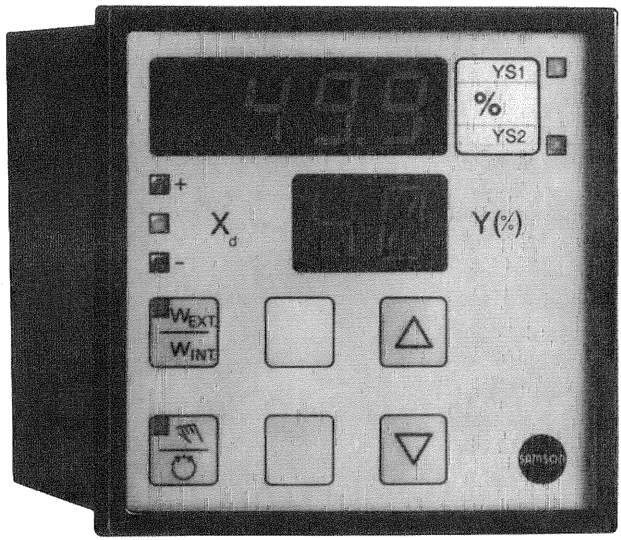
TROVIS 6400

Industrial Controller
TROVIS 6496



Edition June 1994

Mounting and operating instructions

EB 6496 E

Contents

Page

Contents		Page

1.Description

The TROVIS 6496 Controller is used for process automation in industrial and process plants. Since it is designed according to the requirements of practical applications, it can be used to configure different control algorithms. The controller is applicable as continuous-action, on-off, or three-step controller, optionally with P, PI, PD, or PID action.
A self-optimizing function allows automatic determination and adjustment of the control parameters.

Operation is performed via the sealed front-panel keyboard and is divided into three logic levels for operation, parametrization and configuration.
The level of operation and the associated displays for the normal control mode are accessible at any time. Access to the level of parametrization where the control parameters are altered to perform optimum adaptation of the controller to the controlled system as well as to the level of configuration where the control functions have to be selected is protected by means of key numbers.These numbers can be chosen by the user.

The controller inputs can be selected for connection of either Pt 100 resistance thermometers, thermocouples, standardized current or voltage signals or transmitters in two-wire circuits.

Changeover from internal reference variable ***WI*** to external reference variable ***WE*** can be performed by depressing a key or by means of a binary signal. In addition, the individual reference variables can be selected and interconnected.

Operation of the manual/automatic button from the front allows bumpless changeover to the respective operating mode.

1.1 Versions

TROVIS **6496-0▢**

Output

continuous-action with analog output	**1**
continuous-action/on-off/three-step/limit contact, reversible with analog output	**3**

Options

Serial RS 485 interface with Modbus protocol software
6496-03 with 2 additional limt contacts

Controllers for temperature measurements by means of **Pt 100 resistance thermometers** in three-wire circuits differ from oneanother by the temperature ranges for which they are applicable:

Version 1[1)] –100 °C to +400 °C
Version 2[2)] –30 °C to +150.0 °C

This mounting and operating instruction applies for controllers with firmware version 3.01 and higher

> ⚠ **Warning**
> Installation and taking into operation of this controller must be carried out only by experienced personnel.

[1)] Specify version, either **1 or 2**, when ordering the controller

1.2 The functional structure of the controller, schematic representation

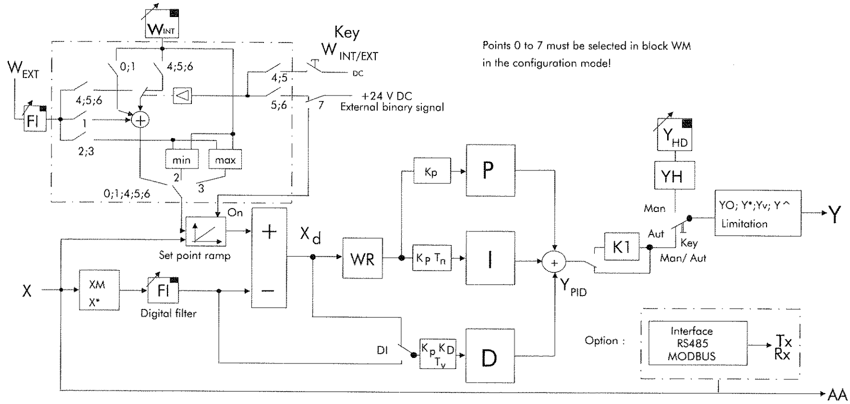


Fig. 1 · TROVIS 6496-01 with continuous output

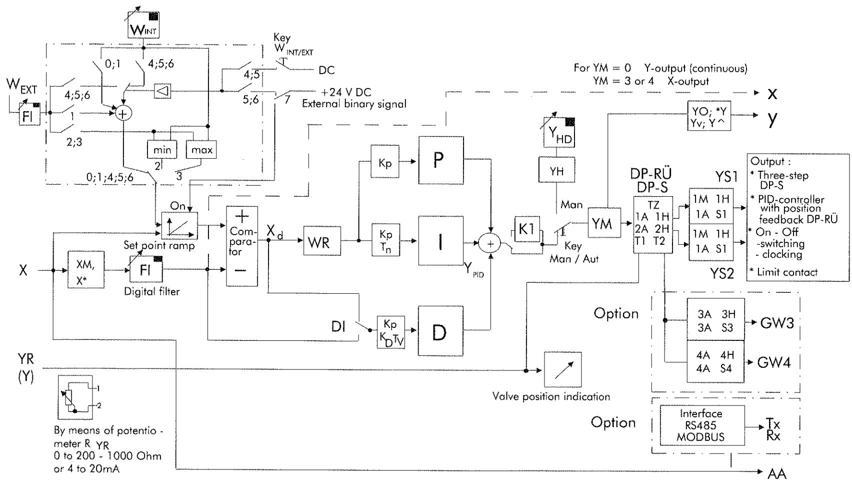


Fig. 2 · TROVIS 6496-03 with switching outputs

1.3 Technical Data

<table>
<tr><td>Inputs</td><td colspan="3">Controlled variable x

d.c. current signal 4(0) to 20 mA $R_i = 50\ \Omega$
d.c. voltage signal 0(2) to 10 V $R_i > 100\ k\Omega$

Potentiometer Pt 100, self-adjusting (three-wire connection)
Version 1 –100 °C to +400 °C resolution 1 °C
Version 2 –30 °C to +150.0 °C resolution 0.1 °C

Thermocouples, reference junction by Pt 100 meas. resistor
Type K: NiCr-Ni 50 °C to +1200 °C IEC 584
S: Pt10Rh-Pt 50 °C to +1700 °C IEC 584
L: Fe-CuNi 50 °C to + 800 °C DIN 43 710
U: Cu-CuNi 50 °C to + 600 °C DIN 43 710

External position feedback y_R (only with Type 6496-03)
Potentiometer 0 to 200 to 1000 Ω or
d.c. current signal 4 to 20 mA (with 500 Ω, 0.5 W, 1 % shunt)

External reference variable WE
4(0) to 20 mA or 0(2) to 10 V due to jumper

External reference variable changeover
Binary input for changeover WI – WE with 24 V d.c.
Signal 0 V → WI; 24 V → WE (selection via WM)
or external restart of set point ramp</td></tr>
<tr><td>Outputs
6496-01

6496-03</td><td colspan="3">Standardized signals
Standard. curr. signal –20, 4(0) to 20 mA, load imped. $R_B < 500\ \Omega$ or
Standard. volt. signal –10, 0(2) to 10 V, load imped. $R_B > 500\ \Omega$ by plug-in jumper

Switching outputs y_{s1} and y_{s2} (Option: GW_3 and GW_4)
Load capability of the contact elements
max. 250 V a.c. / 1 A with cos phi = 1
Differential gap (min.) 0.3 %
Standard. curr. signal –20, 4(0) to 20 mA, load imped.$R_B < 500\ \Omega$ or
Standard. volt. signal –10, 0(2) to 10 V, load imped. $R_B > 500\ \Omega$ due to jumper

Transmitter supply 24 V d.c./max. 30 mA
Analog output 0 to 20 mA/0 to 10 V</td></tr>
<tr><td>Supply</td><td colspan="3">230 V a.c. 48 to 62 Hz; 120 V a.c. 48 to 62 Hz;
Option: 24 V a.c. 48 to 62 Hz</td></tr>
<tr><td>Perm. temperature</td><td colspan="3">Ambient 0 to 50 °C Transportation and storage 0 to 70 °C</td></tr>
<tr><td>Measuring error</td><td>Linearity error</td><td>Zero error</td><td>Upper range value error</td></tr>
<tr><td>mA, V, Pt 100</td><td>0.2 %</td><td>0.2 %</td><td>0.2 %</td></tr>
<tr><td>Thermocouple</td><td>0.3 %</td><td>0.3 %</td><td>0.3 %</td></tr>
<tr><td>Degree of protection</td><td colspan="3">Front IP 54, Enclosure IP 20</td></tr>
<tr><td>Power failure</td><td colspan="3">All parameter values and configuration data are stored in a non-volatile EEPROM</td></tr>
<tr><td>VDE 0110 Part 1</td><td colspan="3">Overvoltage category II Contamination level 2</td></tr>
</table>

2. Installation of the controller

The controller is designed as panel-mounted unit having the front dimensions 96×96 mm^2. For mounting of the plastics housing, a panel cut-out of $90.5^{+0.5} \times 90.5^{+0.5}$ mm^2 is required. After having slid the controller into the cut-out, the enclosed clamps must be inserted either into the lateral or top and bottom openings of the housing. Then, the threaded rods must be turned using a screw driver so that the front frame of the housing is fastened to the panel.

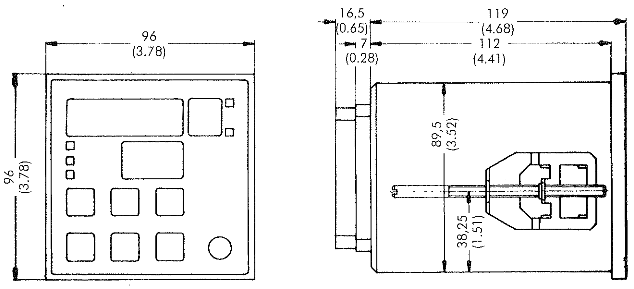


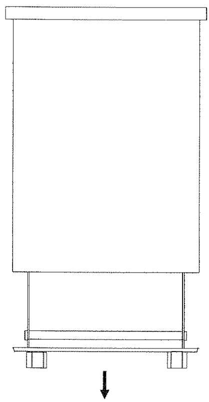
Fig. 3 · Dimensions

2.1 Opening the controller housing for selection of the input and output signals

When reversing the reference variable ***WE***, the output signal y or the recorder connection AA from mA to V or vice versa, the controller housing must be opened.

First remove the terminal clamps and unscrew the four countersunk screws in the rear cover of the housing. Remove the cover and carefully pull out the controller backwards (Fig. 4). **Attention:** the controller itself must remain connected to the front panel via the connecting cables.
The lateral p.c. board for changing the plug-in jumpers is also accessible (see chapter 6.1 and Fig. 5).

