TOP*CONTROL* CONTINUOUS TYPE 8630

CONTENTS:

FUNCTIONS OF THE TOP*CONTROL* CONTINUOUS

1 GENERAL INFORMATION

1.1 Symbols

The following symbols are used in these operating instructions:

→ indicates a working step which must be performed

ATTENTION!

Indicates information, which if not observed can result in harmful effects on the health or the serviceability of the unit.

NOTE

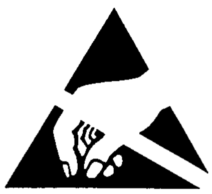
Indicates important additional information, tips and recommendations.

1.2 Safety information

Please observe the information in these operating instructions, as well as the operating conditions and permissible data specified in the date sheets of the Top*Control* and of the relevant pneumatically actuated valve, to ensure satisfactory operation of the unit and a long service life:

- Follow general technical rules when planning the application and operation of the unit!
- Installation and maintenance may only be performed by technical personnel provided with suitable tools!
- Note the accident prevention and safety precautions applicable for electrical units during operation and maintenance of the unit!
- Always switch off the power supply before working on the system!
- Take suitable measures to prevent inadvertent operation or impermissible influences!
- Ensure a defined and controlled re-start of the process following an interruption of the electrical or pneumatic supply!
- We cannot accept any liability if these instructions are ignored or impermissible interventions are made in the unit and the warranty also becomes invalid on units and accessories!

1.3 Important for Handling



ATTENTION
OBSERVE PRECAUTIONS
FOR HANDLING !
ELECTROSTATIC
SENSITIVE
DEVICES

This electronic device is sensitive to electrostatic discharge (ESD). Contact with an electrostatic charged person or object endangers the electronic device. The worst case is that it will be destroyed immediately or just fail after putting into operation.
To minimize the possibility of damage by immediate electrostatic discharge, pay attention to the requirements of EN 100 015 -1. Please also pay attention not to assemble the electronic device while supply voltage is put on.

1.4 Scope of delivery

Check the contents of the delivery for damage and agreement with the details specified on the delivery note immediately following receipt. This normally comprises:

- pneumatically actuated valve of types 2652, 2655, 2672, 2700, 2712, 2730, 2731 or 2731K with the Top*Control* Continuous
- operating instructions for the valve with pneumatic drive
- operating instructions for the Top*Control* Continuous

Suitable cable plugs for the multipole connection are available as accessories.

In the event of discrepancies, please contact our service department immediately:

Bürkert Steuer- und Regelungstechnik
Chr.-Bürkert-Str. 13-17
Service-Abteilung
D-76453 Ingelfingen
Tel.: (07940) 10-252
Fax: (07940) 10-428

or your local Bürkert branch.

1.5 Warranty conditions

This document contains no warranty promises. We refer in this connection to our General Conditions of Sale and Business. The condition for the warranty is use of the unit for the intended purpose under the specified application conditions.

ATTENTION!

The guarantee only covers faults in the Top*Control* Continuous, and in the integrated pneumatically-driven valve. No liability will, however, be accepted for subsequent damage of any kind that may arise as a result of the failure or incorrect functioning of the device.

1.6 Master code

Operation of the device can be locked via a freely selectable user code. Independent of this, there is an unalterable master code with which you can carry out all operations on the device. This 4-digit master code is printed on the last page of these operating instructions.

If needed you can cut out this code and store it separately from these operating instructions.

2 SYSTEM CONFIGURATION

NOTE

The following picture illustrates a complete system, based on
- a control valve with a pneumatic actuator
- a Top*Control* Continuous

These elements linked together compose a functional unit.

The function ranges of the Bürkert pneumatic control valves are greatly increased when in combination with the Top*Control* Continuous. These valves can be fitted with the Top*Control* Continuous in order to obtain continuous control with variable functions.

The figure 2.1 below shows various combination capabilities of the Top*Control* Continuous combined with various pneumatic control valves. A vast range of connections and valve diameters is available, although not displayed in the figure below. All technical informations about these products are described in the relevant data sheets. The product range will be continuously increased.

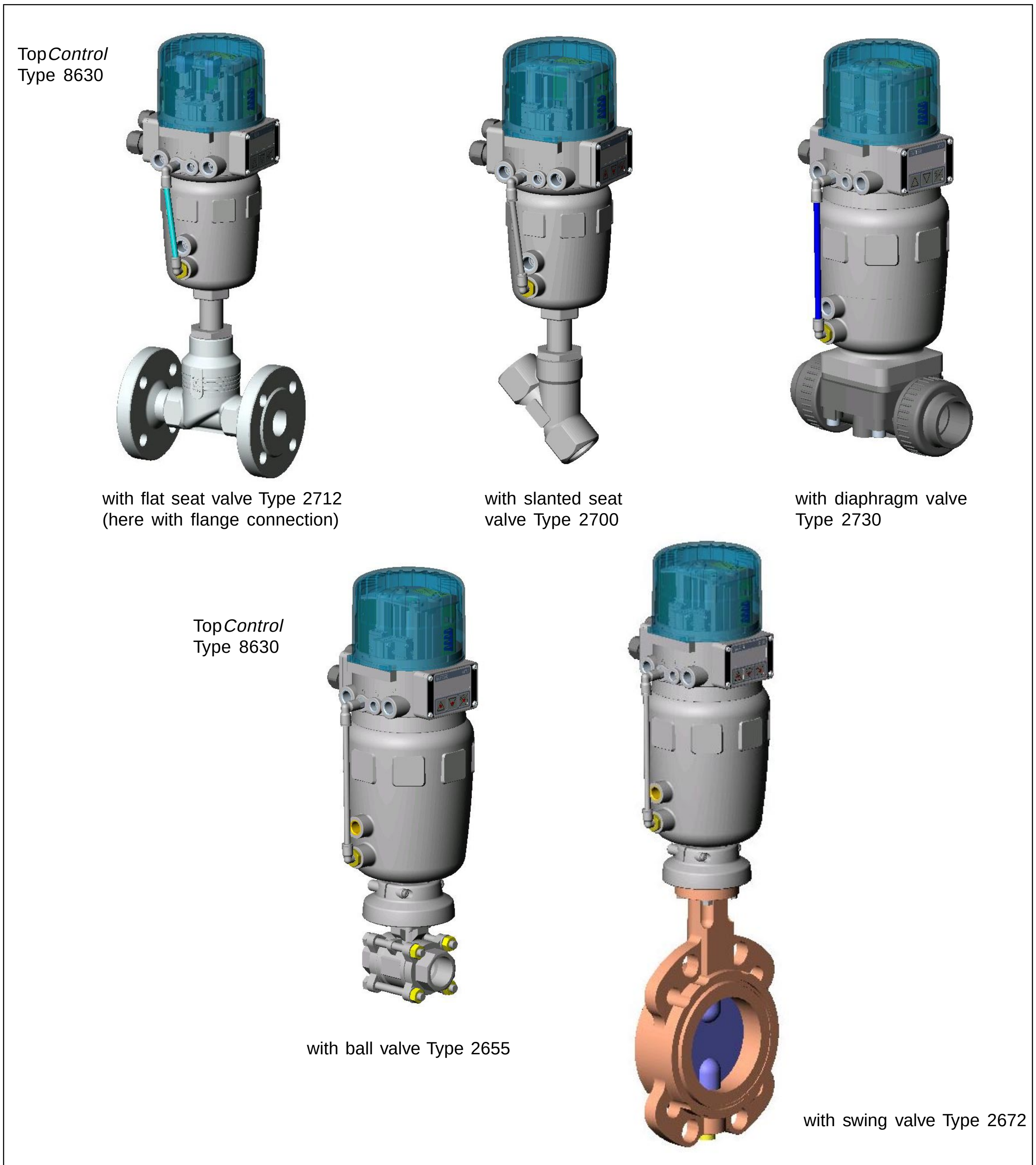


Fig. 2.1: Overview of mounting options for the Top Control Continuous with various valve types

Various control valves from the Bürkert range may be used in connection with the Top*Control* Continuous depending on the installation conditions. Angle valves, diaphragm valves, including ball valves fitted with a control cone are suitable, as well as piston or rotary driven pneumatic actuators.

Pneumatic piston actuators or rotary actuators may be used as actuators. Single acting and double acting actuators may be used in combination with the Top*Control.*

Within a single action actuator a single chamber is filled and exhausted. The resulting pressure acts on a spring, which forces the piston to move until the pressure difference between the piston and spring are equal.
Double chamber actuators posses 2 chambers, which supply the pressure to the piston. The filling of one chamber induces the emptying of the other, as there is no spring within this design.

Valves characteristics:

	Flat seat control valves **Slanted seat control valve**	**Diaphragm valves**	**Ball valves**
Types	• 2700 • 2712	• 2730 • 2731 • 2731K	• 2652 (2 parts) • 2655 (3 parts)
Characte-ristics	• flow over under the seat • protected against water hammer • straight flow direction • high tightness through selfpositioning packing box	• fluid tightly isolated from the actuator and environtment • no dead volume, self purging design • direction of flow as required with minimal turbulence of flow • steam sterilizable • CIP • water hammer free • removable diaphragm and actuator through mounted housing	• possibility of internal scraping • reduced dead volume • low retention of deposits • replaceable seat and seals through 3 parts ball valve design
Typical medium	• water, steam and gas • alcohol, oil, fuel, hydraulic fluids • brine, organic fluids, base • solvent	• neutral fluid and gas • charged or aggressive fluids • high purity or sterilised fluid • high viscosity fluids	• neutral fluid and gas • pure water • low aggressive fluids

3 DESCRIPTION OF THE TOP*CONTROL*

The type 8630 Top*Control* Continuous is an electropneumatic position controller for pneumatically actuated continuous valves. The Top*Control* Continuous and pneumatic actuator are joined together to build one functional unit.

3.1 Construction

The design of the type 8630 Top*Control* Continuous (Fig. 3.1) is based on a modular concept.
Wide ranges of pneumatic and electrical connections are available as options.

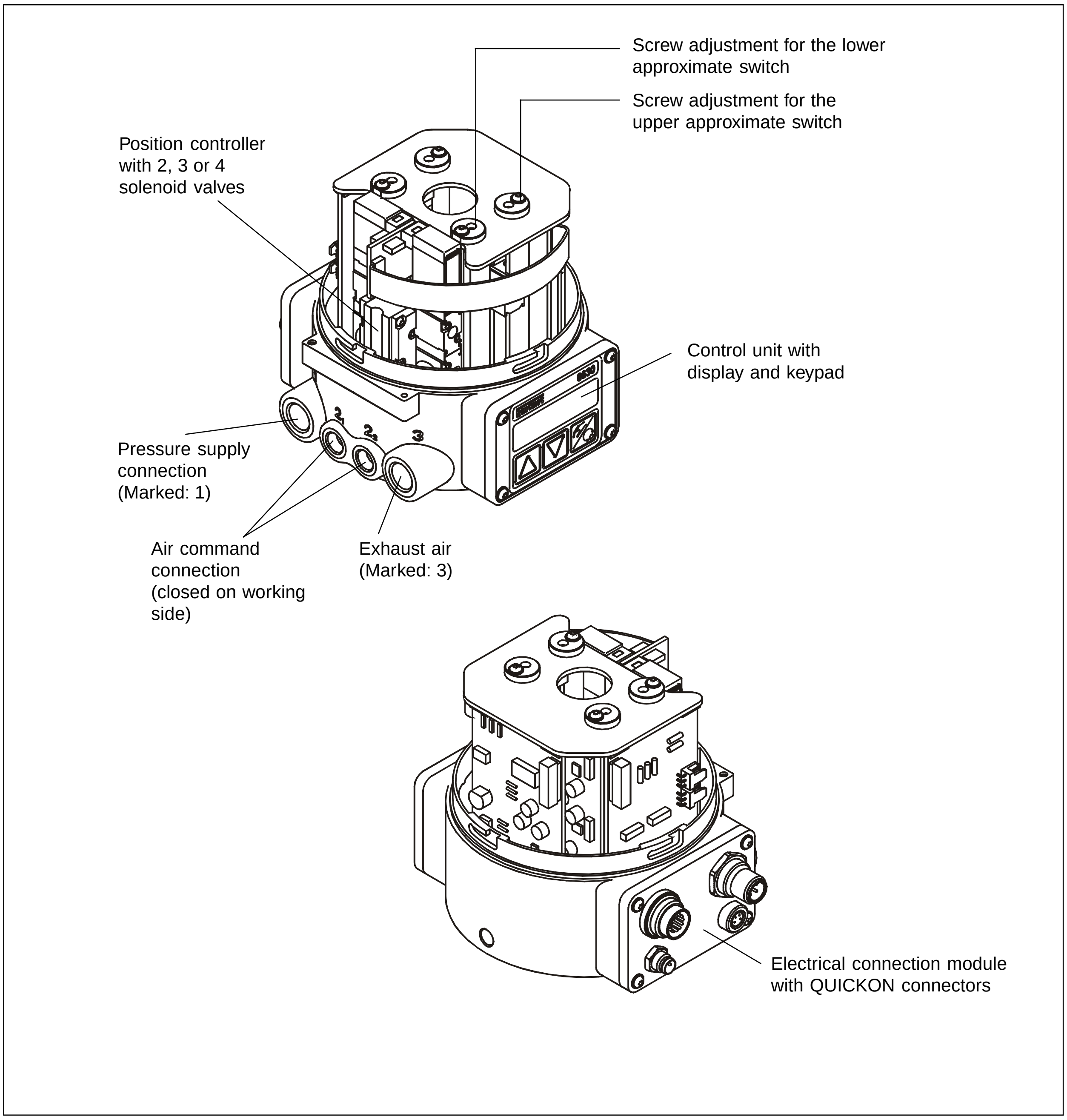


Fig. 3.1: Design of the TopControl, cover removed

CONSTRUCTION FEATURES:

- **Design:**

  for single/double-acting actuators

- **Path measuring system:**

  high linear resolution with plastic potentiometer. Freely coupled to the piston rod of the actuator

- **Electronic system piloted by a microprocessor:**

  ensure an efficient configuration, control, and drive of the actuator

- **Control unit:**

  Operation of the Top*Control* by mean of 3 keys.
  An 8 character LCD ensures the display of setpoint, position, and configuration functions.

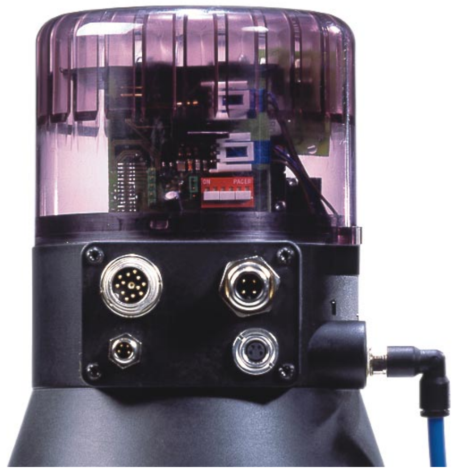


Fig. 3.2: Electrical connection

- **Positioning system:**

  The positioning system is composed and requires 2 solenoid valves for single-acting actuators (air inlet; exhaust air), or 4 solenoid valves for double-acting actuators (2 for air inlet; 2 for exhaust air).
  The controller with a PWM-voltage powers the valves according to the rocker principle which allows fast positioning volumes to be reached as required.
  A large flexibility concerning the volumes of the chambers and the positioning speed is reached in that way. For use of actuators with larger volumes, the positioning valves are fitted with membrane amplifiers in order to increase the maximal flow and optimise the dynamic of the system.

  As an option with single-acting actuators, a fast pressurizing/venting version is available with an additional pressurizing valve and venting valve. This enables the actuator to be completely pressurized and vented more rapidly. This is used with the tight-closing function (see chapter "CUTOFF") and on activating a safety position of 0 or 100% (see chapter "BIN-IN").

Fig. 3.3: Pneumatic connection

- **Position indicator (option):**

  2 inductive approximate value switches (capacitive switches) or mechanical limit switches. Signalling the high or low limit positions of the actuator by a digital output or via a PLC. Positioning screws allow free adjustment of the limit.

- **Electrical connection (Fig. 3.2):**

  Multipole connector, cable glands with terminals, or QUICKON box connection.

- **Pneumatic connection (Fig. 3.3):**

  1/4” connection brass or stainless steel
  with various connection types (G, NPT, RC)

- **Top*Control* Continuous body:**

  Protected against internal over-pressure, (eg. air leakage) by a pressure limit valve.
  Protection against non-authorised opening of the cover by a seal or self-cutting screws.

3.2 Function

The figure 3.4 shows the functional diagram of the Top*Control* Continuous in combination with a single acting piston valve.

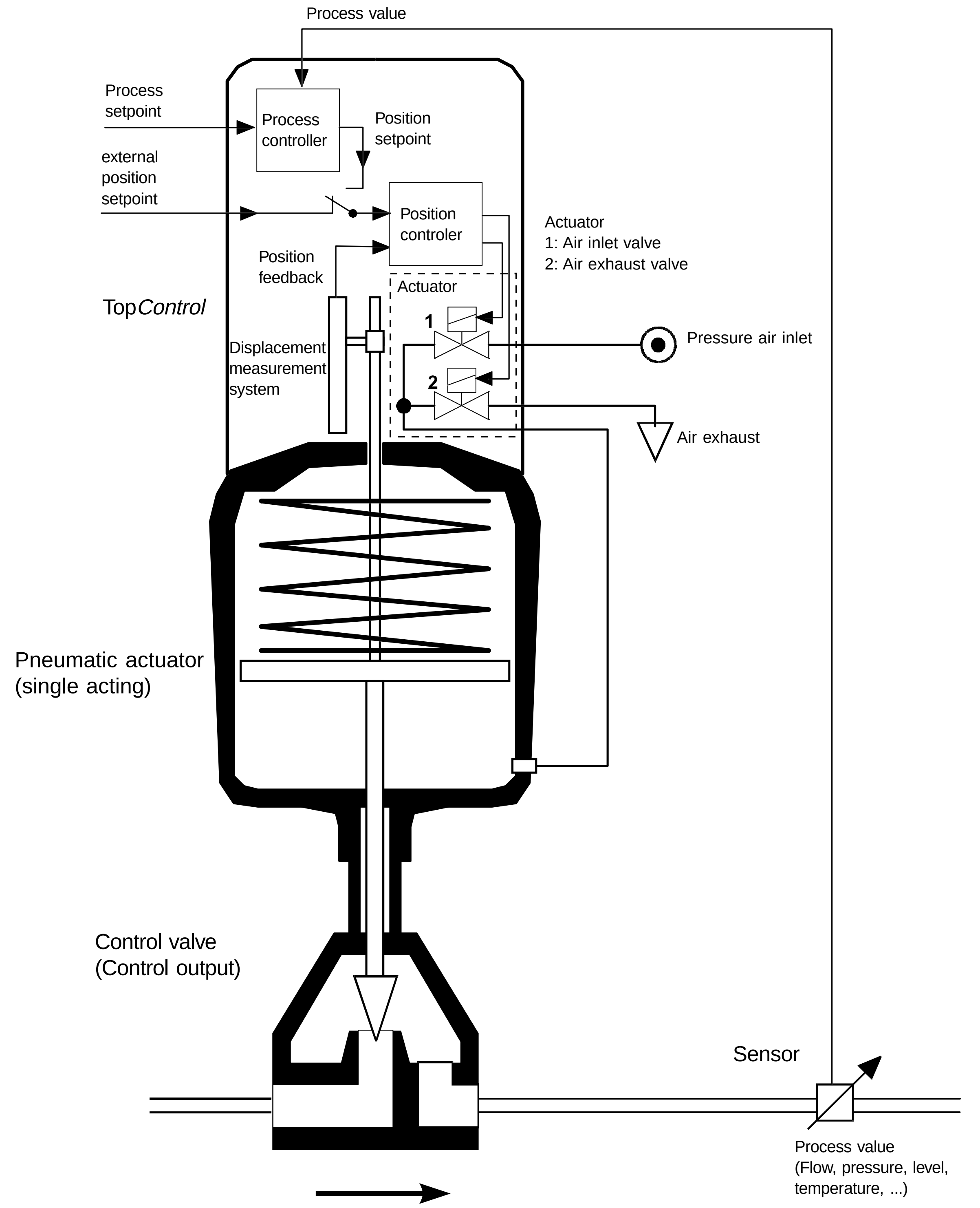


*Fig. 3.4: Functional diagram of the Top*Control *Continuous in combination with a single acting piston valve*

Fig. 3.5: Process control example: TopControl with sensor

3.2.1 Working of the Top*Control* Continuous as position controller (Fig. 3.6)

The actual position (POS) is measured by the displacement measuring system. This position value is compared to the normalized position setpoint signal (CMD). In cases of difference (Xd1), a voltage pulse-width modulation signal is sent as control signal. With single-acting actuators, a positive error exists and pulses are sent from output B_1 to activate the air supply. When a negative error exists, and pulses are sent from output E_1 to activate the exhaust air. With this system, the difference between the position of the actuator and the setpoint is reduced 0. Z1 represents a disturbance variable.

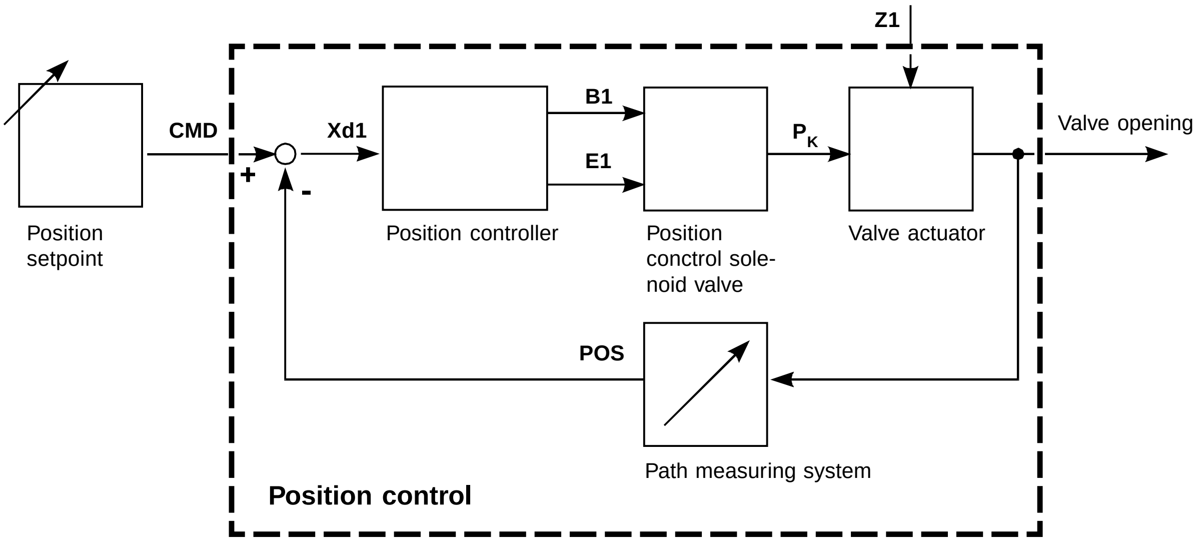


Fig 3.6: Position control diagram

3.2.2 Using the Top*Control* Continuous as a process controller (Fig. 3.7)

By using the Top*Control* Continuous as a process controller, the previous position control function is a component of the main control loop.
The process controller within the main control loop posseses a PID function. The process setpoint (SP) is used and compared to the controlled process value (PV). A sensor delivers the actual value. The manipulated variable correction functions as described in chapter 3.2.1 represents a disturbance variable.

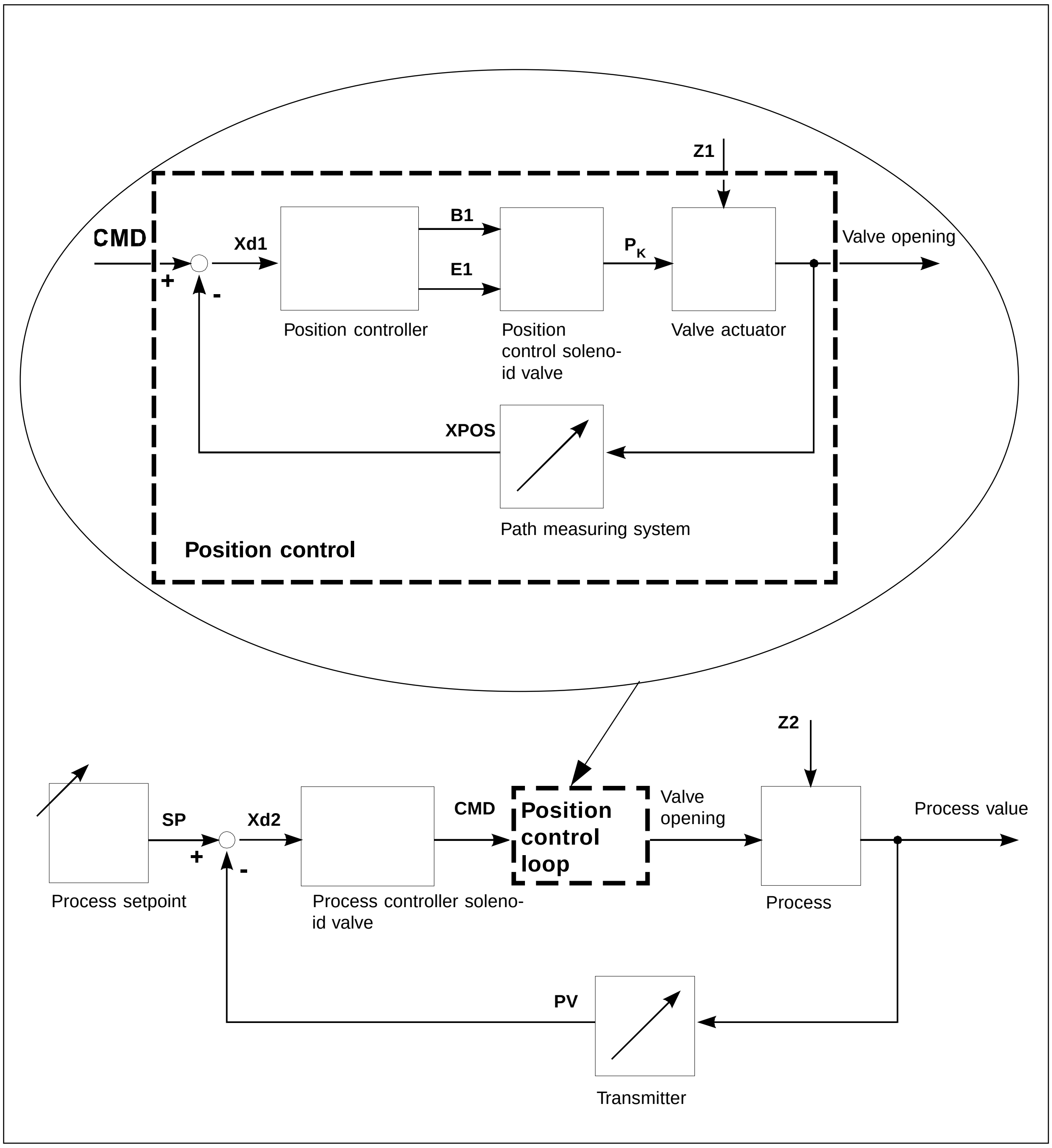


Fig 3.7: Process control diagram

3.3 Top*Control* Continuous variants

The Top*Control* Continuous is available in 3 forms, varying in electrical connection and control functions.

