CONFIGURATION MANUAL

KH 6493 EN

Translation of original instructions

TROVIS 6493 Compact Controller

Firmware version 4.03

Edition August 2021

Notes on this configuration manual

The documentation for TROVIS 6493 Compact Controller is divided into two parts:

- Mounting and Operating Instructions ▶ EB 6493
- Configuration Manual KH 6493

This Configuration Manual KH 6493 is intended for qualified personnel with experience in control engineering. The control options determined by the functions and parameters selected are listed in detail.
It is assumed that users are familiar with the operation of the device, i.e. know how to select and change a function or parameter. If necessary, refer to EB 6493. The Mounting and Operating Instructions EB 6493 describe the installation, electrical wiring and operation of the controller.

Note

The default setting of functions and parameters is printed in ***bold*** *in the following sections.*

Functions of TROVIS 6493 Compact Controller

All functions of the configuration and parameter level are described in this Configuration Manual. The configuration level has nine menus assigned to functions and their parameters: Each one of the nine menus contains the functions for a certain topic:

- PAR: Control parameters
- IN: Input
- SETP: Set point
- CNTR: Controller
- OUT: Output
- ALRM: Limit relay
- AUX: Additional functions
- TUNE: Start-up adaptation
- I-O: Process data

A list of menus, functions and parameters is available in ▶ EB 6493.
"-CO-" on the display indicates a function and "-PA-" the parameter level.

Functions of the binary input BI1

–	SETP menu	-CO- SP.FU/RAMP	Start set point ramp (see section 3.2)
–	SETP menu	-CO- SP.FU/CH.SP	Switch between set points (see section 3.2)
–	CNTR menu	-CO- AC.VA	Increase/decrease process variable (see section 4.8)
–	OUT menu	-CO- SAFE	Activate constant output value (see section 5.1)
–	OUT menu	-CO- MA.AU	Manual/automatic switchover (see section 5.2)
–	OUT menu	-CO- RAMP	Start output ramp (see section 5.4)
–	OUT menu	-CO- BLOC	Blocking output variable (see section 5.5)
–	OUT menu	-CO- B.OUT	Activate binary outputs (see section 5.11)

1 PAR menu: Control parameters

This menu does not include any functions. As soon as this level is opened, the controller immediately jumps to the parameter level -PA- to give quick access to the control parameters.

ℹ Note

The control parameters can also be set in the CNTR menu in the C.PID function (see section 4.1).

PAR			
	KP	Proportional-action coefficient	[0.1 … **1.0** … 100.0]
	TN	Reset time	[1 … **120** … 9999 s]
	TV	Derivative-action time	[1 … **10** … 9999 s]
	Y.PRE	Operating point	[–10.0 … **0.0** … 110.0 %]

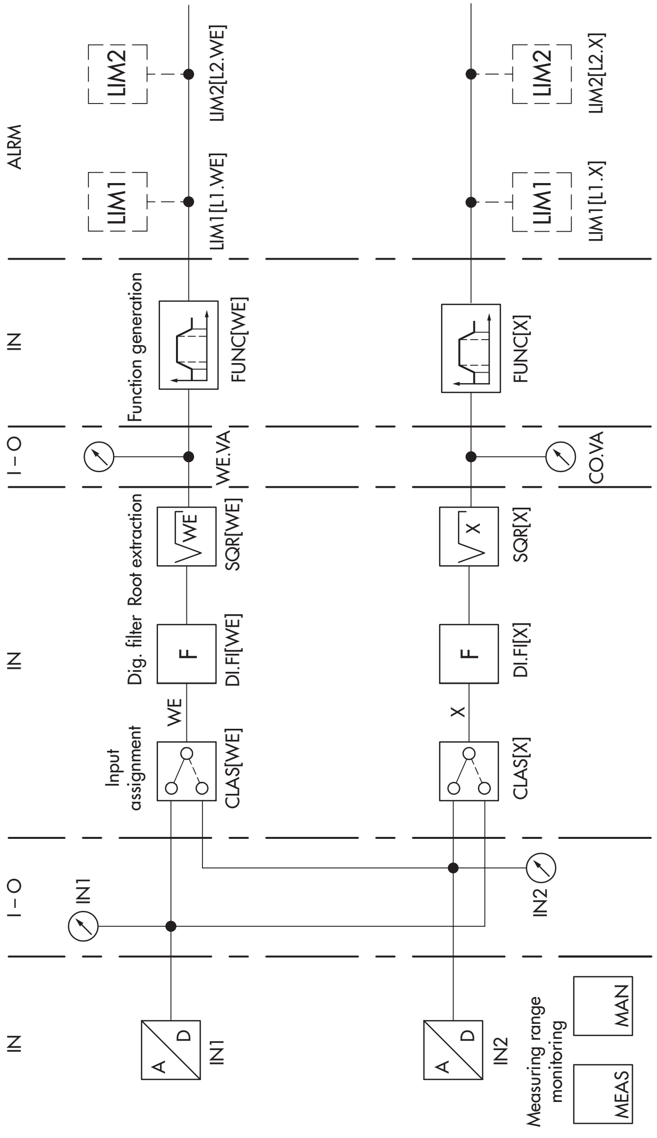

IN
I – O
IN
I – O
IN
ALRM
A
D
IN1
IN1
A
D
IN2
IN2
Measuring range monitoring
MEAS
MAN
Input assignment
CLAS[WE]
CLAS[X]
WE
X
Dig. filter
F
DI.FI[WE]
F
DI.FI[X]
Root extraction
WE
SQR[WE]
X
SQR[X]
WE.VA
CO.VA
Function generation
FUNC[WE]
FUNC[X]
LIM1
LIM1[L1.WE]
LIM2
LIM2[L2.WE]
LIM1
LIM1[L1.X]
LIM2
LIM2[L2.X]

Fig. 1: *IN menu*

2 IN menu: Input

The analog inputs (IN1, IN2) are set in the IN menu.

2.1 -CO- IN1: Input signal IN1

This function is used to set the input signal and measuring range of the analog input IN1.

PAR	**-CO- IN1**	**Input signal IN1**	
	0–20 mA	0 to 20 mA	
	4–20 mA	4 to 20 mA	
	0–10 V	0 to 10 V	
	2–10 V	2 to 10 V	
	100 PT	Pt 100 (–100 … 500 °C)	Resistance values ▶ EB 6493
	1000 PT	Pt 1000 (–100 … 500 °C)	Resistance values ▶ EB 6493
	100 NI	Ni 100 (–60 … 250 °C)	Resistance values ▶ EB 6493
	1000 NI	Ni 1000 (–60 … 250 °C)	Resistance values ▶ EB 6493
	0–1 KOHM	0 to 1000 Ω	
	-PA- IN1		
	⤓ IN1	Lower measuring range value	[–999.0 … **0.0** … ⤒ IN1]
	⤒IN1	Upper measuring range value	[⤓ IN1 … **100.0** … 9999]

2.2 -CO- IN2: Input signal IN2

This function is used to set the input signal and measuring range of the analog input IN2.

IN	-CO- IN2	Input signal IN2	
	0–20 mA	0 to 20 mA	
	4–20 mA	4 to 20 mA	
	0–10 V	0 to 10 V	
	2–10 V	2 to 10 V	
	100 PT	Pt 100 (–100 … 500 °C)	Resistance values ▶ EB 6493
	1000 PT	Pt 1000 (–100 … 500 °C)	Resistance values ▶ EB 6493
	100 NI	Ni 100 (–60 … 250 °C)	Resistance values ▶ EB 6493
	1000 NI	Ni 1000 (–60 … 250 °C)	Resistance values ▶ EB 6493
	0–1 KOHM	0 to 1000 Ω	

	-PA- IN2		
	⊻ IN2	Lower measuring range value	[–999.0 … **0.0** … ⌅ IN2]
	⌅IN2	Upper measuring range value	[⊻ IN2 … **100.0** … 9999]

2.3 -CO- MEAS: Signal monitoring

This function is used to monitor the signal range of the analog inputs IN1 and IN2 for limit violations.

When the signal leaves the rated signal range, the fault alarm output (BO3) is activated and the alarm icon ■ appears on the display. Additionally, a reading on the display blinks to indicate:

- '__o1': Upper limit violation of rated signal range at analog input IN1 or at analog inputs IN1 and IN2
- '__u1': Lower limit violation of rated signal range at analog input IN1 or at analog inputs IN1 and IN2
- '__o2': Upper limit violation of rated signal range at analog input IN2
- '__u2': Lower limit violation of rated signal range at analog input IN2

ℹ *Note*

The controller can be configured to switch to manual mode after a signal range violation is detected (see section 2.4).

IN	**-CO- MEAS**	Signal monitoring
	oFF ME.MO	OFF
	IN1 ME.MO	Analog input IN1
	IN2 ME.MO	Analog input IN2
	ALL ME.MO	Analog inputs IN1 and IN2

2.4 -CO- MAN: Switch to manual mode in case of signal failure

This function is used to automatically change the controller to the manual mode ✋ after signal range violation when the signal monitoring is active (-CO- MEAS ≠ oFF ME.MO).

- **F01 FAIL setting:** The controller changes to manual mode. The constant output value Y1K1 is issued. The constant output value Y1K1 is not active unless the controller was in automatic mode at the time when the signal range violation occurred.
- **F02 FAIL setting:** The controller switches to manual mode. The last output value is issued.

The output value can be changed in manual mode with the cursor keys (△ and ▽). The controller can only switch back to automatic mode again after the signal range violation stops.

IN	**-CO- MAN**	Switch to manual mode in case of signal failure	
	oFF FAIL	OFF	
	F01 FAIL	With constant output value Y1K1	
	F02 FAIL	With last output value	
	-PA- MAN		
	Y1K1	Constant output value	[**–10.0** … 110.0 %]

i Note

The Y1K1 parameter can also be set in the -CO- SAFE and -CO- RE.CO functions (see section 5.1 and section 7.1).

2.5 -CO- CLAS: Assignment of X and WE to analog inputs

The controller operates internally with the input variables X and WE. This function is used to assign the input variables to the analog inputs IN1 or IN2. By default, X is assigned to analog input IN2 and WE to analog input IN1.

IN	**-CO- CLAS**	Assignment of X to analog inputs
	In2 X	X = IN2
	In1 X	X = IN1
		Assignment of WE to analog inputs
	In1 WE	WE = IN1
	In2 WE	WE = IN2

2.6 -CO- DI.FI: Filtering of X and WE

This function is used to filter the input variables X and/or WE.

The first-order filter (low-pass filter or Pt1 behavior) smoothens the selected signals and suppresses input signal interferences of a higher frequency. The time constant of the Pt1 element is defined by the parameters TS.X for the input signal X and TS.WE for the input signal WE.

IN	**-CO- DI.FI**	Filtering input variable X	
	oFF X	OFF	
	on X	ON	
	TS/X	Time constant X filter	[0.1 … **1.0** … 100.0 s]
		Filtering input variable WE	
	oFF WE	OFF	
	on WE	ON	
	TS.WE	Time constant WE filter	[0.1 … **1.0** … 100.0 s]

2.7 -CO- SQR: Root extraction of X and WE

This function is used to calculate the square root of the input variable and standardized it internally to 0 to 100 %: $X' = 10 \cdot \sqrt{X}$ and $WE' = 10 \cdot \sqrt{WE}$.

The root extraction is used for flow rate measurement using an orifice plate assembly to calculate the flow rate from the measured differential pressure.

IN	**-CO- SQR**	Root extraction input variable X
	oFF X	OFF
	on X	ON

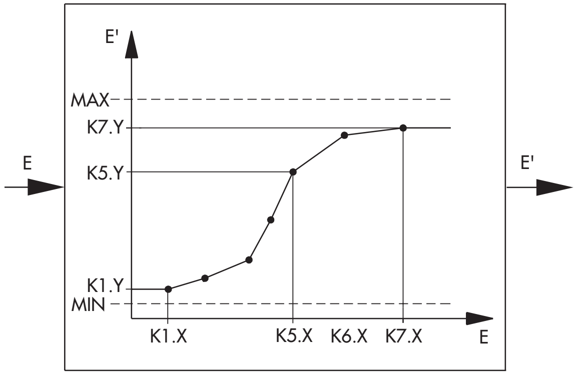
		Root extraction input variable WE
	oFF WE	OFF
	on WE	ON

2.8 -CO- FUNC: Function generation of X and WE

The function generation of the input signal causes it to be revaluated for further processing. Function generation allows auxiliary, reference or equivalence variables, inherent in measurement or industrial processes, to be adapted for the control circuit or to perform a linearization if the correlation between the input signal and the output signal required is known (i.e. due to scientific laws, empirical data or measured data). This could be correlation between steam pressure and temperature, for example.

Seven coordinates exist for function generation. Each coordinate is defined by an input value and an output value.

- The values are entered as absolute values (e.g. in °C or bar).
- The MIN and MAX parameters are used to determine the measuring range of the output signal E'. Provided K1.Y or K7.Y do not match MIN and MAX, the output values for the function-generated signal, which are below or above these limits, are constantly set to K1. Y or K7.Y.
- The controller completes the polygonal curve by generating straight lines (see Fig. 2). If an output value is entered to be greater than MAX or smaller than MIN, it is fixed to the value of MAX or MIN. An example for using function generation can be found in section 10.



