules of the more extensive Controller Protronic PS. For special applications these functions can be incorporated into the program via the monitor function.

In the case of older devices (without (E)EPROM IC 19) one should bear in mind that these program modifications are stored only in the RAM with battery backup and that they can be lost while replacing a battery. The configuration is described in the Configuration Instructions 42/62-63-.. EN.

5.4.1 Selecting a memory address M_E

- Turn switch S4 to MONIT+TEST
- Operate key S5.

Very different displays of the functions which have been last called may now appear in the digital display (7).

The diagram (Fig. 5.10) below shows which keys should be operated depending on the display.

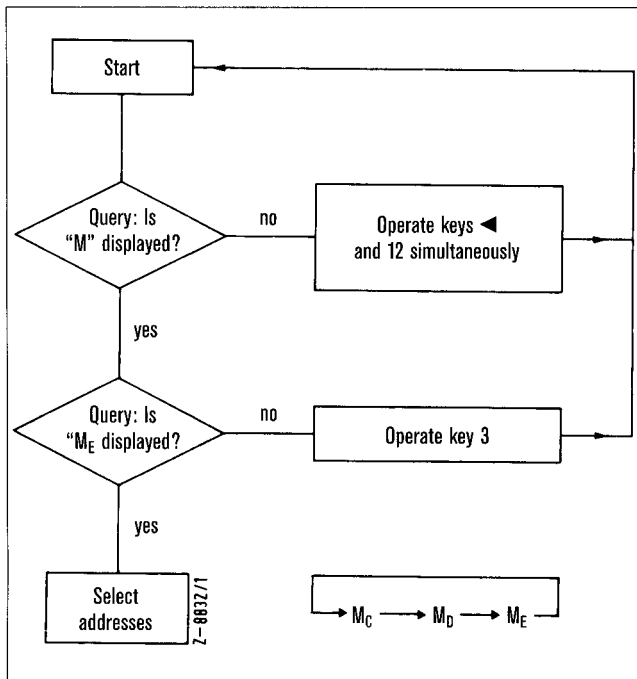


Fig. 5.10 Flow chart for setting memory addresses

- Select address: \blacktriangledown or \blacktriangle .
Only the digits can be altered at which the decimal point is currently located as cursor.
- This cursor is moved by pressing key (10) and one of the keys \blacktriangledown or \blacktriangle .
Key \blacktriangle moves the cursor to the left, \blacktriangledown to the right.

5.4.2 Changing the memory contents

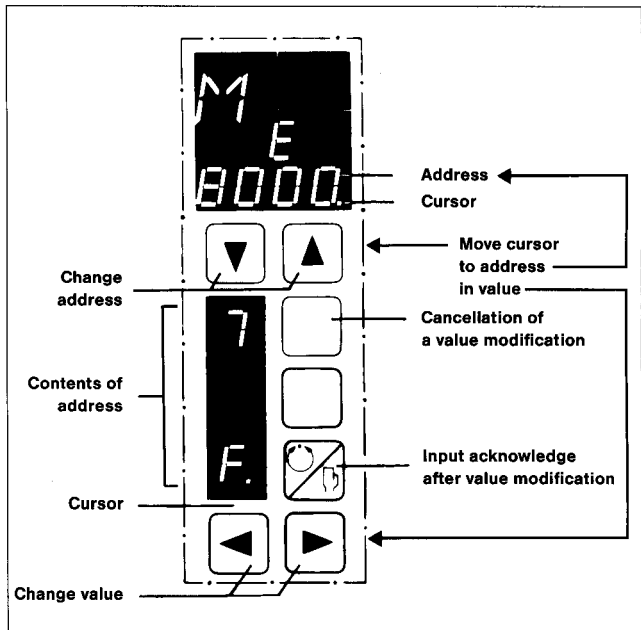


Fig. 5.11

5.5 Conversion to voltage input

The inputs E1 and E2 can be converted by replugging jumpers 0(0.2) ... 1V DC or 0(2) ... 10V DC.

- Switch off the controller at two poles.
- Remove the control electronics and power supply unit from the case (see Section 1.3).
- Undo the rear panel. Now the plug-in jumpers are accessible on the circuit (see Fig. 5.12).
- Replug jumpers (see Fig. 5.12).
- Assemble the device

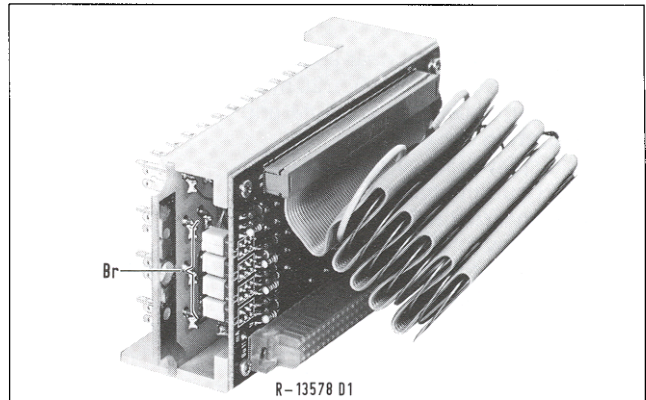


Fig. 5.12 Position of the plug-in jumpers

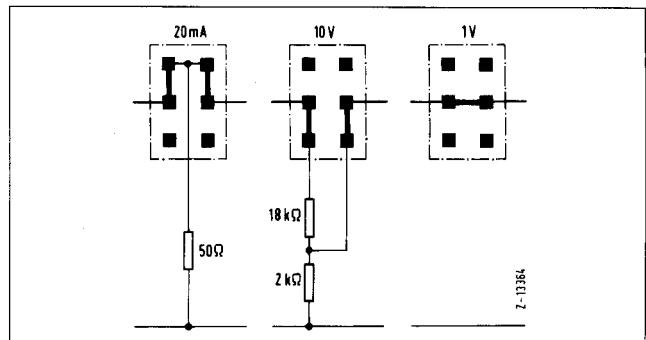


Fig. 5.13 Converting the voltage inputs E1 and E2

5.6 Calibration

The instrument allows limited calibration of inputs and outputs per software.

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.

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 12).

Test equipment with the following facilities is required in addition:

Current source
Ammeter,
both high precision, e.g. H&B Kompavi 10.

Procedure:

1. Set switch S4 to **AUTOCAL** position
2. and operate switch S5
The controller will now display the following:
3. **Calibrating the inputs**
 - 3.1 Select the input channel to be calibrated
 - 3.2 Switch to lower range value
 - 3.3 Set signal range 0...20 mA
 - 3.4 Feed in 1.000 mA at the relevant input
 - 3.5 Set coarse and fine adjustment to a value as close as possible above 0050.
0050 should be read as 5.0%.
The position of the decimal point is immaterial
 - 3.6 Repeat from 3.3 with signal range 0...20 mA
Feed in 4.000 mA, display 0000
 - 3.7 Switch display to upper range value
 - 3.8 Feed in 19.999 or 20.00 mA (19.999 is more precise than 20.00)
 - 3.9 Fine adjustment as near as possible to 1000 (= 100%)
 - 3.10 Switch to signal range 0...20 mA and, if necessary, take the mean between 0...20 mA and 4...20 mA
4. **Calibrating the outputs**
 - 4.1 Set display to lower range value
 - 4.2 Select output channel
 - 4.3 Set signal range 0...20 mA
 - 4.4 Set display to 0050 = 5.0%)
 - 4.5 Measure output current externally; it should be approx. 1 mA
 - 4.6 Set coarse adjustment as close as possible below or at 1.000 mA.
Then fine adjustment to 1.000 mA
 - 4.7 Repeat from 4.3 with signal range 4...20 mA.
Setting 0000, output 4.000 mA
 - 4.8 Switch display to upper range value and adjust to 1000
 - 4.9 Measure output current externally, value should be approx. 20 mA
 - 4.10 Fine adjustment to 19.999 (20.00) mA
 - 4.11 Switch over to signal range 0...20 mA and, if necessary, take the mean between 0...20 mA and 4...20 mA

Note

Calibration is possible at other measuring points besides 0 and 100%.