- Multipole connection with complete functions (Fig. 3.8)
- Terminal with PG cable glands and terminals with restricted functions (Fig. 3.9)
- QUICKON connection with restricted functions

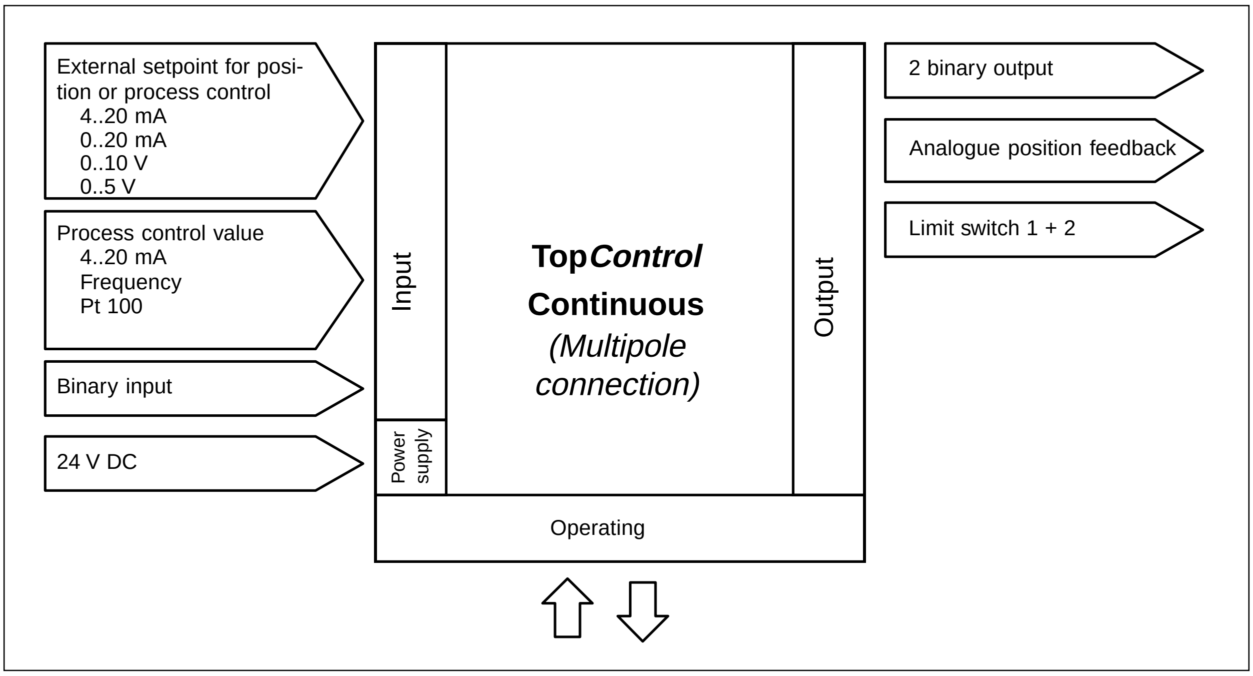


Fig. 3.8: Position interface with multipole connections

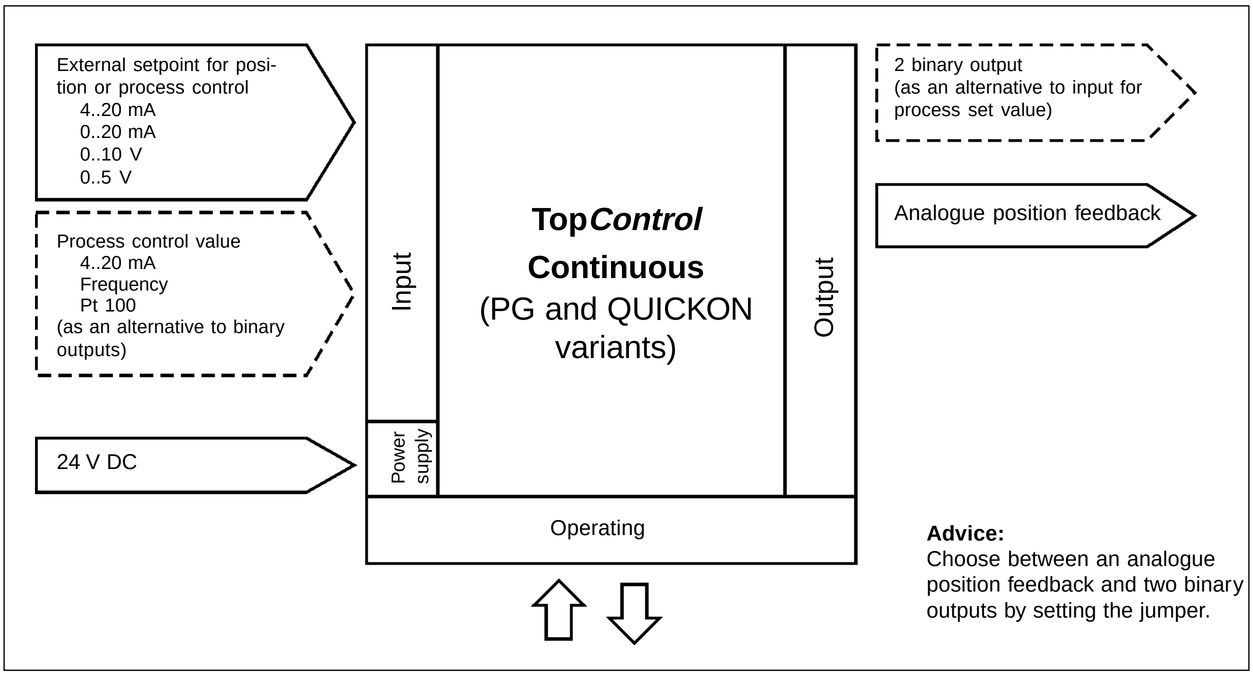


Fig. 3.9: Interfaces of the TopControl Continuous on the variants with PG screw connectors and QUICKON connectors

NOTE The Top*Control* Continuous posses 3-wires instruments. The 24 V DC power supply is isolated from the setpoint signal.

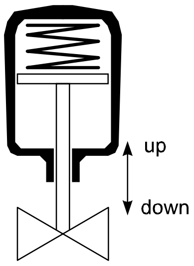
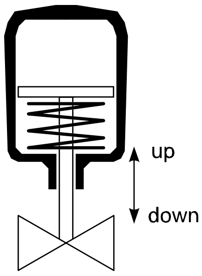
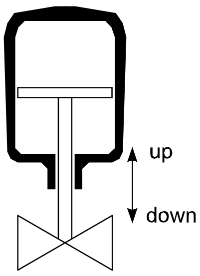
3.4 Software characteristics

Additional function	Operation
Positon controller with additional functions	
Close tight function	Valve tightly closed over the tightness process range Statement of a value (in %) above which the drive is completely de-aerated (at 0 %) or ventilated (at 100 %)
Plug travel limitation	Mechanical movement of the valve piston within a specified stroke range
Split range	The signal is split in 2 or more positions
Characteristics curves for process value adjustment	The linearization of the characteristic curvecan be processed
Deadband	The Top*Control* acts only if a specified control difference is measured
Direction of command of nominal and actual value	Relationship between the setpoint limit values and the position of the actuator
Safety position	The valve moves to a specified safety position
Automatic adjustment to the connected valve	
Connections of the process controller with	**the following functions**
Control type	PID
Available parameters	Proportional coefficient, reset time, action rate and operating point
Input scale	Position of the decimal point, lower and upper scale values of the actual value and setpoint
Selection of the setpoint entry mode	Setpoint entry manual or external
Automatic adjustment to the conditions of the process	

Hierarchical concept for easy commissioning with the following levels:	
Process mode	Selection between automatic and manual modes
Configuration mode	Selection of the basic functions, and if necessary additional functions within this level

3.5 Technical characteristics

3.5.1 Safety positions according to electrical and pneumatic power supplys

Type of actuator	Designation	Safety settings following failure or auxillary power supply	
		electrical	pneumatic
	single acting WW A	down	down
	single acting WW B	up	up
	double acting WW I	down / up (depending on con- nection of control lines)	not assigned

3.5.2 Factory settings of the Top*Control* Continuous

Function	Factory setting	Function	Factory setting
ACTFUNC	FUNCSNGL	X.CONTROL	1 %
INPUT	INP 4'20A	P.CO - DBND	1 %
CHARACT	CHA LIN	P.CO - SETP	SETP INT
DIR.CMD	DIR.CRISE	P.CO - INP	INP 4'20A
CUTOFF	CUT ⊥ = 1 %; CUT ⊤ = 99%	P.CO - FILT	0
DIR.ACT	DIR.ARISE	P.CO - SCAL	UNIT L/S
SPLTRNG	SR ⊥ = 0 (%); SR ⊤ = 100 (%)	CODE	CODE 0000
X.LIMIT	LIM ⊥ = 0%, LIM ⊤ = 100%	OUTPUT	OUT 4'20A
X.TIME	no limitation	BIN-IN	INP 4'20A

3.5.3 Characteristics of the Top*Control* Continuous

Operating data	
Operating temperature	0...+50°C
Degree of protection	IP 65 according to EN 60529 (in correct electrical installation conditions)
Conformity to norms	
CE	According to CE 89/336
Mechanical data	
Dimensions	refer to data sheet
Material of the body	external POM, PSU internal PA 6
Material of the seal	NBR
Electrical data	
Connections	multipole connectors, terminal with two PG 9 screwed glands or QUICKON connection (see fig. 5.2)
Power supply	24 V DC ± 10 % Residual pulsation 10 % **No technical direct voltage!**
Power consumption	< 5 W
Input resistance for actual signal	180 Ω at 4 - 20 mA 17 kΩ at frequency
Input resistance for set-point signal	180 Ω at 0/4 - 20 mA 19 kΩ at 0 - 5/10 V
Protection class	3 according to VDE 0580
Analog position feedback: Max. current for voltage output 0...5/10 V Max. burden for current output 0/4 mA	 10 mA 560 Ω
Inductive proximity switch: Current limitation	 100 mA
Binary outputs: Current limitation	 100 mA
Pneumatic data	
Control medium	instrument air, class 3 according to DIN ISO 8573-1
Compressed air temperature	-20°C
Oil content	max. 1 mg/m³
Dust content	5 µm filtered
Temperature of the pressure air	0..+50°C
Pressure range	3..7 bar 1)
Pressure fluctuations	max. ± 10 % during service 2)
Airflow rates Steuerventile	100 l_N/min (for air supply and exhaust) 3) (Q_{Nn}-Value according to definition of the pressure loss from 7 to 6 bar absolute)
Union connections	G / NPT / RC 1/4" internal thread

1) The control pressure has to exceed the pressure from 0.5- 1 bar, in order to ensure the final positioning of the actuator.
2) Higher pulsation reduces the control accuracy based on the autotune function.
3) We reserve the right to make technical changes to optimize the function of the Top*Control*.

4 INITIAL COMMISSIONING

NOTE

This section allows you to perform the quick commissioning of the Top*Control* Continuous. The not essential additional functions are not described in this section. See chapter 5 and 6 for complete explanations about commissioning and the functions available.

4.1 Pneumatic connection

- Install the valve according to the specific requirements.
- Connect the air supply (3..7 bar, instrument air, oil, water and duster) to port 1.
- Mount the exhaust air pipe or noise reducer on port 3.

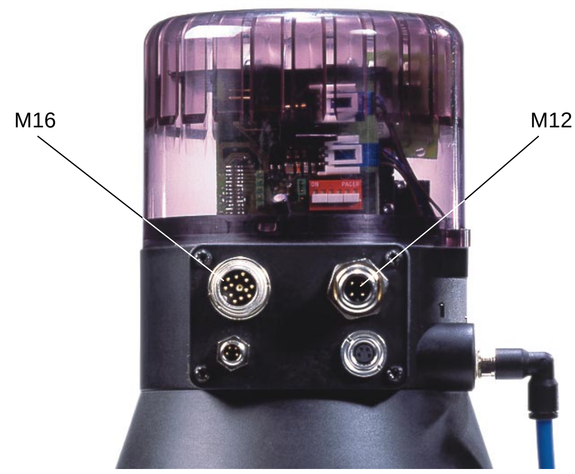


Fig. 4.1: TopControl with multipole connectors

4.2 Electrical connection

4.2.1 Multipole connection

- Connect the external position setpoint signal to the circular connector M16.

Connection of the circular connector M16:

Pin	Assignment	External connection
B	Setpoint + (0/4..20 mA) or 0..5 / 10V	B o——— + (0/4..20 mA) or 0..5 / 10V
A	Setpoint GND	A o——— GND

- Connect the power supply to the circular connector M12.

Connection of the circular connector M12 :

Pin	Assignment	External connection
1	+ 24 V	1, 3: 24 V DC ± 10 % Residual ripple 10 %
2	not connected	
3	GND	
4	not connected	

4.2.2 Cable gland connection

Easy connection of the terminal box:

➔ Remove the 4 self-cutting screws to open the cover of the terminal box.
The connections of the terminals are shown in figure 4.2.

➔ Connect the external position setpoint signal and power supply wires to the terminals (according to the PG-terminal assignment).

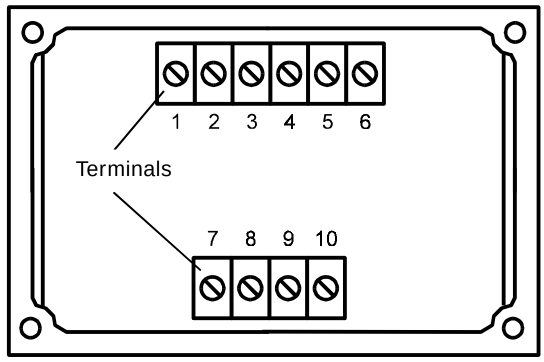


Fig. 4.2: TopControl Terminals

Connection of terminals (with cable glands)

Terminal	Assignment	External connection
1 2	Setpoint + Setpoint GND	1 ○—— + (0/4..20 mA or 0..5 / 10V) 2 ○—— GND
5 6	Power supply + Power supply GND	5, 6: 24 V DC ± 10 % Residual ripple 10 %

NOTE Further installation procedure, see chapter 5.

Once activated, the Top*Control* Continuous will work and the necessary configuration and self-calibration operations of the Top*Control* Continuous will have to be performed (Fig. 4.4).

4.2.3 QUICKON connectors

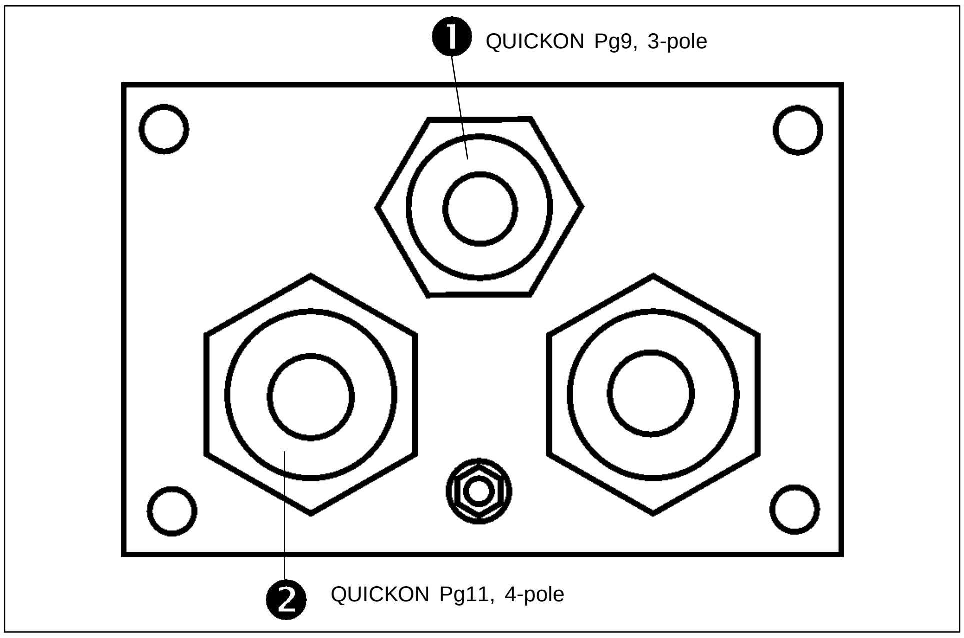


Fig. 4.3:
QUICKON connectors on TopControl

❷ → Lay the set-point signal on the QUICKON connector PG11, 4-pole:

Pin	Assignment	External connection
3 4	Set-point GND Set-point +	4 o——— + (0/4..20 mA or 0..5 / 10V) 3 o——— GND

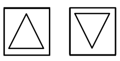
❶ → Lay the supply voltage on the QUICKON connector PG9, 3-pole:

Pin	Assignment	External connection
1 2	Operating voltage +24 V Operating voltage GND	1, 2: 24 V DC ± 10 % max. residual ripple 10 %

4.3 Basic configuration

Key assignment:

MANUAL/AUTOMATIC key — Choice of menu and sub-menu e. g. ACT FUNC - FUNCSNGL



ARROW key — Choice between level menu functions e.g. ACTFUNC - INPUT

Fig. 4.4 Key on TopControl

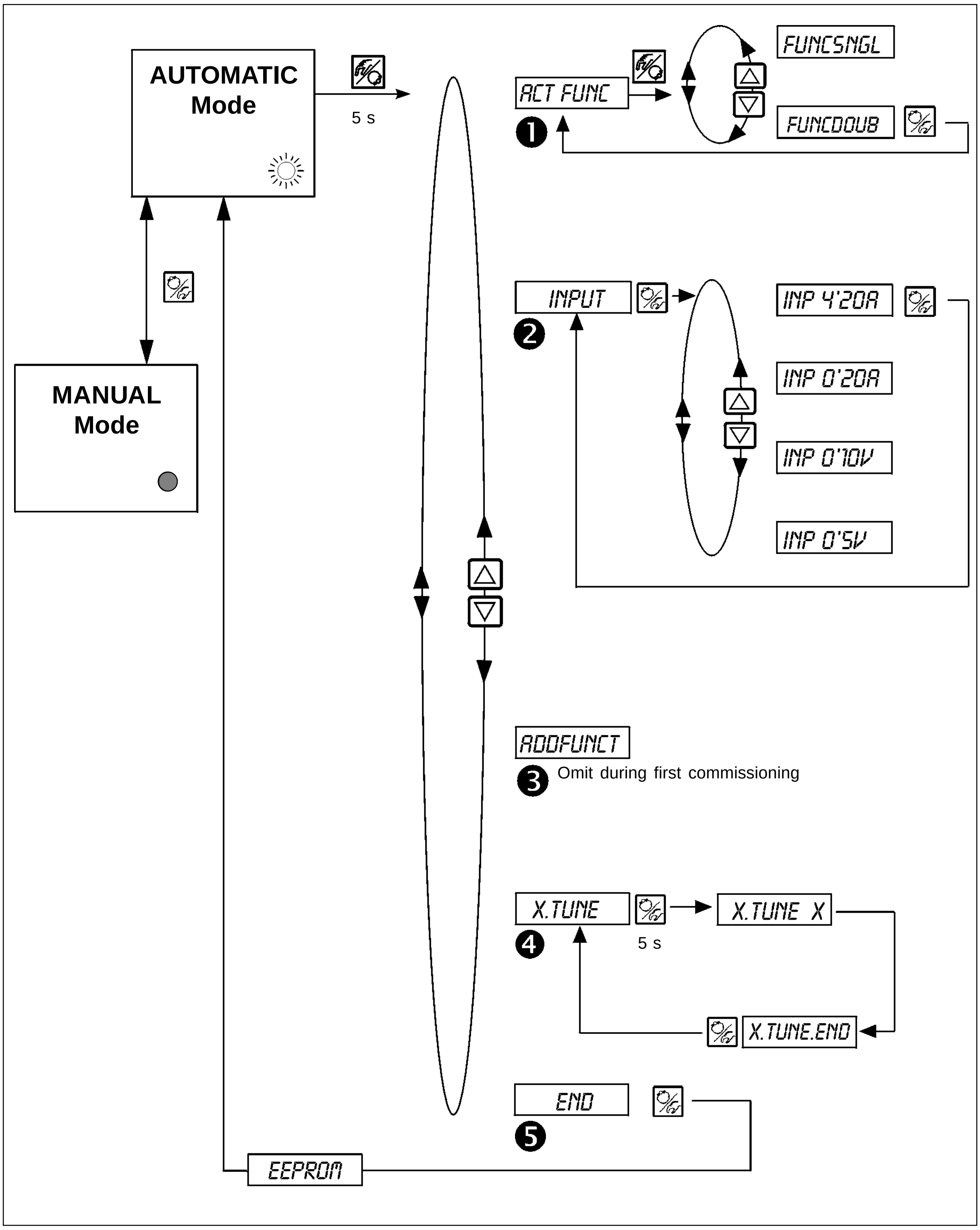


Fig. 4.5: Basic configuration

Configuration within the MAIN menu:

❶ ACTFUNC — **Function of the actuator**

FUNC SNGL - single acting

FUNC DOUB - double acting

❷ INPUT — **Selection of the input signal**

INP 4'20A - Current 4..20 mA

INP 0'20A - Current 0..20 mA

INP 0'10V - Voltage 0..10 V

INP 0'5V - Voltage 0..5 V

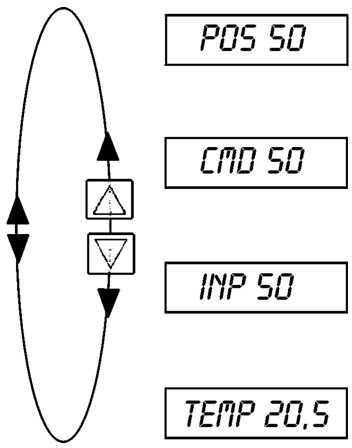
❸ ADDFUNCT — **Omit for quick commissioning**

❹ X.TUNE — **Activation of the self-calibration** (Fig. 4.4).

❺ END XX — **Return to the AUTOMATIC mode**. The message EEPROM is displayed until the new parameters are stored.

Entry of the setpoint within the AUTOMATIC mode

After the configuration the Top*Control* acts as a position controller.



➔ Enter the setpoint as a signal input.

➔ Switch between the display possibilities: △ ▽

Message on display:

- Actual position of the actuator — POS__XXX (0..100%)
- Setpoint of the actuator — CMD__XXX (0..100%)
- Signal entry for the setpoint (equivalent to setpoint) — INP__XXX (0..100%)
- Internal temperature of the Top*Control* — TEMP_XX.X (in °C)

Manual opening and closing of the valve within the MANUAL mode

Open the valveantriebs: △

Close the valveantriebs: ▽

Message on display: The previous display within the AUTOMATIC mode remains active.

NOTE

Advice Select the POS_XXX display, to ensure that the actual position of the actuator is displayed.

5 INSTALLATION

Please refer to the data sheets for dimensions of the Top*Control* Continuous and complete instrument variants of the Top*Control*, pneumatic actuators and valves.

5.1 Installation of the valve

NOTE

The actuator must not be connected.

For dimensions and thread types, see data sheet of process valve.

5.2 Turning the Top*Control* Continuous

If after installation of the continuous valve, the display of the Top*Control* Continuous is poorly visible or the cables or hoses are difficult to connect, the Top*Control* Continuous can be turned relative to the pneumatic actuator.

The procedure is as follows:

➔ Loosen the fluidic connection between the Top*Control* Continuous and the pneumatic actuator.

➔ Loosen the grub screw sunk in the side of the housing (hex socket SW3).

➔ Turn the Top*Control* Continuous clockwise, without lifting, into the desired position.

➔ Retighten the grub screw with a moderate torque.

➔ Remake the fluidic connection between theTop*Control* Continuous and the pneumatic actuator.
If necessary, use longer hoses.

ATTENTION!

If the Top*Control* Continuous is lifted on turning (displaced axially), the mechanically coupling of the distance measuring system may be damaged. By turning in the wrong direction (anticlockwise), there is a risk of unhooking the distance measuring system. It can only be hooked in again with a special tool!

5.3 Pneumatic connection of the Top*Control* Continuous

➔ Connect the air supply (3..7 bar, instrument air, oil, water and duster) to port 1 (Fig. 5.1).

➔ Mount the exhaust air pipe or noise reducer on port 3 (Fig. 5.1).

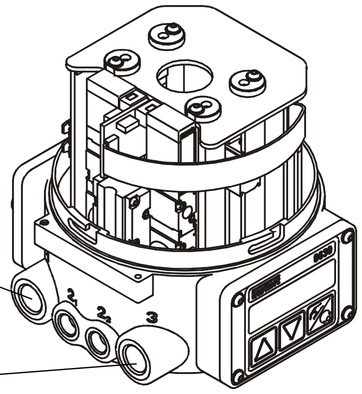


Bild 5.1: Fluidic connections of the TopControl

NOTE

The pressure supply must exceed the pressure required by the pneumatic actuator and must exceed at least 0.5 to 1 bar.
This is to ensure that the control process in the upper ranges of the actuator will not become negative due to a lower pressure difference.

Keep the pressure supply variations within the most restricted limits (max. ±10 %).
Higher variations reduce the reliability of the measured parameters within the AUTOTUNE procedure.

5.4 Electrical connection

Various options are available for electrical connection

- Multipole connection
- Terminals (with cable glands)
- QUICKON connection

ATTENTION!

A screw with a nut is available in the connecting module for connection of the technical earth (TE). In order to comply with the EMC requirements connect this screw to a good earthing point with a short length cable (max. 30 cm).

5.4.1 Multipole connection

The figure 5.2 indicates the functions of the multipole connectors and assignment of the pins.

