Automation System TROVIS 6400
Compact Controller TROVIS 6494

SAMSON

TROVIS®
Electronics from SAMSON

Edition June 1994

Mounting and operating instructions

EB 6494 E

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1. Description

TROVIS 6494 is a digital controller integrating many sophisticated functions into a single compact module used to automate plants used in industrial applications and process engineering. Its well-thought functional design, which takes user needs into mind, allows diverse control circuit arrangements to be configured. **TROVIS 6494** can be effectively used in a wide-range of applications as a either a continuous-action controller, on-off (two-step) controller or three-step controller with the option of P (proportional), PI (proportional-plus-integral), PD (proportional-plus-derivative) or PID (proportional-plus-integral-plus-derivative) action.
Self-tuning, a standard option, uses the built-in intelligence capabilities to automatically determine and set the appropriate control parameters.

Operation of this advanced controller is designed according to the concept of user friendliness and uses the following three-level operating structure: 1) operating level (standard operation), 2) parameterization level and 3) configuration level.
The first level, the operating level, contains visual displays for standard control operation and can be accessed at any time, whereas the parameter and configuration levels are protected by user-definable code numbers. Functions in the second level, the parameterization level, include modification of control parameters and optimum adaption to the controlled system. Selection of controller functions is facilitated in the third level, the configuration level.

Controller input options include the following: Pt 100 resistance thermometers, Ni 100 resistance thermometers and standardized current/voltage signals.

The controller's command variable, to be called the setpoint (SP) in the remainder of this text for reasons of conformity, can be selected between setpoint W1 and setpoint W2 via a key, or by means of a binary signal.

Bumpless transfer in the respective operating mode (MANUAL or AUTOMATIC) is facilitated by means of the MANUAL/AUTOMATIC key.

1.1 Version

This compact controller is delivered in panel-mount design according to DIN 43 700 (dimensions of front frame: 48 mm x 96 mm) as the following versions:

Universal input options:
Ni 100 or Pt 100 resistance thermometer in three-wire circuit, standardized mA/V signals

Standard controller output:
Continuous/on-off/three-step/limit contact

Power supply:
100 to 253 V AC (TROVIS 6494-0111)
20 to 30 V AC (TROVIS 6494-0121)

Connection:
Crimp contacts or optional screw terminals

This manual applies to controllers implementing firmware version 1.00 or later

⚠ **WARNING**
Assembly, commissioning and operation of this controller may only be performed by experienced personnel.

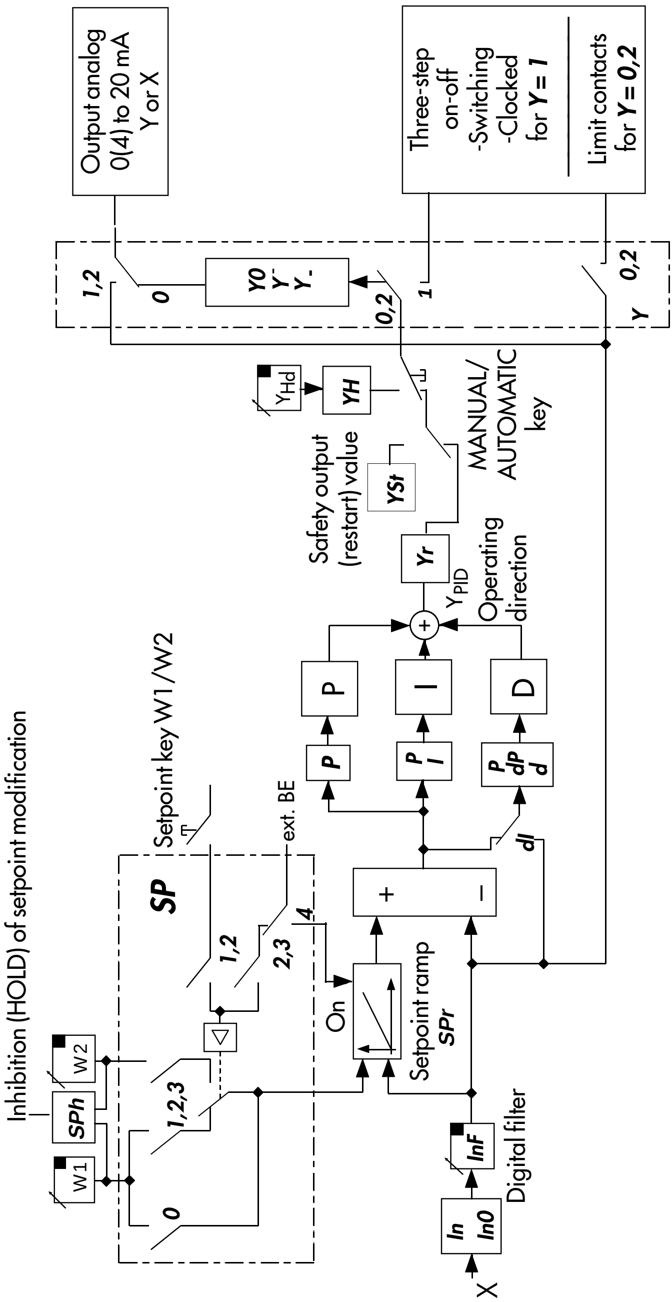


Fig. 1 · Functional structure of controller

1.2 Technical data

<table>
<tr><td>Input options</td><td colspan="6">Controlled variable x
d.c. current signal 4(0) to 20 mA Ri = 50 Ω
d.c. voltage signal 2(0) to 10 V Ri > 100 kΩ

Resistance thermometer Pt 100 (three-wire circuit)
Measuring ranges −100.0 to 400.0 °C
−30.0 to 150.0 °C

Resistance thermometer Ni 100 (three-wire circuit)
Measuring ranges −60.0 to 180.0 °C
−20.0 to 90.0 °C

External changeover of the setpoint
Binary input for selection of setpoint W1 – W2 with 24 V d.c.
Signal 0 V → W1 ; 24 V → W2 (select using SP) or
external restart of the setpoint ramp</td></tr>
<tr><td>Controller outputs</td><td colspan="6">Standardized output signals
Standardized current signal 4(0) to 20 mA, load RB < 650 Ω

Switching outputs Y1 and Y2
a.c. voltage contacts 24 to 250 V a.c./0.5 A

CAUTION:
Never apply d.c. voltage</td></tr>
<tr><td>Power supply</td><td colspan="6">100 to 253 V a.c. or optionally 20 to 30 V AC/DC
48 to 62 Hz, 7 VA 7 VA</td></tr>
<tr><td>Permissible temperature</td><td colspan="6">Ambient 0 to 50 °C Shipping and storage 0 to 70 °C</td></tr>
<tr><td>Measuring accuracy</td><td colspan="2">Linearity error</td><td colspan="2">Zero error</td><td colspan="2">Span error</td></tr>
<tr><td>mA, V, Pt 100, Ni 100</td><td colspan="2">0.2 %</td><td colspan="2">0.2 %</td><td colspan="2">0.2 %</td></tr>
<tr><td>Temperature effect</td><td colspan="3">Zero error</td><td colspan="3">Span error</td></tr>
<tr><td>Pt 100, Ni 100</td><td colspan="3">0.3 % / 10 °K</td><td colspan="3">0.3 % / 10 °K</td></tr>
<tr><td>mA, V</td><td colspan="3">0.2 % / 10 °K</td><td colspan="3">0.2 % / 10 °K</td></tr>
<tr><td>Utilization category according to DIN 40 040</td><td colspan="6">Humidity rating F</td></tr>
<tr><td>Degree of protection</td><td colspan="6">IP 54 (front side), IP 20 (encapsulation)</td></tr>
<tr><td>Power failure</td><td colspan="6">All control parameters and configuration blocks are stored in a non-volatile EEPROM protected against power down (i.e. no-battery design)</td></tr>
<tr><td>Weight</td><td colspan="6">0.3 kg</td></tr>
</table>

2. Installation

TROVIS 6494 is smartly engineered as a panel-mount unit, the front dimensions of which compactly measure 48 x 96 mm^2. A panel cut-out of $45^{+0.6}$ x $92^{+0.8}$ mm^2 is to be fabricated for assembly of the plastic enclosure. After sliding the controller in the panel cut-out, the supplied clamps depicted in Fig. 3 are to be locked in place at the top and bottom in the accommodating pins of the enclosure. A screw driver can consequently be used to turn the threaded rods, clamping the controller's front frame against the panel.