MIN	Lower output signal measuring range value
MAX	Upper output signal measuring range value
K1.Y	Output value 1
K5.Y	Output value 5
K7.Y	Output value 7
K1.X	Input value 1
K5.X	Input value 5
K6.X	Input value 6
K7.X	Input value 7
E	Signal (e.g. input signal) that is to be processed through function generation
E'	Signal (e.g. output signal) that has been processed through function generation

Fig. 2: *Function generation*

i ***Note***

- *We recommend either drawing up a table or creating a curve in a Cartesian coordinate system. Choose the seven points in such a way that a curve can easily be created. The controller calculates the straight lines between adjacent points. Seven points must be specified even if the signal curve can be sufficiently characterized by less points. If necessary, the first two or last two points can have the same values.*
- *The course of the polygonal curve is not limited by the software. Polygonal curves with more than one maximum or minimum are possible. However, make sure that only one output value is assigned to an input value. Otherwise, a clear assignment of the input signal is not achieved.*

IN	**-CO- FUNC**	Function generation input variable X	
	oFF X	OFF	
	on X	ON	
	-PA- FUNC/X		
	MIN	Lower measuring range value Output signal	[–999.0 … **0.0** … MAX]
	MAX	Upper output signal measuring range value	[MIN … **100.0** … 9999]
	K1.X	Input value 1	[⊻ **IN1** … ⊼ IN1; ⊻ **IN2** … ⊼ IN2]
	K1.Y	Output value 1	[**MIN** … MAX]
	…	…	…
	K7.X	Input value 7	[⊻ **IN1** … ⊼ IN1; ⊻ IN2 … ⊼ IN2]
	K7.Y	Output value 7	[**MIN** … MAX]
		Function generation input variable WE	
	oFF WE	OFF	
	on WE	ON	
	-PA- FUNC/WE		
	MIN	Lower measuring range value Output signal	[–999.0 … **0.0** … MAX]
	MAX	Upper output signal measuring range value	[MIN … **100.0** … 9999]
	K1.X	Input value 1	[⊻ **IN1** … ⊼ IN1; ⊻ **IN2** … ⊼ IN2]
	K1.Y	Output value 1	[**MIN** … MAX]
	…	…	…
	K7.X	Input value 7	[⊻ **IN1** … ⊼ IN1; ⊻ IN2 … ⊼ IN2]
	K7.Y	Output value 7	[**MIN** … MAX]

3 SETP menu: Set point

The functions for the set point are determined in this menu. The compact controller has two internal set points W and W2 as well as an external set point WE.

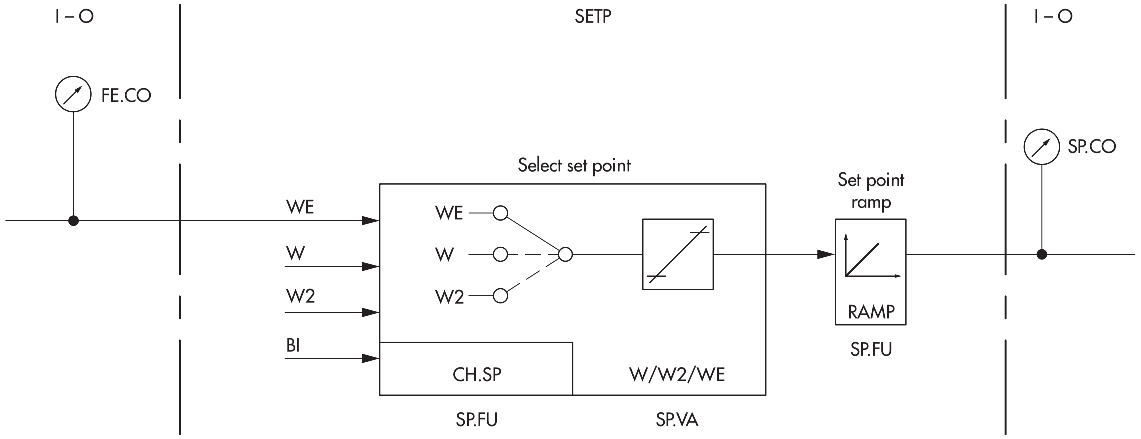


Fig. 3: *SETP menu*

3.1 -CO- SP.VA: Set point adjustment

This function is used to activate the set point W2 or WE. The internal set point W is always activated. The set point and the associated measuring range are set in the parameter level. The measuring range (⊻ WINT, ⊼ WINT) must match the measuring range of the controlled variable X (⊻ IN1, ⊼ IN1 or ⊻ IN2, ⊼ IN2) or the output range (MIN, MAX) when function generation is used. The internal set points W and W2 can be adjusted within the lower and upper range values (⊻ WRAN, ⊼ WRAN).

Function of the input variable WE:

- **on WE setting:** WE is used as an external set point.
- **F01 WE setting:** WE is used with a three-step output for external position feedback (see section 5.10). WE is not displayed in the operating level when this setting is used. Reading only appears in the I-O menu (see section 9.3).
- **F02 WE setting:** WE is used for feedforward control (see section 4.7). WE is not displayed in the operating level when this setting is used. Reading only appears in the I-O menu (see section 9.3).

SETP	**-CO- SP.VA**	Internal set point W	
	on W	ON	
	-PA- SP.VA/W		
	W	Internal set point	[⊻ WRAN … **0.0** … ⊼ WRAN]
	⊻ WINT	Lower measuring range value W/W2	[–999.0 … **0.0** … ⊼ WINT]
	⊼ WINT	Upper measuring range value W/W2	[⊻ WINT … **100.0** … 9999]
	⊻ WRAN	Lower adjustment limit W/W2	[⊻ WINT … **0.0** … ⊼ WRAN]
	⊼ WRAN	Upper adjustment limit W/W2	[⊻ WRAN … **100.0** … ⊼ WINT]
		Internal set point W2	
	oFF W2	OFF	
	on W2	ON	
	-PA- SP.VA/W2		
	W2	Internal set point 2	[⊻ WRAN … **0.0** … ⊼ WRAN]
		Input variable WE	
	oFF WE	OFF	

on W2	External set point WE
F01 WE	Input for external feedback with three-step output
F02 WE	Input for feedforward control

3.2 -CO- SP.FU: Set point functions

3.2.1 -CO- SP.FU/RAMP Set point ramp

A set point ramp is especially suitable for controlled systems that work well with fast set point changes. Oscillations can be prevented by a ramped transition from one set point to a second set point. The set point at the SP.CO comparator in the set point ramp changes at a constant rate from the start set point to the target set point within the adjusted running time. The setting of the -CO- SP.FU function is used to determine whether the ramp is to start with the current value of the controlled variable X at the comparator, with the start value WIRA or with another set point.

The TSRW parameter determines the running time of the set point ramp for the entire measuring range (⊻ WINT to ⊼ WINT). When the set point changes from a value W to a new value W2, the actual running time of the set point ramp is the time t1 as shown in Fig. 4, Fig. 5and Fig. 6.

The value for the TSRW parameter can be calculated as follows:

$$\mathrm{TSRW} = \mathrm{t1} \cdot \frac{\left| \veebar\,\mathrm{WINT} - \barwedge\,\mathrm{WINT} \right|}{\left| \mathrm{W2} - \mathrm{W} \right|}$$

- **F01 RAMP setting – Start set point ramp with current value of the controlled variable X at the comparator:** this ramp function is started by the binary input. The set point at the SP.CO comparator adopts the current value of the controlled variable X at the comparator when the binary input is activated. The ramp is started and the set point runs until the target set point is reached (internal or external set point) after the signal at the binary input changes from active (1) to inactive (0). The ramp stops after the target set point is reached. Afterwards the set point at the SP.CO comparator follows the target set point (e.g. W) directly without any delay.
  If the controller is switched to manual mode while the ramp is running, it is stopped and the set point adopts the current value of the controlled variable X. The ramp continues to run until the target set point is reached after the controller is switched back to the automatic mode. The set point at the SP.CO comparator returns to the current value of the controlled variable X at the comparator after the binary input is activated again while the ramp is running (retriggering).
  If the controller runs in automatic mode after the supply voltage is interrupted for more than one second, the set point at the SP.CO comparator adopts the current value at the comparator (with an active binary input) or the target set point (with an inactive binary input).

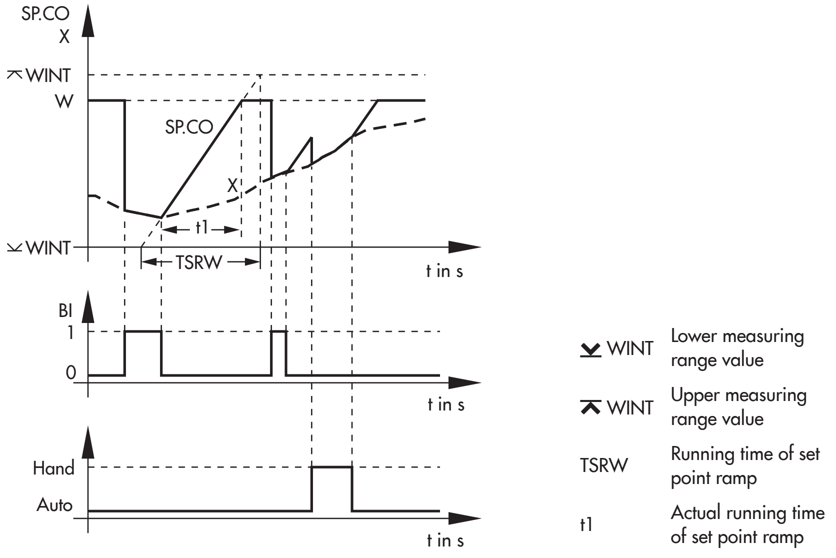


Fig. 4: *Set point ramp start with BI, SP.CO = X*

- **F02 RAMP setting – Start set point ramp with start set point:** this ramp function is started by the binary input. The set point at the SP.CO comparator is set to the predetermined start set point WIRA when the binary input is active.
  The ramp is started and the set point runs until the target set point is reached (internal or external set point) after the signal at the binary input changes from active (1) to inactive (0). The ramp stops after the target set point is reached. Afterwards the set point at the SP.CO comparator follows the target set point (e.g. W) directly without any delay.
  If the controller is switched to manual mode while the ramp is running, it is stopped and the set point at the SP.CO comparator adopts the current value of the controlled variable X.
  The ramp continues to run until the target set point is reached after the controller is switched back to the automatic mode. The set point at the SP.CO comparator returns to the current value at the X comparator after the binary input is activated again while the ramp is running (retriggering).
  If the controller runs in automatic mode after the supply voltage is interrupted for more than one second, the set point at the SP.CO comparator adopts the start set point WIRA (with an active binary input) or the target set point (with an inactive binary input).

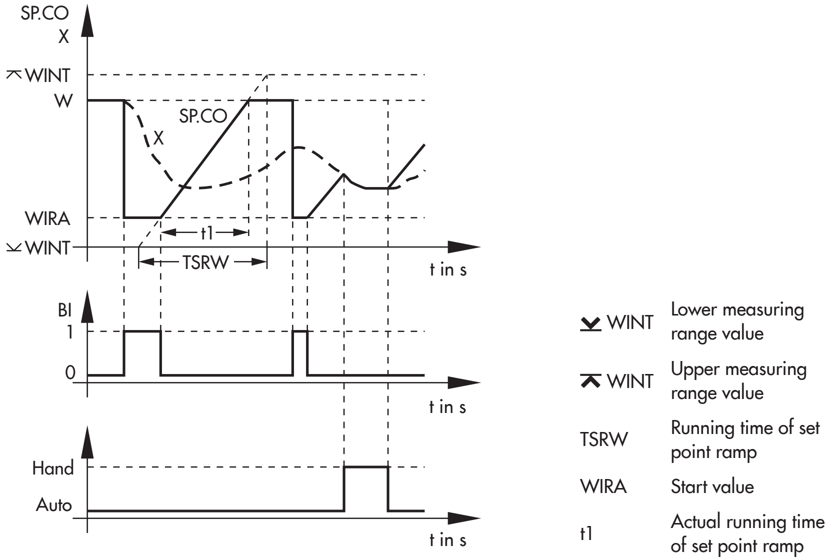


Fig. 5: *Set point ramp start with BI, SP.CO = WIRA*

– **F03 RAMP setting – Set point ramp constantly active, no starting condition:** the ramp function is constantly active. Every change of the set point causes the set point at the SP.CO comparator to change according to the ramp function even when switching between set points. The diagram shows the course of the set point ramp (SP.CO) after a switchover of the set points W and W2 by the binary input (additional settings: -CO- SP. VA = on W2 and -CO- SP.FU = F01 CH.SP). If the controller is switched to manual mode while the ramp is running, it is stopped and the set point at the SP.CO comparator adopts the current value at the comparator X. The rump continues to run until the target set point is reached after the controller is switched back to the automatic mode. If the controller runs in automatic mode after the supply voltage is interrupted for more than one second, the set point at the SP.CO comparator adopts the target set point.

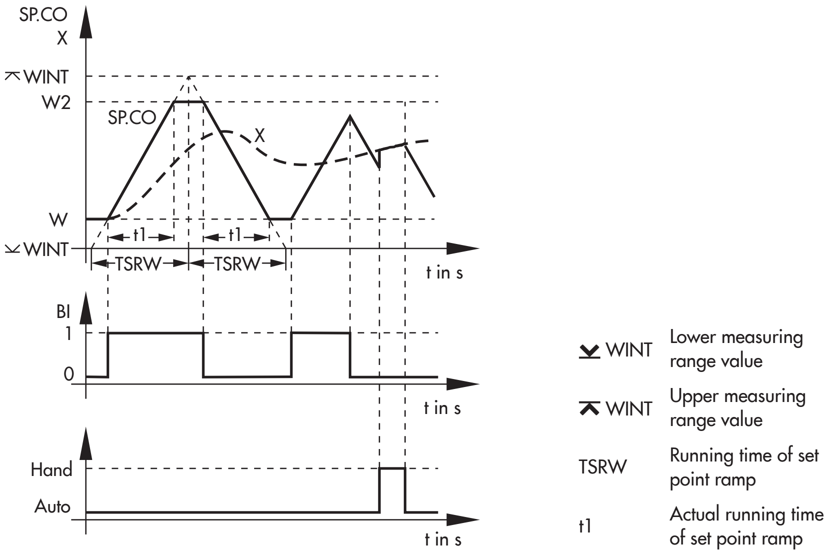


Fig. 6: *Constantly active set point ramp*

3.2.2 -CO- SP.FU/CH.SP Set point switchover by binary input BI

This function is used to determine the conditions for switching between the internal and external set point.

- **oFF CH.SP setting:** No set point switchover
- **F01 CH.SP setting:** Switchover between the active internal and external set point by the binary input BI (W/W2 to WE)
  WE is active when the binary input is active.
- **F02 CH.SP setting:** Switchover between the internal set points by the binary input BI (W to W2)
  W2 is active when the binary input is active.
  W is active when the binary input is not active.
  The -CO- SP.VA function must not be set to 'on WE'. If the set point W2 is activated at the keys while the binary input is not active, it is not possible to switch to the set point W with the binary input.

