SIEMENS

SIPART DR19
6DR 190*–*

Edition 08/2010

Manual

Classification of safety–related notices

This manual contains notices which you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows according to the level of danger:

DANGER
indicates an immenently hazardous situation which, if not avoided, **will** result in death or serious inury.

Warnung
indicates a potentially hazardous situation which, if not avoided, **could** result in death or serious injury.

CAUTION
used with the safety alert symbol indicates a potentially hazardous situation which, if not avoided, **may** result in minor or moderate injury.

CAUTION
used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

NOTICE
indicates a potential situation which, if not avoided, may result in an undesirable result or state.

NOTE
highlights important information on the product, using the product, or part of the documentation that is of particular importance and that will be of benefit to the user.

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Siemens AG
Bereich Automatisierungs– und Antriebstechnik
Geschäftsgebiet Prozessinstrumentierung– und Analytik
D–76181 Karlsruhe

Disclaimer of Liability

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

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Controls and displays

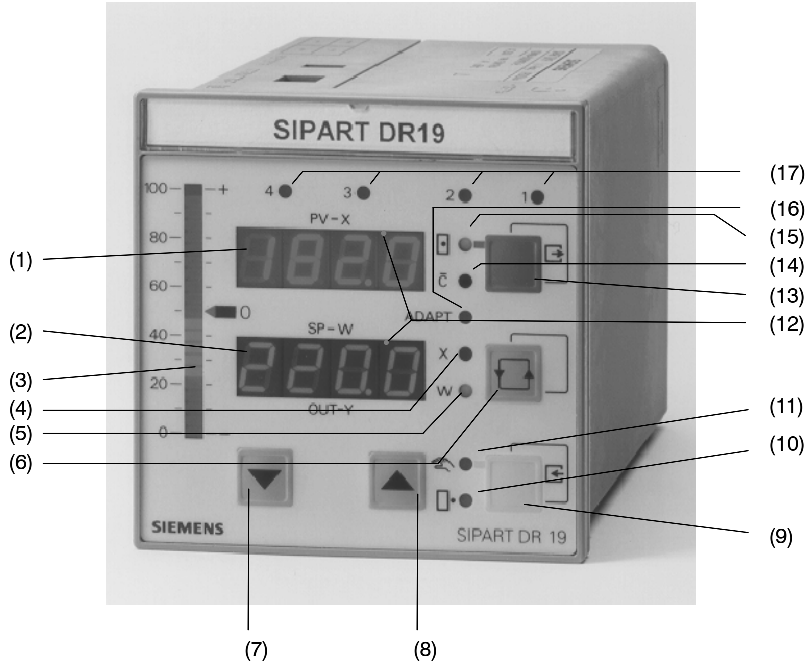


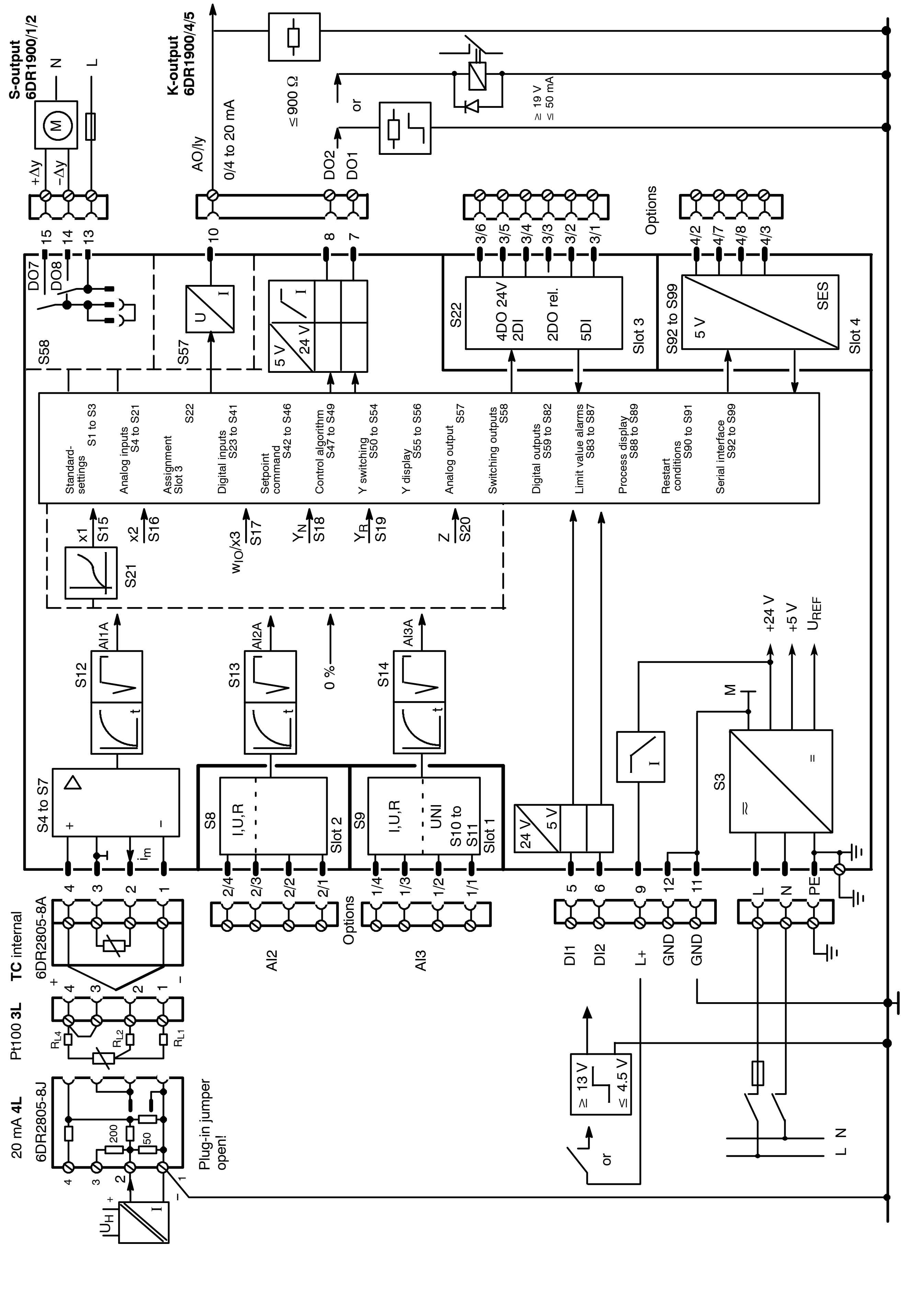
Figure 1 Controls and displays

Display of actual value and setpoint	1	Digital display “PV-X” for actual value x (pv)
	2	Digital display “SP-W for setpoint w (sp) or manipulated variable y (out), other variables possible.
	3	Analog indicator for e (xd) or –e (xw), other variables possible.
	4	Signaling lamp “x” – signaling of displayed variables, see configuring switch S88
	5	Signaling lamp “w” – lights up when w is output on the digital display “SP-W” (2).
	6	Selector pushbutton for digital display “SP-W” (2) and adjustment pushbuttons (7, 8); pushbuttons to acknowledge flashing follwing power return or for accessing selection mode.
Modification of manipulated variable	7	Pushbutton for adjustment of manipulated variable – closed (open) or pushbutton to decrease setpoint.
	8	Pushbutton for adjustment of manipulated variable – open (closed) or pushbutton to decrease setpoint
	9	Selector pushbutton for manual/automatic **or** “Enter” pushbutton from selection mode to configuring mode
	10	Signaling lamp for y–external mode
	11	Signaling lamp for manual mode
	12	Signaling lamp of Δy digital outputs with step controller
Modification of setpoint	13	Selector pushbutton for internal/external setpoint or “Exit” push button from configuring and selection modes to process operation mode.
	14	Signaling lamp for computer switched off (with w_{ext})
	15	Signaling lamp for internal setpoint
Further messages	16	Signaling lamp for adaptation procedure running
	17	Signaling lamp for “Limit violated”, other signals possible

Note

Operation can be blocked using the digital signal bLb;
Exception: switching over of digital display SP-W (2)

Block diagram



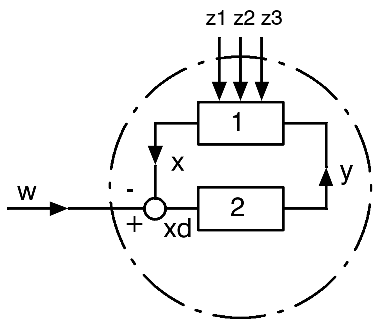
Contents

1 General Part – Fundamental control technology terms

- **Control loop**

The function of a closed-loop control is to bring the output variable x of a controlled system to a predefined value and to retain this value even under the influence of disturbance variables z. The controlled variable x is compared with the command variable w. The resulting system deviation xd = w – x is processed in the controller to the manipulated variable y which acts on the controlled system.

The controlled variable x is measured cyclically in a digital control.



w Command variable
x Controlled variable
xd System deviation
y Manipulated variable
z Disturbance variable

1 Controlled system
2 Control equipment

Figure 1-1 Function diagram of control loop

- **Sensors and transmitters**

The controlled variable can be any physical variable. Frequently controlled variables in process engineering are pressure, temperature, level and flow.

In most process engineering applications, the process variables are measured using sensors and transmitters with a standardized signal output (0 to 20 mA or 4 to 20 mA). The standardized signal can be connected to several process process devices (loop between e.g. recorder/indicator/controller). Temperature sensors such as resistance thermometers or thermocouples, as well as resistance transmitters, can be connected directly to the controller using appropriate input cards (options).

- **Final control elements and actuators**

In process engineering applications, the manipulated variale y primarily acts on the controlled system via a valve, a butterfly valve or another mechanical means of adjustment. Three types of drive are possible for actuating such final control elements:

- Pneumatic actuators with compressed air as the auxiliary energy and electropneumatic signal converters or electropneumatic positioners. These have a proportional action and are driven by continuous controllers.
- Electric actuators, consisting of an electric motor and gear unit. These have an integral action and are driven by three-position step controllers. Electric actuators are also possible with an integrated (series-connected) positioner and then have a proportional action and can be driven by continuous controllers.

- Hydraulic actuators with electric oil pump and electrohydraulic positioner. These have a proportional action and are also driven by continuous controllers.
  These types of actuators can be used to implement continuous controls.
- Temperature control loops with diret electric or gas heating and/or cooling systems are driven by two-postion controllers (on/off controllers). The two-position controllers with the heating or cooling medium via relays, external contactors or thyristor controllers. The manipulated variable y is the on/off ratio. These are referred to as discontinuous controls.

- **Controllers and control response**

The controlled variable x is compared with the command variable w in the input circuit of the controller, and the system deviation xd is determined. This is processed with or without a time response into the output signal. The output signal of the amplifier can directly represent the manipulated variable y if e.g. proportional-action final control elements are to be driven by it.

In the case of electric actuators, the manipulated variable is produced by the actuator. The required positioning inrements are derived from the controller ouptut as a pulse-width-modulated signal by conversion.

Depending on the design of this circuit, the controller has a proportional action (P), a proportional-plus-derivative action (PD), a proportional-plus-integral action (PI) or a proportional-plus-integral-plus-derivative action (PID).

- **Step function**

If a step function is applied to the controller input, a step-forced response results at the output of the controller in accordance with its time response.

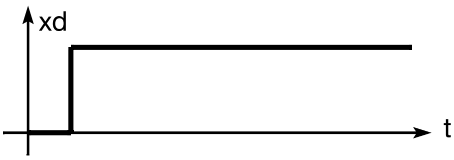


Figure 1-2 Step function

- **P controller, step-forced response**

Characteristic of the P controller are the proportional gain Kp and the working point y_o. The working point is defined as the value of the output signal at which the system deviation is zero. If disturbance variables are present, a steady-state deviation may result depending on y_o.

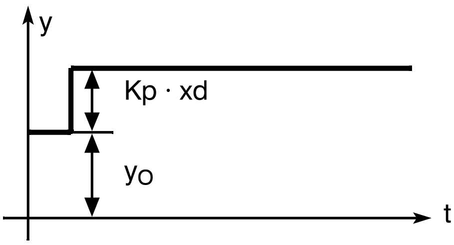


Figure 1-3 Step-forced response of P controller

- **PD controller, step-forced response**

In the case of the PD controller, the decaying D component is superimposed on the P component. The D component depends on the derivative action gain Vv and the derivative action time Tv.

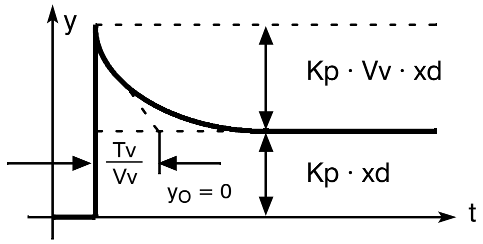


Figure 1-4 Step-forced response of PD controller

- **PI controller, step-forced response**

In contrast to the P controller, a steady-state deviation is prevented in the PI controller by the integral component.

A characteristic of the integral component is the integral action time Tn.