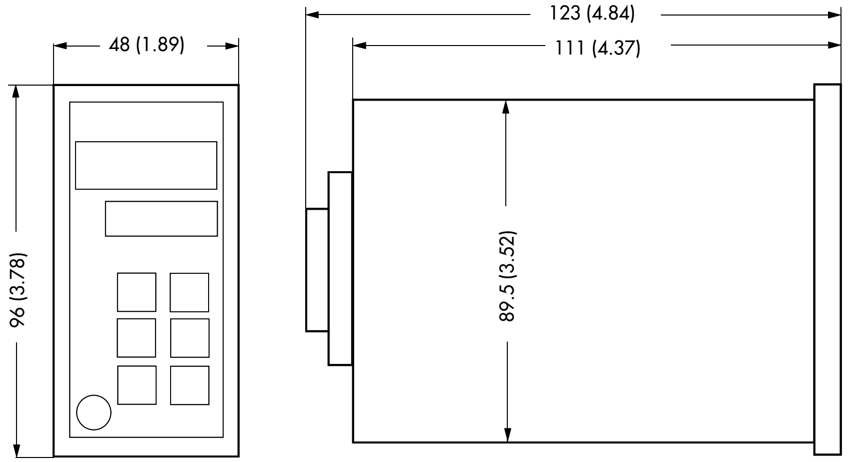


Fig. 2 · Dimensions in mm (inch)

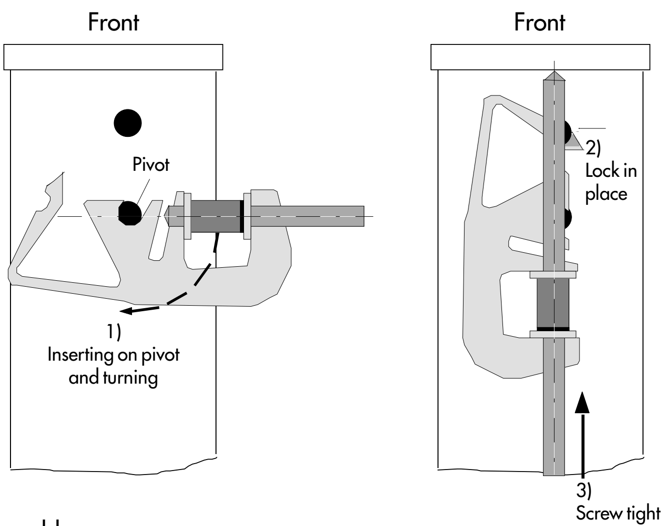


Fig. 3 · Assembly

3. Electrical connections

The easy-to-install compact controller is equipped with plug-type connectors (snap-in contacts) for lead sizes 0.3 to 0.8 mm^2 and an insulating diameter of 1.3 to 2.4 mm^2 or screw terminals for lines 0.5 to 1.5 mm^2. When connecting the electric leads, note the pertinent VDE 0100 regulations and the currently valid regulations mandated by the country where the controller is intended for use.

Wiring information

The signal and sensor leads are to be isolated from those of the controller and power supply.
To avoid measuring errors when radio interference is present, use shielded lines for signals and sensors.
The power supply lines of each controller are to be led separately to the corresponding distributing bus bar.
Suppress contactor circuits located in the vicinity against interference using an RC element.

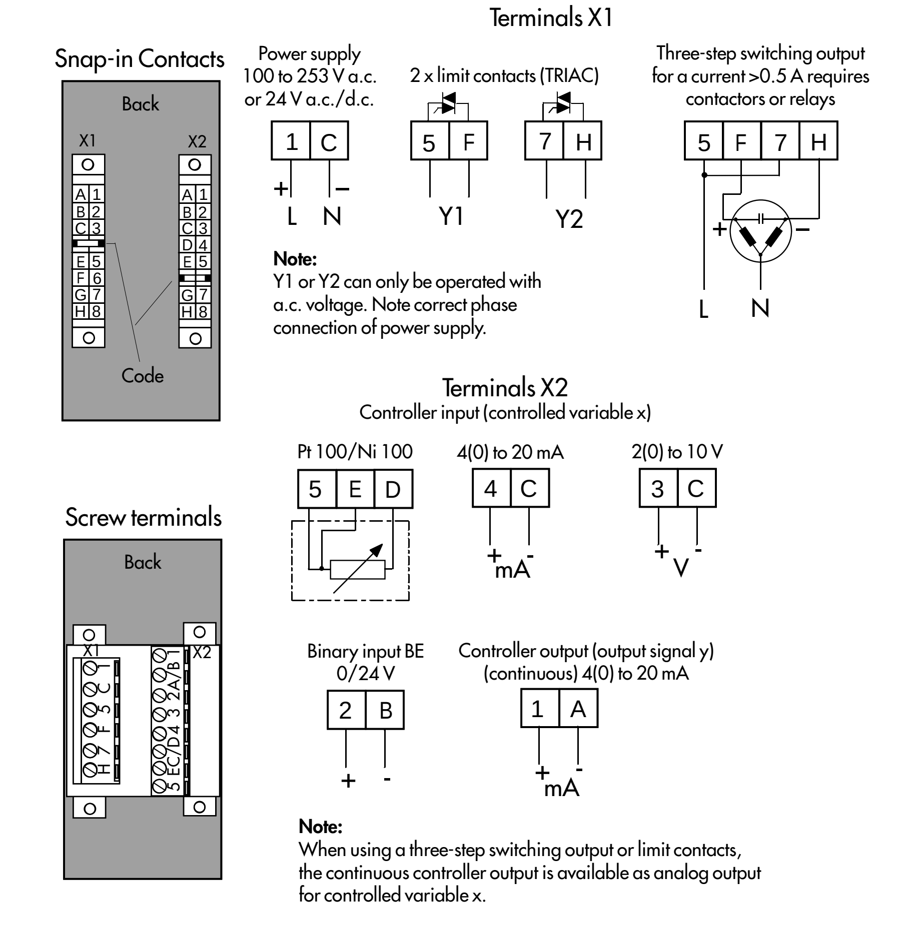


Fig. 4 · Terminal assignment

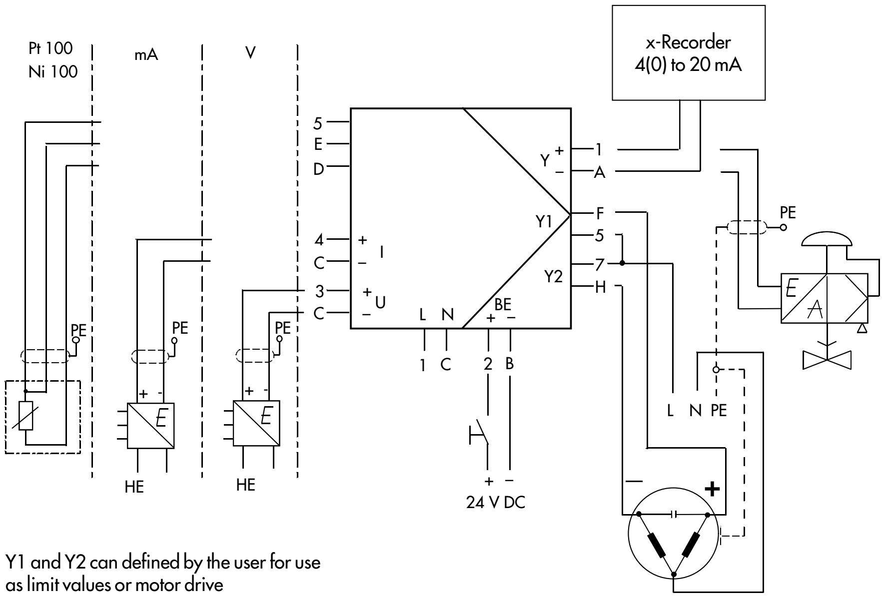


Fig. 5 · Diagram of connections

WARNING

Always disconnect the power supply lines prior to plugging/removing the plug connectors.
If this is ignored, the glass fuse Type T63 mA/250 V (order no. 8834-0298) contained on the power board in the device may be required to be exchanged.

4. Operation

4.1 Control panel, displays and operating elements

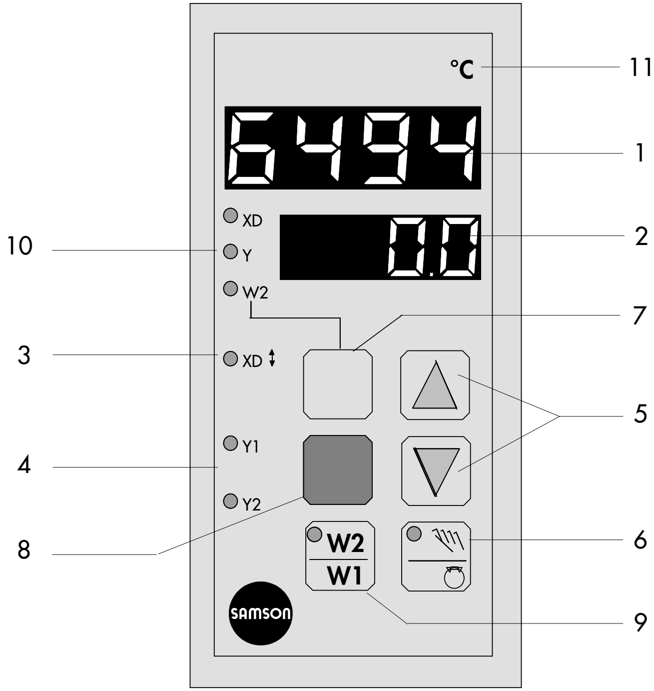


Fig. 6 · Front view

1 Controlled variable display (top display)
Controlled variable x, sometimes referred to as the Process Variable PV, is displayed in the operating level. The value of the selected entry option is can be viewed in the parameterization and configuration level.