Note

Several functions can be assigned to the binary input (see section 1).

SETP	**-CO- SP.FU**	Set point ramp	
	oFF RAMP	OFF	
	F01 RAMP	Started with current value by binary input BI1	
	F02 RAMP	Started with WIRA by binary input BI1	
	F03 RAMP	Without start condition	
	PA- SP.FU/RAMP		
	TSRW	Running time	[1 … **10** … 9999 s]
	WIRA	Start value	[⊻ WINT … **0.0** … ⊼ WINT]
		Switchover W(W2)/WE by BI	
	oFF CH.SP	OFF	
	F01 CH.SP	W(W2)/WE by binary input BI1	
	F02 CH.SP	W/W2 by binary input BI1	

4 CNTR menu: Controller

The control behavior is defined in this menu, especially the controller behavior with either the P, PI, PD, PID or P²I action. Additionally, feedforward control and additional control functions can be set in this menu.

4.1 -CO- C.PID: Control algorithm

This function is used to configure the control algorithm and its control parameters. The controller is set by default to act with PI action.

– The **proportional-action coefficient KP** acts as gain on the P, I and D terms. Increasing the proportional-action coefficient of a P controller causes the output amplitude to increase.

– The **reset time TN** is the parameter of the I term. The reset time TN is the time it takes for the integral component during a step response in a PI controller to produce a change in the output identical to the change produced by the P component.
Increasing the reset time TN causes a reduction in the rate of change in the output when the error is constant.

– The **derivative-action time TV** is the parameter of the D term. The derivative-action time TV is the time it takes the rise response of a PD controller to reach a certain output earlier than it would with just its P term.
Increasing the derivative-action time TV causes an increase in output amplitude when the error rate of change is constant. After ramped error changes, a larger derivative-action time TV causes the D term to continue to have a longer effect.

– The derivative-action gain **TVK1** is a gain factor on the D term.

– The **operating point Y.PRE** of the P or PD controller determines the output value, which is fed to the controlled system when the process variable is the same as the set point.

– The **dead band error DZXD** is used to define the range of the error. Within this range, the effective error is zero. The control signal is not changed. The dead band can be used to suppress the response of the control loop. A valve is prevented from responding too frequently to signal changes (oscillation).

– **Error limitation**
The ⤓ DZXD and ⤒ DZXD parameters limit the effective error for calculating the output signal.
The ⤓ DZXD parameter is used to define the lower limit of the negative error and the ⤒ DZXD parameter the upper limit of the positive error.

CNTR menu: Controller

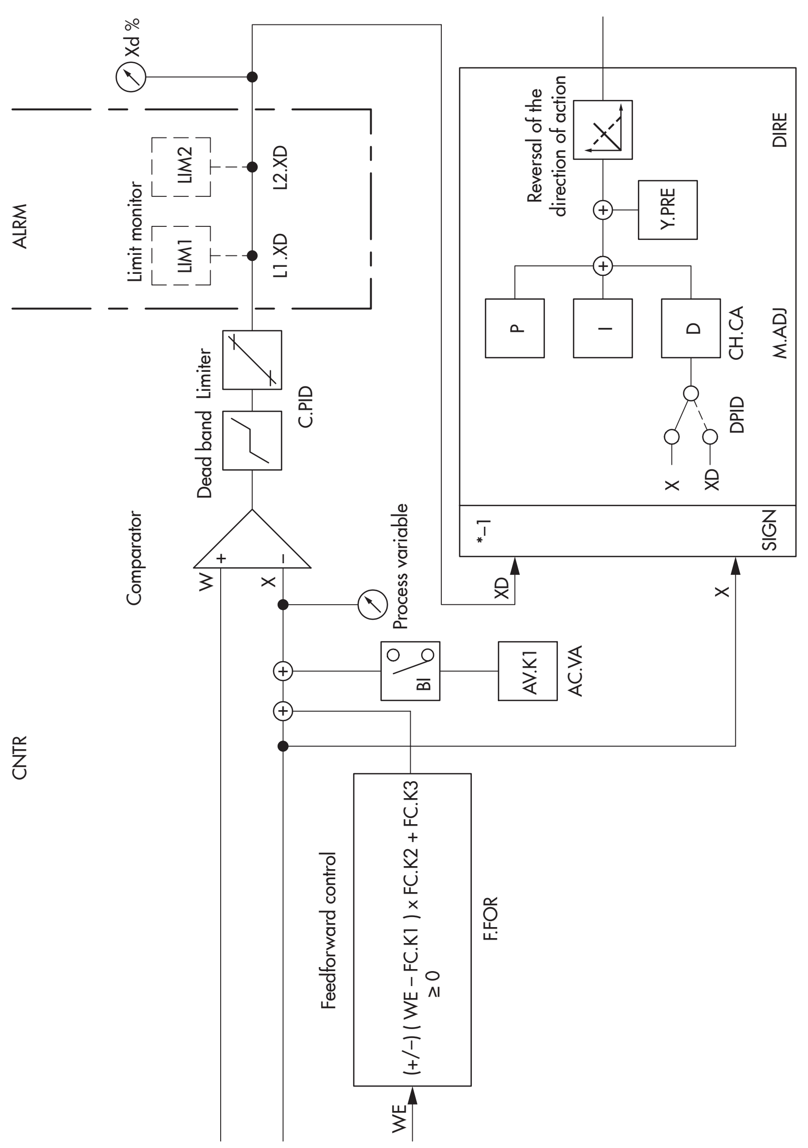


Fig. 7: *CNTR menu*

Assignment between control parameters and control behavior

	P	PI	PD	PID	P^2I
KP	•	•	•	•	•
TN	–	•	–	•	•
TV	–	–	•	•	–
TVK1	–	–	•	•	–
Y.PRE	•	•	•	•	•
DZXD	•	•	•	•	•
⤓ DZXD	•	•	•	•	•
⤒ DZXD	•	•	•	•	•

CNTR	**-CO- C.PID**	Control algorithm	
	P CP.YP	P behavior	
	PI CP.YP	PI behavior	
	Pd CP.YP	PD behavior	
	PId CP.YP	PID behavior	
	PPI CP.YP	P^2I behavior	
	-PA- C.PID		
	KP	Proportional-action coefficient	[0.1 … **1.0** … 100.0]
	TN	Reset time	[1 … **120** … 9999 s]
	TV	Derivative-action time	[1 … **10** … 9999 s]
	TVK1	Derivative-action gain	[0.10 … **1.00** … 10.00]
	Y.PRE	Operating point	[–10 … **0.0** … +110.0 %]
	DZXD	Dead band error Xd	[**0.0** … –110.0 %]
	⤓ DZXD	Minimum effective error Xd	[**–110.0 %** … ⤒ DZXD]
	⤒ DZXD	Maximum effective error Xd	[⤓ DZXD … **110.0 %**]

i Note

The control parameters KP, TN, TV and Y.PRE can also be set in the PAR menu.

4.2 -CO- SIGN: Inversion error Xd

The error's direction of action can be inverted. The inversion converts an increasing error into a decreasing error or a decreasing error into an increasing error. This also inverts the direction of action of the output signal.

CNTR	**-CO- SIGN**	Inversion error Xd
	dir.d XD	Not inverted
	in.d XD	Inverted

ℹ *Note*

The adjusted direction of action can also be changed with the -CO- DIRE function (see section 4.6).

4.3 -CO- D.PID: Assignment of the D element (control output)

Either the error or controlled variable can be assigned as the source for the derivative component in PD and PID controllers.

- **F01 DP.YP setting:** The error Xd is the source for the D component. A change of the controlled variable and set point have an effect on the output over the D component.
- **F02 DP.YP setting:** The controlled variable X is the source for the D component. A change of the controlled variable has an effect on the output over the D component. A change of the set point is not included in the D component.

CNTR	**-CO- D.PID**	Assignment D element control output
	F01 DP.YP	To error
	F02 DP.YP	To controlled variable

4.4 -CO- CH.CA: Control mode selection P(D)/PI(D)

Control mode changeover enables PI and PID controllers to be operated with or without integral action. This function allows the integral action to be activated automatically by the error or set point. This function can only be selected when a PI or PID action has been configured (see section 4.1).

The control mode selection P(D)/PI(D) is preferably to be used when the valve is to move as quickly as possible to the set point without overshooting while no steady-state error is to ex-

ist. This is required especially for control of discontinuous processes, such as during batch operation of an autoclave, an open-steam vulcanizer or a hearth furnace.
When control mode changeover is selected, the P(PD) or PI(PID) action is active depending on the error or set point. Outside a definable range of the error or set point, the controller works with the P or PD control parameters. Within this range, the integral action is activated. The parameters CLI.P and CLI.M are used to define this range. Fig. 8 clearly show this behavior.

ℹ ***Note***

Special note for F01 CC.P setting: *The operating point is determined by the last manual output value if the controller changes from manual to automatic mode while the error is outside the defined range. The operating point applies until the error enters the defined range. In this range, the operating point is determined by the PI(D) behavior. The integral action is saved and the last output value is set as the operating point when the error leaves the defined area again. If the controller changes from automatic to manual mode, the operating point required for the plant must be reset again before returning to the automatic mode. The operating point is only saved temporarily (Y.PRE parameter does not have any effect). After a power failure, the operating point must be reset in manual mode.*

CNTR	**-CO- CH.CA**	Control mode selection P(D)/PI(D)	
	oFF CC.P	OFF	
	F01 CC.P	By error	
	F02 CC.P	By set point	
	-PA- CH.CA		
	CLI.P	Max. limit for PI(D) control	[–110.0 … **10.0** … +110.0 %]
	CLI.M	Min. limit for PI(D) control	[–110.0 … **–10.0** … +110.0 %]

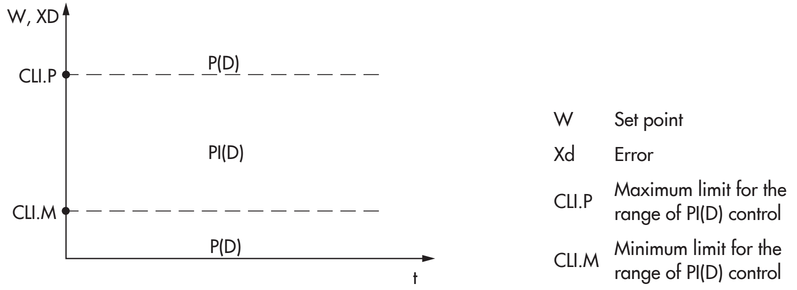


Fig. 8: *Control mode changeover*

4.5 -CO- M.ADJ: Operating point setting (manual mode) for YPID

This function is used to define an operating point in manual mode. In automatic mode, the defined operating point is added to the calculated output variable.

The defined operating point remains active until either the operating point adjustment in manual mode is deactivated by selecting oFF MA.YP or until a new operating point is adjusted in manual mode. If you deactivate operating point adjustment in manual mode, the output variable defined in manual mode assumes the calculated value within approx. two seconds.

After a power failure, the operating point must be reset in manual mode.

CNTR	**-CO- M.ADJ**	Operating point setting (manual mode) for YPID
	oFF MA.YP	OFF
	on MA.YP	ON

4.6 -CO- DIRE: Direction of action of the output variable

The DIRE function allows the direction of action of the output variable to be changed to match the direction of action of the control loop or control valve. The output variable may either act directly or inversely to the error (error = set point – process variable).

Note

The adjusted direction of action can also be changed with the -CO- SIGN function (see section 4.2).

CNTR	**-CO- DIRE**	Direction of action of the output variable
	dir.d DI.AC	Direct
	in.d DI.AC	Inverted

4.7 -CO- F.FOR: Feedforward control

The input variable WE can be used for feedforward control (see section 3.1).

The feedforward input signal can be multiplied and added by parameters according to the formula. The feedforward control signal is then connected to the controlled variable.

±(WE – FC.K1) · FC.K2 + FC.K3, with (WE – FC.K1) ≥ 0

FC.K1, FC.K2 and FC.K3 are constants that are defined in the parameter level. The mathematical sign of the formula is determined in the -CO- F.FOR function (see section 4.7).

The -CO- F.FOR function can be used for a **measured value correction**.
For example, if a Pt 100 sensor is connected in a two-wire circuit and the line resistance causes a higher temperature reading, this reading error can be compensated for with a negative correction value.

Example: the temperature reading is too high by 2 °C (measuring range 0 to 100 °C). The following setting is made to compensate for the reading error:

- Function: -CO- F.FOR, POS FECO setting
- Parameters -PA-: FC.K1 = 0.0 %, FC.K2 = 0.0, FC.K3 = –2.0 %

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i Note

A measured value correction can also be performed with the function generation of the input variable (-CO- FUNC, see section 2.8) or with the calibration of the input (-CO- ADJ, see section 9.5).

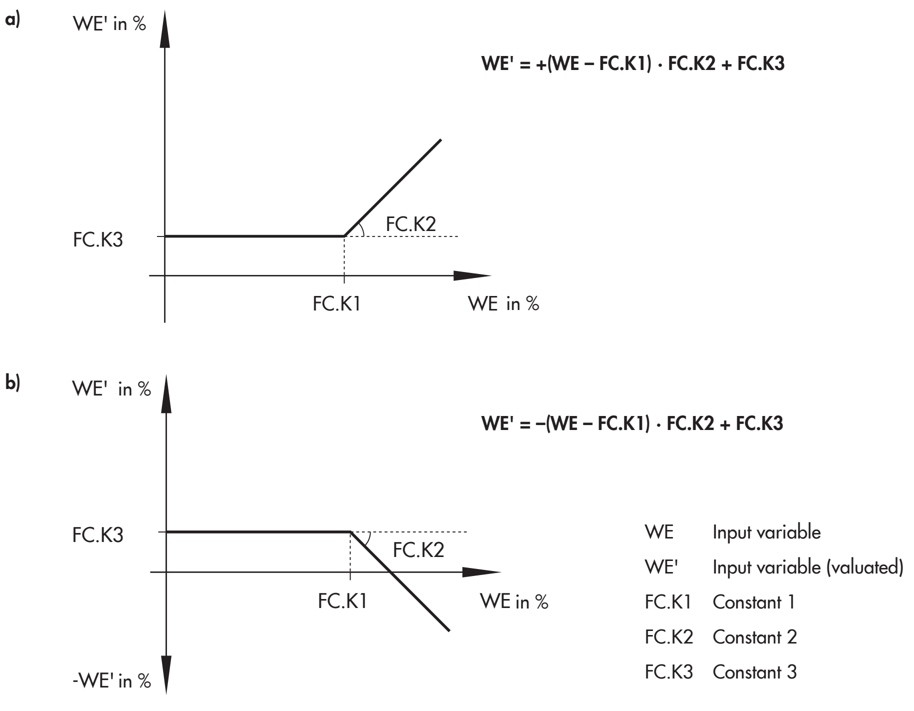


Fig. 9: *Feedforward control with positive (a) and negative (b) signs*

CNTR	**-CO- F.FOR**	Feedforward control	
	oFF FECO	Deactivated	
	P0S FECO	With positive sign	
	nE6 FECO	With negative sign	
	FC.K1	Constant 1 for feedforward control	[**0.0** … 110.0 %] 1)
	FC.K2	Constant 2 for feedforward control	[0.0 … **1.0** … 100.0]
	FC.K3	Constant 3 for feedforward control	[–110.0 … **0.0** … 110.0 %] 1) 2)

1) Percent based on the measuring range of the controlled variable X.
2) The FC.K3 parameter can be adjusted within the range –9.99 to 99.99 with two decimal places.