Then, carefully slide the controller into the housing again and reinstall the cover.



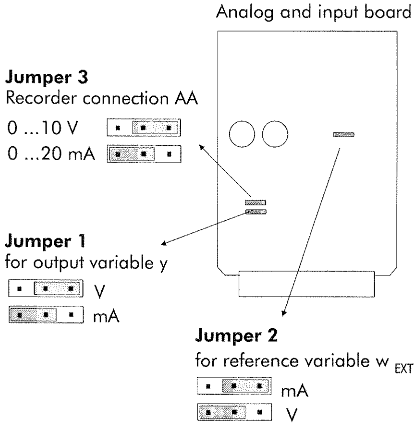


Fig. 4 · Removing the controller from the control panel

Fig. 5 · Jumpers

3. Electrical connections of the controller

The controller is equipped with modular plug-in terminals for leads 0.5 to 1.5 mm^2 (DIN 45 140). For connection, the regulations of VDE 0100 as well as those of the respective countries must be adhered to.

Wiring information:
The signal and sensor leads must be laid isolated from the control and mains leads.
To eliminate measuring errors, screened signal and sensor leads must be used when radio interference occurs. The screened leads must always connect to earth on the controller side.
The supply leads as well as the protective earth conductor must be connected separately from each controller to the respective multi-terminal busbar.
Any nearby contactor circuits must be cleared by using an RC component.

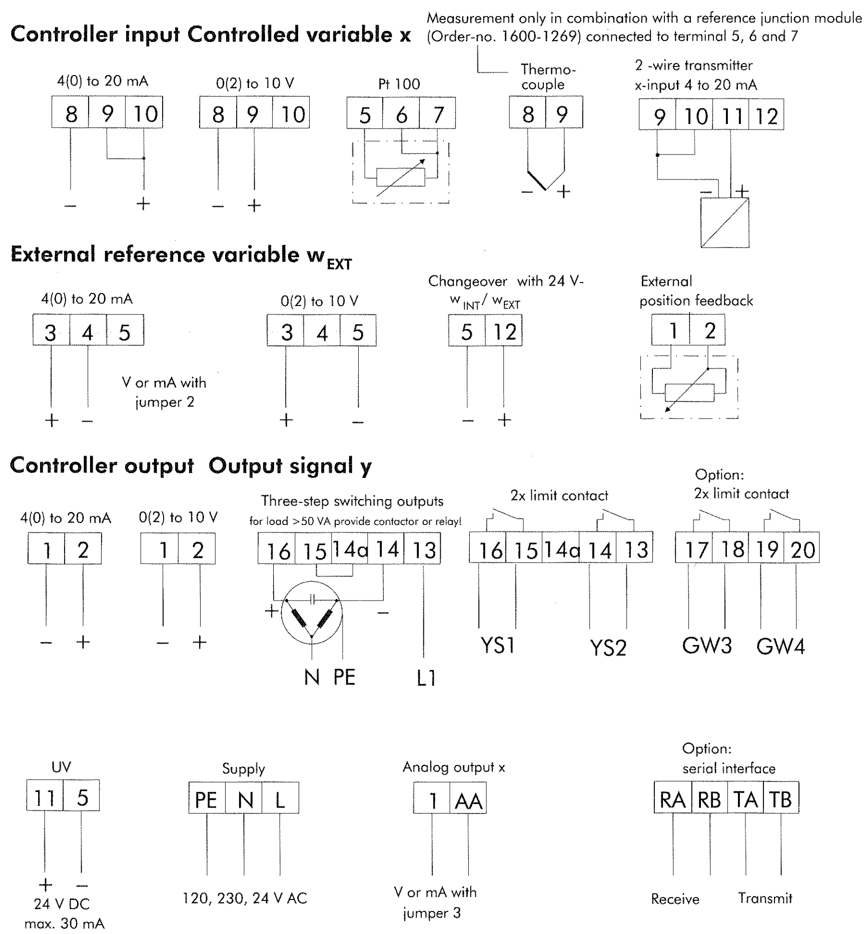


Fig. 6.1 · Connection diagram

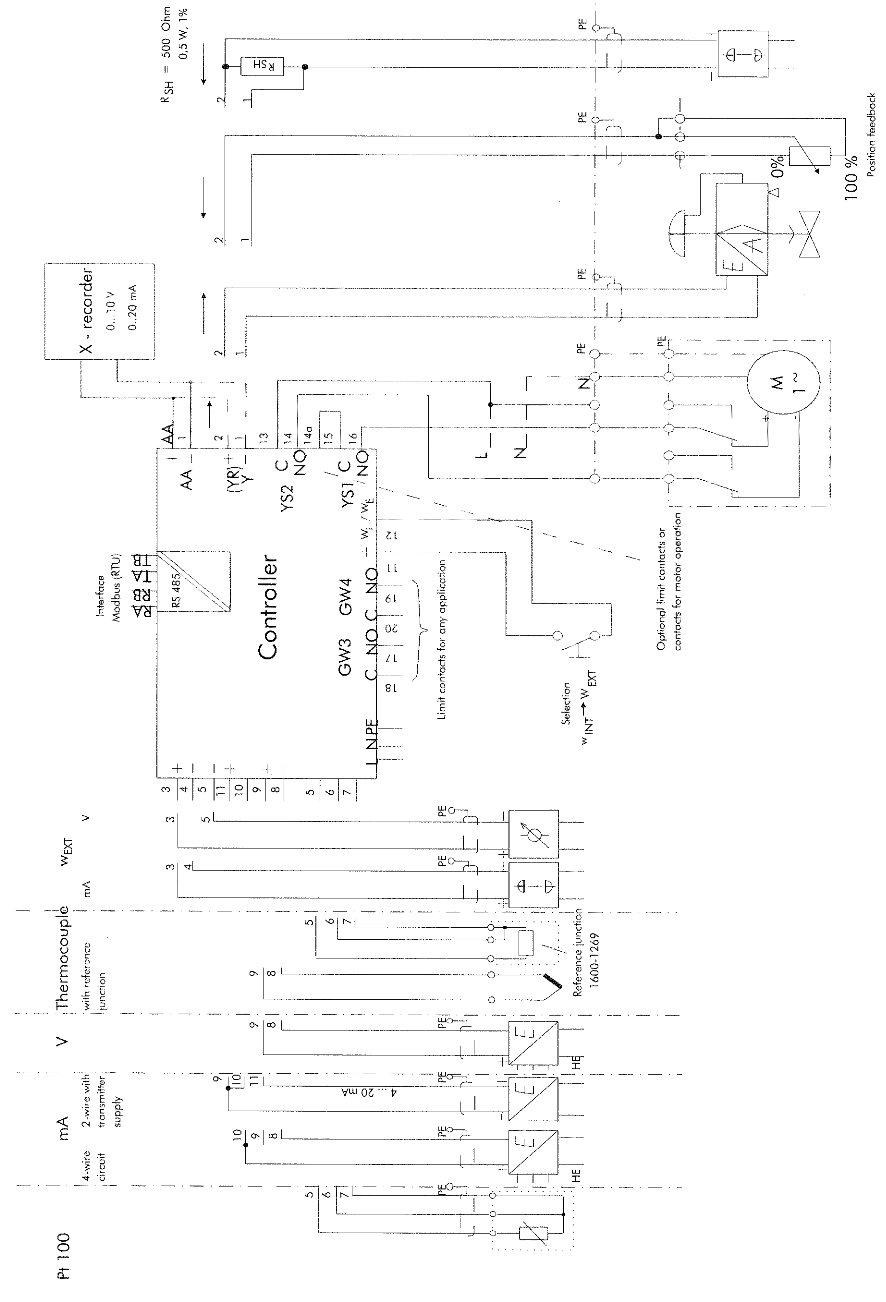


Fig. 6.2 · Connection diagram

4. Operation

4.1 Control panel, controls and displays

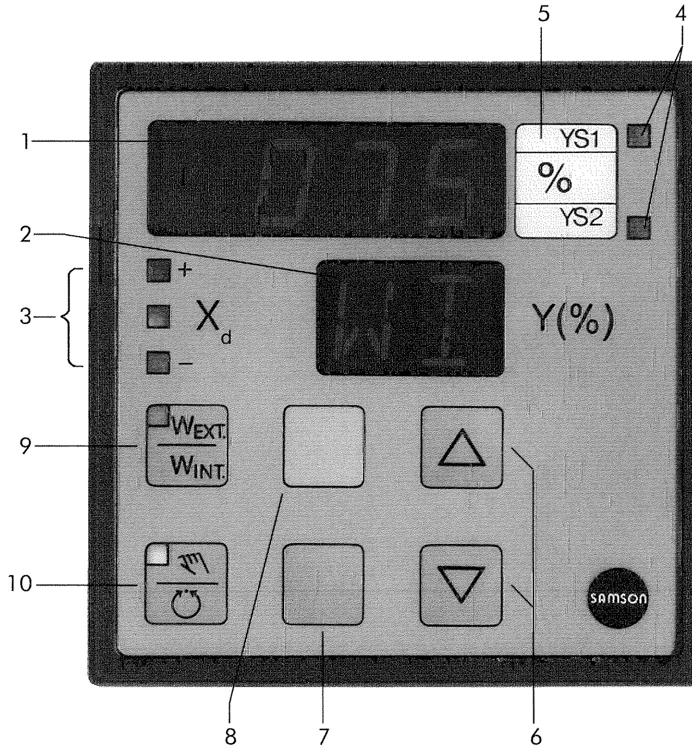


Fig. 7 · Front view

1 Controlled variable display
On the operation level (normal operation), the controlled variable x is displayed. On the parametrization and configuration level, the numerical value of the selected input option is displayed.

2 Manipulated variable display
On the operation level (normal operation), the manipulated variable y is displayed in %. If an upper limit for y > 100 % is entered and the controller output signal is > 100 % , an H appears on the display instead of the one hundred.
Example: y = 107 % = display H7
On the parametrization and configuration level, the designation of the selected input option appears.

3 System deviation
Two red LEDs indicate the system deviation xd within the range of ±1 %, the yellow LED indicates the range in between.

4 **Switching output indicator**
The state of the three-step/on-off controller output or the limit signals of the continuous controller are shown on the display.

5 **Label for the physical unit**
Indicates the physical units of the values indicated on the upper display (1) and the designations of the switching outputs ys1 and ys2 (e.g. + and – or On and Off, etc.).

6 **Cursor keys**
[△] key to increase values
[▽] key to decrease values

Functions on the operation level (normal operation):
After selection of w_{int} → direct change of value.
Interrogation of key number and its selection and input.

Operating mode "manual":
Direct change of the signal y.

Functions on the parametrization/configuration level:
Selection of the individual input options in both directions.
Change of the associated numerical values on the upper display (1).

7 **Operation key**
Functions on the operation level (normal operation):
Changeover for selection of the controller variables in one direction (chapter 4.2.1).

Functions on the parametrization/configuration level:
Return from these levels to the operation level.