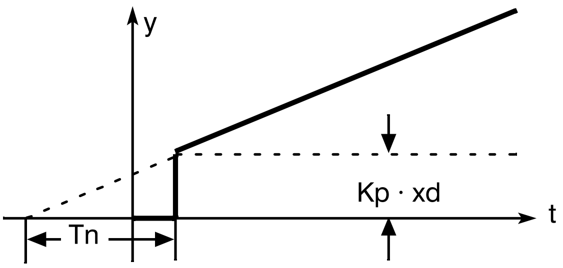


Figure 1-5 Step-forced response of PI controller

- **PID controller, step-forced response**

The PID controller results in improvement of the dynamic control quality as a result of the additional application of a D component.

Refer to the PD and PI controllers.

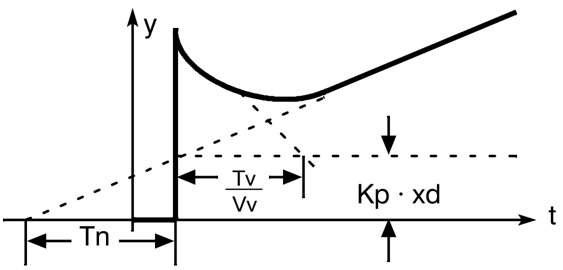


Figure 1-6 Step-forced response of PID controller

- **Controller output signal**

The controller ouptut signal must be adapted to the final control element. The following must be used according to the type of drive/final control element:

Type of drive/actuator	Controller output signal
Electric actuators	Three-position step controllers
Pneumatic and hydraulic actuators	Continuous controllers
Direct heaters/coolers	Two-position controllers

- **Three-position step controller with internal feedback**

The three-position step controller switches the electric motor of the actuator to clockwise, stop or counterclockwise by means of relays or semiconductor switches. The rate of adjustment of the actuator can be influenced using different switch-on/pause ratios.

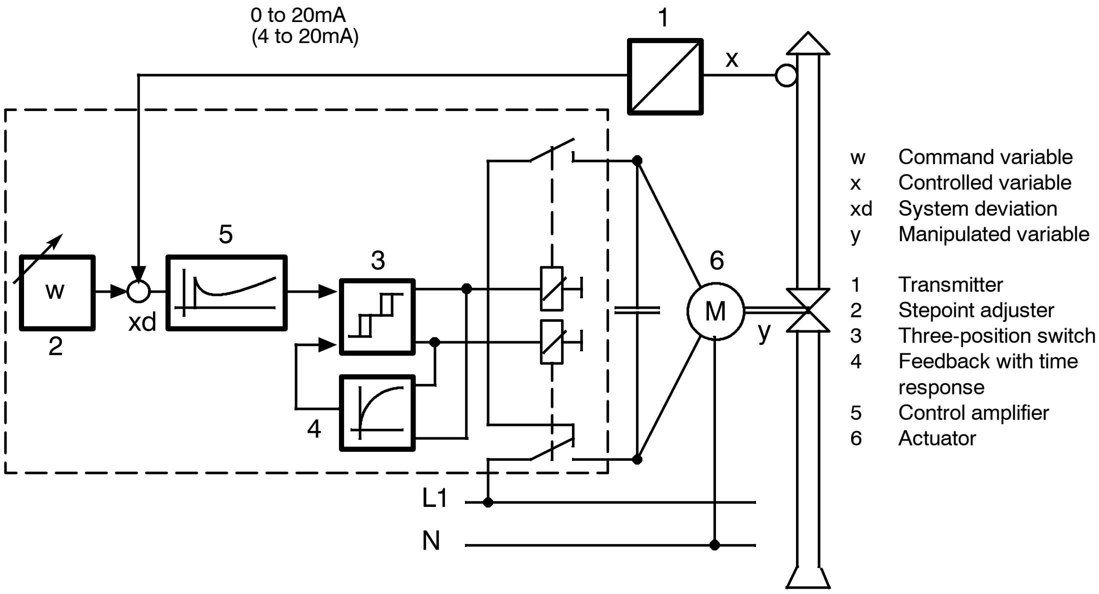
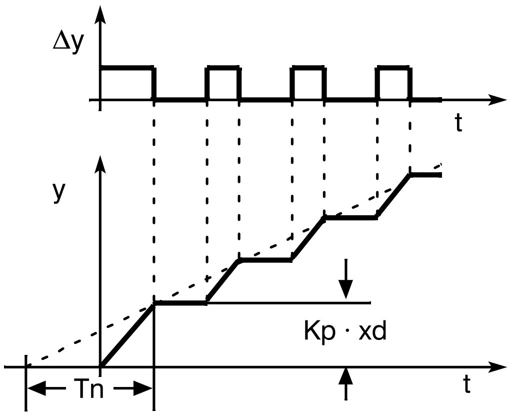


Figure 1-7 Function diagram of three-position step controller

The output response o the three-position amplifier in conjunction with the integral-action actuator permits a “continuous” manipulated variable taking into account the response threshold.

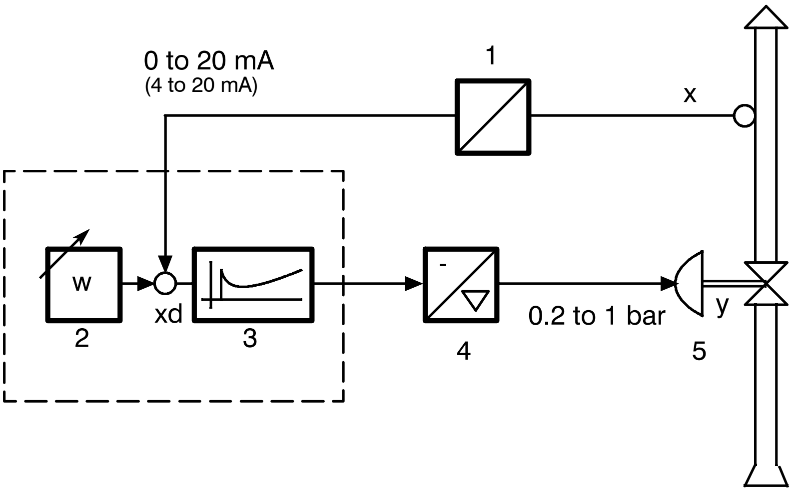


Kp Proportional gain
Tn Integral action time
xd System deviation
Δy Manipulated variable of controller
y Manipulated variable of motor

Figure 1-8 Transient function and parameters of the three-position step controller

- **Continuous controller**

The controller output 0 to 20 mA or 4 to 20 mA acts on the actuator via an electropneumatic singal converter or an electropneumatic positioner.



w Command variable
x Controlled variable
xd System deviation
y Manipulated variable

1 Transmitter
2 Stepoint adjuster
3 Control amplifier
4 Electropneumatic signal converter
5 Pneumatic actuator

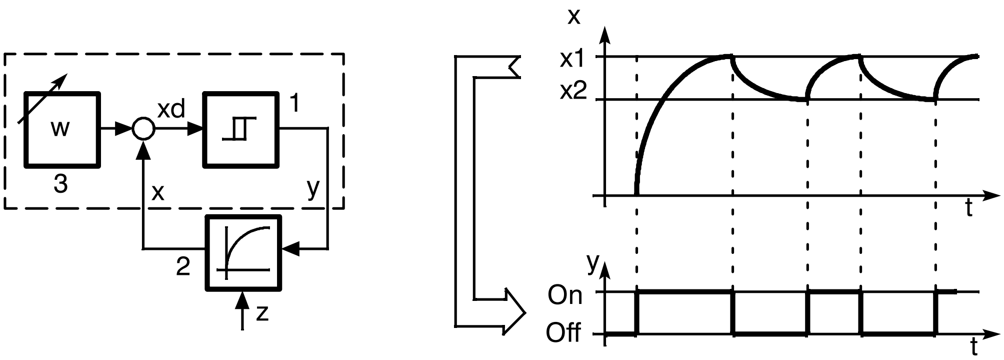
Figure 1-9 Function diagram of continuous controller

This type of controller is preferentially used in the chemical industry.

- **Two-position controller**

  The two-position controller (or three-position controller for heating/cooling) is used to activate relays, contactors or thyristor switches for electric heating or cooling.

  - **Two-position controller without feedback**
    In the simplest version without feedback, two-position controllers operate an on/off switch. The controllers output is switched if the controlled variable violates the upper or lower limits of the switching hysteresis (x1 and x2). The controlled variable x is subject to permanent oscillation whose frequency and amplitude depend on the delay time of the system and the switching hysteresis of the controller.

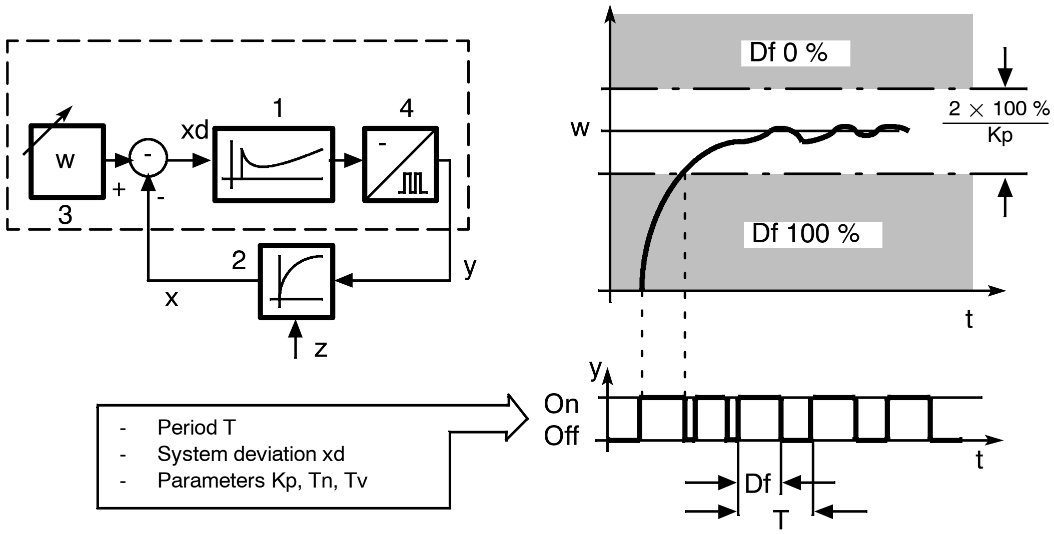


1 Controller
2 Controlled system
3 Setpoint adjuster

w Command variable
x Controlled variable
y Manipulated variable ON/OFF
z Disturbance variable

Figure 1-10 a) Function diagram b) Switching ouptupt and response of controlled variable

- **Two-position controller with feedback**
  In modern two-position controllers with feedack – such as the SIPART DR19 – the switching response is determined by the period, the system deviation and the parameters. The period T is set as a fixed value in the controller. The system deviation xd in conjunctionw ith the parameters Kp/Tn/Tv determines the duty factor (ON/OFF ratio) within the period. Thus the switching response of the controller is not only triggered by changes in the controlled variable; appropriate selection of the parameters results in a largely constant controlled variable x.



1 Control amplifier
2 Controlled system
3 Setpoint adjuster
4 Pulse/pause converter

w Command variable
x Controlled variable
y Manipulated variable
Z Disturbance variable
Df Duty factor (in % if period)
T Period

Figure 1-11 a) Function diagram b) Switching output and resosne of controlled variable

Adjustment of the period (separately for heating/cooling) permits the controller to be adapted to the special type of heater or the cooling unit. A compromise has to be made beween the control quality and the degree of wear.

Short period: Improved control quality, but increased wear on contact/heating valve. Prime use with electric heaters.

Long period: Low wear on contact/heating valve, but poorer control quality. Prime application with gas heaters or coolers.

2 Technical Description

2.1 Safety notes and scope of delivery

WARNING

When operating electrical equipment, certain parts of this equipment automatically carry dangerous voltages. Failure to observe these instructions could therefore lead to serious injury or material damage. Only properly trained and qualified personnel are allowed to work on this equipment. This personnel must be fully conversant with all the warnings and commissioning measures as described in this user's guide.
The perfect and safe operation of this equipment is conditional upon proper transport, proper storage, installation and assembly as well as on careful operation and commissioning.

- **Scope of delivery**

When the controller is delivered the box also contains:

1 Controller as ordered
1 Three–pin plug at 115/230 V AC or special plug at 24 V UC
2 Clamping elements
2 Adhesive labels "Power supply 115 V" (for 115/230 V version).
1 CD ROM with documentation

- **Standard controllers**

The following variants of the SIPART DR19 are available for delivery:

Order number	Output stage	Power supply
6DR1900-4	S/K-output	24 V UC
6DR1900-5	S/K-output	115/230 V AC, switchable

- **Options modules (signal converters)**

Signal converters have separate ordering and delivery items.
For handling reasons standard controllers and signal converters which were ordered at the same time may be delivered by separate mail.

- **Documentation**

This user's guide is available in the following languages:

German	C73000-B7400-C142
English	C73000-B7476-C142

- **Subject to modifications**

  The user's guide has been compiled with great care. However, it may be necessary, within the scope of product care, to make changes to the product and its operation without prior notice which are not contained in this user's guide. We are not liable for any costs ensuing for this reason.

2.2 Application Range

- **Application**

  The SIPART DR19 industrial controller is a digitally operating unit of the mid to upper performance class. It is used in industry, for example in the foods and tobacco industry but also in automatic control systems in process engineering such as chemicals and petrochemicals, furnace building and ironworks/foundries and in the fine ceramics and glass industry.