4.8 -CO- AC.VA: Increase/decrease process variable

This function is used to add the input signal X to the constant AV.K1 when the binary input is activated. The new process variable is used for closed-loop control and is shown on the display (top row). The input signal X is used again for closed-loop control as soon as the binary input is inactive again.

CNTR	**-CO- AC.VA**	Increase/decrease process variable	
	oFF IN.DE	Deactivated	
	bi1 IN.DE	By binary input BI	
	AV.K1	Constant in percent (± process variable)	[–110.0 … **0.0** … 110.0 %]

Note

Several functions can be assigned to the binary input (see section 1).

5 OUT menu: Output

The controller's output functions are set in this menu.

5.1 -CO- SAFE: Activate constant output value

A predefined output value Y1K1 can be issued at the control output Y by the binary input in automatic mode. The constant output value is activated when the binary input is active. Closed-loop control continues starting from this output value after the binary input is inactive again. The function can be used to enable control.

The constant output value cannot be activated in manual mode.

OUT	**-CO- SAFE**	Activate constant output value	
	oFF SA.VA	OFF	
	bi1 SA.VA	By binary input BI1	

	-PA- SAFE		
	Y1K1	Constant output value	[–10.0 … **0.0** … 110.0 %]

ℹ Note

Several functions can be assigned to the binary input (see section 1).

5.2 -CO- MA.AU: Manual/automatic switchover

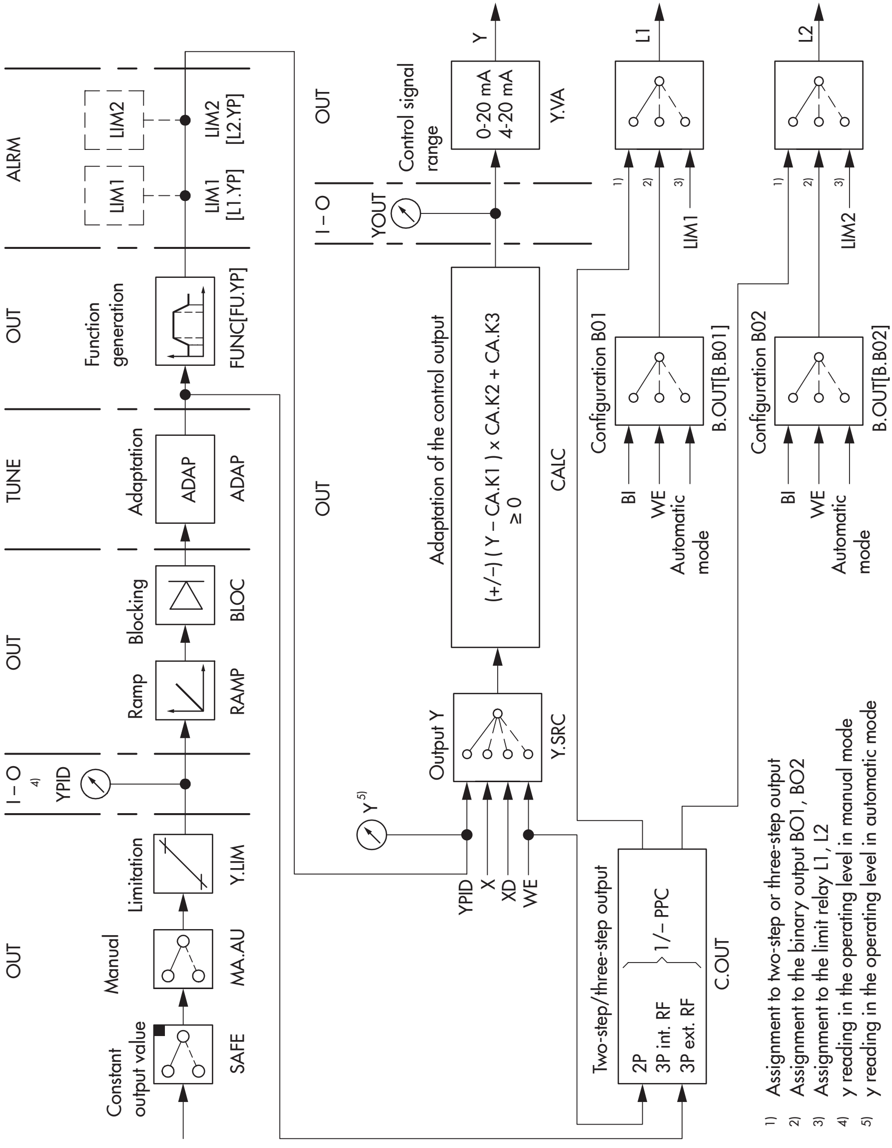
This function is used to switch the controller to the manual mode ✋ and locks the ⊠ key as well when the binary input is activated. The controller switches back to automatic mode when the binary input is deactivated.

After the binary input is inactive again, the controller can be switched in manual mode back to automatic mode using the ⊠ key.

OUT	**-CO- MA.AU**	Manual/automatic switchover
	oFF CH.MA	OFF
	bi1 CH.MA	By binary input BI

ℹ Note

Several functions can be assigned to the binary input (see section 1).



1) Assignment to two-step or three-step output
2) Assignment to the binary output BO1, BO2
3) Assignment to the limit relay L1, L2
4) y reading in the operating level in manual mode
5) y reading in the operating level in automatic mode

Fig. 20: *OUT menu*

5.3 -CO- Y.LIM: Control signal limitation YPID

Control signal limitation is always active. This functions allows you to determine the parameters for the minimum and maximum output variable.

0 % represents 4 mA and 100 % represents 20 mA for a 4 to 20 mA control signal.

OUT	**-CO- Y.LIM**	Control signal limitation YPID	
	on LI.YP	ON	
	-PA- Y.LIM		
	⊻Y	Minimum output variable	[–10.0 … **0.0** … 110.0 %]
	⊼Y	Minimum output variable	[–10.0 … **100.0** … 110.0 %]

5.4 -CO- RAMP: Output ramp/output rate limitation YPID

Settings F01 RA.YP und F02 RA.YP – Output ramp

The output ramp is the change of the output variable at a constant rate. The TSRA parameter determines the running time of the output ramp and the rate as a result.

It is based on a change of the output variable by 100 % (Fig. 10). The control output is set to the start value when the binary input is activated. The deactivation of the binary input causes the output ramp to start.

- The F01 RA.YP setting sets the start value to –10.0 %.
- The F02 RA.YP setting allows the start value to be set as required using the Y1RA parameter.

Manual mode and restart after supply voltage failure cause the output ramp to be deactivated.

Settings F03 RA.YP, F04 RA.YP and F05 RA.YP – Limitation of rate of change of the output variable

The rate of change of the output variable can be restricted when the output variable rises and/or falls. The output variable changes in the restricted direction(s) only as fast at the rate fixed by the TSRA parameter. The TSRA running time is based on a change of the output variable by 100 %. A limitation does not apply when the actual rate of change of the output variable is lower than the defined rate of change.

Fig. 11 shows how the described function works. The rate of change of the output variable v_y is calculated as follows: ≥

$$v_y = \frac{100\ \%}{TSRA}$$

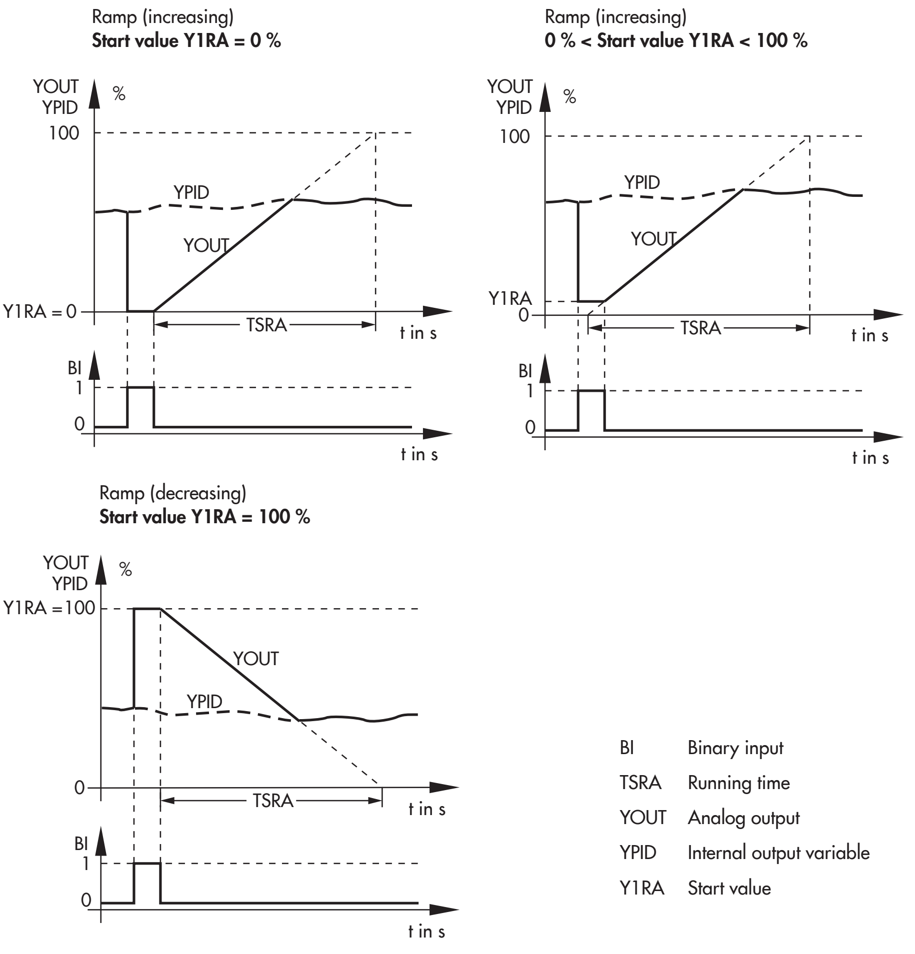


Fig. 10: *Output ramp: setting* ***F02 RA.YP*** *Ramp increasing/decreasing, start with Y1RA by BI*

OUT	**-CO- RAMP**	Output ramp/limitation of rate of change for output variable
	oFF RA.YP	OFF
	F01 RA.YP	Ramp increasing, start with –10 % by BI1
	F02 RA.YP	Ramp increasing/decreasing, start with Y1RA by BI1
	F03 RA.YP	Limitation when output variable decreases and increases
	F04 RA.YP	Limitation when output variable increases
	F05 RA.YP	Limitation when output variable decreases

	-PA- RAMP/RA.YP		
	TSRA	Running time	[**1** … 9999 s]
	Y1RA	Start value	[–10.0 … **0.0** … 110.0 %]

i Note

Several functions can be assigned to the binary input (see section 1).

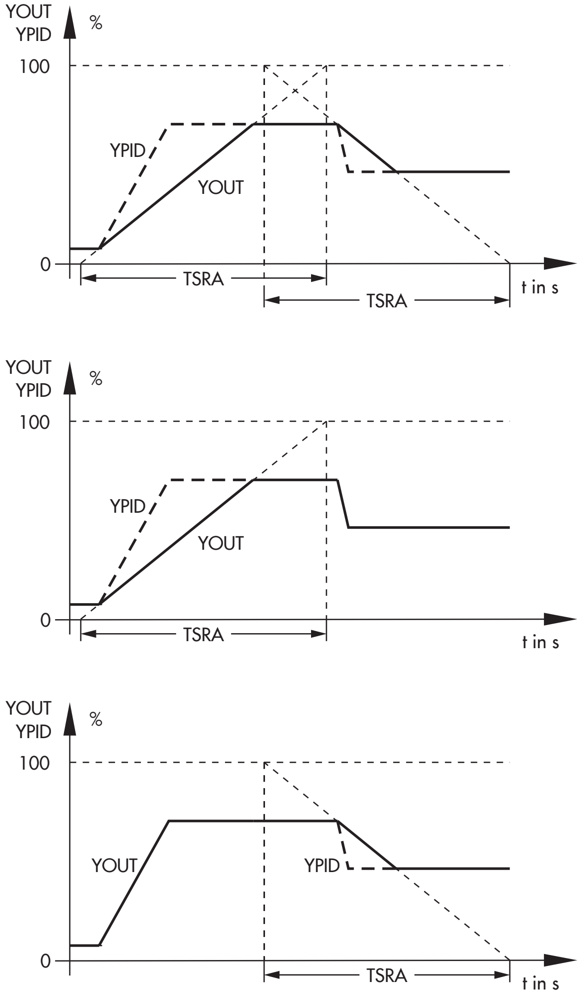
5.5 -CO- BLOC: Blocking output variable YPID

This functions blocks the control signal when the binary input BI is activated. The current output value remains active at the control output while the binary input is active. As soon as the binary input is deactivated, the blocking stops and the control loop continues using the last output value.

OUT	**-CO- BLOC**	Blocking output variable YPID
	oFF BL.YP	OFF
	on BL.YP	By binary input BI1

i Note

Several functions can be assigned to the binary input (see section 1).