8 **Enter key**
Functions on the operation level (normal operation):
Call-up of the key numbers for access to the level of parametrization ***PA*** and the level of configuration ***C0***.
For acknowledgement of the key number entered and for simultaneous access to the selected level.

Functions on the parametrization/configuration level:
For selection of input options (option flashes when selected).
For acknowledgement of numerical value entered.

9 **Reference variable changeover**
For selection of internal or external reference variable. With adjusted external reference variable w_{ext} a yellow LED on the key lights up. In addition, changeover to an external reference variable is possible by means of an external 24 V d.c. signal (see configuration block ***WM*** on page 17).

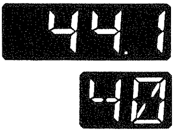
10 **Manual/automatic changeover**
When manual adjustment of the output y or the switching outputs ys1 and ys2 is selected, the yellow LED on the key lights up:
The controller can be changed over bumplessly from manual to automatic operation (or vice versa) via the manual/automatic key.
Manual operation means direct access to the connected control valve. The manipulated variable y can be altered via the cursor keys (6). By means of the operation key (7), it is possible to advance to the y display. The manipulated variable is then displayed as a 3 1/2-digit numerical value.

4.2 Operation of the three levels

The controller features a three-level operation structure for operation, parametrization and configuration.

4.2.1 Level of operation (normal operation)

On the operation level, the controller is in the regular automatic mode.

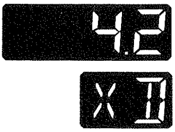


The controlled variable x is indicated on the upper display. The current value of the manipulated variable y is indicated on the lower display.

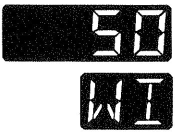
Controlled variable x
The range of values displayed depends on the minimum and maximum limits of the measuring range to be specified as ***XN*** and ***XE*** on the level of configuration (see page 15).

If other controller variables shall be displayed, the operation key (7) must be pressed respectively.

In the following, the controller variables are explained in the sequence as they appear on the display:

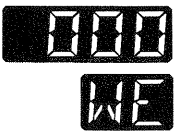


Negative deviation xd (xd = w – x)

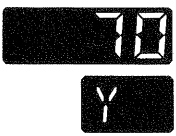


Internal set point *WI*
The range of set point values depends on the limits of the measuring range ***XN*** and ***XE*** specified for the controlled variable x

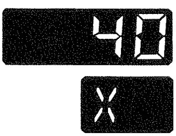
Changing the internal set point *WI*
After the **operation** key (7) has been pressed twice, the current set point appears on the upper display.
This displayed value can be altered via the **cursor** keys △ and ▽.
By pressing the **operation** key, the value is stored such that it is protected against power failure (EEPROM). Subsequently, it is possible to advance to further displays.



External set point *WE*
A value is only indicated when an external set point is actually applied.



Manipulated variable y
The value displayed is a percentage value and is dependent on the limits of the measuring range to be specified as **Y↓** and **Y↑** on the level of parametrization.



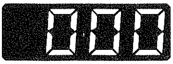
Controlled variable x
The controlled variable x is only displayed for approx. 4 s. Then x and the manipulated variable y are displayed simultaneously.

4.2.2 Level of parametrization

On the level of parametrization, the control parameters can be set. Access to this level is protected by means of a **key number**.

Access to the level of parametrization (entry and change of parameter values)
The level of parametrization can be accessed only by entering the **key number** (see page 19).
This number is set to ***000*** by the manufacturer. The customer may choose another number in configuration block ***C1***.

Entry and alteration of values:
Select **parametrization** point with the **cursor** key.
Press yellow **enter** key, the selected option flashes.
To set the desired value on the upper display, use the **cursor** keys [△] and [▽], and enter it by pressing the **enter** key.
Advance to the next parametrization point with the **cursor** keys or return to the operation level (normal operation) by pressing the **operation** key.

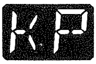


Press yellow **enter** key (8)

PA appears on the lower display and the key number ***000*** on the upper one

Press **enter** key (8) again, the display ***PA*** flashes. Leave the key number ***000*** or enter an **own** one (configuration block ***C1***) using the **cursor** keys [△] and [▽].

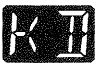
Press **enter** key (8) again. The **level of parametrization is opened**, the display shows the first control parameter ***Kp***.
All parameters can be selected and altered via the **cursor** keys [△] and [▽].



Proportional-action coefficient *Kp*, P component of the controller
Range of values 0.1 to 199.9 (0 = Off)

Reset time *Tn*, I component of the controller
Range of values 1 to 1999 s, **switched off with setting *0***

Rate time *Tv*, D component of the controller
Range of values 1 to 1999 s, **switched off with setting *0***



Rate gain *Kd*, amplification of the D component
Range of values 1 to 10 (D-component only effective, if a value >0 is given for Kd usually set between 5 and 10).

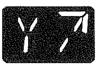
Operating direction, controller characteristic

Setting	***0***	direct,	increasing x → increasing y or
			decreasing x → decreasing y
	1	reverse,	increasing x → decreasing y or
			decreasing x → increasing y

Manipulated variable limitation

y↓ min. = –109.9 % to y↑
y↑ max. = y to +109.9 %

With the function MANUAL, limitation is **not effective**



By selecting the range of the manipulated variable, the lower and the upper range value of the controller output signal is defined. The displayed numerical values refer to the adjusted output range in %.

Example: YM = 0, Y* = **0**, jumper 1 to V signal:
y↓ = 20 %, y↑ = 80 % → output y = 2 V to 8 V

Y0

Operating point *y0*
When selecting a PI or PID control algorithm and an EPROM version up to 2.1 (see chapter 6) is being used, the operating point **must be set to 0**, because its value has an effect on the output signal.
From EPROM version 2.1 onwards, the value ***y0*** is of no importance for PI and PID.

The setting range for ***y0*** is given as a percentage and refers to the manipulated variable y.

For setting of the operating point ***y0***, the current value of the manipulated variable display must be read off during the steady-state-condition of the plant and be set as value for the operating point. Thus, with a fixed set point, the steady-state deviation of a P or PD controller is eliminated.

The following displays of the level of parametrization appear only with the TROVIS 6496-03 Controllers with limit switches and switching outputs.

The displays shown in the following determine the limit value and the differential gap for the outputs **ys1** and **ys2** (GW3 and GW4).

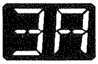
The option "selection of limit value", the signalling condition, is set on the level of configuration in configuration block **1M** or **2M** (3M or 4M). For further explanations of the switching outputs see chapter 5.

Display	Condition	Meaning
1A	with ***YM*** = ***0*** or ***3***	Limit value for ys1
	= **2**	Transfer coefficient KDP+
1H	with ***YM*** = ***0*** or ***3***	Differential gap for ys1
	= **2**	Min. pulse duration ts_{min+}
	= ***1*** or ***4***	Differential gap
2A	with ***YM*** = ***0*** or ***3***	Limit value for ys2
	= **2**	Transfer coefficient KDP–
2H	with ***YM*** = ***0*** or ***3***	Differential gap for ys2
	= **2**	Min. pulse duration ts_{min-}
T1	with ***YM*** = ***0*** or ***3***	Period for pulse-pause Switching output (1M/2M = 8 or 9)
	= **2**	Switching period T+
	= ***1*** or ***4***	Actuator operating time
T2	with ***YM*** = **2**	Switching period T–

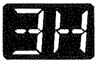
TZ

Dead band *TZ*
Range of values 0 to +109.9 % referring to the output signal.

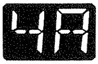
With three-step controllers, enter the switching point (with ***YM*** = ***1***, ***2*** or ***4***).
With switching controller outputs, enter the dead band. For further details see chapter 5 and Fig. 12.
With pulse-pause switching output, set the split-point when the split range option was selected (Fig. 17).



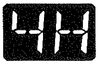
Limit value for GW3



Differential gap for GW3



Limit value for GW4



Differential gap for GW4

Version optional for
Type 6496-03
only available as limit contactor, setting range depending on signalling conditions 3M and 4M

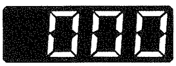
After the operation key (7) has been pressed, the controller returns to the level of operation.

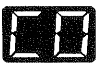
4.2.3. Level of configuration

On the configuration level, the function of the controller to solve the required control task is defined.

Access to the level of configuration (definition and alteration of controller functions)
The level of configuration can only be accessed by entering the **key number** (see page 19).
This is set to ***000*** by the manufacturer. The customer may choose another key number in configuration block **C2**.

Definition and alteration of controller functions
Select the configuration block by using the **cursor** key.
Press the yellow **enter** key (8). The selected block flashes and the manual function is activated.
To set the desired value on the upper display, use the **cursor** keys △ and ▽ and enter it by pressing the **enter** key (8).
Advance to the next **configuration** block with the **cursor** keys and return to the operation level by pressing the **operation** key. The manual function is still activated and the display has changed over to the output variable y. In pressing the manual/auto key, changeover to the automatic mode takes place.





Press yellow **enter** key (8), ***PA*** appears on the lower display.

Press **cursor** key △. **CO** appears on the lower display, on the upper one the key number ***000***.

Press the **enter** key (8). The display **CO** will flash. Leave the key number ***000*** or enter an **own one** (configuration block **C2**) via the **cursor** keys ▽ and △.

Press the **enter** key (8) again. The **level of configuration is opened**, the first configuration block ***XN*** appears.
All configuration blocks can be selected and altered via the **cursor** keys △ and ▽.

Limitation of the measuring range of the controlled variable x

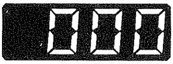
XN — Lower range value
XE — Upper range value

The temperature range of the controlled variable x is determined by means of configuration block ***XM*** (see page 16). Within the limits of ***XM***, it is possible to define the measuring range with ***XN*** and ***XE***. The lower range value and the upper range value limit oneanother.
With a **mA** or **V** input range, the selected range can be displayed as values between –1999 and +1999.

The controller does not process the displayed value but the standardized input percentage value.

Example: x input = 0 to 20 mA, XN = 100, XE = 300
x = 50 % = 10 mA = display 200

Decimal point location (only for mA or V input, ***XM*** = ***1*** or **2**)
The decimal point location for the upper display (1) can be defined in the range 1,000 to 1000.



Selection of the input signal *XM*
The input circuit of the controller can be defined via configuration block XM. By means of the options 0 to 6 (upper display (1)), the following inputs can be selected:

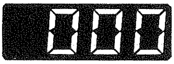
0 —	Pt 100	Version 1	−100 °C to 400 °C
		Version 2	−30.0 °C to 150.0 °C

1 — 4(0) to 20 mA
2 — 0(2) to 10 V
} Disp. of values ±1999; free selec. of decim. point loc. Range selection in configuration block ***X****

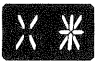
3 —	Thermocouples (Reference junction module see Fig. 6.1)	NiCr-Ni	(K)	50 °C to +1200 °C
4 —		Pt10 Rh-Pt	(S)	50 °C to +1700 °C
5 —		Fe-CuNi	(L)	50 °C to + 800 °C
6 —		Cu-CuNi	(U)	50 °C to + 600 °C

Temperature unit XT
The temperature can be defined in °Celsius or °Fahrenheit.