  The controller's great flexibility makes it suitable for use in simple or intermeshed control circuits. The wide setting ranges of the controller parameters allow the SIPART DR19 to be used in process engineering for fast (e.g. flow) and slow (e.g. temperature) controlled systems. The controller determines the optimum control parameters independently on request without the user being expected to have any prior knowledge of how the control loop may respond.

- **Controlling tasks**

  The input structure of the SIPART DR19 controller can be changed by configuring so that the following control problems can be solved.

  - Fixed value controls, even with disturbance variables applied at the input
  - Fixed value controls for control system coupling*)
  - Three-component controls
  - Control circuits with up to two internal setpoints
  - Control circuits with up to five setpoints
  - Follow-up/synchronization controls
  - Follow-up controls for control system coupling*)
  - Disturbance variables applied at the output
  - Computer-controlled control circuits in SPC operation
  - Ratio controls with fixed or manipulated variables
  - Program controllers and program encoder function (6DR1900/2/5)

  The SIPART DR19 can also be configured as a control device, a manual control unit or a function encoder.

  The SIPART DR19 controller can be used as a continuous controller with 0/4 to 20 mA output, as a step switching controller with built-in relay for controlling motor drives or as a two-position controller for heating/cooling.

  Overlaid control functions or status and alarm messages are possible through digital inputs and outputs.

*) as of software version –A7

2.3 Features

- **General**

The already generously and extensively equipped, fully functional standard controller can accommodate up to four signal converters in the slots in the back of the sealed unit to extend the area of application.

SIPART DR19 offers the following features:

- **Analog inputs**

An analog input for TC/RTD/R/mV with measuring range plug also for mA and V without potential isolation is available in the standard controller.

The SIPART DR19 can be extended to a total of 3 analog inputs by signal converters.

The following signal converters are available:

	Use as (on)	Possible signal generators
UNI-module	AI3 (slot 1)	TC/RTD/R/mV, with adapter plug also mA or V, electrically isolated, permissible common mode voltage 50 V.
U/I-module	AI3 (slot 1) AI2 (slot 2)	0/4 to 20 mA, 0/2 to 10 V, electronic potential isolation, permissible common mode voltage 10 V.
R-module	AI3 (slot 1) AI2 (slot 2)	Resistance potentiometer

- **Output structure**

The SIPART DR19 controller has a y-analog output (manipulated variable) with a current signal of 0/4 to 20-mA and a switching output with two built-in relays which are interlocked. The relay lock can be released for a universal digital output. The relays are designed for 250 V AC, a spark quenching combination for wiring with contactors is provided.

The SIPART DR19 controller can be configured to operate as a continuous controller, as a step switching controller for motorized drives or as a two-position controller.

When used as an S-controller the analog output can be used for outputting x, w or xd for example.

WARNING

The relays are designed for a maximum switching voltage of 250 V AC/8 A in overvoltage class III and degree of contamination 2 according to DIN EN 61010 Part 1.
The same applies for the air- and creep lines on the circuit board.
Resonance increases up to three times the rated operating voltage may occur when phase shift motors are controlled. These voltages are available at the open relay contact. Therefore such motors may only be controlled under observance of the technical data and the pertinent safety conditions via isolated switching elements.

- **Voltage output**

  A voltage output L+ for feeding two-wire transmitters or contacts for digital inputs.

- **Slots for options**

  Four rear slots can be used for functional expansions. The options modules are slot coded so that wrong installation is largely ruled out.
  Slot assignment, see figure 2-2 Rear view, page 27.

- **Power supply unit**

  The power supply unit is designed for the following voltages depending on the standard controller:
  - 230 V/115 V AC, switchable by plug-in jumpers in the device
  - 24 V UC

- **Digital inputs**

  Two digital inputs, potential-bound
  It can be upgraded to four or seven potential-bound digital inputs with signal converters.
  The digital inputs can be assigned to the following controller-internal switching signals.

bLb *Blocking operation*
Blocking the entire instrument operation and configuring.
Exception: Switching the w/x-digital display

bLS *Blocking structuring*
With this signal the controller only allows switching to the online-parameterization levels outside process operation. In this way the parameters for adapting the instrument to the process and the necessary settings for adaptation can be selected. Structuring is blocked.

bLPS *Blocking parameterization and structuring*
The entire configuring of the instrument is blocked, this means the parameterization as well. Only the normal process operation according to the preselected controller type is permitted.

CB — *Computer standby*
Depending on the controller type, this digital signal together with the internal/external key causes either switching in the setpoint range.

He — *Manual external*
This signal blocks the output of the controller and enables direct manual adjustment of the manipulated variable on the front control panel.

N — *Tracking*
With this signal the output of the K controller and the three-position stepper controller with external position feedback is tracked to the tracking signal y_N.

Si — *Safety operation*
The output of the K controller or the three-position stepper controller with external position feedback accepts the parameterized safety value. In three-position stepper controllers with internal position feedback, the manipulated variable runs defined to 0 or 100 %.

P — *P-operation*
Switching from PI (PID) to P (PD)-controller (i.e. switch off the I-part)
This function simplifies automatic start-up of control circuits.

PU — Setpoint switching in 5 setpoint operation (S1 = 2) or program switching in program function (S1 = 5)

$\overline{\text{tS}}$ — *Switch off the setpoint ramp time*
Reset at S1 = 5 (program controller, transmitter = reset the program setpoint)

tSH — *Stop setpoint change (setpoint ramp)*

+yBL / −yBL — *Direction-dependent blocking of the manipulated variable*
Direction-dependent limiting of the manipulated variable by external signals, e.g. the controller output can be blocked by the limit switches of an actuating drive. This limiting is effective in every operating mode.

- **Digital outputs**

Two digital outputs, active, potential-bound.
It can be upgraded to four or six digital outputs with signal converters.
The digital outputs are loadable up to 50 mA per output for direct tripping of relays.
The digital outputs can also be used for the variable output, the relay outputs are then free for any digital signal output.
The following controller-internal switching signals can be assigned to the digital outputs.

$\overline{\text{RB}}$ — *Computer standby*
Message that the controller can be switched to the external setpoint by the CB signal.

$\overline{\text{RC}}$ — *Computer operation*
Message that the controller is presently in computer operation or that it has been switched over to the external setpoint by the CB signal.

H *Manual mode*
Message that the controller has been switched over to manual mode with the manual/automatic key.

Nw *Tracking operation* active
Message that the controller is in tracking operation.

A1 to A4 *Alarm output Alarm 1 to Alarm 4*

MUF *Group alarm transmitter fault*
The instruments's analog input signals can be monitored for exceeding of the measuring range. This signal gives a group alarm if an error is detected.

$\pm\Delta w$ *Output of switching signals for setpoint adjustment*
This function is only active when the controller is structured as a control unit (S1=4).

CLb1 to CLb6 *Output of status messages of the program controller (S1 = 5)*

$\pm\Delta y$ *Output of incremental y-adjustment*
Assignment is only possible to DO1, 2, 7 or 8.

The following signal converters are available for extending the digital inputs and outputs:

	Use on	Description
4 x DO/2 x DI	Slot 3	4 binary outputs 24 V 2 binary inputs 24 V
5 x DI	Slot 3	5 binary inputs 24 V
2 x relays	Slot 3	2 relay outputs 35 V

- **Serial interface**

An interface can be retrofitted with signal converters for RS 232/RS 485 or PROFIBUS DP.

- **Others**

Further functions are also possible. Examples:

	Meaning	see chapter
Adaptation-procedure	Automatic determination of the controller parameters by a rugged adaptation method which noticeably simplifies commissioning of even critical controlled systems.	Configuring level AdAP; 3.9 (page 120) and 5.4.3 (page 169)
adaptive filter for xd	Filter which dampens amplitude-dependent interference, the value of the dampening is adapted automatically.	onPA-parameter tF 3.10.1 (pg. 123) and 5.4.2 (page 167)
Setpoint ramp	Prevents the setpoint or nominal ratio being changed too fast. The desired adjustment speed can be set. The time for the change is set from 0 to 100 % here. The setpoint ramp is not active at x-tracking and digital signal $\overline{tS}$.	oFPA-parameter $\overline{tS}$; 3.4.1 (pg. 59) and 5.4.4 (pg. 173)
Filter for all inputs	A 1st order filter can be connected to every analog input.	onPA-parameters t1 to t4; 3.2 (pg. 51) and 5.4.2 (pg. 167)

	Meaning	see chapter
Root extractor for all controller inputs	A root extractor can be connected before every analog input.	Structure switches S12 to S14; 3.2 (pg. 51) u. 5.4.6 (pg. 180)
Linearizer for an input variable	A linearizer with 13 vertex points (equidistant) and parabolic approximation can be assigned to one of the analog inputs AI1 to AI3 or the control variable x1.	Structure switch S21; 3.10.4 (pg. 126) and 5.4.6 (pg. 180)
Initialization of the displays x/w and w/y	The controlled variable x and the command variable w can be displayed in physical values.	oFPA-parameter dA, dE; 3.4.1 (pg. 59) and 5.4.4 (pg. 173)
Limits for the setpoint w	The setpoint can be limited anywhere within the selected measuring range.	oFPA-parameter SA, SE; 3.4.1 (pg. 59) and 5.4.4 (pg. 173)
Limits of the manipulated variable y	The manipulated variable y can be limited within the setting range –10% and +110 %. (Not in S-controllers with internal feedback)	onPA-parameter YA, YE; 3.5 (pg. 98) and 5.4.2 (pg. 167)
x-Tracking	In manual operation, tracking operation and safety setting value the setpoint w of the controlled variable x is tracked.	Structure switch S44; 3.4.1 (pg. 59) and 5.4.6 (pg. 180)
Limit value alarms	Any controller-internal variables or inputs can be monitored for limit values. The output is by way of alarms A1 to A4.	Structure switch S83 and S87; 3.10.3 (pg. 125) and 5.4.6 (pg. 180)
Transmitter monitoring	All or specific analog inputs can be monitored for dropping below-or-exceeding the range. In the event of a fault, the four-digit digital display outputs a message selectively for every input. A system fault can be output via the digital output MUF.	Structure switches S4, 8, 9, 67; 3.2 (pg. 51) and 5.4.6 (pg. 180)
Adaptation of the direction of action	SIPART DR19 operates in normal direction with the factory setting. The direction of the controller can be changed for reversing systems.	Structure switch S46; 3.5 pg. 98) and 5.4.6 (pg. 180)
Restart conditions	After mains recovery the controller starts automatically with the structured operating modes, setpoints and manipulated variables.	Structure switch S90, 91; 3.10.5 (pg.128) and 5.4.6 (pg. 180)

2.4 Design

- **Standard controller**

The controller has a modular design and is therefore service-friendly and easy to convert and retrofit.
The standard controller consists of
- the front module with the control and display elements
- the backplane module with the power supply unit
- the plastic housing with four slots for optional modules

- **Front module**

  The front module accommodates the control and display elements, the CPU (Central Processing Unit) and the connectors for the backplane and options modules.

  It is operated by a membrane keyboard with IP64 degree of protection. The striking colors of the operating keys effectively increases the operating reliability.

  SIPART DR19 is equipped with a four-digit digital display for the controlled variable x and an additional 4-digit digital display for the setpoint w, switchable to the manipulated variable y or alarm display. The comfortable analog display for the control difference (can be switched to other controlled variables with structure switch S89) as well as various status displays also contribute to a better process observation.

  The measuring point label is changeable.

- **Backplane module with power supply unit**

  The following signal connections are accessible through the backplane.
  - 1 Analog input AI1 potential-bound to M, for mV, RTD, TC, R with measuring range also mA and V.
  - 1 analog output AO, potential-bound to GND, 0/4 to 20 mA
  - 2 Digital outputs +Δy, -Δy, potential-free via 230 V relay contacts
  - 2 Digital inputs DI1, DI2, for 24V-logic, function can be set
  - 2 Digital outputs DO1, DO2, for 24V-logic, function and direction can be set
  - 1 Voltage output L+ to the transmitter supply

  The power supply is located in a die-cast housing on the backplane module. The heat loss is transferred to the back of the controller by cooling fins.

  A DIN rail can be mounted for connecting a powerful coupling relay module.

  The power supply unit is powerful and offers a total 200 mA external current for:
  - Supplying the analog output (0/4 to 20 mA)
  - Active digital outputs (up to 7 digital outputs)
  - L+-output for supplying two-wire transmitters

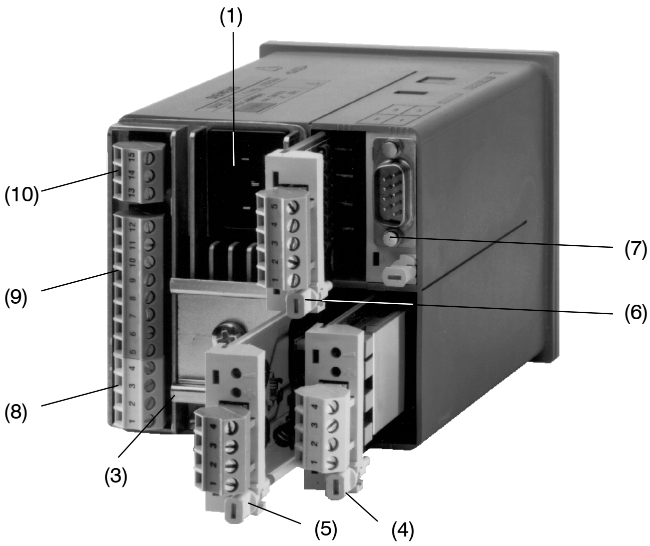
- **Connection technique**

  The power supply is connected
  - for 230 V/115 V AC by a three-pin plug
  - for 24 V UC by a special two-pin plug.