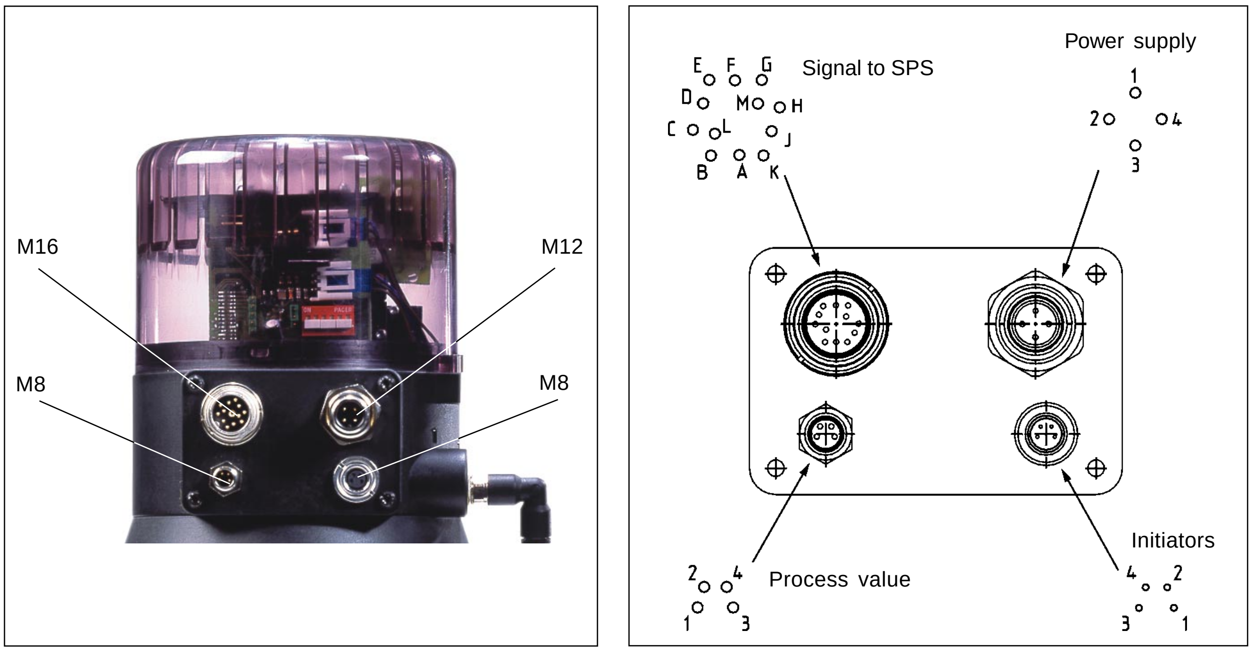
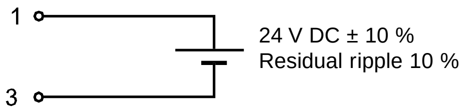


Fig 5.2: Circular connector with pin assignment

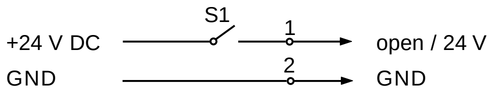
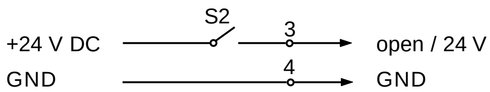
Output signal to SPS (circular connector M16)

Pin	Assignment	External connection
A B	Setpoint GND Setpoint + (0/4..20 mA or 0..5/10 V)	B —— + (0/4..20 mA or 0..5 / 10V) (completely separated galvanically) A —— GND
C D	Analogue position indication + Analogue position indication GND	C ——► + (0/4..20 mA or 0..5 / 10V) (completely separated galvanically) D ——► GND
E F G	Binary output 1 Binary output 2 Binary output GND	E ——► 24 V / 0 V F ——► 24 V / 0 V G ——► GND
H J	Binary input + Binary input GND	H —— + 0..5V (log. 0) / 10..30 V (log. 1) J —— GND
K L M	not connected not connected not connected	

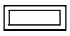
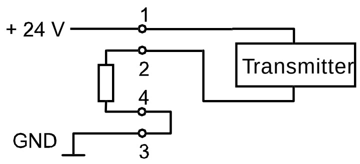
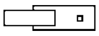
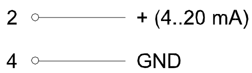
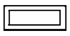
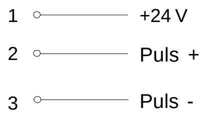
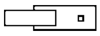
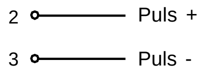
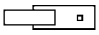
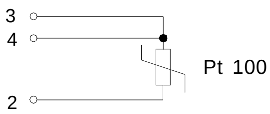
Power supply (circular connector M12)

Pin	Assignment	External connection
1	+ 24 V	
2	not connected	
3	GND	
4	not connected	

Inductive proximity switch (circular connector M8)

Pin	Assignment		External connection
1	Proximity switch 1 +	(NO)	
2	Proximity switch 1	GND	
3	Proximity switch 2 +	(NO)	
4	Proximity switch 2	GND	

Process value (circular connector M8)

Signal *	Pin	Assignment	Jumper	External connection
4..20 mA - internal power supply	1 2 3 4	+ 24 V transmitter entry Transmitter output GND Strap to GND		
4..20 mA - external power supply	1 2 3 4	not connected Analogic signal + not connected Analogic signal -		
Frequency -internal power supply	1 2 3 4	+24 V supply of sensor Pulse + Pulse - not connected		
Frequency -external power supply	1 2 3 4	not connected Pulse + Pulse - not connected		
Pt-100	1 2 3 4	not connected Process 1 Process 3 Process 2		

* Connectable through software (see 6.3.2)

5.4.2 Cable gland connection

Easy connection of the terminal box:

→ Remove the 4 self-cutting screws to open the cover of the terminal box.
The disposal of the terminal is shown on figure 5.3.

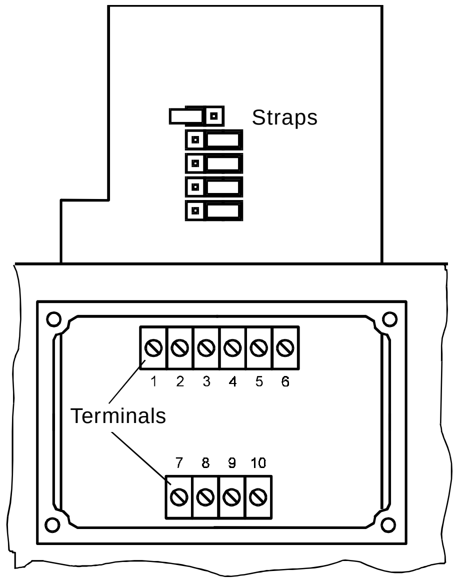


Fig. 5.3: TopControl terminals and straps

Connection of terminals (with cable glands)

Terminal	Assignment	External connection
1	Setpoint +	1 + 0/4..20 mA or 0..5 / 10V
2	Setpoint GND	2 GND
3	Analogic position feedback +	3 → + 0/4..20 mA oder 0..5 / 10V (completely separated galvanically)
4	Analogic position feedback GND	4 → GND
5	Power supply +	5 24 V DC ± 10 % Residual ripple 10 %
6	Power supply GND	6

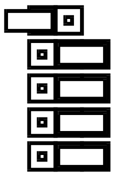
Selection between digital output and process value input:

→ Select using the strap:

- 2 digital outputs (see terminal assignment when digital output selected)
  or
- process value inputs (see terminal assignment when process value is selected).

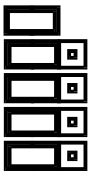
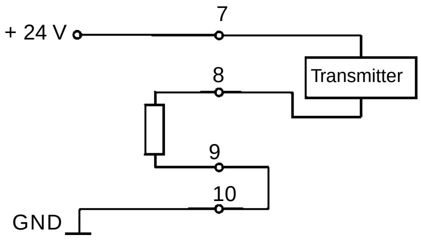
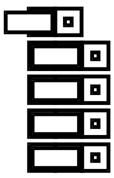
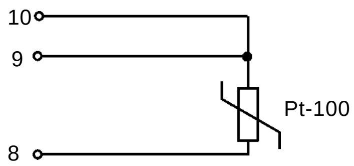
The terminals 7 to 10 are connected to the corresponding signals.

Connect the limit switches to the terminals:

Strap	Terminal	Assignment	External connection
	7	Digital output 1	7 ○—— 24 V / 0V
	8	Digital output 1	8 ○—— GND
	9	Digital output 2	9 ○—— 24 V / 0V
	10	Digital output 2	10 ○—— GND

Connection of the process value to the terminals:

→ Set the type of entry signal within the configuration menu (see 6.3.2).

Signal	Strap	Terminal	Assignment	External connection
4..20 mA internal power supply		7	+24 V transmitter entry	
		8	Transmitter output	
		9	GND	
		10	GND	
Frequency internal power supply		7	+24 V power supply	7 ●—— +24 V
		8	Pulse +	8 ●—— Pulse +
		9	not connected	10 ○—— Pulse -
		10	Pulse -	
4..20 mA external power supply		7	not connected	
		8	Analogic signal +	8 ○—— + (4..20 mA) V
		9	not connected	10 ○—— GND
		10	Analogic signal -	
Frequency external power supply		7	not connected	
		8	Pulse +	8 ○—— Pulse +
		9	not connected	10 ○—— Pulse -
		10	Pulse -	
Pt-100		7	not connected	
		8	Process 1	
		9	Process 2	
		10	Process 3	

5.4.3 QUICKON connectors

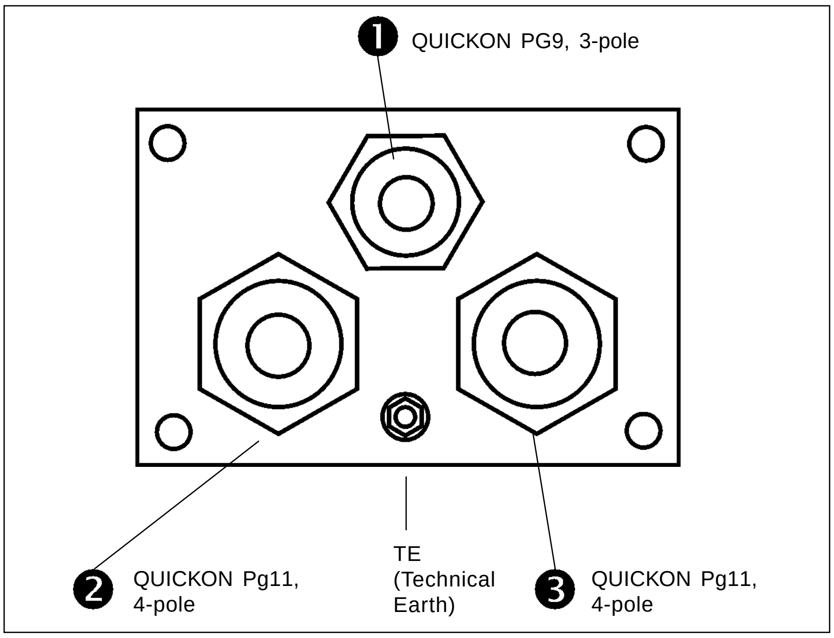


Fig. 5.4: QUICKON connectors on TopControl

❶ **QUICKON connector PG9, 3-pole:**

Pin	Assignment	External connection
1	Operating voltage +24 V	1, 2: 24 V DC ± 10 % Residual ripple 10 %
2	Operating voltage GND	
3	not connected	

❷ **QUICKON connector PG11, 4-pole:**

Pin	Assignment	External connection
1	Analog position transmitter GND	2 → + 0/4..20 mA or 0..5 / 10V) (completely separated galvanically 1 → GND
2	Analog position transmitter +	
3	Set-point GND	4 + (0/4..20 mA or 0..5 / 10V) 3 GND
4	Set-point +	

❸ **QUICKON connector PG11, 4-pole:**

Choice between binary outputs and process actual value input:

➔ Select via jumpers

a) 2 binary ouputs (see pin assignment on choice of binary ouputs)

or

b) Process actual value input (see pin assignment on choice of process actual value input)

a) Pin assignment on selection of the binary outputs

Jumper	QUICKON pin	Assignment	External connection
	1	Binary output 1+	1 — 24 V / 0V
	2	Binary output 1-	2 — GND
	3	Binary output 2+	3 → 24 V / 0V
	4	Binary output 2-	4 → GND

b) Pin assignment on selection of the process actual value input

→ The input type is set via the configuration menu (see 6.3.2).

Input type	Jumper	Pin	Assignment	External connection
4..20 mA supplied internally		1	+24 V input transmitter	+ 24 V, 1, 2, Transmitter, 3, 4, GND
		2	output transmitter	
		3	GND	
		4	GND	
Frequency supplied internally		1	+24 V supply sensor	1 — +24 V
		2	Clock input +	2 — Clock input +
		3	not connected	
		4	Clock input - (GND)	4 — Clock input - (GND)
4..20 mA supplied externally		1	not connected	
		2	Process actual +	2 — + (4..20 mA) V
		3	Process actual -	3 — GND
		4	not connected	
Frequency supplied externally		1	not connected	
		2	Clock input +	2 — Clock input +
		3	not connected	
		4	Clock input -	4 — Clock input -
Pt-100		1	not connected	4, 3, 2, Pt-100
		2	Process actual 1	
		3	Process actual 2	
		4	Process actual 3	

Information on connecting the QUICKON connectors to cable

QUICKON PG9 / 3-pole

Range of wire cross-sections	0.34..0.75 mm²
Strand structure / smallest diameter	VDE 0295 Class 2 to 5 / 0.2
Wire insolation material	PVC / PE
Outside diameter of conductors	4...6 mm
Wire diameter (incl. insolation)	≤ 2.5 mm
Rated voltage	160 V
with overvoltage category / degree of contamination	III / 3

QUICKON PG11, 4-polig

Range of wire cross-sections	0.34..0.75 mm²
Strand structure / smallest diameter	VDE 0295 Class 2 to 5 / 0.2
Aderisolationsmaterial	PVC / PE
Outside diameter of conductors	4...7.5 mm
Wire diameter (incl. insolation)	≤ 2,5 mm
Rated voltage	160 V
with overvoltage category / degree of contamination	III / 2

5.5 Adjusting the inductive proximity switch (option)

ATTENTION!

It is necessary to open the Top*Control* housing to install the inductive proximity switch. Disconnect the power supply before opening open the Top*Control*.

Opening the Top*Control*:

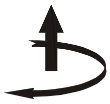
➔ Remove the screws and possible seals between the cover and the housing.

➔ Twist the cover to the left and remove it.

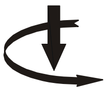
Installing the inductive proximity switch:

➔ Mount each inductive proximity switch at the top over the fixing screws. (Fig. 5.4):

Turn right ensures adjustment to the top



Turn left ensures adjustment to the top



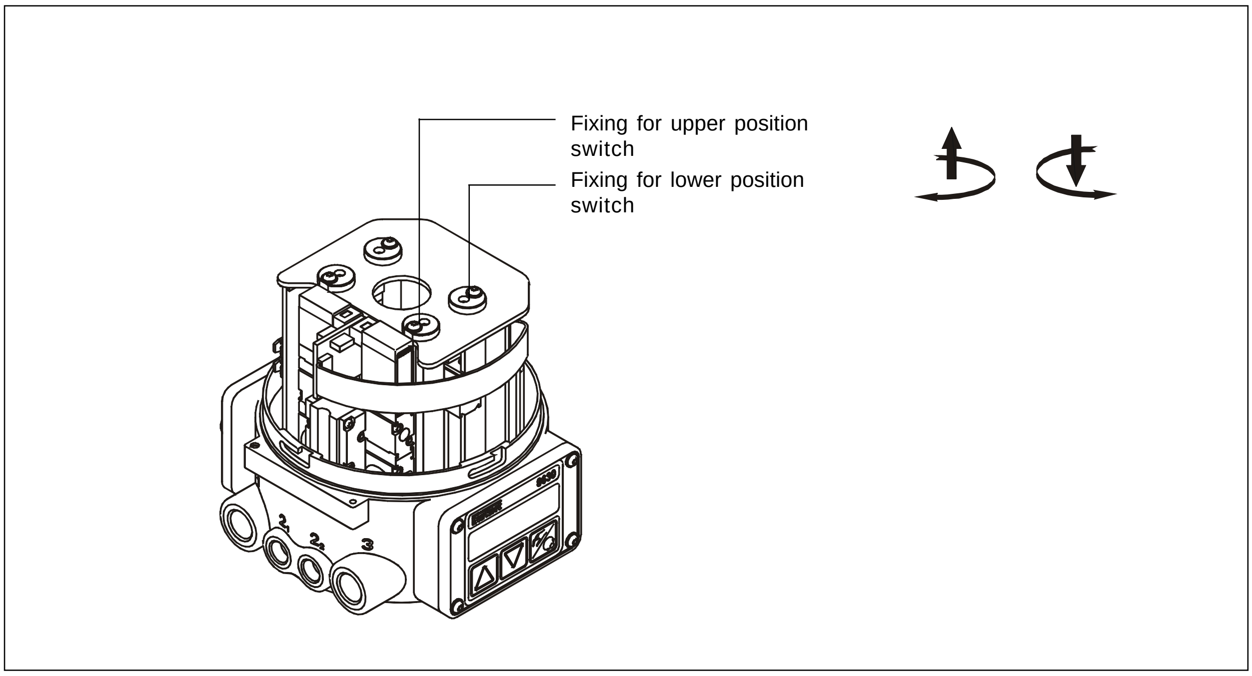


Bild 5.5: Setting of the inductive proximity switch with the setscrews

6 OPERATION

6.1 Control and display elements

The Top*Control* Continuous has 3 keys and a LCD (Fig 6.1).
The functions of the keys are described in the following section.

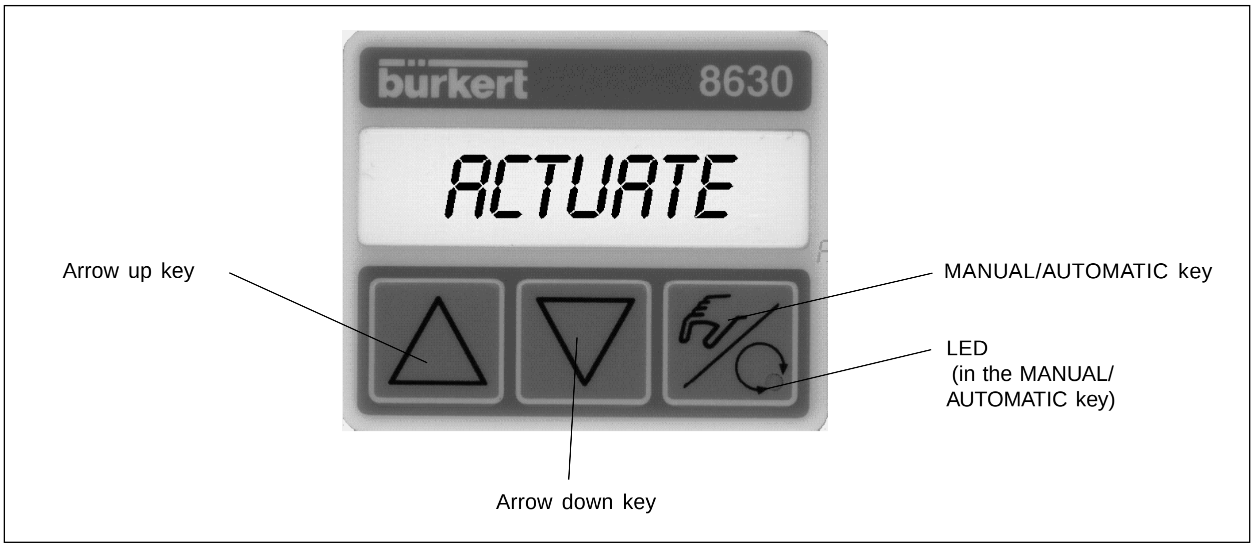


Fig. 6.1: Control and display elements

6.2 Operating levels

2 operating levels are provided for operation of the Top*Control* Continuous (fig. 6.2):

- *Process operation level:*
  This level is automatically set each time the unit is switched on. It allows changing between the MANUAL and AUTOMATIC operating modes. In the AUTOMATIC mode the position control or process control is automatically processed. In the MANUAL mode the valve can be opened or closed manually.

- *Configuration level:*
  Specify the basic functions on initial commissioning and select further additional functions within the configuration level.

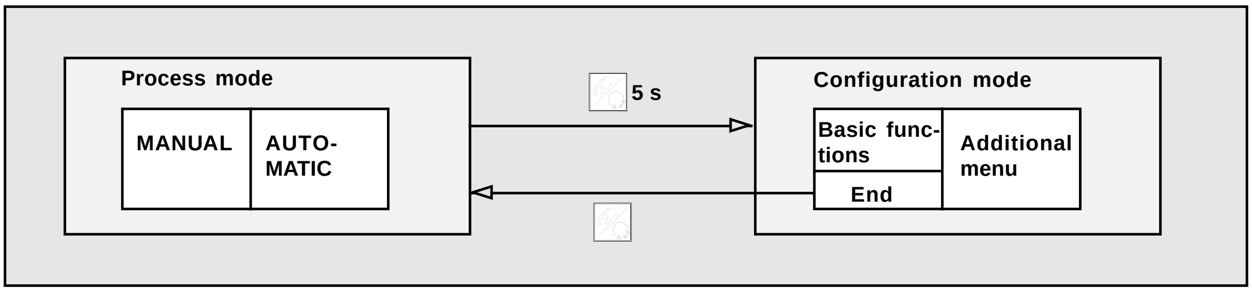


Fig. 6.2: Changing between the operating levels

6.3 Commissioning as a position controller

➔ Follow the pneumatic and electrical connection instructions before commissioning (chapter 5).

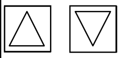
6.3.1 Basic configuration

➔ Select the following basic configuration for the initial commissioning :

- Enter the displacement range of the pneumatic actuator.
- Enter the unit of the selected input signal (4..20 mA, 0..20 mA, 0..10 V or 0..5 V).
- Start the self-calibration of the Top*Control* Continuous to the selected operating conditions(Autotune).

6.3.2 Operating mode for basic configuration

Assignment of the keys:

	MANUAL/AUTOMATIC key	Changing between main- and submenu e. g. ACT FUNC - FUNC SNGL
	Arrow keys	Changing between same level functions e. g. ACTFUNC - INPUT

Main menu for configuration during servicing:

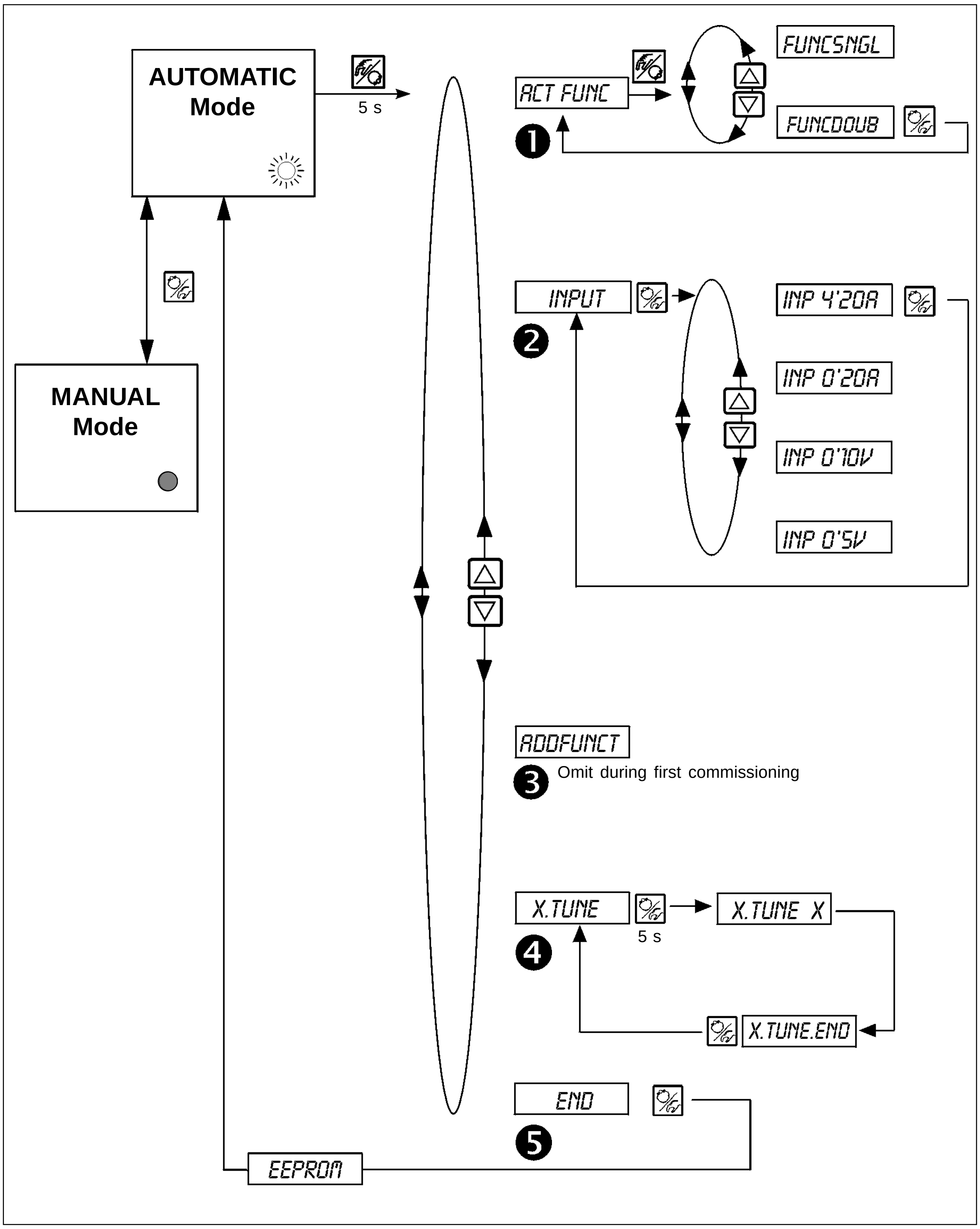


Fig. 6.3: Setting within the main menu

Description of the overview (Fig. 6.3):

After switching the power on, the Top*Control* Continuous is in the process operation level in the AUTOMATIC mode. To enter the basic configuration, within the configuration level, press the MANUAL/AUTOMATIC key for a duration of 5 seconds. The submenu ACTFUNC will then be displayed as the first step of the main menu.

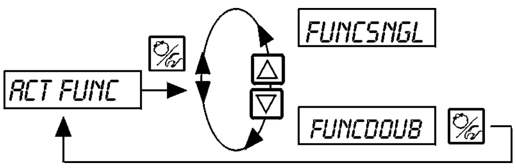
To enter the sub-menu ACTFUNC quickly press the MANUAL/AUTOMATIC key. One of the functions of the sub-menu will be displayed. To move between the different functions, press the arrow keys, additionally enter any desired settings. Press the MA-NUAL/AUTOMATIC key to validate the wished settings after selection.

NOTE The selected function is displayed on 3 or 4 digits right of the 8-characters LCD. These digits will blink on the display.

❶ ACTFUNC

Functions of the actuator

➔ Enter in this sub-menu the configuration of the pneumatical actuator used with the Top*Control*. See the instrument label for function valve description.



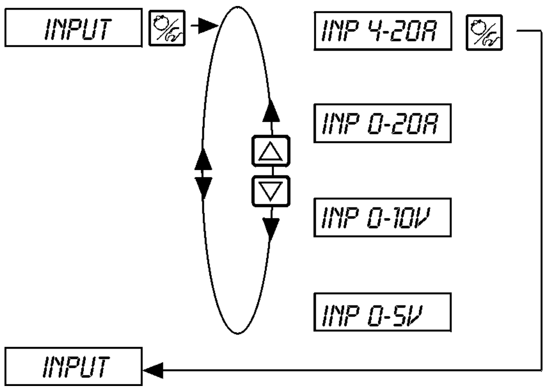
- single acting

- double acting

❷ INPUT

Selected input signal

➔ In this sub-menu enter the unit used for the setpoint value.