F03 RA.YP setting
Limitation when output variable decreases and increases

F04 RA.YP setting
Limitation when output variable increases

F05 RA.YP setting
Limitation when output variable decreases

TSRA	Running time
YOUT	Analog output
YPID	Internal output variable

Fig. 11: *Limitation of rate of change for output variable*

5.6 -CO- FUNC: Function generation of the output variable

Similar to the input variables X and WE, function generation can also be performed for the output variable Y. Read section 2.8 for a detailed description of the function generation. The input and output values are specified in percent.

OUT	**-CO- FUNC**	Function generation of the output variable	
	oFF FU.YP	OFF	
	on FU.YP	ON	
	-PA- FUNC/FU.YP		
	K1.X	Input value 1	[–10.0 … **0.0** … 110.0 %]
	K1.Y	Output value 1	[–10.0 … **0.0** … 110.0 %]
	…	…	…
	K7.X	Input value 7	[–10.0 … **0.0** … 110.0 %]
	K7.Y	Output value 7	[–10.0 … **0.0** … 110.0 %]

5.7 -CO- Y.VA: Signal range for analog output Y

This function is used to set the signal range of the analog output.

OUT	**-CO- Y.VA**	Signal range for analog output Y
	oFF Y	OFF
	0–20 mA	0 to 20 mA
	4–20 mA	4 to 20 mA
	0–10 V	0 to 10 V
	2–10 V	2 to 10 V

5.8 -CO- Y.SRC: Source for analog output Y

This function is used to determine the source for the analog output Y. The output variable YPID is assigned to the analog output by default. Optionally, the input variables X, WE or the error Xd can be assigned as the source.

The input variables X and WE are issued based on the input measuring range (e.g. for an input measuring range 0 to 200 °C):

X = 0 °C ➞ Y = 0 % (e.g. 4 mA) and X = 200 °C ➞ Y = 100 % (e.g. 20 mA)

The error is issued based on the range –100 to +100 %, i.e.:

Xd = –100 % ➞ Y = 0 % (e.g. 4 mA) and X = +100 % ➞ Y = 100 % (e.g. 20 mA)

OUT	**-CO- Y.SRC**	Source for analog output Y
	on Y.PID	Output YPID
	on Y.X	Input X
	on Y.WE	Input WE
	on Y.XD	Error Xd

5.9 -CO- CALC: Mathematical adaptation analog output Y

This function is used for the mathematical adaptation of a continuous-action output. The following formulas are used:

$$YOUT = \pm(Y - CA.K1) \cdot CA.K2 + CA.K3$$

OUT	**-CO- CALC**	Mathematical adaptation analog output Y	
	oFF CA.Y	OFF (no output signal)	
	on CA.Y	Without condition	
	PO5 CA.Y	With positive sign	
	nE6 CA.Y	With negative sign	
	-PA- CALC/CA.Y		
	CA.K1	Constant 1	[**0.0** … 100.0 %]
	CA.K2	Constant 2	[0.0 … **1.0** … 10.0]
	CA.K3	Constant 3	[–10.0 … **0.0** … 110.0 %]

5.10 -CO- C.OUT: Two-step or three-step output

This function is used to set the two-step or three-step output.

- **Setting on 2.STP – Two-step output as limit monitoring of the output variable**
  The two-step output Y+ acts on the relay BO1. It can assume the ON or OFF states. For example, it can be used to control electric heating (oven). This version of the two-step output corresponds to monitoring for a violation above the limit TZ by the output variable YPID. The activation point is determined by the limit TZ and the deactivation point by the switching differential XSDY. The + icon appears on the display as soon as the relay BO1 is activated.
  In manual mode, the two-step output is deactivated and the △ key can be used to activate the relay BO1.

  Electrical connection ▶ EB 6493.

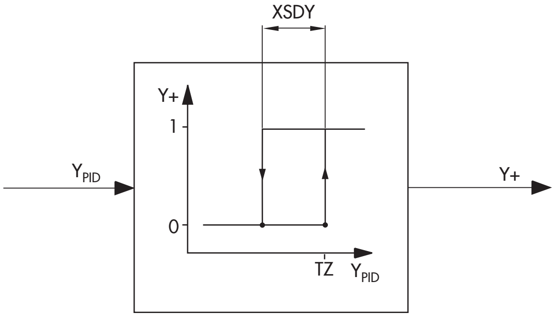


Fig. 12: *Two-step output*

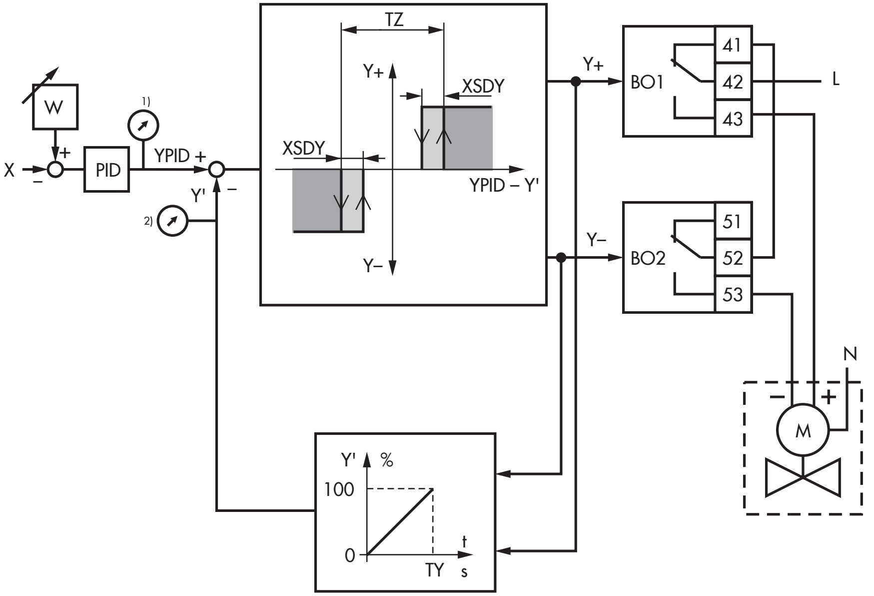
i Note

– Other versions of the two-step output can be configured:
(1) Two-step output with pulse width modulation (PWM), see page 47.
(2) Two-step output as limit monitoring of the error Xd or controlled variable X with the L1 and L2 limit relays (see page 55)

– If the relay BO1 is used with the 'on 2.STP' setting as a two-step output, the relay BO2 is available for the output of limit alarms or status alarms.

OUT	**-CO- C.OUT**	Two-step or three-step output	
	on 2.STP	Two-step output	
	-PA- C.OUT/2.STP		
	XSDY	Switching differential	[0.10 … **0.50 %** … TZ]
	TZ	Dead band	[XSDY … **2.00** … 100.0 %]

- **i.Fb 3.STP setting: Three-step output with internal feedback**
  The three-step output is used to control an electric actuator or other equipment with integrated behavior over two relays.
  The relay BO1 moves the actuator in the + direction (e.g. actuator stem retracts or the valve opens) and the relay BO2 in the – direction (e.g. actuator stem extends or the valve closes). The actuator stops when both relays are switched off.
  For the three-step output with internal feedback, the position of the actuator is calculated from the entered **transit time TY** (transit time of the actuator) and the internally fed back control pulses. In this case, it is important to note that the actual position of the actuator may deviate from the calculated position.
  The three-step output has two pairs of switching points Y+ and Y– each with an activation and deactivation point.
  The **switching differential XSDY** is used to set the distance between the activation and deactivation points. A lower XSDY setting causes the control pulses to become shorter and the switching frequency to increase. Note that the switching differential must always be lower than TZ/2.
  The **dead band TZ** is used to set the distance between the activation points of control pulses Y+ and Y–. The switchover between Y+ and Y– takes longer, the higher the TZ is set.
  The comparator calculates the difference from the output variable YPID (target position) and the feedback signal Y' (calculated actual position). Depending on the difference YPID – Y', the control pulses are generated as follows:
  - The + output BO1 is switched on when the difference between the target and actual position is greater than TZ/2.
  - The — output BO2 is switched on when the difference between the target and actual position is –TZ/2.
  - The BO1 and BO2 are switched off when the difference between the target and actual position is smaller than (TZ/2 – XSDY) and greater than (–TZ/2 + XSDY).



1) Reading of the output variable
– in the operating level as Y in automatic mode
– in the I-O/ANA menu as YPID

2) Reading of the internal position feedback in the operating level as Y in manual mode

Fig. 13: *Three-step output with internal feedback*

- The control pulse Y+ switches the relay BO1 on permanently if the output variable YPID is equal or greater than 100 %.
- The control pulse Y– switches the relay on permanently if the output variable YPID is equal or smaller than 0 %.

In manual mode, the relays are not activated over the three-step output.
In manual mode, the △ key is used to control the relay BO1 (Y+) and the ▽ key to control the relay BO2 (Y–).

i Note

Note on the control signal limitation -CO- Y.LIM: *The ⩡Y parameter must not be set to be greater than 0.0 % and the ⩞Y parameter not lower than 100.0 % to ensure the three-step output can move the actuator to the end position on demand with the constant signals Y+ and Y– (see section 5.3).*

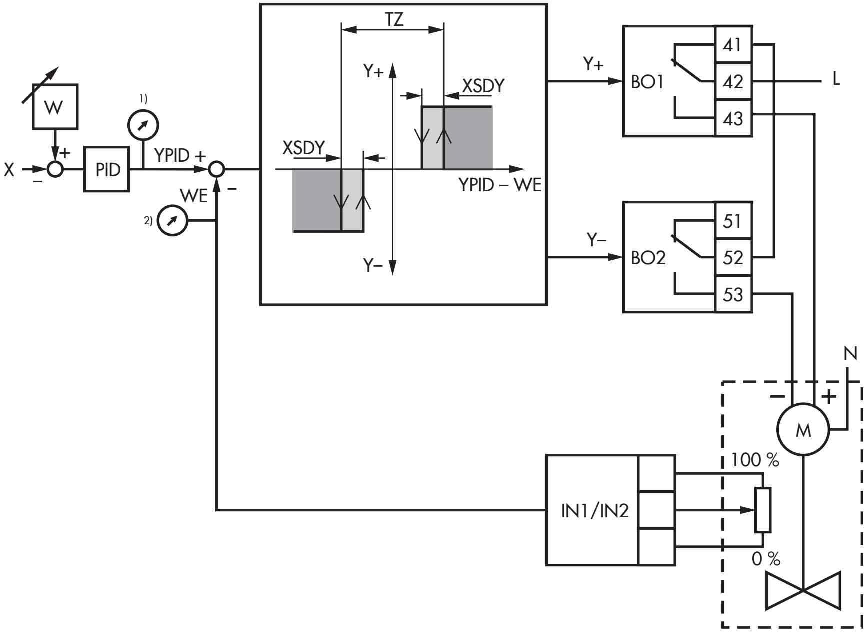
OUT	**-CO- C.OUT**	Two-step or three-step output	
	i.Fb 3.STP	Three-step output with internal feedback	
	-PA- C.OUT/3.STP		
	XSDY	Switching differential	[0.10 … **0.50 %** … TZ]
	TZ	Dead band	[XSDY … **2.00** … 100.0 %]
	TY	Transit time	[1 … **60** … 9999 s]

– **E.Fb 3.STP setting: Three-step output with external feedback**
The three-step output is used to control an electric actuator or other equipment with integrated behavior over two relays.
The relay BO1 moves the actuator in the + direction (e.g. actuator stem retracts or the valve opens) and the relay BO2 in the – direction (e.g. actuator stem extends or the valve closes). The actuator stops when both relays are switched off.
For the three-step output with external feedback, the position of the actuator is fed back over the input variable WE by a potentiometer, for example.
The **switching differential XSDY** is used to set the distance between the activation and deactivation points. A lower XSDY setting causes the control pulses to become shorter and the switching frequency to increase. Note that the switching differential must always be lower than TZ/2.
The **dead band TZ** is used to set the distance between the activation points of control pulses Y+ and Y–. The switchover between Y+ and Y– takes longer, the higher the TZ is set.
The comparator calculates the difference YPID – WE from the output variable YPID (target position) and the feedback signal WE (actual position). Depending on the difference, the control pulses are generated as follows:

- A difference greater than TZ/2 causes the control pulse Y+ to switch on relay BO1.
- A difference smaller than TZ/2 causes the control pulse Y– to switch on relay BO2.
- A difference smaller than the amount TZ/2 – XSDY causes both relays to be switched off.

In manual mode, the relays are not activated over the three-step output.
In manual mode, the △ key is used to control the relay BO1 (Y+) and the ▽ key to control the relay BO2 (Y–).
The input variable WE must be configured for position feedback.

Example: position feedback with a potentiometer over input IN2
- Set input signal for analog input IN2:
  IN menu, -CO- IN2 function, 0–1 kOHM setting (see section 2.2)
- Assign input variable WE to the analog input IN2:
  IN menu, -CO- CLAS function, In2 WE setting (see section 2.5)
- Assign input variable WE to the external position feedback:
  SETP menu, -CO- SP.VA function, F01 WE setting (see section 3.1)



1) Reading of the output variable
– in the operating level as Y in automatic mode
– in the I-O/ANA menu as YPID

2) Reading of the external position feedback
– in the operating level as Y in manual mode
– in the I-O/ANA menu as FE.CO

Fig. 14: *Three-step output with external feedback*

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i Note

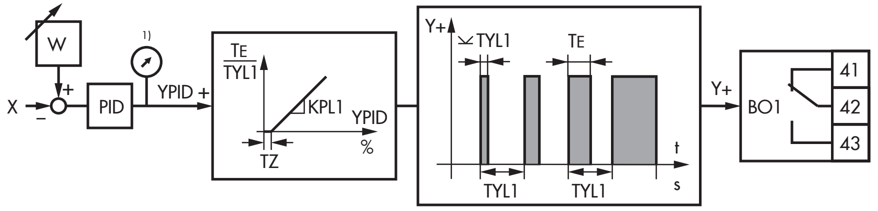
The target position of the actuator can be restricted in -CO- Y.LIM with the ⌄Y and ⌅Y parameters (travel limit).