  On the standard controller the field lines (signal cables) are connected to three functionally combined plug-in screw-type terminals.

  The options modules for analog inputs and digital inputs- and outputs have their own terminals which are also designed as plug-in screw-type terminals.
  The interface module is connected by its own plug.

Figure 2-1 Front view



(1) Mains plug
(2) Power supply module
(3) DIN rail (scope of delivery of the relay-module)
(4) Slot 1 AI3 (I/U, R, P, T)
(5) Slot 2 AI2 (I/U, R, P, T)
(6) Slot 3 4DO, 24 V or 2 DO relay or 5 DI
(7) Slot 4 SES
(8) Terminal strip 1 AI1
(9) Terminal strip 2
AO1
DI1 to DI2
DO1 to DO2 24 V
L+; M
(10) Terminal strip 3
Digital outputs $\pm\Delta y$

Figure 2-2 Rear view

2.5 Mode of Operation

2.5.1 Standard controller

- **General**

The SIPART DR19 controller operates based on a modern, highly integrated microcontroller in CMOS technology. A large number of functions for controlling processing plants are stored in the instrument's ROM. The user can adapt the controller to the task himself by configuring it.

- **Analog input AI1**

Measured value sensors such as thermocouples (TC), resistance thermometers Pt100 (RTD), resistance potentiometers (R) or voltage transmitters in the mV range (mV) can be connected directly to analog input AI1 of the SIPART DR19. The input variables I (0/4 to 20 mA) and U (0/2 to 10 V) are converted to measuring range 0/20 to 100 mV by the measuring range plug 6DR2805-8J and measured in the mV signal range. Type of sensor, type of connection, type of thermocouple and measuring range can be set by the structure switches S4 to S7 and the menu CAE1. The sensor-specific characteristics (linearization) for thermocouples and Pt100-resistance thermometers are stored in the contoller's program memory and are automatically taken into account.

The signal lines are connected by a plug terminal block with screw-type terminals. When using thermocouples with internal reference point, this terminal block must be replaced by the terminal 6DR2805-8A. With the measuring range plug 6DR2805-8J in place of the terminal block, the measuring range of the direct input (0/20 to 100 mV) can be extended to 0/2 to 10 V or 0/4 to 20 mA.

The measuring input has an AD converter with 18 bit resolution. The input is potential bound. The feed current can be switched over at measuring variable resistance/resistance potentiometer for better resolution.

- **Outputs for the manipulated variable Y**

The standard controller has the following outputs:

K-output:	switchable between 0 or 4 to 20 mA, potential-bound
S-output:	two relays, NOC, interlocked in factory setting, built-in spark quenching designed for wiring with medium contactors. Other functions can be assigned to the relay outputs by configuration (structure switches S58 to S69), e.g. manipulated variable output $\pm\Delta$y in S-controller.

- **Digital outputs DO1 and DO2**

The digital outputs are short-circuit-proof and can drive commercially available relays or the interface relays 6DR2804-8A/8B directly. Various functions can be assigned to the digital outputs by configuration (structure switches S58 to S69).

- **Digital inputs DI1 and DI2**

  The inputs are designed in 24 V logic and potential-bound. The function is assigned to the input by configuring the controller (structure switches S23 to S34).

- **CPU**

  The used microcontroller has integrated AD and DA converters and watchdog circuits for the cycle monitoring. The processor operates with a 64k EPROM (on a socket and therefore replaceable) and a 1k RAM.

  The program of the SIPART DR19 runs with a fixed cycle time of 100 ms. A process image is generated at the start of every routine. The analog- and digital inputs, the operation of the front keyboard and the process variables received by the serial interface are acquired or accepted. All calculations are made according to the stored functions with these input signals. Then output to the display elements, the analog outputs and the digital outputs and storage of the calculated variables for transmission mode of the serial interface take place. In S-controllers, the program run is interrupted every 1.1 ms to be able to switch off the S-outputs for better resolution. The interface traffic also runs in interrupt mode.

- **Power supply unit**

  A cast, overload-protected mains transformer for 115 V or 230 V AC built into a heat sink or a primary clocked plug-in type power supply unit for 24 V UC built into a heat sink generates the secondary internal supply voltages +24 V, +5 V and U_{ref} from the power supply. The metal body contacts a PE conductor (protection class I).
  The power supply and internal supply voltages are isolated from each other by safe separation.
  The internal supply voltages are function low voltages.
  Since no further voltages are generated in the instrument, these statements apply for all field signal lines with the exception of the relay leads (used standards, see chapter 2.6 "Technical data", page 37).

- **Configuration**

  The controller has a large number of prepared functions for controlling processing plants. The user programs the instrument himself by selecting the desired functions or setting parameters by setting structure switches. The total functioning of the instrument is given by the combination of the individual structure switches or parameter settings. No programming knowledge is necessary (chapter 5, page 159).

  All settings are made exclusively on the front control panel of the SIPART DR19 or the serial interface.

  The job-specific program written in this way is saved in the non-volatile user program memory.

  The instrument is configured as a fixed value controller in the factory setting. This setting can be restored with the "APSt" function at any time.

The following parameterization and structuring modes are available for configuring the SIPART DR19 controller.

onPA	The transmission properties of the controller and with these the process course are determined with the **online-parameters**. They can be changed during control operation (online)
oFPA	The **offline-parameters** determine the basic functions such as display elements, limit values, safety values. The controller is blocked (offline) while they are being set, the last value of the manipulated variable is held.
StrS	The instrument structure, e.g. fixed value controller or follow-up controller is determined with the **structure switches**. The controller is blocked (offline) while they are being set, the last value of the manipulated variable is held.
CAE1	The measuring range is set and fine adjustment made if necessary here for the **analog input AI1**.
APSt	The **all preset-function** restores the factory setting.
(AdAP)	In the **adaptation level** the output conditions for automatic adaptation of the controller parameters to the process is preset and adaptation started.
(CLPA)	The timing program is defined with the CLPA parameters. Release of the CLPA-menu with structure switch S1 = 5.
(CAE3)	The measuring range is set and fine adjustment made if necessary here for the **UNI-module**. The CAE3-menu is only displayed if it has been released in the structuring level (structure switch S6>3).

2.5.2 Options modules

The following option modules are described in this chapter

6DR2800-8J	I/U-module
6DR2800-8R	R-module
6DR2800-8V	UNI-module
6DR2805-8A	Reference point
6DR2805-8J	Measuring range plug
6DR2801-8D	Module with 2 DO (relay)
6DR2801-8E	Module with 2 DI and 4 DO
6DR2801-8C	Module with 5 DI
6DR2803-8P	Serial interface PROFIBUS-DP
6DR2803-8C	Serial interface RS 232/RS 485
6DR2804-8A	Module with 4 DO relay
6DR2804-8B	Module with 2 DO relays

For information about the option cards 6DR2800−8P Pt100 Input (RTD) and 6DR2800−8T Thermocouple input (TC) please refer to our supplement sheet A5E00097041, internet address www.fielddevices.com.

6DR2800-8J I/U-module

- **Input variables current 0/4 to 20 mA or voltage 0/0.2 to 1 V or 0/2 to 10 V**

  The module’s input amplifier is designed as a differentiating amplifier with shuntable gain for 0 to 1 V or 0 to 10 V input signal. For current input signals the 49.9 Ω 0.1 % impedance is switched on by plug-in bridges on the module. The start value 0 mA or 4 mA or 0 V or 0.2 V (2 V) is defined by configuration in the standard controller. The differentiating amplifier is designed for common mode voltages up to 10 V and has a high common mode suppression. As a result it is possible to connect the current inputs in series as for electrical isolation when they have common ground. For voltage inputs this circuit technique makes it possible to suppress the voltage drops on the ground conductor by two-pole wiring on potential-bound voltage sources. One refers to an electronic potential isolation (see chapter 4.2.3.2, page 147).

6DR2800-8R R-module

- **Input for resistance or current potentiometer**

  Potentiometers with rated values of 80 Ω to 1200 Ω can be connected as resistance potentiometers. A constant current of Is = 5 mA is fed to the potentiometer wiper. The wiper resistance is therefore not included in the measurement. Resistors are switched parallel to the potentiometer by settings on the module and a rough range selection made. Start of scale and full scale are set with the two adjusting pots on the back of the module.

  This fine adjustment can be made on the displays on the front module (if structured appropriately). For adjustment with a remote measuring instrument, the analog output can be assigned to the appropriate input.

  The external wiring must be changed for resistance transmitters which cannot withstand the 5 mA wiper current or which have a rated resistance >1 kΩ. The constant current is then not fed through the wiper but through the whole resistance network of the potentiometer. A voltage divider measurement is now made through the wiper. Coarse adjustment is made by a remote parallel resistor to the resistance potentiometer.

This module can also be used as a current input with adjustable range start and full scale. The load is 49.9 Ω and is referenced to ground.

6DR2800-8V UNI-module

- **Direct connection of thermocouple or Pt100-sensors, resistance or mV transmitters**

  Measured value sensors such as thermocouples (TC), resistance thermometers Pt100 (RTD), resistance potentiometers (R) or voltage transmitters in the mV-range can be connected directly. The measuring variable is selected by configuring the controller in the StrS-level (structure switches S7, S9, S10 and S11); the measuring range and the other parameters are set in the CAE3-menu. The sensor-specific characteristics (linearization) for thermocouples and Pt100-resistance thermometers are stored in the contoller's program memory and are automatically taken into account. No settings need to be made on the module itself.

  The signal lines are connected by a plug terminal block with screw-type terminals. When using thermocouples with internal reference point, this terminal block must be replaced by the terminal 6DR2805-8A. With the measuring range plug 6DR2805-8J in place of the terminal block, the measuring range of the direct input (0/20 to 100 mV) can be extended to 0/2 to 10 V or 0/4 to 20 mA.

  The UNI-module operates with an AD-converter with 18 bit resolution. The measuring inputs and ground of the standard controller are electrically isolated with a permissible common mode voltage of 50 V UC.

  The UNI-module can only be used at slot 1 (AI3).

6DR2805-8A reference point

- **Terminal with internal reference point for thermocouples**

  This terminal is used in connection with the analog input AI1 or in connection with the UNI module for temperature measuring with thermocouples with internal reference point. It consists of a temperature sensor which is pre-assembled on a terminal block and plated to avoid mechanical damage.

6DR2805-8J measuring range plug

- **Measuring range plug for current 0/4 to 20 mA or voltage 0/2 to 10 V**

  The measuring range plug is used in connection with the analog input AI1 or in connection with the UNI module for measuring current and voltage. The input variable is reduced to 0/20 to 100 mV by a voltage divider or shunt resistors in the measuring range plug.

  Wiper resistors with 250 Ω or 50 Ω are available optionally at 2 different terminals for 0/4 to 20 mA signals.

  The electrical isolation of the UNI-module is retained even when the measuring range plug is used.

6DR2801-8D 2 DO relays

- Digital output module with 2 relay contacts

  To convert 2 digital outputs to relay contacts up to 35 V UC.

  This module is equipped with 2 relays whose switching contacts have potential free outputs. The RC-combinations of the spark quenching elements are respectively parallel to the rest- and working contacts.

  In AC-consumers with low power the current flowing through the capacitor of the spark quenching element when the contact is open may interfere (e.g. the hold current of some switching elements is not exceeded). In this case the capacitors (1 μF) must be removed and replaced with low capacitance capacitors.

  The 68 V suppressor diodes parallel to the capacitors act additionally to reduce the induced voltage.

CAUTION

The relays used on the digital output module are designed for a maximum rating up to UC 35 V. The same applies for the air- and creep lines on the circuit board. Higher voltages may therefore only be switched through appropriately approved series connected circuit elements under observance of the technical data and the pertinent safety regulations.

6DR2801-8E 2 DI and 4 DO

- Digital signal module with two digital inputs and 4 digital outputs

  The module serves to extend the digital inputs and digital outputs already existing in the standard controller.

  The inputs are designed in 24-V-logic and are potential-bound. The functions are assigned to the inputs and outputs by configuration of the controller. (Structure switches S23 to S34, S59 to S75).

  The digital outputs are short-circuit proof and can drive commercially available relays or the interface relays 6DR2804-8A/8B directly.

6DR2801-8C 5 DI

- Digital input module with 5 digital inputs

  The module serves to extend the digital inputs already existing in the standard controller.

  The inputs are designed in 24-V-logic and are potential-bound. The function is assigned to the input by configuring the controller (structure switches S23 to S34).

6DR2803-8P Serial interface PROFIBUS-DP

The 6DR2803-8P module is a PROFIBUS-DP-interface module with RS-485-driver and electrical isolation from the instrument. It operates as an intelligent converter module and adapts the private SIPART- to the open PROFIBUS-DP-protocol.