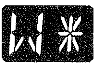
0 — in °C
1 — in °F



Selection of current or voltage ranges
For the signals x and w_{ext}, the following ranges can be determined:



0 — 0 to 20 mA or 0 to 10 V depending on selection
1 — 4 to 20 mA or 2 to 10 V depending on selection
(does not apply when Pt 100 or a thermocouple is used)

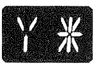


If the range shall be changed, press the yellow **enter** key (8) — ***X****, ***W**** or ***Y**** flashes, depending on selection — change the range by using the **cursor** keys [△] or [▽] and store it via the **enter** key (8).

Selection of current or voltage signal:

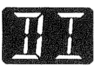
Controlled variable **x** — predetermined in configuration block ***XM***, either ***1*** or **2**

Reference variable $\mathbf{w_{ext}}$ — to be set by means of **jumper 2** (Fig. 5, page 7). Set to mA by the manufacturer.



Manipulated variable **y** — to be set by means of **jumper 1** (Fig. 5, page 7). Set to mA by the manufacturer.

	Y	***AA***
0 —	−20 to 20 mA or −10 to 10 V	0 to 20 mA or 0 to 10 V
1 —	4 to 20 mA or 2 to 10 V	0 to 20 mA or 0 to 10 V
2 —	−20 to 20 mA or −10 to 10 V	4 to 20 mA or 2 to 10 V
3 —	4 to 20 mA or 2 to 10 V	4 to 20 mA or 2 to 10 V



Selection of the input circuit of the D component
The derivative-action component of the controller can be applied directly to the controlled variable x or, behind the set point/ actual value reference point of the system deviation xd (Figs. 2 and 3).

0 — to x input
1 — to system deviation xd

WM

Selection of the reference variable w

An external reference variable wext is connected to the controller either by operating the w_{ext}/w_{int} key (9) or by applying an external signal (+24 V) via the terminal connections 12 and 5 of the binary input.
Selection and possible combinations of the reference variables are defined by means of configuration block ***WM***.

0 — w_{ext} input is **switched off**
1 — addition of w_{int} and w_{ext}
2 — minimum selection between w_{int} and w_{ext}
3 — maximum selection between w_{int} and w_{ext}
4 — w_{int}/w_{ext} changeover via key (9)
5 — w_{int}/w_{ext} changeover via key (9) or by priority of the external binary signal +24 V
6 — changeover only by an externally applied binary signal of +24 V
7 — restart of set point ramp, starting at the connected x value

YH

Locking the manual/automatic key (10)

0 — key function **on**
1 — key function **off**

YM

Selection of the controller output

0 — continuous-action output
1 — three-step controller with position indication (see also chapter 5.4.1)
2 — three-step controller with position feedback
3 — continuous controller output which is available as input "x" to a recorder. The contacts can be used as limit switches
4 — three-step controller (as ***YM*** = ***1***) and pick-off of controlled variable x as input to a recorder. Valve position indication is not possible.

YR

External position feedback

External position feedback can be performed via a potentiometer 0 to 200 to 1000 Ω or via a standardized current signal 4 to 20 mA.

0 — 0 to 200 to 1000 Ω
1 — 4 to 20 mA (with shunt resistor 500 Ω / 0.5 W / 1 % at terminals 1 and 2, see Fig. 6.2)

1M

2M

Limit value signalling condition *1M* and *2M*

For the switching outputs **ys1** and **ys2**.
For ***YM*** = ***1***, ***2*** or ***4***, ***1M*** and ***2M*** must be set to ***0***.
The signalling condition refers to the numerical value of the data entered under parametrization points ***1A*** and ***2A***. For further details see chapter 5.

0 —	Off	switching output not used contact switches when:
1 —	$x_{max.}$	x exceeds the limit value
2 —	$x_{min.}$	x falls below the limit value
3 —	$xd_{min.}$	xd falls below the limit value
4 —	$xd_{max.}$	xd exceeds the limit value
5 —	$xd_{min.}$ and $xd_{max.}$	xd exceeds and falls below the limit value; monitoring of controlled variable at the input with subsequent set point adaptation
6 —	$y_{max.}$	y exceeds the limit value } for on-off output switching
7 —	$y_{min.}$	y falls below the limit value } for on-off output switching
8 —	pulse-modulated (clocking) output pos.	} see also chapter 5.5
9 —	pulse-modulated (clocking) output neg.	} see also chapter 5.5

S1

S2

Switching outputs as break or make contacts

0 — make contact
1 — break contact

3M

4M

Limit value signalling condition *3M* and *4M*

for the switching outputs GW3 and GW4
The signalling condition refers to the numerical value of the data entered under parametrization points ***3A*** and ***4A***.

0 — off	switching output not used	
	contact switches when:	
1 — $x_{max.}$	x exceeds the limit value	
2 — $x_{min.}$	x falls below the limit value	
3 — $xd_{min.}$	xd falls below the limit value	
4 — $xd_{max.}$	xd exceeds the limit value	
5 — $xd_{min.}$ and $xd_{max.}$	xd exceeds and falls below the limit value	
6 — $y_{max.}$	y exceeds the limit value	for on-off output switching
7 — $y_{min.}$	y falls below the limit value	

S3

S4

Switching outputs as break or make contacts

0 — make contact
1 — break contact

TA

Updating the x display *TA*

0 = every 50 ms
1 = every 2 s (settling time of digital display)

FI

Digital filter for analog inputs *FI*

The digital filter FI is used to delay the analog inputs x and w_{ext}. The range of values is 0 to 1999 s; **shut off with *0***, e.g. for fast controlled systems.

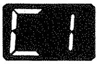
K1

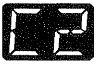
Value of the manipulated variable *K1*, used in case of sensor wire breakage or power failure.

In the case of sensor wire breakage, the controller output is automatically set to the predetermined K1 value.
The value of the manipulated variable can be set within the range of 0 to 109.9 % of the output range.
With power failure <100 ms, the last value of the manipulated variable prior to power failure remains active.
With power failure >100 ms, the manipulated variable y assumes the K1 value with which the controller continues to operate.

Entry of the key numbers

The key numbers C1 and C2





C1 — access to the level of parametrization
C2 — access to the level of configuration

Range of values ***–1999* to *+1999***

For entering or altering the key number, proceed as follows:

Press the yellow **enter** key (8); ***PA*** appears on the lower display.

Press the **cursor** key [△]; **CO** appears on the lower display.

Press the **enter** key (8), the **CO** display flashes, on the upper display the key number ***000*** set by the manufacturer is shown.
If any other key number has already been determined, enter it via the cursor keys. (It can be altered later).

Press **enter** key (8) — the **level of configuration is opened now**. The first configuration block ***XN*** appears on the lower display.

Press the **cursor** keys until configuration block **C1** for the level of parametrization or **C2** for the level of configuration appears.

Press the **enter** key (8) — **C1** or **C2** flashes. On the upper display, ***000*** or the key number already entered appears.

Enter the desired key number via the **cursor** keys or alter the existing one.

Press the **enter** key (8) in order to store the **key number**.

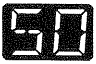
Press the **operation** key (7). The controller returns to the level of operation (normal operation).

Service key number

A special key number is given on page 37 of this instruction. In spite of the already entered key numbers **C1** and **C2**, this superior number allows the user to change any data on the parametrization and configuration level. In order to avoid that this number is used by any unauthorized person, tear out page 37 or cross out the number.

Entry:
Press the yellow **enter** key (8). ***PA*** appears on the lower display.
Press the **cursor** key [△]. **CO** appears on the display.
Press the **enter** key (8). The display **CO** flashes.
Enter the service key number via the **cursor** keys.
Press the **enter** key (8). **The level of configuration is opened now**. The first configuration block ***XN*** is indicated on the lower display.

If any parameter values shall be changed, the key numbers in block **C1** and **C2** can be interrogated and altered, if required, using the **cursor** keys.



Adaptation (Self-optimization)

0 — off, no adaptation
adjustable only when the manual/automatic key (10) is set to **Manual**:
1 — ready for adaptation, optimization according to the reference variable in systems with a delay of >10 s
2 — ready for adaptation, optimization according to the disturbance in systems with a delay of >10 s

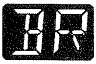
Due to this adaptation function, the controller independently adapts its functions to the requirements of the controlled system and calculates the optimum control parameters during start-up. The appropriate system optimization must be set by selecting the options ***1*** or ***2*** of configuration block ***SO***. An important factor to be considered is the system delay. With critical and very fast operating control systems where the control valve must not abruptly change its position, adaptation must be set to ***SO* = *0***, i.e. must be turned off (see also chapter 6).

The set point ramp (see Fig. 8) causes a change of set point within a defined period of time. The time is set in seconds (for changes by 100 % up to 1800 s). Then, the display changes to ***TM*** and the time is indicated in minutes (max. 500 min.). This ramp is effective for any change of set point. To turn off this function, the corresponding parameter must be set to ***0***.

In this context, configuration block ***WM* = *7*** (see page 17) must be considered. This block causes an x tracking of the set point (w = x) when the binary input is switched on. When the input is switched off again, the set point changes its value within the set time until it has assumed the set value.

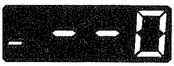
Station address

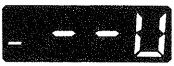
1 — 1 to 246
0 — OFF



Baud rate

0 — 4800 bit/s
1 — 9600 bit/s
Selection of the data transfer rate





Display with sensor breakage: if any sensor breakage is detected at the input of the controller or the measured values exceed or fall below the measuring range, two bars will appear on the upper display with an O for exceeding or U for falling below the measuring range. In this case, the controller output automatically assumes the value of the predetermined K1 value (value of manipulated variable).
When the sensor defect has been removed, the controller continues to operate in the normal mode.