- Current 4..20 mA

- Current 0..20 mA

- Voltage 0..10 V

- Voltage 0..5 V

❸ ADDFUNCT

Configuration of the additional functions (see Fig. 6.4)

➔ Omit this function during the initial operation.

❹ X.TUNE

Autotuning of the Top*Control* Continuous

➔ With the X.TUNE sub-menu, you start a program that performs an automatic parametring of the Top*Control* Continuous.

The following parameters are automatically calculated:

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

➔ To start the autotune function, call the X.TUNE option within the main menu, then leave it by pressing the MANUAL-AUTOMATIC key for 5 seconds.

Start of the automatic adjustment of the Top*Control* Continuous to the operating conditions

Display	Description
TUNE 5 TUNE 4 : TUNE 0	Countdown from 5 to 0, before starting the autotune
¦ X.TUNE 1 ¦ X.TUNE 2 ¦ X.TUNE 3 ¦ X.TUNE 4 :	Display the already passed steps of the autotune procedure (The advancement is figured on a varying barchart (displayed on the right) hand side of the LCD)
X.TUNE.END	Blinking display => End of the autotune function
X.ERR X.X	Display in error occurence (right display: error number; see chapter 7)

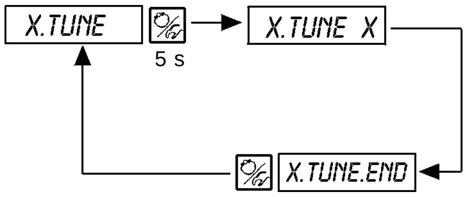


Fig. 6.4: Display during launching and performing the autotune

Advice: The basic configuration of the Top*Control* is pre-set by the factory. On commissioning, however, execution of ”Autotune” **is absolutely necessary**. The Top*Control* then determines autonomously the optimum settings for the current operating conditions.

ATTENTION!

> Avoid incorrect adaptation of the controller by executing an Autotune **in each case** at the supply pressure available in later operation (= pneumatic auxiliary energy).
> If substantial interfering forces are to be expected from the flow through the valve (e.g. from large pressure fluctuations), Autotune should be executed without medium pressure.

❺ END

Quit the main menu and display the version of the software

➔ In order to quit the main menu, select the submenu END with the arrow key, then validate. On the right hand side of the screen, the software version is displayed (END XX).Press the MANUAL/AUTOMATIC key for 3-5 seconds, and the message EEPROM appears on the display during the storage of the changes. The instrument is then in the previous mode (MANUAL-AUTOMATIC), before the main menu is entered.

6.4 Configuration of the additional functions

NOTE

The operating concept of the Top*Control* Continuous is based on a separate basic and additional functions. Only the basic functions of the unit are activated on delivery. This enables the basic settings such as specific units to be set during the initial setting up of the unit (Chapter 4). These are sufficient for the normal operations.

For more demanding tasks of position and process control, additional functions can be selected and configurated.

6.4.1 Keys in the configuration menu

Key description	**within the Menu**	**within a selected sub-menu**
△	Arrow up key	Increase of the numeric value
▽	Arrow down key	Decrease of the numeric value
Key description	**within the Menu**	**within the menu ADDFUNCT**
(MANUAL/AUTOMATIC key)	Validation of the selected sub-menu	Validation of the selected sub-menu of the additional functions for use within the main menu. The sub-menu is marked with a star (*) within the main-Menu and can there be selected and modified.
	Validation of the selected value	Selection of the selected submenu (marked with a star) in order to suppress it from the main menu.

6.4.2 Configuration menu

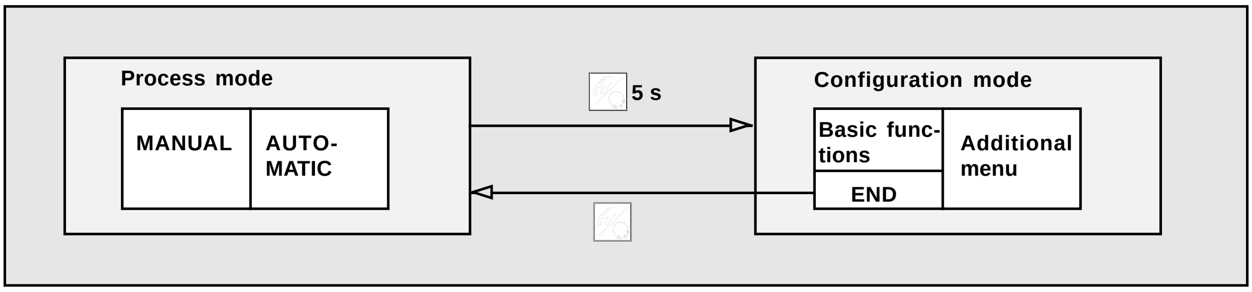


Fig. 6.5: Switch between process mode and configuration mode

➔ (MANUAL/AUTOMATIC key) 5 s — Within process mode, press the MANUAL/AUTOMATIC key and hold down for 5 sec to activate the configuration mode.

The configuration menu is constituted of the main menu and the additional menu. The main menu will contain the functions as specified during the initial commissioning (Chapter 4). The additional menu contains complementary functions and is available through the ADDFUNCT menu within the main menu. If necessary, you may complete the main menu with functions from the additional sub-menu, which you can then specify.

Selection of additional functions within the main menu

➔ Select the sub menu ADDFUNCT within the main menu.

➔ By pressing the MANUAL/AUTOMATIC key, enter within the additional sub-menu.

➔ Select the required function with the arrow-keys.

➔ By pressing the MANUAL/AUTOMATIC key, validate the additional function within the main menu. The function is marked with a star (*).

➔ All functions are activated within the main menu after validation through ENDFUNCT.

➔ Enter the parameters of the additional functions within the main menu.

Withdrawal of additional functions from the main menu

➔ Select the sub menu ADDFUNCT within the main menu.

➔ By pressing the MANUAL/AUTOMATIC key, enter within the additional sub-menu.

➔ Select a function marked with a star (*) by mean of the arrow-keys.

➔ By pressing the MANUAL/AUTOMATIC key, withdraw the additional function from the main menu (the marking star (*) is removed).

➔ The function is deactivated from the main menu after validation through ENDFUNCT.

Entry of numeric values

Enter the numeric values in the previous functions by pressing one or several times the arrow up key (to increase the value) or the arrow down key (to decrease the value). If the value is displayed with 4 digits, only the blinking one can be changed with the arrow key. Pressing the MANUAL/AUTOMATIC key moves to the next position.

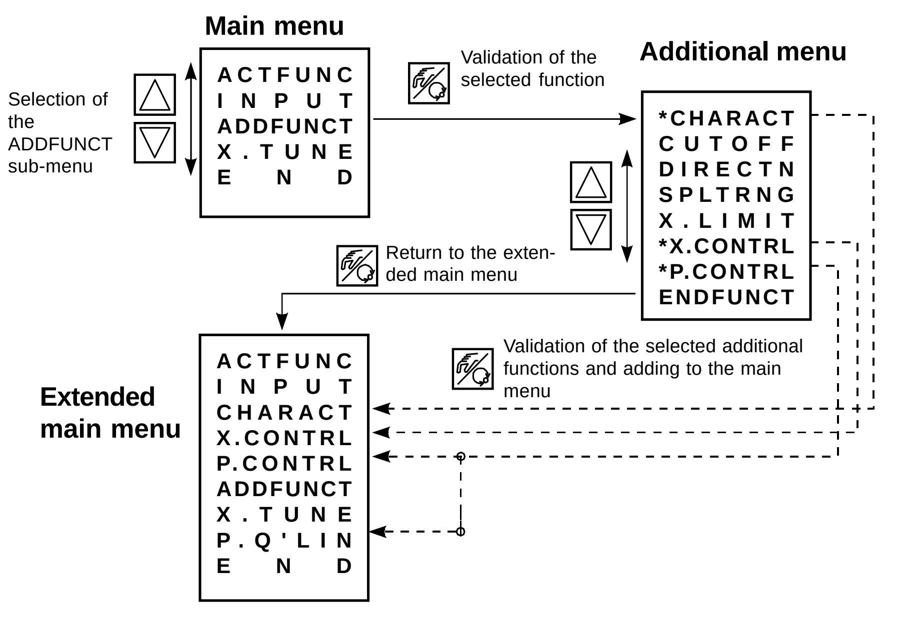
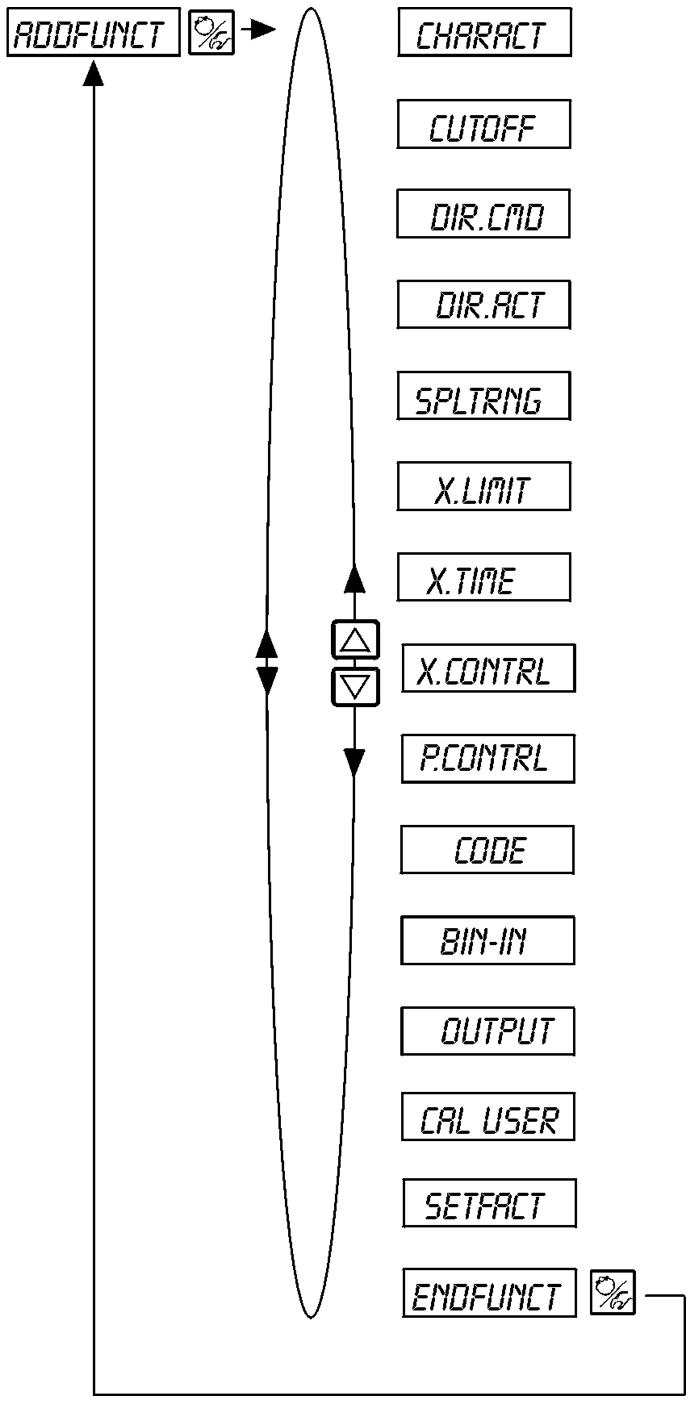


Fig. 6.6: Principle of the selection of an additional function to the main menu

6.4.3 Additional functions



Selection of the transmission characteristic curve between the input signal and stroke (correction characteristic curve)

Close tight function

Relationship between the input signal and the setpoint

Relationship between the indicated position value and the air supply state (Connection 2_1)

Split range: min. and max. value in % of the set value range of the Top*Control* Continuous

Stroke limitation to a given min. and max. value

Speed limitation to open or close the valve

Top*Control* Continuous configuration

Process controller configuration

Protection code for configurations

Operation of binary input

Output configuration

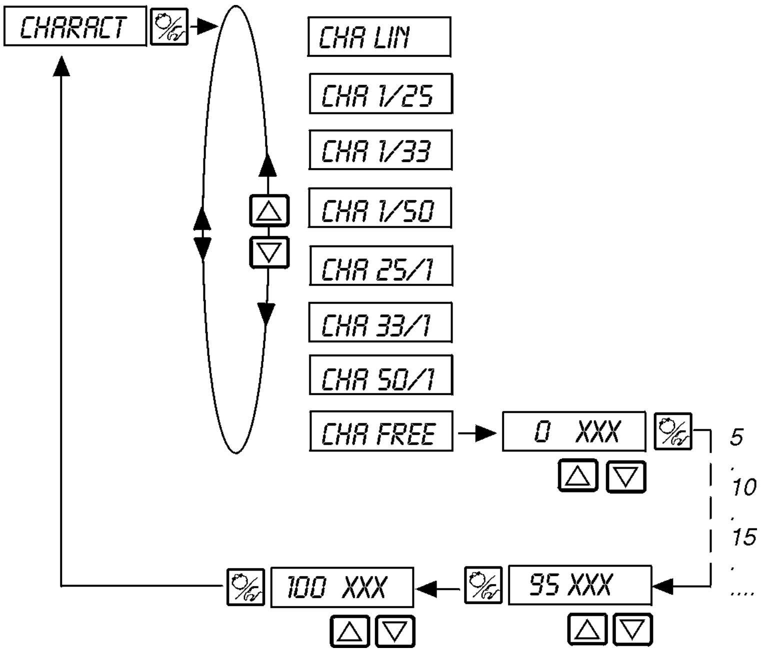
User calibration

Back to factory setting

CHARACT

Selection of the transmission characteristic curve between the input signal and the stroke (correction characteristic curve)
User specific characteristic curve (Characteristic)
Factory setting: CHA LIN

With this function you select a transmission characteristic curve in relation to the position set value (position setpoint) and to the valve stroke to correct the flow rate respectively the operating characteristic curve.



CHA LIN: linear characteristic curve

CHA 1/25: equal percentage characteristic curve, 1 : 25

CHA 1/33: equal percentage characteristic curve, 1 : 33

CHA 1/50: equal percentage characteristic curve, 1 : 50

CHA 25/1: inverse equal percentage, 25 : 1

CHA 33/1: inverse equal percentage, 33 : 1

CHA 50/1: inverse equal percentage, 50 : 1

CHA FREE: user specific freely programmable characteristic curve based on temporary restart points

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 of an equal percentage characteristic curve, a change in stroke ds corresponds to an equal percentage change in the k_v value

$$(dk_v/k_v = n_{equalperc}\ ds).$$

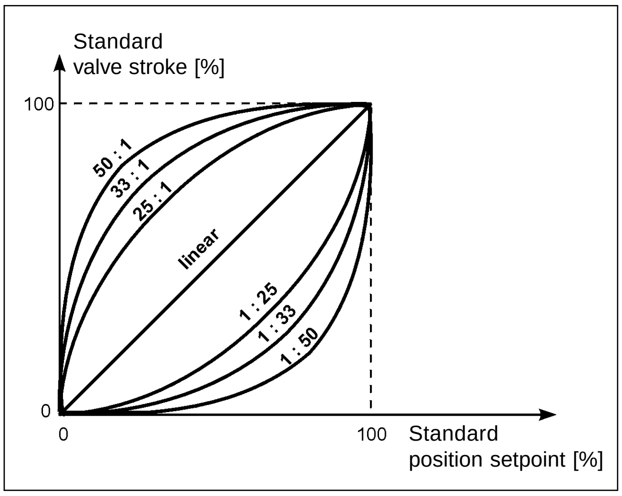


Fig. 6.7: Corrective characteristic curves

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 that can be used to correct the operating curve, is provided in the Top*Control* Continuous for this purpose.

The equipercentile curves 1:25, 1:33, 1:50, 25:1, 33:1 and 50:1 and a linear characteristic may be set. Furthermore, it is possible to programme any characteristic via reference points or have it calibrated automatically.

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. 6.8). 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 CHA 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.

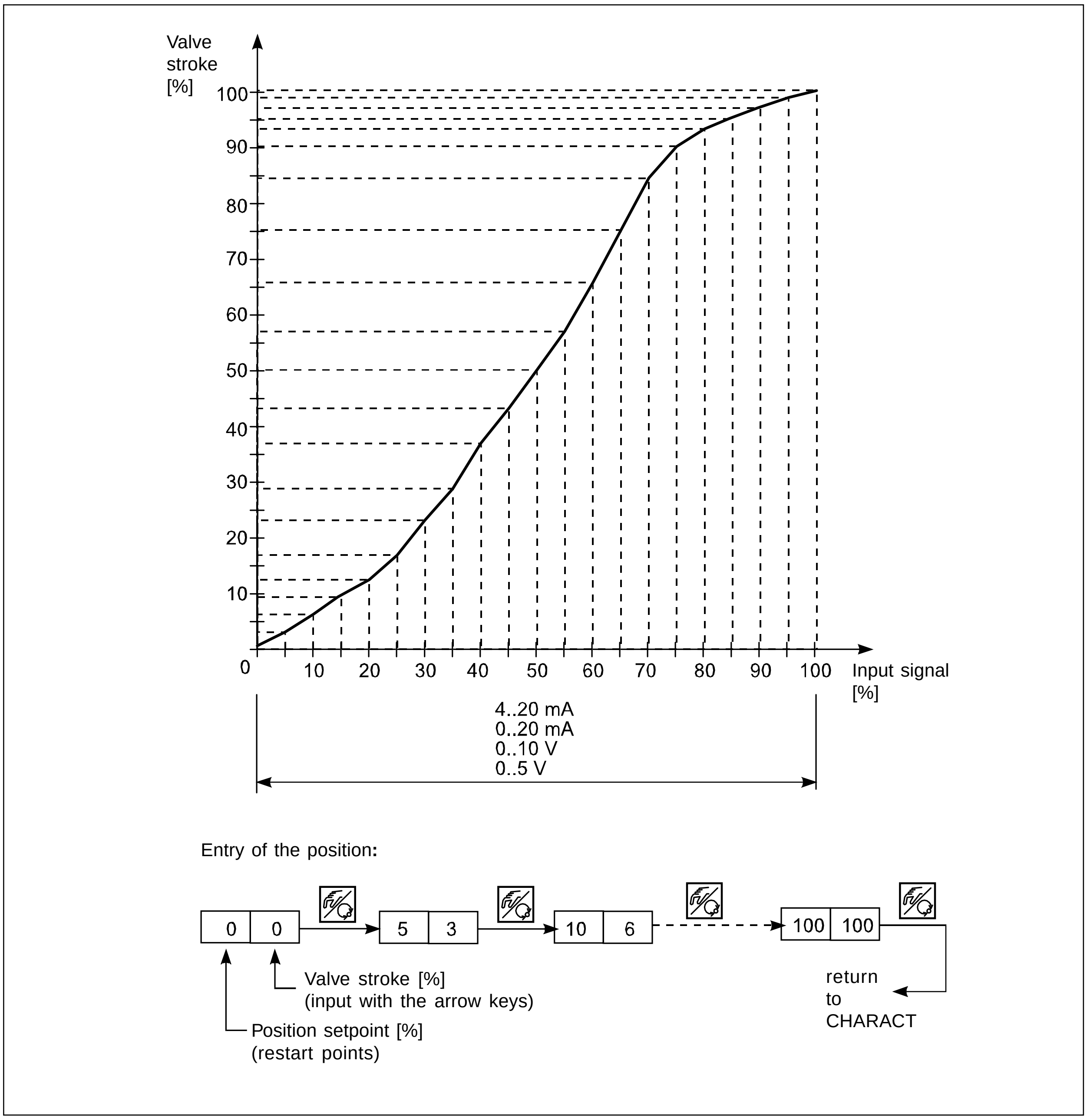


Fig. 6.8: Example of the free programming of a correction curve

NOTE A table for noting the reference points entered is to be found in the Annex

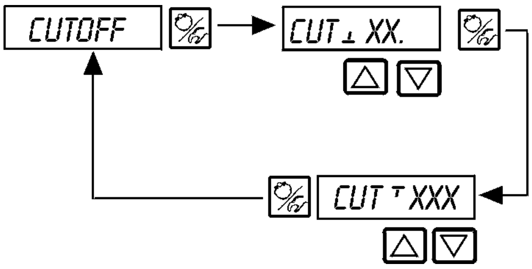
Note: .

CUTOFF

Close tight function

Factory setting: CUT⊥ = 1 %; CUT⊤ = 99%

The closed tight function ensures that the valve is tightly closed outside the control range. Specification of a value (%) from which the actuator air is completely exhausted or supplied with air. With the fast pressurizing/venting version, two valves are driven in each case in order to completely vent and pressurize more rapidly. The opening or resumption of the control operation takes place with a hysteresis of 1% (refer to Fig. 6.9).



Exhaust aired (0 % inactive)
Range: 0.0 ... 10.0 % for complete exhausting

Filled with air (100 % inactive)
90.0 ... 100 % for complete air supply

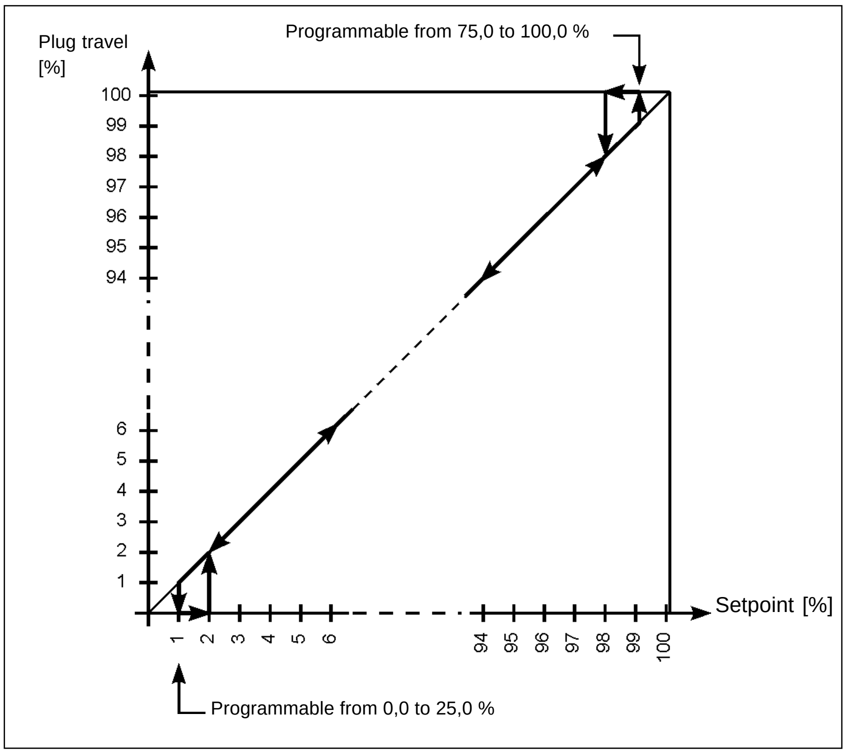


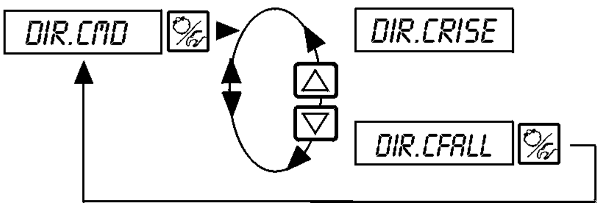
Fig. 6.9: Closed tight function

DIR.CMD

Direction of command of the setpoint of the actuator

Factory setting: DIR.CRISE

With this additional function, the direction of action according to setpoint of the actuator and the input signal (Fig. 6.10).



Rise direction
(i.e. 4 mA bzw. 0 V → 0%
20 mA bzw. 5/10 V → 100%)

Fall direction
(i.e. 4 mA bzw. 0 V → 100%
20 mA bzw. 5/10 V → 0%)

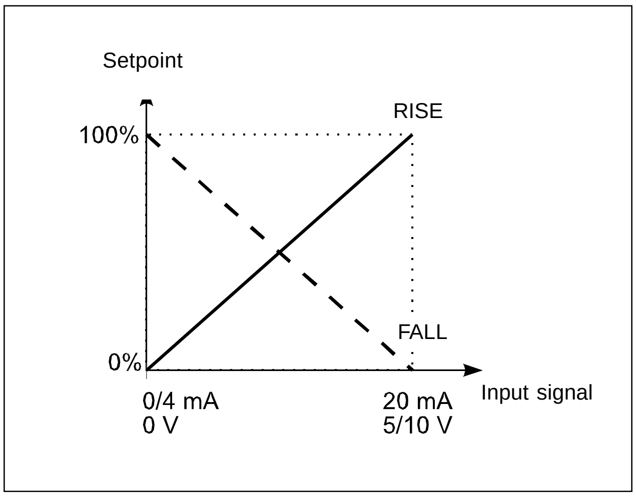


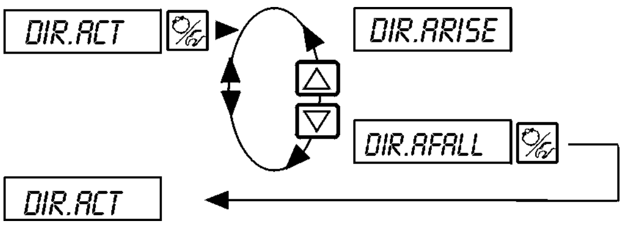
Fig. 6.10: Sense of action between input signal and setpoint

DIR.ACT

Relationship or direction of the actuator

Factory setting: DIR.ARISE

This function determines the direction of action between the air supply state and the actual value indication of the actuator (Fig. 6.11).



Direct command
(exhausted → 0% supplied → 100%)

Inverse command
(exhausted → 100% supplied → 0%)

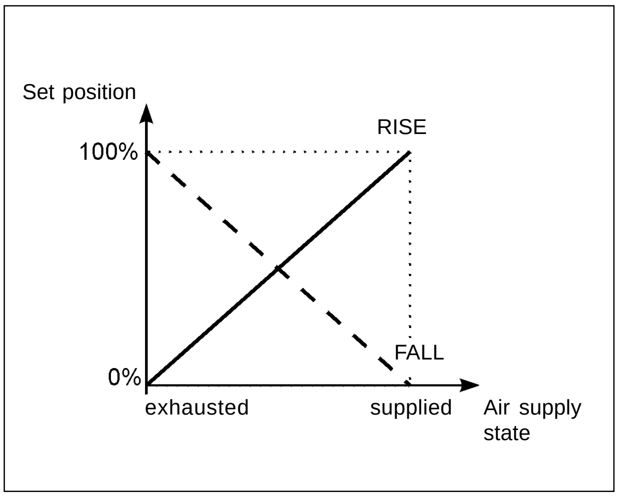


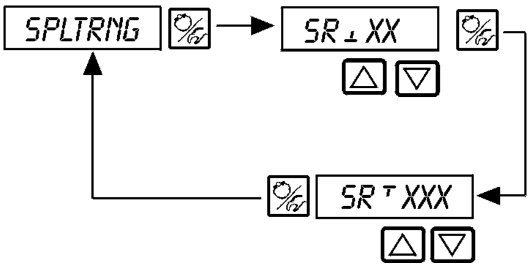
Fig.6.11: Relationship between air delivery state of the actuator and the actual value

SPLTRNG

Splitrange; minimal and maximum values of the input signal (in %) generating the complete displacement of the valve all over the plug range.

