

<b>1</b>	<b>INTRODUCTION</b> .....	<b>E-2</b>
1.1	Unpacking and inspecting .....	E-2
1.2	General notes on use and safety .....	E-2
1.3	Electromagnetic compatibility .....	E-2
<b>2</b>	<b>DESCRIPTION</b> .....	<b>E-3</b>
2.1	Characteristics and possible applications .....	E-3
2.2	Construction .....	E-5
2.3	Principle of operation .....	E-6
2.4	Safety position .....	E-7
2.5	Technical data .....	E-8
<b>3</b>	<b>INSTALLATION</b> .....	<b>E-9</b>
3.1	Construction and assembly .....	E-9
3.1.1	Fitting the positioner to a continuous valve with membrane drive (NAMUR) .....	E-9
3.1.2	Fitting the positioner to a 2031 continuous valve with piston drive .....	E-11
3.1.3	Fitting the positioner to a continuous valve with rotary drive .....	E-13
3.2	Fluid ports .....	E-14
3.3	Electrical connections .....	E-15
<b>4</b>	<b>OPERATION</b> .....	<b>E-16</b>
4.1	Controls and indicators .....	E-16
4.2	Operating levels .....	E-17
4.3	Setting up .....	E-18
4.4	Process control .....	E-19
4.4.1	Meaning of LEDs and keys in the process control level .....	E-20
4.4.2	Displays .....	E-20
4.5	Configuration .....	E-21
4.5.1	Additional functions .....	E-21
4.5.2	Configuration menu .....	E-22
4.5.3	Function of keys in the configuration level .....	E-25
4.5.4	Notes on the basic and additional functions .....	E-25
4.6	Manual operation without power supply .....	E-34
4.7	Structure of the positioner .....	E-35
<b>5</b>	<b>MAINTENANCE</b> .....	<b>E-36</b>
	Fault messages .....	E-36
	<b>APPENDIX</b> .....	<b>E-37</b>
A1:	Characteristics of PID controllers .....	E-37
A2:	Rules for adjusting PID controllers .....	E-39
A3:	Optional board for analog position indication .....	E-44
A4:	Optional board for binary position indication/Booster .....	E-45

Dear Customer,

We congratulate you on the purchase of our positioner 1067. You have made a good choice. To be able to make the best use of the many advantages the product has to offer, it is absolutely necessary to follow our advice and

for electrical equipment shall be complied with during the operation, servicing and repair of the positioner.

Repairs may only be carried out by authorised trained personnel.

## READ THESE OPERATING INSTRUCTIONS CAREFULLY BEFORE FITTING THE UNIT AND PUTTING IT INTO SERVICE



This symbol is shown in the Operating Instructions each time particular care is required to ensure correct installation, functioning and operating safety of the equipment.

### 1.1 Unpacking and inspecting

Please check the delivery for completeness and transportation damage. The standard delivery includes:

- 1 Positioner 1067 Ref 642292
- 1 Operating Instructions Manual

In the event of loss or damage please contact your Bürkert Subsidiary.

### 1.3 Electromagnetic compatibility

This device conforms to the EMC-Directive of the Council of European Communities 89/336/EEC.

In order to comply with this directive, the wiring instructions must be followed.

### 1.2 General notes on use and safety

This publication contains no warranty statement For this we refer to our general purchase and delivery conditions.

To ensure proper functioning and a long life of the positioner, the user must observe these Operating Instructions as well as complying with the installation conditions and permissible data as given in the data sheet. Installation and maintenance personnel must have training and qualifications suitable for the task.

#### Master code

Unauthorised operation can be prevented at the various operating levels by a freely-selectable user code. Independent of this, there is a fixed, programmed master code which cannot be changed, by means of which all operations can be performed. **This four-digit master code is given on the bottom margin of this page.** It can be cut out and kept separately from these Operating Instructions.

Suitable measures are to be taken to prevent unintentional actuation and the resulting effect on the process. Safe electrical isolating and shut-off devices for the media must be provided for the installation task. If the positioner is part of a complex automated system, a defined and controlled restart of the automated system after an interruption shall be guaranteed in accordance with the instructions.

The accident and prevention safety regulations

Master code:  
6568

### 2.1 Characteristics and possible applications (overview)

The 1067 positioner is an electropneumatic position controller for pneumatically actuated continuous valves. The device includes the following main functional groups: a feedback/positional transducer, an electropneumatic system and a microprocessor electronic system. The feedback/positional transducer measures the actual position of the continuous valve. The microprocessor electronic system continuously compares the actual position (actual value) with a desired position value that was preset via the standard signal input and supplies the result to the position controller. If an error exists, the electropneumatic system causes the actual position to be appropriately corrected.

The 1067 positioner can be fitted to various continuous valves (e.g. valves with piston, membrane or rotary drives and with single or double action). Two variant forms of the basic device are offered that differ in their fixing options and feedback/positional transducers. In variant 1, an internal feedback/positional transducer is used that takes the form of a rotary potentiometer. In variant 2, an external linear potentiometer serves as feedback/positional transducer.

The positioner also implements a PID controller by means of which, in addition to position control, process control (e.g. level, pressure, flow or temperature control) can be achieved in the form of sequence control.

A liquid-crystal display and a keypad with three keys are provided for operating the positioner. An operating concept with the following graded operating levels has been implemented:

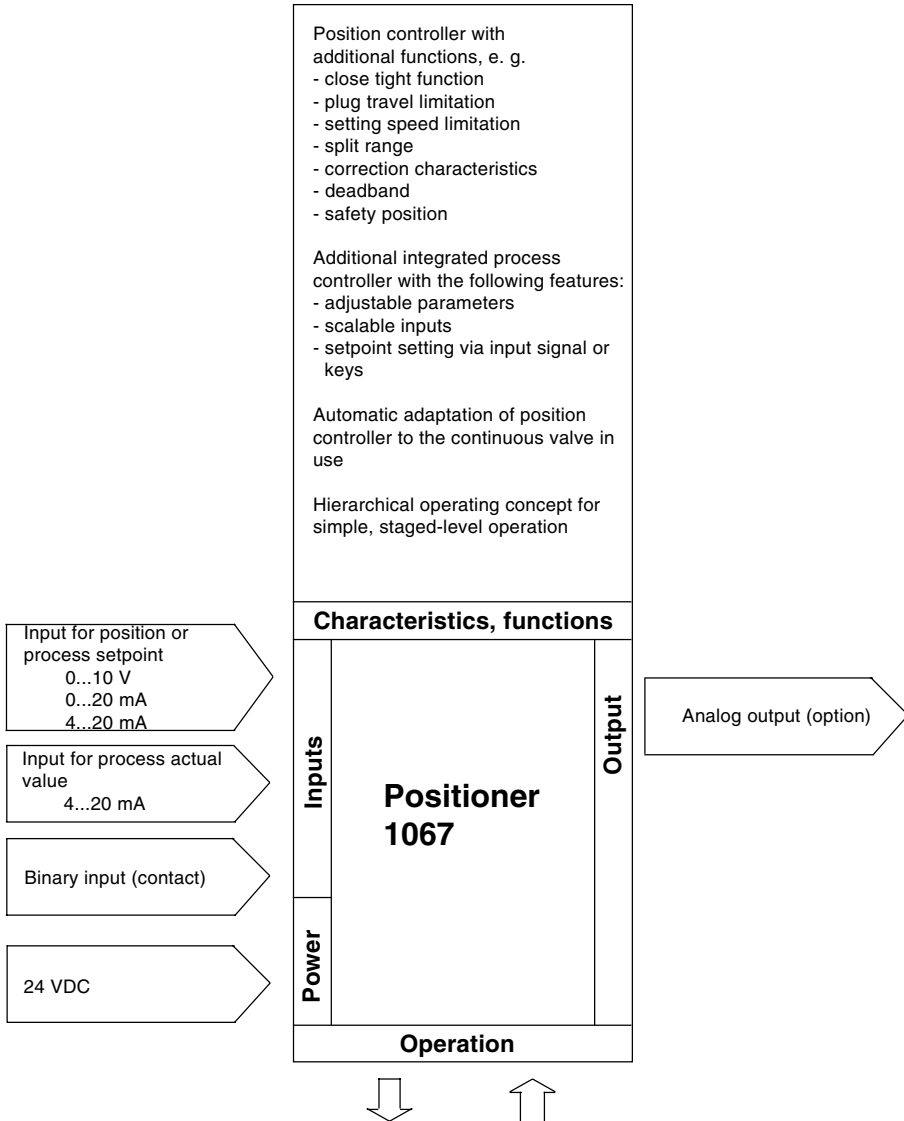
#### **- Process operation**

This level allows switching between automatic and manual operation, and enables manual actuation.

#### **- Configuration**

Configuration level is used to specify certain basic functions when the positioner is taken into service and, if necessary, to configure additional functions.

Fig. 1 Block diagram of the 1067 positioner

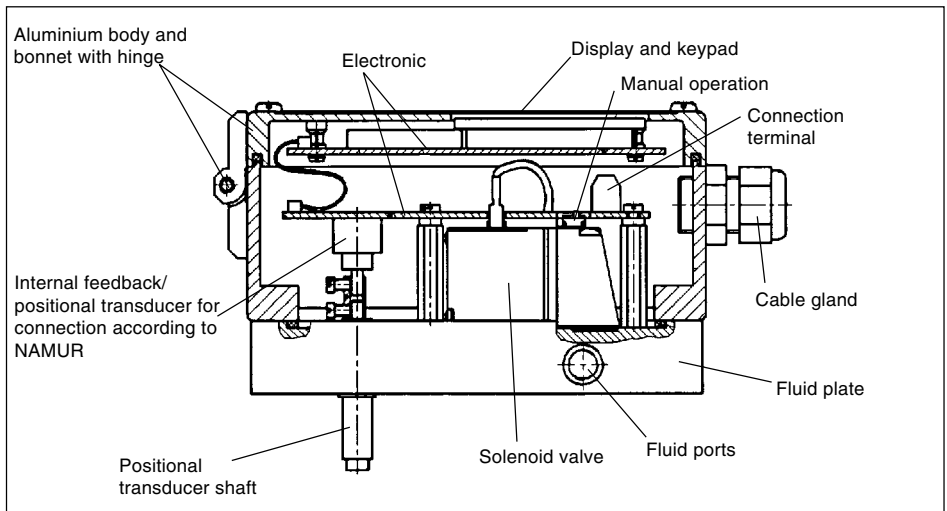


## 2.2 Construction

The positioner consists of the following main assemblies:

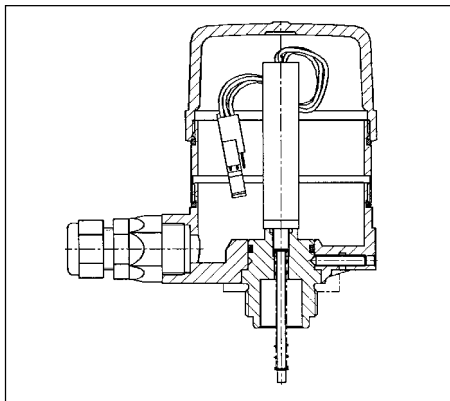
- Body and bonnet (aluminium)
- internal feedback/positional transducer for measuring valve position
- Microprocessor/electronic unit for signal processing and control
- Solenoid valves for control of a continuous action valve
- Fluid plate with fluid ports
- Terminals and cable glands
- Display and keyboard

Fig. 2 Cross section of the positioner with internal feedback/positional transducer



In variant 2, an external linear potentiometer serves as feedback/positional transducer (see fig. 3).

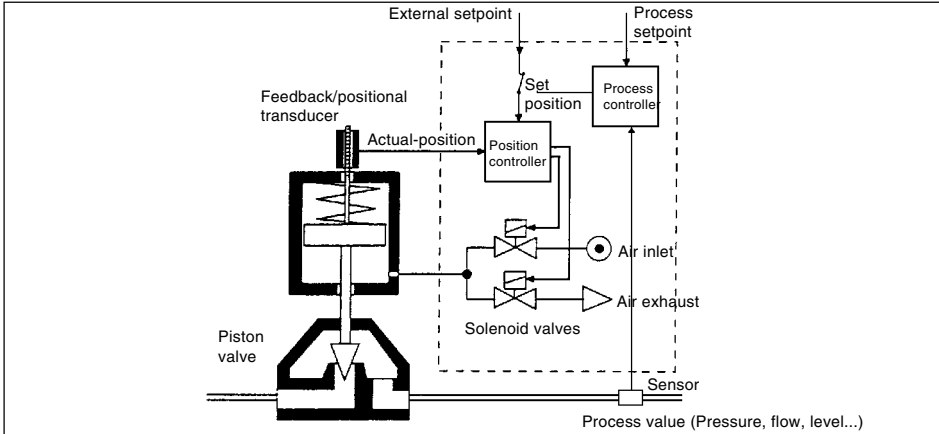
Fig. 3 External feedback/positional transducer



### 2.3 Principle of operation

Fig. 4 shows a operational diagram of the positioner with its relationship to a piston drive control valve. An external feedback/positional transducer is used in this case to measure the actual position.

Fig. 4 Operational diagram



The position (actual position) of the valve drive is determined by the feedback/positional transducer. The signal corresponding to the actual position is continuously compared in the positioner with the desired position and the error (control deviation) is formed. Pulses of variable duration corresponding to the error are delivered to the magnetic valves of the electropneumatic system, by means of which the supplied air and outgoing air for positioning the actuating drive of a continuous valve are controlled. The desired position can be preset either via a standard signal input from outside (e.g. manually or via an external controller) or via the internal process controller. In the latter case, the desired process value is applied to the standard signal input or entered via keypad and a comparison is made with the process quantity (e.g. flow, pressure, level or temperature) that is to be controlled (Fig. 4).

If the desired position is preset externally via the standard signal input provided for that purpose (i.e. if the internal process controller is not used), the device works as a position controller only (Fig. 5). The position controller is implemented as a PD controller within the microprocessor. A pulse-width modulation (PWM) member is connected to the controller output and, via its  $B_1$  and  $E_1$  outputs, the magnetic valves for supplying air to and venting the actuating drive are controlled. When a positive error exists, pulses (PWM signals) are output from output  $B_1$  to switch the supplied air. When a negative error exists, pulses are output from output  $E_1$  to switch the outgoing air.

The positioner can be supplied for both single-acting and double-acting actuating drives. The PWM member has two further outputs,  $B_2$  and  $E_2$ , via which the two additional magnetic valves for supplying air to and evacuating air from double-acting actuating drives are controlled.

