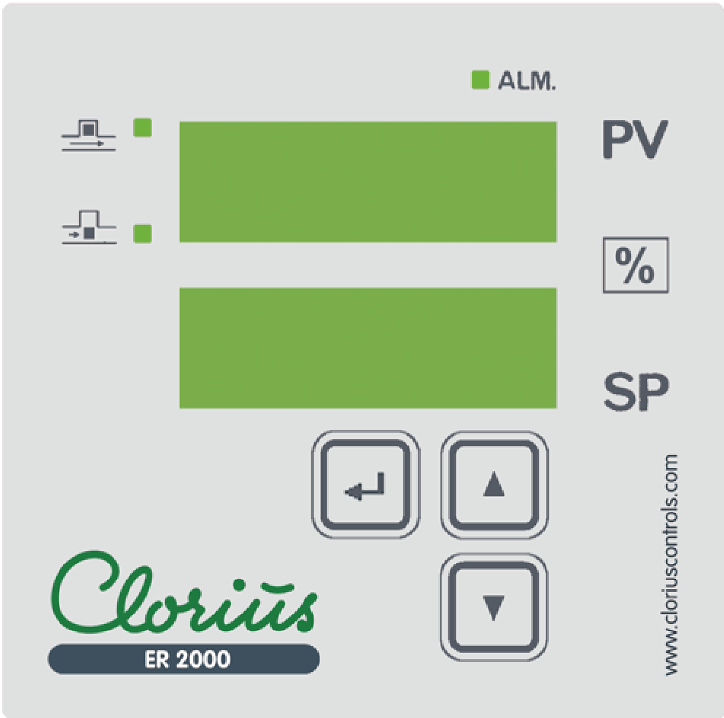
99.46.07-A
GB

ER 2000 Pressure

Operating Instruction

Microprocessor-based controller ER 2000 Pressure
Universal three-position step controller

Industrial controller with special PID step controller algorithm



- Compact design 96mm x 96mm x 135mm
- Easy operation
- User-defined operating level
- Digital displays for process variable and setpoint
- Control structure PI and PID
- Two-position control
- Three-position control
- Setpoint ramp
- Robust self-optimization
- Measurement input 4-20 mA
- Serial interface
- Alarm functions
- Control via digital inputs
- Manual/automatic switch over
- Degree of protection Front IP 65
- Semiconductor memory for data protection
- Plug-type terminal

Subject to changes without notice.

⚠ **Warning:**
When operating electrical equipment, certain parts of this equipment automatically carry dangerous voltages. Failure to observe these instructions could therefore lead to serious injury or material damage. Therefore the warning notes included in the following sections of these operating instructions must be observed accordingly. Persons working with this unit must be properly qualified and familiar with the contents of these operating instructions.
Perfect reliable operation of this unit presupposes suitable transport including proper storage, installation and operation.

Contents

1. Function overview

Basic device

Analog input 4-20 mA	Analog input for the process variable PV.
Relay OPEN	Controller output OPEN: opens the actuator.
Relay CLOSE	Controller output CLOSE: closes the actuator.
Relay ALARM	Alarm relay operates on the base of the idle current principle.

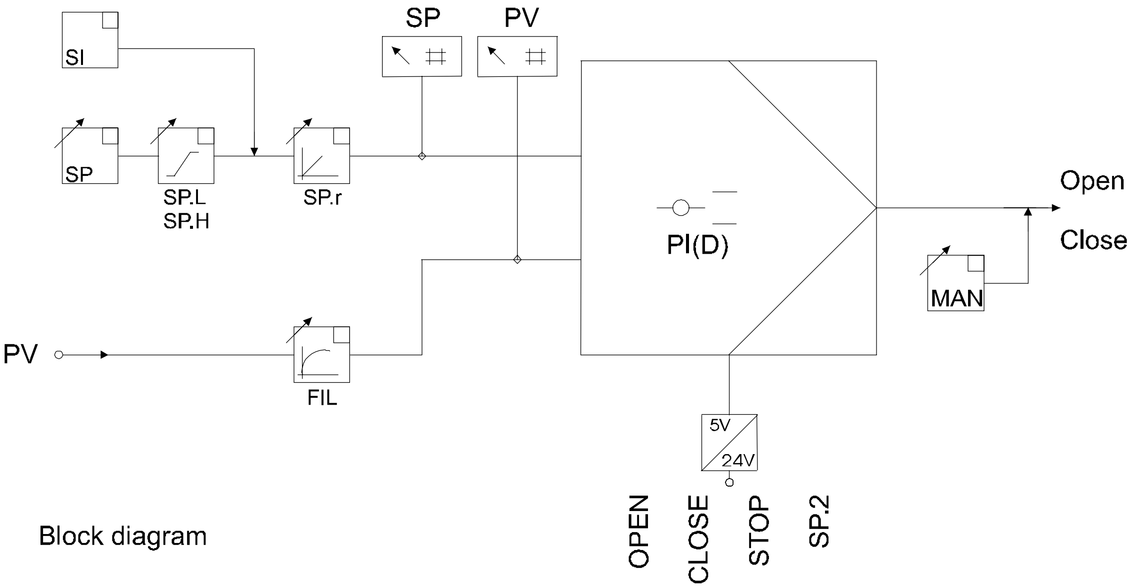
Additional functions

Serial interface RS 485	Data transfer in accordance with modbus protocol
Supply voltage 24 V DC	For the 24 V DC digital input

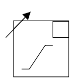
The digital input (terminal 11) is definable to one of these functions by software:

Digital input OPEN	Actuator opens ...	} not in manual mode
Digital input CLOSE	Actuator closes ...	} not in manual mode
Digital input STOP	Actuator persists in its current position ...	} not in manual mode
Digital input SP.2	To switch over to the second setpoint SP.2 ...	

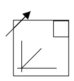
... if connecting 24 V DC (active state) to the appropriate digital input.
Priority: 1. STOP (highest priority) 2. CLOSE 3. OPEN 4. SP.2



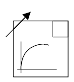
Block diagram



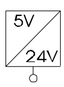
Setpoint limiting. Minimum value SP.L (setpoint low), maximum value SP.H (setpoint high). Only setpoints within the setpoint limiting can be set via keyboard.



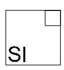
Setpoint ramp SP.r. Setpoint change per minute or hour (gradient). Can be specified for internal and external setpoints by the setpoint ramp.



Filtering FIL of the process variable input PV. Interference signals and small fluctuations of the process variable PV can be smoothed by an adjustable software filter.



Digital inputs, voltage range 0/12-24 V DC.



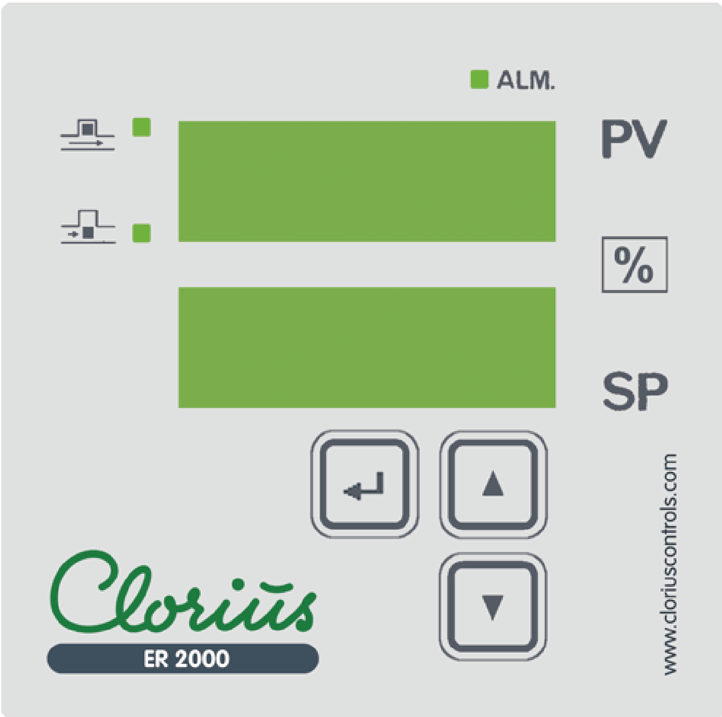
Serial interface RS 485 (modbus, RTU-mode).

2. Operating and setting

Operating level:

Actuator opens

Actuator closes



Alarm

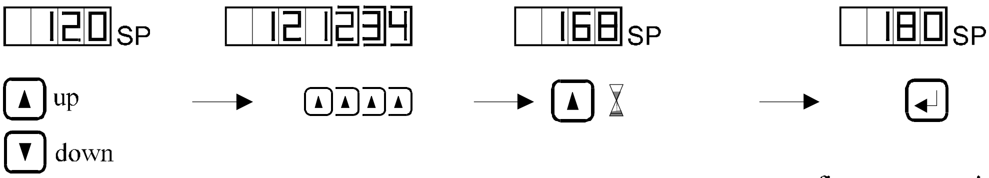
Process variable display

Setpoint display with actual status display for:

StOP = STOP DI active
CLOS = CLOSE DI active
OPEn = OPEN DI active
tunE = optimization running
rAMP = Setpoint ramp running
SP_2 = Second setpoint active

If one of the digital inputs is active, the SP display is alternating between the actual DI-state with the highest priority and the actual setpoint.
StOP has got the highest priority and SP_2 the lowest priority.