Factory setting: SR⊥ = 0 (%); SR⊤ = 100 (%)

This additional function enables the set value range of a Top*Control* Continuous to be restricted by stipulating a minimum and maximum value. This makes it possible to divide the used unit signal range (4..20 mA, 0..20 mA, 0..10 V oder 0..5 V) over several Top*Control* Continuous (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. 6.12).



Entry of the minimal value of the input signal in % (0... 75 (%) of the measuring range)

Entry of the maximum value of the input signal in % (25... 100 (%) of the measuring range)

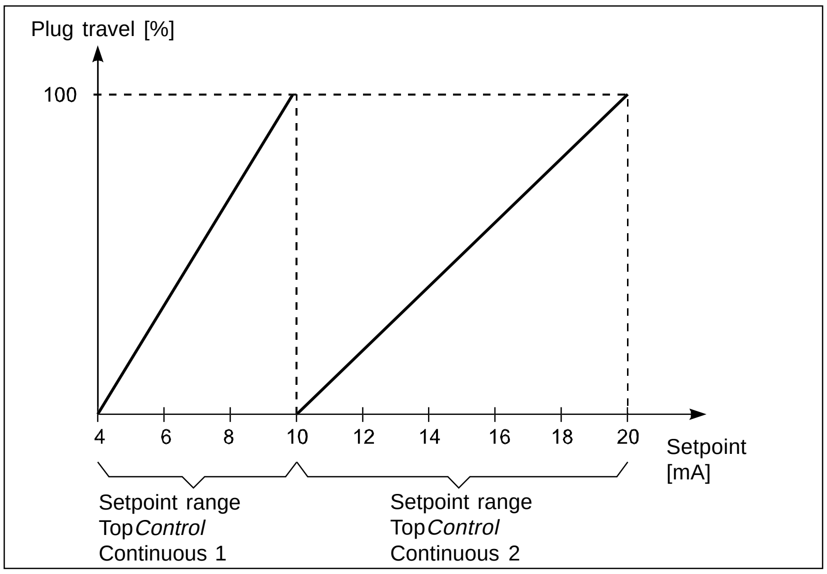


Fig. 6.12: Splitting a unit signal range into two set value ranges

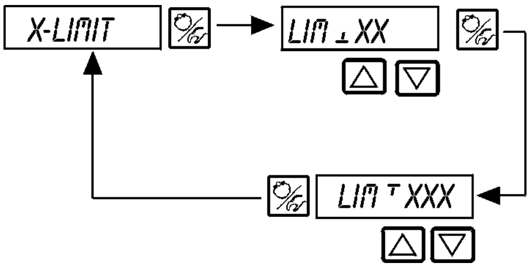
X.LIMIT

Mechanical stroke limitation

Factory setting: ⊥ LIM = 0%, LIM = 100%

This additional function enables the (physical) stroke to be limited to a given MIN and MAX percentage value (Fig. 6.13). There, the stroke range of the limited stroke is set to equal 100%.

If during servicing the selected plug travel is overpassed, then the display of POS value may be greater than 100 % or lower than 0%.



Entry of the lower value of the stroke range in %
0..50% of the total stroke

Entry of the upper value of the stroke range in %
50..100% of the total stroke

The minimum distance between LIM⊥ and LIM⊤ is 50%

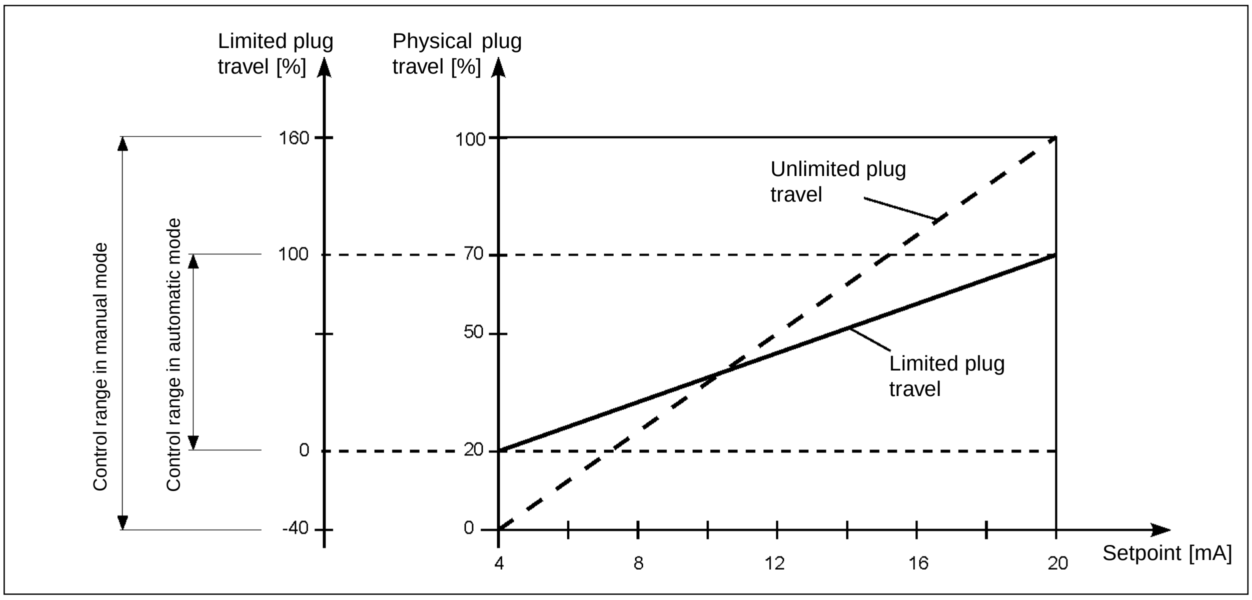


Fig. 6.13: Stroke limitation

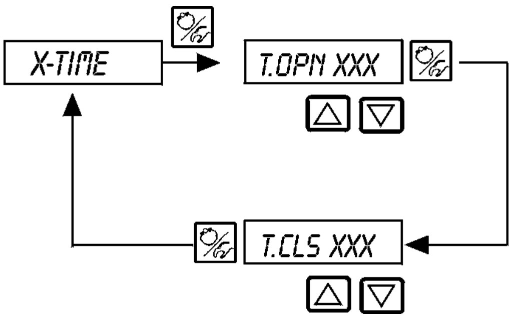
X.TIME

Setting speed limitation

Factory setting: No limitation

On execution of the function X.TUNE, the minimum opening and closing times for the entire stroke are entered in T.OPN and T.CLS automatically. In this way, operation at maximum speed is selected.

If the control speed is to be limited, values for T.OPN and T.CLS may be entered that lie between the minimum values determined by X.TUNE and 60 s.



Opening speed

Entry in s

Closing speed

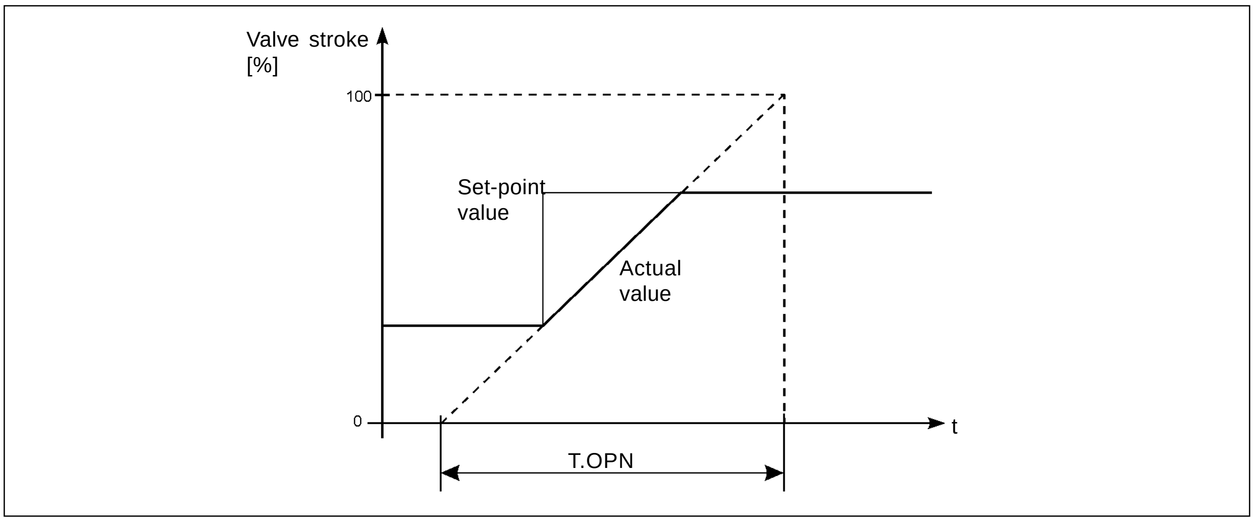
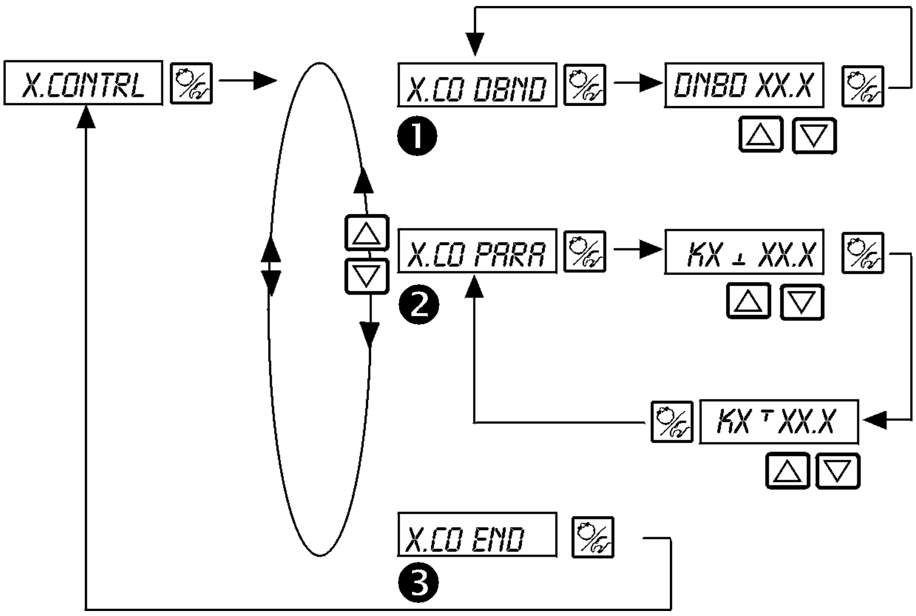


Fig. 6.14: Effect of limiting the opening speed for a jump in the set-point value

X.CONTRL

Parameters setting for the Top*Control* Continuous



❶ Deadband of the Top*Control* Continuous
Enter the deadband in % (0 = automatic) Factory setting: 1 %

This function ensures that the Top*Control* Continuous acts only then a selected control difference is measured (Fig. 6.14).
This function protects the servovalve and pneumatic actuator by controlling the start-up frequency.
The setting is optimized automatically with X.TUNE.

❷ Parameter of the position controller

KX ⊥ XX.X — Proportional factor for the Top*Control* Continuous (to close the valve)

KX ⊤ XX.X — Proportional factor for the Top*Control* Continuous (to open the valve)

❸ End of the parametering of the Top*Control* Continuous. Return to X.CONTRL

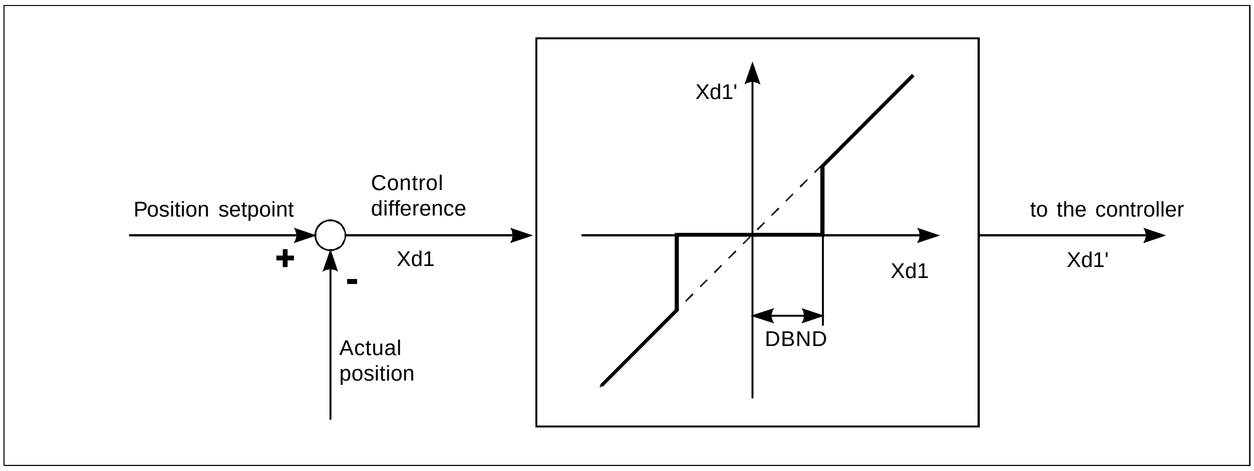
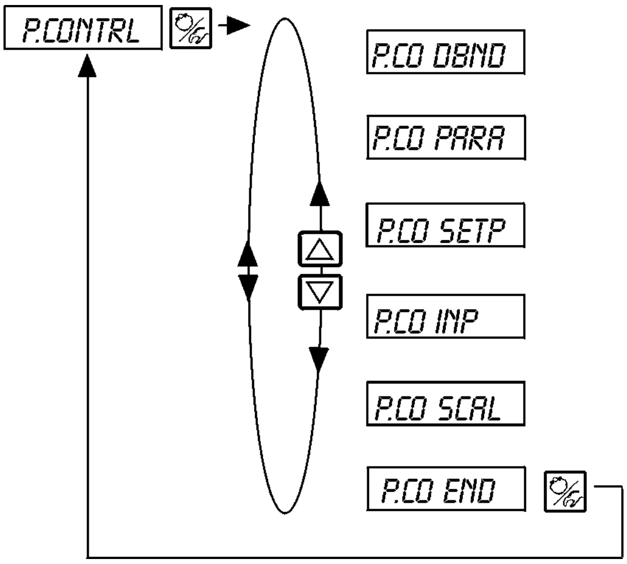


Fig. 6.15: Deadband by position control

P.CONTROL

Parameters setting of the process controller



Dead band of the controller

Parameters of the PID controller

Mode of setpoint entry

Filtering of the process actual value input

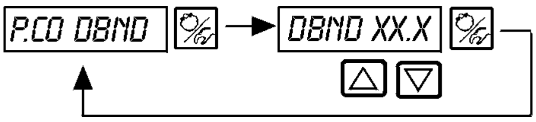
Scale of the controller

Storage of the new parameters
End of the parametering setting of the controller

P.CO - DBND

Deadband of the process controller Factory setting: 1% (relative to the range of the selected process set-point input

This function ensures that the postioner acts only then a selected control difference is measured (Fig. 6.15). This function protects the servovalve and pneumatic actuator by controlling the start-up frequency.



Entry of the deadband in %

Entry of the dead band in % relative to the range of the selected process set-point input

Input type used for PV	Range	Spread (as reference for the dead band)	Example: 1% dead band corresponds to
4..20 mA	4 .. 20 mA	16 mA	0,16 mA
Frequency	0 .. 1000Hz	1000 Hz	10 Hz
Pt100	-20 .. +220°C	240°C	2,4°C

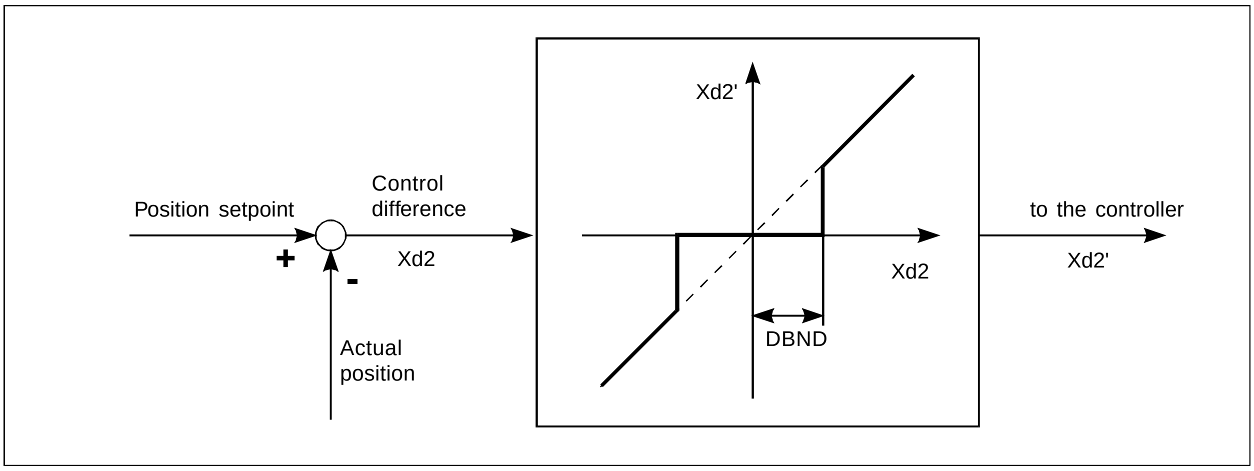
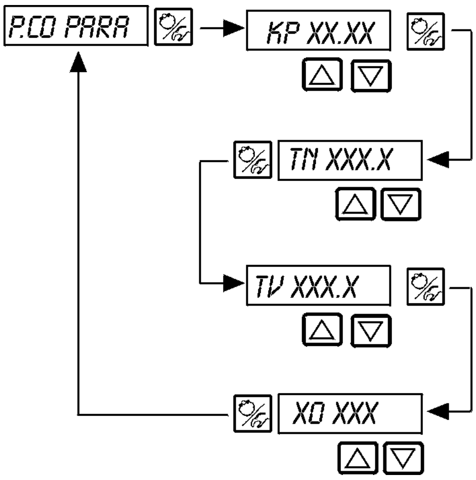


Fig. 6.16: Deadband by process control

P.CO - PARA

Controller PID parameters



Proportional correction value
0...99.99 (factory setting 1.00)

Reset time
0.5...999.9 (factory setting 999.9)

Rate action time
0.5...999.9 (factory setting 0)

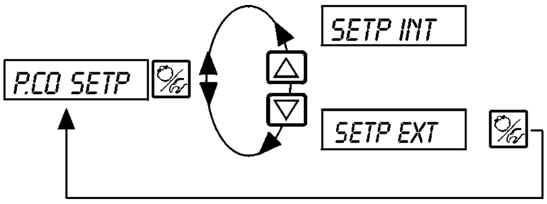
Operating point of process controller
0.0...100 % (factory setting 0 %)

See Appendix

NOTE A table for noting the reference points entered is to be found in the Annex

P.CO - SETP

Type of setpoint (internal/external)

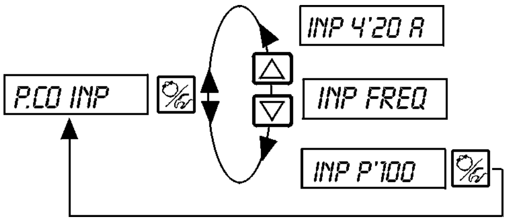


SETP INT: Internal setpoint by keys on the TopControl

SETP EXT: External setpoint by analogue input

P.CO - INP

Analogue input type
Enter the analogue input signal type according to the transmitter signal.



INP 4'20 A: Analogue input 4...20 mA
(Flow; Pressure; Level; Analytical)

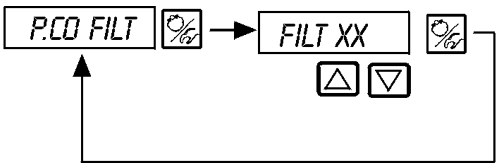
INP FREQ: Analogue input Frequency (Flow)

INP P'100: Analogue input Pt100
(Temperature)

P.CO - FILT

Filtering of the process actual values. Valid for all process actual value types.

Range: 0..9 Works setting: 0



FILT XX
Setting in 10 steps: 0..9

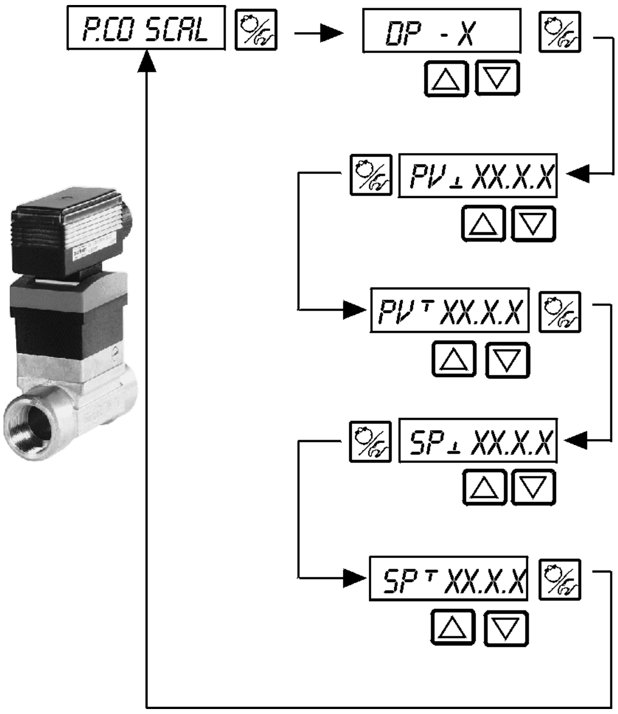
Setting in 10 steps

Setting	Limiting frequency [Hz]	Effect
0	10	**minimum filter effect**
1	5	
2	3	
3	2	
4	1	
5	0,7	
6	0,5	
7	0,3	
8	0,2	
9	0,1	**maximum filter effect**

P.CO SCAL

A) Scale limit for process control by selection of "4 ..20 mA" (P.CO INP 4-20A)

(example see below)



Position of the decimal point for the process setpoint and actual value
(Selectable value: 0..3)

Lower range value for process actual value
(process value);
value assigned to 4 mA.

Higher range value for process actual value
(process value);
value assigned to 20 mA.

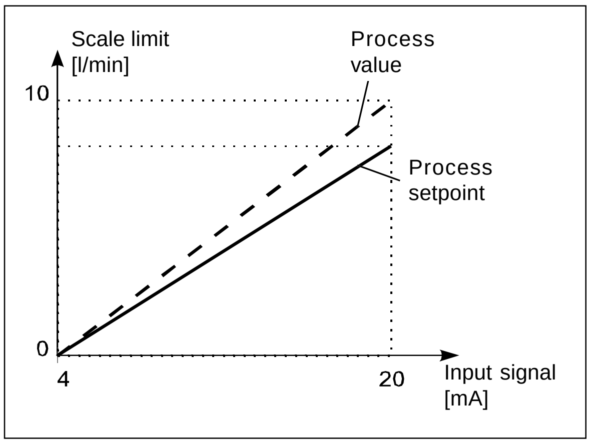
Lower range value for process setpoint
(setpoint); assigned to the highest current/voltage value of the external setpoint signal.
This setting is only activated if
P.CO SETP / SETP EXT is selected.

Higher range value for process setpoint
(setpoint); assigned to the lowest current/voltage value of the external setpoint signal.
This setting is only activated if P.CO SETP / SETP EXT is selected.

Scale limit selection example for the 4..20 mA input (Fig. 6.16):

Actual process value of the transmitter: 4..20 mA match 0..10 l/min

Process setpoint of the SPS: 4..20 mA match 0..8 l/min



Example for scale value entries

	Variant 1	Variant 2	Variant 3
PV ⊥	0	0	0
PV ⊤	1.0	10.0	100.0
SP ⊥	0	0	0
SP ⊤	0.8	8.0	80.0

Fig 6.16: Example of scale limit for controller input

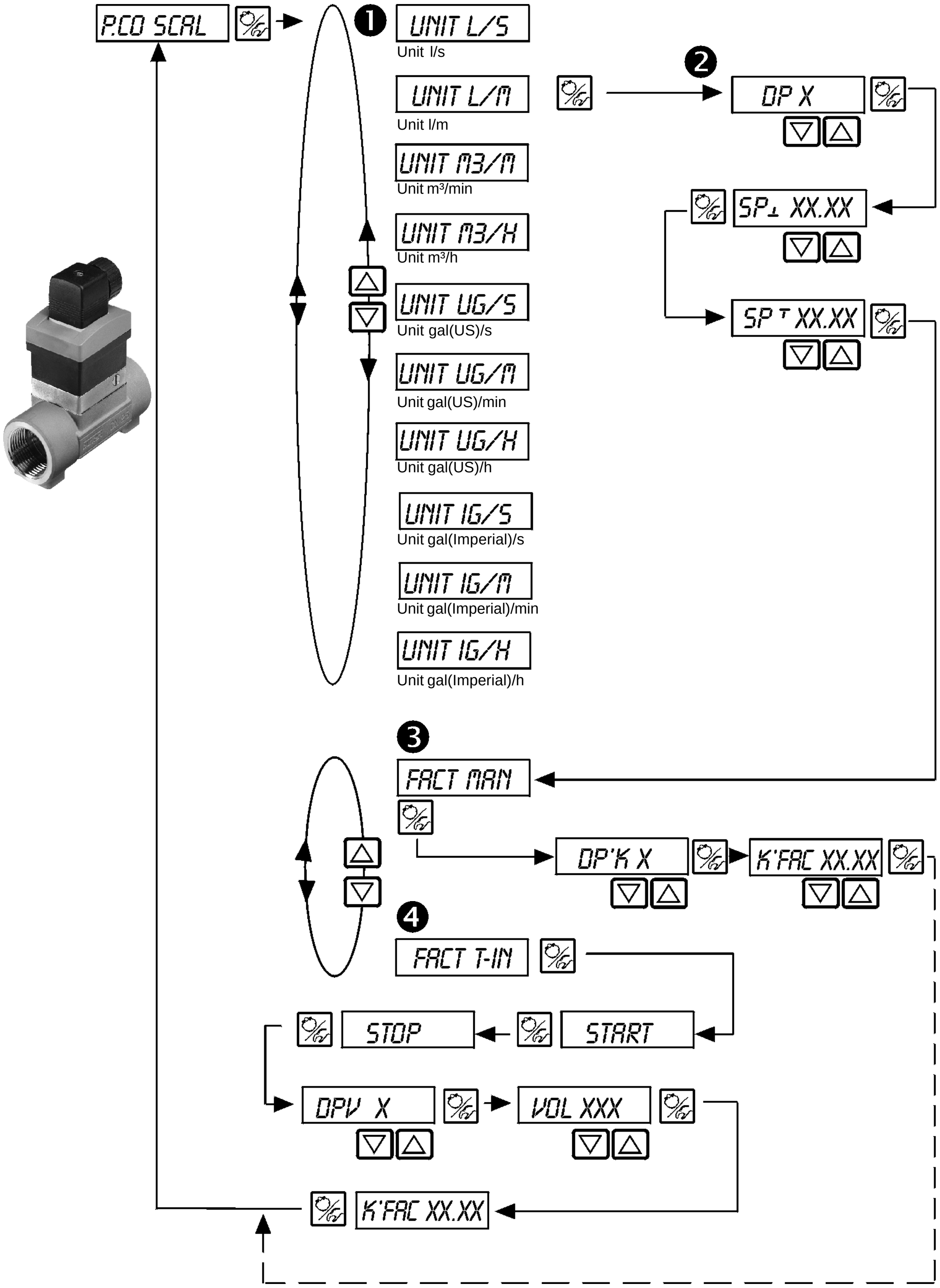
NOTE

On entry of small scaling values, to increase the display accuracy, places after the decimal point are automatically added, so that the maximum possible digit range is obtained between the lower and upper scaling value in each case.
The amplification (KP) of the process controller relates to scale values set.