If the internal process controller is used, it constitutes a component in a higher-level control loop (main control loop). The position controller mentioned above now operates in a lower-level auxiliary control loop. The overall effect is sequence control (Fig. 6). The internal process controller (main controller) is implemented as a PID controller ( $Z1$  and  $Z2$  representing disturbance variables).

Fig. 5 Position control

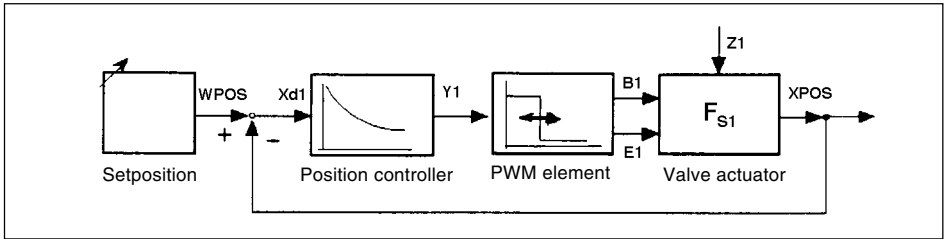
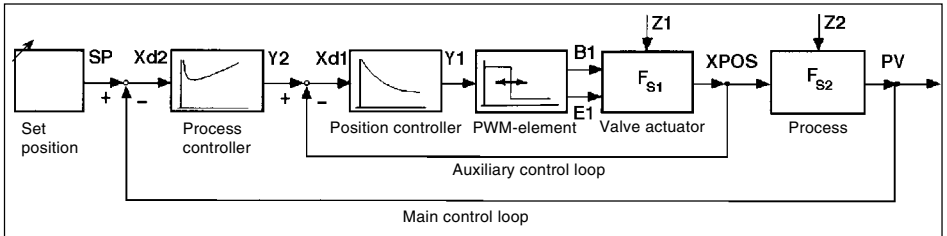


Fig. 6 Process control



### 2.4 Safety position

In the event of power failure, the functioning of the actuator ensures that a pre-determined end position is adopted (opened or closed by spring pressure).

### 2.5 Technical data

#### Electrical data

Power supply:	24 VDC
Power consumption:	< 10 W
Input for desired value	
Input for setpoint for position or process control:	
	- Unit signal 4 ... 20 mA
	- Unit signal 0 ... 20 mA
	- Unit signal 0 ... 10 V
Input for process signal (in case of process control):	
	- Unit signal 4 ... 20 mA
Binary input:	Can be configured as a normally open or normally closed contact.
Terminations:	1.5 mm <sup>2</sup> bolted terminals Two PG 9 screwed glands

#### Pneumatic data

Control medium:	filtered compressed dry air, oiled or non-oiled
Pressure range:	0 ... 6 bar
Air rates	
Inlet valve:	23 NI / min <sup>(1)</sup>
Exhaust valve:	25 NI / min <sup>(1)</sup>
Air consumption by unit	
in stable state:	0 NI / min
Unions:	G 1/8" internal thread
<sup>(1)</sup> When pressure reduction from 6 to 5 bar	

#### Mechanical data

Regulation range of internal path-measuring system:	
	lift turn: 10...80 mm
	rotary movement: 0...180°
Regulation range of external path-measuring system:	
	lift turn: 0...50 mm

#### Process controller data

Proportional correction value KP:	0...99,99
Reset time TN:	0.5...999.9
Rate time TV:	0.0...999.9
Operating point:	0...100%

#### Installation and operating data

External dimensions of positioner :	125 mm x 80 mm x 80 mm (W x H x D)
Material of body:	Aluminium, lacquered
Material of the fluid plate:	Aluminium, anodised
Weight of positioner:	Approx. 1 kg
Degree of protection:	IP 65
Operating temperature:	0 ... 60 °C



## 3.1 Construction and assembly

The 1067 positioner can be fitted to various continuous valves. Depending on the valve type either variant 1, with an internal feedback/positional transducer (a rotary potentiometer) or variant 2, with an external feedback/positional transducer (a linear potentiometer) is used (see section 2.3).

Main dimensions:	<b>Positioner</b>	<b>External feedback/positional transducer</b>
	Width: 125 mm	Diameter: approx. 65 mm
	Height: 80 mm	Height: approx. 95 (115) mm
	Depth: 80 mm	

### 3.1.1 Fitting the positioner to a continuous valve with membrane drive (according to NAMUR)

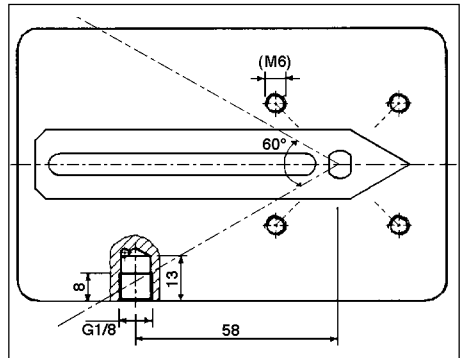
#### Arrangement

In the case of a continuous valve with membrane drive, device variant 1, with an internal feedback/positional transducer (a rotary potentiometer) should be used. The positioner is screwed on to what is termed the «lantern» of the membrane drive (Fig. 7). Transmission of the valve position to the internal feedback/positional transducer is achieved by means of a lever conforming to NAMUR (Fig. 8).

Fig. 7 Fitting to a 265 continuous valve with membrane drive



Fig. 8 Rear view of positioner (variant 1) with lever



#### Assembly

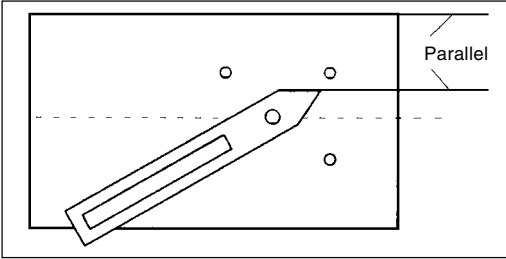
A mounting elbow (Fig. 10) is provided for assembling variant 1 of the positioner to a continuous valve with membrane drive (e.g. 265). The following steps should be carried out:

Screw mounting elbow **1** to the positioner using 4 x M6 **10** screws.

Fasten pin **2** using washer **7** and nut **8** to that position of the lever **4** which corresponds with the desired lift (the lever is marked in mm of lift).

Put lever **4** with pin on to the path-sensor shaft of the positioner so that the marking on the shaft points towards the pin on the lever. Then screw lever tight with screw **9**. Fasten carrier **3** with cheese-head bolts **6** to the lifting rod of the membrane valve.

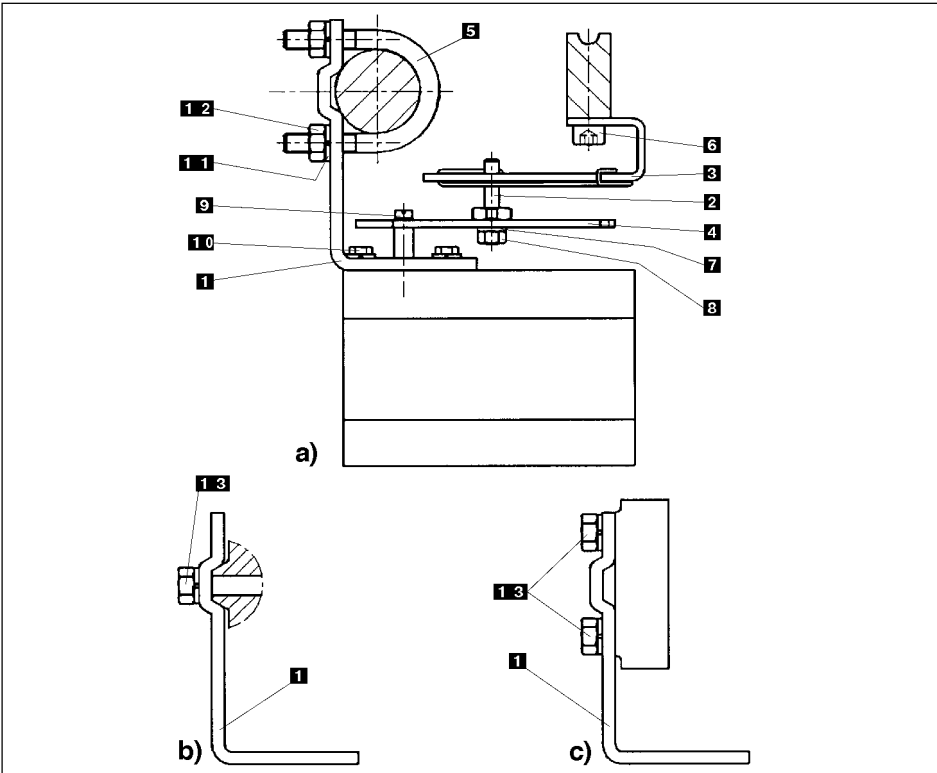
Fig. 9 Position of lever during assembly



Set positioner, with the mounting elbow **1** screwed on to it, on the membrane drive so that the pin **2** slots into the carrier **3**, the point of the lever runs parallel with the upper edge of the positioner (Fig. 9) and the rear side of the positioner runs parallel with the carrier **3**. Fasten the positioner to the membrane drive in this position as appropriate to the following variants:

- In the case of membrane drives with pillar lanterns, fasten mounting elbow **1** with two U-bolts **5**, nuts **1 3** and washers **1 2** to the appropriate pillar lantern (Fig. 10a).
- In the case of membrane drives with cast lanterns, fasten mounting elbow **1** with one screw **1 3** (Fig. 10b) or four screws **1 3** (Fig. 10c) to the appropriate cast lantern (Fig. 10a).

Fig. 10 Assembly of positioner to a continuous valve with membrane drive



## 3.1.2 Fitting the positioner to a 2031 continuous valve with piston drive

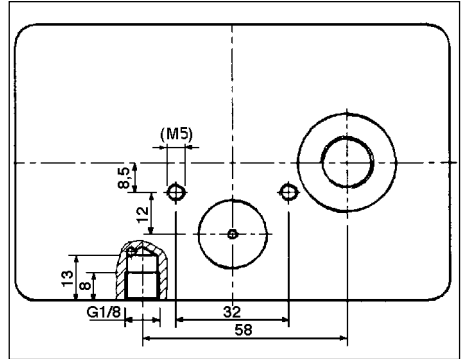
## Arrangement

In the case of a continuous valve with piston drive, variant 2 with the external path-measuring system (Fig. 3) should be used. The positioner is placed on the valve and screwed to it (Figs. 11 and 12). The valve position is transmitted directly via the spring-mounted rod of the path-measuring system (the linear potentiometer).

Fig. 11 Fitting to a 2031 continuous valve with piston drive



Fig. 12 Rear view of positioner (variant 2)



## Assembly

Assembly of variant 2 of the positioner to a 2031 continuous valve with piston drive.

A set of add-on parts (NAMUR adapter, Fig. 13) is provided for assembling variant 2 of the positioner to a piston valve (e.g. 2031). It consists of a mounting plate **1**, two hollow bolts **2**, three O-rings **3** and two cheese-head bolts M5 **4**.

To assemble the positioner on a 2031 continuous valve with piston drive, the following steps should be carried out (Fig. 13):

Place an O-ring **3** in the recess of the mounting plate **1** (drive side). In the case of a large version, place a second O-ring on the other side of the mounting plate.

Put two cheese-head bolts M5 **4** from the drive side through the 5-mm drillings in the mounting plate. Screw the preassembled mounting plate **1** to the two connection pieces of the valve drive with two hollow bolts **2** so that the lower connection piece is sealed by the O-ring.

Place an O-ring **3** in the groove on the reverse side of the positioner.

Add the positioner to the mounting plate and screw it on with the two cheese-head bolts **4**.

Assembly of the external feedback/positional transducer to a 2031 continuous valve with piston drive.

To assemble the external feedback/positional transducer, the following steps should be carried out (Figs. 13 and 14):

Check that an O-ring **3** has been put into the valve drive (top). Insert O-ring if necessary.

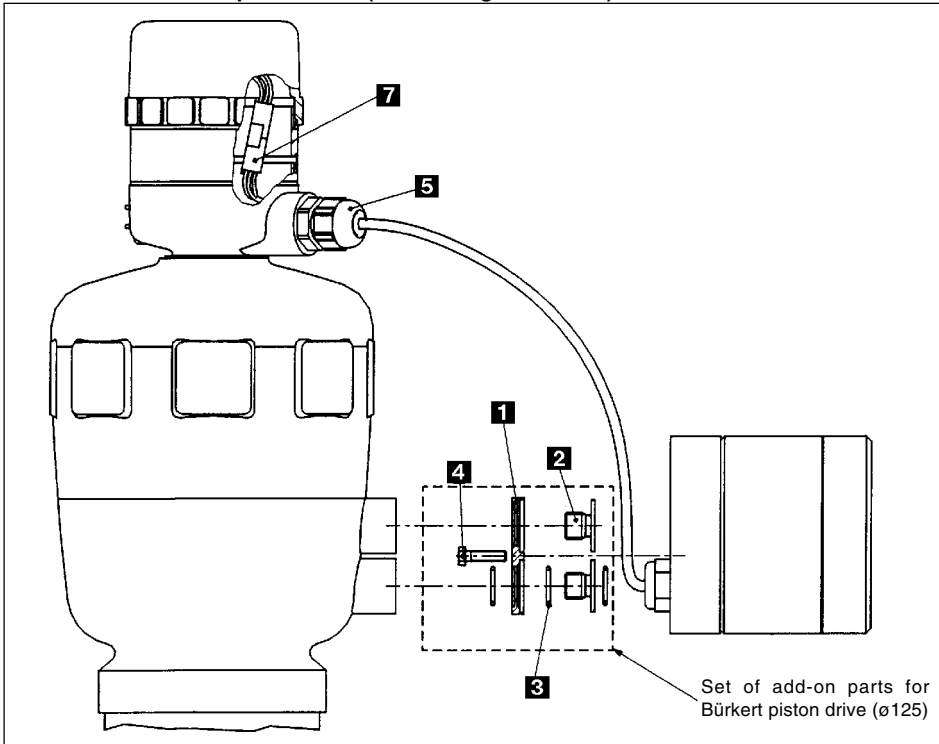
Set path-measuring system directly on the drive from above. Great care must be taken to ensure that the spindle of the path-measuring system is seated on the spindle of the drive.

Screw in the path-measuring system and secure with spanner.