This options card can be used in all SIPART-DR-instruments in slot 4. The following settings must be made with the appropriate structure switches for the serial interfaces.

- Interface on (if possible)
- Even parity
- LRC without
- Baud rate 9600
- Parameters/process values writable (as desired)
- Station number of choice 0 to 125

Make sure that the station number is not assigned double on the bus. The PROFIBUS-module serves to connect the SIPART-controllers to a master system for control and monitoring. In addition the parameters and structure switches of the controller can be read and written. Up to 32 process variables can be selected and read out cyclically by configuration of the PROFIBUS-module.

The process data are read out of the controller in a polling procedure with an update time <300 ms. If the master write process data to the slave, these become active after a maximum 1 controller cycle.

A description of the PROFIBUS interface including the basic device data (*.GSD) is available in Internet for interpreting the signals and useful data from and to the SIPART controller for creating a master-slave coupling software;
Internet address: www.fielddevices.com [Edition: 05.2000]

The SIPART S5 DP and SIPART S7 DP programs are offered for DP-masters SIMATIC S5 and S7.

6DR2803-8C Serial interface RS 232/RS 485

- **Serial interface for RS 232 or RS 485 with electrical isolation**

  Can be inserted at slot 4, the structure switches S92 to S99 must be set for the transmission procedure.

  For connecting the SIPART DR19 controller to a master system for HMI and/or configuration. All process variables and operating states, parameters and structurings can be read in and the data necessary for operation and configuration written via the interface.

  Interface communication can take place:

RS 232	As a point-to-point connection
SIPART bus	The SIPART bus driver is no longer available. Therefore, please realize multi–couplings via RS 485 or PROFIBUS DP.
RS 485	As a serial data bus with up to 32 users.

The interface module 6DR2803–8C offers electrical isolation between Rxd/Txd and the controller. Switching between RS 232, SIPART bus and RS 485 takes place with a plug-in jumper.

A detailed description of the data communication is available in Internet (www.fielddevices.com) [version 05.2000]) for creating a coupling software.

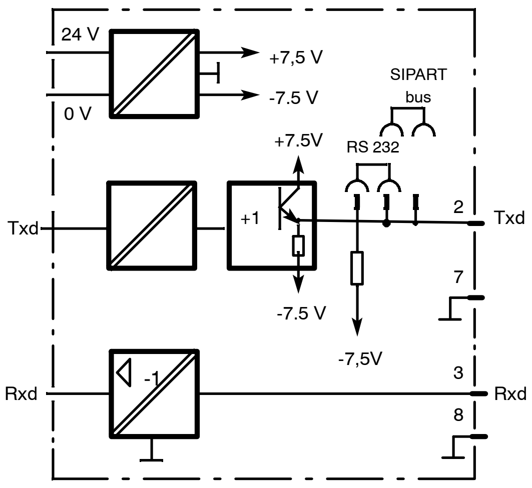


Figure 2-3 Block diagram serial interface in RS 232/SIPART BUS

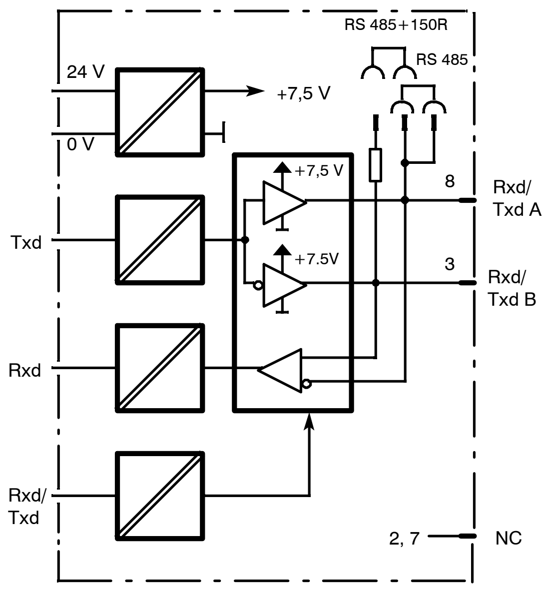


Figure 2-4 Block diagram serial interface at Interface RS 485

6DR2804-8A module with 4 DO-relays
6DR2804-8B module with 2 DO-relays

- Coupling relay module with 2 or 4 relays

  To convert 2 or 4 binary outputs to relay contacts up to 230 V UC.

  The relays can be snapped onto a mounting rail on the back of the controller. The mounting rail is delivered with the coupling relay module.

  One or two relay modules are installed per version. Each of these modules consists of two relays with quench diodes parallel to the control winding. Every relay has a switching contact with spark quenching in both switching branches. In AC-consumers with a very low power, the current flowing (e.g. hold current in contactors) through the spark quenching capacitor (33nF) when the contact is open interferes. In this case they should be replaced by capacitors of the same construction type, voltage strength and lower value.

  The switching contact is connected to the plug-in terminals at three poles so that idle current and operating current circuits can be switched. The relays can be controlled directly from the controller's digital outputs by external wiring.

CAUTION

The relays used on the interface relay module are designed for a maximum rating of AC 250 V in overvoltage class III and contamination factor 2 according to DIN EN 61010 Part 1.
The same applies for the air- and creep lines on the circuit board.
Resonance increases up to double the rated operating voltage may occur when phase shift motors are controlled. These voltages are available at the open relay contact. Therefore such motors may only be controlled under observance of the technical data and the pertinent safety conditions via approved switching elements.

2.6 Technical Data

2.6.1 General data

Installation position	any
Climate class to IEC 721	
Part 3−1 Storage 1k2	−25 to +75 °C
Part 3−2 Transport 2k2	−25 to +75 °C
Part 3−3 Operation 3k3	0 to +50 °C
Type of protection according to EN 60529	
Front	IP64
Housing	IP30
Connections	IP20

Housing design

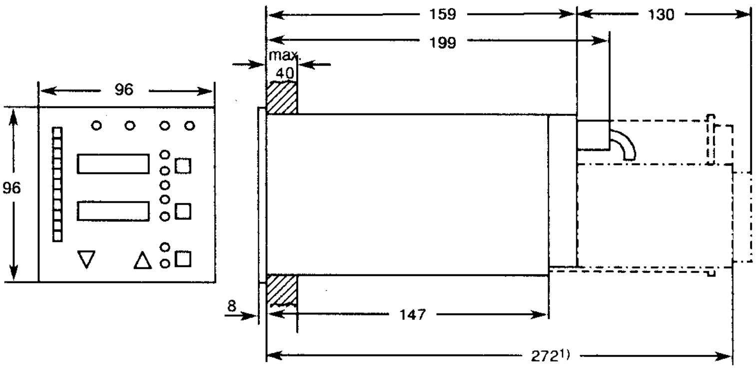
- Electrical safety
  - acc. to DIN EN 61 010 part 1
  - Protection class I acc. to IEC 536
  - Safe disconnection between mains connection and field signals
  - Air and creep lines, unless specified otherwise, for overvoltage class III and degree of contamination 2
- EC Declaration of Conformity No. A5E00065065G−01
  - **Conformity**
    The product described above in the form as delivered is in conformity with the provisions of the following European Directives:
    2004/108/EC EMC
    Directive of the European Parliament and of the Council on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
    2006/95/EC LVD
    Directive of the European Parliament and of the Council on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.
- Spurious emission, interference immunity according to EN 61 326, NAMUR NE21 8/98

Weight, standard controller	approx. 1.2 kg
Color	
Front module frame	RAL 7037
Front surface	RAL 7035
Material	
Housing, front frame	Polycarbonate, glass-fiber reinforced
Front foil	Polyester
Backplanes, modules	Polybutylenterephthalate

Connection technique

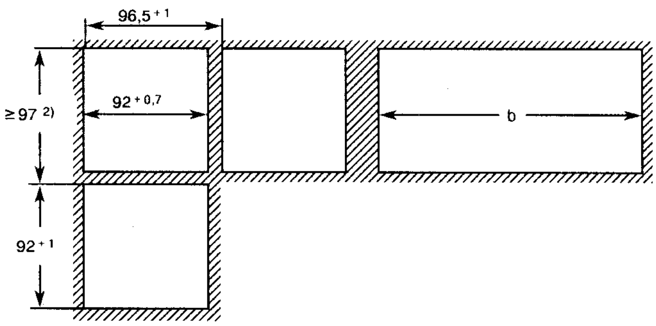
Power supply

115/230 V AC	Three-pin plug IEC320/V DIN 49457A
24 V UC	two-pin special plug
Field signals	Plug-in terminals for 1.5 mm^2 AWG 14



[1] Installation depth necessary for changing the main circuit board and modules

Figure 2-5 Dimensions SIPART DR19, dimensions in mm



Number of Device	Cut-out width b
2	188 +1
3	284 +1
4	380 +1
:	
:	
:	
10	956 +1

Figure 2-6 Panel cut-outs, dimensions in mm

2.6.2 Standard controller

Power supply

Rated voltage	230 V AC	115 V AC	24 V UC	
	switchable			
Operating voltage range	195 to 264 V AC	97 to 132 V AC	20 to 28 V AC	20 to 35 V DC[1]
Frequency range	48 to 63 Hz			– – –
External current I_{Ext}[2]	200 mA			
Power consumption				
Standard controller without options without I_{Ext} active power/apparent power (capacitive)	5 W/9 VA	5 W/9 VA	4 W/6 VA	4 W
Standard controller with options without I_{Ext} active power/apparent power (capacitive)	11 W/15 VA	11 W/15 VA	8.5 W/12 VA	8.5 W
Standard controller with options with I_{Ext} active power/apparent power (capacitive)	15 W/19 VA	15 W/19 VA	12 W/17 VA	12 W
Permissible voltage breaks based on 0.85 U_N and max. load Time[3]	≤20 ms	≤20 ms	≤20 ms	≤20 ms

1) Including harmonic
2) Current transmitted from L+, DO, AO to external loads
3) The load voltages of the AO are reduced hereby to 13 V, L+ to 15 V and the DO to 14 V

Table 2-1 Technical data of standard controller power supply

Analog input AI1

Analog input AI1	**mV** [1]	**TC** [2]	**Pt100**	**R**	**R**
Slot 1		°C		R ≤ 600 Ω	R ≤ 2.8 kΩ
Start of scale MA	≥ -175 mV	≥ -175 mV	≥ -200 °C	≥ 0 Ω	≥ 0 Ω
Full scale ME	≤ +175 mV	≤ +175 mV	≤ +850 °C	≤ 600 Ω	≤ 2.8 kΩ
Span Δ = ME - MA	parameterizable 0 to Δmax				
Min. recommended span	5 mV	5 mV	10 K	30 Ω	70 Ω
Transmitter fault message MUF	-2.5 % ≥ MUF ≥ 106.25 % [3]				
Input current	≤ 1 µA	≤ 1 µA	–	–	–
Supply current	–	–	400 µA	400 µA	140 µA
Perm. common mode voltage	≤ 1 V UC	≤ 1 V UC	–	–	–
Line resistance					
2L: RL1+RL4	≤ 1 kΩ	≤ 300 Ω	≤ 50 Ω	–	–
3L: (RL1) = RL2 = RL4	–	–	≤ 50 Ω	–	–
4L: RL1 to RL4	–	–	≤ 100 Ω	–	–
Open loop signaling	without	≥ 500 to 550 Ω	all terminals	Open loop between Terminal 2-3	
Error			[5]		
Transmission	± 10 µV	± 10 µV	± 0.2 K	± 60 mΩ	± 200 mΩ
Linearity	± 10 µV	± 10 µV	± 0.2 K	± 60 mΩ	± 200 mΩ
Resolution/noise	± 5 µV	± 2 µV	± 0.1 K	± 30 mΩ	± 70 mΩ
Common mode	± 0.1 mV/V	± 0.1 mV/V	–	–	–
Internal reference point	–	± 0.5 K	–	–	–
Temperature error					
Transmission	± 0.05 %/10 K [3]				
Internal reference point	–	± 0.1 K/10 K	–	–	–
Static destruction limit	± 35 V	± 35 V	–	–	–
Cycle time	100 ms	200 ms	300 ms	200 ms	200 ms
Filter time constant adaptive [4]	<1.5 s	<2 s	<2 s	<1.5 s	<1.5 s

1) 20 mA, ± 10 V with measuring range plug 6DR2805-8J
2) Types, see structure switches, internal reference point (plug-in terminal block) 6DR2805-8A
3) Reference to parameterizable span Δ= ME - MA
4) In series with adaptive filter changeable by time constant t1 (onPA)
5) Applies for disturbance according to IEC801–3 to 3 V/m, with 10 V/m at 250 to 400 MHz ≤ 1 K

Table 2-2 Technical data for analog input AI1

Digital inputs DI1, DI2

Signal status 0	≤ 4.5 V or open
Signal status 1	≥ 13 V
Input resistance	≥ 27 kΩ
Static destruction limit	± 35 V

Analog output AO

Rated signal range (0 to 100 %)	0 to 20 mA or 4 to 20 mA
Modulation range	0 to 20.5 mA or 3.8 to 20.5 mA
Load voltage	from −1 to 18 V
No-load voltage	≤ 26 V
Inductive load	≤ 0.1 H
Time constant	10 ms
Residual ripple 900 Hz	≤ 0.2 %
Resolution	≤ 0.1 %
Load dependence	≤ 0.1 %
Zero error	≤ 0.3 % [1]
Full scale error	≤ 0.3 % [1]
Linearity	≤ 0.05 %
Temperature influence	
Zero point	≤ 0.1 %/10 K
Full scale	≤ 0.1 %/10 K
Static destruction limit	−1 to 35 V

NOTE

All error data refer to the rated signal range.

