Automation System TROVIS 6400

Industrial Controller TROVIS 6497

CE

TROVIS®
Electronics from SAMSON

Edition November 2000

Mounting and operating instructions

Firmware 1.10

EB 6497 EN

Contents **Page**

Changes in firmware version 1.10

The factory defaults of the Reset time TN parameter and of the operating direction were changed.

1. Description

The TROVIS 6497 Industrial Controller is used to automate industrial and processing plants. Through the use of a practical, clearly structured functional design, various control circuit arrangements can be configured. It may be used as a continuous-action controller, two-step or three-step controller with the following control mode options: P proportional-only, PI proportional-plus-integral (reset), PD proportional-plus-derivative (rate) or three-mode PID proportional-plus-integral-plus-derivative.

A sealed membrane operator panel is used to operate the industrial controller. Operation is divided into three simple logical levels: 1) OPERATING level, 2) PARAMETER level and 3) CONFIGURATION level.

Accessing the OPERATING level via displays for standard control operation is possible at any time. User-selectable code numbers must be entered in order access the second and third levels; i.e., PARAMETER and CONFIGURATION levels. In the PARAMETER level, control parameters can be modified and optimally tuned specifically to the process. In the CONFIGURATION level, various controller functions can be selected.

The controller accepts the following universal inputs: PT 100 resistance thermometer, thermocouples, standardized current and voltage signals, plus two-wire transmitters.

By means of the WE/WI setpoint switchover key (or via a binary signal), selection can be made between the internal WI and external WE setpoint (reference variable) of the industrial controller. Moreover, the setpoints can be selected and interconnected.

Bumpless transfer in the respective operating mode facilitated via the MANUAL/AUTOMATIC mode selector key.

Essential control parameters can be automatically determined and selected by the program using special "self-tuning" software feature.

1.1. Versions

TROVIS **6497-03**

Output

Continuous-action/two-step)/three-step/analog output, limit switches

Input

Two temperature ranges are available for measuring temperature with three-wire **Pt 100 resistance thermometers**:
Version 1: −100 °C to +400 °C in 1° steps
Version 2: −30.0 °C to +150.0 °C in 0.1° steps
The valid temperature range is printed on the nameplate adjacent to PT 100.

Options

Two additional limit switches

RS-485 serial interface with Modbus RTU software

This manual applies to controllers implementing firmware version 1.10 (see page 35).

CAUTION
This controller may only be assembled, commissioned and operated by trained personnel familiar with such technical procedures.

1.2. Technical data

Inputs	**Controlled variable X** Direct current signal 4(0) to 20 mA Ri = 2.5 Ω DC voltage signal 0(2) to 10 V Ri > 100 kΩ Pt 100 resistance thermometer, self-adjusting (three wires) Version 1 −100 °C to +400 °C Resolution 1 °C Version 2 −30.0 °C to +150.0 °C Resolution 0.1 °C Thermocouples (requires reference junction module, **order no.: 1600-1269**) K: NiCr-Ni 50 °C to +1200 °C DIN IEC 584 S: Pt10Rh-Pt 50 °C to +1700 °C DIN 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 YR Potentiometer 0 to (200 to 1000) Ω or Direct current signal 4 to 20 mA (with 500 Ω; 0.5 W; 1 % shunt)		
	External setpoint WE 4(0) to 20 mA or 0(2) to 10 V (selectable by means of jumpers)		
	External setpoint switchover Binary input switchover between external/internal WE/WI with 24 V DC Signal 0 V → internal WI; 24 V → external WE (select by means of WM) or external re-start of the setpoint ramp		
	Transmitter supply voltage 24 V DC/max. 30 mA		
Outputs	**Control output signal Y** (selectable by means of jumpers) Current −20.4(0) to 20 mA, Load R_B < 500 Ω or Voltage −10. 0(2) to 10 V, Load R_B > 500 Ω **Analog output AA** 0(4) to 20 mA/ 0(2) to 10 V **Additional switching outputs Y1 and Y2** (optional: 2 limit switches GW3 and GW4) Load rating of the switching contacts max. 250 V AC/ 1 A with cos φ = 1 Hysteresis (minimum) 0.3 %		
Power supply	230 V AC, 48 to 62 Hz; 120 V AC, 48 to 62 Hz; Optional: 24 V AC, 48 to 62 Hz		
Power failure	All parameter values and configuration blocks are internally stored against power failure in non-volatile EEPROM		
Power consumption	10 VA		
Permissile temperature	Ambient 0 to 50 °C; shipping and storage, 0 to 70 °C		
Measuring error	Linearity	Zero point	Final value
mA, V, Pt 100	0.2 %	0.2 %	0.2 %
Thermocouple	0.2 %	0.3 %	0.3 %
Degree of protection	IP 54 (front panel), IP 20 (enclosure)		
VDE 0110 Part 1	Overvoltage category II, Degree of contamination 2		
Weight	0.8 kg		

2. Installing the industrial controller

The industrial controller is designed for panel mounting. Its front case has a bezel measuring 96 x 96 mm. Perform the following steps in order to mount the controller:

1. Produce a panel cut-out with the dimensions $92^{+0.8}$ x $92^{+0.8}$.
2. Push the industrial controller in the panel cut-out from the front side.
3. Insert the two supplied mounting brackets in either the left and right (or top and bottom) openings provided in the case (see Fig. 1).
4. Turn the threaded rods in the direction of the control panel using a screw driver, clamping the front frame of the case against the control panel.

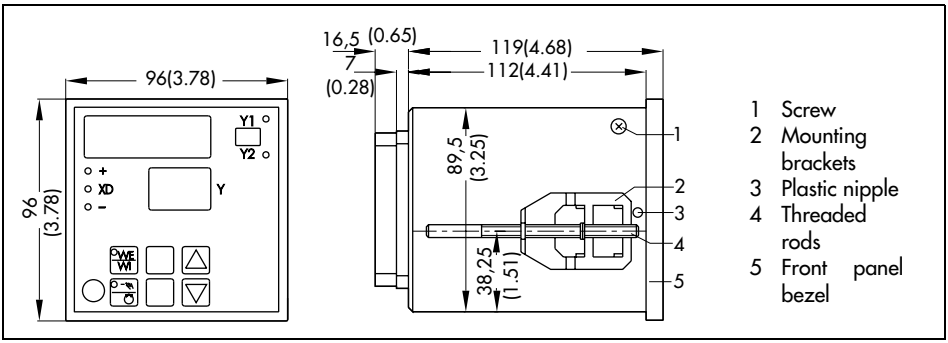


Fig. 1 · Dimensions of the controller case

2.1. Opening the controller case

Exchanging the fuse and re-jumpering (see section 2.2. to 2.4.) requires that the case be opened as follows:

1. Remove terminals, unloosen threaded rods and lift off mounting brackets. Then, pull the industrial controller out of the control panel and force off the front panel.
2. Turn out two lateral screws, and press the two transparent, lateral nipples downwards in the front direction using a suitable screw driver or appropriate tool.
3. Remove the controller section from the front after lightly tapping the connecting rails.
4. Replace the fuses and/or re-jumper as required (see section 2.2. to 2.4.)
5. Subsequently, re-install the controller section, fasten the two screws and assemble the front panel. Proceed as instructed in chapter 2. sections 2 to 4.

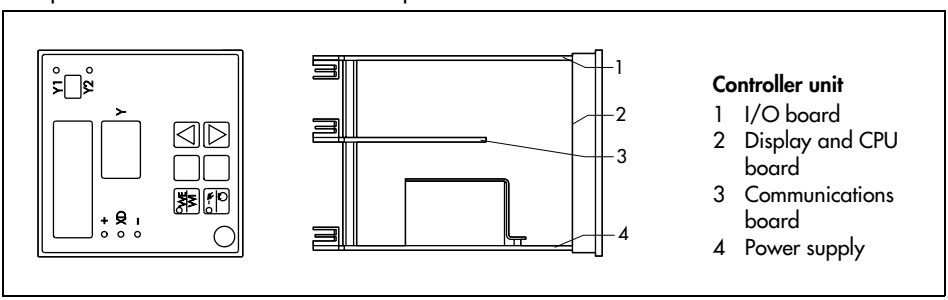


Fig. 2 · Arrangement of microprocessor boards in the controller unit

2.2. Fuses

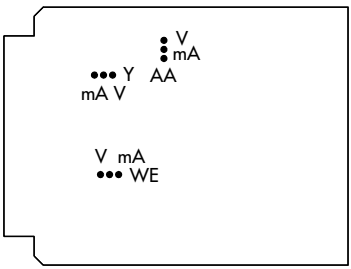
The power supply board (see Fig. 2) contains an overload protection directly adjacent to the terminal block. For the 230 V version, use TR 5 (63 mA), **order number: 8834-0343**; for the 120 V version, use TR 5 (125 mA), **order number: 8834-0346**.

To open the case, see section 2.1., page 6.

2.3. Re-jumpering external setpoint WE, manipulated variable Y and AA

The external setpoint WE, manipulated variable Y and analog recorder connection AA can be wired as either mA or V signals, whereby **mA** is the factory default. These signals can be modified by jumpering the I/O board accordingly (see Fig. 2). Note the jumper locations depicted in Fig. 3.

To open the case, see section 2.1., page 6.



I/O board (components side)

Jumpers

AA For connecting a recorder
Y For manipulated variable signal
WE For external setpoint

Fig. 3 · Jumper locations

2.4. Converting the controller from 230 V to 120 V power supply

Provision is made for subsequent conversion of the power supply from 230 V power supply to 120 V. To allow this, make the following changes on the soldering side of the power supply board (see Fig. 2):

1. Open soldering jumper "230 V".
2. Close soldering jumpers "120 V 1" and "120 V 2".
3. Replace fuse TR 5 63 mA and insert fuse TR 5 125 mA (see also section 2.2.).

3. Electrical connections

Plug-in, modular terminals are provided for the signal lines exhibiting cross sections from 0.5 to 1.5 mm² (DIN 45 140). Always observe the pertinent VDE 0100 regulations and those regulations and guidelines valid in the country where the controller is intended to be installed.
INSTALLATION NOTES:
The signal and sensor lines are to be wired separately from the leads of the controller and power supply.
Use shielded signal and sensor lines to avoid measuring errors associated with radio interference. Always ground the shielded electrical lines on the side of the industrial controller.
Separately install the power supply lines and protective conductors of each industrial controller at the corresponding distributing bar. Protective circuits located in the vicinity must be suppressed against interference by means of a resistor-capacitor (RC) combination.