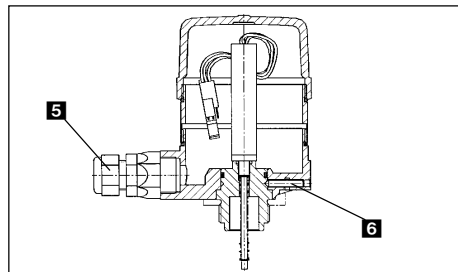
Loosen setscrew **6** and turn feedback/positional transducer so that the cable outlet is in the desired position. Retighten setscrew.

Unscrew lid of path-measuring system. Remove PG-threaded joint **5** from the housing of the path-measuring system. Lead the plug of the positioning cable **7** through and plug it into the housing of the path-measuring system (green to green, white to red, brown to yellow). Draw surplus cable inwards, tighten PG threaded joint. Screw lid back on (O-rings).

**Fig. 13 Diagram for the assembly of positioner and external path-measuring system to a 2031 continuous valve with piston drive (conforming to NAMUR)**



**Fig. 14 External feedback/positional transducer**



## 3.1.3 Fitting the positioner to a continuous valve with rotary drive

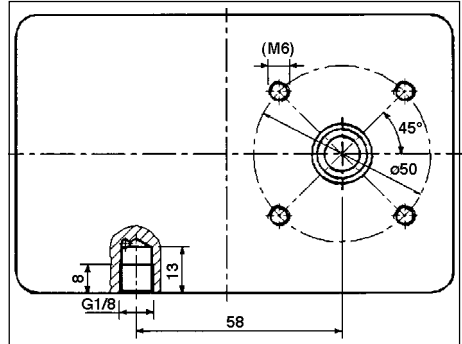
## Arrangement

In the case of a continuous valve with rotary or part-turn valve actuating drive, variant 1 with an internal feedback/positional transducer should be used. Its shaft is coupled to the valve rotary drive (e.g. flap valve). The position of the rotary drive is thus transmitted directly to the shaft of the feedback/positional transducer.

Fig. 15 Fitting to a continuous valve with rotary drive



Fig. 16 Reverse side of positioner (variant 1) with securing holes



## Assembly

A coupling (adapter) **1** is provided for assembling variant 1 of the positioner on to a continuous valve with a rotary or part-turn valve actuating drive (e.g. 3210, Fig. 17). In addition, an assembly clip **3** (Fig. 18) is required and can be obtained from the manufacturer of the part-turn valve actuating drive. (It is normally used for the assembly of a limit-switch box).

To assemble, the following steps should be carried out (Fig. 18):

Secure the assembly clip **3** to the valve drive.

Place the coupling **1** on the shaft of the positioner's feedback/positional transducer. The setscrew **2** on the coupling should first have been slightly withdrawn.

Place the positioner on the assembly clip. Ensure that the flat piece of the coupling fits into the slot in the end of the drive shaft.

Secure the positioner on the assembly clip with 4 x M6 screws.

Fix the coupling to the shaft of the feedback/positional transducer by screwing in the setscrew **2**.

If after the AUTOTUNE function is started the message TURN POT is displayed on the LCD, the setscrew must be loosened and the shaft of the path-measuring system rotated 180° relative to the drive. The setscrew should then be screwed tight and the AUTOTUNE function repeated.

Fig. 17 Coupling for continuous valve with rotary drive

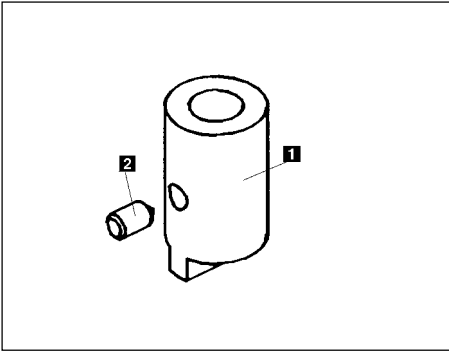
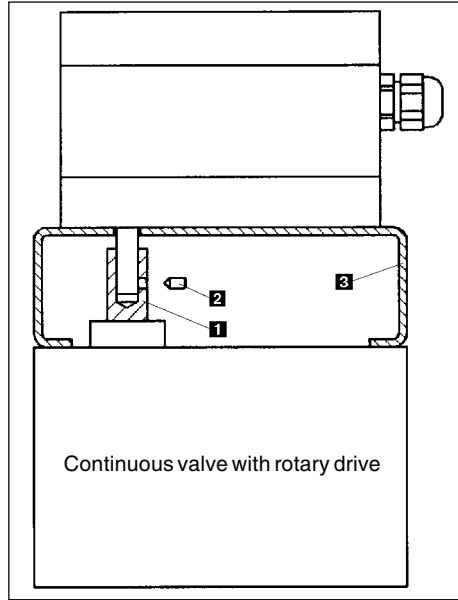
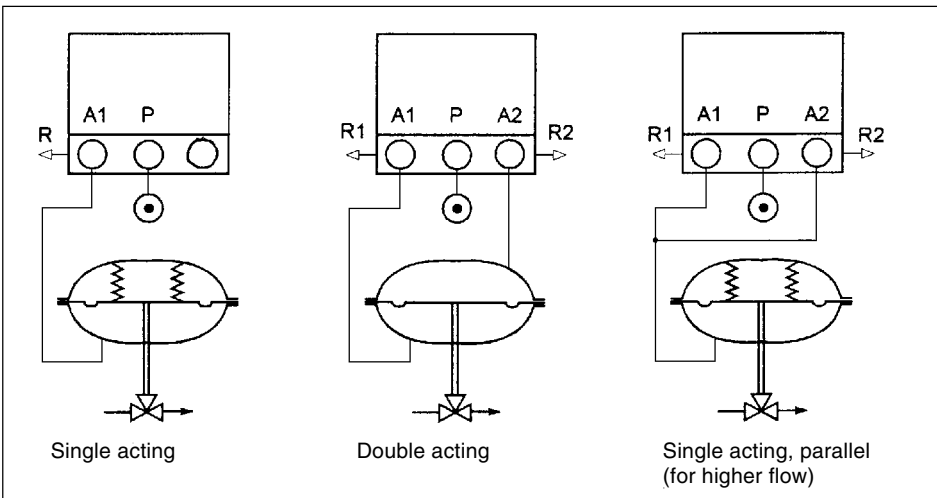


Fig. 18 Assembly of positioner on to a continuous valve with rotary drive



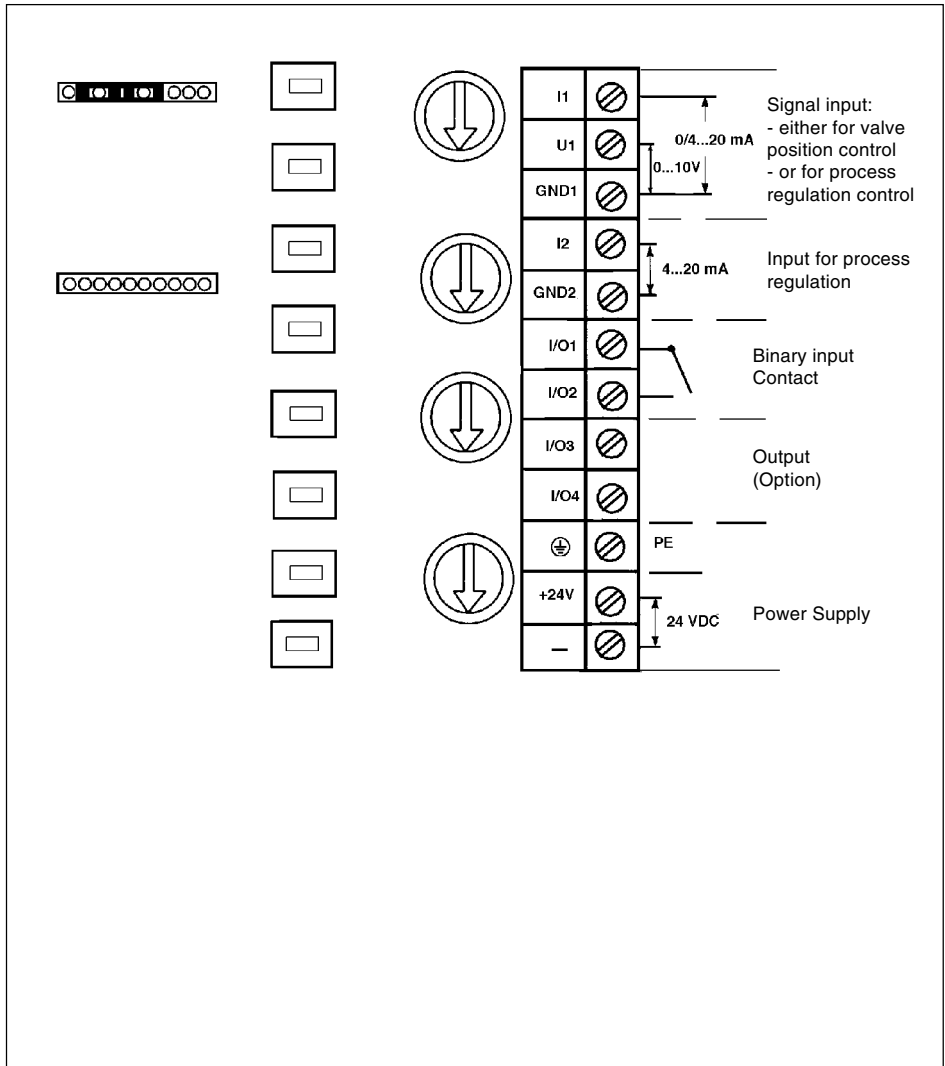
## 3.2 Fluid ports

Connect P port with compressed air supply (6 bar max.)



## 3.3 Electrical connections

Fig. 20 Assignment of terminals



Input U1 (unit signal 0 ... 10 V):

Input resistance 200 kΩ

Input I1 (unit signal 0/4 ... 20mA):

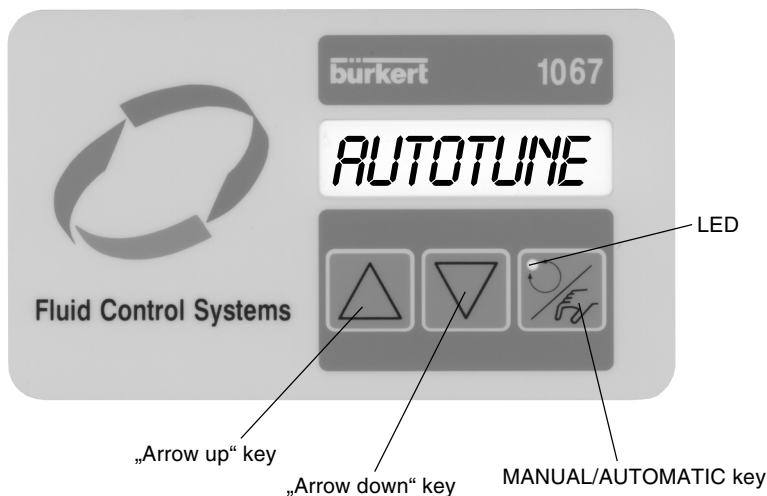
Input resistance < 175 Ω

Input I2 (unit signal 4 ... 20mA):

Input resistance < 175 Ω

**Caution:** The PE terminal must be connected to a ground point using the shortest possible cable (max. 30 cm) to ensure electromagnetic compatibility (EMC).

## 4.1 Controls and indicators



## 4.2 Operating levels

2 operating levels are provided for operation of the positioner:

**1° Process operation level**

This level, which is automatically set each time the unit is switched on, allows to change over between the MANUAL and AUTOMATIC operating modes. In the MANUAL mode the valve can be opened or closed by operating the „arrow keys“.

**2° Configuration level**

The purpose of the configuration level is to enable the basic functions to be specified on initial commissioning and additional functions to be configured as required.

Each time the power is switched on, the positioner is in the **process operation** level in the AUTOMATIC mode. A changeover to the MANUAL mode can be accomplished using the MANUAL/AUTOMATIC key (cf § 4.4). From the **process operation** level it is possible to change over to the **configuration level** by pressing the MANUAL/AUTOMATIC key and holding for 5 seconds.



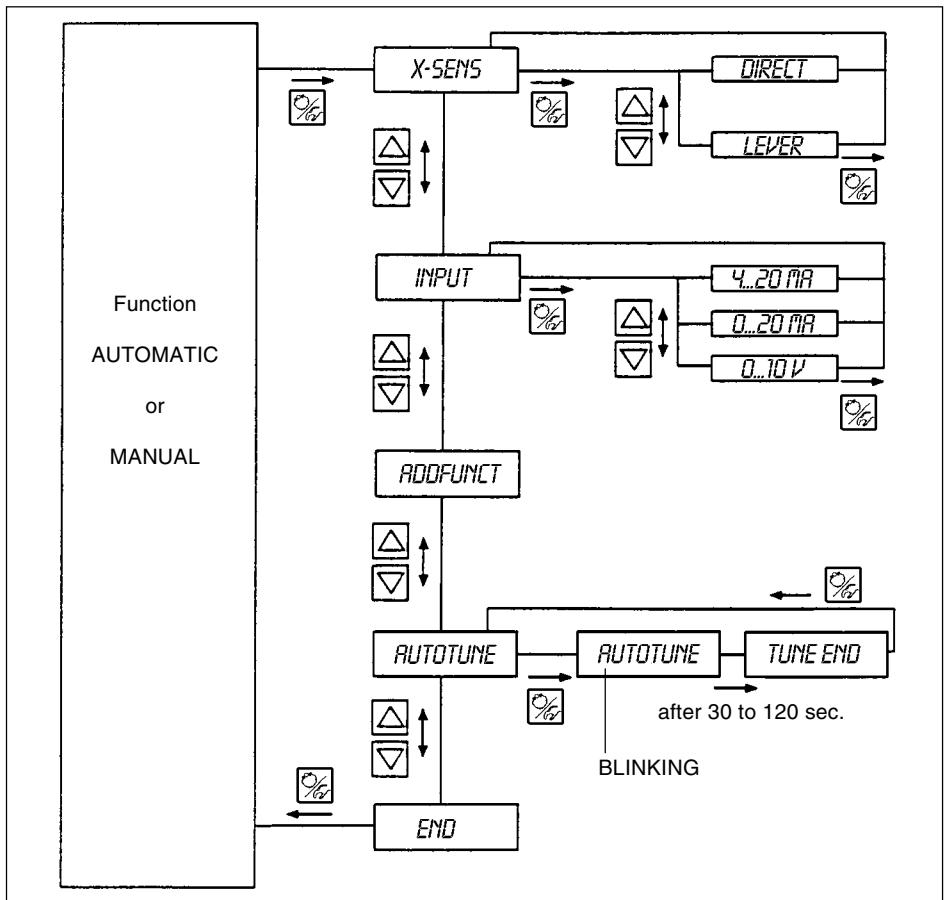
## 4.3 Setting up

The following basic settings are to be carried out on the initial setting up (commissioning) of the positioner in conjunction with the 2632 angle-seat control valves (specification of basic functions):

- Specification of the positional feedback of the continuous valve to the positional transducer (direct or lever),
- Specification of the unit signal input chosen for entering the set position (0 ... 20 mA, 4 ... 20 mA or 0 ... 10 V),
- Initiating the automatic adaptation of the actuator to the valve being used.