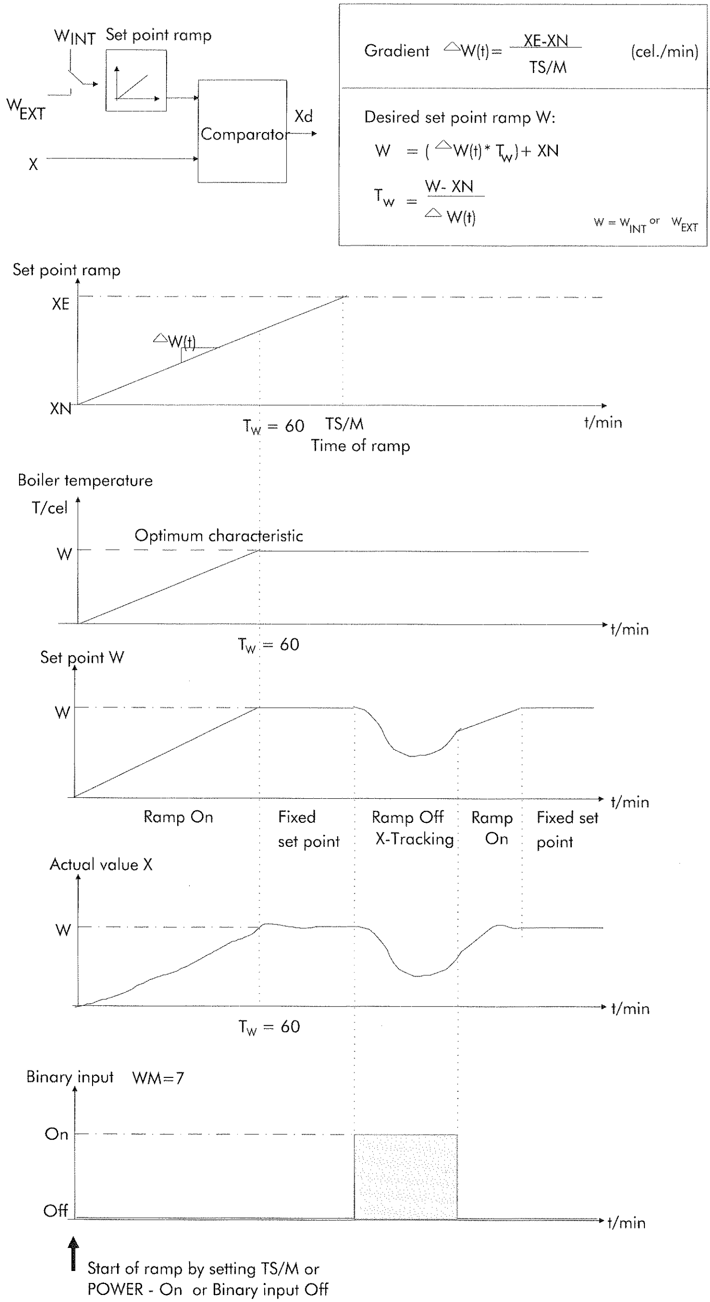


Fig. 8 · Set point ramp

5. The switching outputs ys1 and ys2

The switching outputs can be used as limit contacts or as on-off/three-step outputs.

With TROVIS 6496-03, the output is defined as on-off or three-step output and/or limit contact depending on the selection in configuration block ***YM***. On option, the controller can be equipped with two additional outputs GW3 and GW4 (limit contacts).

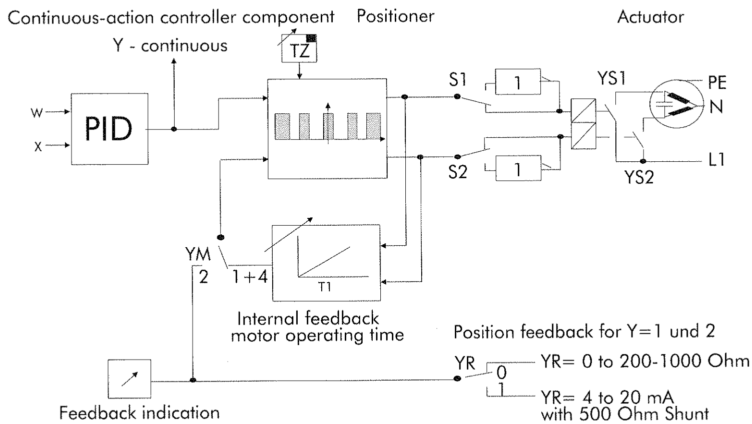


Fig. 9 · Switching outputs

5.1 Limit contacts

If **ys1** and **ys2** (GW3 and GW4) are limit contacts, the limit value must be entered under parametrization point ***1A*** and ***2A*** (3A and 4A) and the differential gap under ***1H*** and ***2H*** (3H and 4H). Configuration blocks ***1M*** and ***2M*** (3M and 4M) determine the selection of the limit value; the signalling condition.
The differential gap is the gap between the switching points. It becomes active when values exceed or fall below the respective switching points.

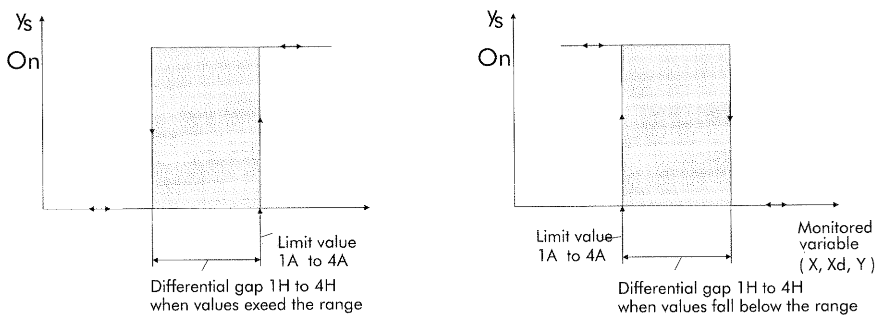


Fig. 10 · Limit contacts

5.2 On-off/three-step output (*YM* = *0*)

If this type of switching output is selected, the output signal y is monitored in the two signalling condition blocks ***1M*** and ***2M*** (config. option set to ***6*** or ***7***). Since this is a pure switching function, we recommend to apply a P or PD control algorithm (set Kp, Tv, KD).
If the controller operates with an operating point ***Y0*** = ***0***, output variable limitation **Y↓** must be set to –100.
The parameters ***1A*** and ***2A*** must be entered according to the differential gap. The differential gap is specified with ***1H*** and ***2H***.

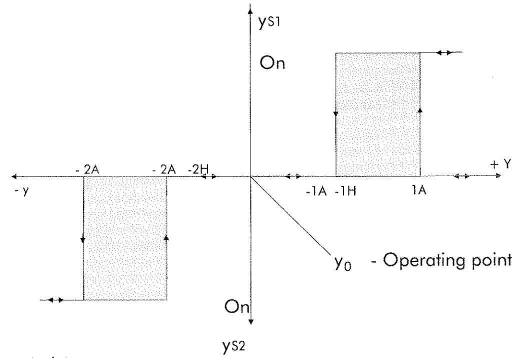


Fig. 11 · Three-step switching output

5.3 Three-step controller with internal feedback

With this version, selected by setting configuration block ***YM*** to ***1***, the transit time of the connected actuator must be entered via parametrization point ***T1***. The desired dead band in % referring to the transit time entered must be entered via ***TZ***.
The % value of the switching pulse put out via the switching outputs ys1 and ys2 refers to the value ***T1***.

Example: Transit time of the actuator = 120 s, output y = 50 %

Transit time tys1-on = T1 · y = 120 s · 0.5 = 60 s

Attention: Dead band of the switching outputs depending on the proportional factor Kp.

$$\text{Desired dead band } \boldsymbol{TZ^*} = \frac{\text{dead band } \boldsymbol{TZ}}{\text{Kp}}$$

In order to obtain a dead band of 10 % with Kp = 2, TZ must be set to 20 %.

With a three-step controller, a potentiometer (adjustment acc. to chapter 5.4) or a current signal 4 to 20 mA must be connected for position feedback yR.

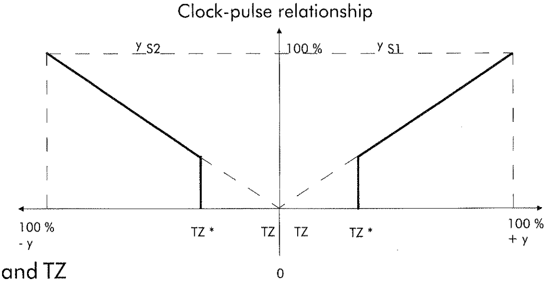


Fig. 12 · Dead band TZ

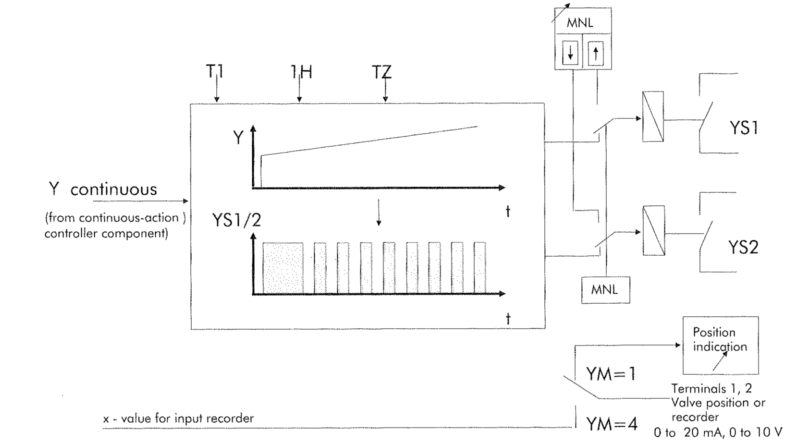


Fig. 13 · Three-step controller output (DP-S)

5.4 Three-step controller with external position feedback

With this type of output circuit, position feedback of the controlled actuator is performed via a potentiometer (0 to 200 to 1000 Ω) or by means of a D.C. current feedback signal with shunt (4 to 20 mA) via input yR (external position feedback).
This type of controller output must be selected with configuration block ***YM*** = **2**.

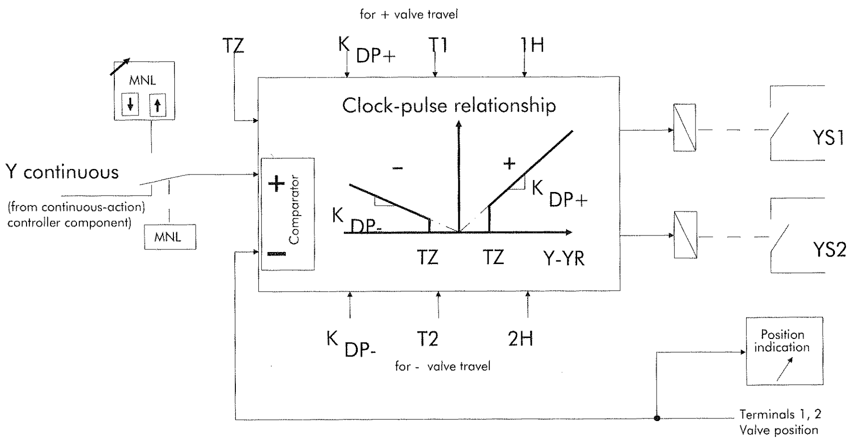
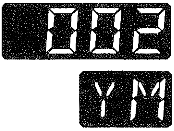


Fig. 14 · Three-step switching algorithm with positioner YM = 2

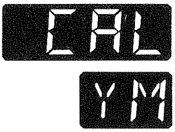
5.4.1 Adjustment potentiometer

(Jumper **1** must be set to **mA**, see Fig. 5)
If a potentiometer 0 to 200 to 1000 Ω is connected to the controller, the controller must be adjusted to this value. This must be completed **prior to start-up**.