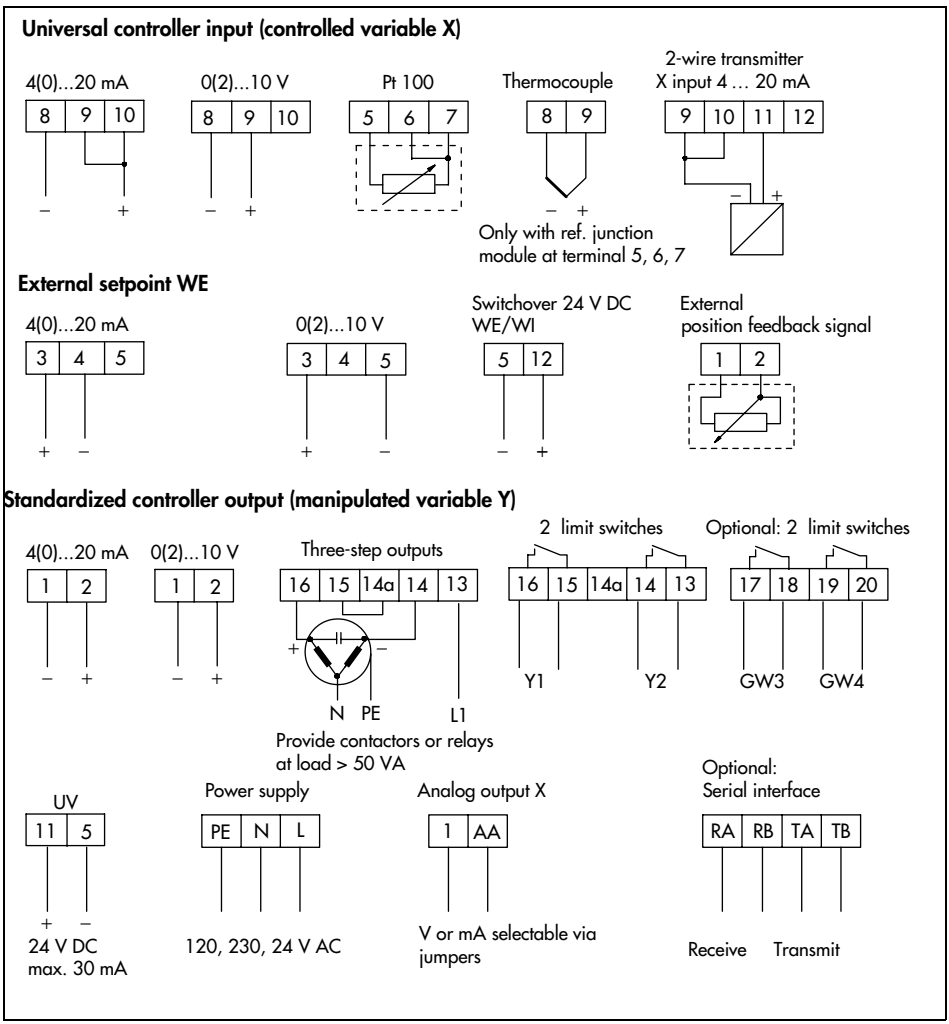


Fig. 4 · Terminal assignments

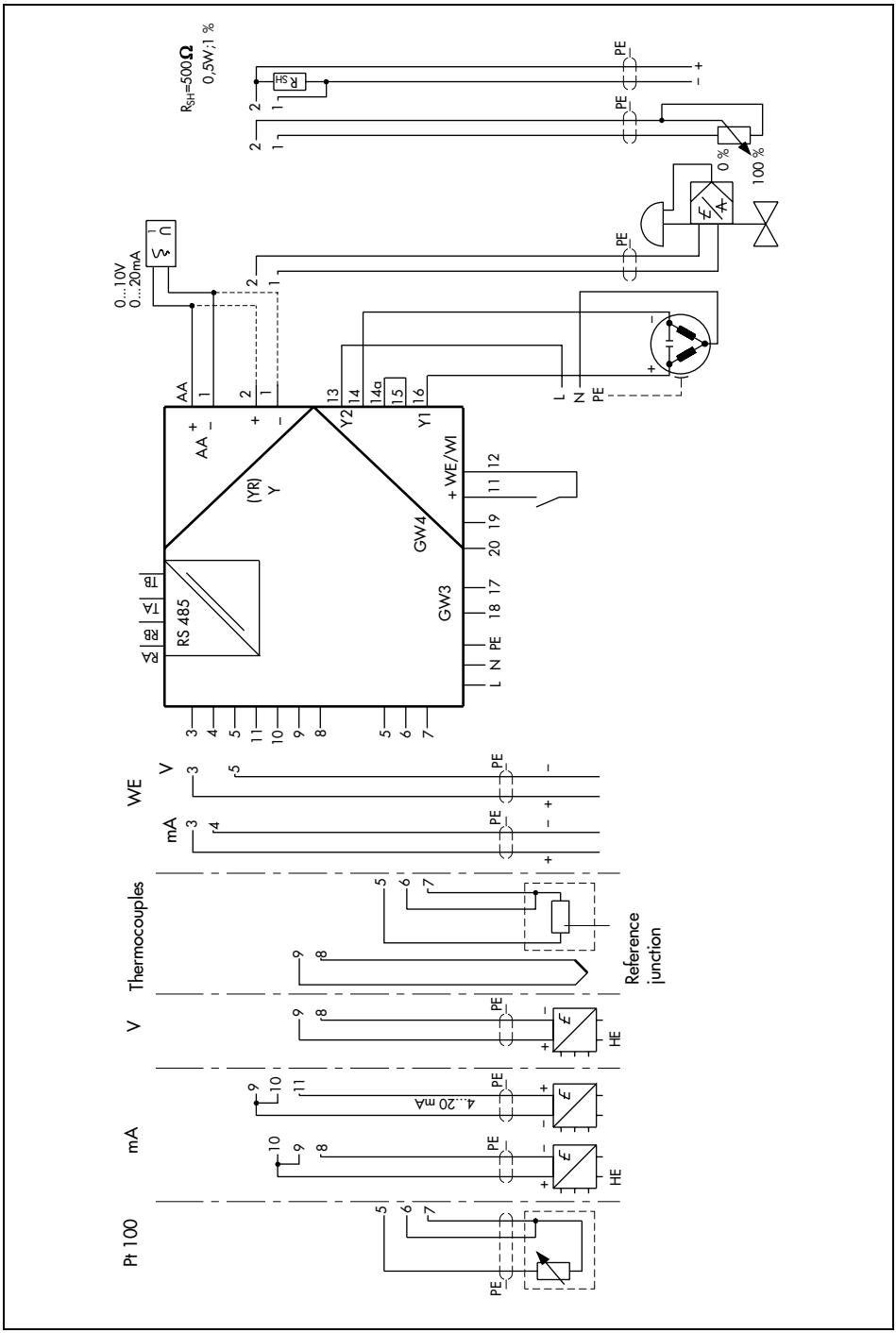


Fig. 5 · Circuit diagram

4. Operation

Unfold the last page of this manual (showing the control panel) to obtain a better understanding of this description when reading the following sections.

The industrial controller is designed according a three-level operating structure: 1) OPERATING level, 2) PARAMETER level and 3) CONFIGURATION level. Depending on the selected level (mode), the keys and visual displays assume various functions.

Chapter 5., page 23 clearly describes how the industrial controller is to be tuned to both the control application and the directly controlled system.

4.1. Process display and control panel elements

1 Controlled variable (actual value) display

OPERATING level: Display of controlled variable X

_-0 **Display upon breakage of sensor line:** If a sensor break is determined at the input of _-U the industrial controller or if the input range is exceeded in either direction, an 0 (over) or U (under) is displayed adjacently. In this case, the manipulated variable is automatically adjusted to the value predetermined in configuration block K1 (safety output value). The industrial controller operates in normal mode once the sensor break has been corrected.

PARAMETER and CONFIGURATION level: Display of the numerical value relating to the selected parameter or configuration block.

2 Manipulated variable (output value) display

OPERATING level: Display of manipulated variable Y in %
(for values > 100, an H appears in the display; for values < 0, NE is displayed),
or display of the external position feedback.

PARAMETER and CONFIGURATION level: Display of the designation associated with the selected parameter or configuration block.

NOTE:
If OC is displayed here, the default calibration of the controller has been lost. If this error occurs, please return the device to SAMSON!

3 Error (w - x) display

The yellow LED indicates the controlled range with zero offset; the two red LEDs indicate the error (designated as XD instead of e on the controller) for a deviation of at least ±1 %.

4 Switching output display

Two LEDs indicate the output state of the two-step/-step control output (or limit alarms).

5 Label for physical unit (of temperature)

Specification of the engineering unit applicable for the controlled variable display (1)

6 Cursor keys

Δ Increase displayed value

∇ Decrease displayed value

OPERATING level: After selecting WI:, direct change of the setpoint,
In MANUAL mode (see MANUAL/AUTOMATIC mode selector key): direct adjustment of manipulated variable signal Y

PARAMETER and CONFIGURATION level: Selection of a single parameter or configuration block (lower display in (2)), selection of the associated values (upper display in (1))

7 Operating key

OPERATING level**:** Selection of certain controller variables (see page 12).

PARAMETER level: Return to the OPERATING level and AUTOMATIC mode.*

CONFIGURATION level: Return to the OPERATING level and MANUAL mode*

* When manipulated variable display (2) flashes, first press the yellow ENTER key (8)!

8 ENTER key

OPERATING level: Invoke the PARAMETER level PA and CONFIGURATION level CO; acknowledge the entered code number, and enter the selected level.

PARAMETER/CONFIGURATION level: Invoke the displayed parameter or configuration block (flashing in the lower display field (2) indicates that values can be modified); enter and accept the value displayed in the upper field (1)

9 WE/WI external/internal setpoint switchover key

Selection of the external and internal setpoint. When the external setpoint WE is selected, the yellow LED in the key illuminates.

Switching to an external setpoint can also be made by applying an external 24 V DC signal (note configuration block WM, see page 18).

10 MANUAL/AUTOMATIC mode selector key

Bumpless transfer from MANUAL to AUTOMATIC mode (or vice versa). MANUAL mode is indicated by a flashing yellow LED in the key.

In MANUAL mode, the manipulated variable Y can be modified using the cursor keys (6), thereby directly influencing the connected control valve.