S-output (relay 230 V) DO7 and DO8

- **Contact material**	Ag / Ni	
- **Contact load capacity**		
Switching voltage		
AC	≤ 250 V	
DC	≤ 250 V	
Switching current	Contacts locked	Contacts unlocked
AC	≤ 8 A	≤ 2.5 A
DC	≤ 8 A	≤ 2.5 A
Rating		
AC	≤ 1250 VA	
DC	≤30 W at 250 V ≤100 W at 24 V	

1) Applies for disturbance according to IEC801−3 to 3 V/m, with 10 V/m at 80 to 100 MHz ≤0.5 %

Service life	
mechanical	$2 \cdot 10^7$ switching cycles
230 V AC 8A electrical ohmic	10^5 switching cycles
Spark quenching element	Series circuit 22 nF/220 Ω parallel to it varistor 420 V_{rms}

Digital outputs DO1 to DO8 (with wired-or diodes)

Signal status 0	≤1.5 V
Signal status 1	+19 V to 26 V
load current	≤50 mA
Short-circuit current	≤80 mA, clocking
Static destruction limit	- -1 V to +35 V

Measuring transmitter feed L+

Rated voltage	+20 to 26 V
load current	≤ 60 mA, short-circuit-proof
Short-circuit current	≤ 200 mA clocking
Static destruction limit	–1 to +35 V

CPU data

Cycle time	100 ms
Minimum integration speed	$\frac{dy}{dt} = \frac{kp \cdot xd}{tn} = \frac{0.1 \cdot 0.1\ \%}{10^4\ s}$

A/D conversion for AI2 and AI3 except UNI module 6DR2800-8V

Procedure	Successive approximation per input >120 conversions and averaging within 20 or 16.67 ms
Modulation range	–5 % to 105 % of the modulation range
Resolution	11 bits ≙ 0.06 % of the modulation range
Zero error	≤ 0.2 %[1)] from the modulation range
Full scale error	≤ 0.2 % · from the modulation range
Linearity error	≤ 0.2 % of the modulation range
Temperature influence	
Zero point	≤ 0.05 %/10 K of the modulation range
Full scale	≤ 0.1 %/10 K of the modulation range

1) Applies for disturbance according to IEC801–3 to 3 V/m, with 10 V/m at 110 to 132 MHz ≤2 %

Setpoint and manipulated variable adjustment

Setting		With 2 keys (more - less)
Speed		Progressive
Resolution	wi	1 digit
	y	0.1 % of rated range 0 to 20 mA

Parameters

Setting	With two keys (more – less)
Speed	Progressive
Resolution	
Linear parameters, %	≤ 0.1 %
Linear parameters, physical	1 digit
Logarithmic parameters	128 values/octave
Accuracy	± 2 %
Time parameters	
All others	Resolution accordingly, absolute

Display technique

– x- and w/y-display digital		4 digit 7-segment LED
Color	x-display	Red
	w/y-display	Green
Digit height		10 mm
Display range	x, w	Adjustable start and end
	y	–10 % to 110 %
Number range	x, w	–1999 to 9999
Overflow x, w		<–1999:–oFL >9999: oFL
Decimal point		adjustable (fixed point) _.––– to ––––
Refresh rate		Adjustable 0.1 to 9.9 s
Resolution	x, w	1 digit, but not better than AD-converter
	y	1 %, with S1 = 4 and S88 = 3 also 0.1 %
Display error		corresponding to AD-converter and analog inputs
– Display analog		LED array vertical 21 LEDs
Color		red
Display range		Selectable by structure switch S89
Overrun		flashing first or last LED
Refresh rate		cyclic
Resolution		2.5 % by alternate glowing of 1 or 2 LEDs, the center of the illuminated field serves as a pointer

2.6.3 Options modules

6DR2800-8J/R Analog inputs AI3 (slot 1), AI4 (slot 2)

Signal converter for Order number:	**Current 6DR2800-8J**	**Voltage 6DR2800-8J**	**Resistance potentiometer 6DR2800-8R**
Range start	0 or 4 mA [1]	0 V or 2 V[1] or 199.6 mV [1]	0 Ω
Min. span (100 %)			ΔR ≥ 0.3 R [3]
Max. zero point suppression			RA ≤ 0.2 R [3]
Range end	20 mA	10 V, 998 mV	1.1 R [3]
Dynamic range	–4 to 115 %	–4 to 115 %	–4 to 115 %
Transmitter fault message MUF	–2.5 % ≥ MUF ≥ 106.25 %		
Input resistance			
Difference	49.9 Ω ±0.1 %	200 kΩ	
Common mode	500 kΩ	≥ 200 kΩ	
Permissible common mode voltage	0 to +10 V	0 to +10 V	
Supply current			5 mA ±5%
Line resistance			
Three-wire-circuit			per < 10 Ω
Filter time constant ±20 %	50 ms	50 ms	50 ms
Error [2]			
Zero point	≤ 0,3 %	≤ 0.2 %	≤ 0.2 %
Gain	≤ 0.5 %	≤ 0.2 %	≤ 0.2 %
Linearity	≤ 0.05 %	≤ 0.05 %	≤ 0.2 %
Common mode	≤ 0.07 %/V	≤ 0.02 %/V	–
Influence of temperature [2]			
Zero point	≤ 0.05 %/10 K	≤ 0.02 %/10 K	≤ 0.1 %/10 K
Gain	≤ 0.1 %/10 K	≤ 0.1 %/10 K	≤ 0.3 %/10 K
Stat. destruction limit			
between the inp.	± 40 mA	± 35 V	± 35 V
referenced to M	± 35 V	± 35 V	± 35 V

1) Start of measuring by structuring
2) Without errors of A/D-converter
3) with R = RA +ΔR + RE adjustable in three ranges: R = 200 Ω, R = 500 Ω, R = 1000 Ω

Table 2-3 Technical data for module 6DR2800-8J/R

6DR2800-8V UNI-module Analog input AI3 (slot 1)

Analog input AI3	**mV** 1)	**TC** 2)	**Pt100**	**R**	**R**
Slot 1		°C		R ≤ 600 Ω	R ≤ 2.8 kΩ
Start of scale MA	≥-175 mV	≥-175 mV	≥-200 °C	≥0 Ω	≥0 Ω
Full scale ME	≤+175 mV	≤+175 mV	≤+850 °C	≤600 Ω	≤2.8 kΩ
Span Δ = ME - MA	parameterizable 0 to Δmax				
Min. recommended span	5 mV	5 mV	10 K	30 Ω	70 Ω
Transmitter fault message MUF	-2.5 % ≥ MUF ≥ 106.25 % 3)				
Input current	≤1 µA	≤1 µA	–	–	–
Supply current	–	–	400 µA	400 µA	140 µA
Potential isolation					
Test voltage	500 V AC				
Perm. common mode voltage	≤50 V UC	≤50 V UC	–	–	–
Line resistance					
2L: RL1+RL4	≤1 kΩ	≤300 Ω	≤50 Ω	–	–
3L: (RL1) = RL2 = RL4	–	–	≤50 Ω	–	–
4L: RL1 to RL4	–	–	≤100 Ω	–	–
Open loop signaling	without	≥500 to 550 Ω	all terminals	Open loop between Terminal 2-3	
Error					
Transmission	±10 µV	±10 µV	±0,2 K	±60 mΩ	±200 mΩ
Linearity	±10 µV	±10 µV	±0,2 K	±60 mΩ	±200 mΩ
Resolution/noise	±5 µV	±2 µV	±0,1 K	±30 mΩ	±70 mΩ
Common mode	±1 µV/10 V	±1 µV/10 V	–	–	–
Internal reference point	–	±0.5 K	–	–	–
Temperature error					
Transmission	±0.05 %/10 K 3)				
Internal reference point	–	±0.1 K/10 K	–	–	–
Statistical destruction limit	±35 V	±35 V	–	–	–
Cycle time	100 ms	200 ms	300 ms	200 ms	200 ms
Filter time constant adaptive 4)	<1,5 s	<2 s	<2 s	<1,5 s	<1,5 s

1) 20 mA, 10 V with measuring range plug 6DR2805-8J
2) Types, see structure switches, internal reference point (plug-in terminal block) 6DR2805-8A
3) Reference to parameterizable span Δ= ME - MA
4) In series with adaptive filter changeable by time constant t3 (onPA)

Table 2-4 Technical data for UNI-module 6DR2800-8V

6DR2805-8J Measuring range plug 20 mA/10 V

- **20 mA**

conversion to 100 mV	±0.3 %
Load terminal 1 - 2	50 Ω
1 - 3	250 Ω
Stat. destruction limit	±40 mA

- **10 V**

divider to 100 mV	±0.2 %
Input resistance	90 kΩ
Statistical destruction limit	±100 V

6DR2801-8D 2DO Relay 35 V Digital outputs DO3 and DO4 (slot 3)

– Contact material	Ag / Ni
– Contact load capacity	
Switching voltage	
AC	≤ 35 V
DC	≤ 35 V
Switching current	
AC	≤ 5 A
DC	≤ 5 A
Rating	
AC	≤ 150 VA
DC	≤ 100 W at 24 V
	≤ 80 W at 35 V
– Service life	
mechanical	$2x10^7$ switching cycles
electrical	
24 V/4 A ohmic	$2x10^6$ switching cycles
24 V/1 A inductive	$2x10^5$ switching cycles
– Spark quenching element	
Series circuit	1 µF/22 Ω parallel to it varistor 75 Vrms

6DR2801-8E **4DO 24 V, 2DI** Digital outputs DO3 to DO6 and digital inputs DI3 to DI4 (slot 3)

– **Digital outputs**

Signal status 0	≤ 1.5 V or open
Signal status 1	19 to 26 V
load current	≤ 30 mA
Short-circuit current	≤ 50 mA
Static destruction limit	–1 V to +35 V

– **Digital inputs**

Signal status 0	≤ 4.5 V or open
Signal status 1	≥ 13 V
Input resistance	≥ 27 kΩ
Static destruction limit	± 35 V

6DR2801-8C **5DI 24 V** Digital inputs DI3 to DI7 (slot 3)

Signal status 0	≤ 4.5 V or open
Signal status 1	≥ 13 V
Input resistance	≥ 27 kΩ
Statistical destruction limit	± 35 V

6DR2803-8P **PROFIBUS-DP**

Transmittable signals	RS485, PROFIBUS-DP-protocol
Transmittable data	Operating state, process variables, parameters and structure switches
Transmission procedure PROFIBUS-/DP-protocol	According to DIN 19245, Part 1 and Part 3 (EN 50170)
Transmission speed	9.6 kbit/s to 1.5 Mbit/s except 45.45 kBit/s
Station number	0 to 125
Time monitoring of the data traffic	Structurable on the controller in connection with DP-watchdog
Electrical isolation between Rxd/Txd- P/- N and the controller	50 V UC common mode voltage
Test voltage	500 V AC
Repeater-control signal CNTR-P	TTL-level with 1 TTL-load
Supply voltage VP (5 V)	5 V -0.4 V/+0.2 V; short-circuit-proof
Line lengths, per segment at 1.5 Mbit/s	200 m, see ET200-Manual 6ES5 998-3ES12 for further details

6DR2803-8C Serial interface

Transmittable signals	RS 232, RS 485 or SIPART BUS *) shuntable
Transmittable data	Operating state, process variables, parameters and structure switches
Transmission procedure	According to DIN 66258 A or B
Character format	10 bits (start bit, ASCII-characters with 7 bits, parity bit and stop bit)
Hamming - distance h	2 or 4
Transmission speed	300 to 9600 bps
Transmission	Asynchronous, semiduplex
Addressable stations	32
Time monitoring of the data traffic	1 s to 25 s or without
Electrical isolation between Rxd/Txd and the controller	
max. common mode voltage	50 V UC
Test voltage	500 V AC

	RS 232	RS 485
Receiver input Rxd Signal level 0 Signal level 1 1) Input resistance	 0 to +12 V 2) -3 to -12 V 2) 13 kΩ	 $U_A > U_B$, +0.2 to +12 V $U_A < U_B$, -0.2 to -12 V 12 Ω
Send output Txd Signal level 0 Signal level 1 1)	 +5 to +10 V -5 to -10 V	 $U_A > U_B$, +1.5 to +6 V $U_A < U_B$, -1.5 bis -6 V
Load resistance	≤ 1.67 mA	54 Ω

1) Signal status 1 is the rest status
2) Input protected with 14 V Z-diode, higher voltages with current limiting to 50 mA possible.

Line capacitance and lengths
at 9600 bits/s

	Line capacitance	Reference values line lengths Ribbon cable without shield	 Round cable with shield
RS 232 point-to-point	≤ 2.5 nF	50 m	10 m
RS 485 bus	≤ 250 nF	1,000 m	1,000 m

*) SIPART bus operation is no longer possible!
The bus driver is no longer available!