2.1 Setting setpoint in automatic mode



up

down

change by individual steps

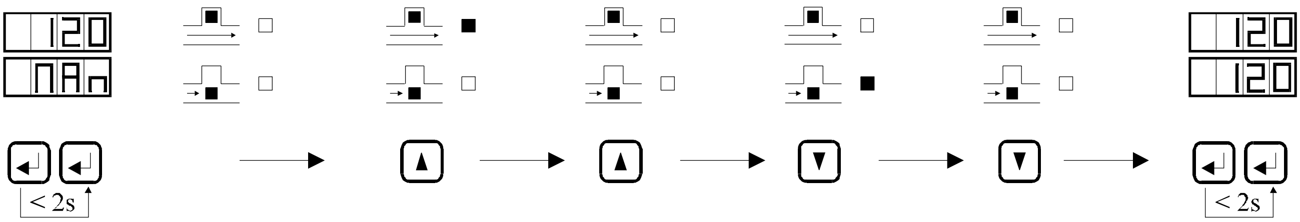
Continuous change with increasing speed

confirm new setpoint within 5s, otherwise the previous, still effective setpoint will be set automatically.

= press continuously

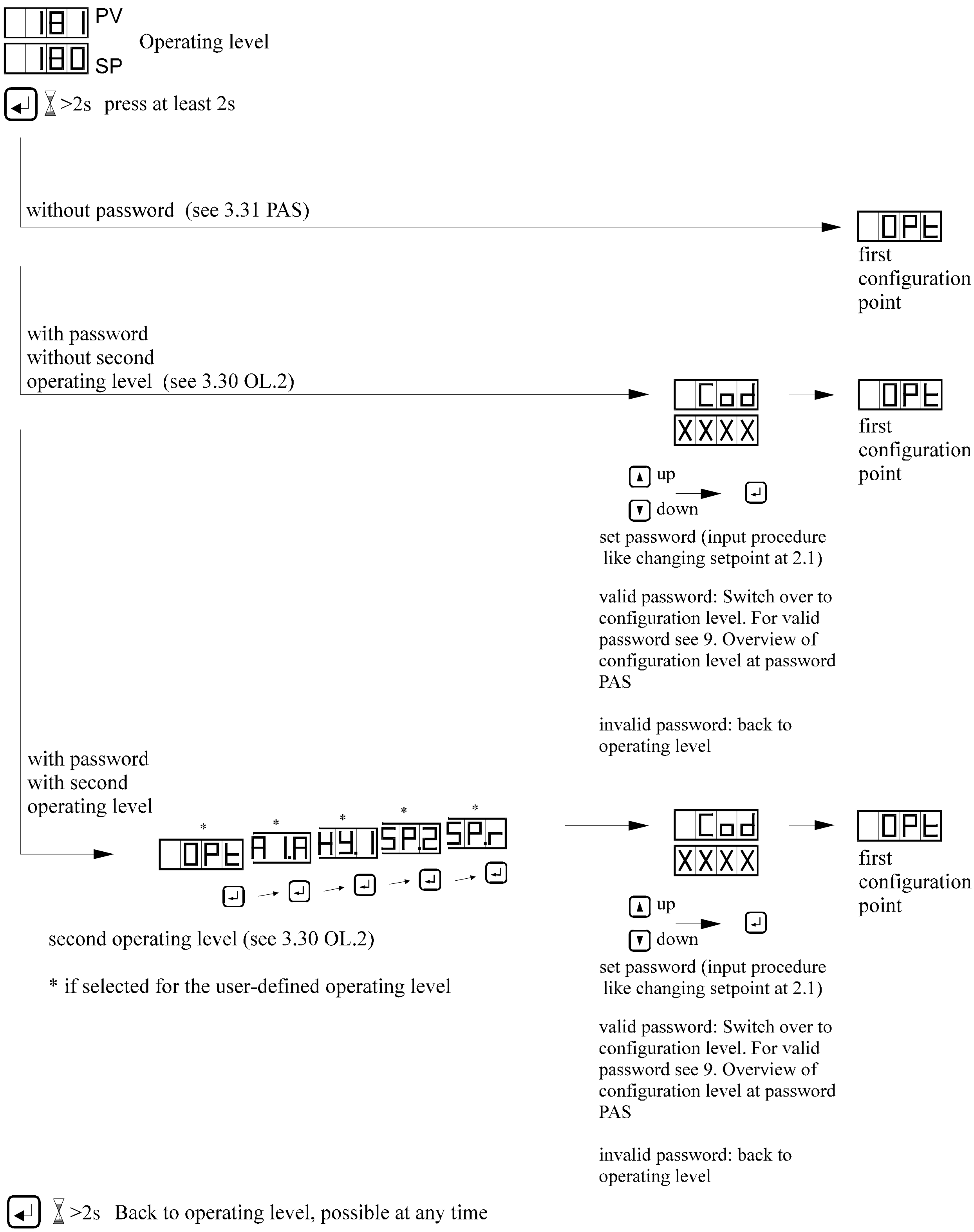
Setting range: SP.L to SP.H
Fixed, if SP.2 is activated or S.C = 1

2.2 Opening/closing actuator in manual mode



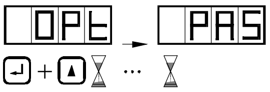
Switch over to manual mode (lockable)	actuator stops	actuator opens	actuator stops	actuator closes	actuator stops	Switch over to automatic mode (lockable)

2.3 Switch over to configuration level

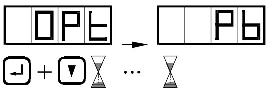


2.4 Changing the scrolling direction for configuration points

In the second operating level as well as in the configuration level it's possible to inverse the scrolling direction. The forward scrolling direction mode is set with every power off-power on.
The selected scrolling mode is valid as long as it is not changed or after a power off-power on.



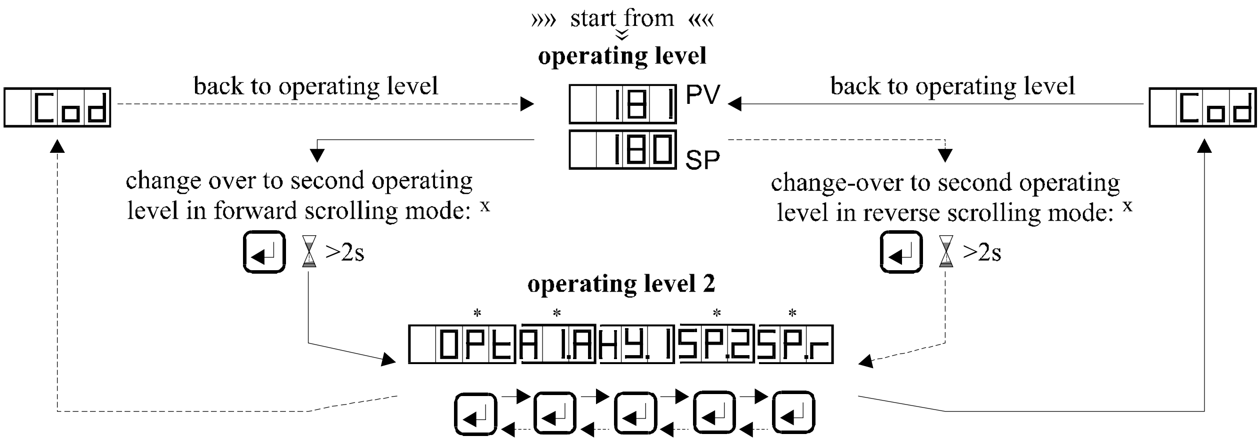
To switch to the reverse scrolling direction mode, hold down the ↵ - key and the ▲ - key until the previous configuration point is displayed. Now, scrolling inside the configuration level works in reverse mode.



To switch to the forward scrolling direction mode, hold down the ↵ - key and the ▼ - key until the next configuration point is displayed. Now, scrolling inside the configuration level works in forward mode.

2.5 Switch over to second operating level (user-defined operating level)

How to switch over from the operating level to the second operating level is described in the following diagram. Which configuration point of the second operating level (OPt or SP.r) will be called up first depends on the selected scrolling mode x.
Configuration points that have been selected for the second operating level (see 3.30 OL.2) can be called up and set without entering the password. In case access to the configuration level is protected by a password, see 3.31 PAS.