4.2. OPERATING level

Q4ß1
40

This is the normal or "standard" mode of the industrial controller. The upper display field (1) indicates the actual value of controlled variable X; the lower two-digit display field (2) indicates the current values (0 to 99 %) of the manipulated variable Y. If the manipulated variable drops below 0 %, NE will be displayed in the lower display field. If the manipulated variable exceeds 99 %, HO to H9 for 100 % to 109 % will be displayed.

Press the operating key (7) to display the following variables in the lower display field (2). The associated values are displayed in the upper display field (1). Select X to return to normal operation.

XD

XD **Error (w - x)**
(abbreviated as XD instead of e on the controller)

WI

WI **Internal setpoint (internal reference variable)**
The range of values depends on the measuring range limits XN and XE predetermined for controlled variable X.

Switch over to internal setpoint WI

Press the operating key (7) until WI appears in the lower display field (2).

Modify the value to the desired value indicated in the upper display field (1) by pressing the cursor keys Δ and ∇.

Press the operating key (7); the value is stored insuseptible to power failure.

WE

WE **External setpoint (external reference variable)**
A value is displayed under the condition that an external setpoint is connected.

YQ

Y **Manipulated variable (output value)**
The range of values is represented as a percentage and depends on the manipulated variable limits determined with Y< and Y>, resp. (see page 14).

XQ

X **Controlled variable (actual value)**
This display only appears for approximately 4 s. Thereafter, controlled variable X and manipulated variable Y are both subsequently displayed again.

The range of values in the display depends on the measuring range limits to be specified in the CONFIGURATION level with XN and X, resp. (see page 17).

4.3. PARAMETER level

Q001
KP

Control parameters can be selected in the PARAMETER level. Access is only possible after the acknowledgement of the code number.
The lower display field (2) indicates the parameter; the associated value is indicated in the upper display field (1).

Q000
PA

Accessing the PARAMETER level
Press the ENTER key (8); PA appears in the lower display field (2).
Press the ENTER key (8) again; the display PAflashes.
Select the code number by pressing the cursor keys Δ and ∇, see the upper display field (1). (Notes on code number, see page 21)
Re-press the ENTER key (8); the PARAMETER level is now opened. The first parameter KP (proportional-action coefficient) appears in the lower display field (2). Upon entry of a wrong code number, the industrial controller returns to the OPERATING level.

Entering and modifying parameter values
To open the PARAMETER level, see above.
Select the parameter using the cursor keys Δ and ∇, see the lower display field (2).
Press the ENTER key (8); the selected parameter flashes.
Select the parameter value using the cursor keys Δ and ∇ (see the upper display field (1)) and accept by pressing the ENTER key (8).
Select the next parameter or exit the PARAMETER level; see below.

Exiting the PARAMETER level
Pressing the operating key (7) returns to the OPERATING level.
If the lower display field (2) flashes, first press the ENTER key (8)!
The following parameters can be selected in the PARAMETER level for the TROVIS 6487 Industrial Controller:

KP

KP **Proportional-action coefficient** (proportional-action component (proportional gain) of the industrial controller)
Range of values 0.1 … 199.9

TN

TN **Reset time** (integral-action component of the industrial controller)
Range of values 1 … 1999 s; disabled when set to 0.

TV

TV **Rate time** (derivative-action component of the industrial controller)
Range of values 1 … 1999 s; disabled when set to 0.

KD

KD **Rate gain** (derivative-action gain)

Range of values 1 … 10; disabled when set to 0. Value commonly set between 5 and 10. Also sometimes abbreviated VD.

WR

WR **Operating direction** (characteristic of the industrial controller)

0	Direct >>,	Increasing X → increasing Y or decreasing X → decreasing Y
1	Reverse <>,	Increasing X → decreasing Y or decreasing X → increasing Y

YL
Y>

Y< , Y> **Manipulated variable limits**

These parameters determine the start (Y<) and the end value (Y>) of the control output signal. The displayed values refer to the percentage of the selected control output range (see YM page 19,Y* page 18).

Y< = -109.9 % ... Y>

Y> = Y< … 109.9 %

The limits have no effect in MANUAL mode.

Y0

Y0 **Operating point**

The operating point Y0 is specified as a percentage in reference to the manipulated variable Y.

PI and PID control modes ignore the operating point.

Parameters for switching outputs Y1 and Y2:

1A, 2A determine the limit values ; 1H, 2H determine the hysteresis for switching outputs Y1 and Y2.

Configuration blocks 1M or 2M determine the type of limit value (signalling condition) and hence the range of values.
Detailed explanations can be found in chapter 5., page 23.

1A

1A **Limit value or transfer coefficient** for switching output Y1

For YM = 0 or 3	Limit value or switching point for Y1
= 2	Transfer coefficient

1H

1H **Hysteresis or minimum pulse duration** for switching output Y1

For YM = 0 or 3	Hysteresis for Y1
= 2	Minimum pulse duration in % of T1
= 1 or 4	Hysteresis

2A

2A **Limit value or transfer coefficient** for switching output Y2

For YM = 0 or 3	Limit value or switching point for Y2
= 2	Transfer coefficient

2H

2H **Hysteresis or minimum pulse duration** for switching output Y2

For YM = 0 or 3	Hysteresis for Y2
= 2	Minimum pulse duration as a percentage of T2

T1

T1 **Switching time**

For YM = 0 or 3	Period (cycle time) for pulse-modulated
For YM = 0 or 3	control outputs (1M/2M = 8 or 9)
= 2	Period (cycle time) in positive op. direction
= 1 or 4	Operating time of the associated actuator

T2

T2 **Switching time**

For YM = 2	Period (cycle time) for negative operating direction

TZ

TZ **Dead band**

Range of values 0 … 109.9 % referring to the manipulated variable range

The following paramters are entered for the three-step controller with internal or external position feedback: Dead band (note definition!), the minimum pulse duration (for pulse-modulated control outputs) and the split point (for pulse-modulated control outputs with split-range).
Further details can be found in chapter 5., page 23.

The following parameters only apply to version with additional limit switches GW3 and GW4:

3A

3A **Limit value** for limit switch GW3
The range of values depends on configuration block 3M.

3H

3H **Hysteresis** On-off differential for limit switch GW3
The range of values depends on configuration block 3M.

4A

4A **Limit value** for limit switch GW4
The range of values depends on configuration block 4M.

4H

4H **Hysteresis** On-off differential for limit switch GW4
The range of values depends on configuration block 4M.

4.4. CONFIGURATION level

Functions appertaining to the required control task can be determined by the configuration blocks in the CONFIGURATION level. Access is only possible after acknowledgement of the code number.
The lower display field (2) indicates the configuration block; the upper display field (1) indicates the associated value. Configuration blocks can be selected and modified in the specified range.

Accessing the CONFIGURATION level
Press the ENTER key (8); PA is indicated in the lower display field (2).
Press cursor key Δ ; CO appears in the lower display field (2).

Press the ENTER key (8); CO flashes.

Enter the code number using the cursor keys Δ and ∇; see upper display field (1). (Notes on the code number, see page 21)

Re-press the ENTER key (8); the CONFIGURATION is opened. The first configuration block XN is indicated in the lower display field (2). Upon entry of a wrong code number, the industrial controller returns to the OPERATING level.

Determining and modifying values of the configuration blocks

Open the CONFIGURATION level, see above.

Select the configuration block using the cursor keys Δ and ∇.

Press the ENTER key (8); the selected configuration block flashes.

Select the desired value in the upper display field (1) using the cursor keys Δ and ∇ and store by pressing the ENTER key (8).

MANUAL mode is enabled the first time a value is modified.

Advance to the next configuration block using the cursor keys or exit the CONFIGURATION level, see below.

Exiting the CONFIGURATION level

Pressing the operating key (7) returns to the OPERATING level, whereby MANUAL mode is still activated. Switch is made to manipulated variable Y in the lower display field (2).

Press the MANUAL/AUTOMATIC mode selector key; switch is made to AUTOMATIC mode.

The following configuration blocks determine the controller functions:

XN XE

XN **and** XE **Measuring range limits of controlled variable X**
These configuration blocks determine the start (XN) and end value (XE) of controlled variable X. They mutually limit themselves.

XM = 0, 3, 4, 5, 6	Measuring range, see temperature range under XM; also can be limited in respective range.
XM = 1, 2	Measuring range selectable between –1999 and +1999 with consideration of the decimal point X, . The selected measuring range refers to an internal signal range from 4 to 20 mA (0 to 100 %); e.g., for a pressure transducer having a measuring range from 1 to 3 bar, select XN =1.0 (i.e. =^20 mA or 100%)

X,

X, **Decimal point** (only for mA or V input; i.e., XM = 1 or 2)
The decimal point for the upper display field (1) can be defined between 0 and 3; e.g., 1000 (no decimal), 1.**000** (**three** decimal places)

XM

XM **Selection of the input signal**
Configuration block XM determines the input circuitry (input signal). The following inputs can be determined:

0	Pt 100		Version 1		–100 °C to 400 °C
			Version 2		– 30.0 °C to 150.0 °C
1	4(0) … 20 mA	} Range selection under X*, decimal point, see X,			
2	0(2) … 10 V				
3	Thermocouples (with ref. junction module)		Ni-Cr-Ni	(K)	50 °C 10 +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

XT

XT **Unit of temperature**
0 °C (°Celsius)
1 °F (°Fahrenheit)

X*

X* **mA or V signal range for controlled variable X**
0 0...20 mA or 0...10 V Depending on selection of XM (1 or 2)
1 4...20 mA or 2...10 V Depending on selection of XM (1 or 2)
(ignored for Pt 100 or thermocouple)

W*

W* **mA or V signal range for external setpoint WE**

0	0...20 mA or 0...10 V	Depending on jumper WE
1	4...20 mA or 2...10 V	Depending on jumper WE (factory default, **mA**)

Y*

Y* **mA and V signal range for manipulated variable Y and AA**

	Y (depending on jumper Y) (factory default, **mA**)	AA (depending on jumper AA) (factory default, **mA**)
0	–20 … 20 mA or –10 … 10 V	0 … 20 mA or 0 … 10 V
1	4 … 20 mA or 2 … 10 V	0 … 20 mA or 0 … 10 V
2	–20 … 20 mA or –10 … 10 V	4 … 20 mA or 2 … 10 V
3	4 … 20 mA or 2 … 10 V	4 … 20 mA or 2 … 10 V

DI

DI **Selection of the input circuitry of the derivative-action component**

The input variable for the derivative-action component of the industrial controller can optionally be the controlled variable X or error XD.