OUT	**-CO- C.OUT**	Two-step or three-step output	
	E.Fb 3.STP	Three-step output with external feedback	
	-PA- C.OUT/3.STP		
	XSDY	Switching differential	[0.10 … **0.50 %** … TZ]
	TZ	Dead band	[XSDY … **2.00** … 100.0 %]

- **Setting PP 2.STP – on/off output with pulse width modulation (PWM)**
  The on/off output with pulse width modulation (PWM) converts the continuous YPID signal into a pulse sequence with a pulse width modulation that varies depending on the YPID value (Fig. 15). The two-step output can be used to control electric heating (oven). The duty cycle TE of the two-step signal Y+ is calculated as follows:

$$TE = \frac{(Y \text{ in } \% - TZ \text{ in } \%) \cdot KPL1}{100\ \%} \cdot TYL1 \text{ in s}$$

  The TYL1 parameter is the cycle duration and at the same time the maximum duty cycle. KPL1 is a gain factor.
  The ⩡ TYL1 parameter indicates the minimum duty cycle of the two-step signal Y+.
  It is at least 0.3 seconds (due to the hardware).
  By selecting the appropriate TYL1, KPL1 and ⩡ TYL1 parameters, it is possible to achieve a compromise between a low fluctuation range of the controlled variable (high switching frequency) and a long service life of the control valve (low switching frequency) at the two-step output with PWM. The two-step output acts directly on the relay BO1 and in reverse on the relay BO2.
  In manual mode, the two-step output is controlled over the manual output value and the pulse of the relay according to the adjusted pulse width ratio.



[1] Reading of the output variable
– in the operating level as Y
– in the I-O/ANA menu as YPID

Fig. 15: *Two-step output with PWM*

ℹ *Note*

- *Another version of the two-step output can be set:*
  (1) Two-step output as limit monitoring of the error Xd or controlled variable X with the L1 and L2 limit relays (see section 6)
  (2) Two-step output as limit monitoring of the output variable Y (see section 5.10 for 'on 2.STP' setting).
- *The relay BO1 cannot be used for limit monitoring when the two-step output is configured. The relay no longer acts as a two-step output with PWM if limit monitoring (-CO- LIM2) is configured for relay BO2.*
- *The minimum duty cycle is (also) set in -CO- Y.LIM with the ⊻Y parameter in percent in relation to the cycle duration.*
- *The maximum duty cycle is set in -CO- Y.LIM with the ⊽Y parameter in percent in relation to the cycle duration.*

OUT	**-CO- C.OUT**	Two-step or three-step output	
	PP 2.STP	Two-step output with PWM	
	-PA- C.OUT/2.STP		
	KPL1	Gain Y+ (BO1)	[0.1 … **1.0** … 100.0]
	TYL1	Cycle duration Y+ (BO1)	[1.0 … **10.0** … 9999 s]
	⊻ TYL1	Min. duty cycle Y+ (BO1)	[0.1 … **1.0 s** … TYL1]
	TZ	Dead band	[0.10 … **2.00** … 100.0 %]

- **i.PP 3.STP setting: Three-step output with internal feedback and PWM**
  For the three-step output with internal feedback and pulse width modulation, the control pulses are issued with pulse width modulation.
  The position of the actuator is calculated from the entered **transit time TY** (transit time of the actuator) and the internally fed back control pulses. In this case, it is important to note that the actual position of the actuator may deviate from the calculated position.
  A characteristic can be adjusted for the control pulses Y+ and Y–.
  - The distance between both characteristic zero points is set by setting the dead band TZ. The switchover between Y+ and Y– takes longer, the higher you set TZ.
  - The KPL1 parameter is used to adjust the gain of the characteristic for the signal Y+.
  - The KPL2 parameter is used to adjust the gain of the characteristic for the signal Y–.
  - The TYL1 parameter is used to adjust the cycle duration of the characteristic for the signal Y+.
  - The TYL2 parameter is used to adjust the cycle duration of the characteristic for the signal Y–.
  - The ⩡TYL1 parameter is used to adjust the minimum duty cycle for the signal Y+.
  - The ⩡TYL2 parameter is used to adjust the minimum duty cycle for the signal Y–.

  The minimum duty cycle is at least 0.3 seconds (due to the hardware).
  The three-step output can be adapted to various transit times (e.g. the extending and retracting the actuator) with gain factors and cycle durations.
  The comparator calculates the difference from the output variable YPID (target position) and the feedback signal Y′ (calculated actual position). Depending on the difference YPID – Y′, the control pulses are generated as follows:
  - The control pulses Y+ become longer as the positive difference increases.
  - The control pulses Y– become longer as the negative difference increases.
  - A control pulse is not issued if the difference is within the range of ±TZ/2.
  - A control pulse Y+ is not issued if the positive difference is smaller than TZ/2 + ⩡TYL1.
  - A control pulse Y– is not issued if the negative difference is smaller than TZ/2 + ⩡TYL2.
  - The control pulse Y– switches the relay BO2 on permanently if the output variable YPID is equal or smaller than 0 %.
  - The control pulse Y+ switches the relay BO1 on permanently if the output variable YPID is equal or greater than 100 %.

  In manual mode, the relays are not activated over the three-step output.
  In manual mode, the △ key is used to control the relay BO1 (Y+) and the ▽ key to control the relay BO2 (Y–).

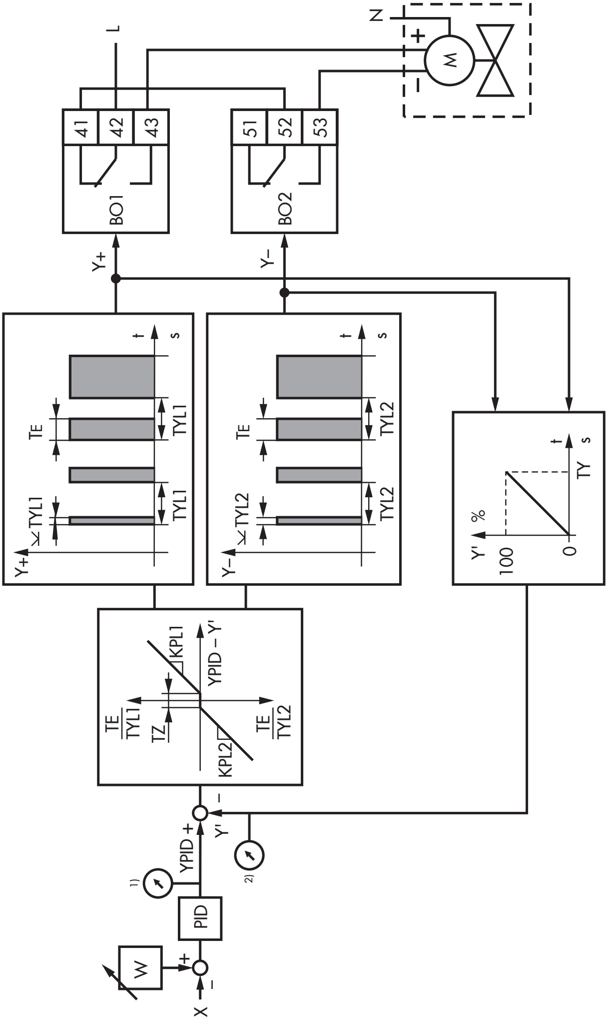


Fig. 16: *Three-step output with internal feedback and PWM*

[1] Reading of the output variable
– in the operating level as Y in automatic mode
– in the I-O/ANA menu as YPID

[2] Reading of the internal position feedback in the operating level as Y in manual mode

OUT	**-CO- C.OUT**	Two-step or three-step output	
	i.PP 3.STP	Three-step output with internal feedback and PWM	
	-PA- C.OUT/2.STP		
	KPL1	Gain Y+ (BO1)	[0.1 … **1.0** … 100.0]
	KPL2	Gain Y– (BO2)	[0.1 … **1.0** … 100.0]
	TYL1	Cycle duration Y+ (BO1)	[1.0 … **10.0** … 9999 s]
	TYL2	Cycle duration Y– (BO2)	[1.0 … **10.0** … 9999 s]
	⩡ TYL1	Min. duty cycle Y+ (BO1)	[0.1 … **1.0 s** … TYL1]
	⩡ TYL2	Min. duty cycle Y– (BO2)	[0.1 … **1.0 s** … TYL2]
	TZ	Dead band	[0.10 … **2.00** … 100.0 %]
	TY	Transit time	[1 … **60** … 9999 s]

- **E.PP 3.STP setting: Three-step output with external feedback and PWM**
  For the three-step output with external feedback and pulse width modulation, the control pulses are issued with pulse width modulation.
  The position of the actuator is fed back over the input variable WE by a potentiometer, for example.
  A characteristic can be adjusted for the control pulses Y+ and Y–.
  - The distance between both characteristic zero points is set with the dead band TZ. The switchover between Y+ and Y– takes longer, the higher the TZ is set.
  - The KPL1 parameter is used to adjust the gain of the characteristics for the signal Y+.
  - The KPL2 parameter is used to adjust the gain of the characteristics for the signal Y–.
  - The TYL1 parameter is used to adjust the cycle duration of the characteristic for the signal Y+.
  - The TYL2 parameter is used to adjust the cycle duration of the characteristic for the signal Y–.
  - The ⩡TYL1 parameter is used to adjust the minimum duty cycle for the signal Y+.
  - The ⩡TYL2 parameter is used to adjust the minimum duty cycle for the signal Y–.

The minimum duty cycle is at least 0.3 seconds (due to the hardware).
The comparator calculates the difference YPID – WE from the output variable YPID (target position) and the input variable WE (actual position). Depending on the difference, the control pulses are generated as follows:

- The control pulses Y+ become longer as the positive difference increases.
- The control pulses Y– become longer as the negative difference increases.
- A control pulse is not issued if the difference is within the range of ±TZ/2.
- A control pulse Y+ is not issued if the positive difference is smaller than TZ/2 + ⊻TYL1.
- A control pulse Y– is not issued if the negative difference is smaller than TZ/2 + ⊻TYL2.

The input variable WE must be configured for position feedback.

Example: position feedback with a potentiometer over input IN2

- Set input signal for analog input IN2:
  IN menu, -CO- IN2 function, 0–1 kOHM setting (see section 2.2)
- Assign input variable WE to the analog input IN2:
  IN menu, -CO- CLAS function, In2 WE setting (see section 2.5)
- Assign input variable WE to the external position feedback:
  SETP menu, -CO- SP.VA function, F01 WE setting (see section 3.1)

In manual mode, the relays are activated over the three-step output. The manual output value Y is used to determine the target position for the three-step output.

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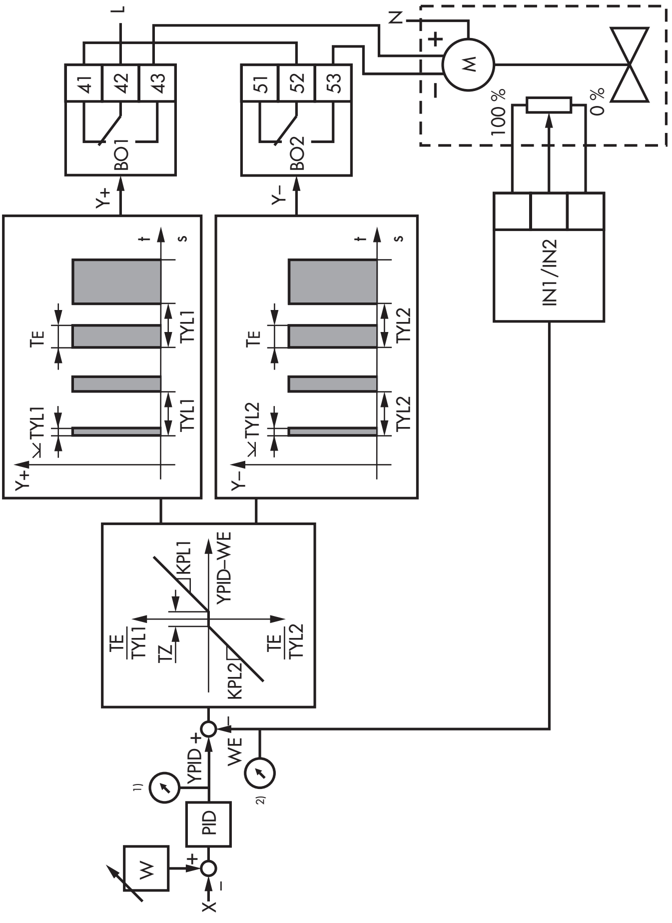
i ***Note***

The target position of the actuator can be restricted in -CO- Y.LIM with the ⊻Y and ⊼Y parameters (travel limit).



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1) Reading of the output variable
– in the operating level as Y in automatic and manual mode
– in the I-O/ANA menu as YPID

2) Reading of the external position feedback in I-O/ANA menu as FE.CO

Fig. 17: *Three-step output with external feedback and PWM*

OUT	**-CO- C.OUT**	Two-step or three-step output	
	E.PP 3.STP	Three-step output with external feedback and PWM	
	-PA- C.OUT/3.STP		
	KPL1	Gain Y+ (BO1)	[0.1 … **1.0** … 100.0]
	KPL2	Gain Y– (BO2)	[0.1 … **1.0** … 100.0]
	TYL1	Cycle duration Y+ (BO1)	[1.0 … **10.0** … 9999 s]
	TYL2	Cycle duration Y– (BO2)	[1.0 … **10.0** … 9999 s]
	⩡ TYL1	Min. duty cycle Y+ (BO1)	[0.1 … **1.0 s** … TYL1]
	⩡ TYL2	Min. duty cycle Y– (BO2)	[0.1 … **1.0 s** … TYL2]
	TZ	Dead band	[0.10 … **2.00** … 100.0 %]

5.11 -CO- B.OUT: Binary outputs BO1 and BO2 for status indication

This function is used to set the binary outputs BO1 and BO2 to indicate operating states. The status of the binary outputs can be read in the I–O menu (BIN) (see section 9.4).