Access to the level of configuration acc. to chapter 4.2.3



Press the **cursor** key [△] and select configuration block ***YM***, so that ***YM*** = ***1*** or ***2*** appears on the upper display. Then press the **enter** key. ***YM*** flashes on the lower display.
Set the upper display to ***001*** or ***002*** via the **cursor** key [△] and store the value with the **enter** key (8).
Set the **potentiometer** to the maximum value (position with max. output signal)



Press the **manual/automatic** key (10) ***CAL*** appears on the upper display for a few seconds. The controller then adjusts itself to the connected potentiometer.

When the ***CAL*** display has cleared, continue configuration as planned.

YM = ***1***: if a potentiometer shall not be connected to the controller, the adjustment mentioned above must be performed with the terminals open. After the ***CAL*** display has cleared, terminal 1 and 2 must be bridged with a wire. In so doing, the 2-digit display is set to ***00***.

Another possibility is to select YM = 4. Then, an **x** appears on the display instead of ***00***. With this setting, it is possible to connect a recorder for logging of "x".

5.5 Pulse-modulated output signal at ys1 and ys2

The pulse-modulated output is a switching output whose on-time is proportional to the internal output signal y related to an adjusted time ***T1***. This type of output is similar to an on-off switching output with internal position feedback.

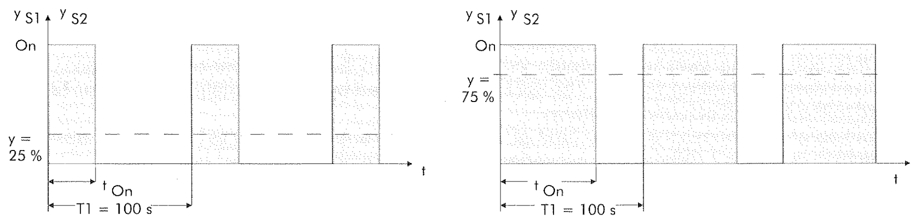


Fig. 15 · Example of a clocking switching output

Table for pulse-modulated outputs

The following table gives an overview of the functions of the configuration blocks ***1M*** and ***2M*** (3M and 4M) when set to ***8*** or ***9*** respectively. Possible output interconnections are shown.

Abbreviation used, e.g. a***M*** = ***8***

- a: variable for y_s (y_{s1} or y_{s2})
- M: configuration point
- 8: selection of limit value (signal. condition)

As far as their operating direction is concerned, the switching outputs are exchangeable. (see a***M*** and b***M***)

Setting	Condition: a = ***1*** → b = ***2***; a = ***2*** → b = ***1***		**c** = selection of limit value = ***1...7***
1)	a***M*** = ***8*** ; b***M*** = **c**	→	pulse-modulated output active, with positive y output limit value signal
2)	a***M*** = ***9*** ; b***M*** = **c**	→	pulse-modulated output active, with negative y output limit value signal
3)	a***M*** = ***8*** ; b***M*** = ***9***	→	pulse-modulated output active, with pos. and neg. y, three-step pulse-modulated
4)	a***M*** = ***8*** ; b***M*** = ***8***	→	split-range positive } split-point by ***TZ*** in %
5)	a***M*** = ***9*** ; b***M*** = ***9***	→	split-range negative } split-point by ***TZ*** in %

5.6 Pulse-modulated on-off output with limit signal

This output connection may be set with the configuration blocks ***1M*** and ***2M***. Possible are:
on-off output with positive operating direction and limit signal
on-off output with negative operating direction and limit signal
also see the table in chapter 5.5

5.7 Pulse-modulated three-step output for heating and cooling

If these types of switching outputs are selected, both outputs are set with a pulse-modulated signal. They form a three-step output for a positive or a negative actuating signal y.
In practice, the outputs are realized by 2x a pulse-modulated on-off signal. See Fig. 16 and chapter 5.5.
For heating-cooling the pulse-modulated outputs are suitable to control connected aggregates.

5.8 2x pulse-modulated on-off output in split-range positive or negative

With this option, the switching outputs ys1 and ys2 can be set in split-range for positive or negative internal actuating signals. The split point is defined by the parametrization point ***TZ*** in %, related to the internal actuating signal y.
The split point determines the upper limit of the switching range of output ys1 and starts operation of switching output ys2. When ***TZ*** is exceeded, output ys1 remains switched on.

In the following example (Fig. 17), the split point within the positive range (***1M*** = ***2M*** = ***8***) is set to ***TZ*** = 40 %.
The representation of the split point applies to positive and negative system deviations xd.

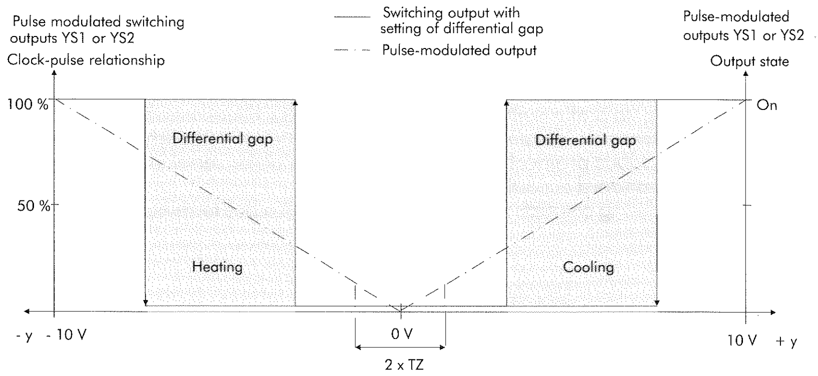
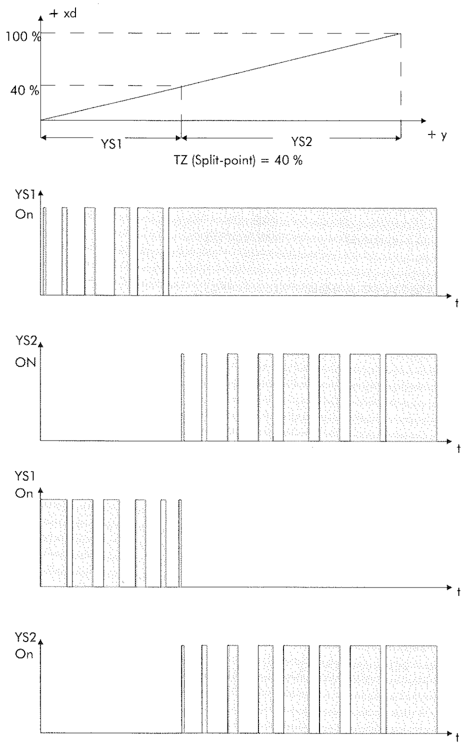


Fig. 16
Pulse-modulated output **positive** and **negative**

With this setting selected, the output types described before are realized all together.



Split-range (switching)

Split-range cooling-heating

If configuration block **S1 = 1** is set, ys1 opens within the range 0 to 40 % of the system deviation and remains open after the signal has reached the split-point TZ.

Fig. 17 · On-off pulse-modulated in split-range (above) and split-range cooling-heating (below)

6. Serial interface

6.1 Description

6.1.1 Characteristics of the serial interface

By means of a serial interface, the TROVIS 6496 Controller is capable of communicating with a control station. With the help of a suitable software for process visualization and data communication, a complete automation system for process control can be established. For communication, the well-known Modbus protocol is used. The hardware of the serial interface meets RS 485 (RS = Recommended Standard according to EIA).
The devices have 5 soldering contacts that can be closed when a bus termination is provided.

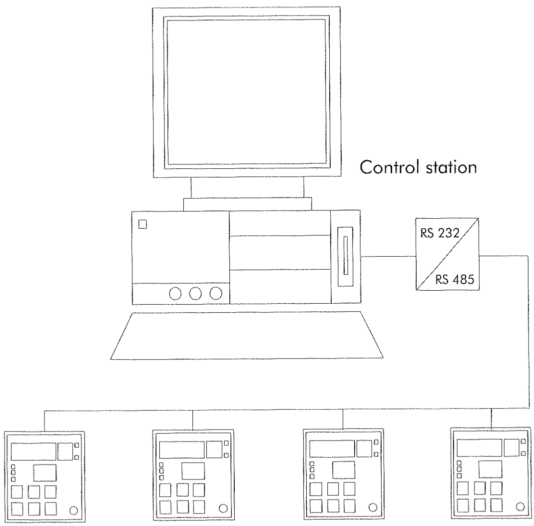


Fig. 18 · Process control system composed of TROVIS 6496 Controllers

6.1.2 Technical Data

Physical interface: RS 485

Data communications system protocol: Modbus protocol

Transmission type: asynchronous, half duplex, 4-wire

Transmission mode: RTU (8 bit)
1 start bit, 8 data bits, 1 stop bit

Transmission rate: 4800 or 9600 bit/s

Number of stations supported: 246

Optional transmission data: configuration data, parameters, operating state, process variables

6.2 Operation

6.2.1 Setting the station addresses

To identify a slave device in the communications system, each controller is assigned a free station number (address).
This station address has to be set in the configuration mode in configuration block ***SN***. The standard setting is O (=OFF) which is the factory preconfiguration. After having set the station address, the configuration block SN cannot be reset to O (=OFF).

6.2.2 Dividing the holding registers

The holding registers 1, 2, 3, 4, 6, 7, 8, 11, 55, 56, 57 can only be read from the master control station. This is indicated by an R (Read). The other holding registers can be both read and written to from the control station (W/R = Write/Read).

6.2.3 Dividing the coils

The coils 1 – 4 can only be read from the control station.
The coils 5 – 14 can be read and written to.

6.3 Modbus protocol

The Modbus protocol covers the rules for communication between the control station (master) and the controller (slave). Therefore, the controller can only answer to queries from the control station.

After having sent a query to the controller, the control station must wait for at least one second to receive the beginning of a response. The next query cannot be sent until after the response or one second has elapsed.

6.3.1 Function code 01 (Read Coil Status)

This function allows reading binary information such as fault indications, relay operating states or operational indications from the digital controller and transmitting this information to the control station.
Example: Read status registers 5 to 8 from the controller having the address number 11
Query from the control station

Address	Function	Starting address		Number	Coils	Checksum	
		high	low	high	low	high	low
0B	01	00	04	00	04	7C	A2

Response of interface

Address	Function	Number of bytes	Status register Coils 5 – 8	Checksum	
				high	low
0B	01	01	00	52	50

6.3.2 Function code 05 (Force Single Coil)

This function permits changing a binary process condition in the controller from the control station (such as operating state of limit switch or operating mode).
Example: Write status register number 13 (Manual/Auto changeover)
In order to set the controller to the MANUAL mode, coil 13 must be set "1".
In this example, the controller address is 15.
Writing command from control station

Address	Function	Status reg.-no.		Status register		Checksum	
		high	low	on/off	-----	high	low
0F	05	00	0C	FF	00	4D	24

Response of the controller

Address	Function	Status reg.-no.		Status register		Checksum	
		high	low	on/off	-----	high	low
0F	05	00	0C	FF	00	4D	24

The fourth byte of the Modbus command contains the coil number 0C (hexadecimal). This corresponds to 12 (decimal) and is the coil number 13, since the Modbus protocol numbers coils from zero. If a coil is set to one, byte 5 must transmit the information FF. To clear the coil, 00 must be transmitted.