0 X input
1 Error XD

WM

WM **Selection between external and internal setpoint**

An external setpoint WE can be applied either by actuating the WE/WI setpoint switchover key (9) or by applying an external signal (+24 V) at terminals 12 and 5 of the binary input.
Configuration block WM determines the setpoint and the combination option.

0 WE input disabled
1 Addition of external WE and internal WI
2 Minimum selection between WE and WI
3 Maximum selection between WE and WI
4 Switchover by means of WE/WI external/internal setpoint switchover key (9)
5 Switchover by means of WE/WI external/internal setpoint switchover key (9) or by preference of the external +24 V signal
6 Switchover only by means of an externally applied +24 V signal
7 Re-start of the setpoint ramp beginning with applied X value

YH

YH **Inhibiting the MANUAL/AUTOMATIC mode selector key**

0 Key function enabled
1 Key function disabled (inhibited)

YM

YM **Selection of the controller output**

0 Continuous analog output (see page 23)

1 Three-point step. controller with internal pos. feedback (s. page 26)

2 Three-point step. controller with external pos. feedback (see page 27)

3 Continuous control output available as recorder connection "X"

4 Three-point stepping controller (same as YM = 1) and recorder connection for controlled variable X at the continuous control output; no valve position (travel) display possible.

YR

YR **External position feedback**

Position feedback is also possible via a potentiometer 0 to (200 to 1000) Ω or via a standardized 4 to 20 mA current signal .

0 0 to (200 to 1000) Ω

1 4 to 20 mA (with shunt resistor 500 Ω / 0. 5W / 1 % at terminal 1 and 2, see Fig. 5, page 9)

1M 2M

1M **and** 2M **Signalling condition of the limit values**

For switching outputs Y1 and Y2

For YM = 1, 2 or 4, set 1M and 2M to 0.

Parameters 1A and 2A determine the limit values for the corresponding signalling condition. (Further details, see chapter 5., page 23).

0	Off	Switching output not activated	
	Switches when:		
1	Xmax	X over limit	
2	Xmin	X under limit	
3	XDmin	XD under limit	
4	XDmax	XD over limit	
5	XDmin and XDmax	XD over or under limit, feedback of the controlled variable monitoring to the setpoint	
6	Y_{max}	Y over limit	Two-step/ three-step control output
7	$Y_{min.}$	Y under limit	
8	Pulse-modulated control output, positive		See section 5.5., page 29
9	Pulse-modulated control output, negative		

S1 S2

S1 **and** S2 **Switching outputs Y1 or Y2 (as NO or NC contacts)**

0 NO make contact

1 NC break contact

3M
4M

3M **and** 4M **Signalling condition of the limit values**
For the optional limit switches GW3 and GW4
Parameters 3A and 4A define the values for the corresponding signalling condition.

0	Off	Switching output inactive
	Switches when:	
1	X_{max}	X over limit
2	X_{min}	X under limit
3	XD min	XD under limit
4	XD max	XD over limit
5	XD min and XD max	XD under or over limit
6	Y_{max}	Y over limit
7	Y_{min}	Y under limit

S3
S4

S3 **and** S4 **Limit switches GW3 and GW4 (as NO or NC contacts)**
0 NO make contact
1 NC break contact

TA

TA **Update cycle to refresh the controlled variable display**
0 Every 50 ms
1 Every 2 s

FI

FI **Digital filter**
The digital filter FI is used to delay the analog inputs X and external setpoint WE. Rang of values 0 to 1999 s; disabled when set to 0

K1

K1 **Safety output value** Upon a sensor line break, re-start value after power failure
Selectable between 0 and 109.9 % of the manipulated variable output range.
Should the sensor line break, manipulated variable Y is automatically set to the predetermined value of K1.
In case of a power failure > approximately 100 ms, manipulated variable Y is used again from the value predetermined in K1. In the case of a power failure < approximately 100 ms, the manipulated variable Y remains at the last value output.

C2

C1 **and** C2 **Code numbers**

C1 Access to the PARAMETER R level

C2 Access to the CONFIGURATION level

Both code numbers are factory set to **000**. Their values can be changed in the range –1999 to +1999 as required. In the event that a code number has been forgotten, see notes under section **Code number important for servicing**

Code number important for servicing

A superior code number for servicing is specified on page 38 of this manual, permitting the CONFIGURATION level to be opened despite the entered code numbers C1 and C2. To avoid unauthorized use, separate this number from page 38 (or scratch over to make fully illegible). The code numbers selected can then be read when configuration blocks C1 or C2 are called.

Entry: Open CONFIGURATION level (see page 16); use the **Code number important for servicing** as the code.

SO

SO **Self-tuning** (adaption)

0 Disabled, no self-tuning;

Only selectable when MANUAL/AUTOMATIC mode selector key (1) is set to MANUAL mode:

1 Ready for tuning, Optimization according to the setpoint for systems with a delay >10 s

2 Ready for tuning, Optimization according to the disturbance for systems with a delay >10 s

Self-tuning (auto-tuning) enables the industrial controller to automatically tune itself to the characteristics of the control loop in the start-up phase and to calculate the "ideal" control parameters. The appropriate tuning is to be determined by selecting 1 or 2. For control loops which are critical and extremely fast and for which the control valve must not be abrubtly adjusted, select 0 in order to disable the tuning facility (see also section 7.2., page 38).

TS
TM

TS **Setpoint ramp time**

A setpoint ramp alters the setpoint at a constant speed. Configuration block TS determines the time for completing the entire setpoint range (XN to XE). The actual time (TS1) to modify the setpoint is calculated by the industrial controller from this (see Fig. 6). This setpoint ramp is effective for every modification of the setpoint.

In this respect, note configuration block WM = 7, see page 18. This setting causes the setpoint to perform an X-tracking (W = X) by adding the binary input. After switching back the input, the setpoint changes by the speed selected with TS until the desired value is obtained.

Range of values: TS is first indicated in the lower display field (2), and the value in the upper display field (1) is specified in seconds (0 to 1800 s). Afterwards, the lower display in (2) switches to TM, and the time is displayed in minutes (30 to 500 min).

To disable, set the parameter to 0.

SN

SN **Station address number**

0 Off (disabled)

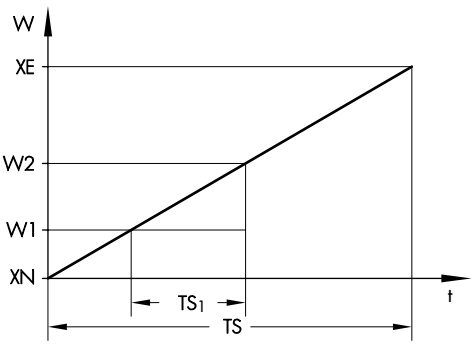
1 to 246

BR

BR **Baud rate** (selection of the data transmission speed)

0 4800 bits/second

1 9600 bits/second



XN	Minimum measuring range limit
XE	Maximum measuring range limit
W	Setpoint
W1	Old setpoint value
W2	New setpoint value
TS	Time set for setpoint ramp (TS)
TS_1	Actual calculated time for switching the setpoint from W1 to W2

Fig. 6 · Setpoint ramp

5. Standard controller outputs

The standard version of the TROVIS 6497 Industrial Controller has one continuous output.

Two switching outputs Y1 and Y2 are additionally available. These outputs can be configured as limit switches or two-step/-step control outputs.

5.1. Continuous-action controller

Configuration block YM = 0 configures TROVIS 6497 as a continuous-action controller. Depending how the jumper Y is selected (see Fig. 3 on page 7), either a continuous mA or V signal is applied at terminals 1 and 2.

5.2. Switching outputs Y1 and Y2

Configuration blocks YM and 1M/2M determine the functions of switching outputs Y1 and Y2.

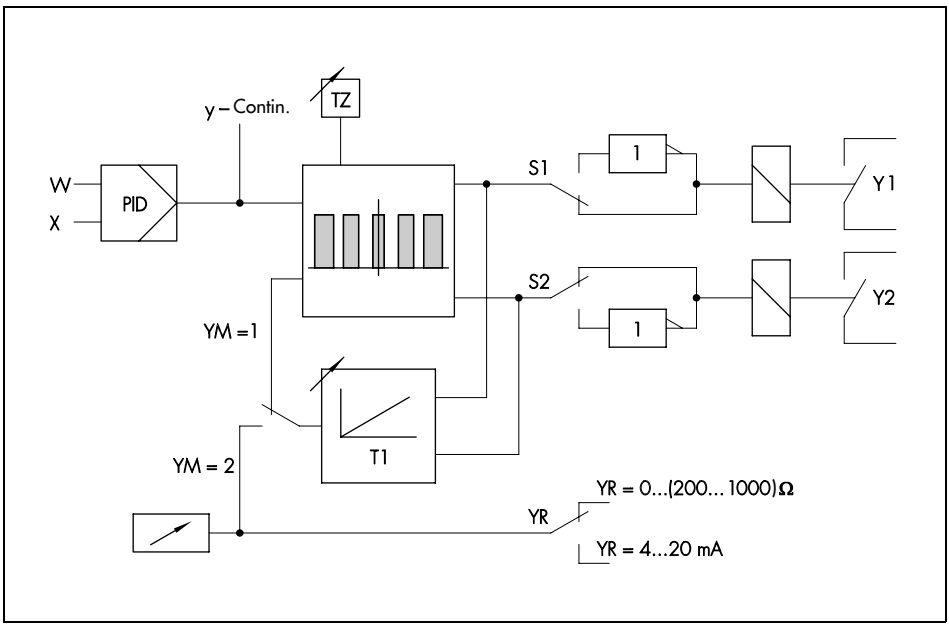


Fig. 7 · Switching outputs Y1 and Y2

5.2.1. Limit switches

TROVIS 6497 provides four limit switches (switching outputs Y1 and Y2 and two optional limit switches GW3 and GW4).

A limit switch monitors a variable to ensure that a minimum or maximum value (limit value) is maintained. Configuration blocks 1M, 2M, 3M and 4M (signalling condition of limit value) determine which variable is to be monitored for exceeding in either direction. Parameters 1A, 2A, 3A and 4A determine the limit value for the corresponding variable. Moreover, a hysteresis value (on-off differential) must be specified for each limit switch by means of parameters 1H, 2H, 3H and 4H.

This hysteresis is the differential gap between the on-off state of the limit switch. When exceeded in either direction, the hysteresis acts in the opposite direction of the monitored variables (see Fig. 8).