2 Setpoint (SP) display
The current setpoint is displayed in the operating level. The display mode can be modified in the following sequence by actuating the operating key (7): setpoint W1, control deviation (error) XD, output variable Y, setpoint W2.
Configuration blocks and parameters values are presented in both the configuration and parameterization levels, resp.

3 Control deviation
Whenever xd is greater than 0.9 % or less than –0.9 %, the red LED (light-emitting diode) illuminates.

4 Display of switching outputs Y1 and Y2
Two red LEDs display indicate the circuit state of the three-step/on-off controller output, or the limit alarms.

5 Cursor keys

△ Increase displayed value
▽ Decrease displayed value

Function in the operating level (standard operation):
After selecting setpoint W1 or W2 → (modify setpoint directly), acknowledge the value using ENTER key (8).

In MANUAL operating mode:
Direct adjustment of output signal Y.

Function in the parameterization/configuration level:
Selection of the individual entry options in both directions.
Adjustment of the related numeric value in the top display (1).

6 MANUAL/AUTOMATIC changeover
When selecting manual adjustment to either controller output Y or switching outputs Y1 and Y2, the yellow LED located in the key illuminates:
Using the MANUAL/AUTOMATIC key, the controller can be bumplessly switched over from MANUAL to AUTOMATIC operation (or vice versa).
The MANUAL setting allows the user to directly operate the connected control valve. Controller output value Y can be modified using cursor keys (5) △ and ▽. In MANUAL operating mode, the controller output value can be viewed in the bottom display panel.

7 Operating key
Function in the operating level (standard operation):
Switch over to select the controller variables in one direction; following sequence: setpoint W1, XD, output variable Y, setpoint W2 (see section 4.2.1).

Function in the parameterization/configuration level:
Return to the operating level (standard operation) from the current levels.

8 ENTER key
Function in the operating level (standard operation):
Accept and store the numeric value specified for setpoint W1 or W2. Access the code numbers for parameterization level ***PA*** and configuration level ***C0***.
To acknowledge the code number entered and simultaneously enter the selected level.

Function in the parameterization/configuration level:
Selection of the entry options (flashes when selected).
Accept and store the numeric value entered.

9 Changeover between setpoints W1 and W2
Choice between setpoint W1 and W2. When setpoint W2 is active, the yellow LED located in the key illuminates.
In addition, selection can be made between setpoint W1 to W2 by applying 24 V d.c. to an external signal (note configuration block ***SP***, page 19).

10 Display variables XD, Y and W2
The three yellow LEDs indicate which variable (control deviation XD, controller output Y, setpoint W2) is displayed in the bottom display panel that was selected using the operating key (7). Setpoint W1 is usually displayed here.

11 Label for physical unit of temperature
Physical unit specification of the top and bottom display. It is attached above the top display panel using the supplied adhesive label. For this purpose, first remove the clamped-on frame.

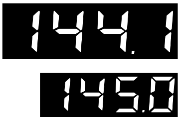
4.2 Operation of the three levels

Operation of the controller is divided into the following three levels of operation, also referred to as operating modes: 1) operating level (standard operation), 2) parameterization level and 3) configuration level.

4.2.1 Operating level

This is the standard operating level of the controller.

Controlled variable x is displayed in the top display panel; setpoint W1 is displayed in the bottom display panel.



Controlled variable x

The range of values in the display depends on the minimum and maximum measuring range limits, which are to be specified in the configuration level (see page 18) with ***In_*** and ***In‾***.

Setpoint W1

Setpoint W2 is displayed in the bottom display panel. If no LED (10) illuminates, setpoint W1 is selected in the display. The range of values depends on the measuring range limit ***In_*** and ***In‾*** specified for controlled variable x. Any decimal points are displayed analogous to the controlled variable display.

Modify setpoint W1

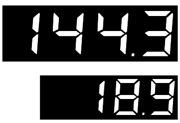
The displayed value can be modified to the desired value using **cursor** keys (5) △ and ▽.

After a single press of a **cursor** key (5), the display of the setpoint flashes, indicating that a new value may now be set.

Afterwards actuate the **ENTER** key (8) to accept and store the value, which is then retained in non-volatile memory even in event of power loss. If the new setpoint is not to be stored or activated, return can be made to the operating level (standard operation) by means of the operating key (7).

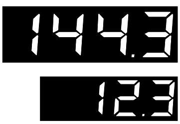
If other controller variables are to be displayed in the bottom display panel, the operating key (7) must be actuated each time.

In the sequence of the defined display, the following control parameters are displayed in the bottom display in conjunction with a yellow LED (10):



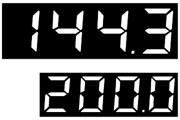
Control deviation (error) xd (xd = w – x)

The numeric value of the control deviation is displayed in the bottom display panel. In connection with this yellow LED, XD illuminates for the display mode control deviation (10). The displayed value is specified as a percent.



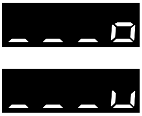
Output variable y

The numeric value of the output variable is displayed as a percent in the bottom display panel. The range of values in the display depends on the measuring range limit, which is to be specified with ***Y_*** and ***Y‾*** in the parameterization level. The yellow LED (10) of output variable Y illuminates.



Modify setpoint W2

Setpoint W2 is presented for viewing purposes in the bottom display panel. A change of setpoint W2 is performed analogous to that of setpoint W1. The yellow LED (10) of setpoint W2 illuminates.
If no LED (10) illuminates, W1 is selected as active setpoint in the display.



Display sensor line breakage

If a sensor wire break or short-circuit is detected at the controller input or an input range is exceeded in either direction, three bars appear in the top display panel, designated ***o*** (over) or ***u*** (under). In this case, the output signal is automatically set to the value specified in configuration block ***YSt*** (safety output value to restart) when AUTOMATIC mode is enabled.
After correcting the defect, the controller operates in standard operation.

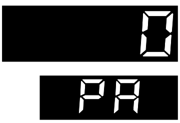
4.2.2 Parameterization level

Control parameters can be set in the parameterization level.
Values set in this level are protected against unauthorized access by means of a **code number** (personal security code lock).

Access to the parameterization level must be first obtained by entering the code number before set values can be modified.
The code number is pre-set (factory configuration) to ***0*** and can be modified in configuration block ***CPA*** (see page 22).

Determine and modify the control parameters
If control parameters are to be set, the parameterization level is opened after the code number has been entered and accepted.
Select the desired **parameterization** option using **cursor** keys (5) △ and ▽. If the yellow **ENTER** key (8) is consequently pressed, the selected option flashes in the bottom display panel.
Use **cursor** keys (5) △ and ▽ to set the desired value in the top display; press the **ENTER** key (8) to accept and store this value.
Advance to the next **parameterization** option using **cursor** keys (5) △ and ▽, or return to the operating level (standard operation) by pressing the **operating** key (7).

Open the parameterization level



Press yellow **ENTER** key (8)

PA appears in the bottom display panel; code number ***0*** appears in the top display panel.

Press **ENTER** key (8). ***PA*** flashes in the bottom display panel.
Enter the specified code number (if no number was entered, the factory default value ***0*** is assumed) in configuration block **CPA** using **cursor** keys (5) ▽ and △.

Press **ENTER** key (8) again to **open** the **parameterization level**. ***P*** appears as the first control parameter in the display.
If the wrong code number is entered, the controller returns to the operating level.
The following **parameterization** options listed can be selected and modified using **cursor** keys (5) △ and ▽.

`P` **Proportional-action coefficient P (Kp)**, **P**-action component of the controller
Range of values 0.1 to 100.0

`I` **Integral-action (reset) time I (Tn)**, **I**-action component of the controller
Range of values 0 to 2000 s, **disabled when set to *0***

`d` **Derivative-action (rate) time D (Tv)**, **D**-action component of the controller
Range of values 0 to 2000 s, **disabled when set to *0***

`dP` **Derivative-action (rate) gain *dP***, gain of the D-action component
Range of values 0.0 to 10.0 (D-action component only enabled when a value >0 is specified for ***dP***.

`Y_` `Y¯` **Output variable limits** ***Y_*** = −110.0 % to Y¯
Y¯ = Y_ to +110.0 %

This limit is **ineffective** for MANUAL function.

Selection of the output variable range determines the lower-limit (start) and upper-limit (end) value of the output signal range. The numeric values are displayed as percents of the selected controller output range.

Example: ***Y0*** = 0, current range 0 to 20 mA
Y_ = 20 %, Y¯ = 80 % → controller output Y = 4 to 16 mA

`YP` **Working point *YP*** (only active if I-action component = 0)

The setting range of working point ***YP*** corresponds to the setting range for output variable Y.
To set working point ***YP***, the current value of the output variable display must be read when the plant is in the steady-state and set as value for the working point. Thus, the offset (steady-state deviation) of a P or PD controller is eliminated when the setpoint is fixed-set.