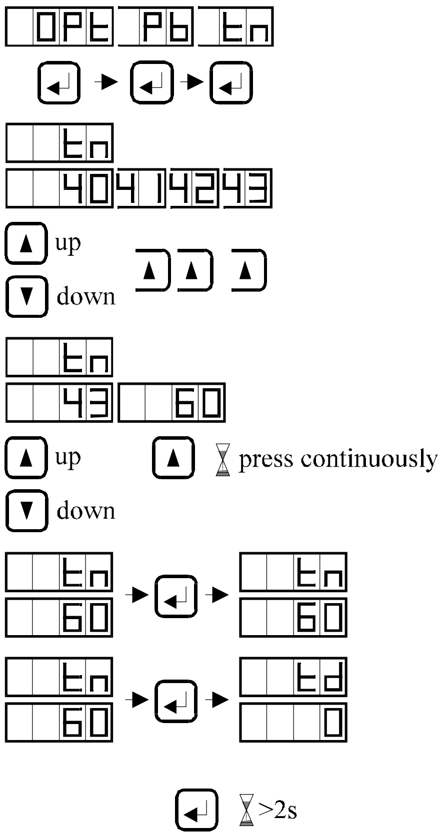


* if this function has been selected for the user-defined operating level and the access to the configuration level has been interlocked by the password.
x to change the scrolling direction see 2.4.

For the second operating level one of the following settings can be adjusted:

- optimization OPt
- alarm (i.e. A1, HY.1)
- serial communication S.C
- second setpoint SP.2
- setpoint ramp SP.r

2.6 Setting configuration points



1 Select configuration point

▼

2a Set new value by change in individual steps and...

▼

2b Set new value by continuous change with increasing speed and...

▼

3 ...confirm new value within 5s, otherwise the previous, still effective value (at start of the input procedure) will be set automatically.

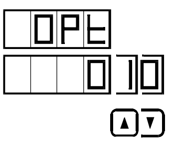
▼

4 After the new value has been set press ↵ to call up the next configuration point

Back to operating level, possible at any time

3. Configuration level

Access to this level see 2.3. To switch to the next/previous point (depending on the scrolling direction mode) press the ↵ -key. Inside the configuration level it's not possible to switch over to the manual mode.



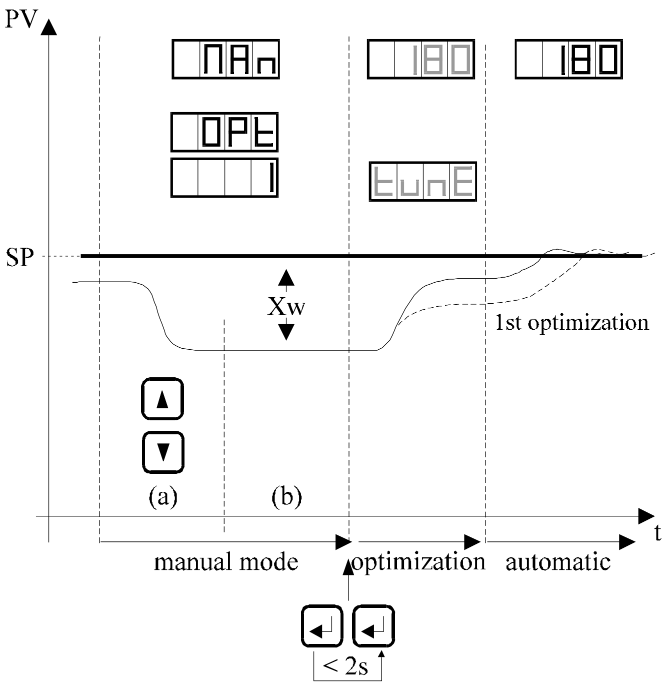
3.1 Optimization for automatic determination of favourable control parameters.

Selections: 0 No optimization
1 optimization activated

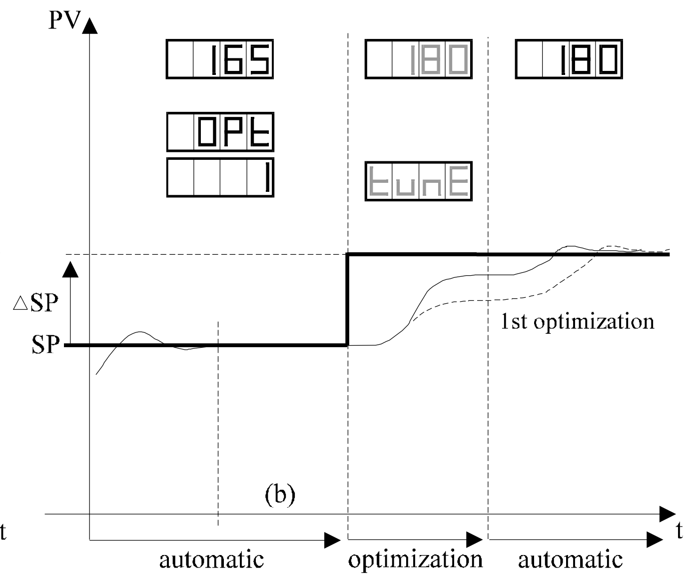
Optimization is triggered by:

- manual mode: pressing the manual/automatic switch
- automatic mode: changing the setpoint SP

When **tunE** is shown cyclically in the setpoint display SP, the optimization process is running.



optimization from manual mode



optimization from automatic mode

Procedure of optimization:

- Set target setpoint SP
- Switch to manual mode
- By opening/closing the actuator, the actual value PV is set on a higher/lower value than the target setpoint (a)
- Wait until PV is in a stable state (b)
- Switch over to configuration level
- Set "OPt = 1"
- To optimize a PI-controller set derivation action time "td = 0"; to optimize a PID-controller set "td ≠0"
- If known, set process gain "P.G" (usual setting: P.G = 100%)
- Back to operating mode
- Switch over to automatic mode, thereby optimization is started ("tunE" starts flashing, actuator changes)
- During the optimization process no inputs or switch overs are tolerated
- Wait until the optimization is finished (flashing "tunE" goes out, controller works in automatic mode now)
- Switch over to configuration level to show the control parameters "Pb", "tn" and "td" that where calculated by the optimization. Also the process gain P.G has been calculated again, "OPt" got set back to "0" automatically
- In case it was the first optimization process, better results are available by another optimization run (because of the processs gain P.G, already calculated during the first run)

- Set initial setpoint SP
- Wait until PV is in a stable state (b)
- Switch over to configuration level
- Set "OPt = 1"
- To optimize a PI-controller set derivation action time "td = 0"; to optimize a PID-controller set "td ≠0"
- If known, set process gain "P.G" (usual setting: P.G = 100%)
- Back to operating mode
- Set the target setpoint SP, thereby optimization is started ("tunE" starts flashing, actuator changes)
- During the optimization process no inputs or switch overs are tolerated
- Wait until the optimization process is finished (flashing "tunE" goes out, controller works in automatic mode now)
- Switch over to configuration level to show the control parameters "Pb", "tn" and "td" that where calculated by the optimization. Also the process gain P.G has been calculated again, "OPt" got set back to "0" automatically
- In case it was the first optimization process, better results are available by another optimization run (because of the processs gain P.G, already calculated during the first run)

Problems/solutions with optimization

1. Setting “OPt = 1” is not possible

Possible reasons:

a) Digital input (OPEN, CLOSE, STOP) is active
Solution: deactivate the digital input or take it out of the configuration level

b) Sensor doesn’t work (display “Err”)
Solution: make sure there is a valid actual value PV (check measuring lines and sensor)

2. Optimization does not start (no flashing “tunE”)

By switching from manual to automatic mode or changing the setpoint in the automatic mode, the optimization is not started like usually expected (no flashing “tunE”).

Possible reasons:

a) In the configuration level the “OPt” setting is not “1” (anymore). “OPt = 0” is set automatically when:
- optimization is finished (flashing “tunE” goes out)
- a digital input (OPEN, CLOSE, STOP) is still active or was active for a short moment
- actual sensor failure or sensor failure for a short moment in the past

Solution: Set “OPt = 1”, deactivate digital input (OPEN, CLOSE, STOP) if needed or remove sensor failure (see 1a, 1b). Try again.

b) Digital input SP2 is active. Optimization with or on SP2 is impossible.
Solution: deactivate digital input or take it out of the configuration level.

c) The control error between actual value and target setpoint is less than 3.125% of the entire measuring range.
Solution: Magnify the difference between actual value and target setpoint up to at least 3.125% of the measuring range before starting the optimization (the bigger the deviations the better the optimization results, see also 6a, 6b). When optimizing from manual mode, the actuator has to be changed as long as the difference between actual value and target setpoint is big enough. When optimizing from automatic mode, an initial setpoint, which has got the necessary difference to the target setpoint, has to be defined.

d) A modbus RAM-setpoint is used. Optimization with or on the modbus RAM-setpoint is impossible.
Solution: deactivate the RAM-setpoint via the modbus (see "Modbus documentation").