6.3.3 Function code 03 (Read Holding Register)

This function allows reading analog variables from the addressed controller (slave). These variables are represented on the PC after their number format has been adapted (controlled variable, set point etc.)
Example: Read holding register no. 1
This register contains the controller identification number. The controller has the address 1.
Query from the control station

Address	Function	Holding reg.-no.		Holding reg. Number		Checksum	
		high	low	high	low	high	low
01	03	00	00	00	01	84	0A

Response of the controller

Address	Function	Number of bytes	Value Register 1		Checksum	
			high	low	high	low
01	03	02	19	60	B3	FC

Since, in this example, only register one is read and this register always contains the decimal value 6496, it can be used to check communication.

When checking data communication according to this example, the controller address must be set 1. If not, an other checksum will result.
Byte four contains the number 00 (hexadecimal). This equals 0 (decimal) and corresponds to holding register 1, since the Modbus protocol numbers registers from zero.

6.3.4 Function code 06 (Preset Single Register)

This function allows modifying the contents of a holding register. An analog value like the set point or Kp value can be altered in the controller.
Example: Write holding register 10. This is the set point value. The controller has the station address number 18. It shall receive a set point of 100 from the control station.
Command from the control station

Address	Function	Holding reg.-no.		Value in Reg. 35		Checksum	
		high	low	high	low	high	low
12	06	00	09	00	64	5A	80

Response of the controller

Address	Function	Holding reg.-no.		Value in Reg. 35		Checksum	
		high	low	high	low	high	low
12	06	00	09	00	64	5A	80

6.3.5 Error messages (Modbus)

In the case of illegal operations of the control station, the interface responds by issuing an error message.
Such operations are:

- Attempts of reading more than 58 holding registers
- Attempt of writing to illegal status or holding registers

The following example shows the error message following an attempt of writing holding register 3 (controlled variable) to station address 1.
The controller gives the following message:

Address	Function	Exception code	Checksum	
			high	low
01	86	02	C3	A1

Note:
If parameter values that are out of the permissible range are written, the controller assumes the lower or upper range limit value.

6.4 Holding Registers

No.	Name	Access	Range of numbers		Divisor	Description
01	ID	R	6496		0	Controller ID
02	VN	R	2101 /	2102	1 1)	Software version/PT100
3	X	R	– 1999 –	1999	2)	Controlled variable
04	WEX	R	– 1999 –	1999	2)	Set point (external)
05			0			Spare
06	YSTELL	R	– 10 –	110	0	Position feedback
07	XD	R	– 1999 –	1999	2)	System deviation
08	Y	R	– 1099 –	1099	1	Output value PID
09	YMANL	R/W	– 1999 –	1999	1	Output value
10	WIN	R/W	– 1999 –	1999	2)	Set point (internal)
11	NR	R	1 –	246	0	Station address
12	KP	R/W	0 –	1999	1	Proportional-action coefficient
13	TN	R/W	0 –	1999	0	Reset time
14	TV	R/W	0 –	1999	0	Rate time
15	KD	R/W	0 –	10	0	Derivative-action gain
16	WR	R/W	0 –	1	0	Inversion of system deviation
17	YMIN	R/W	– 1099 –	1099	1	Output variable limitation min.
18	YMAX	R/W	– 1099 –	1099	1	Output variable limitation max.
19	Y0	R/W	– 1099 –	1099	1	Operating point adjustment
20	1A	R/W	– 1999 –	1999	3)	Limit value/Switching output 1
21	1H	R/W	0 –	1999	3)	Differential of relay 1
22	2A	R/W	– 1999 –	1999	3)	Limit value/Switching output 2
23	2H	R/W	0 –	1999	3)	Differential of relay 2
24	T1	R/W	0 –	1999	0	Actuating time/Period +
25	T2	R/W	0 –	1999	0	Period –
26	TZ	R/W	0 –	1099	1	Dead band
27	3A	R/W	– 1999 –	1999	3)	Limit value 3
28	3H	R/W	0 –	1999	3)	Differential of relay 3
29	4A	R/W	– 1999 –	1999	3)	Limit value 4
30	4H	R/W	0 –	1999	3)	Differential of relay 4
31	XN	R/W	– 1999 –	1999	2)	Controlled variable limitation min.
32	XE	R/W	– 1999 –	1999	2)	Controlled variable limitation max.
33	X,	R/W	0 –	3	0	Decimal places
34	XM	R/W	0 –	6	0	Input configuration
35	XT	R/W	0 –	1	0	Temperature unit
36	X*	R/W	0 –	1	0	Selection of range X
37	W*	R/W	0 –	1	0	Selection of range W
38	Y*	R/W	0 –	3	0	Selection of range Z
39	DI	R/W	0 –	1	0	Assignment D element
40	WM	R/W	0 –	7	0	Set point function
41	YH	R/W	0 –	1	0	Locking Manual button
42	YM	R/W	0 –	4	0	Controller output selection
43	YR	R/W	0 –	1	0	Position feedback signal Ω/mA
44	1M	R/W	0 –	9	0	Assignment Limit value 1
45	2M	R/W	0 –	9	0	Assignment Limit value 2
46	S1	R/W	0 –	1	0	Make contact/Break contact 1
47	S2	R/W	0 –	1	0	Make contact/Break contact 2
48	3M	R/W	0 –	7	0	Assignment Limit value 3
49	4M	R/W	0 –	7	0	Assignment Limit value 4

No.	Name	Access	Range of numbers		Divisor	Description
50	IS3	R/W	0 –	1	0	Make contact/Break contact 3
51	S4	R/W	0 –	1	0	Make contact/Break contact 4
52	TA	R/W	0 –	1	0	Refresh X display
53	FI	R/W	0 –	1999	0	Filter constant for X
54	K1	R/W	0 –	1099	1	Safety output value
55	C1	R	– 1999 –	1999	0	Key number for parameters
56	C2	R	– 1999 –	1999	0	Key number for configuration
57	S0	R	0 –	2	0	Adaptive self-optimization
58	TS	R/W	0 –	60000	0	Set point ramp in seconds

6.5 Coils

No.	Access	Description
01	R	Centralized fault
02	R	Safety output value active
03	R	Parameterization active
04	R	Configuration active
05	R/W	Limit value/Switching output 1
06	R/W	Limit value/Switching output 2
07	R/W	Limit value 3
08	R/W	Limit value 4
09	R/W	Locks parameterization
10	R/W	Acknowledges parameteriztaion
11	R/W	Locks configuration
12	R/W	Acknowledges configuration
13	R/W	Changeover Manual mode
14	R/W	Changeover W external

Notes:

[1]) Combination of software version e.g. 2.10 and variant of PT100 input configuration 1 or 2. Version 1: 210.1 Version 2: 210.2

[2]) Varies depending on configuration of XM
— No places behind the decimal point for XM = 3, 4, 5, 6 and XM = 0 Version 1
— One place behind the decimal point for XM = 0 Version 2
— Places 0 to 3 behind the decimal point depending on X, for XM = 1, 2

[3]) Depends on XM, YM and the assignments 1M to 4M

7. Start-up

The position of the jumpers 1, 2, 3 depends on the input and output signals required. For this purpose, see chapter 2.1 and Fig. 5 on page 7.

EPROM version: When the power to the controller is turned on, the current Eprom version appears on the upper display for a few seconds, e.g. version **3.00** (important to know for any possible inquiries!).

Important: When starting-up the controller, always proceed in the sequence configuration, parametrization and finally optimization.

Configuration: When the controller is supplied with power and all inputs and outputs are connected properly, it must be adapted to the control task to be performed by means of programming the required functions on the configuration level. For this purpose, the individual configuration blocks (see paragraph 4.2.3) must be set.
With the Type 6496-03 Three-step Controller with external position feedback, the potentiometer at the control valve must be adjusted to 0 to 100 % travel (see chapter 5.4.1).

Parametrization: The control mode (P, PI, PD or PID) as well as the operating direction (characteristic) must be set on the parametrization level. Here, too, all parametrization blocks must be set (see chapter 4.3.2).

Optimization: During optimization of the control parameters (see chapter 6.1), the parameter values of ***Kp***, ***Tn*** and ***Tv*** must be set or changed to adapt the controller to the controlled system. Prior to optimization, the connected control valve must be closed by all means.

7.1 Proceeding with the different controller outputs

When the controller is started-up, the different controller output signals require a different proceeding as far as configuration, parametrization and optimization is concerned. Proceed as follows:

Note on the switching controllers, chapter 5.1.2 and 5.1.3
Attention: When switching outputs are used, the switched current must be >100 mA. If I_{switch} <100 mA, the RC-element for spark suppression, which is connected in parallel to the switching contacts (relay), must be released (cut the resistor wire).

7.1.1 Continuous-action controller (*YM* = *0*)

- Access the **configuration level** (page 15)
- Select the input signal via ***XM***
- Define the input measuring range with ***XN*** and ***XE***
- Determine the output signal by setting ***YM*** = ***0*** (continuous-action)
- Select the desired special functions such as digital filter ***FI***, temperature display in Fahrenheit ***XT*** or limit values ***1M*** and ***2M*** (3M or 4M)

- Access the **parametrization level** (page 13)
- Determine the operating direction via ***WR***
- Limit the output signal with **Y↑** and **Y↓**
- Input the desired limit values via ***1A***, ***2A*** (3A or 4A)

- Optimize the system by entering the control parameters ***Kp***, ***Tn*** and ***Tv*** and ***Tv-KD*** (see chapter Optimization on page 35).

7.1.2 Three-step controller with internal position feedback (*YM* = *1* or *4*)

The position feedback signal is not required in the control process but may be indicated to check and monitor the control valve when ***YM*** = ***1***. With ***YM*** = ***4*** the continuous x signal is indicated only. It can be used as input signal to a recorder.

— Access the **configuration level** (see page 15)
— Select the input signal via ***XM***
— Define the input measuring range with ***XN*** and ***XE***
— Determine the output signal via ***YM***:
YM = ***4***, three-step controller without position indication.
With this setting, the signal is selectable via ***Y**** and jumper 1 between (4)0 and 20 mA and 0(2) and 10 V.
YM = ***1***, three-step controller with position indication.
With this setting, the feedback signal must be defined in configuration block ***YR***. For adjustment of the connected potentiometer proceed as described in chapter 5.4.1, page 25.
Attention: jumper **1** must be set to the **mA**-position (Fig. 5).
— Select the desired special functions such as digital filter ***FI*** and temperature display in Fahrenheit ***XT***.
— Here, ***1M*** and ***2M*** **cannot** be used to determine the limit values. Therefore, set these blocks to ***0***.

— Access the **parametrization level** (see page 13)
— Determine the operating direction via ***WR***
— Enter the motor operating time with parameter ***T1***
the differential gap with parameter ***1H*** (SO)
and the dead band with parameter ***TZ***

— Optimize the system by entering the control parameters ***Kp***, ***Tn*** and ***Tv-KD***
(see chapter 7.2, page 35)

7.1.3 Three-step controller with position feedback (positioner) (*YM* = *2*)

The position feedback signal is required in the control process.