The limit value and the differential gap for switching outputs ***Y1*** and ***Y2*** are defined with the displays shown below:

Selection of the limit value and the alarm condition is set in the configuration level via configuration block ***Y1*** or ***Y2***.
Further explanations on the switching outputs can be found in chapter 5.

`1A`	For ***Y*** = ***0*** or ***2***	Limit value ***Y1***
`1H`	For ***Y*** = ***0*** or ***2***	Differential gap for ***Y1***
`2A`	For ***Y*** = ***0*** or ***2***	Limit value for ***Y2***
`2H`	For ***Y*** = ***0*** or ***2***	Differential gap for ***Y2***

t 1

For ***Y*** = ***0*** or ***2*** — Duration of period for pulse-pause Switching output (Y1/Y2 = 8 or 9)
Setting range: 1 to 9999 sec.

For ***Y*** = ***1*** — Motor operating time of the final control element connected
Setting range: 1 to 9999 sec.

td

Dead band (neutral zone) ***td***

Range of values 0.1 to +100.0 % in reference to the output signal.

The dead band (for ***Y*** = ***1***) is entered for the three-step controller, and the minimum pulse duration is entered for the switching outputs (see chapter 5, page 9 for further details).

tH

For ***Y*** = ***1*** — **Differential gap**
Range: 0.1 to 100.0 %

After actuating the operating key (7), the controller returns to the operating level (standard operation).

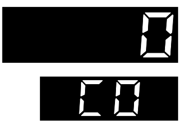
4.2.3 Configuration level

In the configuration level, the controller function is determined for the required control task to be solved.
Access can be made to the configuration level by entering the code number.
The code number is preset (factory preconfiguration) to ***0*** and can be modified in configuration block ***CCO*** (see page 22).

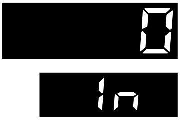
Determine and modify the controller functions

If controller functions are to be set, the configuration level is opened, considering the code number has been entered and stored first.
Use **cursor** keys (5) [△] and [▽] to select the desired configuration block. If the yellow **ENTER** key (8) is subsequently pressed, the block chosen flashes in the bottom display panel.
Now use **cursor** keys (5) [△] and [▽] to set the desired value or selection block in the top display panel. Accept and store this entry by pressing the **ENTER** key (8).
After modifying a value and actuating the ENTER key (8), the controller operates in MANUAL mode.
Use **cursor** keys (5) [△] and [▽] to advance to the next configuration block, or press the **operating** key (7) to return to the operating level.
The MANUAL function is activated, and switch was made to output variable Y in the bottom display. Switch can be made to AUTOMATIC operation by actuating the MANUAL/AUTOMATIC key (6).

Open the configuration level



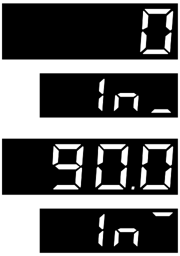
Press the yellow **ENTER** key (8); ***PA*** appears in the bottom display panel.
Press **cursor** key [△]. ***CO*** appears in the bottom display panel. Code number ***0*** appears in the top display panel.
Press **ENTER** key (8); ***CO*** flashes in the bottom display panel.
Use **cursor** keys (5) [▽] and [△] to set the specified code number in configuration block ***CCO*** (if no number was entered in ***CCO***, the factory default ***0*** remains in force).
Press the **ENTER** key (8) to confirm the code number and **open** the **configuration level**. The first configuration block ***In*** appears.
If the wrong code number is entered, the controller returns to the operating level (standard operation).
All the configuration blocks listed below can be selected and modified via **cursor** keys (5) [△] and [▽].



Select input signal *In*

Configuration block ***In*** determines the controller input signal. The following input options can be defined using selection options 0 to 5:

0 —	Pt 100	– 30.0 to 150.0 °C
1 —	Pt 100	–100.0 to 400.0 °C
2 —	Current	0(4) to 20 mA
3 —	Voltage	0(2) to 10 V
4 —	Ni 100	– 20.0 to 90.0 °C
5 —	Ni 100	– 60.0 to 180.0 °C



Measuring range limits *In_* and *In‾*

In_ — Starting value (minimum value)
In‾ — End value (maximum value)

The measuring range of controlled variable x is determined in configuration block ***In***. Using ***In_*** and ***In‾***, the measuring range can be determined by the user in the range of ***In***. Both the lower-limit and upper-limit range value mutually limit each other. If, for example, the configuration is assigned ***In*** = ***0*** (for Pt 100 with –30.0 to 150.0 °C measuring range), the measuring range of controlled variable x is defined at ***In_*** = –30.0 and ***In‾*** = 150.0. This measuring range can be modified within limits ***In_*** and ***In‾***. For the input signals involving current or voltage, the measuring range is determined at ***In_*** = 0.0 and ***In‾*** = 100.0 in the configuration process. If the measuring range limits are modified in the range from –1999 to 9999 with variable decimal point, the input signals are only converted for display purposes.

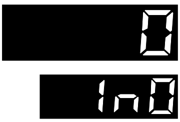
Example: x-input = 0 to 20 mA, ***In_*** = 100.0, ***In‾*** = 300.0
x = 50 % = 10 mA = display 200.0

Decimal point *Ind* (for ***In*** = ***2*** or ***3***)

The decimal point and the controlled variable can be selected by the user in the bottom display and top displays, resp.

0 —	No decimal point	e.g., W1 = 132
1 —	One decimal point	e.g., W1 = 13.2
2 —	Two decimal points	e.g., W1 = 1.32
3 —	Three decimal points	e.g., W1 = 0.132

When input signal of resistance thermometers Pt 100 or Ni 100 is selected, ***Ind*** = ***1*** is set; i.e., a decimal point is shown.



Select the current or voltage ranges of controlled variable x with *In0*

0 —	0 to 20 mA	or	0 to 10 V	Depending on the selection
1 —	4 to 20 mA	or	2 to 10 V	Depending on the selection

(inapplicable for Pt 100 or Ni 100)

Unit of temperature *Int*

Temperatures can be displayed in either °Celsius or °Fahrenheit.

0 — °C
1 — °F

Any change of this configuration block causes the new measuring range limits to be stored.
Example: ***In*** = ***0*** → Measuring range ***In_*** = –30.0 and ***In¯*** = 150.0 in °C (with ***Int*** = ***0***).
Change the unit of temperature to Fahrenheit with ***Int*** = ***1***.
The new measuring range is now modified according to the limits below:
In_ = –22.0 and ***In¯*** = 302.0 in °F.

Digital filter *InF*

Digital filter ***InF*** has the function of filtering analog input x. Range of values 0.0 to 120.0 sec., with 0.0 disabled; e.g., for fast controlled systems.

Select the input circuitry of the D (derivative)-action component with *dI*

The differential-action component of the controller can be either directly applied to controlled variable x, or behind the setpoint/actual reference junction of xd (Fig. 1).

0 — To x-input
1 — To control deviation xd

Select setpoint *SP*

Switching between setpoints W1 and W2 is accomplished either by actuating the W1/W2 key (9), or applying an external signal (+24 V) via terminal connections 2 and B of the binary input. Selection and combination options of the setpoints are determined via configuration block ***SP***.

0 — W1 active, W2 disabled
1 — W1/W2 Switchover only permitted via key
2 — W1/W2 Switchover permitted by either key or binary input
(binary input has priority, i.e.,:
BE = 0 → Switchover permitted via key
BE = 1 → Switchover not permitted via key, W2 is active)
3 — Switchover permitted only via binary input
4 — Restart the setpoint ramp via binary input BE beginning from existing x-value; W2 is disabled.

SPr

Setpoint ramp *SPr*
(explanatory Fig. 7, see page 23)

The setpoint ramp causes a modification of the setpoint over a defined time. Range of values: 0 to 9999 sec.
The time in which a modification of the setpoint by 100 % should be set. This time ramp is effective for every modification of setpoint. To disable this option, set the parameter to ***0***.

In this context, note configuration block ***SP*** = ***4***, which performs an x-tracking (w = x) by enabling the binary input of the setpoint. After the input is switched back (disabled), the setpoint is modified with the set speed until the set value is reached.

SPH

Inhibit (HOLD) modification of the setpoint *SPH*

0 — W1/W2 can be modified
1 — W1 can be modified, W2 inhibited
2 — W2 can be modified, W1 inhibited
3 — W1/W2 inhibited

YH

Lock (HOLD) the MANUAL/AUTOMATIC key *YH*

0 — Switchover to MANUAL/AUTOMATIC permitted with key
1 — Switchover to MANUAL upon sensor breakage; safety output value YSt applied
2 — Switchover to MANUAL/AUTOMATIC locked using key

Y

Select controller output *Y*

0 — Continuous controller output with limit contacts Y1 and Y2
1 — Three-step controller and recorder input for controlled variable x
2 — Continuous controller output is available as recorder input for controlled variable x, with limit contacts Y1 and Y2

Yr

Operating direction *Yr*

Setting

0	Inverse <>,	Increasing x → decreasing Y or decreasing x → increasing Y
1	Direct >>,	Increasing x → increasing Y or decreasing x → decreasing Y

Y0

Select the current range of controller output Y with *Y0*

0 — 0 to 20 mA
1 — 4 to 20 mA

Safety output (restart) value *YSt*

Should the sensor line break, this is used as the restart value following power failure

If the senor line breaks, the controller output is automatically set to specified value ***Yst***. The controller output value can be set from –10.0 to 110.0 % of the output variable range.