When the power is switched on, the positioner is in the process control level. It is necessary to switch to the configuration level for specification of the basic functions. To do this, press the MANUAL/AUTOMATIC key and hold for 5 seconds. The first menu point X-SENS of the main menu is then displayed.

Fig. 21 Main menu for first setting up



To perform a setting within the X-SENS and INPUT menu items, briefly press the MANUAL/AUTOMATIC key again. One of the menu sub-items then appears in the display. It is possible to switch back and forwards between these sub-items, each of which describes a possible setting, by again pressing the arrow keys. The actual setting is carried out by pressing the MANUAL/AUTOMATIC key on the selected menu sub-item.

Fig. 22 Signification of the menu options in the main menu

Basic function	Associated settings
<b>X-SENS</b> - DIRECT - LEVER	Type of information transfer between the actuator and travel measuring system (factory-set to DIRECT) - Linear relationship - Sinusoidal relationship (use of a lever)
<b>INPUT</b> - 4 ... 20 MA - 0 ... 20 MA - 0 ... 10 V	Specification of selected unit signals - Unit signal current 4 ... 20 mA - Unit signal current 0 ... 20 mA - Unit signal voltage 0 ... 10 V
<b>ADDFUNCT</b>	Configuration of additional functions
<b>AUTOTUNE</b>	Actuation of automatic adaptation of the actuator to the valve
<b>END</b>	End of menu

Under the menu option X-SENS, indicate whether the mechanical transmission of path information from the positioner to the feedback/positional transducer is based on a linear or sinusoidal relationship. A sinusoidal relationship results if the lever mechanism is used for the transmission of path information (cf. section 3.1.1). In this event, when LEVER is confirmed an internal linearization takes place by means of an approximated sinusoidal function.

The ADDFUNCT menu item can be skipped on the initial setting up. It is used only to configure additional functions.

The AUTOTUNE menu item is used to start the programme for automatic parametering of the positioner. This automatically triggers the following functions:

- Matching the sensor signal to the (physical) stroke of the control valve used.
- Determining parameters of PWM signals for control of the internal solenoid valves.
- Optimum adjustment of the control parameters of the position controller (target function: fastest possible movement to the set position without hunting).

The programme for automatic parametering is started by setting the AUTOTUNE menu item in the main menu and then pressing the MANUAL/AUTOMATIC key and holding for 5 seconds. TUNE is displayed with a countdown from 5 to 0. The word AUTOTUNE then flashes for approximately 30 to 120 seconds (depending on the actuator volume). After the flashing ends, the message TUNE END is displayed.

**Note:** In case of complete delivery of a valve fitted with a positioner, the AUTOTUNE function has already been run through in factory. In order to obtain the best accuracy, it is recommended to run the AUTOTUNE function once more before putting the valve in operation.

If it is not possible to fully complete the AUTOTUNE routine, an error message is displayed (refer to the list of error messages in part 5).

To leave the main menu for the settings during the setting up, first select the END menu item by pressing the arrow keys. Then press the MANUAL/AUTOMATIC key to restore the unit to the operating mode which was present before the changeover to the main menu (MANUAL or AUTOMATIC).

## 4.4 Process operation

### 4.4.1 Meaning of LEDs and keys in the *process operation level*

**LED** Green LED in the MANUAL/AUTOMATIC key is on: AUTOMATIC mode  
Green LED in the MANUAL/AUTOMATIC key is off: MANUAL mode

#### Keys

- Operation of the MANUAL/AUTOMATIC key (key pressed for less than 5 seconds) changes over between the MANUAL and AUTOMATIC modes.
- Pressing the MANUAL/AUTOMATIC key and holding for longer than 5 seconds gives entry to the configuration menu.
- Pressing the arrow keys in the AUTOMATIC mode with additional function PCONTROL SETPOINT INTERN and display set to SP (holding for longer than 3 seconds): changes the setpoint value (see section).
- Operation of the arrow keys in the AUTOMATIC mode (key held for less than 3 seconds) changes over the display.
- Pressing the „Arrow up“ key in the MANUAL mode moves the actuator to open.
- Pressing the „Arrow down“ key in the MANUAL mode moves the actuator to closed.

### 4.4.2 Displays

#### Displays in the AUTOMATIC mode

##### Process controller inactive

The following displays are possible for the position controller.

Actual position of valve actuator: **XPOS**\_\_\_ (0...100%)

Set position of valve actuator: **WPOS**\_\_\_ (0...100%)

It is possible to change over between these displays by operating the „arrow keys“.

##### Process controller active

When the process controller is active, the following values can be displayed:

Actual value of process variable (actual process value): **PV**\_\_\_ (-99.9...999.9)

Desired value of process variable (desired process value): **SP**\_\_\_ (-99.9...999.9)

Actual value of valve drive: **XPOS**\_\_\_ (0...100%)

Desired value of valve drive: **WPOS**\_\_\_ (0...100%)

The arrow keys can be used to switch between these four displays. The «down arrow» key allows paging through displayed values in the above sequence.

If the additional function PCONTROL SETPOINT INTERN (set desired value via keyboard) was specified during configuration, pressing either of the two arrow keys for more than 3 seconds while SP (Setpoint) is shown in the display activates the mode for changing the desired process value. If the key is released after this time, the first digit of the desired process value flashes on and off. This digit can be changed by pressing the key again. After confirmation with the HAND/AUTOMATIC key, the set value is accepted. The same process can be applied to the other digits. When the fourth digit has been confirmed, the mode switches back.

## Displays in the MANUAL mode

### Process controller inactive

The actual position of the actuator is displayed: **XPOS**\_\_\_ (0...100%)

### Process controller active

In the HAND operating condition no operations are being carried out, the actual value of the process quantity is continuously displayed: **PV**\_\_\_ (-99.9...999.9).

If the arrow keys are pressed (cf. section) for manual actuation of the valve, the actual position is displayed: **XPOS**\_\_\_ (0...100%)

When the keys are not being pressed, the display again shows the actual process value PV.

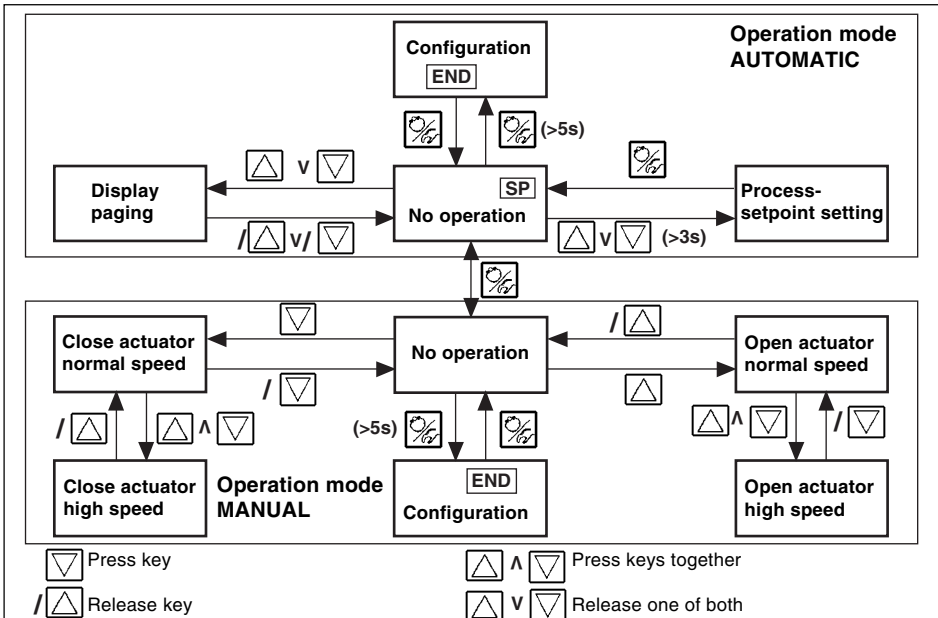
The changeover between the MANUAL and AUTOMATIC modes is achieved by operating the MANUAL/AUTOMATIC key.

If the „Arrow up“ key is pressed whilst in the MANUAL mode, the continuous action valve is continuously moved in the open direction by the actuator. When the key is released this operation is interrupted and the valve remains in the position it has taken up. Pressing the „Arrow down“ moves the valve towards the closed position in a corresponding manner.

If a different arrow key is additionally pressed after pressing an arrow key, the valve moves in rapid action in the direction specified by the key which was first operated.

Changeover to the configuration level can be achieved in both the MANUAL and AUTOMATIC modes by pressing the MANUAL/AUTOMATIC key and holding for 5 seconds. A switch back to the process control level sets the mode which was present before the changeover.

Fig. 23 Overview of the operation structure



## 4.5 Configuration

### 4.5.1 Additional functions

The operating concept of the positioner is based on a strict separation between basic and additional functions. Only the basic functions are activated in the delivery state of the unit. These enable the unit-specific basic settings to be carried out on the initial setting up (cf § 4.3). These are adequate for normal operation. For more demanding tasks of position and process control, additional functions which have been preset in the configuration level, can be selected and specified.

The additional functions are listed below. For further informations about these functions , see § 4.5.4.

Fig. 24 **Additional functions**

Additional function	Parameter	Description
ACTUATE	- SINGLE - INTERN - BOOST - DOUBLE	Function of actuator  Single acting actuator with intern or without boost valves Single acting actuator with extern boost valves - Double acting actuator
CHARACT	- LINEAR - 1 : 25 - 1 : 50 - 25 : 1  - 50 :1  - FREE	Selection of the transmission characteristic curve between the input signal and stroke (correction characteristic curve) - Linear characteristic curve - Equal percentage characteristic line with a rangeability of 1 : 25 - Equal percentage characteristic line with a rangeability of 1 : 50 - Inverse equal percentage characteristic with a rangeability of 25 : 1 - Inverse equal percentage characteristic with a rangeability of 50 : 1 - User-defined, characteristic line freely programmable
DEADBND	- DBD	Dead band with regard to the closed tight function system deviation
CLTIGHT	- CLT	Close tight function - Closed tight threshold
DIRECTN	WPOS - RISE - FALL XPOS  - RISE - FALL	Relationship between input signal and measure - Direct direction of action - Inverse direction of action Relationship between ventilation of the actuators chamber A1 and the setpoint - Direct direction of action - Inverse direction of action
SPLTRNG	- MIN - MAX	Signal range splitting, input signal in % for the complete stroke range through which the valve passes - Input of minimum value of input signal. - Input of maximum value of input signal.

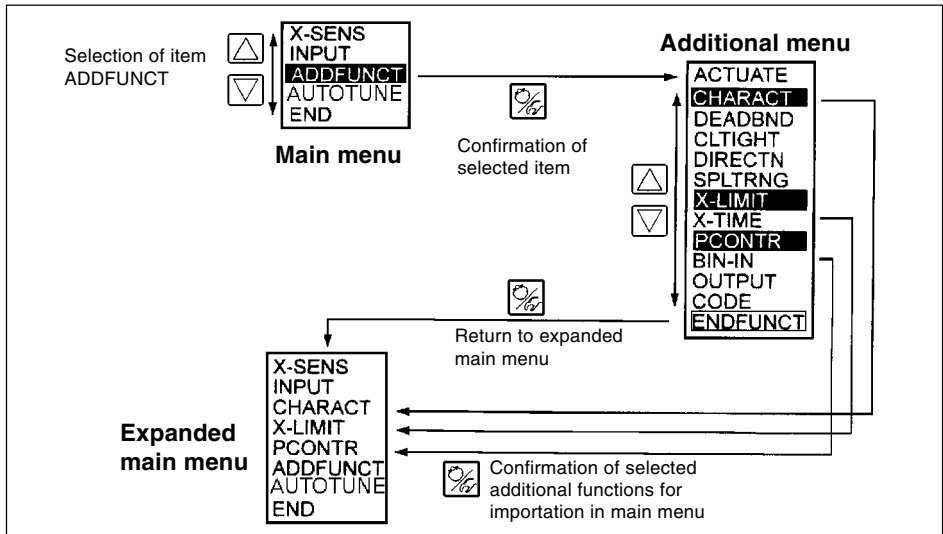
X-LIMIT	<ul style="list-style-type: none"> <li>- XMIN</li> <li>- XMAX</li> </ul>	Limitation of mechanical range - Input of initial value of stroke range in % - Input of final value of stroke range in %
X-TIME	<ul style="list-style-type: none"> <li>- OPN FAST</li> <li>- OPN SLOW</li> <li>- CLS FAST</li> <li>- CLS SLOW</li> </ul>	Limitation of correcting time - No limitation of correcting time during opening - Limitation of correcting time during opening - No limitation of correcting time during closing - Limitation of correcting time during closing
PCONTRL	<ul style="list-style-type: none"> <li>- SETPOINT   INTERN   EXTERN</li> <li>- PARAM   KP   TN   TV   X0   DBD</li> <li>- SCALE   DP   PV-L   PV-H   SP-L   SP-H</li> </ul>	Process controller configuration - Method of presetting desired value Desired value preset internally via keys Desired value preset externally via signal input - Process controller parameters Proportional correction value Reset time Rate time Operating point No sensibility range of the process controller - Scalling input and setpoint values Position of decimal point Lower scale value for process quantity Upper scale value for process quantity Lower scale value for setpoint (only for SETPOINT EXTERN) Upper scale value for setpoint (only for SETPOINT EXTERN)
BIN-IN	<ul style="list-style-type: none"> <li>- INACTIVE</li> <li>- SAFEPOS   SPOS</li> <li>- NORM OPN</li> <li>- NORM CLS</li> </ul>	Operation of binary input. - Binary input inactive - Safety position Position in % - Binary input open, if not active (closed) - Binary input closed, if not active (open)
OUTPUT	<ul style="list-style-type: none"> <li>- ANALOG</li> <li>- BINARY   XDO   XD   NORM OPN   NORM CLS</li> <li>BOOST</li> </ul>	Output configuration (option) - Analogic position feedback - Programmable Binary output Control value deviation alarm Limit value of admissible control value deviation - Binary output normally open - Binary output normally closed - Signal output for external Booster valve
CODE	<ul style="list-style-type: none"> <li>- MENU+M/A</li> <li>- MENU+M/A</li> </ul>	4 Positions user code Protection code for all operating functions Protection code for configuration menus

## 4.5.2 Configuration menu

The configuration menu can be activated from the process control level by pressing the MANUAL/AUTOMATIC key during 5 seconds. It consists of a main menu and additional menu. The main menu contains mainly the basic functions which are to be specified on the initial setting up (cf § 4.3). The additional menu covers all the additional functions which can be selected. It can be reached via the ADDFUNCT item in the main menu. The equipment functions and parameters can only be specified within the main menu. If necessary, however, the main menu can be extended by additional functions from the additional menu, and these can in turn also be specified.