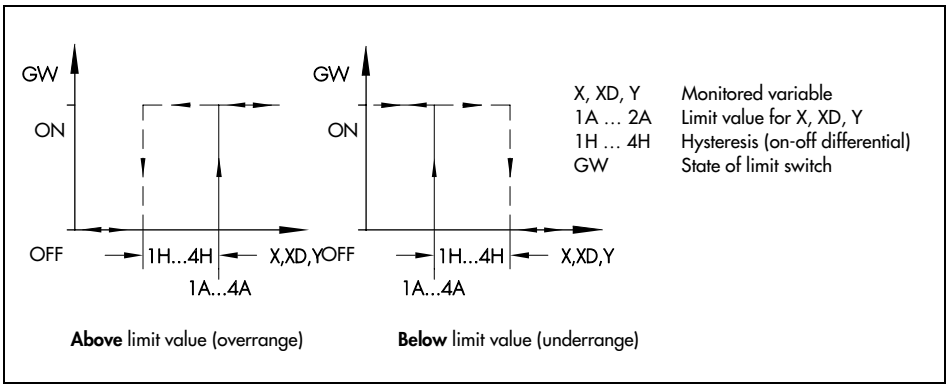


Fig. 8 · Limit switches

Switching outputs Y1 and Y2 can be used as limit switches when configuration block YM = 0.

The signalling conditions of the limit values are assigned as follows:

1M/2M/3M/4M =	0	Disabled limit switch
	= 1/ 2	Maximum/minimum absolute value of the controlled variable
	= 3/ 4	Minimum/maximum absolute value of the error percentage
	= 5	Minimum and maximum absolute value of the error percentage (with XD_{min}, limit values set under 1A/2A/3A/4A are negative)
	= 6/ 7	Absolute value of the manipulated variable

Configuration blocks to be set:

1M/2M	= 1 to 7	Y1/ Y2 as limit switch (only when YM = 0, otherwise 0)
3M/4M	= 1 to 7	Optional limit switch GW3/ GW4

Parameters to be entered:

1A / 2A	= Limit value	For Y1/ Y2 (only when YM = 0, otherwise 0)
1H / 2H	= Hysteresis	For Y1/ Y2 (only when YM = 0, otherwise 0)
3A / 4A	= Limit value	For GW3/ GW4
3H/ 4H	= Hysteresis	For GW3/ GW4

5.2.2. Two-step (on-off)/three-step control output

Configuration blocks YM = 0 and 1M = 6 or 7 configure the two-step control output, which corresponds to monitoring an limit value for overcrossing by manipulated variable Y. Parameter 1A determines the limit value for the switching point; 1H determines the hysteresis as an absolute value of the manipulated variable Y.

Configuration blocks YM = 0, 1M = 6 and 2M = 7 configure the -step control output. Parameters 1A and 2A determine limit value for the switching point; 1H and 2H determine the hysteresis as an absolute value of the manipulated variable Y.Ensure that the difference between the upper and lower switching point is larger than the sum of the respective differential values: 1A –2A > 1H + 2H

When selecting the two-step or three-step control output, it is recommended to choose a P (proportional) or PD (proportional-plus-derivative) algorithm for the process control application (set proportional-action coefficient KP, rate time TV, rate gain KD). The operating point Y0 and the minimum/maximum control manipulated variable limits (Y< and Y>) are to be selected in such a way that the outputs are always able of being switched on or off.

Limit switches GW3 and GW4 (also Y2 with two-step control output) can be further assigned to any signalling condition of the limit value.

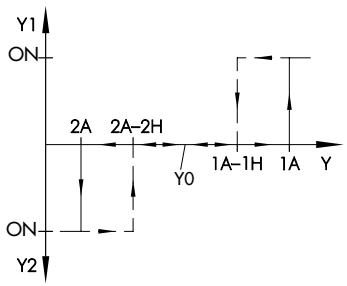
Configuration blocks S1/2/3/4 are used to configure switching outputs Y1 and Y2 and limit switches GW3 and GW4 as: 1) NO make contact (S1/S2/S3/S4 = 0); i.e., the relay closes when the signalling condition is satisfied or 2) NC break contact (S1/S2/S3/S4 = 1); i.e., the relay opens when the signalling condition is satisfied.

Configuration blocks be set:

YM	= 0	
1M	= 6 or 7	(two-step controller)
2/3/4M	= 0 to 7	
1M	= 6 or 7	(-step controller)
2M	= 7 or 6	
3/4M	= 0 to 7	

Parameters to be entered:

1A / 2A	= Limit value for switching point
1H / 2H	= Hysteresis



Y1, Y2	Switching output
Y	Manipulated variable
1A, 2A	Limit value for snap-over point
1H, 2H	Differential hysteresis
Y0	Operating point

Fig. 9 · Three-point control output

5.3. Three-step controller with internal position feedback

The three-step controller employing internal position feedback is selected with configuration block YM = 1. Switching outputs Y1 and Y2 form the -step output and are no longer available as limit switches. 1M and 2M are to be set to zero.

The operating time and effective ON time of the actuator are used to calculate the position of the final control element. The operating time of the actuator is specified by means of parameter T1. This value can be found in the technical description pertaining to the actuator. In this output circuitry, it must have the same value to enable opening and closing of the final control element. The range of values for the manipulated variable cannot be limited. The parameters of the manipulated variable limits Y< and Y> are to be set to the minimum and maximum value.

External position feedback is not required for the control algorithm. However, the position of the final control element can be indicated in the lower display field to monitor the control valve. For this purpose, the position feedback signal must be determined using configuration block YR. When a potentiometer is connected, it must be adjusted (see section 5.3.1., page 27). If the position of the final control element is not to be displayed, see notes in section 5.3.1.

Parameter 1H specifies the hysteresis as a percentage of the manipulated variable Y and must not be larger than the product of 2 * TZ. Paramter TZ (dead band) defines the range from the current operating point to the respective switching point and is to be specified as a percentage of manipulated variable range. To obtain the value for the variable commonly defined as dead time (from negative switching point to positive switching point), TZ must be doubled.

Requisite: The industrial controller must be configured as a PI controller in order for it to perform the required three-point stepping characteristic. When this requirement is met, it operates as a quasi-continuous controller.

In MANUAL mode, a modification of Y directly effects the -step output.
Configuration blocks to be set:

YM = 1

1/2M = 0

Parameters to be entered:

T1 = Operating time of the actuator, e.g. 120 s

1H = Hysteresis in per cent, e.g. 2.8 %

TZ = Dead band in per cent of the manipulated variable range, e.g. 3 %

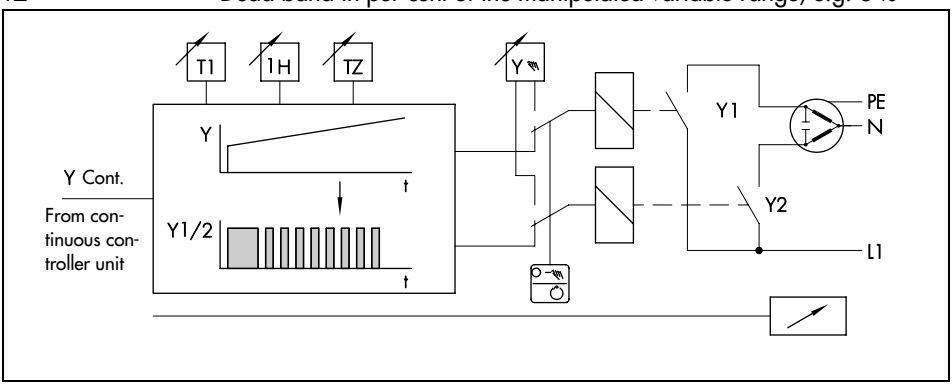


Fig. 10 · Three-step controller with internal position feedback

5.3.1. Balancing the potentiometer

After connecting a potentiometer for the position feedback, it must be adjusted. Adjustment must be made prior to commissioning! NOTE: The industrial control automatically adjusts the span; zero, however, remains and is not adjusted.

Adjusting the potentiometer involves the following eight steps:

1. Set the jumper Y to the mA position (see Fig. 3, page 7)!
2. Set the potentiometer to the maximum value (200 to 1000 Ω)!
3. Open the CONFIGURATION level (see page 16)!
4. Select the configuration block YM using the cursor keys!
5. Press the ENTER key!
6. Depending on the output, select YM = 1 or 2 using the cursor keys!
7. Press the ENTER key!
8. Press the MANUAL/AUTOMATIC mode selector key! CAL appears in the upper display field as long as the adjustment is being made. The adjustment is finished when CAL disappears. The position feedback message is indicated in the lower display field.

NOTE:

If position feedback is not wanted for YM =1, the lower display field can be set to 00 . To achieve this, perform the adjustment described above using "open" terminals. Subsequently, lay the jumper between terminal 1 and 2.

Optionally, select YM =4. After aligning with "open" terminals and laying the jumper (see above), 00 will be displayed instead of X. In this configuration, a recorder can be connected to log the controlled variable X.

5.4. Three-step controller with external position feedback

Select this output using configuration block YM = 2. The position of the final control element operated is transmitted as a feedback signal by means of a potentiometer (0 to (200 to 1000) Ω) or a direct current signal (4 to 20 mA) with shunt via the input of the external feedback YR (terminals 1 and 2)

The manipulated variable can be limited as required.

Actuators utilizing different transit times to open and close the valve are supported. Parameters T1 and T2 specify the period (not the transit time!) in the positive and negative direction of the actuator. An appropriately selected period offers a suitable compromise between the low residual ripple of the controlled variable (high switching frequency; i.e., cylce time selected to a low value) and a high operating life of the final control element (low switching frequency; i.e., period selected to a high value).

Parameters 1H and 2H determine the minimum pulse duration as a percentage of the corresponding period (T1 and T2). The value of the minimum pulse duration is to be selected in such a way that the connected actuators or contactors can just begin to switch.

The transfer coefficients 1A and 2A specify the inclination of the duty factor T_{Ein}/TP (T_{Ein} = ON time, TP = period (T1 or T2)). This allows the difference to be calcuated when the duty factor is one (manipulated variable calculated by the industrial controller minus the feedback position of the final control element); i.e., the controller releases a continuous signal. The ON time is calculated according to $T_{Ein} = (Y–YR) \cdot A \cdot TP$, whereby T_{Ein} = TP; A = 1A or 2A applies for T_{Ein} > TP.