For Y = 1: ***YSt*** < 0.0 % → – Signal is output
YSt > 100.0 % → + Signal is output
YSt in the range from 0.0 to 100.0 %; no signal is output.

Limit alarm condition for switching output *Y1*

For Y = 1, Y1 is inactive and cannot be modified. The alarm condition refers to the numeric value of the value entered under parameterization option ***1A***.

0 — Switching output Y1 is not set
1 — Contact Y1 switches when x falls below the limit value
2 — Contact Y1 switches when x exceeds the limit value
3 — Contact Y1 switches when xd falls below the limit value
4 — Contact Y1 switches when xd exceeds the limit value
5 — Contact Y1 switches when lxdl exceeds the limit value
6 — Contact Y1 switches when y falls below the limit value
7 — Contact Y1 switches when y exceeds the limit value
8 — Clocked controller output positive
9 — Clocked controller output negative

Switching output Y1 as break or make contact *Y1C*

0 — Make (NC) contact
1 — Break (NO) contact

Limit alarm condition for switching output *Y2*

For Y = 1, Y2 is inactive and cannot be modified. The alarm condition refers to the numeric value of the value entered under parameterization option ***2A***.

0 — Switching output Y2 is not set
1 — Contact Y2 switches when x falls below the limit value
2 — Contact Y2 switches when y exceeds the limit value
3 — Contact Y2 switches when xd falls below the limit value
4 — Contact Y2 switches when xd exceeds the limit value
5 — Contact Y2 switches when xd exceeds the limit value
6 — Contact Y2 switches when y falls below the limit value
7 — Contact Y2 switches when y exceeds the limit value
8 — Clocked controller output positive
9 — Clocked controller output negative

Switching output Y2 as break and make contact *Y2C*

0 — Break (NO) contact
1 — Make (NC) contact

Adaption (self-tuning) *AdP*

0 — Off, no adaption
1 — Ready for adaption, optimize following disturbance z

Adaption is an auto-tuning function implemented in the start-up phase which allows the controller to independently adapt (tune) itself to the conditions of the controlled system and calculate the optimum control parameters. For those controlled systems which are critical and extremely fast, those in which the control valve is not adjusted abruptively, configuration block is to be set to ***AdP* = *0*** and, hence, disabled (see also section 6.3).

Enter code numbers *CPA* and *CCO*

Code numbers *CPA* and *CCO*

CPA — Code number of the parameterization level
CCO — Code number of the configuration level

Range of values ***0 to 9999***

Procedure for entering/modifying the code number:

Press yellow **ENTER** key (8); ***PA*** appears in the bottom display.

Press **cursor** key (5) △; ***CO*** appears in the bottom display.

Press **ENTER** key (8); ***CO*** display flashes. Default code number ***0*** is displayed in the top display panel.
If a code number has already been defined, enter this number using **cursor** keys (5) △ and ▽ (subsequent modification is then possible).

Press **ENTER** key (8)—. **The configuration level is opened** and the first configuration block ***In*** is displayed.

Actuate **cursor** keys (5) △ and ▽ until either configuration block ***CPA*** appears for the parameterization level or configuration block ***CCO*** appears for the configuration level.

Press **ENTER** key (8)—. ***CPA*** or ***CCO***, resp. flash. ***0*** or the previously entered code number appear in the top display.

Use the **cursor** keys (5) △ and ▽ to enter or modify the desired code number.

Press **ENTER** key (8) in order to accept and store the personal **code number**

Actuate **operating** key (7) in order to return the controller to the operating level (standard operation)

Code number for servicing

Page 33 of this operating manual contains the subordinate code number for servicing which should be memorized. This special code allows, despite the entered code number ***CPA*** and ***CCO***, values to be modified in the configuration level. In order to prevent this code number from access by unauthorized persons, either cut out or scribble over this number on page 33, making it unrecognizable. Access can be made to configuration level ***CO*** by entering the special code number described above.

The code numbers for the parameterization level can be interrogated and modified in configuration block ***CPA***. The configuration level can be manipulated similarly in configuration block ***CCO***.

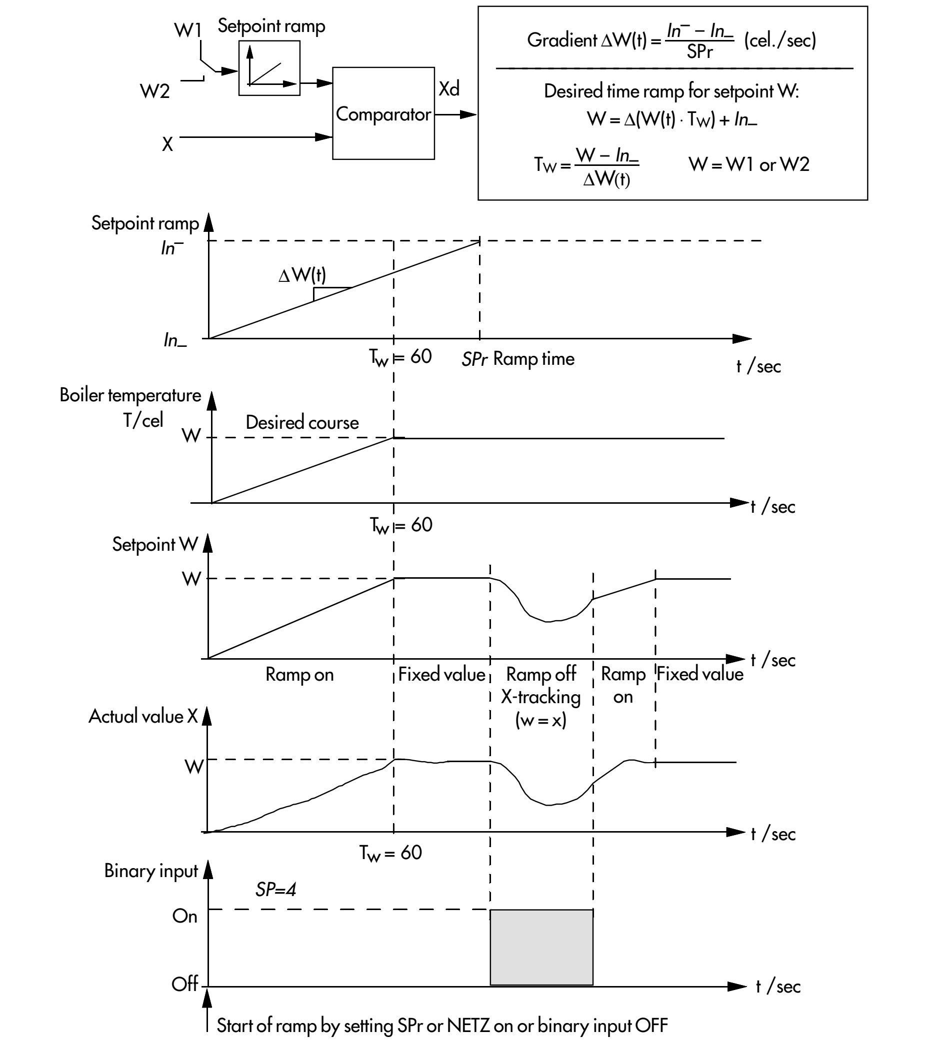


Fig. 7 · Setpoint ramp ***SPr***

5. Switching outputs *Y1* and *Y2*

Depending on how configuration block ***Y*** was selected, the output signal is defined in **TROVIS 6494** as either a three-step or on-off output signal and/or limit contacts.

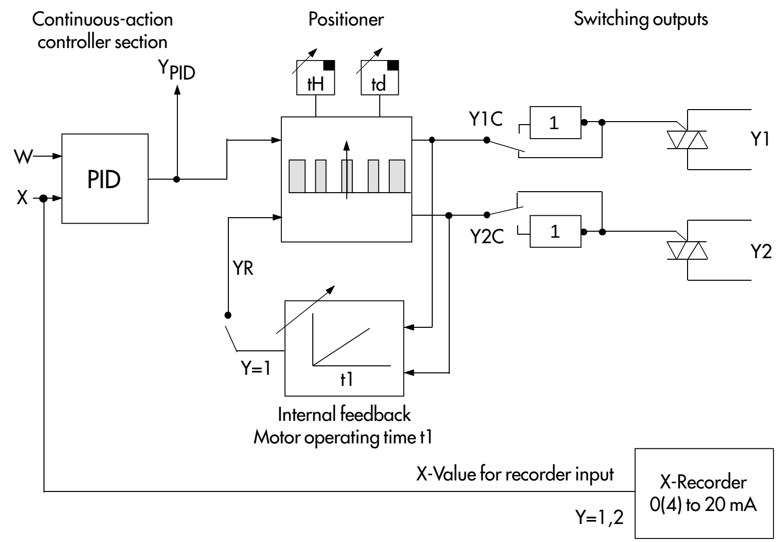


Fig. 8 · Switching outputs

5.1 Three-step controller with internal feedback (*Y* = *1*)

The three-step controller incorporating internal feedback is selected in the configuration level with configuration switch ***Y*** = ***1***.
In this configuration scheme, switching output ***Y1*** is then active when the difference between the calculated Y_{PID} signal and the internal feedback is positive. Switching output ***Y2*** is always active when this difference is negative.
With dead band **td**, a range (neutral zone) can be defined in which the switching signal is still not to be active.
Dead band ***td*** applies in equal proportions for positive and negative output signals (50% each). The hysteresis which can be commonly set for both switching points is set as a percentage using parameter ***tH***.