The principle of taking menu items from the additional menu into the main menu is described by figure 25. First select the ADDFUNCT item in the main menu and then press the MANUAL/ AUTOMATIC key to enter the additional menu. When in the additional menu the „Arrow up“ or „Arrow down“ keys can be pressed to set the required additional function. If this additional function is confirmed by pressing the MANUAL/ AUTOMATIC key, it is then automatically marked with a star (\*). All the functions marked in this way are brought into the main menu after the ENDFUNCT is confirmed. The additional functions can now be parametered in the main menu expanded in this way, and automatically activated.

Fig. 25 Principle of integration of additional function in the main menu

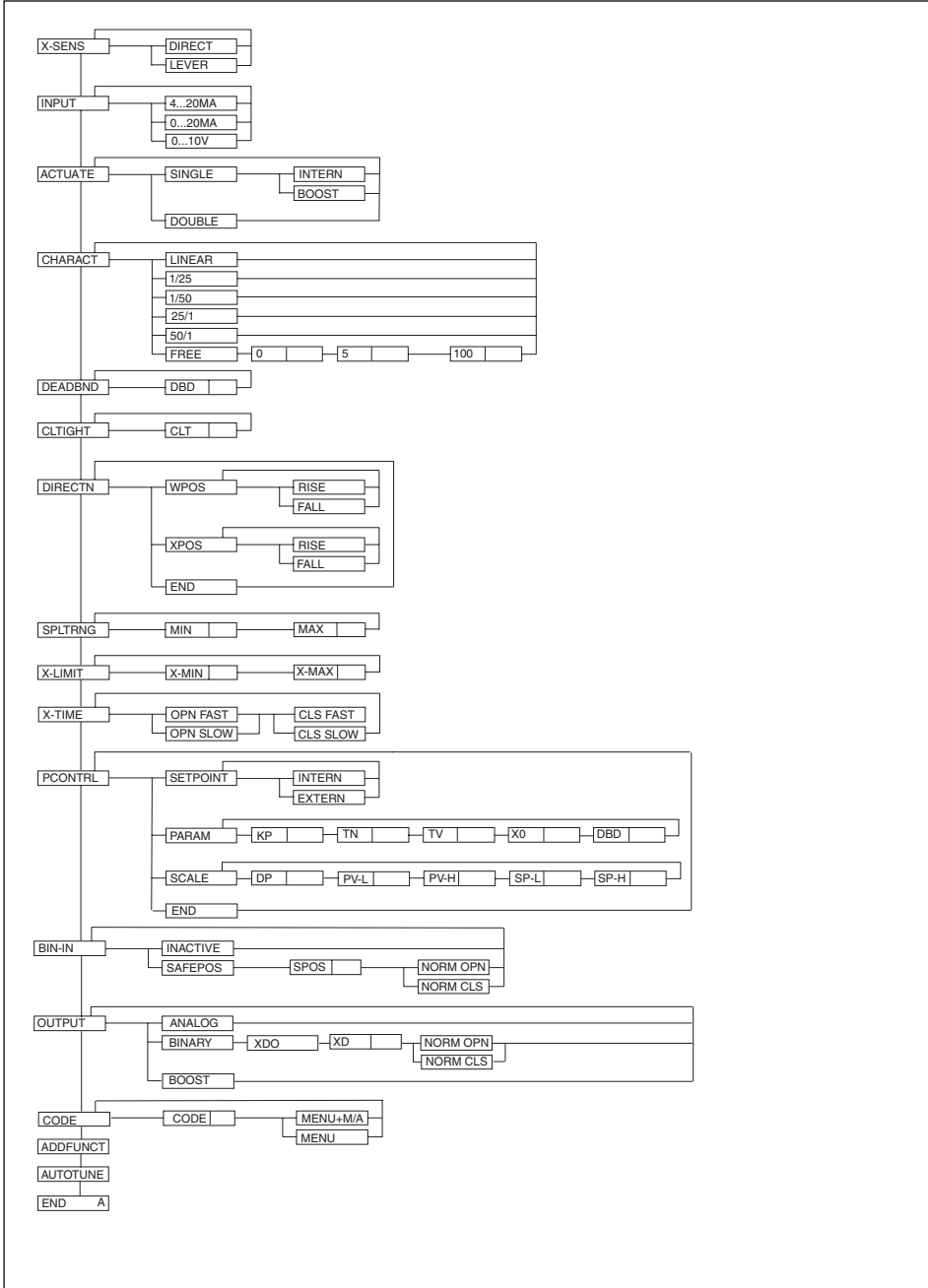


To remove additional functions which have brought into the main menu, again select the ADDFUNCT function and then press the MANUAL/AUTOMATIC key in the additional menu. If only one additional function marked with a star (\*) is now selected and confirmed by pressing the MANUAL/AUTOMATIC key, it will then be removed from the main menu, and deactivated..

Fig. 26 shows the complete configuration menu with all the basic and additional functions. Continued selection in the vertical direction is achieved by pressing the appropriate arrow keys. Press the MANUAL/AUTOMATIC key to move in the horizontal direction.

Setting numerical values in the appropriate menu items is achieved by pressing the „Arrow up“ key once or several times (increment numerical value) or the „Arrow down“ (decrement numerical value). In the case of 4-digit numbers, only the flashing position can be set using the „Arrow keys“. Pressing the MANUAL/AUTOMATIC key changes to the next position.

Fig. 26 Complete configuration menu





### 4.5.3 Function of keys in the configuration level

Operation of the „Arrow up“ key

- Scroll upwards in menu (selection).
- Incrementing numerical values in a selected and confirmed menu item.

Operation of the „Arrow down“ key

- Scrolling downwards in the menu (selection).
- Decrementing numerical values in a selected and confirmed menu item.

Operation of the MANUAL/AUTOMATIC key within the main menu

- Confirmation of a selected menu item.
- Confirmation of a set value.

Operation of the MANUAL/AUTOMATIC key within the additional menu

- Confirmation of a selected menu item of the additional menu for inclusion in the main menu. The selected menu item is marked with a star (\*) in the additional menu. The menu item now appears in the main menu where it can be selected and manipulated.
- Confirmation of a selected menu item of the additional menu, marked with a star, for deletion from the main menu.

### 4.5.4 Notes on the basic and additional functions

**X-SENS** (factory setting: DIRECT): Specification of the type of information transfer between the continuous action valve (valve setting) and the travel measuring system.

**Options:**

**DIRECT:** There is a linear relationship between the valve position and the input signal of the path-measuring system.

**Examples:**

Fitting the positioner to a piston valve (e.g. 2031) and using the external feedback/positional transducer (linear potentiometer) to measure the piston position (see section 3.1.2 and Fig. 11). Here, the linear movement of the piston is transformed into a linear movement of the potentiometer. A characteristic correction is therefore not required.

Fitting the positioner to a flap valve with part-turn valve actuating drive (e.g. 3210) and using the internal feedback/positional transducer (rotary potentiometer) to measure the flap position (see section 3.1.3 and Fig. 15). The rotary movement of the flap is converted into a proportional rotary movement of the potentiometer. A characteristic correction is not required.

**LEVER:** There is a sinusoidal relationship between the valve position and the input signal of the path-measuring system.

**Example:**

Fitting the positioner to a membrane valve (e.g. 265) and using the internal feedback/positional transducer (*rotary potentiometer*) to measure the valve position (see section 3.1.1 and Fig. 7). Coupling is via a lever conforming to NAMUR. The linear movement of the membrane is transformed into a rotary movement of the potentiometer. A sinusoidal curve results. In this option, therefore, the transmission characteristic is linearized internally.

**INPUT** (factory setting: 4 - 20 mA): Specification of the selected unit signal.

**Options:**

- 4 - 20 mA:** Use of the 4 ... 20 mA unit signal input
- 0 - 20 mA:** Use of the 0 ... 20 mA unit signal input
- 0 - 10 V:** Use of the 0 ... 10 V unit signal input

**ACTUATE** (factory setting: SINGLE, INTERN): Method of operation of the valve actuator used.

**Options:**

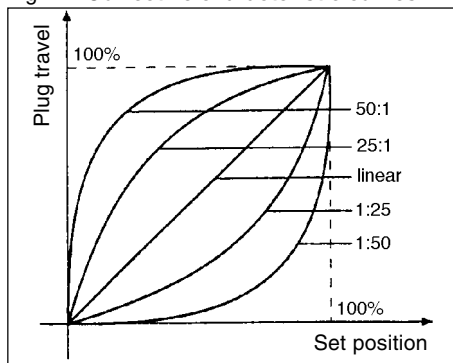
- SINGLE, INTERN:** Use of a single acting actuator with intern or without boost valves,  
**SINGLE, BOOST:** Use of a single acting actuator with boost valves,  
**DOUBLE:** Use of a double acting actuator

**CHARACT** (factory setting: LINEAR):

Customer-specific characteristic.

This additional function enables a transmission characteristic curve with regard to the desired value of the setting (set position) and valve stroke for correction of the flow or operating curve to be chosen (Fig 27).

Fig. 27 Corrective characteristic curves



The flow characteristic  $k_v = f(s)$  characterises the flow of a valve and is expressed by the  $k_v$  value relative to the stroke  $s$  of the valve spindle. It is determined by the shape of the valve body. There are normally two types of flow characteristic curves: linear and equal percentage. In the case of linear characteristic curves equal changes in stroke  $ds$  are assigned to equal  $k_v$  value changes  $dk_v$  ( $dk_v = n_{lin} ds$ ). In the case an equal percentage characteristic curve a change in stroke  $ds$  corresponds to an equal percentage change in the  $k_v$  value ( $dk_v/k_v = n_{gleichpr} ds$ ).

The operating curve  $Q = f(s)$  represents the relationship between the rate of flow  $Q$  which flows through a valve fitted in the system and the stroke  $s$ . This curve is also affected by the properties of the pipelines, pumps and consumers. It therefore has a form which deviates from the flow characteristic curve.

Specific requirements are usually laid down for the operating characteristic curve (e.g. linearity) in the case of correcting tasks for closed loop control systems. Therefore it is sometimes necessary for this reason to correct the pattern of the operating curve in a suitable manner. A transmission element which implements various characteristic curves which can be used to correct the operating curve is provided in the positioner for this purpose. One linear and various equal percentage characteristic curves with a control ratio of 1:25, 1:50, 25:1 and 50:1 can be set (see fig. 27). It is also possible to freely programme a characteristic curve via restart points.

**Options:**

- LINEAR** Linear characteristic curve  
**1:25** Equal percentage characteristic curve with a control ratio of 1:25  
**1:50** Equal percentage characteristic curve with a control ratio of 1:50  
**25:1** Inverse equal percentage characteristic curve with a control ratio of 25:1  
**50:1** Inverse equal percentage characteristic curve with a control ratio of 50:1  
**FREE** Freely-programmable characteristic curve based on temporary restart points

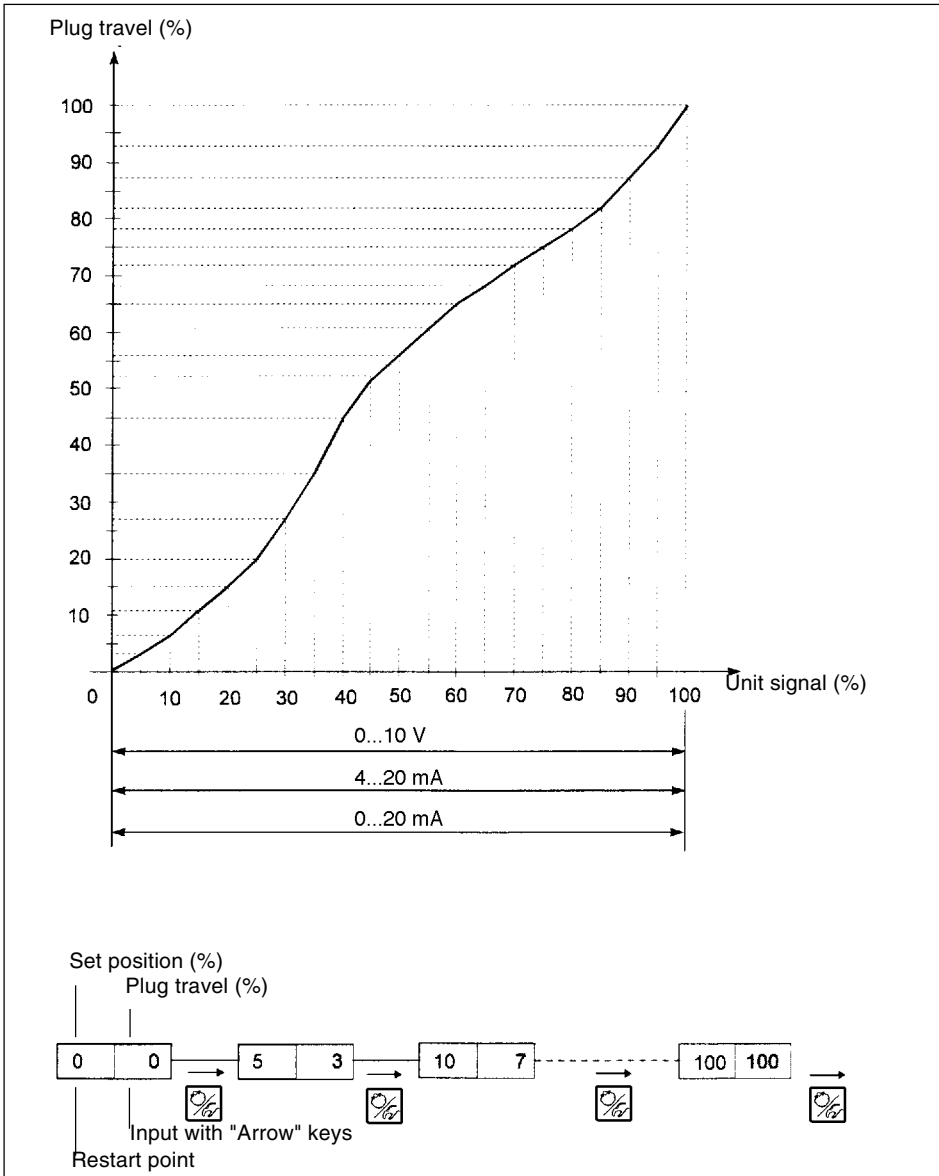
### Input of the freely-programmable characteristic curve

The characteristic curve is defined by means of 21 restart points distributed uniformly over the set positioning range of 0 ... 100%. These are spaced at 5%. A freely-selectable stroke (range 0 ... 100%) can be assigned to each restart (Fig. 28). The difference between the values of the stroke of two adjacent restart points shall not exceed 20%.