Parameter TZ (dead band or neutral zone) defines the range extending from the current operating point to the respective switching point and is to be specified as a percentage of the manipulated variable range. To obtain the value for the variable commonly defined for dead band (from negative switching point to positive switching point), double TZ.

In MANUAL operation, a modification of Y does not directly effect the -step output, rather the input of the positioner integrated in the industrial controller. The duty cycle is shifted by changing the positioner's error (deviation). The industrial controller is pulsed according to the new duty cycle.

Configuration blocks to be set:

YM = 2
1/2M = 0
YR = 0 or 1 (selection of the external feedback signal)

Parameters to be entered:

T1 = Period in the positive operating direction, e.g. 20 s
T2 = Period in the negative operating direction, e.g. 20 s
1H = Minimum pulse duration in the positive operating direction in per cent of T1, e.g. 10 %
2H = Minimum pulse duration in the negative operating direction in per cent of T2, e.g. 10 %
1A = Gain (transfer coefficient) in the positive operating direction, e.g. 15
2A = Gain (transfer coefficient) in the negative operating direction, e.g. 15
TZ = Dead band in per cent of the manipulated variable range, e.g. 3 %

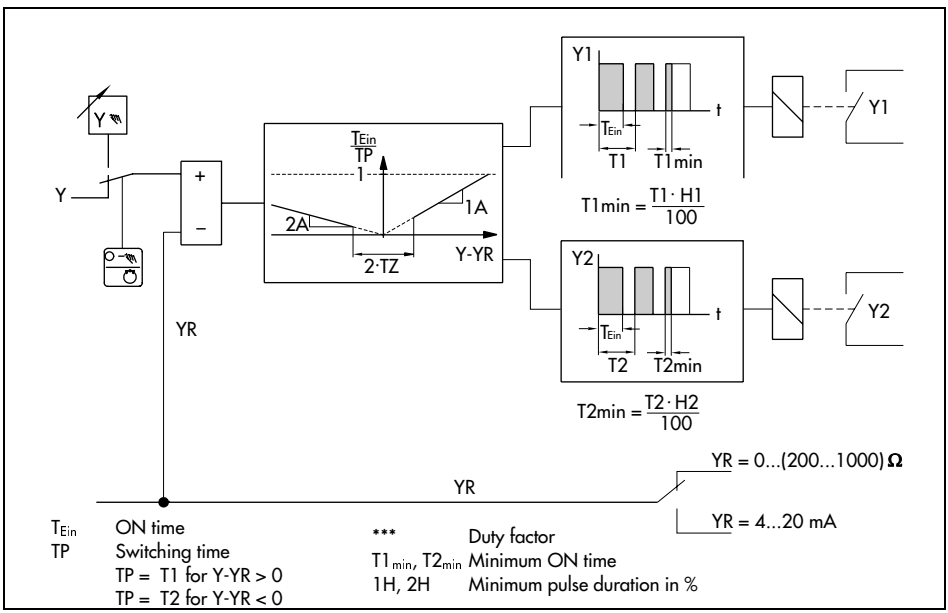


Fig. 11 · Three-step controller with external position feedback

5.5. Pulse-modulated control outputs

The pulse-modulated control output consists of a switching output, its ON time T_{Ein} of which is directly proportional to the internal manipulated variable Y in reference to the selected period T1.

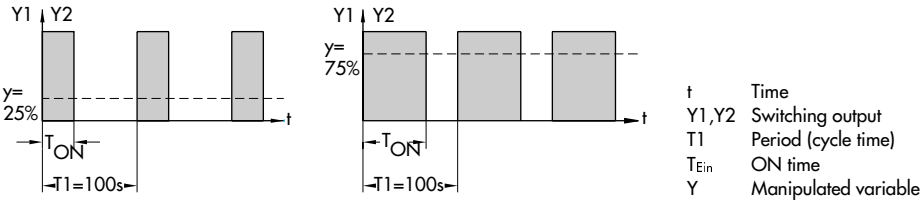


Fig. 12 · Pulse-modulated control output

5.5.1. Pulse-modulated control outputs

This switching output is configured for Y1 by means of configuration block 1M = 8 or 9, where 1M = 8 configures an two-step control output with positive operating direction, 1M = 9 with a negative operating direction. Configure Y2 equivalent to 2M.

The dead band (neutral zone) TZ indicates at which percentage of the manipulated variable Y the output begins to switch. This corresponds to the minimum pulse duration as a percentage of the period.

Configuration blocks to be set:

YM = 0

1M/ 2M = 8 or 9 (two-step with positive or negative operating direction)

Parameters to be entered:

T1 = Period (cycle time), e.g. 20 s

TZ = Minimum period in per cent of period T1, e.g. 10 %

5.5.2. Dual two-step pulse-modulated control outputs

This configuration is selected with 1M = 8 and 2M = 9. Both switching outputs Y1 and Y2 are pulse-modulated and form two on-off control outputs for the positive and negative internal manipulated variable Y.

Parameter TZ indicates at which percentage of the manipulated variable Y the output begins to switch. This corresponds to the minimum pulse duration as a percentage of the period.

Configuration blocks to be set:

1M = 8 (pulse-modulated control output, positive)
2M = 9 (pulse-modulated control output, negative)

Parameters to be entered:

T1 = Period (cycle time), e.g. 20 s
TZ = Minimum pulse duration in per cent of the period T1, e.g. 3 %

5.5.3. Dual two-step pulse-modulated output in split range (positive or negative)

This selection is used to operate switching outputs Y1 and Y2 in split range. Parameter TZ determines the split-range point in reference to internal manipulated variable Y; parameter TZ no longer specifies the minimum pulse duration

Parameters S1/ S2 determine the operating direction of the split-range outputs. This is positive for S1/ S2 = 0, otherwise negative.

Configuration blocks to be set:

1M = 8 (positive split range) or 9 (negative split range)
2M = 8 (positive split range) or 9 (negative split range)

Parameters to be entered:

T1 = Period (cycle time), e.g. 20 s
TZ = Split-range point

6. Serial interface

6.1. Description

Via the serial interface, the TROVIS 6497 Industrial Controller is able to communicate with a control station. A complete automation system for process control can be constructed by means of software suitable capable of process visualization and communication. Here, the wide-spread Modbus communications protocol is implemented as the communication standard. The hardware relating to the serial interface satisfies the requirement of the RS-485 interface (**RS** = **R**ecommended **S**tandard according to EIA).
If the controller is intended to terminate the bus, five soldering jumpers "LB1" to "LB5" must be connected on the components (soldering) side of the interface board (see Fig. 2, page 6).

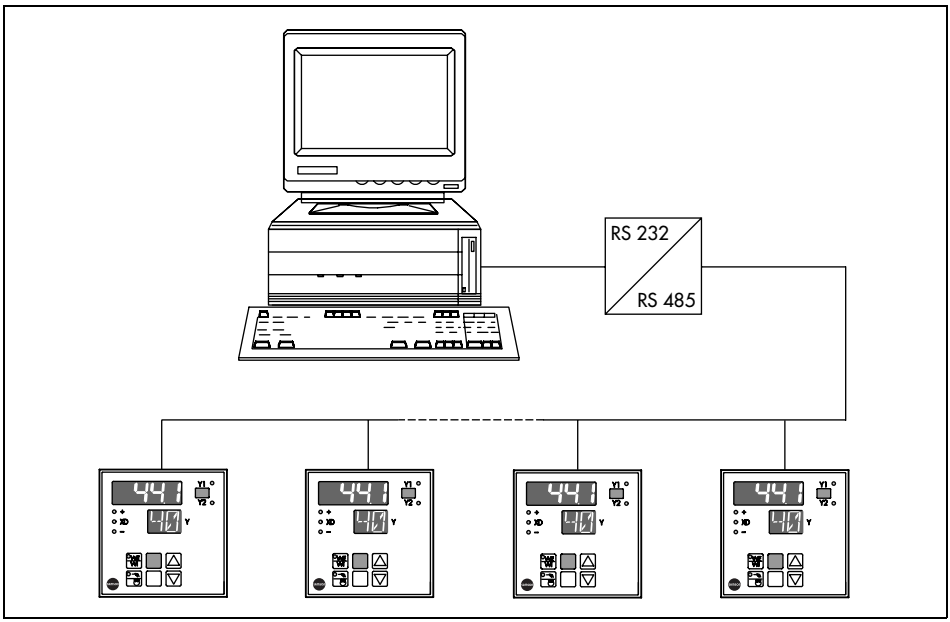


Fig. 13 · Process control system with TROVIS 6497 Industrial Controllers

6.2. Technical specifications

Physical interface	RS-485
Communications protocol	Modbus RTU 584
Data transmission	Asynchronous, half-duplex (four wires)
Character format	RTU (8 bits) 1 start bit, 8 data bits, 1 stop bit
Baud rate	4800 or 9600 bits/second
Number of addressable stations	246
Transmittable data	Configuration, parameters, operating state, process variables

6.3. Operation

6.3.1. Selecting the station addresses

An unassigned station address is defined in the industrial controller to identify a subscriber (user) in the communication network. Configuration block SN configures a station address in the CONFIGURATION level, where the factory default is set to **0** (= off). After a station address has been configured, configuration block SN cannot be reset to 0 any more.

6.3.2. Allocation of the value registers (holding registers)

Value registers contain values of analog variables; e.g., controlled variable, setpoint, etc.

Value registers 1, 2, 3, 4, 6, 7, 8, 11, 55, 56, 57 can only be read by the control station if they are denoted by an **R** (**Read**). The remaining value registers can be both read and written by the control station (**R/W** = **Read/Write**).

6.3.3. Allocation of the status registers (coils)

Status registers contain binary information such as fault alarms, relay states or operating messages.

Status registers 1 to 4 and 15, 16 can only be read by the control station (read-only). Status registers 5 to 14 can be both read and written (R/W).

6.3.4. Modbus communications protocol

The Modbus communications protocol defines the communication standard implemented between the industrial controller and the control station. In this communication scheme, the control station acts as the "master", the industrial controller as the "slave". Therefore, the industrial controller may only respond to control station requests.

6.3.5. Function code 01 (Read Coil Status)

This function code reads status registers (see table on page 34) in the industrial controller and transmits these to the control station.

6.3.6. Function code 05 (Force Single Coil)

With this function code, a control station modifies a certain status register (see table on page 34) in the industrial controller.

6.3.7. Function code 03 (Read Holding Register)

With this function code, value registers (see table on page 33) can be read from the industrial controller and, after conversion in the numeric format, displayed on the PC.