6DR2804-8A/B Coupling relay 230 V

1 relay module	6DR2804-8B
2 relay modules	6DR2804-8A
per relay module	2 relays with 1 switching contact each with spark quenching element
Mounting rail for mounting on back of power supply unit	NS 35/7.5 DIN/EN 50 022
- **Contact material**	Silver-cadmium oxide
- **Contact load capacity**	
Switching voltage	
AC	≤ 250 V
DC	≤ 250 V
Switching current	
AC	≤ 8 A
DC	≤ 8 A
Rating	
AC	≤ 1250 VA
DC	≤30 W at 250 V ≤100 W at 24 V
- **Service life**	
mechanical	2×10^7 switching cycles
electrical AC 220 V, ohmic	$2 \times 10^6/I(A)$ switching cycles
- **Spark quenching element**	Series circuit 22 nF/220 Ω parallel plus varistor 420 V_{rms}
- **Exciter winding**	
Voltage	+19 to +30 V
Resistance	1.2 kΩ ±180 Ω
- **Electrical isolation between**	
Exciter winding – contacts Relay module – relay module (6DR2805-8A)	Safe isolation [1)] by reinforced insulation, air – and creep lines for overvoltage class III [1)] and degree of contamination 2 [1)]
contact – contact of a relay module	Safe isolation [1)] by reinforced insulation, air – and creep lines for overvoltage class II [1)] and degree of contamination 2 [1)]

1) according to DIN EN 61010 Part 1

- **Degree of protection**	
Housing	IP50 according to DIN 40050
Connections (in plugged state)	IP20 according to DIN 40050

- **Housing material** Polyamide 66

- **Rail mounted** on
  NS 35/7.5 DIN EN 50022
  NS 35/15 DIN EN 50035
  NS 32 DIN EN 50035

- **Dimensioned drawing** see figure 2-7

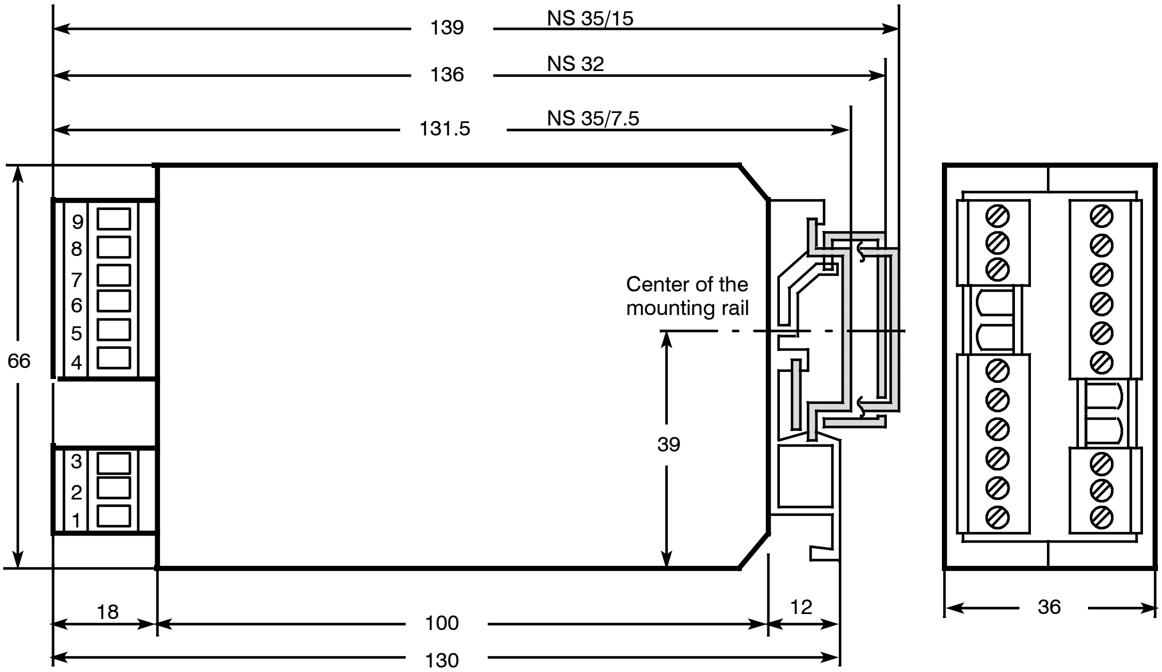


Figure 2-7 Dimensioned drawing coupling relay, dimensions in mm

3 Functional description of the structure switches

3.1 General

The controller is adapted to the respective job by structure switches. The factory setting corresponds to the most usual setting of the individual functions so that only few structure switches usually need to be set selectively during commissioning. However, it is recommendable to compare the compatibility of the individual structure switch settings with the task in any case.

The structure switches S1 and S2 are fundamentally important. With S1 the controller type is set and thus the processing of command variable, main controlled variable and auxiliary controlled variables up to control difference generation determined. With S2 the controller output structure is set and thus the processing of the automatic manual, safety and tracking variables as well as the manipulated variable output determined as a K- or S-output.

The functions of the structure switches S3 to S89 correspond to the logical order of signal processing. S90 and S91 describe the restart conditions, S92 to S99 the transmission procedure of the serial interface.

The structure switches are described in this order in the following description.

NOTE

The control elements on the front are shown in Figure 1, page 5 and are indicated in the text by numbers in brackets. The structure switches are designated by S**.

3.2 Analog input signal processing (S3 to S21)

see fig. 3-1, page 53

Each of the maximum 3 analog inputs is fed through an AD-converter which performs the 50 or 60 Hz interference suppression (S3) by averaging over 20 or 16 2/3 ms. UNI input signals can be applied at input AI1. With S5 the type of input signal is determined, S6 selects the thermocouple type at the thermocouple input. The temperature unit is determined at PT100 and the thermocouple inputs with S7.

S8 and S9 are assigned to the module inputs AI2 and AI3 (e.g. current input 0/4 to 20 mA). With S9> 3 AI3 is structured for use of the UNI module. Analogously with input AI1, S10 determines the type of input signal and S11 the thermocouple type for AI3.

At the same time S4, S8 and S9 decide whether operation is to take place with or without measuring range monitoring (transmitter fault). A separate AD-converter routine without averaging is responsible for monitoring so that the manual operation which is possible via S51 comes in to action as bumplessly as possible in the event of a transmitter fault. The monitor signals dropping below -2.5 and exceeding +106.25 % per channel with a hysteresis of 0.25 % on the PV-X-digital display. By an OR link of all single messages the group transmitter fault MUF is formed which can be assigned to the digital outputs and negated optionally (see figure 3-2, page 56 and chapter 3.8, page 118). Only the analog inputs selected with the transmitter fault monitor are monitored, displayed on the front panel (the appropriate position stays dark in the case of analog inputs not selected with transmitter fault) and signaled with the OR link. The error message is acknowledged with the Shift key (12). The fault message signal via the OR link is available until the selected analog inputs are back in the working range.

After measuring range monitoring the 3 analog inputs are each fed through a 1st order filter (parameter t1 to t3 can be set in the parameterization mode onPA). The factory setting is 1 s.

With S12 to S14 every channel can now be reduced optionally and a channel linearized optionally with S21. This enables even unlinear process variables to be represented physically correctly (function and setting of the 13 vertex values, see chapter 3.10.4 (page126) and figure 3-39, page 127).

The controllers-, manipulated- or disturbance variables to be processed for the controller types (S1) can be acquired with S15 to S20 from the 3 analog inputs.

The disturbance variable z is connected optionally via the D-element or the controller output (S48). y_N serves as a tracking input for the manipulated variable in K-controllers (S2=0) or S-controllers with external feedback (S2=3) and y_R as a manipulated variable feedback in S-controllers with internal feedback (S2=2) or as position feedback in S-controllers with external feedback (S2=3).

The controller or process variables are available for assignment to the analog output (S57) and the limit value alarm (S83 to S87) and can be read by the SES. With this input structure most control tasks can be solved in connection with the different controller types and controller output structures.

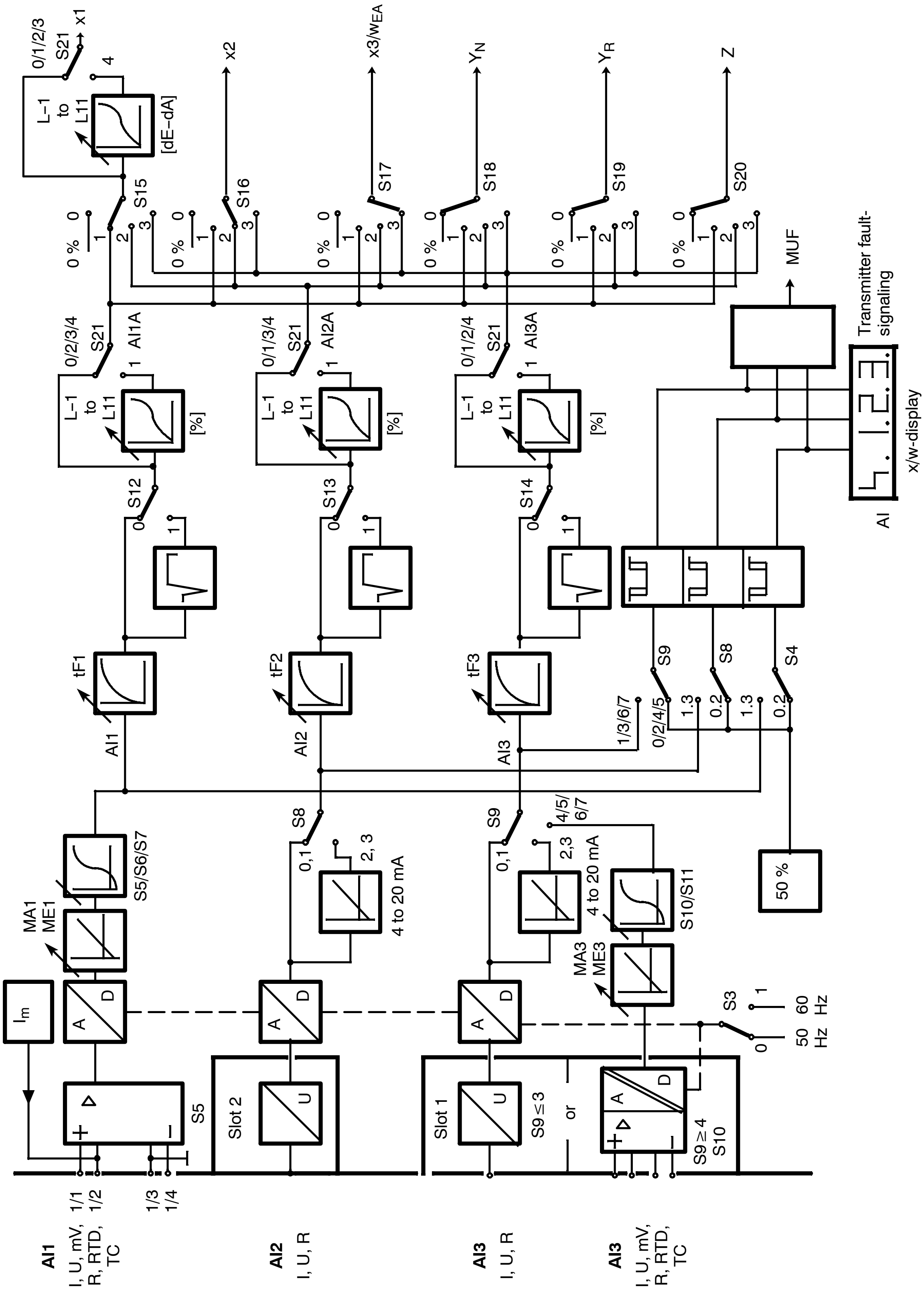


Figure 3-1 Analog input signal processing S5 to S21

3.3 Digital input signal processing (S23 to S42)

- **Assignment and direction of action of the digital inputs (S23 to S42)**

see figure 3-2, page 56

The control signals CB, He ...bLS, bLPS, PU are assigned by the structure switches S23 to S34 to the digital inputs DI1 to BE7 or the Low status. The High status is also possible when assigning CB (S23) and P (S27). The control signals can also be negated optionally by the structure switches S35 to S41.

The number of digital inputs (DI1 and DI2 already in the standard controller) can be extended for example by DI3 to DI7 with the options module 5BE (6DR2801−8C) in slot (S22 = 2).

When using the module 4DO 24 V + 2DI (6DR2801−8E) it is possible to extend by two (DI3, DI4) inputs (S22 = 1).

When using options modules in slot 3, structure switch S22 must be set according to the assignment, otherwise there will be an error message (see chapter 5.5, page 202).

All digital inputs can be read by the SES.

- **Linking the digital inputs DI1 to DI7 with the control signals via the SES. (S42, S43, S52 and S93)**

see figure 3-3, page 57

The control signal CB (S23) may be available either as a static signal or as a pulse (key operation by control desk) at the digital input (S42). Every positive edge trips the flip-flop when selecting the pulse input. In the following descriptions the output status of the flip-flop is assumed as CB.

All control signals (bLb as of software version −B6, tSH as of software version −B9) can also be specified by the SES at S93 = 2, 3, (4, 5)[1)] and Ored with the appropriate control signals via the digital inputs. Since the top operating hierarchy in a computer coupling should be in the autarchic signal controller, the control signals can be switched off by the rounding with RC = $\overline{\text{Int}} \wedge$ CB via the internal/external key (13) of the controller or via CB_{ES} (with optional time monitor) or via CB_{DI} (central computer fail line).