To input the characteristic curve points (function values), the FREE menu item is first set. After operation of the MANUAL/ AUTOMATIC key the first restart point is input with the display 0 (%). After this the next function value is 0 (%). A function value from 0 to 100% can be set using the arrow keys. After confirmation using the MANUAL/AUTOMATIC key the next restart point is shown on the display etc. If finally the MANUAL/AUTOMATIC key is pressed to confirm the function value for the last restart point (100%), the program switches back to the CHARACT menu item.

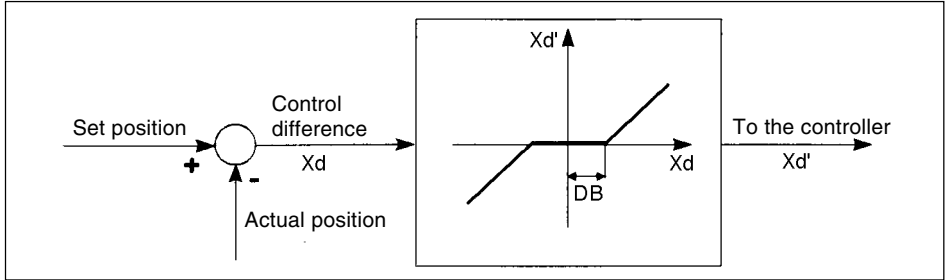
Fig. 28 demonstrates an example of the free programming of a correction curve.

Fig. 28 Example of a characteristic curve to be programmed



**DEADBND** (factory setting : DBD = 0.5%): Deadband around the system deviation  
 The DEADBND additional function enables the response of the actuator to occur only after a specific system deviation [DBD] (Fig. 29). This „protects“ the servo valve.

Fig. 29 Deadband DBD



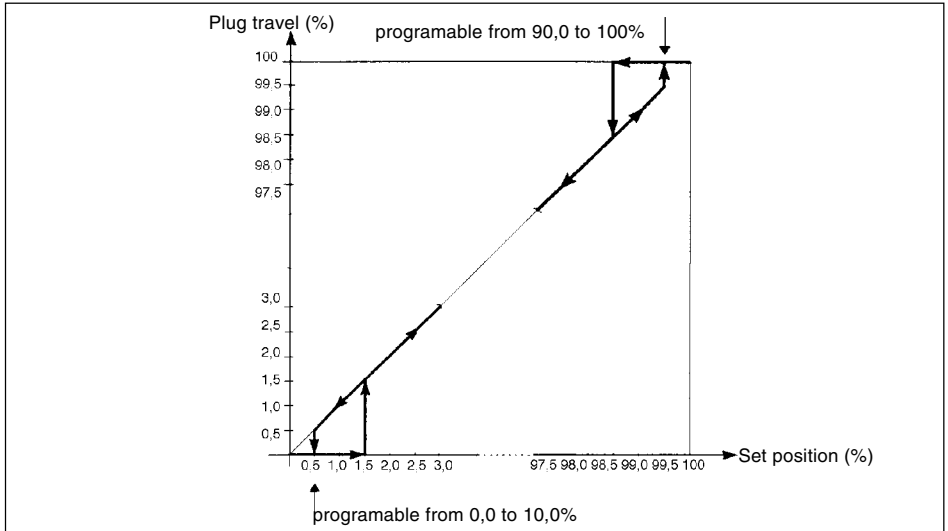
**Rangeability:**

Maximum 5% relative to the stroke range.  
 The bottom limit is determined by AUTOTUNE.

**CLTIGHT** (factory setting: CLT = 0.5%): Closed tight function.

The closed tight function ensures that the valve is tightly closed outside the control range.

Fig. 30 Closed tight function



**CLT:** Closed tight threshold

Specification of a value (%) from which the actuator air is completely exhausted (at 0%) or supplied with air (at 100%). The opening or resumption of the control operation takes place with a hysteresis of 1% (refer to Fig. 30).

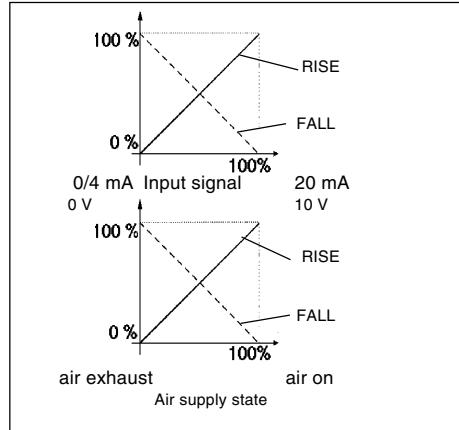
**Setting range:**

0.0 ... 10.0% (applies both for complete exhausting as well as for complete air supply, see Fig. 30).

**DIRECTN** (FACTORY SETTING: WPOS = RISE, XPOS = RISE): Sense or direction of action. By means of the **WPOS** additional function the sense of action between the input signal and the setpoint (WPOS). can be set, and also by means of **XPOS** the assignment of the air supply state of the actuator A1 to the indicated value (XPOS).

Input		DIRECTN WPOS	Setpoint (WPOS)
I1	U1		
0/4 mA 20 mA	0 V 10 V	RISE	0 % 100 %
0/4 mA 20 mA	0 V 10 V	FALL	100 % 0 %
Air supply State A1		DIRECTN XPOS	Measure (XPOS)
Air exhaust Air on		RISE	0 % 100 %
Air exhaust Air on		FALL	100 % 0 %

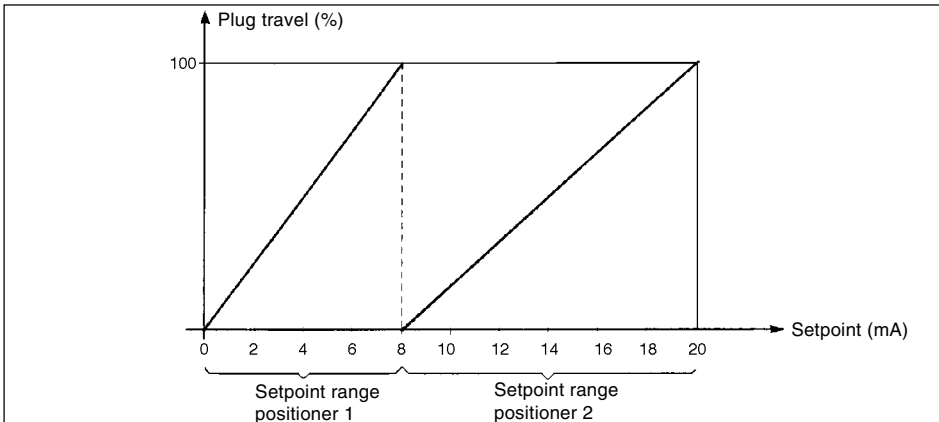
Fig. 31 Sense of action



**SPLTRNG** (factory setting: MIN = 0%, MAX = 100%): Split range

This additional function enables the set value range of a positioner to be restricted by stipulating a minimum and maximum value. This makes it possible to divide the used unit signal range (0 ... 10 V, 0 ... 20 mA or 4 ... 20 mA) over several positioners (without or with an overlap). In this way, several valves can be partially used either simultaneously or in sequence as a final controlling element (Fig. 32).

Fig. 32 Splitting a unit signal range into two set value ranges



**Setting range:**

**MIN:** 0 ... 75 % of the unit signal range,

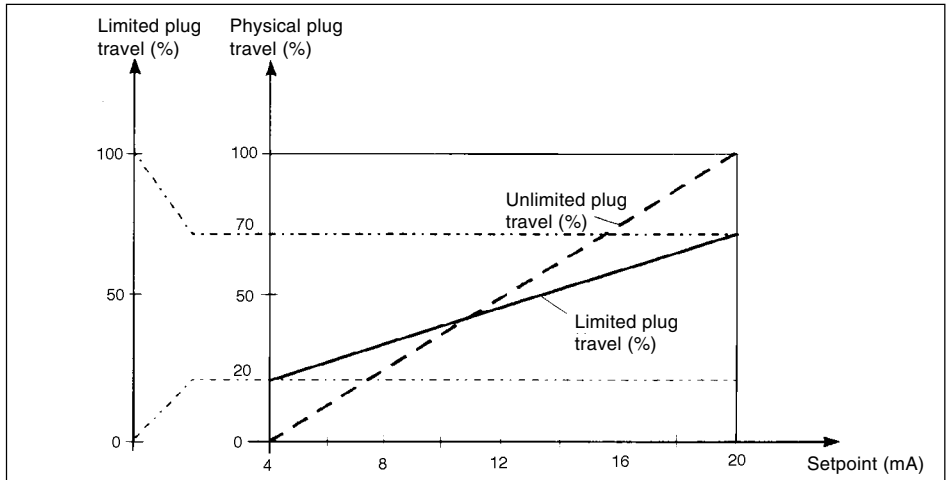
**MAX:** 25 ... 100 % of the unit signal range.

The minimum distance between MIN and MAX is 25%.

**X-LIMIT** (factory setting: XMIN = 0%, XMAX = 100%): Stroke limitation.

This additional function enables the (physical) stroke to be limited to a given MIN and MAX percentage value (Fig. 33). In the AUTOMATIC mode the stroke range of the limited stroke is then set to equal 100%. In the MANUAL mode, on the other hand, the physical stroke is displayed. (It should therefore be noted that a limited stroke will be displayed differently in the AUTOMATIC and MANUAL modes).

Fig. 33 **Stroke limitation**



**Setting range:**

**XMIN:** 0 ... 50 % of the total stroke,

**XMAX:** 50 ... 100 % of the total stroke.

The minimum distance between XMIN and XMAX is 50%.

**X-TIME** (factory setting: OPN FAST, CLS FAST): Setting speed limitation

**Options:**

**OPN FAST** (open fast): Opening of the control valve happens with maximal control speed.

**OPN SLOW** (open slow): The maximum setting speed of the control valve is limited during opening.

**CLS FAST** (close fast): Closing of the control valve happens with maximal control speed.

**CLS SLOW** (close slow): The maximum setting speed is limited when the control valve is closing.

**PCONTRL** (process control): Process controller configuration

**SETPOINT** (factory setting: EXTERNAL): Preset desired value.

**INTERN:** Desired value can be input using the arrow keys (see § 4.4.2).

**EXTERN:** Desired value is preset via the standard signal input.

**PARAM:** Set parameters for process controller (PID controller)

**KP:** (Proportional correction value or amplification)

**Range of settings:** 0...99.99 (factory setting: 1.00)

**TN:** (reset time)

**Range of settings:** 0.5...999.9 (factory setting: 999.9)

**TV:** (rate time)

**Range of settings:** 0.0...999.9 (factory setting: 0)

**X0:** (Operating point of process controller)

**Range of settings:** 0...100% (factory setting: 0%)

**DBD:** No sensibility range of the process controller

**Range of settings:** 0,2...5% (factory setting: 0,5 %)

**SCALE:** Scales the inputs of the process controller.

**DP:** Decimal point position

**Range of settings:** 0 ... 3 (factory setting 0)

**PV-L:** Lower scale value for actual process value. It is assigned to the smallest current or voltage value of the standard signal.

**Range of settings:** -99.9...990.0 (factory setting: 0.0)

**PV-H:** Upper scale value for actual process value. It is assigned to the greatest current or voltage value of the standard signal.

**Range of settings:** -90.0...999.9 (factory setting: 100.0)

**SP-L:** Lower scale value for desired process value (setpoint). It is assigned to the smallest current or voltage value of the standard signal. (Applies only with the setting SETPOINT EXTERN).

**Range of settings:** -99.9...990.0 (factory setting: 0.0)

**SP-H:** Upper scale value for desired process value (setpoint). It is assigned to the greatest current or voltage value of the standard signal. (Applies only with the setting SETPOINT EXTERN).

**Range of settings:** -90.0...999.9 (factory setting: 100.0)

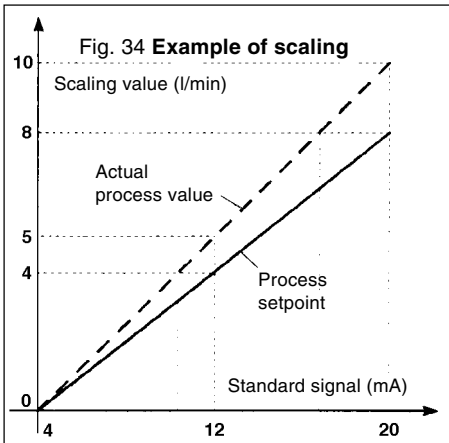
### Example of scaling:

Actual process value via transmitter:

4...20 mA corresponds to 0...10 l/min

Desired process value from SPC:

4...20 mA corresponds to 0...8 l/min



Possible scale-value inputs in the example of scaling

	Variante 1	Variante 2	Variante 3
PV-L	0	0	0
PV-H	1,0	10,0	100,0
SP-L	0	0	0
SP-H	0,8	8,0	80,0

The input of large scale values increases display precision.

The amplification (KP) of the process controller relates to the set scale values.

With SETPOINT INTERN (desired values preset via the arrow keys) no scaling of the desired value (SP-L, SP-H) is possible. It can be entered directly in correspondence with the scaled process variable (PV-L, PV-H).



**BIN-IN** (factory setting: INACTIVE): Binary input.

The action of the binary input (contact) can be specified by means of this additional function.