6.3.8. Function code 06 (Preset Single Register)

With this function code, the control station reads and modifies a certain value register in the industrial controller (see table on page 33).

6.3.9. Error messages according to the Modbus

The communication interface responds with an error message upon illegal operations. These types of illegal actions include, for example, attempt to read more than 58 value registers or attempt to write read-only registers containing status information or values.

6.4. Value registers (holding registers)

No.	Name	Access	Register range	Div.	Description
1	ID	R	6497	0	Controller ID
2	VN	R	1001 or 1002	1[1)]	Version: Software/ Pt 100
3	X	R	–1999 to 1999	[2)]	Controlled variable (actual value)
4	WE	R	–1999 to 1999	[2)]	External setpoint (ext. reference variable)
5			0		Reserved
6	YSTELL	R	–10 to 110	0	Position feedback
7	XD	R	–1999 to 1999	[2)]	Error (w - x)
8	Y	R	–1099 to 1099	1	Manipulated variable PID
9	YHAND	R/W[4)]	–1999 to 1999	1	Manual manipulated variable output
10	WI	R/W[4)]	–1999 to 1999	[2)]	Internal setpoint (int. reference variable)
11	SN	R	1 to 246	0	Station address number
12	KP	R/W[4)]	0 to 1999	1	Proportional-action coefficient
13	TN	R/W[4)]	0 to 1999	0	Reset time (integral-action component)
14	TV	R/W[4)]	0 to 1999	0	Rate time (derivative-action component)
15	KD	R/W[4)]	0 to 10	0	Rate gain (also abbreviated VD)
16	WR	R/W[4)]	0 or 1	0	Reverse error
17	YMIN	R/W[4)]	–1099 to 1099	1	Minimum manipulated variable limit
18	YMAX	R/W[4)]	–1099 to 1099	1	Maximum manipulated variable limit
19	Y0	R/W[4)]	–1099 to 1099	1	Operating point
20	1A	R/W[4)]	–1999 to 1999	[3)]	Limit value/switching output Y1
21	1H	R/W[4)]	0 to 1999	[3)]	Hysteresis of Y1
22	2A	R/W[4)]	–1999 to 1999	[3)]	Limit value/switching output Y2
23	2H	R/W[4)]	0 to 1999	[3)]	Hysteresis of Y2
24	T1	R/W[4)]	0 to 1999	0	Manipulating time/period (cycle time) +
25	T2	R/W[4)]	0 to 1999	0	Manipulating time/period (cycle time) –
26	TZ	R/W[4)]	0 to 1099	1	Dead band
27	3A	R/W[4)]	–1999 to 1999	[3)]	Limit value of GW3
28	3H	R/W[4)]	0 to 1099	[3)]	Hysteresis of GW3
29	4A	R/W[4)]	–1999 to 1999	[3)]	Limit value of GW4
30	4H	R/W[4)]	0 to 1099	[3)]	Hysteresis GW4
31	XN	R/W[4)]	–1999 to 1999	[2)]	Minimum controlled variable limit
32	XE	R/W[4)]	–1999 to 1999	[2)]	Maximum controlled variable limit
33	X,	R/W[4)]	0 to 3	0	Decimal point(s)
34	XM	R/W[4)]	0 to 6	0	Input signal
35	XT	R/W[4)]	0 or 1	0	Unit of temperature
36	X*	R/W[4)]	0 or 1	0	Range selection for controlled variable X
37	W*	R/W[4)]	0 or 1	0	Range selection for setpoint W
38	Y*	R/W[4)]	0 to 3	0	Range selection for manip. variable Y
39	DI	R/W[4)]	0 or 1	0	Assignment of derivative component
40	WM	R/W[4)]	0 to 7	0	Choice of setpoint (reference variable)
41	YH	R/W[4)]	0 or 1	0	Inhibit MANUAL/AUTOMATIC mode key
42	YM	R/W[4)]	0 to 4	0	Choice of control output
43	YR	R/W[4)]	0 or 1	0	Position feedback signal Ω/mA
44	1M	R/W[4)]	0 to 9	0	Signalling condition of limit switch GW1

No.	Name	Access	Register range	Div.	Description
45	2M	R/W[4)]	0 to 9	0	Signalling condition of limit switch GW2
46	S1	R/W[4)]	0 or 1	0	NO (make)/NC (break) contact of Y1 (GW1)
47	S2	R/W[4)]	0 or 1	0	NO/NC contact of Y2 (GW2)
48	3M	R/W[4)]	0 to 7	0	Signalling condition of limit switch GW3
49	4M	R/W[4)]	0 to 7	0	Signalling condition of limit switch GW4
50	S3	R/W[4)]	0 or 1	0	NO (make)/NC (break) contact of GW3
51	S4	R/W[4)]	0 or 1	0	NO/NC contact of GW4
52	TA	R/W[4)]	0 or 1	0	Update cycle to refresh display field (1)
53	FI	R/W[4)]	0 to 1999	0	Digital filter for controlled variable X and external setpoint WE
54	K1	R/W[4)]	0 to 1099	1	Safety output value
55	C1	R	–1999 to 1999	0	PARAMETER level code
56	C2	R	–1999 to 1999	0	CONFIGURATION level code
57	SO	R	0 to 2	0	Tuning (adaption)
58	TS	R/W[4)]	0 to 30000	0	Setpoint ramp time

[1)] Consisting of software version, e.g., 1.00 and PT 100 version 1 or 2 version 1: 100.1, version 2: 100.2
[2)] Varies depending on how input signal XM is configured:
– No decimal point for XM=3, 4, 5, 6 and XM=0 version 1
– One decimal point for XM=0 version 2
– 0 to 3 decimal point(s) depending on configuration block X, for XM=1, 2
[3)] Depending on XM, YM and assignments 1M to 4M
[4)] Data is written in the non-volatile memory (EEPROM). This type of memory is restricted to approx. 100000 write cycles. Therefore, you should not always write in it automatically.

6.5. Status registers (coils)

No.	Access	Description
1	R	Centralized fault
2	R	Enable manipulated variable
3	R	Enable parameterization
4	R	Enable configuration
5	R/W	Limit value/switching output Y1
6	R/W	Limit value /switching output Y2
7	R/W	Limit value of GW3
8	R/W	Limit value of GW4
9	R/W	Inhibit (disable) parameterization
10	R/W	Acknowledge parameterization
11	R/W	Inhibit (disable) configuration
12	R/W	Acknowledge configuration
13	R/W[1)]	Switchover to MANUAL mode
14	R/W[1)]	Switchover to external setpoint WE
15	R	Reserved
16	R	Reserved

[1)] Data is written in the non-volatile memory (EEPROM). This type of memory is restricted to approx. 100000 write cycles. Therefore, you should not always write in it automatically.

7. Commissioning

The configuration blocks and parameters must be determined after: 1) making all electrical connections (see page 8), 2) deciding on what jumpers are needed (see page 7) and 3) installing the industrial controller (see page 6).

Always take the characteristics of the control loop into account before putting the industrial controller into operation. Avoid potential risks by means of appropriate parameters.

Make note of the configured values after placing the controller in service.

IMPORTANT:
Always follow the sequence: 1) first configure, 2) then enter parameters and, as the last step, 3) tune!

Firmware version (EPROM version):
After power-on, the implemented firmware version of the industrial controller is shown in the upper display field. This version number is important when making inquiries.

Configure and parameterize the industrial controller using the following basic procedure:

- Open the **CONFIGURATION** level (see page 16)
- Select the input signal XM
- Determine the measuring range of the input signal by means of XN (start value) and XE (end value)
- Select the control outputs with YM, 1M, 2M, YR; see also chapter 5. beginning with page 23
- Select the desired special functions such as digital filter FI, unit of temperature XT, signalling conditions of the limit value 1/2/3/4M or safety output value K1

- Open the **PARAMETER** level (s. page 13)
- Determine the operating direction by means of WR
- Limit the output signal by means of Y< and Y>
- Enter the parameters for the desired output; see also chapter 5. beginning with page 23
- Determine the desired limit values with 1/2/3/4A

- **Tune** the plant by entering the three parameters: 1) Proportional-action coefficient KP, 2) reset time TN and 3) rate gain KD; see also section 7.1. and 7.2.

7.1. Tuning the control parameters

The industrial controller must be tuned to the dynamic behaviour of the loop using three parameters: 1) Proportional-action coefficient KP, 2) reset time TN and 3) rate time TV. This permits the controller to compensate for control deviations caused by disturbances by reducing these to zero or maintain them in very confined limits.

If you do not have previous experience in selecting values for the control loop, proceed according to the following basic procedure:

Set the MANUAL/AUTOMATIC mode selector key (1) to MANUAL mode.

Exercise the attached control valve is the CLOSED position; if applicable, via the cursor keys.

After deciding which control mode is necessary, proceed further as instructed below:

Proportional controller (P mode)

- Specify control paramters proportional-action coefficient KP = 0,1; reset time TN = 0 and rate time TV = 0 in the PARAMETER level.
- Enter the desired value of the setpoint in the OPERATING level. Then, modify the manipulated variable Y until the control valve slowly opens and the error XD is eliminated (becomes zero).
- Switch over to AUTOMATIC mode
- Increase the KP value until the control loop tends to hunt.
- Reduce the KP value until oscillation cannot be determined any more.
- Correct steady-state deviation by selecting the operating point Y0 as follows:
  Read the current value of manipulated variable Y when the plant is in the steady state, and enter as value under parameter Y0.
  IMPORTANT: A setpoint modification also means a change of the operating point Y0.

Integral-plus-proportional controller (PI mode)

- Specify control parameters proportional-action coefficient KP = 0.1; reset time TN = 1999 (maximum) and rate time TV = 0 in the PARAMETER level.
- Enter the value of the deisred setpoint in the OPERATING level. Then, modify the manipulated variable Y until the control valve slowly opens and the error XD is eliminated (becomes zero).
- Switchover to AUTOMATIC mode
- Increase the KP value until the control loop tends to hunt.
- Slightly decrease the KP value until oscillation cannot be determined any more.
- Reduce the TN value until the control loop tends to chat.
- Slightly increase the TN value until oscillation cannot be determined any more.

Derivative-plus-proportional controller (PD mode)

- Specify control parameters proportional-action coefficient KP = 0.1; rate time TV = 0 and reset time TN = 0 in the PARAMETER level. Select the rate gain KD to a common value between 5 and 10.
- Enter the value of the desired setpoint in the OPERATING mode. Then, modify the manipulated variable Y until the control valve slowly opens and the error XD is eliminated (becomes zero).