With P.CO SETP / SETP INT (desired value pre-set via the arrow key), no scaling of the desired value SP⊥ and SP⊤ not possible. It can be entered directly in correspondence with the scaled process variable (PV ⊥, PV ⊤).

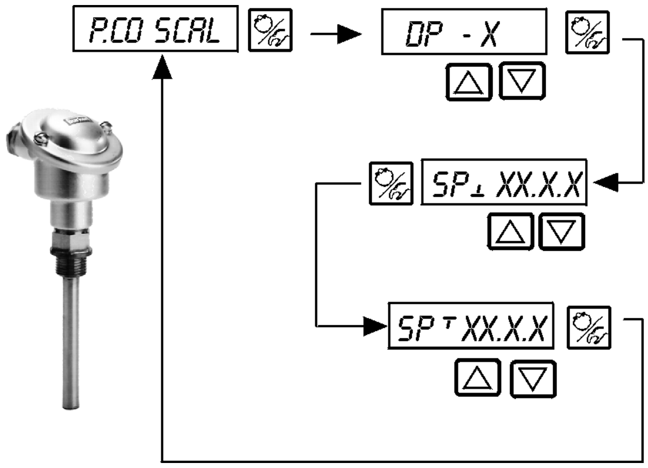
B) Scale limit for process control by selection of frequency input (P.CO INP FREQ)

NOTE The valve is closed as this menu is activated. Then, the Teach-In is performed with a defined output conditions.



❶		Entry of the required flow unit
❷	DP X	Position of the decimal point for the process setpoint and actual value (Selectable value: 0..3).
	SP⊥ XX.XX	Lower range value for process setpoint ; assigned to the lower current/voltage value of the external setpoint signal. This setting is only activated if P.CO SETP / SETP EXT is selected.
	SP⊤ XX.XX	Higher range value for process setpoint; assigned to the higher current/voltage value of the external setpoint signal. This setting is only activated if P.CO SETP / SETP EXT is selected.
❸	FACT MAN	Manual entry of the K-factor of the flow sensor (refer to the data sheet of the flow sensor)
	DP'K X	Position of the decimal point of the K-factor (Selectable value: 0..2)
	K'FAC XX.XX	K-factor (range: 0..9999)
❹	FACT T-IN	Teach-In-Function: Calculation of the K-Factor, by measuring a known fluid volume .
	START	Starting the measurement. - Run the pump or open the valve. The tank is full, shut the pump or close the valve. - Open and close the valve with the arrow keys. The valve must not be tightly open.
	STOP	End of the measurement.
	DPV X	Position of the decimal point of the measured volume (Selectable value: 0..3).
	VOL XXX	Enter the measured volume (Selectable value: 0..9999). Unit as previously selected UNITXXXX.
	K'FAC XX.XX	Display of the calculated K-Factor

C) Scale limit for process control with Pt100 (P.CO INP PT100)



Position of the decimal point for the process setpoint and actual value (Selectable value: 0..3)

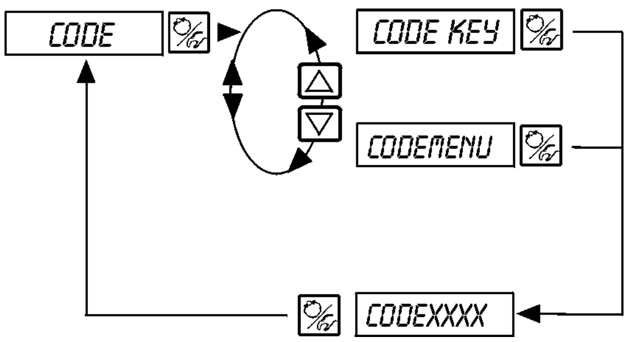
Lower range value for external process setpoint Assigned to the lower current/voltage value of the external setpoint signal (this setting is only activated if P.CO SETP / SETP EXT is selected).

Higher range value for external process setpoint Assigned to the higher current/voltage value of the external setpoint signal (this setting is only activated if P.CO SETP / SETP EXT is selected).

CODE

Code protection for the settings

Factory setting: CODE 0000



Blocking of all actions that would change the operating status of the device.
The contents of the display can be switched over.

Blocking of entry into the configuration level.

Entry of the 4-digit code

CODEXXXX

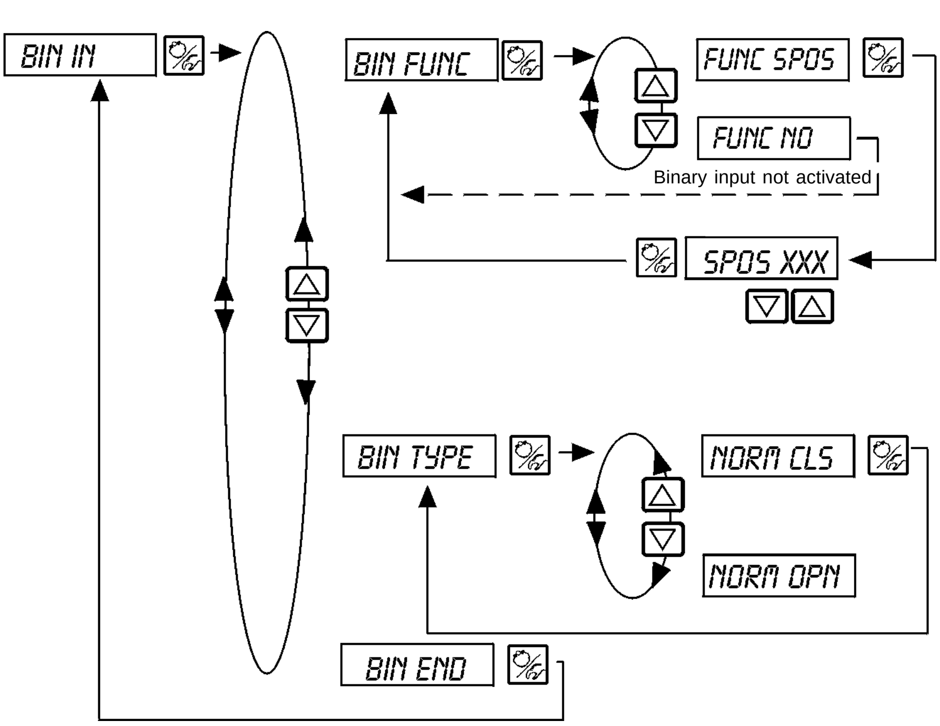
When code protection is active, the entry code is demanded every time a blocked operation is attempted:

Alteration of the flashing place/digit

Confirmation of the digit and switching to the next place

BIN-IN

Configuration of the binary input



Selection of the function of the binary input

Searching of a security position

Enter the security position (0..100%) *

Type of binary input

normally closed
(0..5 V = 1; 10..30 V = 0)

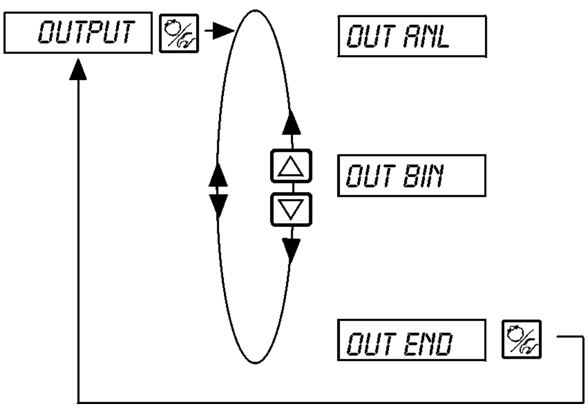
normally open
(0..5 V = 0; 10..30 V = 1)

End of the binary input function

* If the safety position is 0 or 100%, the actuator is completely vented or pressurized, respectively, as soon as the relevant signal is applied to the binary input.
With the fast pressurizing/venting version, two valves are driven in each case in order to completely vent and pressurize more rapidly.

OUTPUT **Option**

Configuration of the output signals

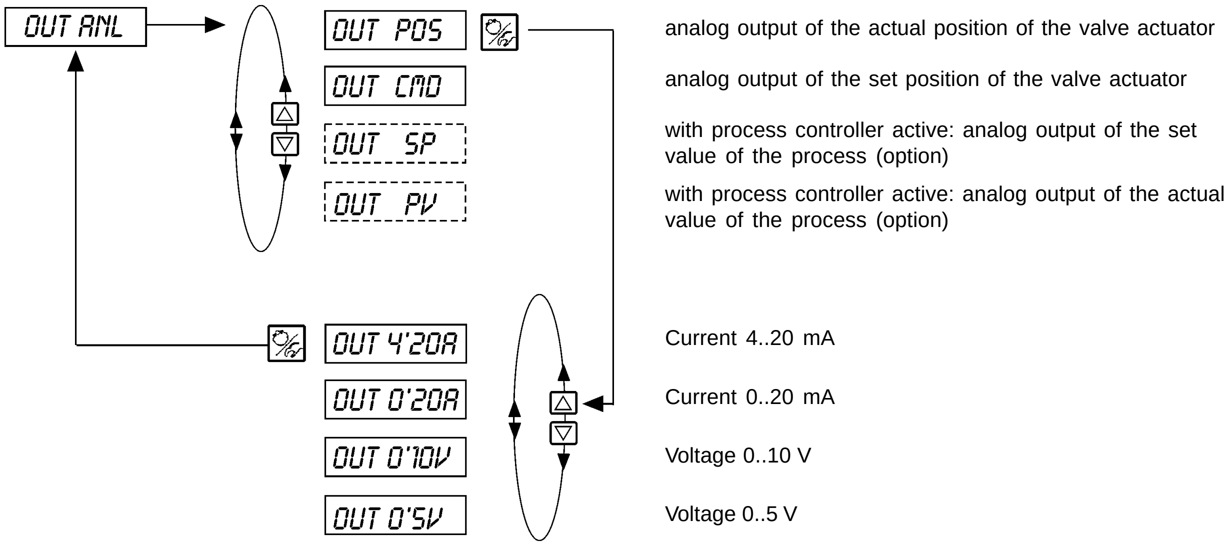


❶ Setting the analogue output
(see next page)

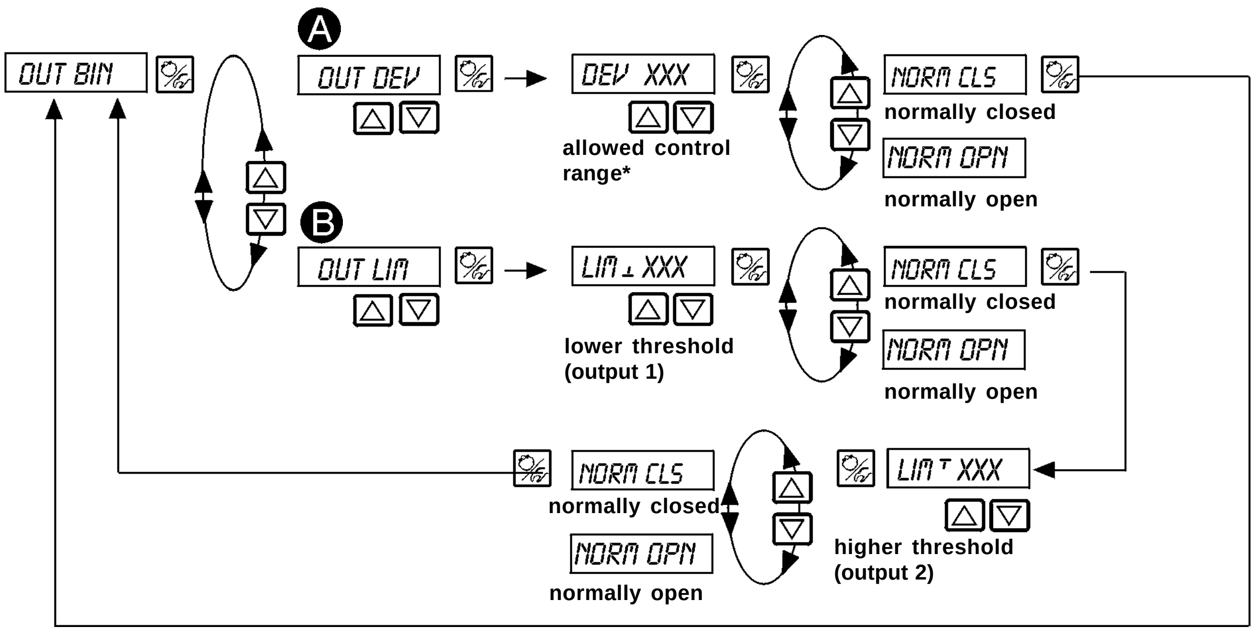
❷ Setting the binary output
(see next page)

❸ End of the configuration of the output signals

❶ OUT ANL **Unit of analogue position indication**



❷ OUT BIN **Configuration of the output signal**



A OUT DEV — Choice: Alarm output for high control deviation (output 1)
* the selected control deviation DEV XXX must not be lower than the deadband.

NORM CLS	The output functions as normally closed output.
NORM OPN	The output functions as normally open output.

B OUT LIM — Choice: 2 binary position output signals

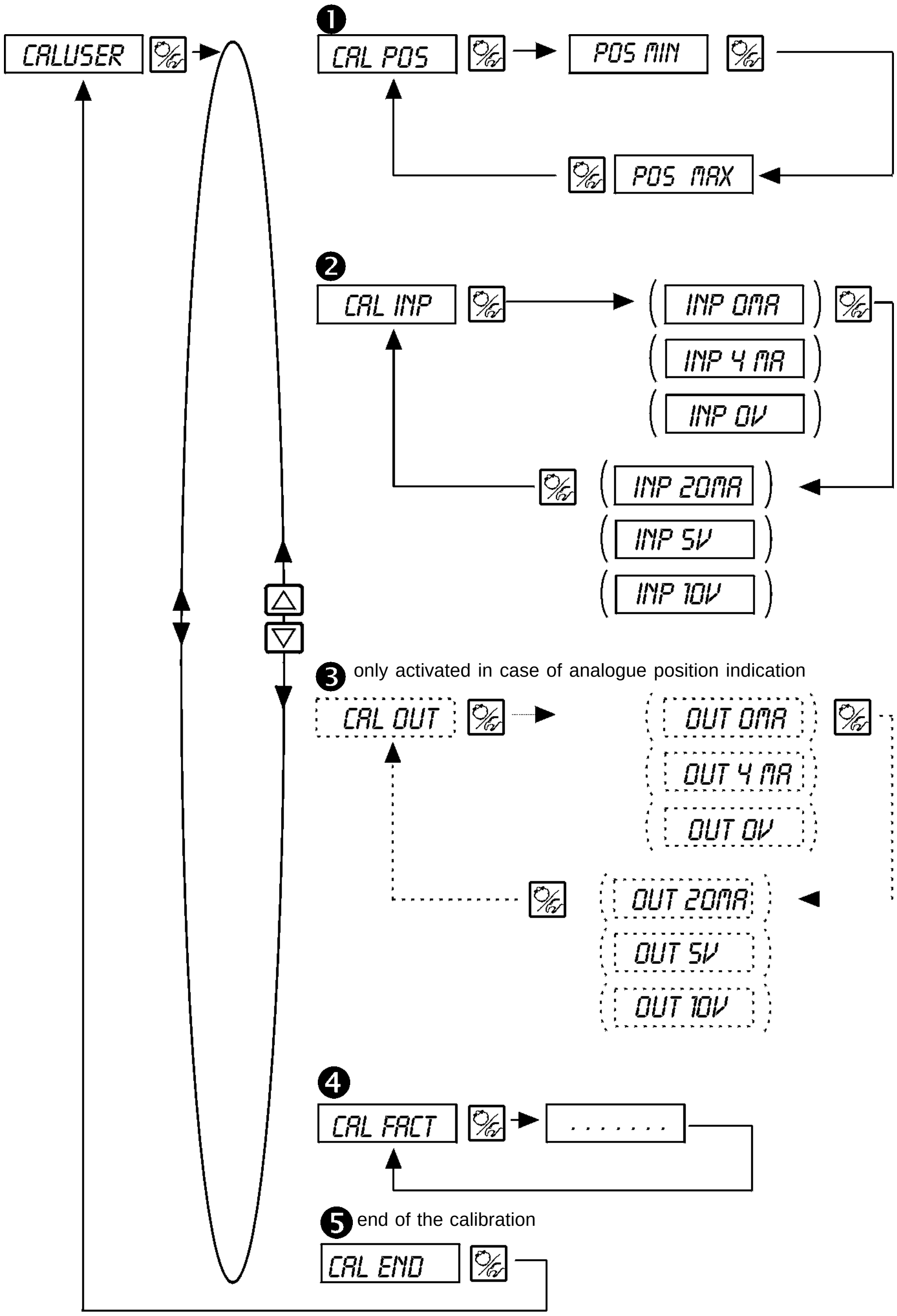
LIM ⊥ XXX	lower threshold (output 1)
LIM ⊤ XXX	higher threshold (output 2)
NORM CLS	The output functions as normally closed output.
NORM OPN	The output functions as normally open output.

CAL.USER

Calibration of the actual value display, entries for position and process control setpoint, process value, and K-Factor of the valve.

A) POSITION CONTROL ACTIVATED

Description see next page



NOTE

The signal values within parenthesis are only available as a display and cannot be modified. The type of signal as previously selected in the configuration menu is displayed:
CAL INP: Display of the selection within the INPUT menu
CAL OUT: Display of the selection within the OUTPUT menu

❶ CAL.POS Calibration of the position indication (0 - 100 %)
Entry of the minimal position: set the minimal position of valve with the arrow key, then validate by pressing the MANUAL/AUTOMATIC key

Entry of the maximal position:
set the valve to the maximal position with the arrow key, then validate by pressing the MANUAL/AUTOMATIC key

❷ CAL INP Calibration of the position setpoint (4..20 mA; 0..20 mA; 0..5 V; 0..10 V)
Entry of the minimal input signal (0 mA; 4 mA; 0 V):
set the minimal input signal with the arrow key, then validate by pressing the MANUAL/AUTOMATIC key

Entry of the maximal input signal (20 mA; 5 V; 10 V):
set the maximal input signal with the arrow key, then validate by pressing the MANUAL/AUTOMATIC key

❸ CAL OUT Calibration of the analogue signl output (4..20 mA; 0..20 mA; 0..5 V; 0..10 V)

Adjustment of the minimal output signal (0 mA; 4 mA; 0 V):
Change the minimal output signal with the arrow key until the displayed value is correct, then validate by pressing the MANUAL/AUTOMATIC key.

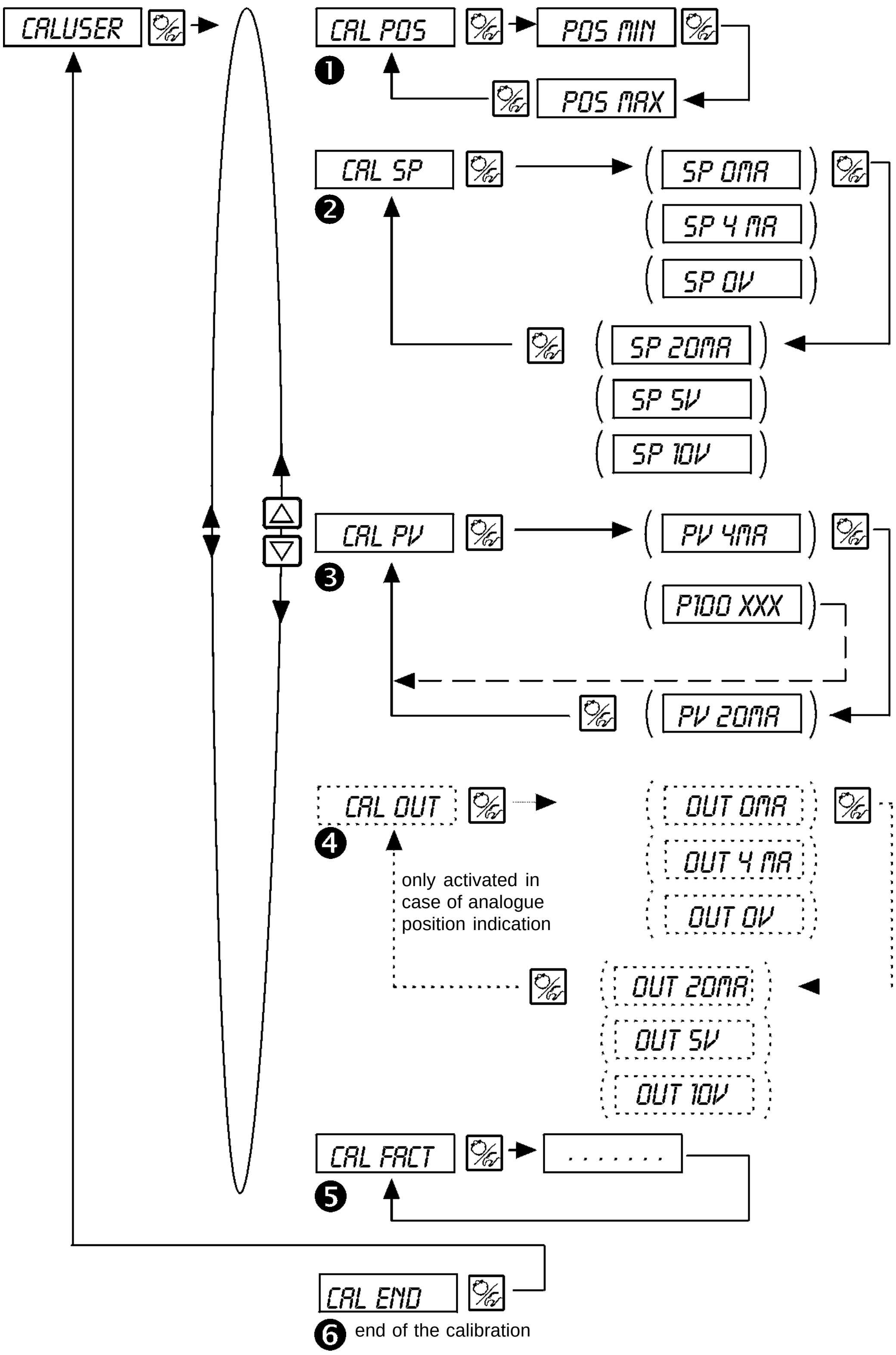
Adjustment of the maximal output signal (20 mA; 5 V; 10 V):
Change the maximal output signal with the arrow key until the displayed value is correct, then validate by pressing the MANUAL/AUTOMATIC key.

CAL OUT **is only activated in case of analogue position indication!**

❹ CAL FACT Return to the factory setting within the Cal.user function:
Press the MANUAL/AUTOMATIC key until the countdown elapsed.

B) PROCESS CONTROL ACTIVATED

Description see next page



NOTE

The signal units within parenthesis are only available as a display and cannot be modified. The type of signal as previously selected in the configuration menu is displayed:
CAL PV: Display of the selection within the P.CO.INP menu
CAL SP: Display of the selection within the P.CO.SETP menu
CAL OUT: Display of the selection within the OUTPUT menu

❶ CAL POS — Calibration of the position indication
Entry of the minimal position:
Set the minimal position of valve with the arrow key, then validate by pressing the MANUAL/AUTOMATIC key

Entry of the maximal position:
Set the valve to the maximal position with the arrow key, then validate by pressing the MANUAL/AUTOMATIC key

❷ CAL SP — Calibration of the position setpoint; the type of setpoint (4..20 mA; 0..20 mA; 0..5 V; 0..10 V) was selected in the INPUT menu

Set the minimal setpoint (0 mA; 4 mA; 0 V) with the arrow key, then validate the value by pressing the MANUAL/AUTOMATIC key

Set the maximal setpoint (20 mA; 5 V; 10 V) with the arrow key, then validate the value by pressing the MANUAL/AUTOMATIC key

❸ CAL PV — Calibration of the actual process value ; the type of the actual process value (4..20 mA; Pt 100) was selected in the PCO-INP menu

if 4..20 mA selected:
Set the minimal input then validate by pressing the MANUAL/AUTOMATIC key

Set the maximal input signal then validate by pressing the MANUAL/AUTOMATIC key

if Pt-100 selected:
Correct the displayed value with the arrow key until the display on the TopControl is in accordance with the reference measuring instrument, then validate by pressing the MANUAL/AUTOMATIC key.

❹ CAL OUT — Calibration of the analogue signl output (4..20 mA; 0..20 mA; 0..5 V; 0..10 V)

Adjustment of the minimal output signal (0 mA; 4 mA; 0 V):
Change the minimal output signal with the arrow key until the displayed value is correct, then validate by pressing the MANUAL/AUTOMATIC key .

Adjustment of the maximal output signal (20 mA; 5 V; 10 V):
Change the maximal output signal with the arrow key until the displayed value is correct, then validate by pressing the MANUAL/AUTOMATIC key.

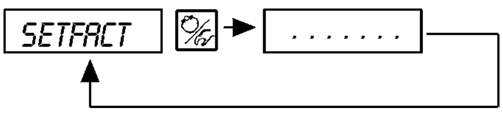
CAL OUT **is only activated in case of analogue position indication!**

❺ CAL FACT — Return to the factory setting within the Cal.user function:
Press the MANUAL/AUTOMATIC key until the countdown elapsed.

SETFACT

Return to the factory setting

This function allows the user to return to the initial factory setting. All EEPROM parameters are reset to default value. Finally a complete hardware reset of the instrument is performed.



3 s — Press the MANUAL/AUTOMATIC key during ca. 3 seconds, until the countdown elapsed.