3. Target setpoint is not reached during the optimization

Immediately after the optimization is finished (flashing “tunE” goes out) the actual value is not close to the target setpoint. To get really good optimization results it’s recommendable to reach for the target setpoint as exactly as possible at the end of the optimization.

Possible reasons:

a) The process gain P.G, defined before starting the optimization, doesn't correspond to the actual process gain P.G of the process. Frequently this happens during the first optimization when the process gain P.G is still set to the usual value = 100%.
Solution: Restart optimization. The setpoint value will be reached more exactly this time, because the process gain P.G, which was also calculated during the previous optimization process, is used as a base of the following optimization process. If the process gain is known or measured it can be set manually already before starting the first optimization run.
Measuring the process gain P.G in manual mode:
Change the actuator about a fixed rate (ΔY in %) and determine the given change of the actual value ΔPV. Then the process gain can be calculated by: P.G = (ΔPV/ΔY) * 100%. If the controlled system has got a linear behaviour, the process gain is constant all over the entire control range.
I.e.: The actuator is changed from 30% to 70% $\rightarrow$ ΔY = 40%, thereby the actual value rises from 0,5 - 1,1 bar, ΔP = 0,6 bar. At a measuring range 0 - 3 bar it corresponds to the change of the actual value ΔPV = 20%. The process gain P.G. can be calculated then by: P.G = (20% / 40%) * 100% = 50%.
Dependent on the process gain the controller calculates the necessary change of the actuator at start of the optimization for reaching the target setpoint at the end of the optimization.
Therefore a small process gain P.G causes a bigger change of the actuator instead of a bigger process gain.
If the pressure rises up to a not permitted high value, it could be necessary to cancel the optimization (see also 5.).

b) In non-linear controlled systems, even by proceeding a following optimization, the target setpoint might not be reached exactly enough.
Solution: In this case let the optimization run a couple times until the target setpoint is reached exactly enough. The process gain will be defined then by an iterative method, what means, with every run the process gain comes closer to the actual process gain.
In non-linear controlled systems for different sub-ranges within there'll be optimized, different optimization results will be created. Therefore it's necessary to determine the most important range for the control which should be optimized.
If all ranges do have the same importance we recommend you to optimize the sub-range with the slowest time behaviour (see also 6.a) and 6.b)).

c) The prime pressure is not sufficient to reach the target setpoint.
Solution: Increase prime pressure or chose a target setpoint that will be reached definitely.

d) The actuator doesn't move to the new position given by the controller.
Solution: Check function of the actuator and its control.

4. The optimization "doesn't" finish or just after 42 minutes respectively

The maximum time of optimization is limited up to 42 minutes. In case that the conditions to finish the optimization are not given even after 42 minutes, the optimization process will be cancelled automatically.

Possible reasons:

a) The limited time of 42 minutes for optimization might be too short for several, very slow processes.
Solution: Switch over to the configuration level just before the 42 minutes are elapsed and change the setting "OPt = 1" to "OPt = 0". Therefore the optimization is cancelled manually and the control parameters will be recalculated.

b) At processes with no stable state (drift) finishing the optimization after 42 minutes is possible just as a later ending.
Solution: The movement of the actual value has to be observed to recognize the approximate end of the settling. Then the optimization can be finished manually with recalculating of the control parameters by switching over to the configuration level and setting "OPt = 0". If there's a drift before starting the optimization, you have to watch out (optimization from manual mode) that the optimization is not started too late after the proper stabilization of the actual value because of the drift.

c) The change of the actual value ΔPV at the beginning of the optimization, arose from the change of the manipulated variable, is so small that the recognition of the end of the optimization is not working yet.
The change of the actual value ΔPV, arose from the optimization, has to be at least a quarter of the difference between target setpoint and actual value at beginning of the optimization so that the optimization can be finished automatically.
I.e. actual value at start of the optimization = 0,6 bar, target setpoint = 1,0 bar, that means there's a difference of ΔP = 0,4 bar. A quarter of that is 0,4 bar $\rightarrow$ the actual value has to be at least 0,6 bar + 0,1bar = 0,7 bar until the optimization can be finished automatically.
This can happen when a bad process gain is defined which causes that the target setpoint will not be reached (see also 3a) and 3b)).
Solution: cancel the optimization manually (see 5.), reduce the process gain P.G in the configuration level (e.g. half), restart the optimization. Instead of cancelling the optimization it can also be finished manually including a recalculation of

control parameters and process gain: switch over to the configuration level and change the setting “OPt = 1” to “OPt = 0”. Restart optimization.

5. The optimization is/shall be cancelled precocious

An already started optimization (flashing “tunE”) shall be cancelled without recalculating the control parameters.
This can happen when the pressure rises much higher than the tolerated limit during the optimization.
After a cancel (possibilities, see below) the process gain P.G can be magnified manually to get a smoother change of pressure within the next optimization (see also 3a) and b)).

Possibilities/reasons for cancelling the optimization:

a) activating manual mode (double click return key)
b) setting setpoint once more → open the setpoint input via the scroll keys and set a new or the previous setpoint. Confirm within 5s (return-key)
c) activating a digital input (OPEN, CLOSE, STOP, SP2)
d) activating the modbus RAM-setpoint (see "Modbus documentation")

6. The optimization results are not satisfying

Possible reasons:

a) The optimization didn’t run within the range the relevant control is working later. I.e. the range between 0,6 bar and 0,8 bar was optimized, but the following relevant control will be a change of the setpoint from 0,5 to 1 bar.
Solution: Chose the same target setpoint for the optimization as the target setpoint used for the following control (belongs to example 1,0 bar). At start of the optimization the actual value should be the same like the initial setpoint of the control (belongs to example 0,5 bar; see also 2c)).
b) Processes with strongly different time behaviour (e.g. fast pressure rise) where the change of the actual value during the optimization worked reverse to the following control.
I.e. optimization from 1 to 0,5 bar but the following relevant control from 0,5 to 1 bar.
Solution: If possible, optimize in the same direction the following relevant control is working. If it has to be controlled in both directions, the more important direction has to be optimized. Do both directions have the same relevance, the slower process has to be optimized.
c) The actual value hasn’t been in a stable state before starting the optimization.
Solution: Wait as long as the actual value is in a stable state before starting the optimization. If the actual value can’t get stabilized in the automatic mode (oscillation), an optimization started from the manual mode is necessary (see above, “Procedure of optimization”).
d) The target setpoint couldn’t be reached at the end of the optimization.
Solution: see 3)
e) During the optimization (flashing “tunE”) the actuator mustn’t run over the limit → not 0% nor 100%. Nevertheless at start of the optimization a completely closed actuator is tolerated, i.e. in case that a pressurised system (with closed actuator) is to be optimized that runs to its target setpoint right after switching it on.
Solution: Set a bigger process gain and restart optimization or just set another target setpoint.
f) Power supply is not stable or collapses because of too many peripherals.
Solution: Optimizations only when a stable source is guaranteed.
g) Controlling the process is almost impossible because the actuator doesn’t fit (valve is over-sized)
Solution: Check dimensions of the actuator, change it if necessary.
h) With the chosen type of controller the process can’t be controlled perfectly.
Solution: Let the optimization run with an other type of controller (PI or PID) and compare (see above, “Procedure of optimization”).

Pb

3.2 Proportional band Pb

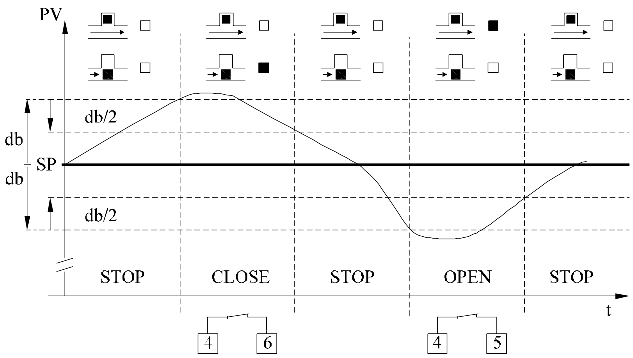
Setting range: 1.0% to 999.9%
Proportional action of the PI(D) three-position step controller

Pb
0.0

3.2.1 Three-position controller

Pb = 0.0
tn > 0

Control action adjustable via dead band db.
(see also 3.5 db)



3.2.1 Three-position controller

tn

3.3 Integral action time tn

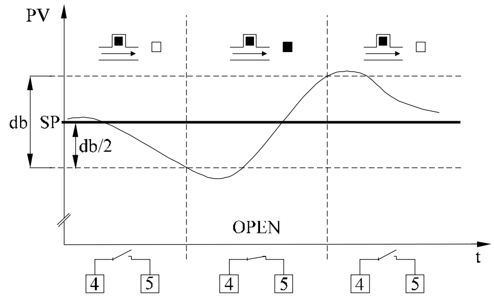
Setting range: 1s to 2600s
Integral action of the PI(D) three-position step controller

tn
0

3.3.1 Two-position controller

tn = 0

Control action adjustable via dead band db.
(see also 3.5 db)



3.3.1 Two-position controller

td

3.4 Derivative action time td

Derivative action of the PID three-position step controller

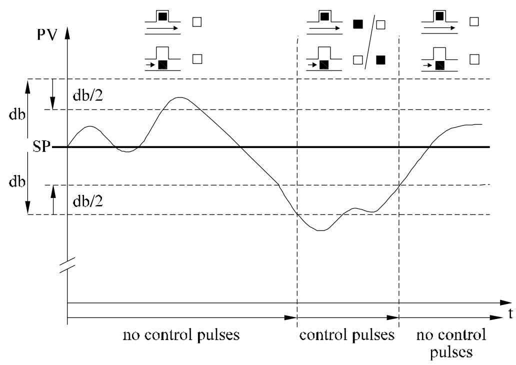
Setting range: 1s to 255s

db

3.5 Dead band db

No actuating pulses if control deviation is smaller than db.
Hysteresis: db/2
Setting range: 0 to the 10th part of the measuring range [phys. units] (entire measuring range at dP = 3).