If only one signal range is required, calibration of the other range may be omitted.

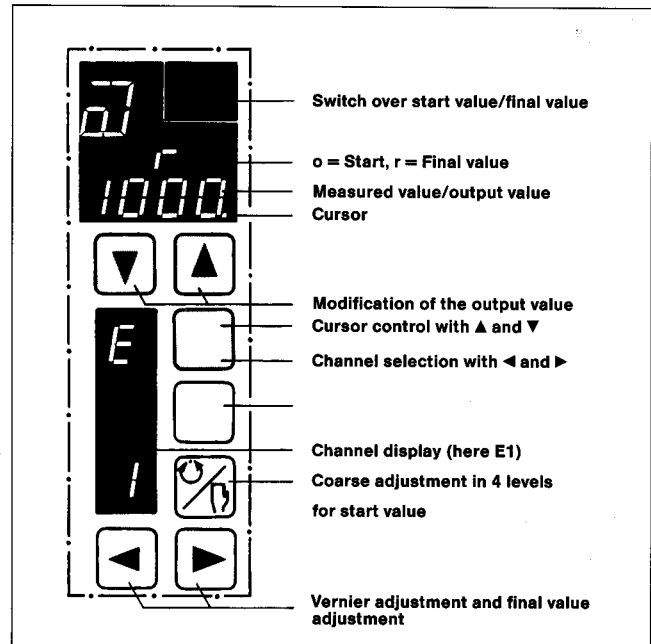


Fig. 5.14

5.7 Reinitialization

- Keep key S5 depressed and actuate key S6 thrice within on second.

The controller loads its old function from the EPROM or EEPROM (if stored with priority) and goes to manual. The parameters last set are still active.

The controller output goes to 0%.



- Er.00 appears in the digital display (acknowledge with key 12).

6 Maintenance

6.1 Safety instructions

Warning

Any interruption of the protective connector inside the unit or of the protective conductor outside the unit 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 except 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.

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.

Make sure that only fuses with the required rated current and of the specified type are used for replacement.

The use of makeshift fuses and short-circuiting of fuse-holders is prohibited.

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

It must be assumed that the protection has been impaired when

- the apparatus has visible signs of damage,
- the apparatus no longer functions,
- the apparatus has been stored in unfavorable conditions for a long time,
- the apparatus has been subjected to adverse transport conditions.

Servicing

The standard controller Protronic PE does not require any servicing.

Inspection

The controller disposes of various test routines which are described in detail in Section 5.3.

See Section 4 for reports from the self-monitoring.

6.2 Battery replacement

The battery can be replaced during operation. If the mains supply is maintained during the battery change all values in RAM are retained.

1. Pull out the control electronics slide-in unit (see Section 1.3)

See Fig. 1.2 for position of the battery (H).

2. After removing the two fastening screws the used battery can be replaced with a new one of the same type (see Spare Parts List in the Appendix). The coded pins ensure correct polarity.

Battery replacement after dismantling the controller



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 the site to the power supply of a spare instrument.

Dismantling the instrument:

1. Switch the instrument to "manual" and set a correction value which is not critical for the controlled system.
2. Switch controller to "HOLD" with S4 and activate this function with S5. The controller signals "HOLD". The control cycle is now interrupted and the correction values y1 and y2 are "frozen" in the analog output memories (drift rate $\leq 1\%$ per minute).
3. Withdraw the control electronics and replace battery (see battery replacement)
4. Reassemble the instrument
5. Change from "HOLD" to "NORMAL".
6. Press key 5.



The controller takes over the correction values which were last present in the memory and values remain at "manual".

If during this time the instrument was without both battery and power supply, the parameters and any modifications will have to be re-entered.

Appendix

Technical data

(Extract from Data Sheet 62-5.11 EN)

Input

Analog

2 x 4...20 mA switchable internally to 0...20 mA
 $R_e = 50 \Omega$ (built in to case), with electronic potential isolation
Permitted common-mode voltage ± 5 V
1st input for measured variable x
2nd input for external set point w_e

Voltage input

Inputs E1 and E2 can be converted with plug-in jumpers to 0(0,2)...1 V into approx. 60 k Ω or 0(2)...10 V into 20 k Ω

Transmitter supply

Supply voltage 21 V, I_{max} 65 mA, short-circuit proof, can also be used to activate the binary outputs.

Binary

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

Output

Analog

2 x 4...20 mA switchable internally to 0...20 mA
Output 1: output variable
Output 2: Set point
Permitted load 0...750 Ω
Effect of load: typically 0.1%/100 Ω

Characteristic

Output characteristic and controller characteristic adjustable separately

Binary

5 transistor outputs (open collector) with respect to reference (without electrical isolation) for max. 42 V, max. 50 mA

The control algorithm corresponds the following transfer function

$$F_{\text{continuous}} = \frac{1}{XP} \left(1 + \frac{1}{T_n \cdot p} + \frac{T_d \cdot p}{1 + T_d/V_d \cdot p} \right)$$

$$F_{\text{step controller}} = \frac{1}{XP} \left(1 + \frac{T_d \cdot p}{1 + T_d/V_d \cdot p} \right) \left(1 + \frac{1}{T_n \cdot p} \right)$$

leakage current when "off" < 0.1 mA
overvoltage proof for short durations up to 90 V
short-circuit proof for short durations via 10 Ω protective resistors

Diagnostics

Self monitoring
Binary output Q00:
Q00 = L: Unit in order, transistor conducting
Q00 = 0: Unit faulty, transistor blocked

Power supply

Input-clocked power supply unit with electrical isolation. Can be plugged into case independently of control electronics. Also contains analog memory, outputs and connection for service auto-manual unit.
Power consumption approx. 9 W/16 VA

Voltage ranges

Optionally

220 V AC (188 ... 264 V, 48... 400 Hz)
115 V AC (93.5... 140 V, 48... 400 Hz)
24 V AC/DC (18... 30 V DC or 20... 27 V AC, 48... 400 Hz)

Tolerances apply to approximately sinusoidal voltages.
Data specified for direct voltage including superimposed alternating voltage.