Example:
Y_{PID} = 20 %; ***YR*** = 16 %;
$Y = Y_{PID} - YR$ = 20 % – 16 % = **4 %**.

In a situation where the set dead band ***td*** = 10 %, ***Y1*** is not active. Reason: 5 % dead band for positive output signals is not exceeded. If differential gap ***tH*** is set with 1 %, then ***Y1*** is only active when ***Y*** > 5 %. ***Y1*** is then disabled whenever ***Y*** < 4 %.

The internal feedback is to be adapted, in seconds, to the installed actuator using parameter ***t1*** (motor operating time). The internal feedback simulates the behaviour of the installed actuator. By inserting an internal feedback, the discontinuous-action controller output takes on a behaviour resembling that of a continuous controller output (quasi-continuous controller output).

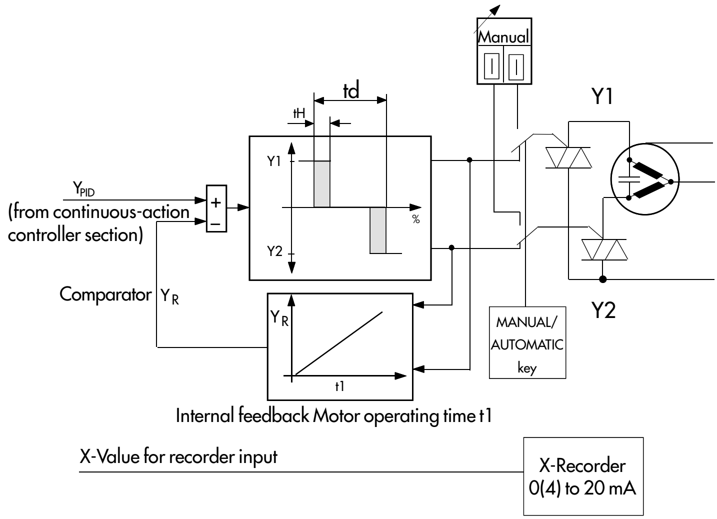


Fig. 9 · Three-step switching

t1 = Operating time of the implemented actuator (in seconds)
td = Dead band as a percentage
tH = Hysteresis as a percentage

For the selection of three-step controller providing internal feedback (***Y*** = ***1***), configuration blocks ***Y1*** and ***Y2*** are insignificant and cannot be altered.

5.2 Limit contacts (*Y = 0* or *2*)

5.2.1 General definition

Each limit contact (***Y1*** and ***Y2***) can, independent of one another, be assigned a value. This value can be monitored to determine whether it is exceeded in either direction. Limit contacts are assigned using configuration block ***Y1*** (switching output ***Y1***) and configuration block ***Y2*** (switching output ***Y2***).
The limit value is set in the paramterization level as a percentage using parameter ***1A*** or ***2A***. This is set absolutely (assignment to input signal X) or as a percent (assignment to an internal signal Y or XD) using parameter ***1A*** or ***2A***, resp.
A limit contact, similar to an on-off controller output, contains a differential gap which is set as a percentage with parameter ***1H*** or ***2H***, referring to the range of the monitored variable.
The limit alarm contact basically contains two circuit states (closed/opened), triggered by means of a snap-action element. If the switching condition of the limit value is satisfied, the switching output is closed; otherwise it is open.
Fig. 10 clarifies the behaviour of the activated limit alarm contact ***Y1*** or ***Y2*** when it is exceeded in either direction. The controller output is disabled up to a set limit value. After limit value ***1A*** is exceeded - minus the differential gap ***1H*** -, the limit contact is open.
Underrange of a limit value is monitored analogous to that of an exceeded limit value. The controller output remains disabled until the limit contact is reached. After the limit value has been fallen short of, the contact is closed. As soon as the limit value plus differential gap has been exceeded, the contact is opened.

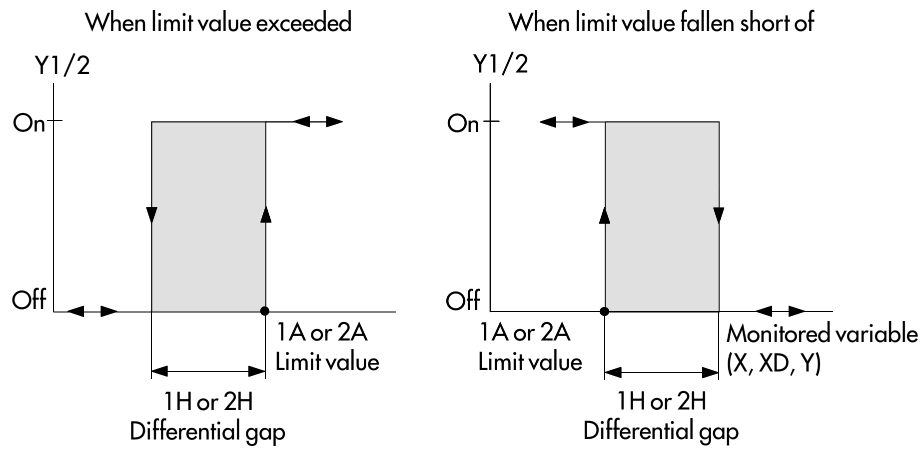


Fig. 10 · Limit contacts with snap-action element

5.2.2 Assignment of the limit alarm conditions for switching outputs *Y1* and *Y2*

Limit alarm contact ***Y1*** is assigned in configuration block ***Y1***. ***Y2*** is assigned with configuration block ***Y2***. The default configuration does not assign an alarm condition to the limit alarm contacts (configuration switches ***Y1*** = ***0*** and ***Y2*** = ***0***).
Only the assignment options for limit alarm contact ***Y1*** are described in the following section. Note that limit alarm contact ***Y2*** functions in the same way as that of contact ***Y1***. Input variable ***X*** can be monitored to determine if a limit value is fallen short of (***Y1*** = ***1***) or exceeded (***Y1*** = ***2***). There is also the possibility of monitoring controlled deviation ***XD***. In this case, it is possible to monitor the controlled deviation to determine if it is fallen short of (configuration switch ***Y1*** = ***3***) or exceeded (configuration switch ***Y1*** = ***4***).
When ***XD*** is monitored with configuration switch ***Y1*** = ***5***, the value can be evaluated to identify whether or not XD has been exceeded.
Likewise, controller output Y can be monitored to determine if it has fallen short of (***Y1*** = ***6***) or exceeded (***Y1*** = ***7***). The method of monitoring output signal Y is described in the next section.

5.2.3 Monitor output signal *Y*

Output signal Y can be monitored to determine if it the limit value is exceeded in either direction. Apart from the pure two-output used to determine if a limit value is exceeded in either direction, a three-step action can be implemented when configuration blocks ***Y1*** and ***Y2*** are appropriately set.
With the combination ***Y1*** = ***6*** and ***Y2*** = ***7*** or ***Y1*** =***7*** and ***Y2*** = ***6***, a three-step switching output is implemented which uses fixed switching points. No internal feedback is applied in this case.
In this type of configuration, either a P or PD algorithm (set ***P***, ***d***, ***dP***) is recommended. Working point ***YP*** should be set, and the output variable limit ***Y_*** should be set to –100.0 %.