6.5 Setting a process control function

In order to use the Top*Control* Continuous as a process controller, apply the following requirements:

➔ Perform first the self-calibration procedure for the position controller (X.TUNE - see 6.3.2).

➔ Select the P.CONTRL additional function within the configuration mode in the main menu (see 6.4).

The function P.CONTRL will also be activated into the main menu.

➔ Enter the basic configuration of the process controller within the P.CONTRL function (see 6.4).

If the process control acts on a flow process control, it is possible to use the automatic linear characteristic curve of the process:

➔ Release the function P.Q'LIN (see 6.5.1).

ATTENTION!

Perform the functions in the following order, in any case!	X.TUNE P.Q'LIN

6.5.1 Starting the function to obtain linear characteristic curve

P.Q'LIN

This function is only useful for a flow process control

➔ Start the function to obtain the automatic linear characteristic curve by selecting the function P.Q'LIN within the main menu and pressing the MANUAL/AUTOMATIC key during 5 seconds.

NOTE

It is only possible to activate the function P.Q'LIN within the main menu if the functions P.CONTRL / P.COINP / INP.FREQ or P.CONTRL / P.COINP / INP 4'20MA has been selected.

By activation of the function P.CONTRL the function P.Q'LIN is automatically copied within the main menu. Start the function to run the program to obtain the automatic correction curve.

The program increases the valve stroke in 20 steps from 0 to 100 % and measures the associated process variable. The couple of points of the correction characteristic curve are used within the sub-menu CHARACT/CHAFREE as a free programmable characteristic curve, and can be checked within this sub-menu.

If the function CHARACT was not previously, transferred within the main menu by the sub-menu ADDFUNC this will be automatically performed by the call to the P.Q'LIN function, and the function CHARACT/CHAFREE will be simultaneously activated.

Display	Description
P.Q'LIN 5 P.Q'LIN 4 : P.Q'LIN 0	Countdown from 5 to 0 before starting the function
¦ P.Q'LIN 0 ¦ P.Q'LIN 1 ¦ P.Q'LIN 2 ¦ P.Q'LIN 3 :	Display the already passed steps of the function performed (The advancement is figured on a varying bar chart displayed on the right side of the LCD)
P.Q'LIN.END	(flashing) End of the function
Q.ERR X.X	Display in error occurrence (right display: error number; see chapter 7)

Fig. 6.17 Display during launching and performing the linearisation function

6.6 Process operation level

The process operating level is automatically set each time the unit is switched on. From configuration level you can change over to the process operation level by using the MANUAL/AUTOMATIC key and after validation of the instruction END of the menu.

The process operating level allows viewing of normal control functions (AUTOMATIC mode) and to open and close the valve manually (MANUAL mode).

Change of operating levels:

[MANUAL/AUTOMATIC key]	To change over between MANUAL and AUTOMATIC operating mode press the MANUAL/AUTOMATIC key.
[MANUAL/AUTOMATIC key] 5 s	From MANUAL or AUTOMATIC mode you can change over to the configuration level by pressing the MANUAL/AUTOMATIC key for 5 seconds. Returning to the process operation level, the unit operates in the last selected level before changing.

Operating mode	Yellow LED in MANUAL/AUTOMATIC key	Display
AUTOMATIC	flashing	a quotation mark is continuously flashing from left to right.
MANUAL	off	-

6.6.1 AUTOMATIC operating mode

In *AUTOMATIC* operating mode the system functions in the process control configuration.

Key functions in *AUTOMATIC* operating mode:

△ or ▽	Display switching
△ or ▽ > 3 s	Change of the process setpoint If the additional function P.CONTRL / P.CO SETP / SETP INT is configured and SP selected

Display indications in AUTOMATIC operating mode:

A) Process controller not active

The following information from the Top*Control* Continuous is possible:

- Actual position of the valve actuator: POS__XXX (0..100%)
- Set position of the actuator after scaling i.e. split range function or characteristic curves modification: CMD__XXX (0..100%)
- Input signal for set position: INP__XXX (0..5/10 V or 0/4 .. 20 mA)
- Internal temperature of the Top*Control* Continuous: TEMP_XX.X (in °C)

By pressing the arrow keys you activate the changing over between the 4 display possibilities (Fig. 6.19).

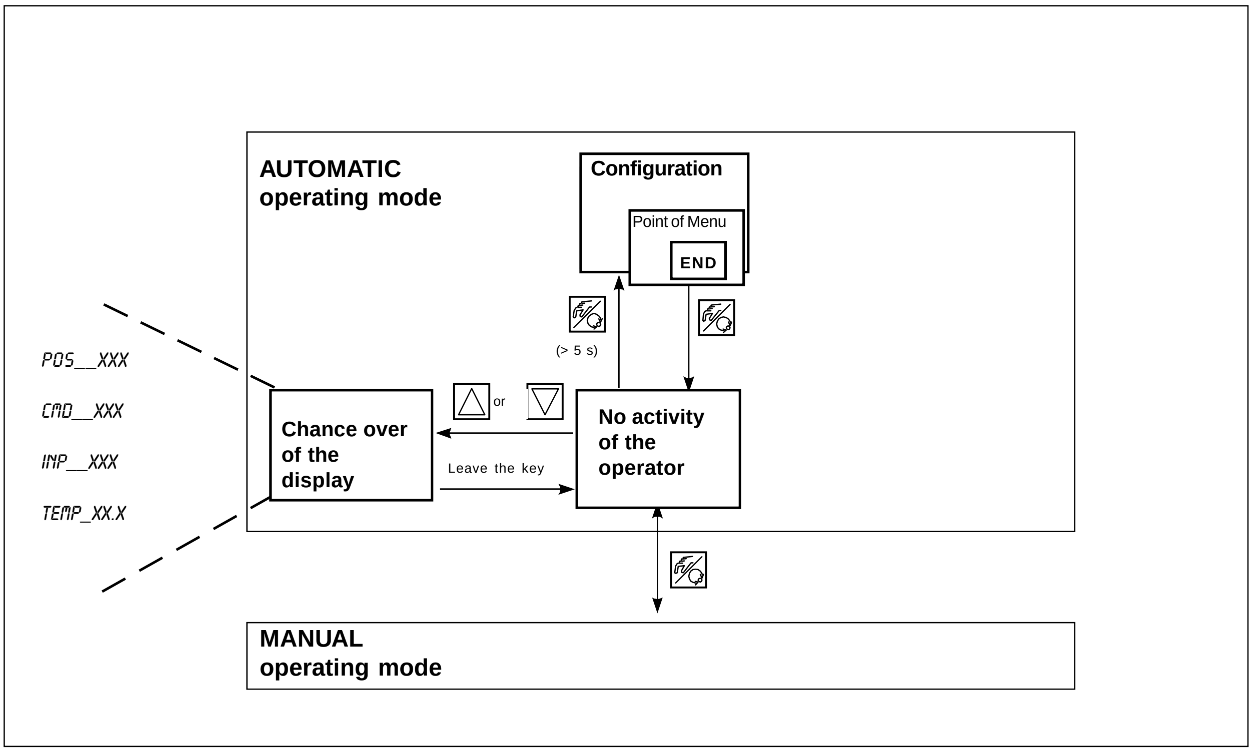


Fig. 6.19: Display, operation structure and operating instructions in AUTOMATIC mode with inactive process controller

NOTE

When the menu item BIN IN / BIN FUNC / FUNC SPOS is active and the binary input is switched, the message SAFE XXX appears in the display.
The value XXX indicates the previously selected safety position in %.

B) Active process controller

The following points are shown:

- Actual process value: PV___(-999..9999)
- Process set point: SP___(-999..9999)
- Actual position of the actuator: POS__XXX (0..100%)
- Set position of the actuator after scaling
  i.e. split range function or characteristic curves modification: CMD__XXX (0..100%)
- Internal temperature of the Top*Control* Continuous: TEMP_XX.X (in °C)

By pressing the arrow keys you activate the changing over between the 6 display possibilities (Fig. 6.120).

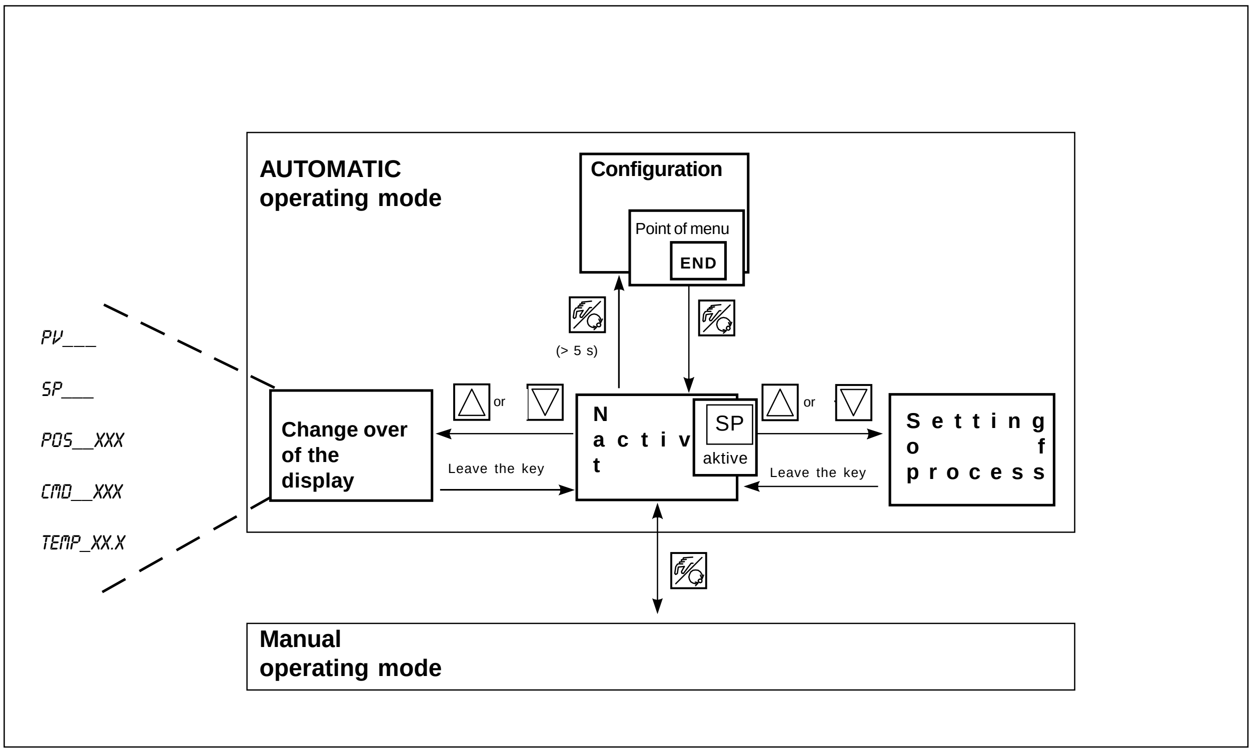


Fig. 6.20: Display, operation structure and operating instructions in AUTOMATIC mode with active process controller

NOTE

When the menu item BIN IN / BIN FUNC / FUNC SPOS is active and the binary input is switched, the message SAFE XXX appears in the display.
The value XXX indicates the previously selected safety position in %.

Manual modification of the process set-point:

△ or ▽ > 3 s — If programming the additional functions P.CONTRL / P.CO SETP / SETP INT is required, it is possible to activate the process set point mode by using one of the arrow keys. Press the key for more than 3 sec. (Fig. 6.18, 6.19). After the first digit of the process set point will blink.

△ ▽ — Now select the first digit of the process set point. or

MANUAL/AUTOMATIC key — Validate the value with the MANUAL/AUTOMATIC key.

Use the same procedure for the next digits. After validating of the 4th digit, the program automatically returns to the menu.

6.6.2 MANUAL operating mode (yellow LED off)

In the MANUAL operating mode the valve can be opened or closed manually.

Key functions in the MANUAL operating mode:

△ — Pressing the ”up arrow” key:
Opens the actuator

▽ — Pressing the ”down arrow” key:
Closes the actuator

△ and ▽ — Continuously pressing the ”up arrow” and ”down arrow” keys simultaneous:
Produces a quick opening action

▽ and △ — Continuously pressing the ”down arrow” and ”up arrow” keys simultaneous:
Produces a quick closing action

Display indications in MANUAL operating mode:

1. Process controller not active

- The last indication of the AUTOMATIC operation mode is displayed.
  Selecting POS__XXX provides an option to check the actual value of the actuator.

2. Process controller active

- The last indication of the AUTOMATIC operation mode is displayed.
  Selecting PV__XXX provides an option to check the actual value of the actuator.

- To display the actual value of the actuator during the MANUAL operation mode, previously selected in the AUTOMATIC mode display POS__XXX.

Normal / Quick manual operating of the valve:

By continuously pressing the ”up arrow” key in the MANUAL operating mode, the valve is continuously opened.
To stop the function release the key and the valve will remain in the open position. By pressing the ”down arrow” key the valve will be closed proportionally.

An additional pressing of the second arrow key generates a quick action of the valve (closing or opening) depending on the first selected arrow (Fig. 6.21).

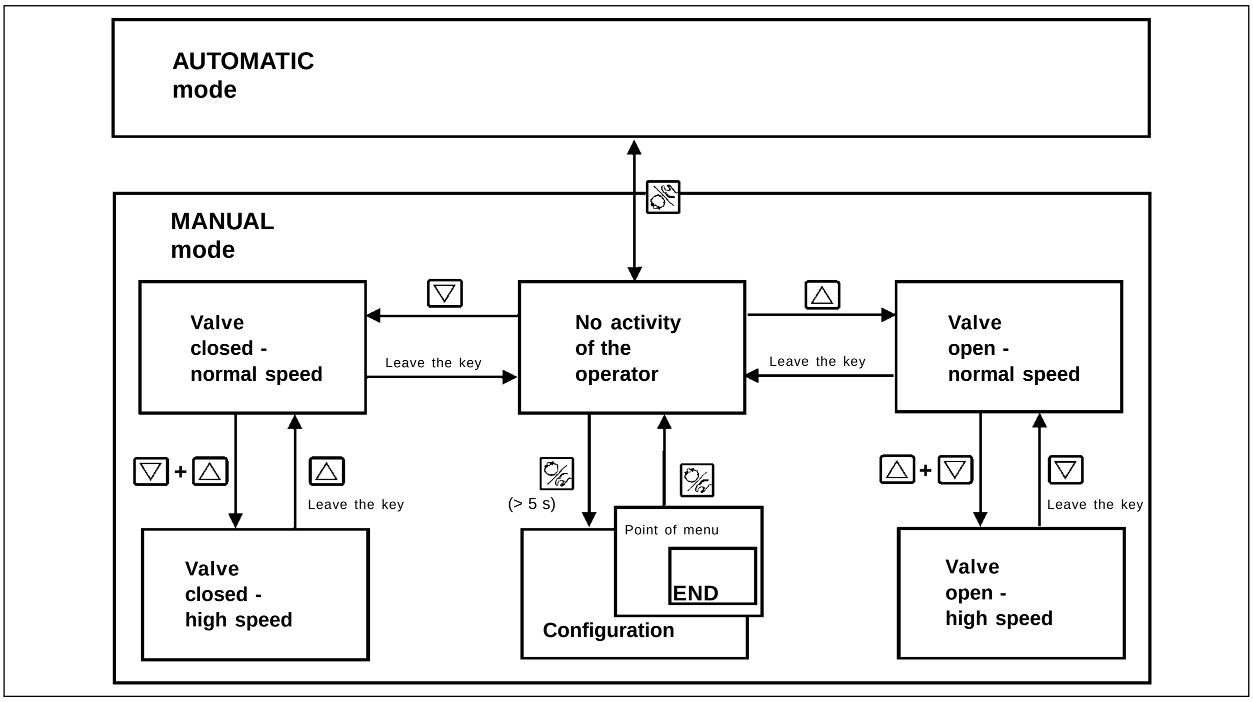


Fig. 6.21: Operation structure and operating instructions in MANUAL mode

7 FAILURES AND REPORT ERRORS

The Top*Control* Continuous is maintenance free if used according to the recommendations of this manual.

7.1 Report errors on LCD display

- **Faults during initial activation:**

Message	Possible cause	Remedy
INT.ERROR	Internal fault	Not possible, unit defective

- **Report errors during AUTOTUNE function:**

Message	Possible cause	Remedy
X.ERR 1	Pressure supply not connected	Connect the compressed air supply
X.ERR 2	Air pressure failure during Autotune	Control the compressed air supply
X.ERR 3	Air supply of the actuator/ Top*Control* not secure	Not possible, unit defective
X.ERR 4	Exhaust air of the positio-ner not secure	Not possible, unit defective

- **Error messages during execution of the P.Q'LIN function:**

Display	Causes of error	Remedy
Q.ERR 1	No supply pressure connected No change in process variable	Connect supply pressure Check process, if necessary switch on pump or open the shut-off valve
Q.ERR 2	Current reference point of valve stroke was not reached because • supply pressure failure occurred during P.Q'LIN • no AUTOTUNE was executed	 • Check supply pressure • Execute AUTOTUNE

7.2 Miscellaneous failures

Problem	Possible cause	Remedy
POS = 0 (by CMD > 0%) resp. POS = 100%, (by CMD < 100%)	Close tight function (CUTOFF) is involuntary active	Disactivate the close tight function (see 8.7.4)

APPENDIX A

Selection criteria for continuous valves

For optional control behaviour and the reaching of the desired maximum flowrate the following criteria must be observed:

- The correct selection of the k_V value, which is in fact defined by the valve size;
- The correct adjustment of the valve size to the pressure conditions, taking into account the pressure differences of the installation.

Sizing guidelines can be given based upon the k_V value. The k_V value relative to the normal conditions for pressure, temperature and fluid.

The k_v value is the flowrate in m³/h though a piping port under a pressure difference of Δp = 1 bar and T = 20°C.

For continuous valves the k_{VS} value is used in addition. It corresponds to the k_V value of a continuous valve, which is fully open.

In relation with the given data, we distinguish the two following cases for the sizing of the valves:

a) The pressures p_1 and p_2 must be known before and after the valve before the desired maximum flowrate Q_{max} can be calculated:

The needed k_{VS} value is calculated according to:

$$k_{VS} = Q_{\max} \cdot \sqrt{\frac{\Delta p_0}{\Delta p}} \cdot \sqrt{\frac{\rho}{\rho_0}} \qquad (1)$$

Where:

k_{VS}:	maximal flowrate of fully opened continuous valve [m³/h]
Q_{max}:	maximal volumetric flowrate [m³/h]
Δp_0:	= 1 bar; pressure drops of the valve according to the k_V value defined
ρ_0:	= 1000 kg/m³; density of water (according to the k_V value definition)
Δp:	pressure drop of the valve [bar]
ρ:	density of fluid [kg/m³]

b) The pressures p_1 and p_2 at the inlet and outlet of the complete installation for the desired maximum flowrate Qmax can be calculated:

1.Step: Calculation of the k_{Vges} value for the complete installation according to rule (1).

2. Step: Determination of the flowrate through the installation without a continuous valve (possible by by-passing the pipe where the valve is installed).

3. Step: Calculation of the k_{Va} value of the installation without the continuous valve according to rule (1).

4. Step: Calculation of the needed k_{VS} value of the continuous valve according to rule (2):

$$k_{VS} = \sqrt{\frac{1}{\frac{1}{k_{Vges}{}^2} - \frac{1}{k_{Va}{}^2}}} \qquad (2)$$

Important rule:

The k_{VS} value of the valve should reach at least the value calculated by the formula (1) or (2) depending on the application. It should also not greatly exceed this value.
The often used rule for on/off valves ‘a little bit higher cannot be wrong’ can strongly influence the control behaviour of continuous valves!

A practical rule for the determination of the k_{VS} value for the upper limits in respect to continuous valves consists of using the so called ‘valve authority Ψ :

$$\Psi = \frac{(\Delta p)_{V0}}{(\Delta p)_0} = \frac{{k_{Va}}^2}{{k_{Va}}^2 + {k_{VS}}^2} \qquad (3)$$

with

$(\Delta p)_{V0}$: pressure drop with a fully open valve
$(\Delta p)_0$: pressured drop over the complete installation

NOTE

For valve authority Ψ < 0,3 the valve is oversized.
In this case, the flow resistance with a fully open valve is much lower than the other components of the installation. This means that only in the lower opening range, the valve position is working according to the characteristics. For that reason the characteristics are strongly deviated. This can be partially compensated and the characteristics linearized within the limits by using an equal percentage characteristic between set position and the plug travel.**The valve authority Ψ should, even when using a corrected characteristic, be > 0,1.**

The control behaviour (standard choice, maximum adjustment time) is strongly dependent on the working point when using a corrected characteristic.

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 = Kp · Xd**

Kp is the proportional action coefficient. It results from the ratio of the manipulating range ΔY to the proportional range ΔXd.

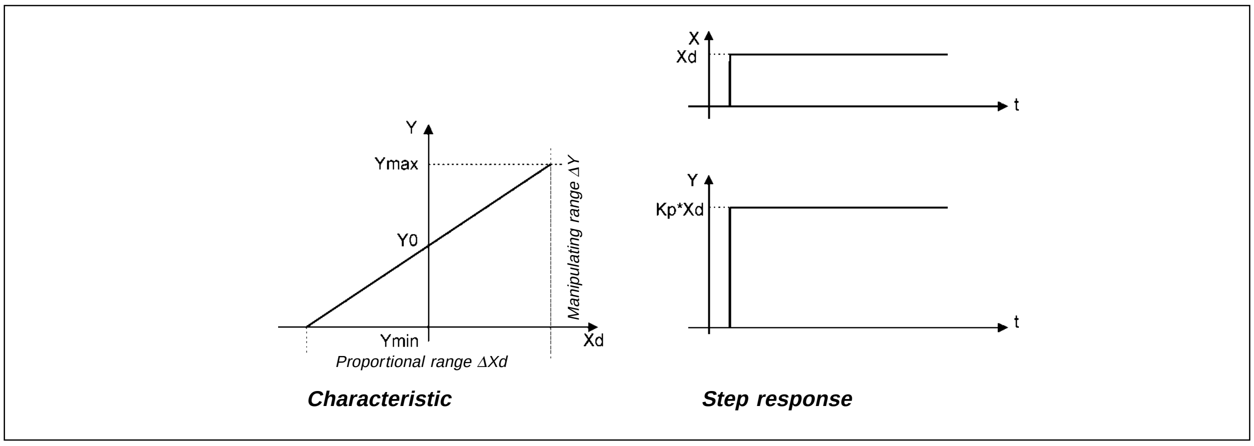


Fig. 8.1: Characteristics and step response of the P component of a PID controller

Characteristics:

Theoretically, a pure P controller operates without delay, i. e. it is fast and therefore dinamically 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: $Y = \frac{1}{Ti} \int Xd\, dt$

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

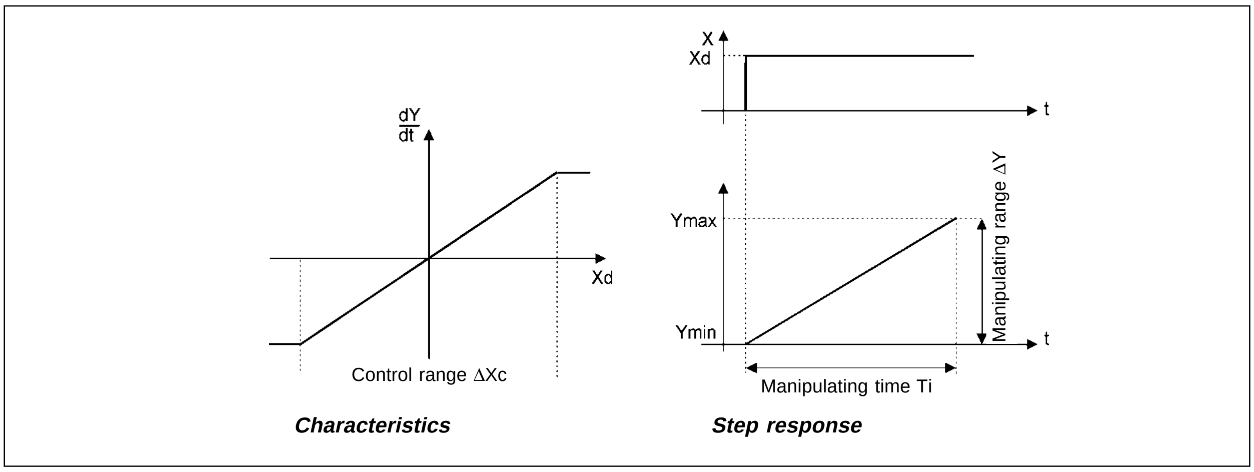


Fig. 8.2: Characteristics and step response of the I component of a PID controller

Characteristics:

A pure I controller eliminates the effects of occuring 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 = Kd d Xd/dt**

Kd is the derivative action coefficient.

The higher Kd is, the stronger the D influence is.

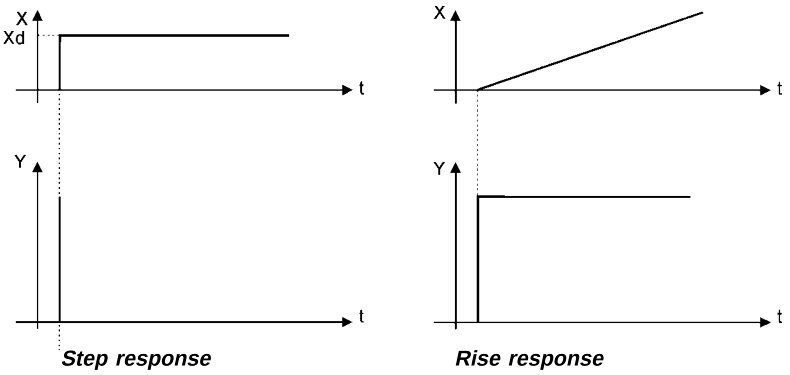


Fig. 8.3: Characteristics and step response of the D component of a PID controller

***Characteristics*:**

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

Supperposition of P-, I- and D components:

$$Y = Kp\ Xd + \frac{1}{Ti} \int Xd\ dt + d\ Xd/dt$$

Where Kp · Ti = Tn and Kd/Kp = Tv, results with regard to ***functioning of the PID controller:***

$$Y = Kp\ (Xd + \frac{1}{Tn} \int Xd\ dt + Tv\ \ dXd/dt)$$

Kp: ***Proportional action coefficient / gain***

Tn: ***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)

Tv: ***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)

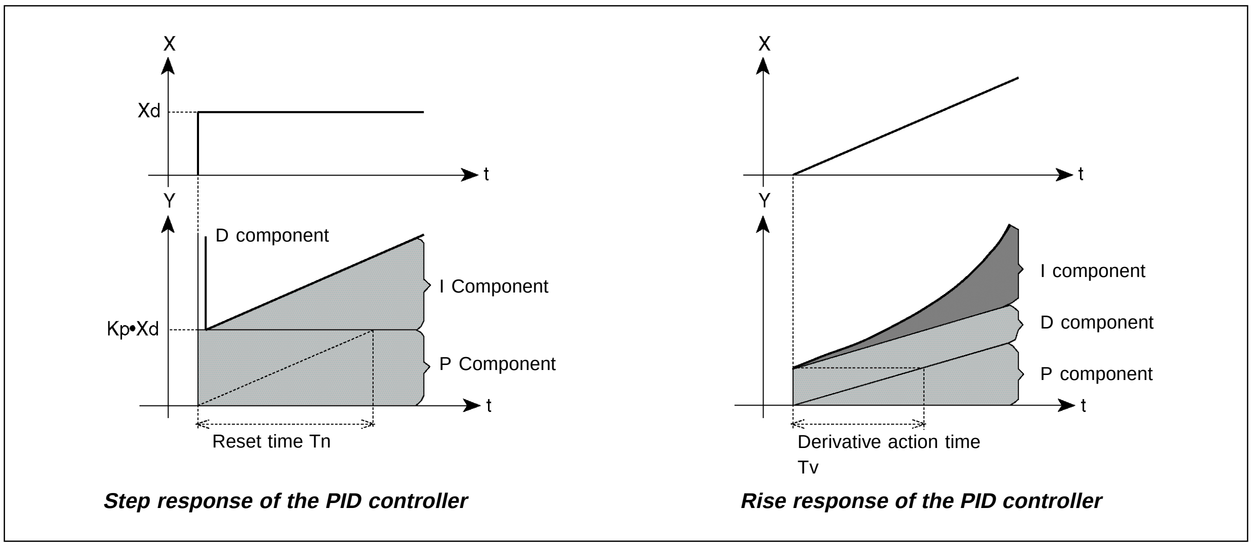


Fig. 8.4: Step response and rise response of the PID controller

Realised PID controller

D component with delay:

In the Top Control 8630, the D component is realised with a delay T.