Fusing

Internal

220 V: Glass fuse cartridge T0.2 C DIN 41 662
115 V: Glass fuse cartridge T0.315 C DIN 41 662
24 V: Glass fuse cartridge T1.25 C DIN 41 662

Battery for RAM buffer

Type: VARTA (blue)
CR-1/3 N LF (3.4 V, LiCi)

Environmental capabilities

H&B climate group

2 (DIN 40 040, KWF)

Ambient temperature

0...+50 °C

Transportation and storage temperature

-25...+65 °C

Relative humidity

$\leq 75\%$ annual average, short duration 95%

Condensation

None

Mechanical capabilities

Test to

DIN 40 046 part 7/IEC 68-2-27
DIN IEC 68 part 2-6

Transport

shock 30g/11 ms
vibration 2g/ ± 10 mm/3... 150 Hz

in operation

vibration 2g/ ± 10 mm/3... 150 Hz
acc. to seismic capability class II to DIN 40 046 part 55

Case and mounting

Mounting orientation

Permissible inclination -30° to +30° in vertical panel

Electrical connections

Power supply:

Tab connectors A 6.3 mm x 0.8 mm

Signal leads:

Tab connectors DIN 46 244
A 6.3 mm x 0.8 mm or A 2.8 mm x 0.8 mm
and pins 2.4 mm x 0.8 mm for Maxi-Termi-Point (MTP) (clamp connection DIN 41 611 Part 4)
Optionally:
Screw terminals as accessory
(fitted during wiring)

Type of protection

Slide-in unit in case IP 40
Blade-type terminals and MTP IP 00
Screw terminals and power plug IP 20
to DIN 40050

Class of protection

I to VDE 0411

Insulation group

A to VDE 0110

Color

Front face and case pebble grey, RAL 7032
See Data Sheet 62-5.11 EN for other colors (Options)

Weight

Slide-in unit including power supply approx. 1.45 kg
Case approx. 2.1 kg

Approval certification for special application

The following approval certification have been issued for the PE compact controller:

1. Temperature controller according to DIN 3440, 07.84 edition.

DIN-tested; Reg.-No. TR 78488 S.

"The instrument can be used in accordance with DIN 3440 as part of a temperature control assembly when connected to temperature sensors or transmitters which fulfill DIN 3440 requirements and output standard signals".

Supplement No. 780.

Documentation:

VdTÜV (Federal German Inspectorate) Bulletin 784 on temperature,
H&B documentation No. 48/62-05 DIN.

2. Water level controllers according to VdTÜV Bulletins 100/1, 03.86 edition and 100/3, 09.76 edition on water levels.

Component No. TÜV, WSR.87-334 S.

"Controllers may be connected to a primary element or transmitters which output standard signals and whose components have been tested according to standard in VdTÜV Bulletins 100/1 and 100/3".

Supplementary No. 775.

Documentation:

VdTÜV Bulletin 334 on water levels,
H&B documentation No. 48/62-04 TÜV.

3. Germanischer Lloyd conformity test according to certificate No. 92 586 HH 3/85.

"Instrument of the same type are permitted for use on ships or other constructions with Germanischer Lloyd classification.



suitable for unqualified use within the framework of Germanischer Lloyd construction standards".

Supplementary No. 785.

Documentation:

GL certificate on conformity tests,
H&B documentation No. 48/62-01 GL.

When using controllers in the above mentioned fields of application, approvals and valid regulations as well as standards must be adhered to.

If the controller is designed and produced in accordance with approved standards, it will carry the component number associated with it on the rating plate of the slide-in unit (above).

Packing instructions

If the original packing is no longer available, the unit must be wrapped in an insulating air foil or corrugated board and packed in a sufficiently large crate lined with shock absorbing material (foamed material or similar) for the transportation. The thickness of cushioning must be adapted to the weight of the unit and to the mode of transport. The crate must be labeled "Fragile".

For overseas shipment the unit must additionally be sealed airtight in 0.2 mm thick polyethylene together with a desiccant (e.g. silica gel). The quantity of the desiccant must correspond to the packing volume and the probable duration of transportation (at least 3 months). Furthermore, for this type of shipment the crate should be lined with a double layer of kraft paper.

Accessories and spare parts

Accessories

	B-No.
Insulating sleeve (plastic)	92195-4-0454484
Tab connectors (0.5...1 mm ²)	92195-4-0542681
Tab connectors (0.75...2.5 mm ²)	92195-4-0538045
15 tab connectors with sleeve	60604-4-0801243

Spare parts are given in the following Spare Parts List. When ordering spare parts please quote the designation and the Catalog No. of the spare part. Always state the Serial No. inscribed on the rating plate as well as the Order No.

The designations in the Spare Parts List, the confirmation of order, the delivery note and the invoice may differ from the function-related names given to these parts in this Operating Manual.

The Catalog No. is the sole criterion.

Protronic P.