(see also 3.2.1 three-position controller
3.3.1 two-position controller)



3.5 Dead band

t.P

3.6 Actuating time t.P

(Valve actuation time)

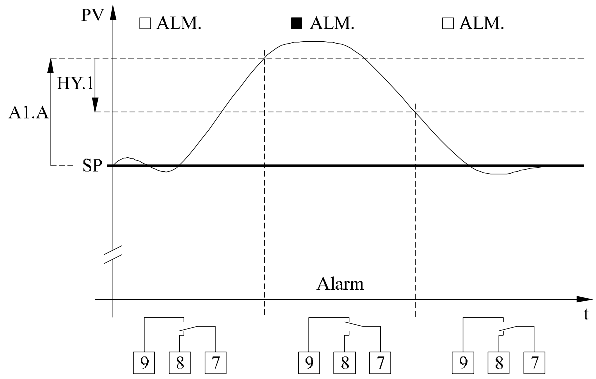
Setting range: 5s to 300s
Time to pass through the setting range 0% to 100% (stroke) at constant OPEN- or CLOSE-pulse

3.7 Basic alarm type description

The controller has got three basic types of alarms called type A, type B and type C. For type B two versions are available.

3.7a Alarm type A

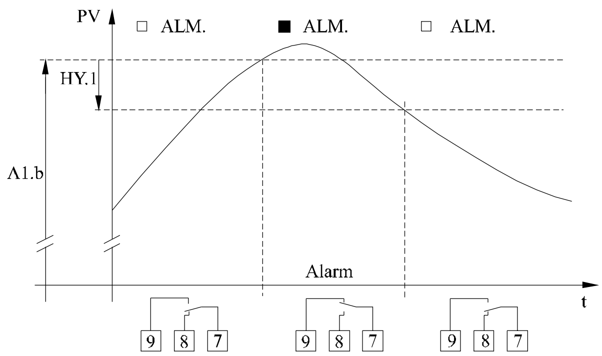
Alarm at a limit value based on the setpoint SP (setpoint dependent). Alarm at over-pressure if alarm setting A1.A is positive. Alarm at under-pressure if alarm setting A1.A is negative. At positive setting the alarm is triggered if PV is bigger than SP + A1.A. At negative setting the alarm is triggered if PV is smaller than SP - |A1.A|. The algebraic sign of the alarm value A1.A only indicates the direction of effect (over- or under-pressure).
The hysteresis defines a span between alarm state and switching back to normal state. At positive setting of A1.A returning to normal state is at SP + A1.A - HY.1 . At negative setting of A1.A returning to normal state is at SP - |A1.A| + HY.1 .



Alarm type A

3.7b Alarm type B

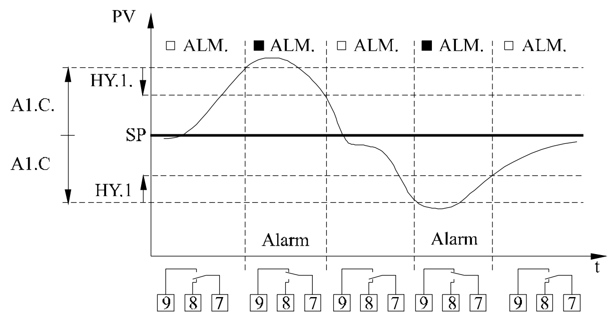
Alarm at a fixed limit value of PV.
If A1.1 = 2, alarm is triggered if the value set at A1.b is reached or exceeded.
The hysteresis defines a span between alarm state and switching back to normal state. Returning to normal state is at A1.b - HY.1 .
If A1.1 = 4, alarm is triggered if the value set at A1.b is reached or dropped below.
The hysteresis defines a span between alarm state and switching back to normal state. Returning to normal state is at A1.b + HY.1 .



Alarm type B

3.7c Alarm type C

Alarm at leaving a band around the setpoint SP.
The lower half of the band is defined by A1.C ,
the higher one by A1.C. .
The value entered at A1.C is always negative because the process variable PV has to be smaller than SP - |A1.C| to trigger the alarm.
The value entered at A1.C. is always positive because the process variable PV has to be bigger than SP + A1.C. to trigger the alarm.
The hysteresis defines a span between alarm state and switching back to normal state. For the lower band returning to normal state is at SP - |A1.C| + HY.1 . For the higher band returning to normal state is at SP + A1.C. - HY.1. .



Alarm type C

At all three types (A, B, C) alarm is always triggered in case of sensor failure.

AL.1
0...4

3.7.1 Alarm type selection for alarm relay

The alarm relay operates on the base of the idle current principle.

AL.1 = **0:** no alarm selected
Also not in case of sensor failure, see also 3.18 SE.b

A 1.A

AL.1 = **1:** selects Al.A Alarm type A (see description 3.7a)
Setting range: 0 to ± scope of the measuring range [phys. units]

HY. 1

Alarm hysteresis HY.1 for A1.A
Setting range: 0 to 10th part of measuring range [phys. units]

A 1.b

AL.1 = **2:** selects Al.b Alarm type B (see description 3.7b)
Setting range: measuring range [phys. units]

HY. 1

Alarm hysteresis HY.1 for A1.b
Setting range: 0 to 10th part of measuring range [phys. units]

AL.1 = **3:** selects Al.C and Al.C. Alarm type C (see description 3.7c)

A 1.C

Lower half of the band around the setpoint (negative setting)
Setting range: 0 to - measuring range [phys. units]

HY. 1

Alarm hysteresis HY.1 for A1.C
Setting range: 0 to 10th part of measuring range [phys. units]

A 1.C.

Upper half of the band around the setpoint (positive setting)
Setting range: 0 to + measuring range [phys. units]

HY. 1.

Alarm hysteresis HY.1. for A1.C.
Setting range: 0 to 10th part of measuring range [phys. units]

A 1.b

AL.1 = **4:** selects A1.b Alarm type B, version 2 (see description 3.7b)
Setting range: measuring range [phys. units]

HY. 1

Alarm hysteresis HY.1 for A1.b
Setting range: 0 to 10th part of measuring range [phys. units]

dP
0...3

3.8 Decimal point for LED displays

Selections:
0 Display without decimal point: ####
1 Display with decimal point (1 decimal): ###.#
2 Display with 2 decimals: ##.##
3 Display with 3 decimals: #.###

After any change of the decimal point the process variable display PV has to be rescaled (see 3.9 dI.L, dI.H). By changing the decimal point several other inputs in the configuration level are concerned. Because of the high degree of accuracy of some inputs approximation errors may be possible.

3.9 Scaling the process variable display PV

dI.L

Display low: enter zero point of the measuring range
Defines the starting point for the PV indication related to the measuring range.
Setting range: -999 ... 9999 [phys. units] at dP = 0 (dI.L must be lower than dI.H)
range is dependent on the dP setting : from -999 ... 9999 at dP = 0 and -0.999 ... 9.999 at dP = 3 respectively. See also 3.8 dP
standard value: **0**%

dI.H

Display high: enter final point of the measuring range
Defines the final point for the PV indication related to the measuring range.
Setting range: -999 ... 9999 [phys. units] at dP = 0 (dI.H must be higher than dI.L)
range is dependent on the dP setting : from -999 ... 9999 at dP = 0 and -0.999 ... 9.999 at dP = 3 respectively. See also 3.8 dP
standard value: **100**%

⚠ - When changing dI.L or dI.H, all values entered as physical units are rescaled expressed as percentage

3.10 Setpoint limiting

SP.L

Setpoint low lowest setpoint which can be set
Defines the starting point for the PV indication related to the measuring range.
Setting range: dI.L to SP.H [phys. units] (see also 3.9 dI.L)
Effective for the setpoint adjustable via keyboard.