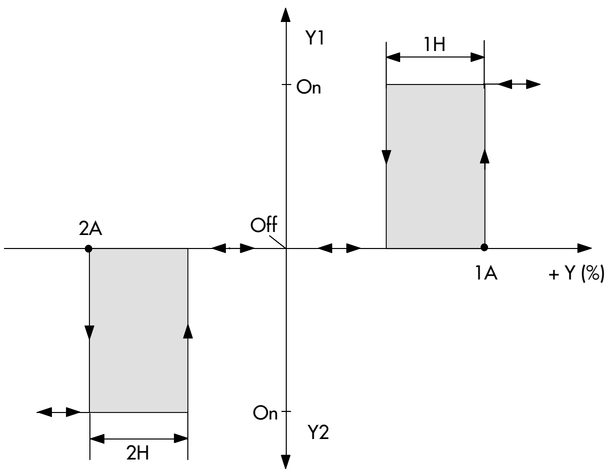
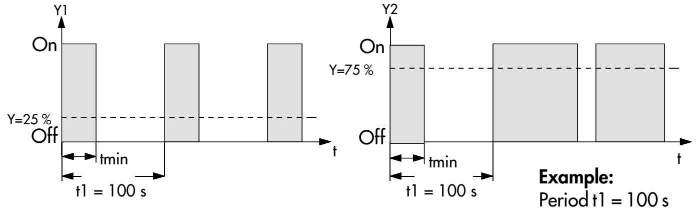


Fig. 11 · Switching 2*on-off output with Y1 = 7 and Y2 = 6

5.2.4 Pulse-modulated on-off controller output at switching output *Y1* and/or *Y2*

The pulse-modulated controller output is a switching output in which the output signal is a pulse frequency. In this case, the pulse-pause ratio is varied for a specified period of time (***t1***). Here, the period is entered in seconds with parameter ***t1***. The minimum on-time is set as a percentage using parameter ***td***.
Selection of the pulse-modulated switching output is made in configuration block ***Y1 = 8/9*** and/or ***Y2 = 8/9***. ***Y1 = 8*** selects a clocked controller output in a positive direction of output signal Y. When configuration switch ***Y1 = 9***, a clocked control controller output ***Y1*** is selected in a negative direction of output signal Y. Switching output ***Y2*** operates similarly, with ***Y2 = 8*** or ***9***.
The switching action operates the same as an on-off controller output with internal feedback.



$$t_{min} = \frac{td \cdot t1}{100\ \%}$$

Example:
Period t1 = 100 s
Min. puls time td = 5 %

This corresponds to: $t_{min} = \frac{5\ \% \cdot 100\ s}{100\ \%} = 5\ s$

Fig. 12 Clocked controller output

5.2.5 On-off pulse-modulated controller output with limit alarm

In this type of output circuit, a switching output (***Y1*** or ***Y2***) is pulse modulated in either a positive output signal direction (***Y1*** or ***Y2 = 8***) or negative output signal direction (***Y1*** or ***Y2 = 9***). In this case, the period of time ***t1*** and the minimum pulse duration ***td*** is set for the pulse-modulated controller in the parameterization level.
The other switching output is activated upon an alarm condition. The limit alarm condition is set with configuration switch ***Y1 = 1*** to ***7*** (controller output ***Y1***) or ***Y2 = 1*** to ***7*** (controller output ***Y2***). This limit condition refers to the parameter ***1A*** (*for* ***Y1***) or ***2A*** (*for* ***Y2***) set in the parameterization level. In addition, the differential gap must be set with parameter ***1H*** (controller output ***Y1***) or ***2H*** (controller output ***Y2***).

5.2.6 Two pulse-modulated on-off switching outputs

In order to achieve two pulse-modulated controller outputs which are effective with positive and/or negative output signals Y, configuration switch ***Y1 = 8/9*** and ***Y2 = 8/9*** must be set. In this case, the period of time ***t1*** and the minimum pulse duration ***td*** are simultaneously set for both pulse-modulated controller outputs.

Example:
Configuration switch ***Y1 = 8*** sets the pulse-modulated two-point switching output which is set by positive output signal Y. Configuration switch ***Y2 = 9*** sets a pulse-modulated switching output for negative output signals Y.
Pulse-modulated on-off controller outputs are suitable to control heating — cooling applications.

6. Start-up procedure

EPROM version: After switching on the power supply, the controller displays the current EPROM version installed for a few seconds in the bottom display panel; e.g., **1.00**,. Device type 6494 is displayed in the top display panel (note: important information to be specified when servicing or placing customer inquiries!).

IMPORTANT

Always proceed in the following order: 1) configuration, 2) parameterization, 3) optimization (same order as described in this manual!)

1) Configuration: After power is supplied to the controller and all inputs/outputs have been connected, the controller must be adapted (tuned) to the control task to be solved by determining functions in the configuration level. For this purpose, individual configuration blocks are to be configured and set as detailed in section 4.2.3.

2) Parameterization: Whether the controller shall operate as a P, PI, PD or PID controller must be determined in the parameterization level. Even in this case, all parameterization options must be set (section 4.2.2).

3) Optimization: Control parameters ***P***, ***I*** and ***d*** for adaption to the controlled system must be set and modified in the optimization procedure (section 6.2). P, I and d represent Kp, Tn and Tv (proportional, reset and rate), resp.

6.1 Configure the different controller outputs

The different controller output signals also require a different procedure in the commissioning phase. Proceed in the order presented below:

6.1.1 Continuous-action controller (*Y = 0*)

— Open the **configuration level** (page 17)
— Select the input signal via ***In***
— Determine the input range via ***In_*** and ***In¯***
— Determine the output signal via ***Y = 0*** (continuous)
— Determine the operating direction via ***Yr***
— Select the desired extended function such as digital filter ***InF***, temperature display in °Fahrenheit ***Int*** or alarm conditions for limit contacts ***Y1*** and ***Y2***
— Open the **parameterization level** (page 14)
— Limit output signal Y via ***Y_*** and ***Y¯***
— Enter desired limit values for ***1A***, ***2A***
— Optimize the plant by entering control parameters ***P***, ***I***, ***d*** and ***dP***

6.1.2 Three-step controller with internal feedback (*Y* = *1*)

Controlled variable x can also be used as a recorder input.

- Open the **configuration level** (see page 17)
- Select the input signal via ***In***
- Determine the input range via ***In_*** and ***In‾***
- Determine the output signal via ***Y***:
  Y = ***1***, three-step controller.
- Determine the operating direction via ***Yr***
- Select the desired extended functions such as digital filter ***InF*** and temperature display in °Fahrenheit ***Int***.
- ***Y1*** and ***Y2*** **cannot** be used as limit contacts here any more. Therefore, set both of these to ***0***.
- Open the **parameterization level** (see page 14)
- Motor operating time via parameter ***t1***
  Differential gap via parameter ***tH***
  Enter dead band via parameter ***td***
- Optimize the plant by entering control parameters ***P***, ***I***, ***d*** and ***dP***

6.1.3 Controlled variable x as recorder input (*Y* = *2*)

Controlled variable x can be used as a recorder input. Switching outputs ***Y1*** and ***Y2*** are available as limit contacts.

- Open the configuration level (see page 17)
- Select the input signal via ***In***
- Determine the input range via ***In_*** and ***In‾***
- Determine the output signal via ***Y*** = ***2***
- Determine the operating direction via ***Yr***
- Select the desired extended function such as digital filter ***InF*** and temperature display in °Fahrenheit ***Int***
- Alarm conditions can be selected for limit contacts ***Y1*** and ***Y2*** by means of configuration blocks ***Y1*** and ***Y2***, resp.
- Open the parameterization level (see page 14)
- Limit the output signal Y via ***Y_*** and ***Y‾***
- Enter the desired limit values for ***1A*** and ***2A***
- Enter the desired differential gap of the limit values via ***1H*** and ***2H***, rep.
- Optimize the plant by entering control parameters ***P***, ***I***, ***d*** and ***dP***

6.2 Optimize the control parameters

(tune the controller to the controlled system)

In order for the controller to keep the control deviations caused by disturbances in certain limits (or eliminate) for all setpoints, control parameters ***P***, ***I***, ***d*** and ***dP*** are used to adapt (tune) the controller to the dynamic performance of the controlled system.
Note that control parameters and setpoints entered are only effective after they have been accepted and stored by pressing the yellow ENTER key (8).

P controller

— In the parameterization level, specify control parameters with ***P = 0.1***, ***I = 0 = off*** and ***d = 0 = off***.
— In the operating level, set the setpoint to the desired value and then modify the output variable using **cursor** keys (5) △ and ▽ such that the control valve slowly opens, and xd becomes zero.
— Switch to **AUTOMATIC**.
— Increase P value until the controlled system inclines to oscillate.
— Slightly decrease P value until no more oscillation can be determined.
Correct offset (steady-state deviation) by setting working point ***Y0*** as indicated below:
In the steady-state of the plant, read the current value of output variable y and enter as value for working point ***YP*** in parameterization option ***YP***.
IMPORTANT:
Every change of setpoint also causes a change of working point ***YP***.

PI controller

— In the paratmerization level, specify control parameters with ***P = 0.1***, ***I = 2000*** (maximum) and ***d = 0 = off***.
— In the operating level, set the setpoint to the desired value and then modify the output variable using **cursor** keys (5) △ and ▽ such that the control valve slowly opens, and xd becomes zero.
— Switch to **AUTOMATIC**.
— Increase P value until the controlled system inclines to oscillate.
— Slightly decrease the P value until no more oscillation can be determined.
— Decrease I value until the system inclines to oscillate.
— Slightly increase I value until no more oscillation can be determined.

PD controller

— In the parameterization level, specify control parameters with ***P* = *0.1***, ***I* = *0* = *off*** and ***d* = *0* = *off***, and set derivative-action (rate) gain ***dP*** normally to a value between ***5*** and ***10***.
— In the operating level, set the setpoint to the desired value and then modify the output variable with using **cursor** keys (5) △ and ▽ such that the control valve slowly opens, and xd becomes zero.
— Increase P value until control system inclines to oscillate.
— Set d value to 1 s and then increase until oscillations cease.
— Increase P value until oscillations resume.
— Increase d value until no more oscillations can be determined.
— Proceed a few times in the same manner until oscillations cannot be suppressed any more. Slightly decrease P value and d value so that the controlled system comes to abatement again.