Spare Parts

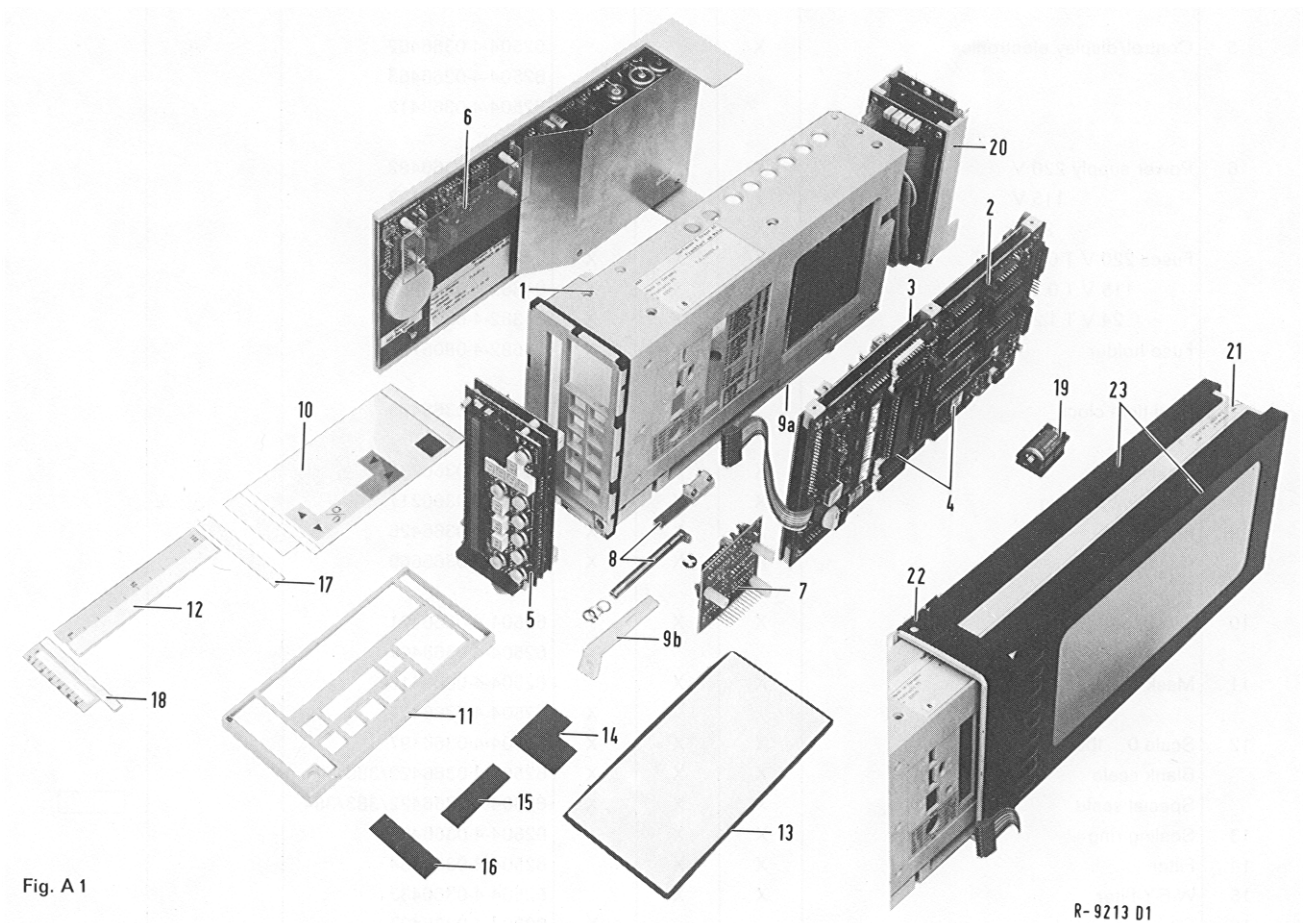


Fig. A 1

R- 9213 D1

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 (processor part with 11 MHz quartz) without program storage	X		X	62504-4-0342423		
	(processor part with 12 MHz quartz) without program storage		X		62504-4-0342429		
			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		62504-5-3100215		
	Program storage (EPROM) IC 15	X			62504-5-3100219		
				X	62504-5-3100212		
	Additional program storage for programmer IC 14		X		62504-5-3100229		
	Additional program storage IC 14		X		62504-5-3100296		
	Contronic P coupling						
	Program storage (EEPROM) without program	X	X		94682-4-0873094		
	Plug-in jumpers (also write protection)	X	X	X	94682-4-0806610		
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	94382-4-0865951		
	115 V T 0.315 A	X	X	X	94682-4-0865953		
	24 V T 1.25 A	X	X	X	94382-4-0804335		
	Fuse holder	X	X	X	94682-4-0805729		
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		
				X	62504-4-0366497		
12	Scale 0...100 linear	X	X	X	62504-4-0366422/380		
	Blank scale	X	X	X	62504-4-0366422/383/384		
	Special scale	X	X	X			
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		

Spare parts

		PE	PS	PA	Catalog No.	Price	Delivery time
17	Cover	X	X	X	42105-4-0456699		
18	Cover	X	X	X	62504-4-0366419		
	Cover			X	42105-4-0456700		
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		
Configurator							
	Case				62504-4-0368437		
	Keyboard film				62504-4-0368442		
	Connection cable to controller				62504-4-0368457		
	NiCad battery				94682-4-0873679		
	Power supply				94682-4-0873641		
	Positioning bar				62504-4-0366349		
	On/of switch				94682-4-0870542		
	Box				62505-4-0368486		
	Lid insert				62504-4-0366210		
	Base insert				62504-4-0366211		
	programme memory EPROM IC 4				62504-5-3100204		
	programme memory EPROM IC 5				62504-5-3100205		
	programme memory RAM IC 6 and IC 7				94682-4-0873108		

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

Connection diagrams

Note

In the following connection diagrams the internal circuits of the respective device are illustrated in a greatly reduced form. Based on the overview connection diagram for the continuous controller (Fig. A2), the functional circuits of the inputs and outputs of all device versions can be seen in detail.

Overview

Fig. A2	Overview connection diagram of continuous control	(100)
Fig. A3	Single-channel continuous controller	(100)
Fig. A4	Single-channel three-point step action controller	(200)
Fig. A5	Single-channel programmer	(300)
Fig. A6	Manual station, continuous	(400)
Fig. A7	Manual station, step action output	(500)
Fig. A8	Setpoint station	(600)
Fig. A9	Ratio station	(700)
Fig. A10	Bias station $Y = X \cdot K1 \pm W$	(800)
Fig. A11	Three-point positioner	(900)
Fig. A12	Two-channel continuous controller	(010)
Fig. A13	Cascade control	(020)
Fig. A14	Minimum selection (with max. selection the min. limits YL/Y.L are set)	(030)
Fig. A15	Program controller, continuous fixed value	(050)
Fig. A16	Program controller, continuous ratio	(060)
Fig. A17	Programmer, two-channel	(070)

Examples of Applications:

- Fig. A18** Connecting a positioning motor via SE1
- Fig. A19** Connecting a positioning motor via relay

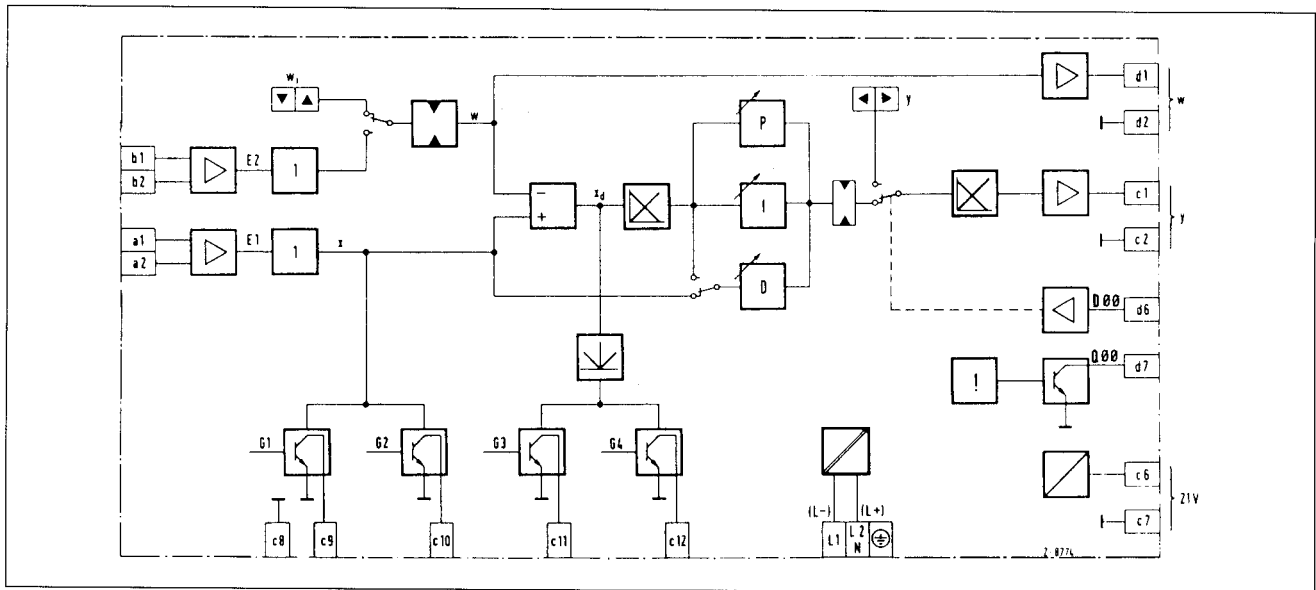


Fig. A2 Continuous controller
 D00 = Forced manual
 Q00 = Instrument malfunction
 ! = Internal monitoring