SP.H

Setpoint high highest setpoint which can be set
Setting range: SP.L to dI.H [phys. units] (see also 3.9 dI.H)
Effective for the setpoint adjustable via keyboard.

⚠
- If the range of dI.L/dI.H is changed, SP.L/SP.H is automatically set according to it expressed as percentage.
- When SP.L = SP.H, the setpoint is fixed to this value. Changing the setpoint is not possible.
- When SP.L > SP.H, only between these two values can be switched via keyboard. To set up the change between the two setpoints: enter SP.L > SP.H.
  When switching back to operating level, the last entered setpoint is displayed. Select one of the two possible setpoints via keyboard an press ↵ -key.

SP.2

3.11 Second setpoint SP.2

Setting range: dI.L to dI.H [phys. units] (see also 3.9 dI.L, dI.H)

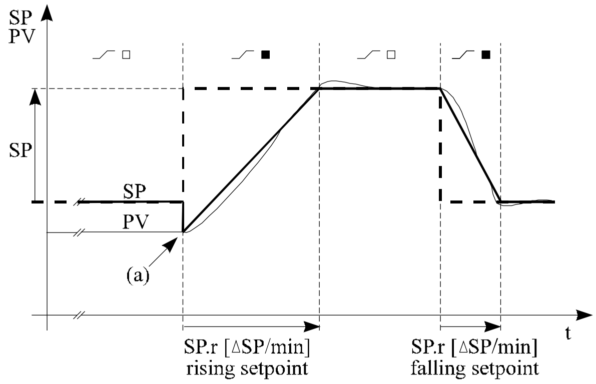
When the digital input assigned to SP.2 is active, the corresponding value (entered in SP.2) becomes the actual setpoint (see also 3.21-3.25 Assigning the digital inputs).

SP.r

3.12 Setpoint ramp SP.r

Setting SP.r = 0: no setpoint ramp.
Defines the ramp of the setpoint SP via time (gradient)
Setting range: 1 to end of measuring range in PV/ minutes or hours (see also 3.13 rA.d); PV [phys. unit]

Initial value of the setpoint ramp is always the current value of the process variable PV (a). The current setpoint is displayed.



3.12 Setpoint ramp SP.r

The setpoint ramp is triggered after:

- switching on the device or a power failure
- sensor failure
- every setpoint change
- switching to the second setpoint SP.2
- a control function STOP, CLOSE, OPEN (via digital input)
- switching from manual mode to automatic mode

rA.d

0...6

3.13 Ramp direction

Setting the direction of effect and time behaviour of the setpoint ramp SP.r (if SP.r > 0)

Selections:
0 Ramp with SP.r as *physical unit/min, at falling and rising setpoint changes.
1 Ramp with SP.r as *physical unit/min, only at rising setpoint changes.
2 Ramp with SP.r as *physical unit/min, only at falling setpoint changes.
3 Ramp is deactivated (similar to setting SP.r = 0).
4 Ramp with SP.r as *physical unit/hour, at falling and rising setpoint changes.
5 Ramp with SP.r as *physical unit/hour, only at rising setpoint changes.
6 Ramp with SP.r as *physical unit/hour, only at falling setpoint changes.

(see also 3.12 SP.r) * physical unit see 3.9 adjusting dI.L, dI.H

dSP

3.14 Delta setpoint

Setting range: 0 to ± scope of measuring range [phys. units]

dSP = 0 no delta setpoint
dSP ≠ 0 as soon as the STOP command is deactivated by an assigned digital input the setpoint will be changed by the value [phys. unit] set in dSP.

Assigning the control function STOP to a digital input, see 3.24.

3.15 Delta setpoint description

Not used at ER 2000 Pressure.

P.G

3.16 Process gain P.G

Setting range: 1% to 255%

$$\text{Process gain of the controlled system P.G} = \frac{\text{Change of the process variable PV}}{\text{Change of the actuating variable Y}} = \frac{\Delta PV}{\Delta Y}$$

Δ PV [% of the measuring range of PV]
Δ Y [% of the setting range 0-100]

e.g: P.G = 50%: $\frac{\Delta PV}{\Delta Y} = 0{,}5$	Changing the valve position ΔY for 10% causes a change of the process variable PV of 5%.
P.G = 100%: $\frac{\Delta PV}{\Delta Y} = 1{,}0$	Changing the valve position ΔY for 10% causes a change of the process variable PV of 10%.
P.G = 125%: $\frac{\Delta PV}{\Delta Y} = 1{,}25$	Changing the valve position ΔY for 10% causes a change of the process variable PV of 12.5%.

The process gain P.G is required for the optimization of the control parameters. If P.G is unknown, it is determined automatically during optimization. (see also 3.1 OPt)
In case of non-linear transfer behaviour of the plant the process gain changes with the working point (e.g. when controlling different setpoints).

FIL

3.17 Measured value filter for the process variable PV

Software 1st order low-pass filter with adjustable time-constant Tf for suppressing interference signals and smoothing fast fluctuations of the actual value.

formula :
Tf = -0,04/ln (input/256)

Setting range: 0 to 255
At FIL = 0 : no software filter is active

The following assignment applies:

Input:	255	254	252	250	240	230 *	220	200	0
Tf [s]:	10,22	5,10	2,54	1,69	0,62	0,37	0,26	0,16	off

* standard setting

SE.b
0...2

3.18 Behaviour in case of sensor failure for PV

Reaction of the actuator in automatic mode in case of sensor short circuit or sensor break.

Selections: 0 actuator closes
1 actuator opens
2 actuator stays in its current position

In case of a transmitter/sensor failure the error message **Err** (error) appears in the LED display PV. Alarm message if alarm A, B or C is configured, independent of the adjusted alarm limit. After the error is no longer present the controller automatically returns to the automatic mode.

Err PV

MAn
0 1

3.19 Interlocking the manual/automatic switch over

Selections: 0 Switch over by keyboard, possible at any time
1 Interlocking in the current state, switching to the other mode is not possible:
Set MAn.= 1 in automatic mode: permanent automatic mode
Set MAn.= 1 in manual mode: permanent manual mode

dIr
0 1

3.20 Direction of effect of the controller

Selections: 0 Heating controller: the actuator closes with process variable PV > setpoint SP
1 Cooling controller: the actuator opens with process variable PV > setpoint SP

S2.d
0...5

3.21 Assigning the control function SECOND SETPOINT SP.2 to a digital input

Selection: 0 : No digital input is selected.
1 ... 5 : Defines the number of the digital input to activate the second setpoint SP.2 .

In case of a "high" signal at the selected input the controller switches to the second setpoint.
See also 3.25 Important informations about setting digital inputs

OP.d
0...5

3.22 Assigning the control function OPEN to a digital input

Selection: 0 : No digital input is selected.
1 ... 5 : Defines the number of the digital input to activate an OPEN command.

In case of a "high" signal at the selected input the actuator is set to permanent OPEN.
See also 3.25 Important informations about setting digital inputs

CL.d
0...5

3.23 Assigning the control function CLOSE to a digital input

Selection: 0 : No digital input is selected.
1 ... 5 : Defines the number of the digital input to activate a CLOSE command.
CLOSE function is assigned to digital input 1 by factory.

In case of a "high" signal at the selected input the actuator is set to permanent CLOSE.
See also 3.25 Important informations about setting digital inputs

St.d
0...5

3.24 Assigning the control function STOP to a digital input

Selection: 0 : No digital input is selected.
1 ... 5 : Defines the number of the digital input to activate a STOP command

In case of a "high" signal at the selected input the actuator is set to permanent STOP and persists in its current position. No OPEN or CLOSE pulses are given.
See also 3.25 Important informations about setting digital inputs

3.25 Important informations about setting digital inputs

- Possibly not all the adjustable software settings are supported by your device version. See also 8. By the ordering number the qualities of your controller can be inspected. The software settings from 1 ... 5 in 3.21 ... 3.24 are possible, even if your controller has got no or only one single digital input.
- If one of the digital inputs is assigned to multiple control functions, e.g.: CL.d = 1 and St.d = 1, only the function with the highest priority will be executed if active. Following priorities are given: 1. STOP (highest priority), 2. CLOSE, 3. OPEN, 4. SP.2

3.26 Adjusting the digital inputs for the usage with INBAS

If the keywords "DIOPEN", "DICLOSE", "DISTOP" and "DISP2" shall be used, following adjustments for the digital inputs have to be set: OP.d = 1, CL.d = 2, St.d = 3, S2.d = 5.
INBAS-version ≥ 1.4 has to be used for ER 2000 controller types. The keyword for the "assignment loop → device" is "X90A".

bd
0...4

3.27 Transmission speed for serial interface (baud rate)

Serial interface RS 485, data transmission according to modbus protocol in RTU-mode.

Selection:				
	0	19200 baud	3	2400 baud
	1	9600 baud	4	1200 baud
	2	4800 baud		

If the baud rate is selected via keyboard, the new value is active immediately. A reset is not necessary.
If the baud rate is changed via modbus, a reset (power off-power on) is necessary.