**Options:**

**INACTIVE:** Binary input is not active.

**SAFEPOS** (safety position): Input of a safety position SPOS selected if necessary.

**Setting range:** 0 ... 100% of the stroke range (factory setting: SPOS = 0).

**NORM OPN** (normally open): Binary input in de-energised position open (normally-open contact or closer). Safety position is adopted when the contact closes.

**NORM CLS** (normally closed): Binary input in de-energised position closed (normally-closed contact or opener). Safety position is adopted when the contact opens.

**OUTPUT** (option): (Additional function only activable with optional board.)

- **ANALOG** Analogic position feedback (4...20 mA) (see Appendix 3)
- **BINARY** Programmable Binary output (see Appendix 4)
  - XDO** Alarm deviation value exceeds XD
  - XD** Deviation limit value ; Setting range: 0,1 ... 20% (Factory setting 1%)
  - NORM OPN** Binary output normally open
  - NORM CLS** Binary output normally closed
- **ALARM** Alarm signal, XMIN or XMAX threshold reached
  - XMIN** Low alarm limit value ; Setting range: 0...100%
  - NORM OPN** Binary output XMIN normally open
  - NORM CLS** Binary output XMIN normally closed
  - XMAX** High alarm limit value ; Setting range: 0 ... 100%
  - NORM OPN** Binary output XMAX normally open
  - NORM CLS** Binary output XMAX normally closed
- BOOST** Signal output for external Booster valve (see Appendix 4)

**CODE** (factory setting: 0000) User code. The positioner can be protected from unauthorised operation by means of a 4-digit user code. 2 Levels of protection are available.

**MENU+M/A:** All functions protected by the user-code

**MENU:** Access to configuration menu restricted. MANU/AUTO switching and change of process values are free (cf § 4.4.1).

**Setting range:** 0000 ... 9999

Regardless of the possibility of the existence of a preset code, there is a fixed programmed master code which when entered enables all control operations to be performed.

**ADDFUNCT** (Additional functions): Additional functions.

This enables additional functions to be taken into the main menu and then removed (see § 4.5.2).

**AUTOTUNE:** Automatic parametering.

This function enables the program for automatic adaptation of the actuator to the valve in use to be started. The following functions are automatically initiated (see section 4.3):

- The sensor signal is matched to the (physical) lift of the continuous valve,
- The parameters of the PWM signals are determined in order to control the internal magnetic valves,
- The parameters of the position controller are adjusted optimally.

This automatic setting of parameters is completed in approximately 30-120 seconds.

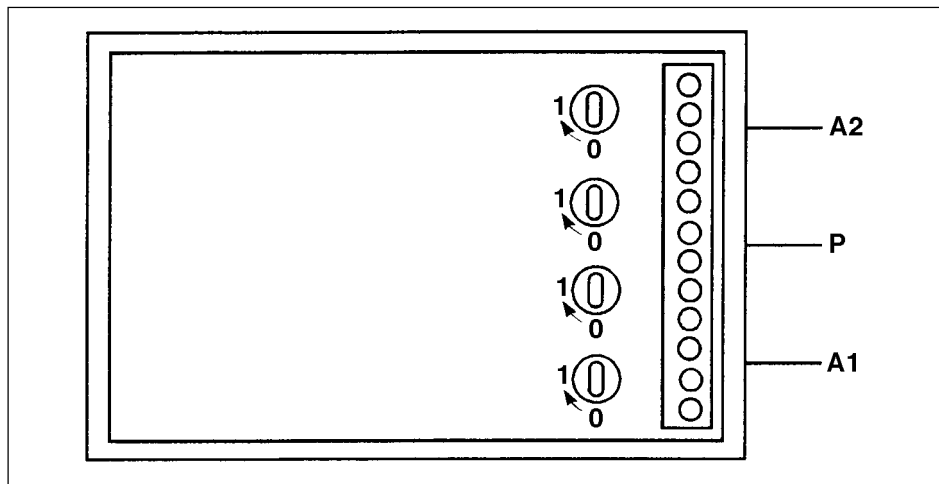
**END:** End of configuration menu.

(The software version is displayed on the right margin of the display). This menu item enables the configuration menu to be left by operation of the MANUAL/AUTOMATIC key (cf § 4.3).

### 4.6 Manual operation without power supply

The solenoid valves integrated in the positioner can be manually operated without a power supply by using rotary knobs. These rotary knobs (red) are accessible when the bonnet of the unit is opened. They are located immediately behind the electrical terminals. Two rotary knobs are provided on the type for single-acting actuator (Fig. 35).

Fig. 35 Manual operation



Preconditions for manual operation using the rotary knobs.

- The power supply of the unit must not be connected under any circumstances.
- The pneumatic connections and the pressure supply must be present.

#### Settings

All rotary knobs are in position 0 (normal position):  
**Drive is vented.**

In this case, in the design for double-acting actuating drives, the chamber connected to terminal A1 is vented and the chamber connected to terminal A2 is supplied with air.

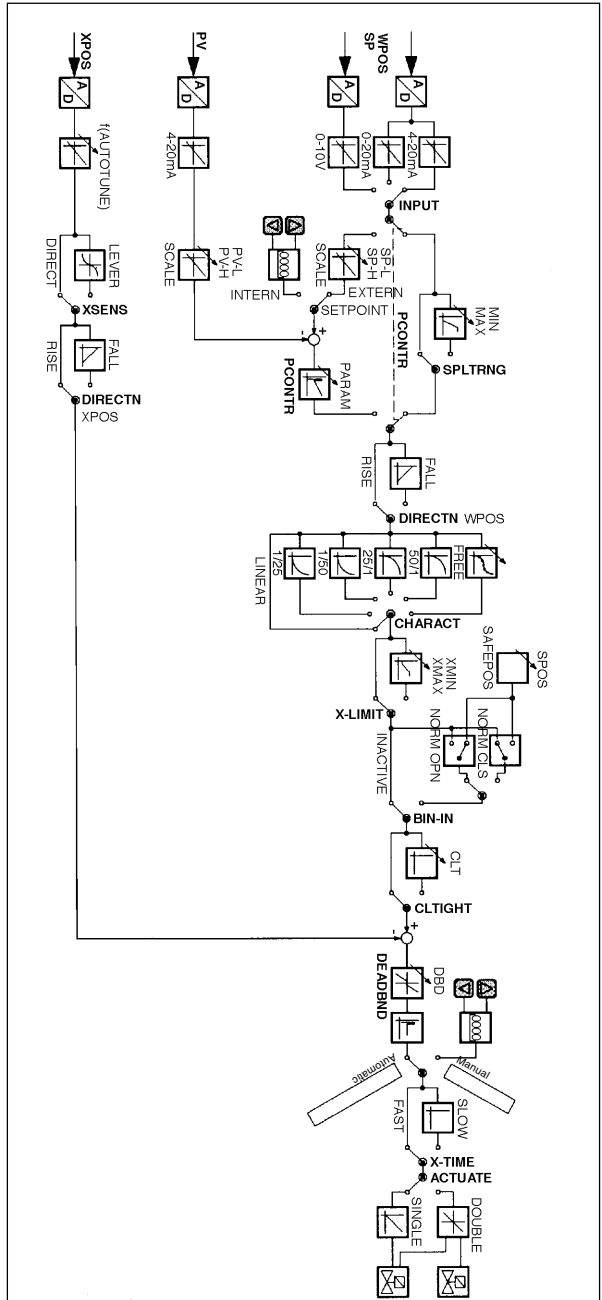
All rotary knobs are in position 1:  
**Drive is supplied with air.**

In this case, in the design for double-acting actuating drives, the chamber connected to terminal A1 is supplied with air and the chamber connected to terminal A2 is vented.

**Caution!:** All rotary knobs must be returned to the 0 position before connecting the power supply to the positioner.

4.7 Structure of the positioner

Fig. 36 Flowchart of positioner 1067



**Fault messages****Faults during switch on**

<i>Message</i>	<i>Possible cause</i>	<i>Remedy</i>
INT.ERROR	Internal fault	Not possible, unit defective

**Fault messages during AUTOTUNE function**

<i>Message</i>	<i>Possible cause</i>	<i>Remedy</i>
TURN POT	Range of the position transducer exceeded (only with internal feedback transducer option)	Remove the positioner from the actuator, and turn the transducer from 180°. cf fig 2.
ERR 2	Actuator not adjustable Opening time < 0.5 s	Fit the positioner with bigger air chambers. Reduce the air pressure
ERR 3	Miscellaneous failures causes Manual operation of valve not in basic setting No air pressure connected Position transducer not connected	Check manual actuation parameters Check compressed air supply Check the electrical connection of the transducer; If external position control system only. (cf fig. 3) Check the mechanical coupling of the position controller; if internal position control system (cf fig. 2)

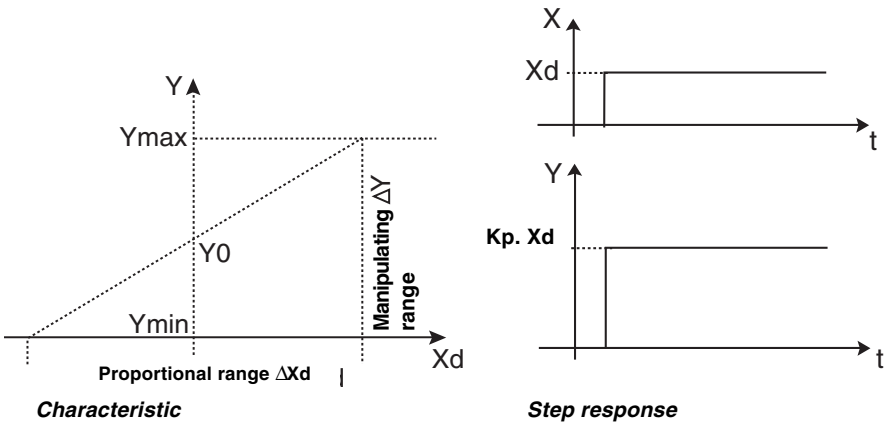
**A1: Characteristics of PID controllers**

A PID controller has a proportional, an integral and a differential component (P, I and D components).

**P component :**

**Function :**  $Y = K_p \cdot X_d$

$K_p$  is the proportional action coefficient. It results from the ratio of the manipulating range  $\Delta Y$  to the proportional range  $\Delta X_d$ .



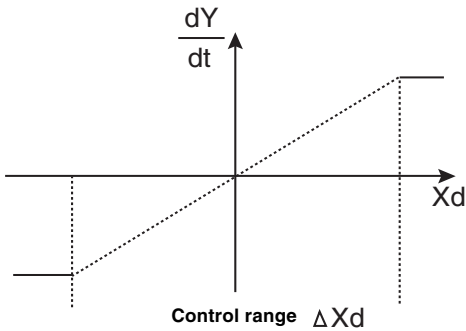
**Characteristics :**

Theoretically, a pure P controller operates without delay, i. e. it is fast and therefore dynamically favorable. It has a lasting system deviation, i. e. it does not balance out the effects of disturbances completely and is therefore relatively unfavorable from the static point of view.

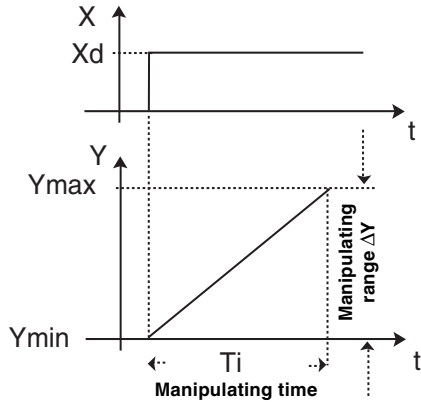
**I component :**

**Function :**  $Y = \frac{1}{T_i} \int X_d dt$

$T_i$  is the integration or manipulating time. This is the time that elapses before the manipulated variable has passed through the complete manipulating range.



**Characteristic**



**Step response**

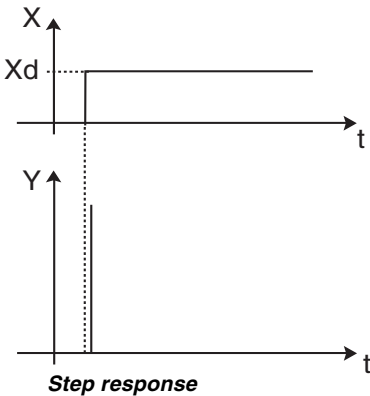
**Characteristics :**

A pure I controller eliminates the effects of occurring disturbances completely. Therefore, it has a favorable static response. Owing to its finite manipulating speed, it operates more slowly than the P controller and tends to oscillate. Therefore, it is relatively unfavorable from the dynamic point of view.

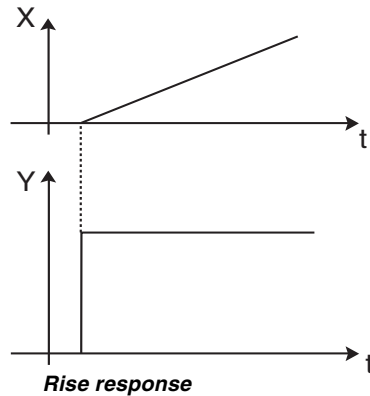
**D component :**

**Function :**  $Y = K_d \frac{d X_d}{dt}$

$K_d$  is the derivative action coefficient.  
The higher  $K_d$  is, the stronger the D influence is.



**Step response**



**Rise response**

**Characteristics :**

A controller with a D component reacts to changes in the controlled variable and is accordingly capable of dissipating occurring deviations faster.

Superposition of P-, I- and D components:

$$Y = K_p X_d + \frac{1}{T_i} \int X_d dt + K_d \frac{d X_d}{dt}$$

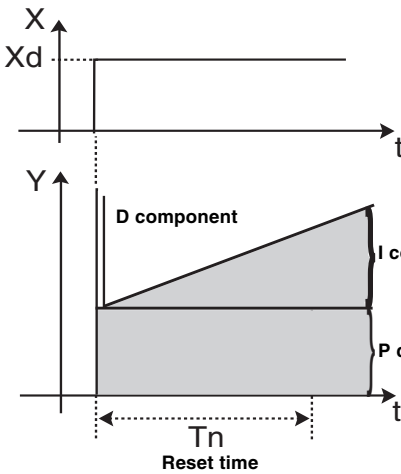
Where  $K_p \cdot T_i = T_n$  and  $\frac{K_d}{K_p} = T_v$ , results with regard to **functioning of the PID controller**:

$$Y = K_p \left( X_d + \frac{1}{T_n} \int X_d dt + T_v \frac{d X_d}{dt} \right)$$

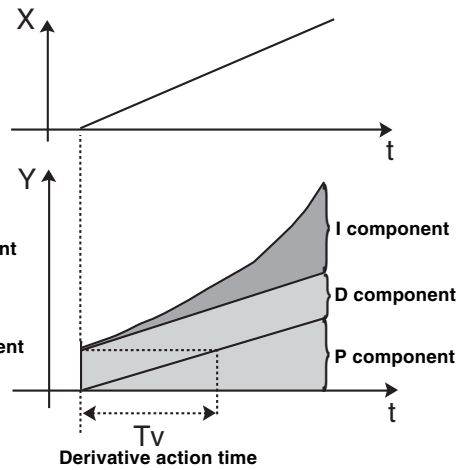
**K<sub>p</sub>** : *Proportional action coefficient / gain*

**T<sub>n</sub>** : *Reset time* (the time needed to achieve the same manipulated variable change by the I component as is produced as the result of the P component).