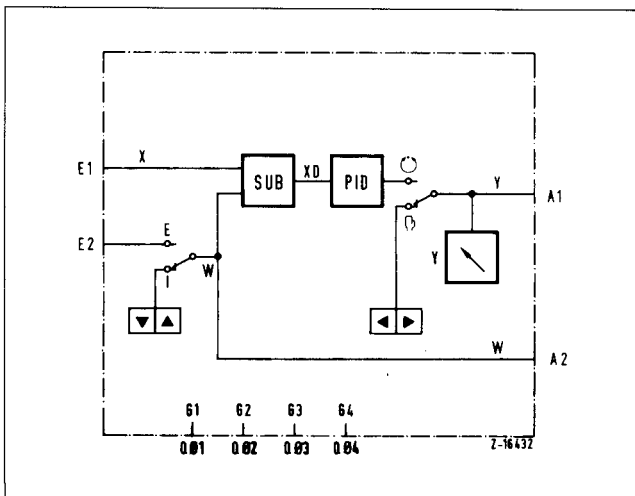


Fig. A3 Single-channel continuous controller (100)

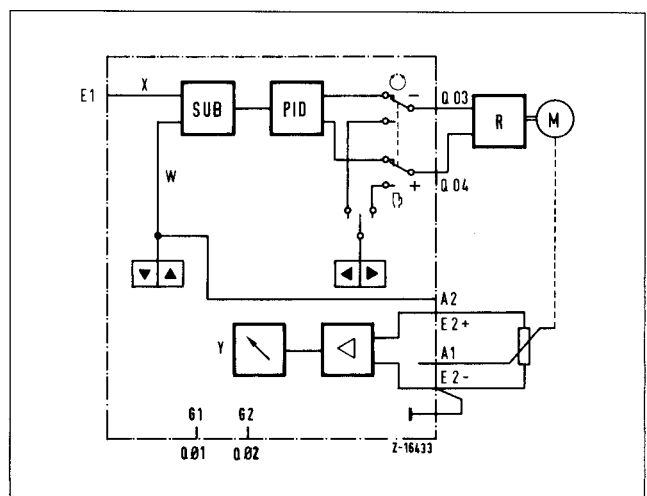


Fig. A4 Single-channel three-point step action controller (200)

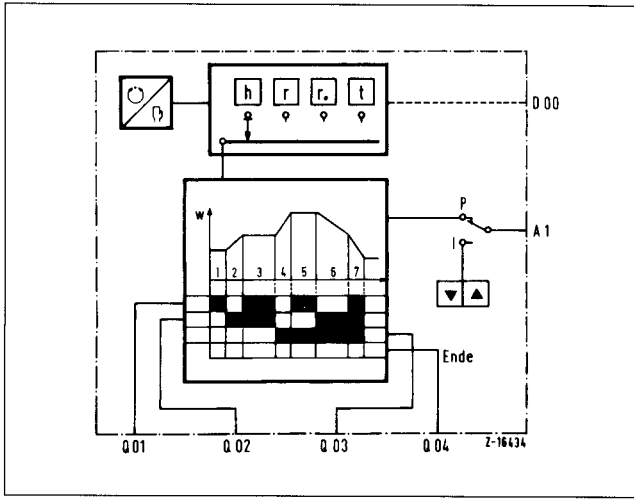


Fig. A5 Single-channel programmer (300)

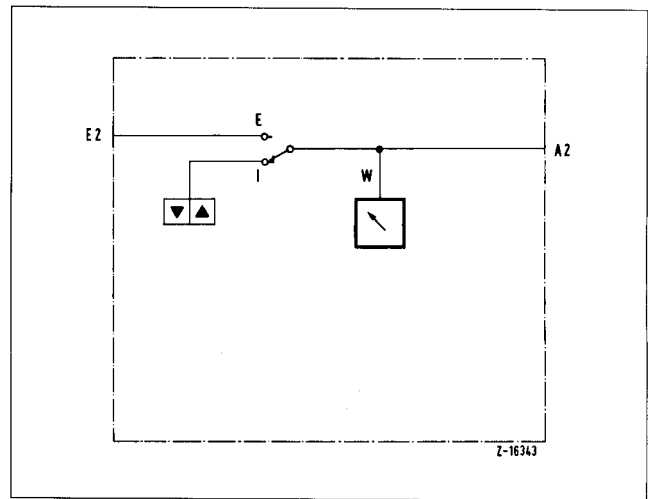


Fig. A8 Setpoint station (600)

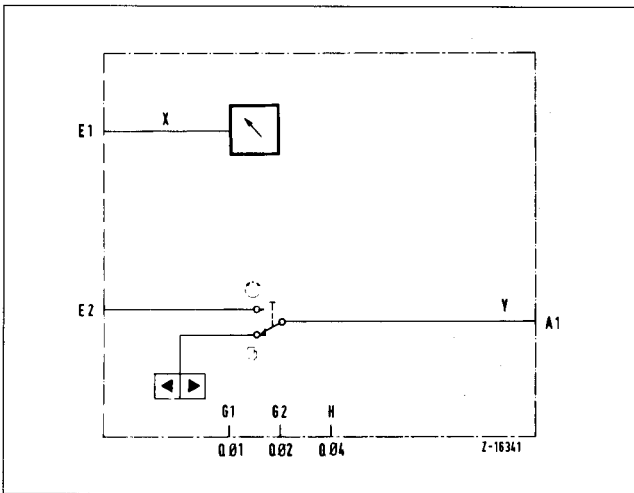


Fig. A6 Manual station, continuous (400)

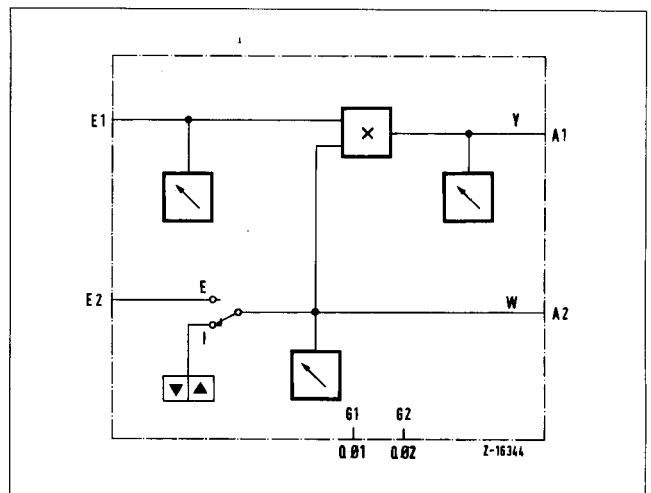


Fig. A9 Ratio station (700)