Adr
01

3.28 Address of serial interface

Defines the modbus address of the controller.

Setting range: 1 to 247

If the address is selected via keyboard, the new value is active immediately. A reset is not necessary.
If the address is changed via modbus, a reset (power off-power on) is necessary.

S.C
01

3.29 Serial communication

Selection: 0 Operation of the controller via keyboard and modbus-master is possible.
1 Operation of the controller is only possible via modbus-master, except configuration point S.C.

OL.2

3.30 Second operating level

Select functions for the user-defined operating level (only if the password is activated, see 3.31 PAS).

Setting range: 0 to 255:

- 0 No second operating level
- 1 **Optimization** (see also 3.1 OPt) can be activated in the second operating level.
- 2 **Alarm** functions and their hysteresis (see also 3.7 Alarms) can be entered in the second operating level.
- 4 Reserved, no function yet.
- 8 **Second setpoint SP.2** (see also 3.11 SP.2) can be adjusted in the second operating level .
- 16 **Setpoint ramp SP.r** (see also 3.14 SP.r) can be adjusted in the second operating level.

To activate the various functions above, the index numbers on the left side have to be added and the result has to be entered.
The index numbers 4, 32, 64, 128 are reserved and have no function yet. If exclusively reserved index numbers are adjusted, only **Cod** will be displayed in the second operating level.

PAS
01

3.31 Access to the configuration level

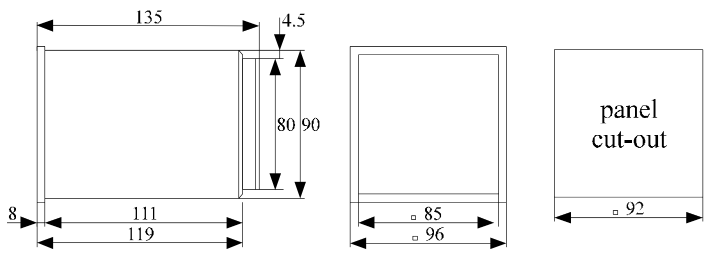
Selections: 0 No interlocking of the configuration level.
OL.2 is ineffective.

1 Access to the configuration level only by entry via password.
OL.2 is effective.
see above 3.30 OL.2; valid password see on page 30 PAS/Cod

4. Mounting

The device is suitable for installations into front panels as well as into consoles in any position.
Insert the controller from the front into the prepared panel cut-out and fasten it with the supplied clamps.

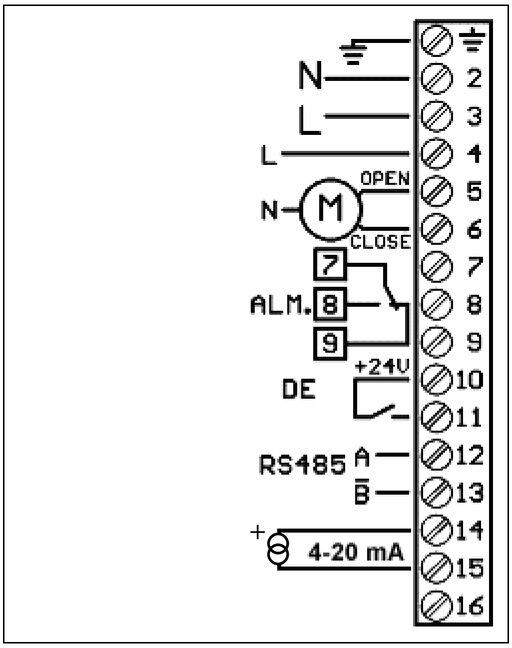
⚠ The ambient temperature at the installation site must not exceed the permissible temperature for rated operation.
Adequate ventilation must be assured even when the devices are mounted very close to each other.
The device must not be installed within explosion-hazardous areas.



5. Electrical connection

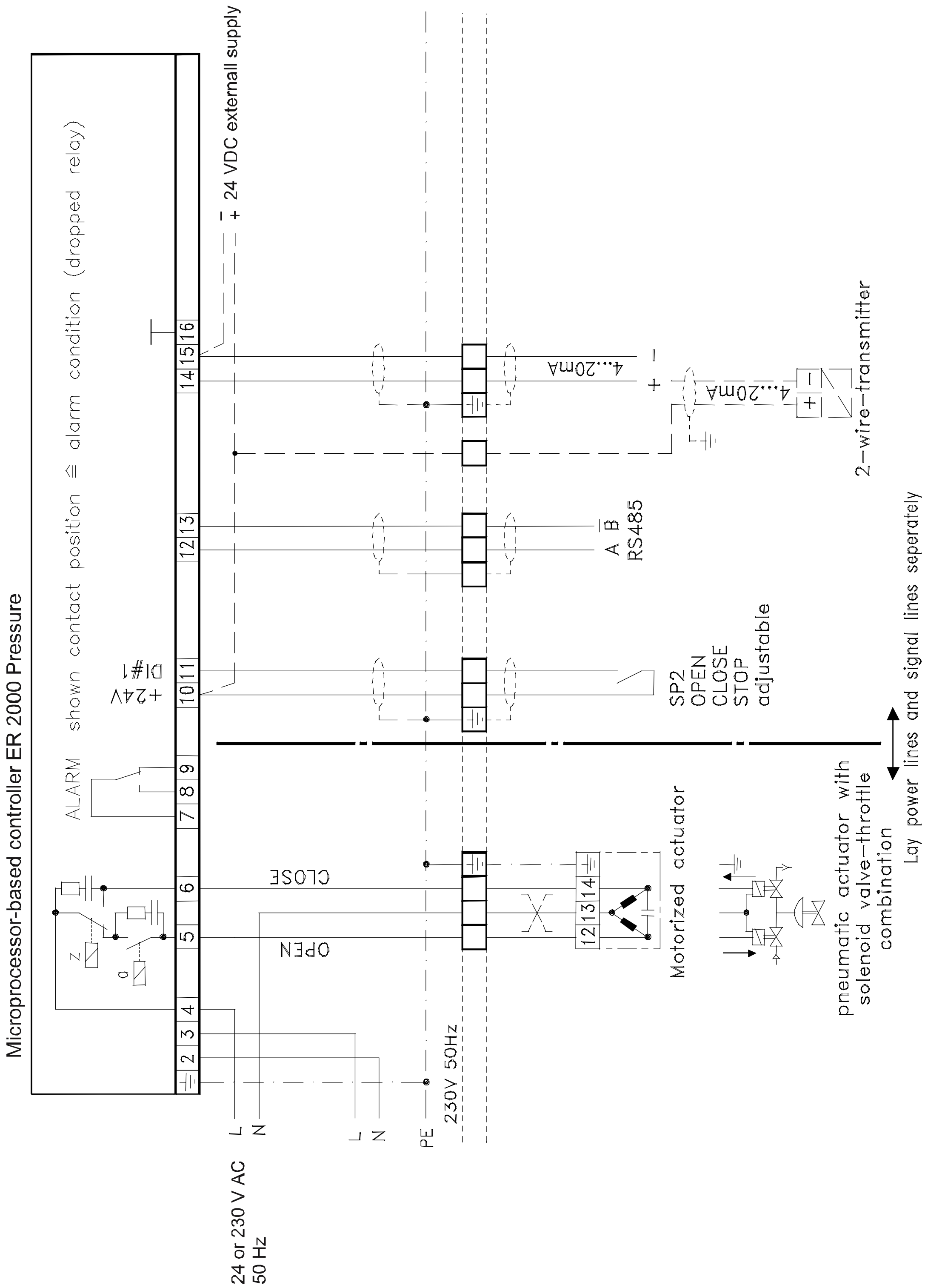
The wiring diagram is located on the backplane of the controller.
The plug-type terminals are located on the backplane of the controller.

⚠ The given national rules must be observed for installation.
The electrical connection has to conform to the connection diagram of the device.
For measurement and control leads (digital inputs) shielded cables must be used. Also in the switch cabinet these leads must be installed separately from the power systems with rated voltage.
Before the device is switched on make absolutely sure that the operating voltage, specified on the rating plate, conforms to the mains voltage.
The connecting terminals may only be disconnected from the device when the connected lines are in a de-energized state.