Correct offset by setting working point YP as indicated below:
In the steady-state of the plant, read the current value of output variable y and enter as value for working point ***YP***.
IMPORTANT:
Every change of setpoint also causes a change of working point ***YP***.

PID controller

— In the parameterization level, specify control parameters with ***P* = *0.1***, ***I* = *2000*** and ***d* = *0* *off*** and set derivative-action (rate) gain ***dP*** to a value normally between ***5*** and ***10***.
— In the operating level, set the setpoint to the desired value and then modify the controller output value with the cursor keys (5) △ and ▽ such that the control valve slowly opens, and xd becomes zero.
— Increase P value until the controlled system inclines to oscillate.
— Set d value to 1 s and increase until oscillations cease.
— Slowly increase P value until oscillations resume.
— Increase d value until no more oscillations can be determined.
— Proceed a few times in the same manner until oscillations cannot be suppressed any more.
— Slightly decrease P and d value so that the controlled system comes to abatement again.
— Decrease I value until the plant inclines to oscillate again and increase again until oscillations cease.

6.3 Adaption (self-tuning)

For optimum configuration of control loops, the characteristic values of the controlled system must be known. Self-tuning is an automized function used to record and optimize the dynamic system characteristics.
Self-tuning of **TROVIS 6494** involves evaluation of the measured transfer function from which the ideal control parameters are calculated.
Before conducting the adaption, the control loop should assume a calm state for five minutes, with an controller output value under 80%.
The desired control mode (***PI*** or ***PID*** response) must be selected prior to conducting the adaption. PI control mode is selected with the control parameters ***P***, ***I*** > ***0*** (for I (integral)-action component) and ***dP*** = ***0***; ***PID*** control mode implies use of control parameters ***P***, ***I*** > ***0*** and ***dP*** > ***0*** (for I (integral)-action component and D (derivative)-action component). Select the operating direction and the controller output prior to proceeding with the adaption.
The adaption option is selected in the configuration level with configuration block ***AdP***. Configuration switch ***AdP*** = ***1*** is used to set an adaption for optimum behaviour when the disturbance z is instabile. After exiting the configuration level, the controller assumes MANUAL operation. Controlled variable x can be viewed in the top display; output variable y can be viewed in the bottom display. Now, the adaption is ready to be started by means of the MANUAL/AUTOMATIC key (6). If not desired, de-select in the configuration level with configuration switch ***AdP*** = ***0*** using the yellow ENTER key (8).
Running the adaption procedure is accomplished by actuating the MANUAL/AUTOMATIC key. If the current controller output value is less than 80 %, no adaption is initiated. As soon as the adaption has been started, all keys except the MANUAL/AUTOMATIC key are locked until the adaption has completed.
By starting the adaption routine, a 20 % step change of output variable y is controller output in a positive direction, which informs the controller of a step response which it uses to calculate the ideal control parameters.
The LED in the MANUAL/AUTOMATIC key continues to flash until the control parameters are calculated and stored.

If necessary, the adaption procedure can be aborted at any time using the MANUAL/AUTOMATIC key.

After the adaption is finished, the controller assumes MANUAL operation. All control parameters determined by the adaption are stored and in non-volatile and memory protected against power loss. Their values can be changed as desired in the parameterization level.

Restraint:

The controller output option of the self-tuning function is to be selected so small that the system excitation does not assume a critical value for the process.
The adaption procedure implemented in **TROVIS 6494** is intended for controlled systems where recovery action and dead time are crucial factors which must be dealt with.

Code number for servicing	1732

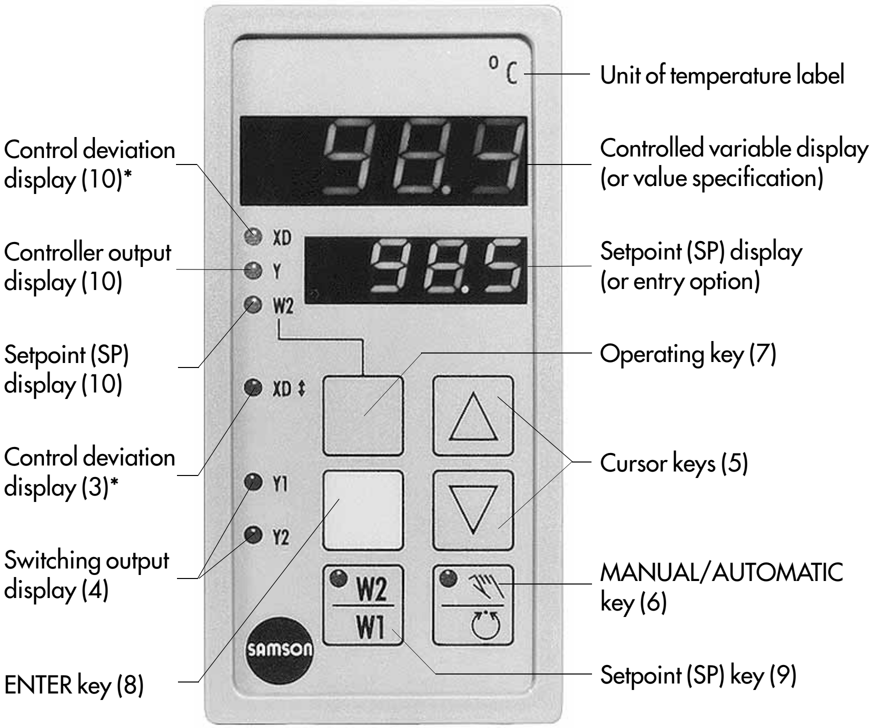
Checklist:			
Device:	Plant:	Process designation:	Date:

Selection option/ block	Designation	Range of values	Factory default	Start-up values/ modifications		
Operating level:						
X	Controlled variable	Dep. on input	—			
W1	Internal setpoint 1	In_to In¯	0			
XD	Control deviation (error)	–100.0 to 100.0 %	—			
Y	Output variable	Y_to Y¯	—			
W2	Internal setpoint 2	In_to In¯	0			
Parameterization level:						
P	Proportional-action coefficient Kp	0.1 to 100.0	1.0			
I	Integral (reset) time Tn 0 = Off	0 to 2000 s	0			
d	Derivative (rate) time Tv 0 = Off	0 to 2000 s	0			
dP	Derivative (rate) gain 0 = Off	0.0 to 10.0	0.0			
Y_	Min. output variable limit	–110.0 to Y¯ %	0.0			
Y¯	Max. output variable limit	Y_to 110.0 %	100.0			
YP	Working point	–110.0 to 110.0 %	0.0			
1A	Limit value Y1	Acc. to alarm cond.	0.0			
1H	Differential gap Y1	0.1 to 100.0 %	1.0			
2A	Limit value Y2	Acc. to alarm cond.	0.0			
2H	Differential gap Y2	0.1 to 100.0 %	1.0			
t1	Period	1 to 9999 s	120			
	Motor operating time	1 to 9999 s	120			
td	Dead band (Y = 1)	0.1 to 100.0 %	1.0			
	Min. pulse duration	0.1 to 100.0 %	2.0			
tH	Hysteresis	0.1 to 100.0 %	1.0			

Checklist:			
Device:	Plant:	Process designation:	Date:

Selection option/ block	Designation	Range of values	Factory default	Start-up values/ modifications		
Configuration level:						
In	Type of input signal	0 to 5	1			
In_	Min. measuring range limit X	Depending on In	–100.0			
In¯	Max. measuring range limit X	Depending on In	400.0			
Ind	Decimal point	0 to 3	1			
In0	Range selection current/voltage	0 or 1	1			
Int	Unit of temperature °C/°F	0 or 1	0			
InF	Digital filter	0.0 to 120.0 s	0.5			
dI	D-action component	0 or 1	0			
SP	Selection of setpoint (SP)	0 to 4	0			
SPr	Setpoint ramp	0 to 9999 s	0			
SPH	Inhibition of setpoint modification	0 to 3	0			
YH	Lock MANUAL/AUTOMATIC key	0 to 2	0			
Y	Select controller output	0 to 2	0			
Yr	Operating direction	0 or 1	1			
Y0	Select the current range output	0 or 1	1			
YSt	Safety output (restart) value	–110.0 to 110.0 %	–10.0			
Y1	Limit alarm condition	0 to 9	0			
Y1C	Make or break contact Y1	0 or 1	0			
Y2	Limit alarm condition	0 to 9	0			
Y2C	Make or break contact Y2	0 or 1	0			
AdP	Adaption	0 or 1	0			
CPA	Code no. of parameterization level	0 to 9999	0			
CCO	Code no. of configuration level	0 to 9999	0			

Front view



* Due to technical reasons, the term control deviation XD has been used to represent the setpoint error ($e = w - x$). The correct abbreviation reads correctly as e.

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