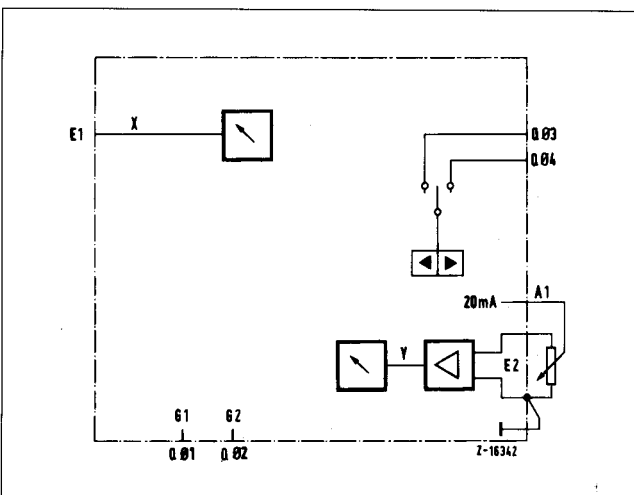


Fig. A7 Manual station step action output (500)

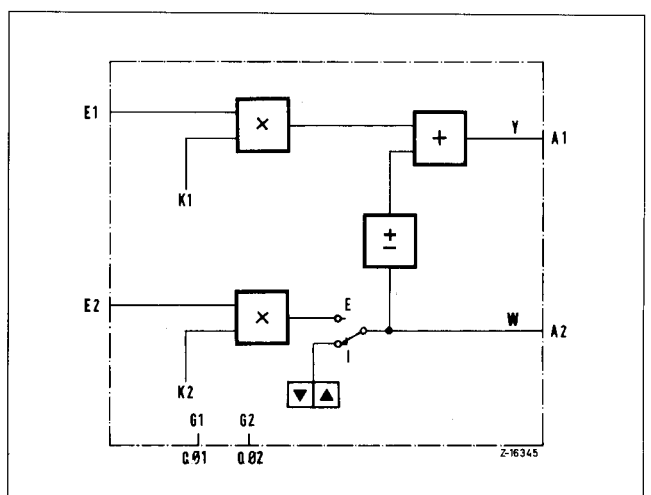


Fig. A10 Bias station $Y = X \cdot K1 \pm W$ (800)

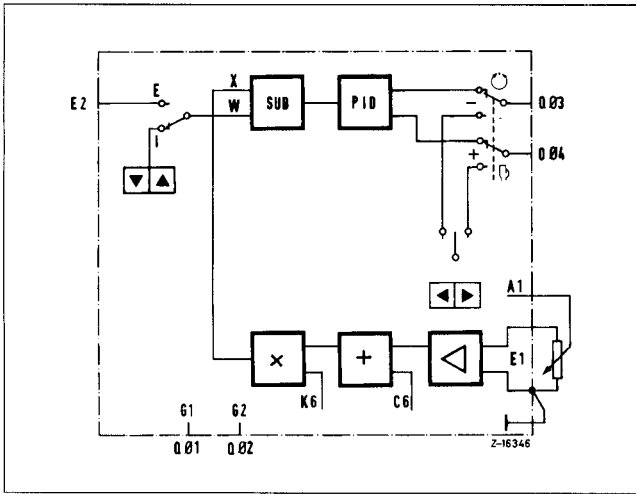


Fig. A11 Three-point positioner (900)

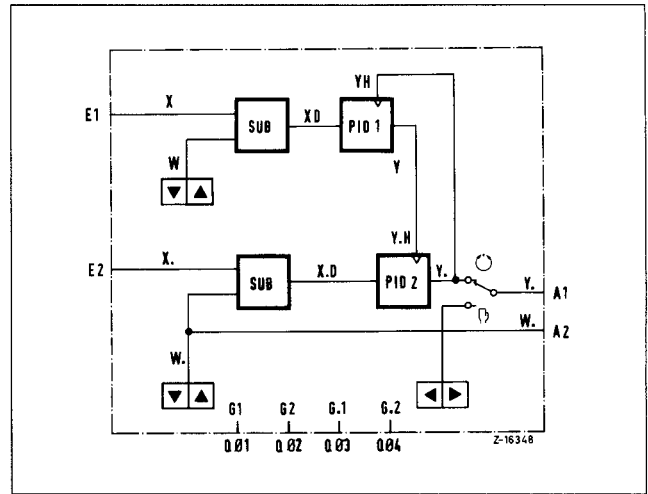


Fig. A14 Override minimum selection (030)
(with max. selection the min. limits YL/Y.L are set)

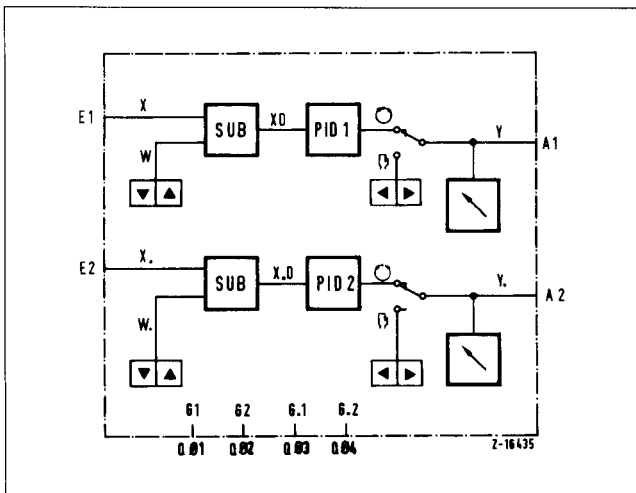


Fig. A12 Two-channel continuous controller (010)

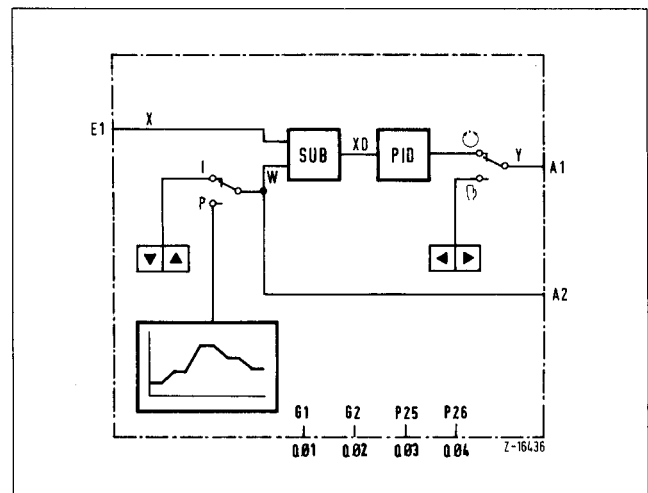


Fig. A15 Time-schedule controller, continuous fixed value (040)
P 25; P 26 are time schedule steps

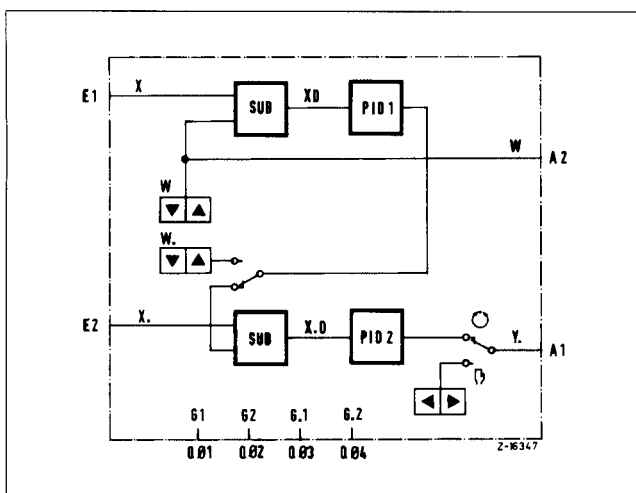


Fig. A13 Cascade control (020)