Configuration of ER 2000 Pressure

5.1 Wiring diagram



6. Commissioning

Procedure:	**Remedy in case of malfunctions**
☐ Unit properly installed ?	See 4. Mounting
☐ Electrical connection according to valid regulations and connection diagrams ?	See 5. Electrical connection
☐ Switch on mains voltage. When the unit is switched on, all display elements on the front plate light up for approx. 2 sec. (lamp test). Then the unit is ready for operation.	Compare operating voltage (indicated on the type plate) with mains voltage.
☐ Switch to manual mode.	See 2.2 Opening/closing in manual mode
• Does the actual value display PV correspond to the process variable at the measuring location?	Check sensor, measuring line and electrical connection. See 5. Electrical connection
• Actual value display PV is fluctuating/jumping ?	Adjust measuring filter FIL. See 3.17 FIL Unit installed close to powerful electric or magnetic interference fields ?
• Connecting and setting digital inputs	Check settings of the digital inputs (3.21-3.25) Check electrical connection (5.)
- Is the corresponding DI-state text displayed in the SP-display (e.g.: "StOP"; "CLOS"; ...) ?	Check voltage supply for digital inputs, external switching contacts, signal lines and electrical connection. Consider the display priorities like explained in 2. Operating and setting.
• Open actuator - Pressure maintaining controller: actual value PV rising? - Pressure relief controller: actual value PV falling? • Close actuator - Pressure maintaining: actual value PV falling ? - Pressure relief controller: actual value PV rising ?	See 2.2 Opening/closing in manual mode No response: Check actuator and electrical connection controller ↔ actuator reverse response: Change the actuator control OPEN and CLOSE See 5.1 Wiring diagram
• Enter actuating time of connected actuator.	See 3.6 Actuating time t.P
• Set controller parameters using optimization.	See 3.1 Optimization for automatic determination of favourable control parameters OPt
☐ Automatic mode	
Manual/automatic switch over	See 2.2 Opening/closing in manual mode
Set setpoint SP	See 2.1 Setting setpoint in automatic mode
☐ Controller actuating pulses are too short, switching rate is too high	Adjust dead band db See 3.5 dead band

7. Technical data

Line voltage	230 V AC / 115 V AC / 24 V AC } -15% / +10%, 50/60 Hz
Power consumption	approx. 7 VA
Weight	approx. 1 kg
Permissible ambient temperature	
- Operation	0°C to 50ºC
- Transport and storage	-25ºC to + 65ºC
Degree of protection	Front IP 65 according to DIN 40050
Design	For control panel installation 96 x 96 x 135 mm (W x H x D)
Installation position	arbitrary
DI-feed voltage	24 V DC, Imax. = 20 mA
Analog inputs	Pressure transmitter 4-20 mA, 2-wire
Measuring accuracy	0.1% of the measuring range
Digital inputs	high active, low = n.c. / 0 V DC high = 15 V to 24 V DC
Displays	Two 4-digit 7 segment displays, LED red, character height = 13mm
Alarm	Alarm types A, B, C (operation on the base of the idle current principle)
Relay	Switching capacity: 250 V AC / 3 A Spark quenching element
Serial interface	RS 485, modbus protocol in RTU-mode 1200 to 19200 baud 1 start bit, 8 data bits, 1 stop bit, no parity bit
Data protection	Semiconductor memory

8. Clorius ER 2000 type specification

Equipment / Device - type	Front-panel housing 96 x 96	Degree of protection Front IP 65	PI(D) three-position step-contoller	Number of selectable analog inputs	DI-supply voltage	Number of digital inputs	Second setpoint SP.2 via digital input (DI)	OPEN command via digital input (DI)	CLOSE command via digital input (DI)	STOP command via digital input (DI)	Number of alarm relays	With RS 485 interface (modbus, RTU-mode)	Scalable linear input
ER 2000	■	■	■	1	■	1	S	S	S	S	1	■	■

■ = Feature/function present

□ = Feature/function not present

1 = Feature/function present, with quantity

S = Selectable by **S**oftware (which digital input will be assigned to which function). Selection not available in some controller modes

9. Overview of configuration level, data list

Configuration point	Display	Setting		Remarks
Optimization	OPt	0		No optimization
		1		Optimization activated
Proportional band	Pb	☐		1,0% to 999,9%
Three-position controller	Pb =	0	☐	tn > 0; dead band is in accordance with dead zone
Integral action time	tn	☐		1s to 2600s
Two-position controller	tn =	0	☐	Dead band is in accordance with dead zone
Derivative action time	td	☐		1s to 255s; PI-control at td = 0
Dead band (dead zone)	db	☐		0 to measuring range [phys. unit] at dP = 3 (x0.1 at dP = 0-2)
Valve actuating time	t.P	☐		5s to 300s
Alarm 1	AL.1	0	☐	No alarm, also not in case of sensor failure
		1	☐	Alarm A, dependent on setpoint, also in case of sensor failure
		2	☐	Alarm B, fixed limit value, also in case of sensor failure
		3	☐	Alarm C, band transgression by setpoint, also in case of sensor failure
		4	☐	Alarm B, fixed limit value, alarm at low-pressure, also in case of sensor failure
Alarm 1, type A (at AL.1=1)	A1.A	☐		0 to ± scope of measuring range [phys. unit]
Alarm 1, type B (at AL.1=2/4)	A1.b	☐		Measuring range: dI.L to dI.H [phys. unit]
Hysteresis for A1.A/A1.b	HY.1	☐		0 to 10th part of measuring range [phys. unit]
Alarm 1, type C lower limit (at AL.1=3)	A1.C	☐		0 to - scope of measuring range [phys. unit]
Hysteresis, lower limit	HY.1	☐		0 to 10th part of measuring range [phys. unit]
Alarm 1, type C upper limit (at AL.1=3)	A1.C.	☐		0 to + scope of measuring range [phys. unit]
Hysteresis, upper limit	HY.1.	☐		0 to 10th part of measuring range [phys. unit]
Decimal point	dP	0	☐	Display without decimal point e.g. 1234
		1	☐	Display with 1 decimal e.g. 123.4
		2	☐	Display with 2 decimals e.g. 12.34
		3	☐	Display with 3 decimals e.g. 1.234
Scaling low	dI.L	☐		Displayed value at start of measuring range, -999 to dI.H-1 [phys. unit]
Scaling high	dI.H	☐		Displayed value at end of measuring range dI.L+1 to 9999 [phys. unit]
Setpoint limiting , lower	SP.L	☐		usually dI.L to SP.H [phys. unit] SP.L = SP.H: fixed SP not valid
Setpoint limiting, upper	SP.H	☐		usually SP.L to dI.H [phys. unit] SP.L > SP.H: two SPs for SP.2
Second setpoint	SP.2	☐		dI.L to dI.H [phys. unit], switch over via digital input SP.2
Setpoint ramp	SP.r	☐		0 to measuring range [phys. unit per min, hour]
Ramp direction, time unit	rA.d	0	☐	phys. unit/min, rising and falling setpoint ramp
		1	☐	phys. unit/min, only rising setpoint ramp
		2	☐	phys. unit/min, only falling setpoint ramp
		3	☐	Ramp deactivated (similar to SP.r = 0)
		4	☐	phys. unit/hour, rising and falling setpoint ramp
		5	☐	phys. unit/hour, only rising setpoint ramp
		6	☐	phys. unit/hour, only falling setpoint ramp
delta setpoint	dSP	☐		0 to ± scope of measuring range [phys. unit]
Process gain	P.G	☐		1% to 255%

Configuration point	Display	Setting		Remarks
Measured value filter	FIL	[ ]		0 to 255, complies with 0ms to 10s
Sensor break PV	SE.b	0	☐	Actuator closes [1]
		1	☐	Actuator opens [1]
		2	☐	Actuator persists in its current position [1]
				[1] only in automatic mode
Manual-/automatic switch over	MAn	0	☐	Switch over via keyboard
		1	☐	Interlocking in the current status automatic
			☐	Interlocking in the current status manual
Direction of effect of controller	dIr	0	☐	Pressure maintaining
		1	☐	Pressure relief
Assigning the functions of the digital inputs		0 to 5		Defining the number of the digital input. 0 = inactive
Second setpoint	S2.d	[ ]		
OPEN	OP.d	[ ]		
CLOSE	CL.d	[ ]		
STOP	St.d	[ ]		
Transfer rate	bd	0	☐	19200 baud
		1	☐	9600 baud
		2	☐	4800 baud
		3	☐	2400 baud
		4	☐	1200 baud
Address	Adr	1 to 247		Slave address in bus-mode
		[ ]		Address
Serial communication	S.C	0	☐	Operation of the controller via keyboard and modbus-master
		1	☐	Operation of the controller is only possible via modbus-master, except configuration point S.C
Second operating level	OL.2	0	☐	No second operating level
		1	☐	Optimization
		2	☐	Alarm functions and their hysteresis
		4	☐	Reserved, no function yet.
		8	☐	Second setpoint SP.2
		16	☐	Setpoint ramp SP.r
		[ ]		Result of added index numbers
Password	PAS	0	☐	No interlocking, OL.2 deactivated
		1	☐	Access only after entry via password. OL.2 active: functions on OL.2 not interlocked
		[1500]		Code

Notices :

Clorius Controls A/S
Tempovej 27
DK-2750 Ballerup
Denmark
Tel.: +45 77 32 31 30
Fax: +45 77 32 31 31
E-mail: mail@cloriuscontrols.com
Web: www.cloriuscontrols.com