**T<sub>v</sub>** : *Derivative action time* (the time to achieve a specific manipulated variable on the basis of the D component earlier than when using a pure P controller).



*Step response of the PID controller*



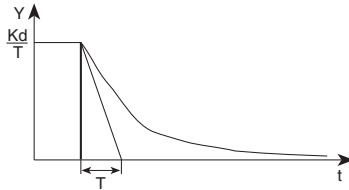
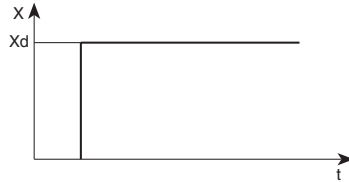
*Rise response of the PID controller*

**Realised PID controller**

**D component with delay :**

In the 1067 positioner, the D component is realised with a delay T.

**Function :**  $T \frac{dY}{dt} + Y = K_d \frac{dX_d}{dt}$

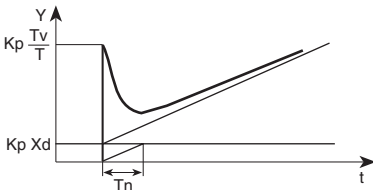
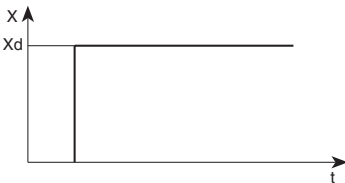


**Step response**

**Superposition of P-, I- and DT components :**

**Function of the real PID controller :**

$$T \frac{dY}{dt} + Y = K_p \left( X_d + \frac{1}{T_n} \int X_d dt + T_v \frac{dX_d}{dt} \right)$$



**Step response of the real PID controller**



## A2: Rules for adjusting PID controllers

The literature on control systems specifies a series of adjustment rules with which a favorable adjustment of controller parameters can be achieved experimentally. To avoid bad adjustments, the conditions under which the respective adjustment rules have been elaborated must always be observed. In addition to the characteristics of the controlled system and of the controller itself, it is important to know whether it is intended to balance out a disturbance change or a command variable change.

### Adjustment rules according to Ziegler and Nichols (oscillation method)

When using this method, controller parameters are adjusted on the basis of the control loop's response at the stability limit. In doing so, the controller parameters are adjusted so as to ensure that the control loop begins to oscillate. A conclusion as to a favorable adjustment of the controller parameters is reached from critical characteristic values occurring in this case. It goes without saying that, when using this method, it must be possible to bring the control loop to oscillation.

#### Method:

- Set the controller as a P controller (i.e.  $T_n = 999$ ,  $T_v = 0$ ), initially selecting a low  $K_p$  value.
- Set the required setpoint.
- Increase  $K_p$  until the controlled variable oscillates continuously without attenuation (see following figure).

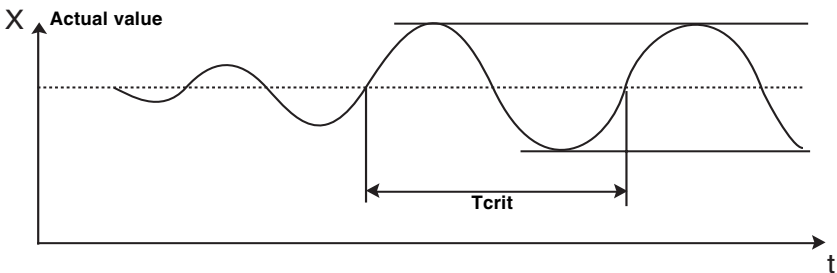


Figure : Progression of the control variable at the stability limit

The proportional action coefficient set at the stability limit is referred as  $K_{crit}$ . The resulting oscillation period is referred to as  $T_{crit}$ .

On the basis of  $K_{crit}$  and  $T_{crit}$ , the controller parameters can then be calculated in accordance with the following table:

**Parameter settings according to Ziegler und Nichols :**

Controller type	Parameter settings		
P controller	$K_p = 0,5 K_{crit}$		
P controller	$K_p = 0,45 K_{crit}$	$T_n = 0,85 T_{crit}$	
P controller	$K_p = 0,6 K_{crit}$	$T_n = 0,5 T_{crit}$	$T_v = 0,12 T_{crit}$

The Ziegler and Nichols adjustment rules were determined for P systems with a time delay of the first order and a dead time. However, they apply only to controllers with a disturbance response, but not to controllers with a command response.

**Adjustment rules according to Chien, Hrones and Reswick (manipulated variable method):**

When using this method, the controller parameters are adjusted on the basis of the controlled system transition response. Be a 100% change in the manipulated variable; The times  $T_u$  and  $T_g$  are derived from the progression of the variable (following figure).  $K_s$  is the proportional action coefficient of the system.

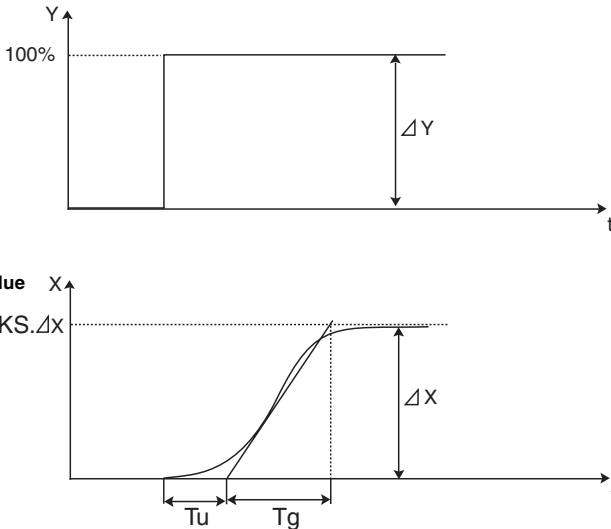


Figure : **Progression of the controlled variable after a manipulated variable change  $\Delta Y$**

**Method :**

- Set the controller to MANUAL mode.
- Output a manipulated variable change and record the controlled variable with a recorder.
- Switch off in good time if you encounter critical progressions (e. g. a risk of overheating) (Pay attention to the fact that, in thermally inert systems, the actual value of the controlled variable may increase further switching off).

The following table lists the settings for the controller parameters depending on  $T_u$ ,  $T_g$  and  $K_s$  for command and disturbance response and for an aperiodic control operation as well as a control operation with 20% overshoot. They apply to systems with a P response, with a dead time and with a delay of the 1st order.

**Parameter settings according to Chien, Hrones and Reswick :**

Controller type	Parameter settings			
	Aperiodic control operation (0% overshoot)		Control operation with 20% overshoot	
P controller	Command	Disturbance	Command	Disturbance
	$K_p = 0,3 \frac{T_g}{T_u \cdot K_s}$	$K_p = 0,3 \frac{T_g}{T_u \cdot K_s}$	$K_p = 0,7 \frac{T_g}{T_u \cdot K_s}$	$K_p = 0,7 \frac{T_g}{T_u \cdot K_s}$
PI controller	$K_p = 0,35 \frac{T_g}{T_u \cdot K_s}$	$K_p = 0,6 \frac{T_g}{T_u \cdot K_s}$	$K_p = 0,6 \frac{T_g}{T_u \cdot K_s}$	$K_p = 0,7 \frac{T_g}{T_u \cdot K_s}$
	$T_n = 1,2 T_g$	$T_n = 4 \cdot T_u$	$T_n = T_g$	$T_n = 2,3 \cdot T_u$
PID controller	$K_p = 0,6 \frac{T_g}{T_u \cdot K_s}$	$K_p = 0,95 \frac{T_g}{T_u \cdot K_s}$	$K_p = 0,95 \frac{T_g}{T_u \cdot K_s}$	$K_p = 1,2 \frac{T_g}{T_u \cdot K_s}$
	$T_n = T_g$ $T_v = 0,5 \cdot T_u$	$T_n = 2,4 \cdot T_u$ $T_v = 0,42 \cdot T_u$	$T_n = 1,35 \cdot T_g$ $T_v = 0,47 \cdot T_u$	$T_n = 2 \cdot T_u$ $T_v = 0,42 \cdot T_u$

As shown in the figure of the previous page, the proportional action coefficient  $K_s$  of the control system can be calculated by way of the increase in the inflectional tangent, i. e. by way of  $\Delta X/\Delta Y$ : manipulated variable change)

$$K_s = \frac{\Delta X}{\Delta Y}$$

**A3 : OPTION BOARD "4-20 mA ANALOG POSITION INDICATION" (IDENT. 427193G): MOUNTING AND CONNECTION**



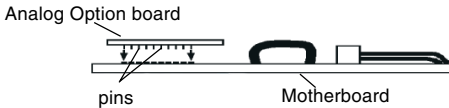
The positioner must be equipped with the software version F, or higher. Check it in the main menu, option END: it is displayed at the right-hand side of the screen.

**Technical characteristics of the Option output of the positioner**

- Output signal for the current value : 4-20 mA
- External working resistance / Input resistance of a connected device : 0-560 Ohms
- Output error rate : < 0,05 %
- Potential free output ; electrically separated from the position electronics.

**Mounting**

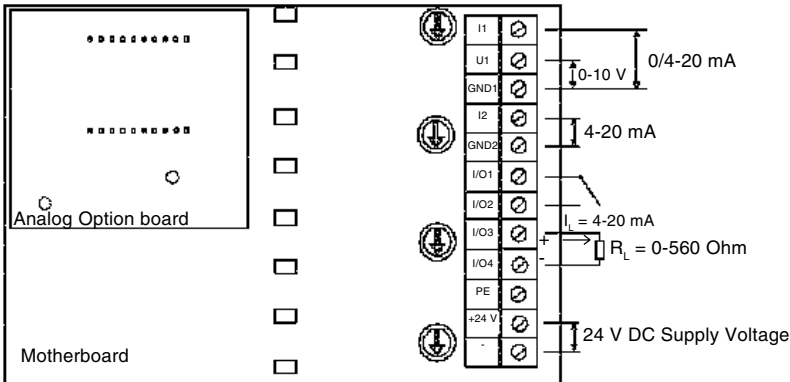
- Disconnect the positioner from the voltage supply
- Unscrew the 4 screws of the positioner cover and open the cover
- Remove the 2 red jumpers from the motherboard
- Insert the optional board onto the motherboard (see figure below)



Make sure the pins correctly slide into the motherboard.

- Pass the cables through one of the 2 PG9 cable glands, dismantle them over 6 mm and connect them to the connection block according to the connection schematic (terminals I/O3 and I/O4)
- Close the cover and tighten the 4 screws, making sure neither the cables nor the wires are wedged in.

**Connection diagram**



**Configuration**

- Configure the positioner as described in chapter 4.5.
- Activate the analog position indication by choosing the ANALOG option of the OUTPUT function

**A4 : OPTION BOARD "BINARY POSITION INDICATION/BOOSTER":  
MOUNTING AND CONNECTION**



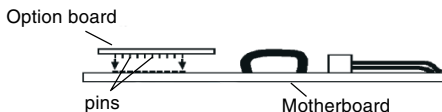
- The positioner must be equipped with the software version F, or higher. Check it in the main menu, option END: it is displayed at the right-hand side of the screen.
- For positioners manufactured before 1996 mounting is only possible if the motherboard is fitted with black connection blocks (if not, please contact you nearest Bürkert agent).

**Technical characteristics**

Positioner	Relay
<ul style="list-style-type: none"> <li>- Operating voltage : 24 VDC</li> <li>- Electric power consumption : max. 30 W</li> <li>- Electric connection : screw terminals, 1,5 mm<sup>2</sup> cross-section</li> </ul>	<ul style="list-style-type: none"> <li>- Contact type : closed</li> <li>- Commutation current : 0,5 A</li> <li>- Breaking capacity : 10 W</li> <li>- Contact resistance : 100 mOhm</li> </ul>

**Mounting**

- Disconnect the positioner from the voltage supply
- Unscrew the 4 screws of the positioner cover and open the cover
- Remove the 2 red jumpers from the motherboard
- Insert the optional board onto the motherboard (see figure below)



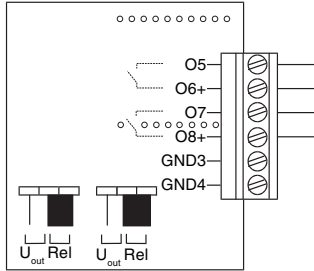
Make sure the pins correctly slide into the motherboard.

- Pass the cables through one of the 2 PG9 cable glands and dismantle them over 6 mm.

## Connection

1) As potential free contacts

- connect the cables to the O5 and O6 or O7 and O8 terminals according to the connection schematic
- place the jumper on the "REL" position (see figure below)



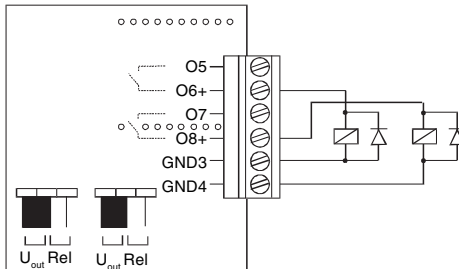
2) For connecting receivers to the outputs O6 and O8 (operating voltage of 24 V DC)

- connect the cables to the terminals O6 and O8 and to GND3 and GND4 according to the connection schematic below.



For inductive receivers, use the recovery diode.

- place the jumper on the "U<sub>out</sub>" position (see figure below)



**Short-circuit hazard** : before closing the device, make sure the screws of the connection block are tightend.

- Close the cover and tighten the 4 screws, making sure the cables are not wedged in.

## Configuration

- Configure the positioner as described in chapter 4.5.
- Activate the binary position indication or the Booster function by choosing either the BINARY or the BOOST option in the OUTPUT function.

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