Function: $$T \frac{dY}{dt} + Y = Kd \frac{dXd}{dt}$$

Superposition of P, I and DT components

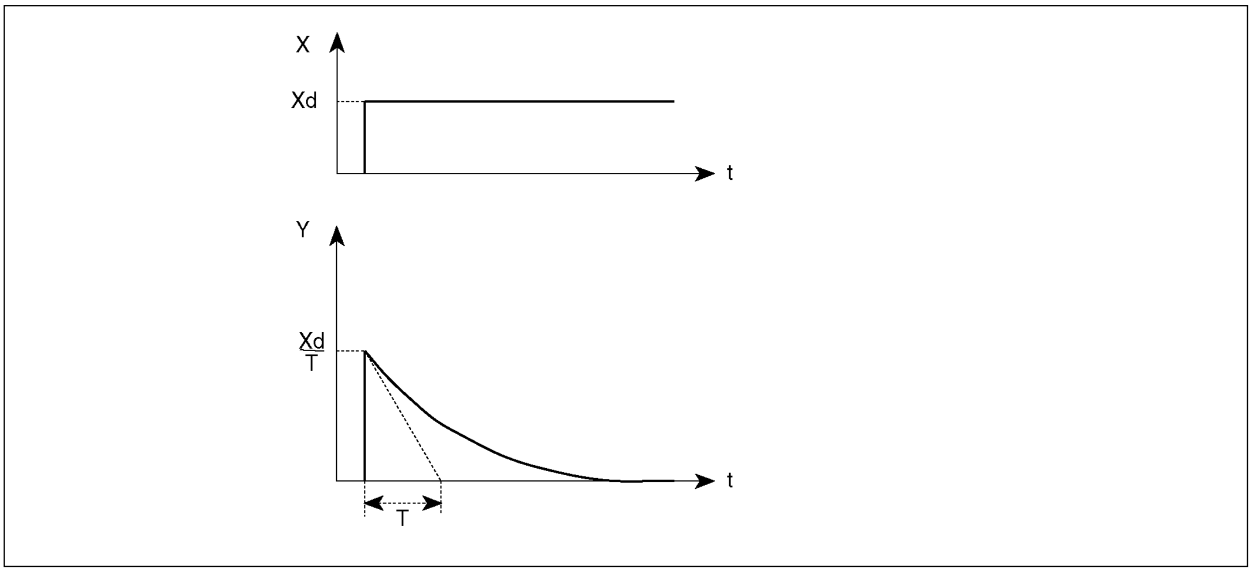


Fig. 8.5: Superposition of P, I and DT components

Function of the real PID controller :

$$T\frac{dY}{dt} + Y = Kp\,(Xd + \frac{1}{Tn}\int Xd\,dt + Tv\,\frac{dXd}{dt})$$

Step response of the real PID controller:

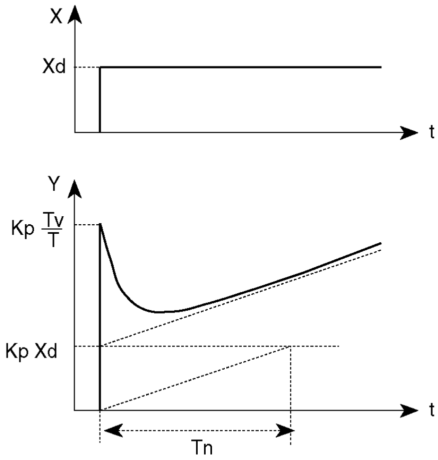


Fig. 8.6: Step response of the real PID controller

Rules for adjusting PID controllers

The litterature 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 intented 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. Tn = 999, Tv = 0), initially selecting a low Kp value
- Set the required setpoint.
- Increase Kp until the controlled variable oscillates continuously without attenuation (see following figure).

The proportional action coefficient set at the stability limit is referred as Kcrit. The resulting oscillation period is referred to as Tcrit.

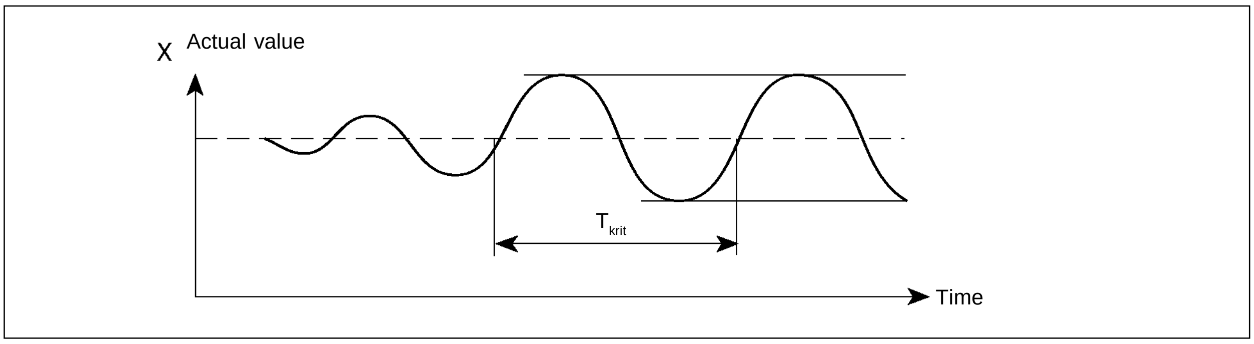


Figure 8.7 : Progression of the control variable at the stability limit

On the basis of Kcrit and Tcrit, 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	Kp = 0,5 Kkrit	-	-
PI controller	Kp = 0,45 Kkrit	Tn = 0,85 Tkrit	-
PID controller	Kp = 0,6 Kkrit	Tn = 0,5 Tkrit	Tv = 0,12 Tkrit

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 methode)

When using this method, the controller parameters are adjusted on the basis of the control system's transition response. A 100% change in the manipulated variable is output. The time Tu and Tg are derived from the progression of the actual value of the control variable (following figure).

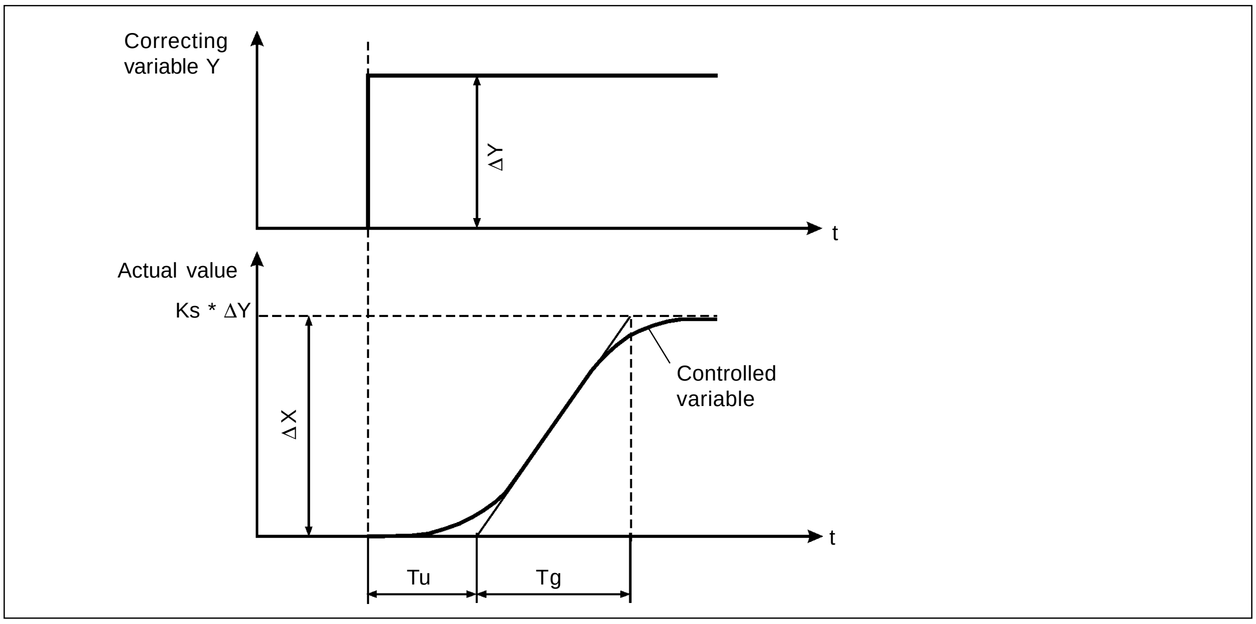


Figure 8.8: Progression of the controlled variable after a manipulated variable change ΔY

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).

NOTE 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 Tu, Tg and Ks 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.

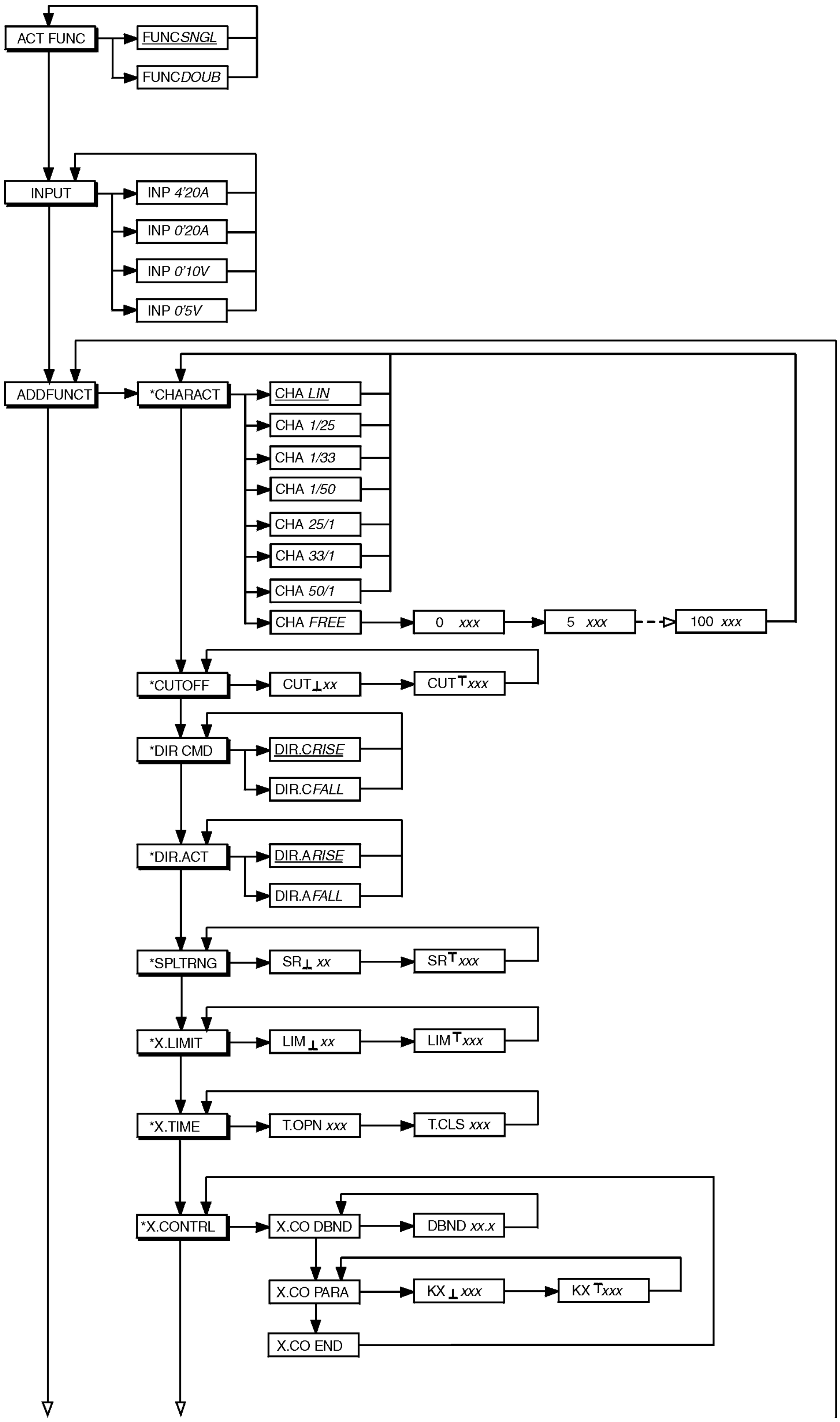
Parameter settings according to Chien, Hrones and Reswick:

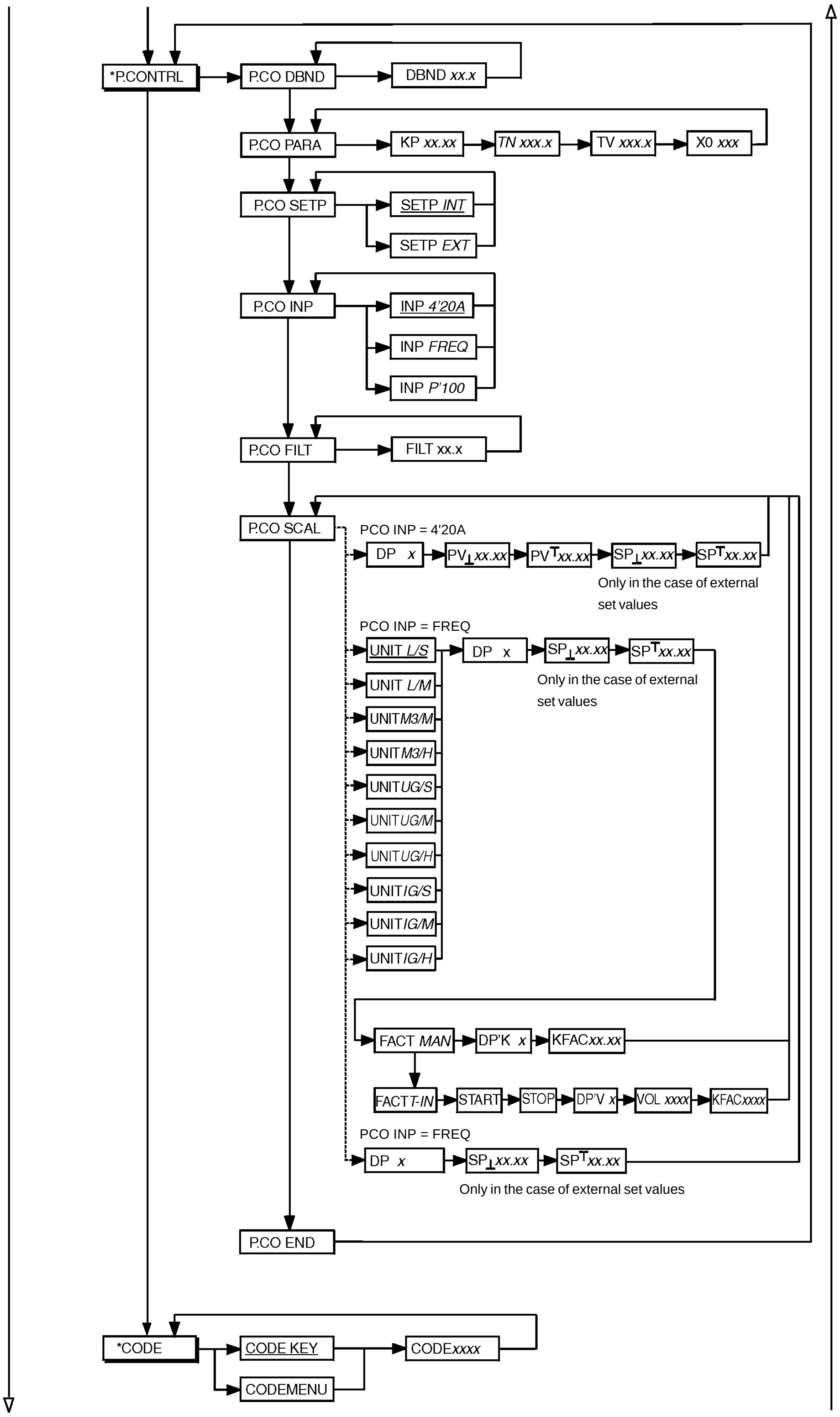
Controller type	Parameter settings: Aperiodic control operation (0 % overshoot)		Control operation with 20 % overshoot	
	Command	Disturbance	Command	Disturbance
P controller	$Kp = 0{,}3 \frac{Tg}{Tu*Ks}$	$Kp = 0{,}3 \frac{Tg}{Tu*Ks}$	$Kp = 0{,}7 \frac{Tg}{Tu*Ks}$	$Kp = 0{,}7 \frac{Tg}{Tu*Ks}$
PI controller	$Kp = 0{,}35 \frac{Tg}{Tu*Ks}$ Tn = 1,2 Tg	$Kp = 0{,}6 \frac{Tg}{Tu*Ks}$ Tn = 4 · Tu	$Kp = 0{,}6 \frac{Tg}{Tu*Ks}$ Tn = Tg	$Kp = 0{,}7 \frac{Tg}{Tu*Ks}$ Tn = 2,3 · Tu
PID controller	$Kp = 0{,}6 \frac{Tg}{Tu*Ks}$ Tn = Tg Tv = 0,5 · Tu	$Kp = 0{,}95 \frac{Tg}{Tu*Ks}$ Tn = 2,4 · Tu Tv = 0,42 · Tu	$Kp = 0{,}95 \frac{Tg}{Tu*Ks}$ Tn = 1,35 · Tg Tv = 0,47 · Tu	$Kp = 1{,}2 \frac{Tg}{Tu*Ks}$ Tn = 2 · Tu Tv = 0,42 · Tu

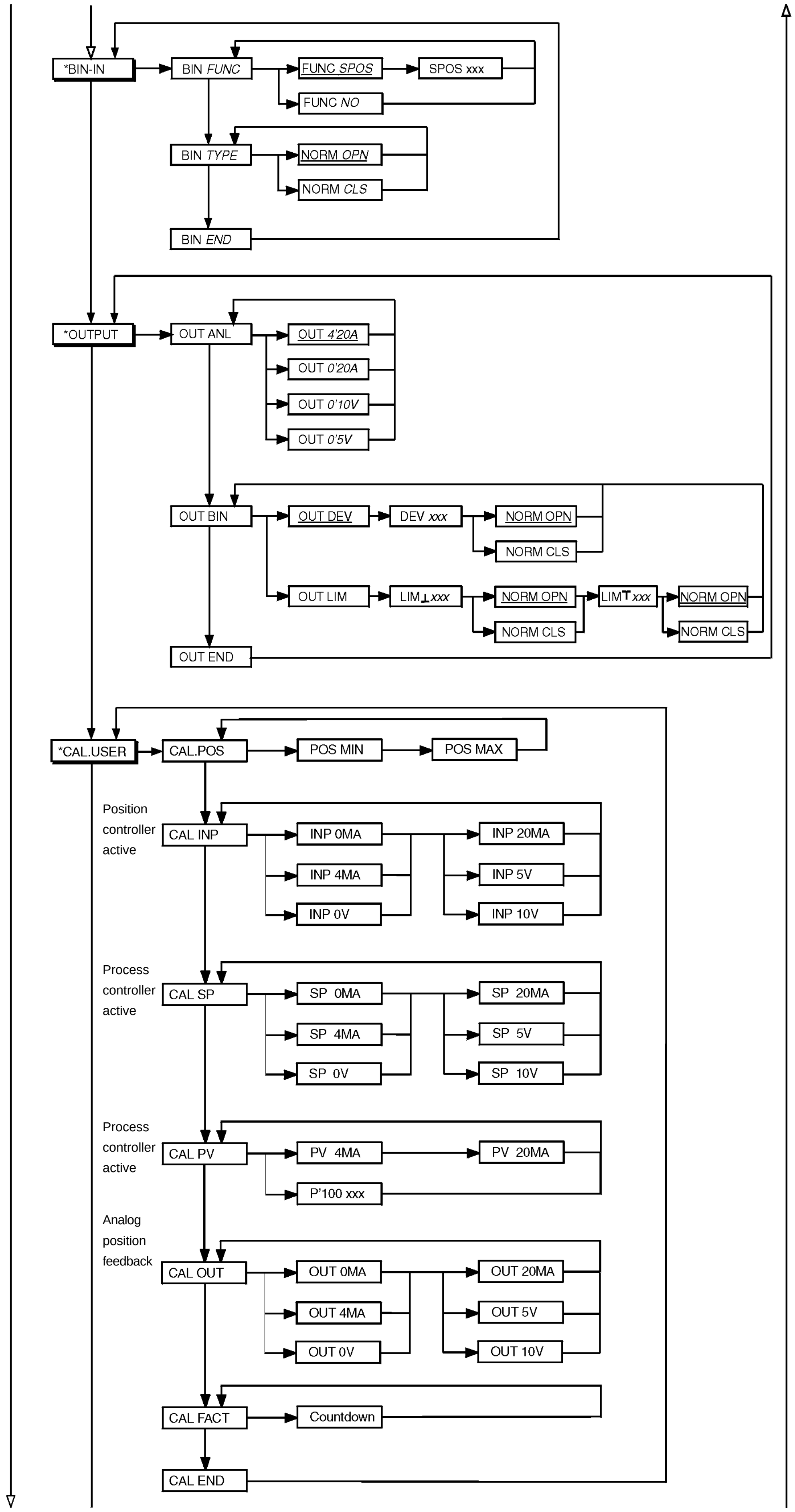
The proportionality factor Ks of the controlled member is given according to Figure 8.8 by:

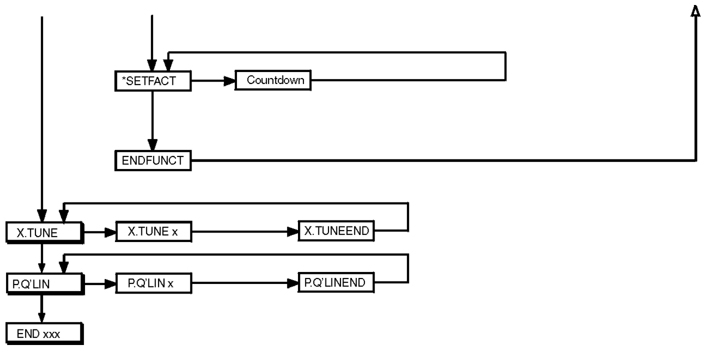
$$Ks = \frac{\Delta X}{\Delta Y}$$

APPENDIX B: OPERATING STRUCTURE OF THE TOP*CONTROL* CONTINUOUS




*P.CONTRL
P.CO DBND
DBND xx.x
P.CO PARA
KP xx.xx
TN xxx.x
TV xxx.x
X0 xxx
P.CO SETP
SETP INT
SETP EXT
P.CO INP
INP 4'20A
INP FREQ
INP P'100
P.CO FILT
FILT xx.x
P.CO SCAL
PCO INP = 4'20A
DP x
PV⊥xx.xx
PV⊤xx.xx
SP⊥xx.xx
SP⊤xx.xx
Only in the case of external set values
PCO INP = FREQ
UNIT L/S
UNIT L/M
UNIT M3/M
UNIT M3/H
UNIT UG/S
UNIT UG/M
UNIT UG/H
UNIT IG/S
UNIT IG/M
UNIT IG/H
DP x
SP⊥xx.xx
SP⊤xx.xx
Only in the case of external set values
FACT MAN
DP'K x
KFACxx.xx
FACT T-IN
START
STOP
DP'V x
VOL xxxx
KFACxxxx
PCO INP = FREQ
DP x
SP⊥xx.xx
SP⊤xx.xx
Only in the case of external set values
P.CO END
*CODE
CODE KEY
CODExxxx
CODEMENU


*BIN-IN
BIN FUNC
FUNC SPOS
SPOS xxx
FUNC NO
BIN TYPE
NORM OPN
NORM CLS
BIN END
*OUTPUT
OUT ANL
OUT 4'20A
OUT 0'20A
OUT 0'10V
OUT 0'5V
OUT BIN
OUT DEV
DEV xxx
NORM OPN
NORM CLS
OUT LIM
LIM⊥xxx
NORM OPN
NORM CLS
LIMTxxx
NORM OPN
NORM CLS
OUT END
*CAL.USER
CAL.POS
POS MIN
POS MAX
Position controller active
CAL INP
INP 0MA
INP 4MA
INP 0V
INP 20MA
INP 5V
INP 10V
Process controller active
CAL SP
SP 0MA
SP 4MA
SP 0V
SP 20MA
SP 5V
SP 10V
Process controller active
CAL PV
PV 4MA
PV 20MA
P'100 xxx
Analog position feedback
CAL OUT
OUT 0MA
OUT 4MA
OUT 0V
OUT 20MA
OUT 5V
OUT 10V
CAL FACT
Countdown
CAL END


*SETFACT
Countdown
ENDFUNCT
X.TUNE
X.TUNE x
X.TUNEEND
P.Q'LIN
P.Q'LIN x
P.Q'LINEND
END xxx

APPENDIX C

TABLES FOR YOUR SETTINGS

Settings in the freely programmable characteristic

Ref. point (Set point of position in %)	Valve stroke [%]			
	Date:	Date:	Date:	Date:
0				
5				
10				
15				
20				
25				
30				
35				
40				
45				
50				
55				
60				
65				
70				
75				
80				
85				
90				
95				
100				

Parameters set in the process controller

	Date:	Date:	Date:	Date:
KP				
TN				
TV				
X0				
DBND				

NOTES