ℹ *Note*

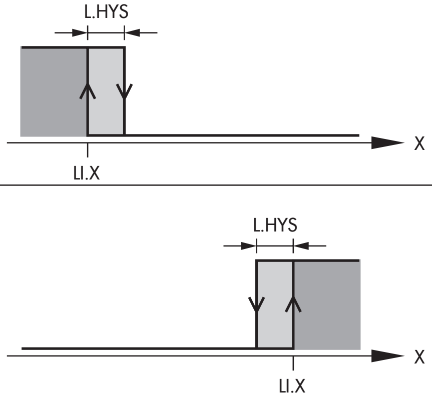
The functions of two-step or three-step output -CO- C.OUT have priority over the functions of the binary outputs B.OUT (see section 5.10). Only the function of BO2 can be used if the C.OUT function is set to 'on 2.STP' or 'PP 2.STP' (see section 5.10). All settings of B.OUT have priority over the setting of the LIM1 and LIM2 functions (see section 6.1 and section 6.2).

OUT	**-CO- B.OUT**	Binary output BO1
	oFF B.BO1	OFF
	F01 B.BO1	Active when binary input is set
	F02 B.BO1	Active when WE is active
	F03 B.BO1	Active in automatic mode
		Binary output BO2
	oFF B.BO2	OFF
	F01 B.BO2	Active when binary input is set
	F02 B.BO2	Active when WE is active
	F03 B.BO2	Active in automatic mode

6 ALRM menu: Limit relays

The functions of the limit relays L1 and L2 are set in this menu.
The limit relays monitor a variable for a violation above or below limits. The -CO- LIM1 and -CO- LIM2 functions are used to enter the variable to be monitored and the condition (violation above or below the limit) to switch the limit relay L2.
The limit is defined in the parameter level with LI.X, LI.WE, LI.YPID or LI.XD. A switching differential (hysteresis) must also be defined with the L.HYS A parameter. This switching differential is the distance between the switching points to activate and deactivate the limit relay and is specified in percent based on the measuring range.
Fig. 18 and Fig. 19 show an example of monitoring of the controlled variable X with the parameters that need to be set to illustrate the function of the limit relay. The example shows: if a variable is monitored for a violation of a maximum limit, the limit relay is activated when the variable exceeds the adjusted limit LI.X, LI.WE, LI.YPID or LI.XD. In the reverse direction, the limit relay is deactivated when the variable falls below the limit minus the switching differential L.HYS. If a variable is monitored for a violation of a minimum limit, the limit relay is activated when the variable falls below the adjusted limit LI.X, LI.WE, LI.YPID or LI.XD. In the reverse direction, the limit relay is deactivated when the variable exceeds the limit plus the switching differential L.HYS.

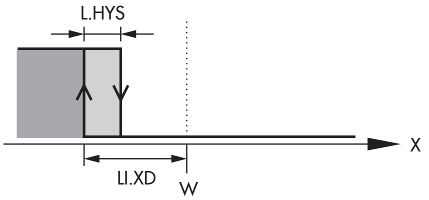
The **L1** icon for limit relay 1 and **L2** for limit relay 2 appear on the display when the limit relay is active.



Controlled variable X **lower than** the limit
-CO- LIM1: Lo L1.X
-PA- LI.X = 10.0 °C
-PA- L.HYS = 0.5 %

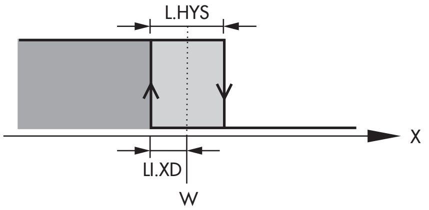
Controlled variable X **greater than** the limit
-CO- LIM1: Hi L1.X
-PA- LI.X = 90.0 °C
-PA- L.HYS = 0.5 %

Fig. 18: *Functioning of the limit relay L1 and L2 (example shows L1) – Part 1*



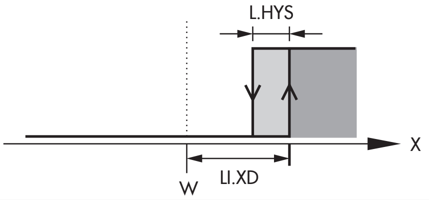
Error Xd **greater than** the limit

-CO- LIM1: Hi L1.XD
-PA- LI.XD = 1.5 %
-PA- L.HYS = 0.5 %



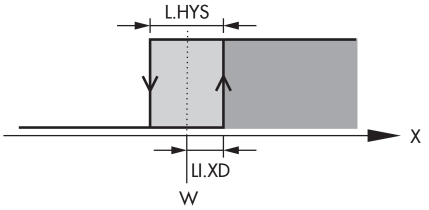
Error Xd **greater than** the limit
Application: Two-step controller for heating

-CO- LIM1: Hi L1.XD
-PA- LI.XD = 0.5 %
-PA- L.HYS = 1.0 %



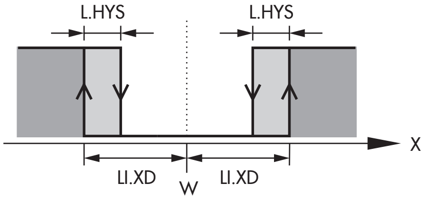
Error Xd **smaller than** the limit

-CO- LIM1: Lo L1.XD
-PA- LI.XD = −1.5 %
-PA- L.HYS = 0.5 %



Error Xd **smaller than** the limit
Application: Two-step controller for cooling

-CO- LIM1: Lo L1.XD
-PA- LI.XD = –0.5 %
-PA- L.HYS = 1.0 %



Absolute value of error Xd **greater than** the limit

-CO- LIM1: AbS L1.XD
-PA- LI.XD = 1.5 %
-PA- L.HYS = 0.5 %

Fig. 19: *Functioning of the limit relay L1 and L2 (example shows L1) – Part 2*

6.1 -CO- LIM1: Limit relay L1

This function is used to enter the variable to be monitored and the condition (violation above or below the limit) to switch the limit relay L1. A detailed description of how the limit monitoring functions can be found on page 55.

Note

The functions of two-step or three-step output -CO- C.OUT (see section 5.10) and functions for the binary outputs -CO- B.OUT (see section 5.11) have priority over the settings in functions -CO- LIM1 and -CO- LIM2.

ALRM	**-CO- LIM1**	Limit relay 1	
	oFF L1	OFF	
	Lo L1.X	When X is not reached	
	Hi L1.X	When X is exceeded	
	Lo L1.WE	When WE is not reached	
	Hi L1.WE	When WE is exceeded	
	Lo L1.YP	When YPID is not reached	
	Hi L1.YP	When YPID is exceeded	
	Lo L1.XD	When Xd is not reached	
	Hi L1.XD	When Xd is exceeded	
	AbS L1.XD	When absolute value of Xd is exceeded	

	-PA- LIM1/L1		
	LI.X	Limit for X	[⤓ IN1 … **100.0** … ⤒ IN1] [⤓ IN2 … **100.0** … ⤒ IN2]
	LI.WE	Limit for WE	[⤓ IN1 … **100.0** … ⤒ IN1] [⤓ IN2 … **100.0** … ⤒ IN2]
	LI.YP	Limit for YPID	[⤓ Y … **100.0** % … ⤒ Y]
	LI.XD	Limit for Xd	[–110.0 … **0.0** … 110.0 %]
	LI.HYS	Switching differential	[0.10 … **0.50** … 100.0 %]

6.2 -CO- LIM2: Limit relay L2

This function is used to enter the variable to be monitored and the condition (violation above or below the limit) to switch the limit relay L2. A detailed description of how the limit monitoring functions can be found on page 55.

ℹ Note

The functions of two-step or three-step output -CO- C.OUT (see section 5.10) and functions for the binary outputs -CO- B.OUT (see section 5.11) have priority over the settings in functions -CO- LIM1 and -CO- LIM2.

ALRM	**-CO- LIM2**	Limit relay 2	
	oFF L2	OFF	
	Lo L2.X	When X is not reached	
	Hi L2.X	When X is exceeded	
	Lo L2.WE	When WE is not reached	
	Hi L2.WE	When WE is exceeded	
	Lo L2.YP	When YPID is not reached	
	Hi L2.YP	When YPID is exceeded	
	Lo L2.XD	When Xd is not reached	
	Hi L2.XD	When Xd is exceeded	
	AbS L2.XD	When absolute value of Xd is exceeded	
	-PA- LIM2/L2		
	LI.X	Limit for X	[⊻ IN1 … **100.0** … ⊼ IN1] [⊻ IN2 … **100.0** … ⊼ IN2]
	LI.WE	Limit for WE	[⊻ IN1 … **100.0** … ⊼ IN1] [⊻ IN2 … **100.0** … ⊼ IN2]
	LI.YP	Limit for YPID	[⊻ Y … **100.0** % … ⊼ Y]
	LI.XD	Limit for Xd	[–110.0 … **0.0** … 110.0 %]
	LI.HYS	Switching differential	[0.10 … **0.50** … 100.0 %]

7 AUX menu: Additional functions

7.1 -CO- RE.CO: Restart conditions after power failure

This function is used to define which controller output value and operating mode is to be used after a restart due to power failure.

- **F01 MODE setting:** Manual mode with constant output value Y1K1
- **F02 MODE setting:** Automatic mode, start with output value Y1K1 and the current set point

AUX	**-CO- RE.CO**	Restart conditions after power failure	
	F01 MODE	Manual mode with constant output value Y1K1	
	F02 MODE	Auto, start with constant output value Y1K1	
	-PA- RE.CO/MODE		
	Y1K1	Constant output value	[–10.0 … **0.0** … 110.0 %]

7.2 -CO- ST.IN: Reset to default settings

➔ See ▶ EB 6493.

This function causes all parameters, functions and calibration data to be reset. After the reset, "FrEE INIT" appears on the display.

AUX	**-CO- ST.IN**	Reset to default settings
	FrEE INIT	OFF
	All INIT	All functions, parameters and code number
	FUnC INIT	All functions
	PArA INIT	All parameters and code number
	AdJ INIT	Calibration values for IN1, IN2, Y

7.3 -CO- KEYL: Lock control keys

The keys can be locked:

- **bi1 LOCK setting:** Locks all keys over the binary input BI
- **on noH.W setting:** the ⇆, ✋, △ and ▽ keys are locked. The controller remains in the operating mode that it was in before the keys were locked.

AUX	**-CO- KEYL**	Lock control keys
	oFF LOCK	OFF
	bi1 LOCK	Activate/deactivate over the binary input BI1
	on noH.W	Selector, manual/automatic and cursor keys OFF

i *Note*

Several functions can be assigned to the binary input (see section 1).

7.4 -CO- VIEW: Top/bottom viewing angle of display

The contrast for the top and bottom viewing angle of the display can be changed from Level 1 to Level 10.
The default setting (Level 6) only needs to be changed in extreme installation situations.

AUX	**-CO- VIEW**	Top/bottom viewing angle of display
	01 VIEW	Level 1
	…	…
	06 VIEW	Level 6
	…	…
	10 VIEW	Level 10

7.5 -CO- FREQ: Power line frequency (ripple filter)

This function is used to filter out the supply voltage hum of 50 Hz or 60 Hz superimposed on the analog input signals. For this purpose, the power line frequency of a low-voltage system must be set at the controller. The power line frequency must be set even when the controller is operated with DC voltage.

AUX	**-CO- FREQ**	Power line frequency
	on 50Hz	50 Hz
	on 60Hz	60 Hz

7.6 -CO- DP: Decimal separator setting

This function is used to set the number of decimal places for the controlled variable and set point readings.
Additionally, the decimal places for parameters directly related to the analog inputs can be changed with this function. These parameters include:

- Measuring ranges of the analog inputs
- Function generation of input variables X and WE
- Limits LI.X and LI.WE for limit monitoring of input variables X and WE

The number of decimal places is automatically reduced if the measured value (parameter value) is so high that it cannot be displayed with the decimal separator settings. The number of decimal places increase again to the configured decimal separator setting when the measured value (parameter value) falls.

AUX	**-CO- DP**	Decimal separator setting
	on DP1	No digit
	on DP2	One digit
	on DP3	Two digits

8 TUNE menu: Start-up adaptation

-CO- TUNE: Start-up adaptation

➔ ▶ EB 6493.

The purpose of the adaptation is to quickly determine the best settings for the control parameters KP, TN and TV with minimum knowledge of the process to be controlled.

TUNE	**-CO- ADAP**	Adaptation	
	oFF ADP.S	OFF	
	run ADP.S	Start	
	-PA- ADAP		
	KP	Proportional-action coefficient	[0.1 … **1.0** … 100.0]
	TN	Reset time	[1 … **120** … 9999 s]
	TV	Derivative-action time	[1 … **10** … 9999 s]
	Y.JMP	Step-change value for adaptation	[–100.0 … **20.0** … 100.0 %]

9 I-O menu: Process data

➔ ▶ EB 6493.

You can read various variables and data in this menu. In addition, you can calibrate zero and span for the analog inputs IN1 and IN2 as well as the analog output Y.

9.1 -CO- CIN: Firmware version

Read the firmware version

I-O	**-CO- CIN**	Firmware version

9.2 -CO- S-No: Serial number

Read the serial number

I-O	**-CO- S-No**	Serial number

9.3 -CO- ANA: Show analog inputs and outputs

The analog values are shown in this function.

I-O	**-CO- ANA**	Analog values
	IN1	Analog input IN1
	IN2	Analog input IN2
	CO.VA	Controlled variable before function generation
	WE.VA	WE before function generation
	FE.CO	WE after function generation
	SP.CO	Set point at comparator
	YPID	YPID after limitation
	YOUT	Analog output

9.4 -CO- BIN: Show binary inputs and outputs

The states of the binary input and the binary outputs are shown in this function

I-O	**-CO- BIN**	Binary values
	BI1	Binary input BI
	BO1	Binary output BO1
	BO2	Binary output BO2

9.5 -CO- ADJ: Calibration of analog inputs and analog output

➔ ▶ EB 6493.

This functions allows you to calibrate the zero and span for the analog inputs and analog output.
The analog inputs and analog output are factory-calibrated.

I-O	**-CO- ADJ**	Calibration
	AdJ IN1	Analog input IN1
	AdJ IN2	Analog input IN2
	AdJ YOUT	Analog output

10 Sample applications

10.1 Temperature control

Sample application 1: Flow temperature control of a heat exchanger (fixed set point control with Pt 100 input and mA output)

The controller receives the flow temperature (T) in the secondary circuit from a resistance thermometer (Pt 100) at the input IN2. It issues a 4 to 20 mA signal at output Y to position the valve in the primary circuit to keep the flow temperature constant to 50 °C.