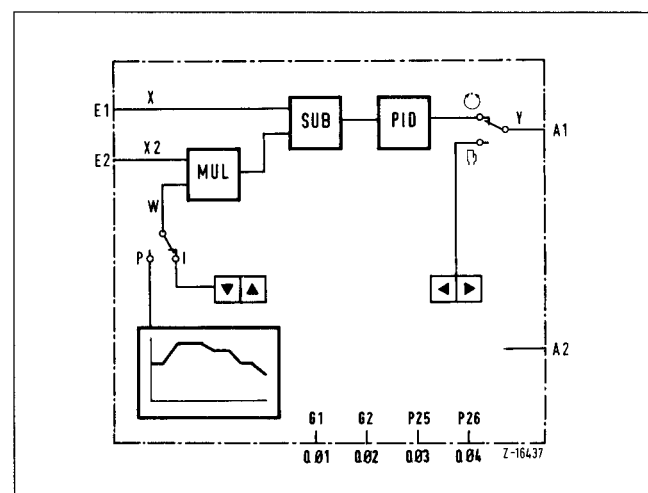


Fig. A16 Time-schedule controller, continuous ratio (050)
P 25; P 26 are time schedule steps

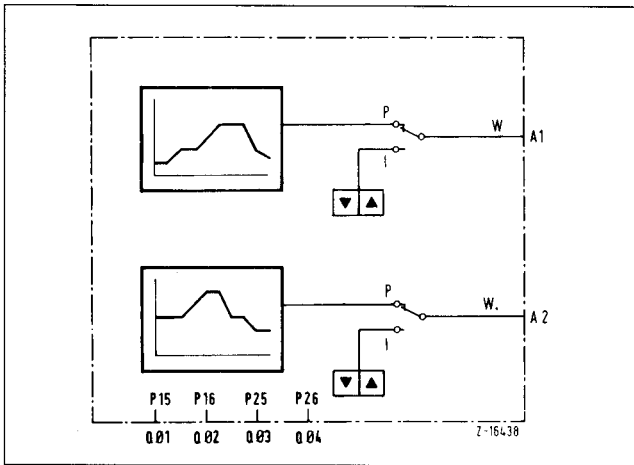


Fig. A17 Time-schedule controller, two-channel (070)
P15; P16; P25; P26 are time schedule steps

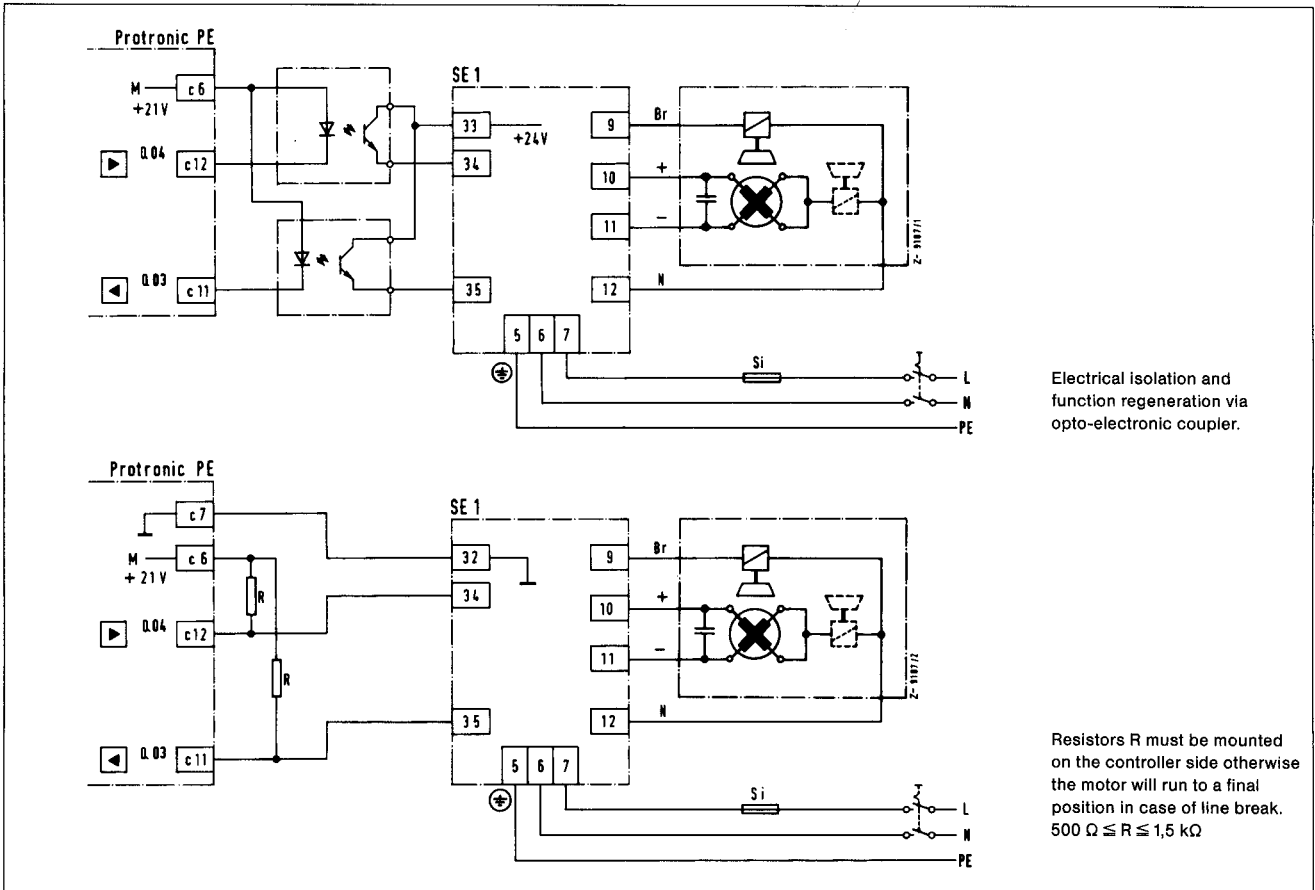


Fig. A18 Connection of a servomotor via SE 1.