- Increase the KP value until the control loop tends to hunt.
- Set the TV value to 1 s. Then, slowly increase until oscillation cannot be determined any more.
- Increast the KP value until the control loop tends to chat again.
- Increase the TV value until oscillation cannot be determined any more.
- Proceed in the same manner a few times until oscillation subdues.
  Slightly decrease the KP value and TV value, enabling the loop to stabilize again.
- Eliminate steady-state deviation by adjusting the operating point Y0 as follows:
  Read the current value of the manipulated variable Y when the plant is in the steady state, and enter as value for parameter Y0.
  IMPORTANT: A setpoint modification also means a change of the operating point Y0 .

Proportional-plus-integral-plus-derivative controller (PID mode)

- Specify the control parameters proportional-action coefficient KP = 0.1, reset time TN = 1999 and rate time TV = 0 in the PARAMETER level. Set the rate gain KD to a common value between 5 and 10.
- Enter the value of the deisred setpoint in the OPERATING level. Then, modify the manipulated variable using the cursor keys until the control valve slowly opens and the error is eliminated (becomes zero).
- Increase the KP value until the control loop tends to hunt.
- Set the TV value to 1s. Then, increase until oscillation cannot be determined any more.
- Slowly increase the KP value until the control loop tends to chat again.
- Increase the TV value until oscillation cannot be determined any more.
- Proceed in the same manner a few times until oscillation subdues.
- Slightly reduce the KP and TV value, enabling the control loop to stabilize again.
- Reduce the TN value until the plant tends to hunt again, and increase again until oscillation cannot be determined any more.

7.2. Self-tuning (self-optimization)

Auto-tuning is a special feature of the industrial controller which, in the start-up phase, effectively determines the characteristics of the control loop and calculates the optimum control parameters.

This function should only be used on control loops which are not critically fast and exhibit short dead bands. If self-tuning is used, the tuning procedures described in section 7.1. can be omitted.

The automatically determined control parameters should be checked for applicability before switching to AUTOMATIC mode.

If the industrial controller indicates an unsatisfactory behaviour when being operated, the calculated control parameters must be manually modified.

Proceed as follows to automatically determine the control parameters::

1. Requirements:
   The control loop must be stable and in the steady state for at least 5 minutes; i.e., the error XD must not have changed.

   A PI algorithm is to be specified for the industrial controller (rate gain KD = 0). If a three-mode PID algorithm is desired, set the parameter to (KD = 1).

   The controller is runs in the OPERATING level (normal operation); controlled variable X and manipulated variable Y are displayed.
2. Switch the MANAUL/AUTOMATIC mode selector key to MANUAL mode! (LED illuminates in the key!)
3. Open the CONFIGURATION level (see page 16)!
4. Select configuration block SO using the cursor keys!
5. Set the desired tuning mode SO = 1 or 2, and store using the ENTER key (8).
6. Press the operating key (7)! (The industrial controller returns to the OPERATING level.)
7. Specify the value for the setpoint (internal WI or external WE) for which a positive error XD of at least 20 % of the measuring range is set. Check at XD !
8. Press the MANUAL/AUTOMATIC mode selector key (10) in order to switch to AUTOMATIC mode!

   The control parameters are calculated and stored against power failure as long as the yellow LED flashes in the key. After dis-illuminating, the controller operates in AUTOMATIC mode.

   If the LED continues to illuminate without fading , parameters cannot be determined in this manner. Abort the process by pressing the MANUAL/AUTOMATIC mode selector key.

Code number important for servicing 1732

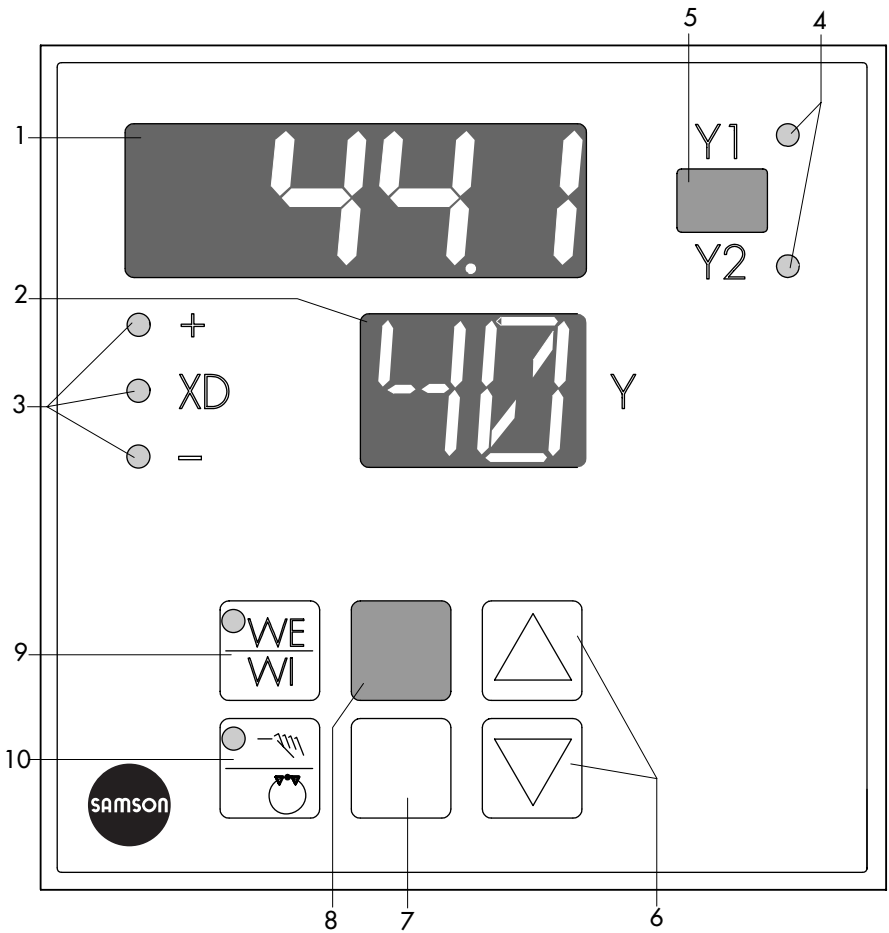
8. Checklist

Device	Installation:	Process designation	Date:

Selection	Designation	Range of values	Factory default	Start-up values, modifications		
OPERATING level						
X	Controlled variable (actual value)	Depending on sensor	–			
XD	Error (w - x)	–	–			
WI	Internal setpoint (int. ref. variable)	XN to XE	0			
WE	External setpoint (ext. ref. variable)		–			
Y	Manipulated variable	Y< to Y>	–			
PARAMETER level						
KP	Proportional-action coefficient	0.1 to 199.9	1.0			
TN	Reset time (integral component)	1 to 1999	10			
TV	Rate time (derivative component)	1 to 1999	0 (off)			
KD	Rate gain (also abbreviated VD)	1 to 10	0 (off)			
WR	Operating direction	0 or 1	1 (<>)			
Y<	Min. manipulated variable limit	–109.9 to Y>	0			
Y>	Max. manipulated variable limit	Y< to +109.9	100			
Y0	Operating point	–109.9 to +109.9 %	0			
1A	Limit value of Y1	Depending on 1M	0			
	Transfer coefficient +	0.0 to 100.0	0.0			
1H	Hysteresis of Y1	Depending on 1M	0			
	Minimum pulse duration	0.0 to 100.0 %	0.0			
2A	Limit value of Y2	Depending on 2M	0			
	Transfer coefficient –	0.0 to 100.0	0.0			
2H	Hysteresis of Y2	Depending on 2M	0			
	Minimum pulse duration	0.0 to 100.0 %	0			
T1	Period (cycle time) +	0 to 1999 s	10			
T2	Period (cycle time) –	0 to 1999 s	10			
TZ	Dead band	0 to 109.9 %	2.0			
Options						
3A	Limit value of GW3	Depending on 3M	0			
3H	Hysteresis of GW3	Depending on 3M	0			
4A	Limit value of GW4	Depending on 4M	0			
4H	Hysteresis of GW4	Depending on 4M	0			

Selection	Designation	Range of values	Factory default	Start-up values, modifications		
CONFIGURATION level						
XN	Min. measuring range limit of X	–1999 to XE	0			
XE	Max. measuring range limit of X	XN to +1999	100.0			
X,	Decimal point	1.000 to 1000	100.0			
XM	Choice of input signal	0 to 6	0(Pt 100)			
XT	Unit of temperature	0 or 1	0			
X*	mA or V signal range	0 or 1	0 (mA)			
W*			0 (mA)			
Y*		0 to 3	0 (mA)			
DI	Derivative-action component	0 or 1	0			
WM	Choice of setpoint	0 to 7	0			
YH	MANUAL/AUTOMATIC mode key	0 or 1	0			
YM	Choice of control output	0 to 4	0			
YR	External position feedback	0 or 1	0			
1M	Signalling condition of limit value	0 to 9	0			
2M			0			
S1	NO (make) or NC (break) contact	0 or 1	0			
S2			0			
Options for versions with GW3 and GW4 limit switches						
3M	Signalling condition of limit value	0 to 7	0			
4M			0			
S3	NO(make) or NC (break) contact	0 or 1	0			
S4			0			
All versions						
TA	Update cycles to refresch the control output display	0 or 1	0			
FI	Digital filter	0 to 1999 s	1			
K1	Safety output value	0 to 109.9 %	0			
C1	PARAMETER level code	–1999 to +1999	0			
C2	CONFIGURATION level code		0			
SO	Tuning (adaption)	0 to 2	0			
TS/TM	Setpoint ramp (sec., min.)	1 s to 500 min	0			
Option for versions with interface						
SN	Station address number	0 to 246	0			
BR	Baud rate	0 or 1	0			

9. Control panel



1 Controlled variable (actual value) display
2 Manipulated variable (output value) display
3 Error (w - x) indication
4 Switching output indication
5 Label for engineering unit (of temperature)
6 Cursor keys
7 Operating key
8 ENTER key
9 WE/WI setpoint* switchover key
10 MANUAL/AUTOMATIC mode selector key

** Reference variable*

SAMSON AG · MESS- UND REGELTECHNIK
Weismüllerstraße 3 · 60314 Frankfurt am Main · Germany
Phone +49 69 4009-0 · Fax +49 69 4009-1507
Internet: http://www.samson.de

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