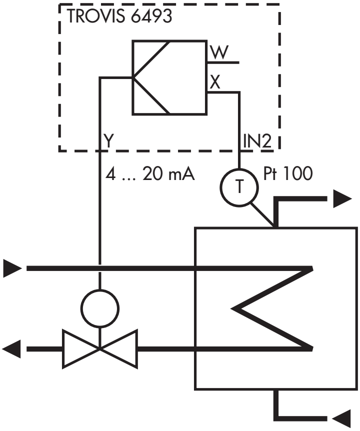


Fig. 21: *Temperature control · Sample application 1*

Based on the default settings, only the settings marked with → need to be changed.

		PAR		
Proportional-action coefficient (specific to plant)	→	-PA-	KP	= 1.0
Reset time (specific to plant)	→		TN	= 120 s
		IN		
Input IN2: Input signal Pt 100		-CO-	IN2	= 100 PT
Input IN2: Lower measuring range value 0 °C		-PA-	⊻ IN2	= 0.0 °C
Input IN2: Upper measuring range value 100 °C			⌅ IN2	= 100.0 °C
Input variable X: Input IN2		-CO-	CLAS	= In2 X

	SETP		
	-CO-	SP.VA	= on W
Internal set point: 50 °C →	-PA-	W	= 50 °C
	CNTR		
Control mode: PI	-CO-	C.PID	= PI CP.YP
Operating direction: Increasing	-CO-	DIRE	= dir.d DI.AC
	OUT		
Output signal Y: 4 – 20 mA	-CO-	Y.VA	= 4–20 mA
	AUX		
Restart conditions after power failure: in automatic mode	-CO-	RE.CO	= F02 MODE
Start value of output variable Y		Y1K1	= 0.0 %

Sample application 2:
Flow temperature control of a heat exchanger
(fixed set point control with Pt 100 input and three-step output)

The controller receives the flow temperature (T) in the secondary circuit from a resistance thermometer (Pt 100) at the input IN2. It issues a three-step signal to position the valve in the primary circuit to keep the flow temperature constant to 50 °C.

The transit time of the electric actuator is 120 s.

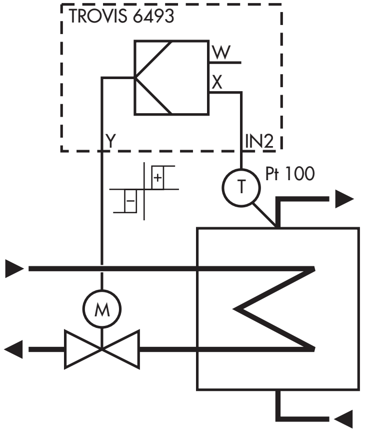


Fig. 22: *Temperature control · Sample application 2*

Based on the default settings, only the settings marked with ➞ need to be changed.

		PAR		
Proportional-action coefficient (specific to plant)	➞	-PA-	KP	= 1.0
Reset time (specific to plant)	➞		TN	= 120 s
		IN		
Input IN2: Input signal Pt 100		-CO-	IN2	= 100 PT
Input IN2: Lower measuring range value 0 °C		-PA-	⊻ IN2	= 0.0 °C
Input IN2: Upper measuring range value 100 °C			⊼ IN2	= 100.0 °C
Input variable X: Input IN2		-CO-	CLAS	= In2 X
		SETP		
		-CO-	SP.VA	= on W
Internal set point: 50 °C	➞	-PA-	W	= 50 °C
		CNTR		
Control mode: PI		-CO-	C.PID	= PI CP.YP
Operating direction: Increasing		-CO-	DIRE	= dir.d DI.AC
		OUT		
Three-step output with internal feedback	➞	-CO-	C.OUT	= i.Fb 3.STP
Switching differential		-PA-	XSDY	= 0.5 %
Dead band			Surcharge	= 2.0 %
Actuator transit time	➞		TY	= 120 s
		AUX		
Restart conditions after power failure: in automatic mode		-CO-	RE.CO	= F02 MODE
Start value of output variable Y			Y1K1	= 0.0 %

Variation on sample application 2:

If the measured temperature at the analog output is to be issued as a 4 to 20 mA signal, the following settings need to be changed.

		OUT		
Output signal Y: 4 – 20 mA		-CO-	Y.VA	= 4–20 mA
Assign output to the input variable X	➞		Y.SRC	= on Y.X

Sample application 3: Flow temperature control of a heat exchanger based on the outdoor temperature (follow-up control with Pt 100 input and three-step output)

The controller receives the flow temperature (T2) in the secondary circuit from a resistance thermometer (Pt 100) at the input AI2. It issues a three-step signal to position the valve in the primary circuit to keep the flow temperature constant.

In outdoor-temperature-compensated control, the set point is determined by the outdoor temperature. In this case, the outdoor temperature T1 is measured by a resistance thermometer Pt 100 at input AI1 and assigned to the input variable WE. The function generation of the input variable WE is used to calculate the set point for flow temperature based on the outdoor temperature.

	1	2	3	4	5	6	7
Outdoor temperature T1 in °C	–20.0	5.0	25.0	25.0	25.0	25.0	25.0
Set point for T2 in °C	80.0	50.0	20.0	25.0	25.0	25.0	25.0

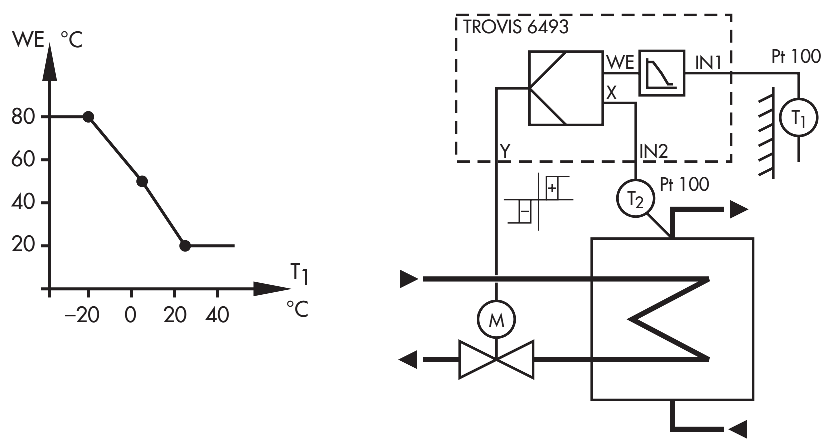


Fig. 23: *Temperature control · Sample application 3*

Based on the default settings, only the settings marked with → need to be changed.

		PAR		
Proportional-action coefficient (specific to plant)	→	-PA-	KP	= 1.0
Reset time (specific to plant)	→		TN	= 120 s

		IN		
Input IN1: Input signal Pt 100	→	-CO-	IN1	= 100 PT
Input IN1: Lower measuring range value 0 °C		-PA-	⊻ IN1	= 0.0 °C
Input IN1: Upper measuring range value 100 °C			⊼ IN1	= 100.0 °C
Input IN2: Input signal Pt 100		-CO-	IN2	= 100 PT
Input IN2: Lower measuring range value 0 °C		-PA-	⊻ IN2	= 0.0 °C
Input IN2: Upper measuring range value 100 °C			⊼ IN2	= 100.0 °C
Input variable X: Input IN2		-CO-	CLAS	= In2 X
Input variable WE: Input IN1				= In1 WE
Function generation input variable WE	→	-CO-	FUNC	= on WE
Lower range value of the output signal		-PA-	MIN	= 0.0 °C
Upper range value of the output signal		-PA-	MAX	= 100.0 °C
Input value 1	→	-PA-	K1.X	= –20.0 °C
Output value 1	→	-PA-	K1.Y	= 80.0 °C
Input value 2	→	-PA-	K2.X	= 5.0 °C
Output value 2	→	-PA-	K2.Y	= 50.0 °C
Input value 3	→	-PA-	K3.X	= 25.0 °C
Output value 3	→	-PA-	K3.Y	= 20.0 °C
Input value 4	→	-PA-	K4.X	= 25.0 °C
Output value 4	→	-PA-	K4.Y	= 20.0 °C
Input value 5	→	-PA-	K5.X	= 25.0 °C
Output value 5	→	-PA-	K5.Y	= 20.0 °C
Input value 6	→	-PA-	K6.X	= 25.0 °C
Output value 6	→	-PA-	K6.Y	= 20.0 °C
Input value 7	→	-PA-	K7.X	= 25.0 °C
Output value 7	→	-PA-	K7.Y	= 20.0 °C
		SETP		
		-CO-	SP.VA	= on W
Internal set point: 25 °C	→	-PA-	W	= 25 °C
Enable external set point WE	→	-CO-	SP.VA	= on WE
		CNTR		
Control mode: PI		-CO-	C.PID	= PI CP.YP
Operating direction: Increasing		-CO-	DIRE	= dir.d DI.AC

	OUT		
Three-step output with internal feedback →	-CO-	C.OUT	= i.Fb 3.STP
Switching differential	-PA-	XSDY	= 0.5 %
Dead band		Surcharge	= 2.0 %
Actuator transit time →		TY	= 120 s
	AUX		
Restart conditions after power failure: in automatic mode	-CO-	RE.CO	= F02 MODE
Start value of output variable Y		Y1K1	= 0.0 %

Activate the external set point WE in the operating level:

1. Press ⇅ until 'WE' appears on the display (WE blinks).
2. Press ☐ and activate WE (WE stops blinking).

10.2 Pressure control

Sample application 4:
Pressure control
(fixed set point control with mA input and mA output)

The controller receives the pressure downstream of the control valve as a 4 to 20 mA signal from a transmitter at the input IN1. It issues a 4 to 20 mA signal at the output Y to position the valve to keep the pressure constant to 6 bar. The measuring range of the transmitter is 0 to 10 bar.

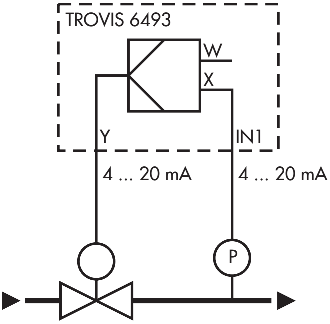


Fig. 24: *Pressure control · Sample application 4*

Based on the default settings, only the settings marked with → need to be changed.

		PAR		
Proportional-action coefficient (specific to plant)	→	-PA-	KP	= 1.0
Reset time (specific to plant)	→		TN	= 10 s
		IN		
Input IN1: Input signal 4 to 20 mA		-CO-	IN1	= 4–20 mA
Input IN1: Lower measuring range value 0 bar		-PA-	⊻ IN1	= 0 bar
Input IN1: Upper measuring range value 10 bar	→		⊼ IN1	= 10 bar
Input variable X: Input IN1	→	-CO-	CLAS	= In1 X
		SETP		
		-CO-	SP.VA	= on W
Internal set point: 6 bar	→	-PA-	W	= 6 bar
		CNTR		
Control mode: PI		-CO-	C.PID	= PI CP.YP
Operating direction: Increasing		-CO-	DIRE	= dir.d DI.AC
		OUT		
Output signal Y: 4 to 20 mA		-CO-	Y.VA	= 4–20 mA
		AUX		
Restart conditions after power failure: in automatic mode		-CO-	RE.CO	= F02 MODE
Start value of output variable Y			Y1K1	= 0.0 %

Sample application 5:
Pressure control
(follow-up control with mA input and mA output)

The controller receives the pressure downstream of the control valve as a 4 to 20 mA signal from a transmitter at the input IN1. It issues a 4 to 20 mA signal at the output Y to position the valve to keep the pressure constant. The external set point is issued as a 4 to 20 mA signal.

The measuring range of the transmitter is 0 to 10 bar.

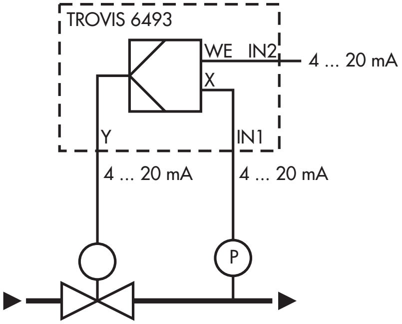


Fig. 25: *Pressure control · Sample application 5*

Based on the default settings, only the settings marked with → need to be changed.

		PAR		
Proportional-action coefficient (specific to plant)	→	-PA-	KP	= 1.0
Reset time (specific to plant)	→		TN	= 10 s
		IN		
Input IN1: Input signal 4 to 20 mA		-CO-	IN1	= 4–20 mA
Input IN1: Lower measuring range value 0 bar		-PA-	⊻ IN1	= 0 bar
Input IN1: Upper measuring range value 10 bar	→		⊼ IN1	= 10 bar
Input IN2: Input signal 4 to 20 mA		-CO-	IN2	= 4–20 mA
Input IN2: Lower measuring range value 0 bar			⊻ IN2	= 0 bar
Input IN2: Upper measuring range value 10 bar	→		⊼ IN2	= 10 bar
Input variable X: Input IN1	→	-CO-	CLAS	= In1 X
Input variable WE: Input IN2				= In2 WE
		SETP		
		-CO-	SP.VA	= on W
Internal set point: 6 bar	→	-PA-	W	= 6 bar
Enable external set point WE	→	-CO-	SP.VA	= on WE
		CNTR		
Control mode: PI		-CO-	C.PID	= PI CP.YP
Operating direction: Increasing		-CO-	DIRE	= dir.d DI.AC

	OUT		
Output signal Y: 4 to 20 mA	-CO-	Y.VA	= 4–20 mA
	AUX		
Restart conditions after power failure: in automatic mode	-CO-	RE.CO	= F02 MODE
Start value of output variable Y		Y1K1	= 0.0 %

Activate the external set point WE in the operating level:

1. Press ⇅ until 'WE' appears on the display (WE blinks).
2. Press ☐ and activate WE (WE stops blinking).

10.3 Abbreviations

X	Controlled variable
Y	Output variable
W	Internal set point (reference variable)
W2	Internal set point (reference variable)
WE	External set point (reference variable), feedforward control input value, external position feedback
Xd	Error
⤓	Minimum value of a variable
⤒	Maximum value of a variable

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