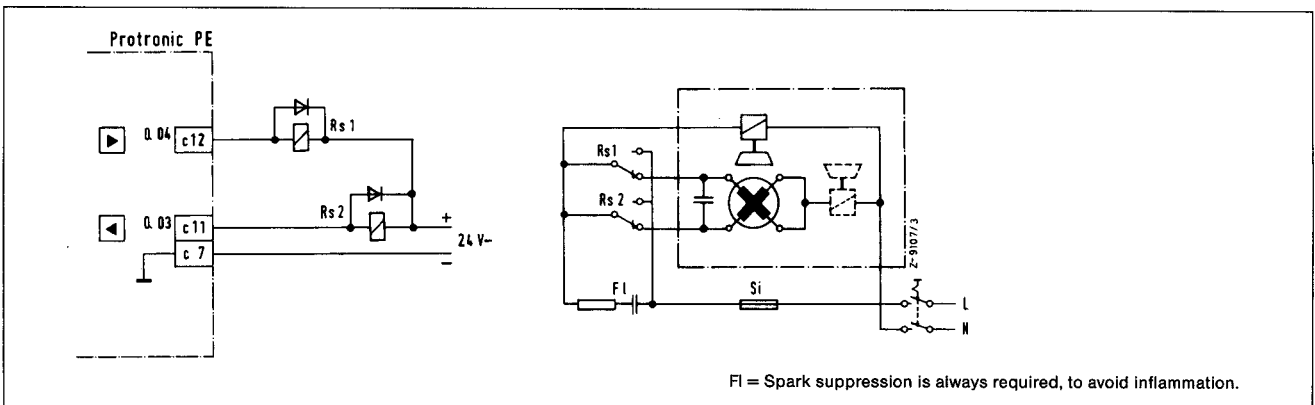


Fig. A19 Connection of a servomotor via relay
e.g. RHM 1004 (including diodes) Cat. No. 3004004-311 (024)

List of keywords

Accessories		Maintenance	6
Alarm values, bipolar, unipolar		Manual characteristic	3.5
Alarm values, output variable Y_H, Y_L	2.7	Manual control elements	2.1
Alarm values, setpoint W_H, W_L	2.7	Manual operation	3.1
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Alarm values, $X_{max}, X_{min}, G1, G2$	2.7	Manual station, step action output HS	3.9
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Characteristic, manual	3.5	Processor test	6.3
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	5.2	Self-parameter definition	2.8
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Line installation	2.3	Write protection	Fig. 2.1
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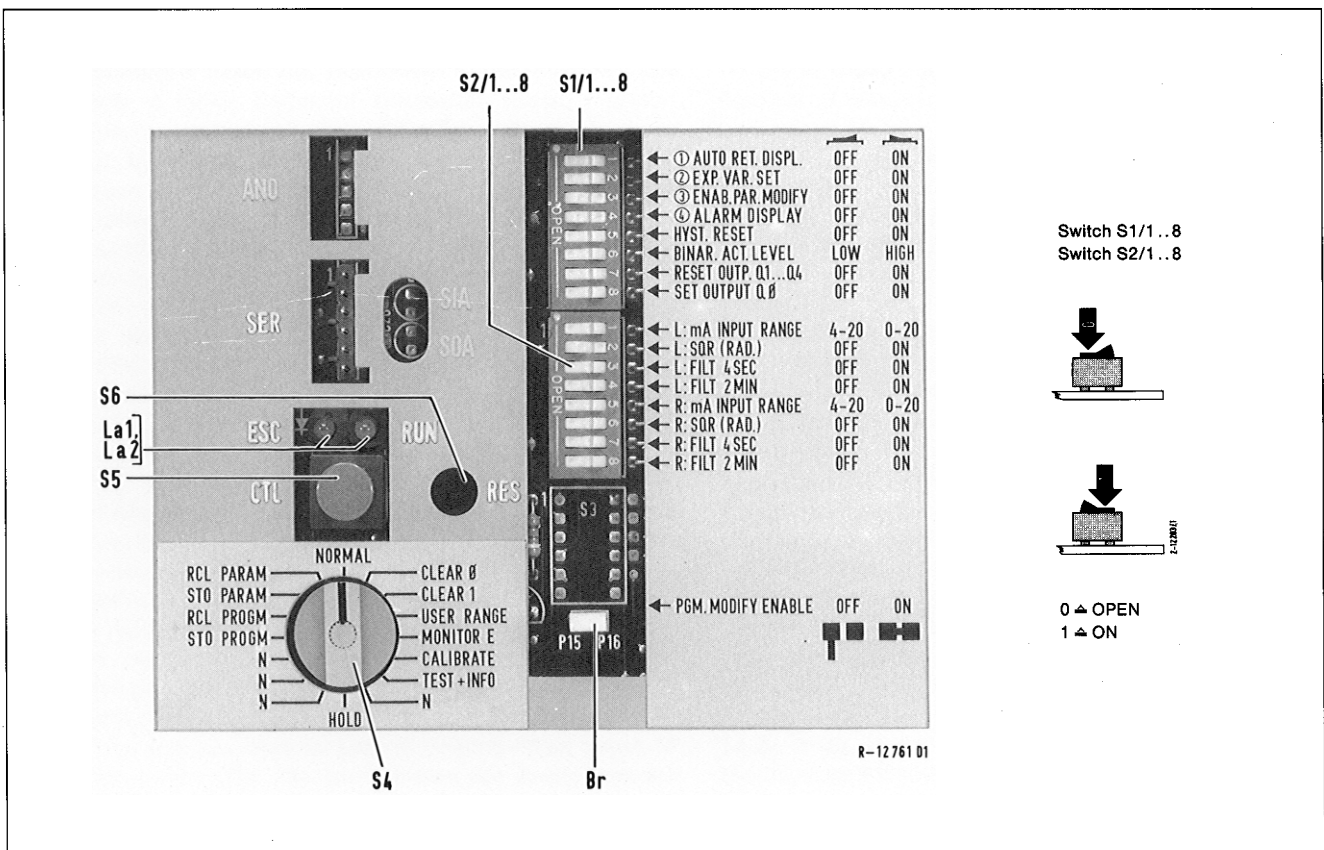


Bild 2.1 Display and manual control elements of the control electronics slide-in unit

Switch S1, Functions:

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

Switch S2, Functions:

- | | | |
|--|-------------------|--------------------|
| 1. Control characteristic | reverse* | direct |
| 2. Differentiation of | PV=x* | DEV=x _w |
| 3. Differential gain | V _D =1 | V _D =4* |
| 4. P action (proportional) | no | yes* |
| 5. I action (integral) | no | yes* |
| 6. D action (derivative) | no* | yes* |
| 7. and 8 Time range according to table (see Section 5.2) | | |

Switch S4, Functions:

- | | |
|---------------|---|
| NORMAL | Normal operating position |
| CLEAR 0 | operating position for serial interfaces |
| CLEAR 1...4 | Reset non-return pointers |
| USER RANGE | Unused |
| MONIT+TEST | Set the physical readout for the digital display |
| AUTOCAL | Test routines and configuration |
| HOLD | Calibration of inputs and outputs |
| (STO PROGRAM) | Disconnect internal processing |
| RCL PROGRAM | Store configuration in EEPROM (optional) |
| | Enter the configuration contained in the EPROM (without parameters) |
| STO PARAM | Store parameters |
| RCL PARAM | Recall saved parameters |

Key S5

Individual operating modes will only be activated if in addition to turning switch S4, key S5 (CTL) is also operated. Should an EEPROM be available, load from the EEPROM as long as the configuration has a priority identification.

Key S6

With S5 depressed, if S6 is operated three times within a second, the configuration contained in EPROM including default parameters is transferred to RAM. Note write protection status.

Jumper Br

If the jumper is removed or only plugged in to one terminal the data stored in RAM is write protected. Functions such as USER RANGE or STO PARAM are blocked.

Jumper horizontal: not protected
Jumper vertical: protected

Lamps La1 and La2

The LEDs 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.

Subject to technical changes.

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