— Access the **configuration level** (page 15)
— Select the input signal via ***XM***
— Define the input measuring range with ***XN*** and ***XE***
— Determine the output signal by setting ***YM*** = ***2***, three-step controller with position feedback.
With this setting, the feedback signal must be defined in configuration block ***YR***. For adjustment of the connected potentiometer proceed as described in chapter 5.4.1, page 25.
Attention: jumper **1** must be set to the **mA**-position (Fig. 5).
— Select the desired special functions such as digital filter ***FI*** and temperature indication in Fahrenheit ***XT***.
— Here, ***1M*** and ***2M*** **cannot** be used to determine the limit values. Therefore, set these blocks to ***0***.

— Access the **parametrization level** (page 13)
— Determine the operating direction via ***WR***
For further explanation of the following see Fig. 14
— Enter the pulse-pause period for pos./neg. valve travel with parameters ***T1*** and ***T2***
— Determine the minimum pulse duration for pos./neg. valve travel with parameters ***1H*** and ***2H***
— Set the gain (transfer coefficient) with parameters ***1A*** and ***2A***
— Enter the dead band with parameter ***TZ***

— Optimize the system by entering the control parameters ***Kp***, ***Tn*** and ***Tv-KD***
(see chapter 7.2, page 35)

7.2 Optimization

(Adaptation of the controller to the controlled system)

To enable the controller to eliminate any system deviation caused by disturbances or to keep this deviation within certain limits for all set points, it must be adapted to the dynamic performance of the controlled system by means of the parameters Kp, Tn and Tv.
Note that entered parameter values do not become effective until they are stored by pressing the yellow enter key (8).

If you, so far have not gained any experience as far as the setting values for different control systems are concerned, proceed as described below:

For all the controllers described in the following (P, PI, PD and PID), first set the **manual/automatic key** (10) to **manual operation**. **The connected control valve must be closed**. The lower display must indicate ***0***. If necessary, press **cursor** keys (6) to set the display accordingly.

P controller

- Access the level of parametrization and set the control parameters ***Kp* = *0.1***, ***Tn* = *0*** and ***Tv* =*0* = *off***.
- Access the level of operation and set the desired set point. Then use the **cursor** keys (6) to alter the output variable such that the control valve will open slowly and the system deviation xd will become zero.
- Change over to **automatic mode**.
- Increase the Kp value until the system tends to oscillate.
- Slightly decrease the Kp value until oscillation has disappeared.

  A steady-state deviation can be eliminated by setting the operating point y0 as follows: determine the current value of the output variable y when the controller is in the steady-state condition, and enter it as value for y0 in parametrization block ***y0***.
  Caution: any change in set point results in a change of the operating point y0.

PI controller

- Access the level of parametrization and set the control parameters ***Kp* = *0.1***, ***Tn* = *1999*** (maximum) and ***Tv* = *0* = *off***.
- Access the level of operation and set the desired set point. Then use the **cursor** keys (6) to alter the output variable such that the control valve will open slowly and the system deviation xd will become zero.
- Change over to **automatic mode**.
- Increase the Kp value until the system tends to oscillate.
- Slightly decrease the Kp value until oscillation has disappeared.
- Decrease the Tn value until the system tends to oscillate.
- Slightly increase the Tn value until oscillation has disappeared.

PD controller

- Access the level of parametrization and set the control parameters ***Kp* = *0.1***, ***Tv* = *0* = *off*** and ***Tn* = *0* = *off***. Set the rate gain ***KD*** to a value normally between ***5*** and ***10***.
- Access the level of operation and set the desired set point. Then use the **cursor** keys (6) to alter the output variable such that the control valve will open slowly and the system deviation xd will become zero.
- Increase the Kp value until the system tends to oscillate.
- Set the Tv value to 1 s. Then increase it until oscillation has disappeared.
- Increase the Kp value until oscillation returns.
- Increase the Tv value until oscillation has disappeared.
- Repeat these steps for several times until oscillation can no longer be suppressed. Slightly decrease the Kp and the Tv value so the system can recover.

A steady-state deviation can be eliminated by setting the operating point y0 as follows: determine the current value of the output variable y when the controller is in the steady-state condition, and enter it as value for ***y0***.
Caution: any current change in set point results in a change of the operating point y0, when the controller is in the steady-state condition.

PID controller

- Access the level of parametrization and set the control parameters ***Kp* = *0.1***, ***Tn* = *1999*** and ***Tv* = *0* = *off***. Set the rate gain ***KD*** to a value normally between ***5*** and ***10***.
- Access the level of operation and set the desired set point. Then use the **cursor** keys (6) to alter the output variable such that the control valve will open slowly and the system deviation xd will become zero.
- Increase the Kp value until the system tends to oscillate.
- Set the Tv value to 1 s. Then increase it until oscillation has disappeared.
- Slowly increase the Kp value until oscillation returns.
- Increase the Tv value until oscillation has disappeared.
- Repeat these steps for several times until oscillation can no longer be suppressed.
- Slightly decrease the Kp and the Tv value so that the system can recover.
- Decrease the Tn value until the system tends to oscillate again, and increase it until oscillation has disappeared.

7.3 **Adaptation** (self-optimization)

If the adaptation function shall be selected with configuration block **SO**, optimization as described in chapter 7.2 is not required. The controller detects the system's performance during start-up and calculates the optimum control parameters.
Prerequisite: the control-loop must be in the steady-state condition for at least 5 min., i.e. system deviation xd must not have changed.
The setting of the configuration block ***SO*** = ***1*** or **2** only means that the controller is ready for adaptation (standby function). In order to activate the adaptation function proceed as follows:

— The controller is set to the level of operation (normal operation). The controlled variable x and the output variable y are displayed.
— Operate the manual/automatic switch to change over to the **manual mode** (the diode on the key lights up).
— Press the yellow **enter** key (8). ***PA*** appears on the lower display.

Note: The standard control algorithm is the PI one (***KD*** = ***0***). If a PID algorithm is required, access the parametrization level (see page 13) and set KD = 1.

Press the **cursor** key [△], ***CO*** appears on the lower display. On the upper display the key number ***000*** is indicated.
Press the **enter** key (8). The display **CO** flashes. Leave the key number 000 or enter an **own** one (to be entered in configuration block **C2**) via the **cursor** keys [▽] and [△].
Press the **enter** key (8) again, the **level of configuration is open**. The first configuration block ***XN*** appears.
Select configuration block **SO** via the **cursor** keys.
Press the **enter** key (8). The selected block flashes.
Set the desired type of optimization ***SO*** = ***1*** or **2** via the **cursor** keys and store it via the enter key (8).
Press the **operation** key (7) and return to the level of operation.
Press the **cursor** key [△] twice. The set point ***WI*** is displayed.
Use the **cursor** keys [△] and [▽] to enter a set point at which a positive system deviation of at **least 20 %** of the measuring range will occur.
Press the **operation** key (7). The x display will appear for about 4 s. Then, the controlled variable x and the output variable y are displayed simultaneously.
Press the **manual/automatic key** (10) and set the controller to the **automatic mode**.
The yellow LED on the key flashes until the control parameters are calculated and stored with protection against power failure. When the diode has gone out, the controller operates in the automatic mode.

If larger system deviations caused by disturbances in the plant occur during operation, or if the controller does not operate satisfactorily, the control parameters calculated by the controller must be altered manually on the level of parametrization.

Service key number	1732

Check list:			
Instrument:	Plant:	Process designation:	Date:

Selection point/ block	Designation	Range of values	Setting by the manufac.	Start-up values alterations		
Level of operation:						
X	Controlled variable	acc. to sensor	—			
XD	System deviation	—	—			
WI	Int. set point	XN to XE	0			
WE	Ext. set point		—			
Y	Output variable	Y↓ to Y↑	—			
Level of parametrization:						
KP	Proportional factor	0.1 to 199.9	1.0			
TN	Reset time 0 = Off	1 to 1999	0			
TV	Rate time 0 = Off	1 to 1999	0			
KD	Rate gain 0 = Off	1 to 10	0			
WR	Operating direction	0 or 1	0 (>>)			
Y↓	min. output variable limit	–109.9 % to Y↑	0			
Y↑	max. output variable limit	Y↓ to +109.9 %	100			
Y0	Operating point	–109.9 % to +109.9 %	0			
Type 6496-03 only						
1A	Limit value y_{s1}	depend. on sign. cond.	0			
	Transfer coefficient +	0.0 to 100.0	0.0			
1H	Differential gap y_{s1}	depend. on sign. cond.	0			
	Min. pulse duration +	0.0 to 100.0 %	0.0			
2A	Limit value y_{s2}	depend. on sign. cond.	0			
	Transfer coefficient –	0.0 to 100.0				
2H	Differential gap y_{s2}	depend. on sign. cond.	0			
	Min. pulse duration –	0.0 to 100.0 %	0			
T1	Period +	0 to 1999 s	10			
T2	Period –	0 to 1999 s	10			
TZ	Dead band	0 to 109.9 %	2.0			
Optional for Type 6496-03						
3A	Limit value GW_3	depending on signalling condition	0			
3H	Differential gap GW_3		0			
4A	Limit value GW_4		0			
4H	Differential gap GW_4		0			

Selection point/ block	Designation	Range of values	Setting by the manufac.	Start-up values alterations		
Level of configuration:						
XN	Lower limit of meas. range x	–1999 to XE	0			
XE	Upper limit of meas. range x	XN to +1999	100.0			
X.	Decimal point location	1.000 to 1000	100.0			
XM	Type of input signal	0 to 6	0 (Pt 100)			
XT	Temperature unit °C - °F	0 or 1	0			
X*	Selection of range current/voltage	0 or 1	0 (mA)			
W*			0 (mA)			
Y*			0 (mA)			
DI	D component	0 or 1	0			
WM	Selection of set point	0 to 7	0			
YH	Manual/Auto-key	0 or 1	0			
Type 6496-03 only						
YM	Selection of controller output	0 to 4	0			
YR	Position feedback	0 or 1	0			
1M	Limit value signalling cond.	0 to 9	0			
2M			0			
S1	Make or break contact	0 or 1	0			
S2			0			
Optional for Type 6496-03						
3M	Limit value signalling cond.	0 to 7	0			
4M			0			
S3	Make or break contact	0 or 1	0			
S4			0			
TA	Updating of display	0 or 1	0			
FI	Digital filter	0 to 1999 s	1			
K1	Restart value	0 to 109.9 %	0			
C1	Param. key number	–1999 to +1999	0			
C2	Config. key number		0			
S0	Adaptation	0 to 2	0			
TS (TM)	Set point ramp	1s to 500 min.	0			
Optional for interface						
SN	Interface address	0 to 246	0			
BR	Baud rate (Bd)	4800 or 9600	0			

SAMSON AG · MESS- UND REGELTECHNIK
Weismüllerstraße 3 · D-60314 Frankfurt am Main
Postfach 10 19 01 · D-60019 Frankfurt am Main
Telefon (0 69) 4 00 90 · Telefax (0 69) 4 00 95 07

S/W 03.95

Control panel