In addition the internal toggle stage can be addressed at S93 = 2 to 5 parallel to the key actuation via Int_{ES}.

The CB-signal is formed at S93 = 2, (4)[1)] as OR-function from CB_{ES} via the serial interface and CB_{DI} via the digital input so that operation is optionally possible with one signal.

1) as of software version –A7

At S93 = 3, (5)[1] the OR-function is replaced by an AND-function so that the CB set by the SES can be reset by a central computer fail line.

At the same time the sources for the external setpoint w_{ES} or w_{EA} and for the tracking manipulated variable y_{ES} or y_N are switched over with S93. The depth of intervention is determined additionally by the serial interface. This makes it possible to specify the process variables analogly for example and the corresponding status signals via the SES.

The function $RC = \overline{Int} \wedge CB$ (computer operation) also controls the manipulated variable switching in the command variable switching in the controller types S1 = 0 to 4, i.e. also in SPC-operation (see chapter 3.4, page 59).

The two controller types S1 = 5/6 operate without command variable switching. The internal key and the control signal CB are available with the link $\overline{RC} = Int \vee \overline{CB}$ for locking operation through the serial interface (e. g. when linking to control systems).

At S42 = 0 static switching is performed by the logical function $RC = \overline{Int} \wedge CB$. When preset to $\overline{Int}$ (Internal LED (15) off) you can switch statically between the controller and controller values (command- and manipulatede variable) with CB. The computer standby CB is displayed negated by the $\overline{C}$-LED (14) ($\overline{C}$ = CB, CB = 1 $\triangleq$ $\overline{C}$ LED off). The computer standby of the controller is signaled negated as a message signal $\overline{RB} = Int$. Computer operation RC is also signalled negated as a message signal $RC = \overline{\overline{Int} \wedge CB}$.

At S42 = 1 a static switching with acknowledgement takes place. Every time the computer is recovered (CB from 0 → 1) If the internal flip-flop is set to 1 (internal LED on, $\overline{C}$ LED off), so that computer operation $RC = \overline{Int} \wedge CB$ only becomes effective after pressing the internal key (Int = 0).

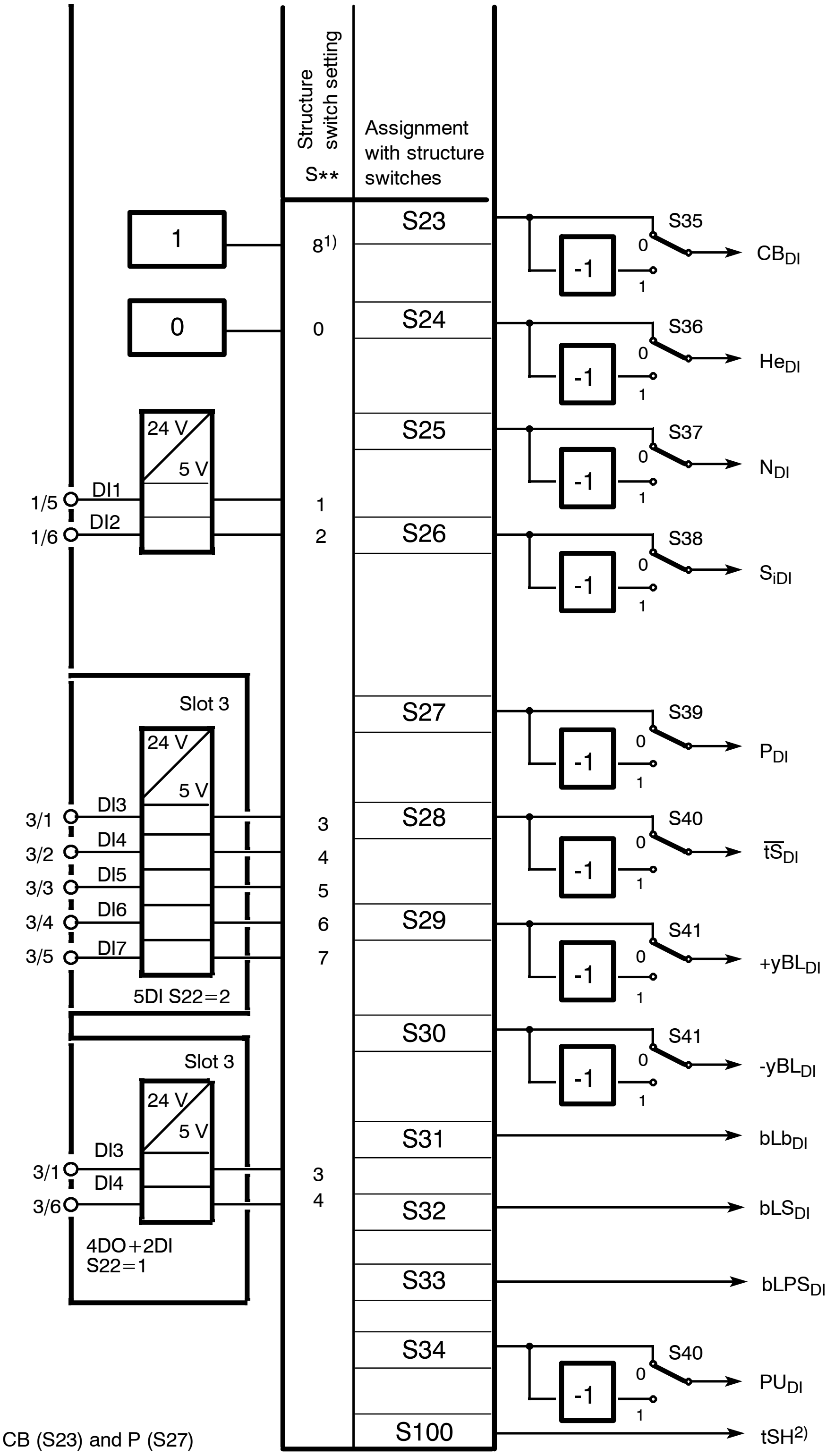
With S43 = 0/2 the internal/external key can be deactivated and only internal or external operation selected.

The control signal H is generated as an OR-function by the manual/automatic key (9) with subsequent flip-flop (Hi) and the control signal He whereby He can be preset by the SES or the digital inputs in the way described above.

With the structure switch S52 the automatic/manual switching on the control front panel (S52 = 1 only automatic mode or S52 = 2 only manual mode) is blocked. It is still possible to switch to manual operation by He in the “only automatic” position. The manual LED (12) always indicates the active status (see also chapter 3.6, page 101).

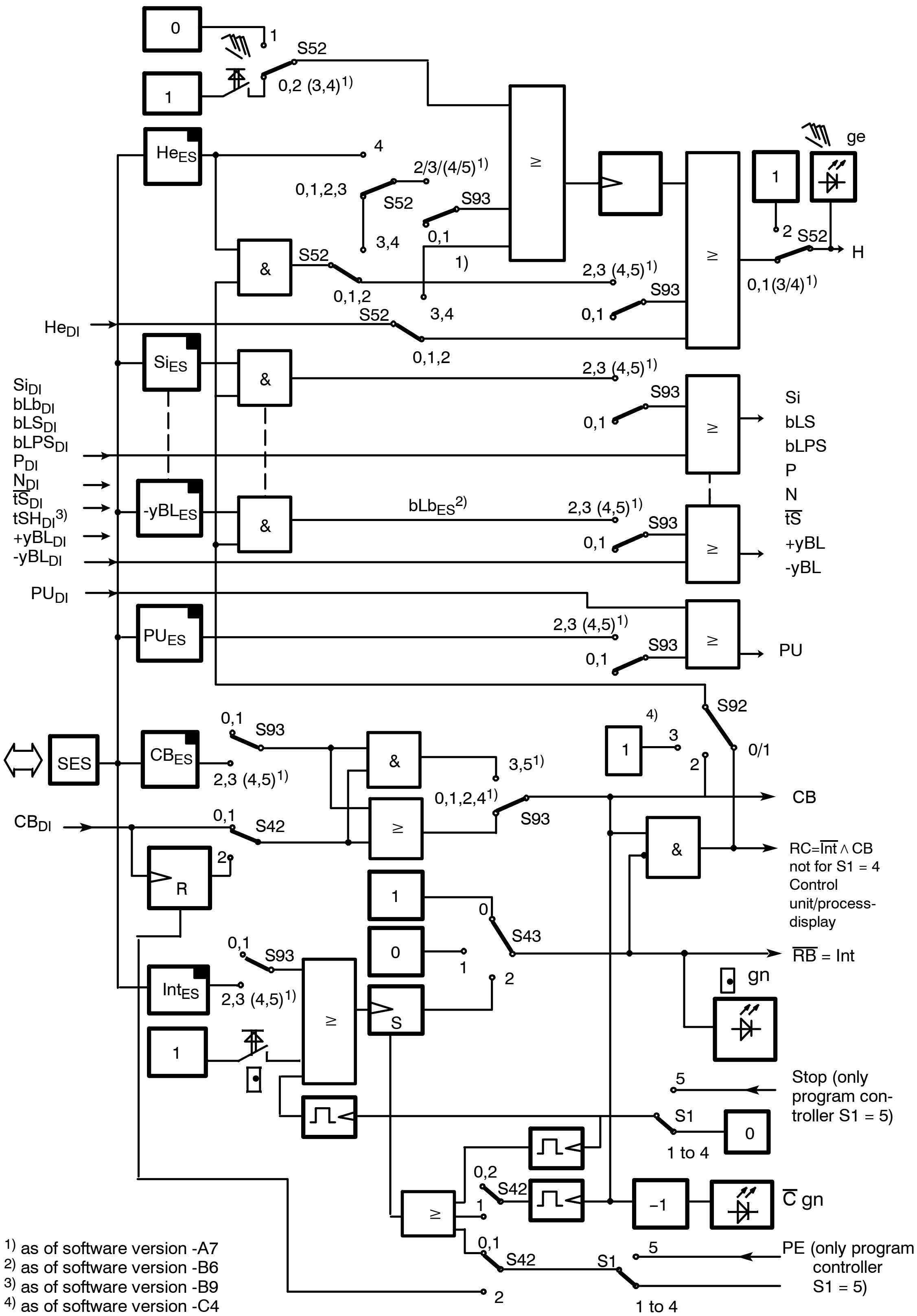
At S52 = 0 to 2 He is switched statically both via the SES and the digital inputs At S52 = 3/4 the connection takes place dynamically, i.e. every positive edge switches manual-automatic-manual. In addition, at structure switch S52 = 4 the locking of He_{ES} with $\overline{RC} = Int \vee \overline{CB}$ is released.

[1] as of software version –A5



1) only for CB (S23) and P (S27)
2) as of software version –B9

Figure 3-2 Assignment and direction of action digital inputs S23 to S41



1) as of software version -A7
2) as of software version -B6
3) as of software version -B9
4) as of software version -C4

Figure 3-3 Linking the digital inputs DI with the control signals via the SES (S42, S43, S52, S93)

- **Functional explanation of the control signals**

CB — *Computer-standby*
This digital signal together with the internal/external key causes switching in the setpoint range. In SPC central Computer-Fail-line.

He — *Manual external*
This signal blocks the output of the controller and enables direct manual adjustment of the manipulated variable on the front control panel.

N — *Tracking*
With this signal the output of the K-controller and the three-position stepper controller with external position feedback is tracked to the tracking signal y_N.

Si — *Safety operation*
In K-controllers and three-position stepper controllers with external position feedback the manipulated variable approaches the parameterized safety value. In three-position stepper controllers with internal feedback the manipulated variable runs independently of the safety setting value to a defined limit position.

bLS — *Blocking structuring*
The whole configuration is blocked with the exception of the online parameterization level.

bLPS — *Blocking of the parameterization and structuring*
The entire configuring of the instrument is blocked, this means the parameterization as well. Only the normal process operation according to the preselected controller type is permitted.

bLb — *Blocking operation*
This signal blocks the entire front panel operation of the instrument.

P — *P-Operation controller*
With this signal the controller is switched to P-operation.

PU — *Setpoint/program switching*
Control signal for connecting SHN in multiplpe setpoint mode (S1 = 1) or control signal for switching the program from P1 to P2 (only program controller 6DR1902/5, S1 = 5)

$\overline{tS}$ — *Setpoint ramp*
With this signal the set setpoint ramp time can be rendered ineffective ($\overline{tS}$ = High ≙ ramp switched off). Reset at S1 = 5 (program controller, transmitter)

tSH — *Setpoint change (setpoint ramp)*
The setpoint change is stopped with this signal. The setpoint change continues when the signal is reset.

± yBL — *Direction-dependent blocking of the manipulated variable*
Direction-dependent limiting of the manipulated variable by external signals, e.g. from the limit switches of the actuating drives. This limiting is effective in every operating mode.

3.4 Controller type (S1, S43 to S46)

3.4.1 General, recurrent functions

- **Manual setpoint preset wi or nominal ratio preset wvi on the control front panel.**

  The internal setpoint can always be adjusted with the keys (7), (8) when the green internal-LED (15) lights up and the setpoint is displayed by the switching key in the display (2). The signal lamp “w” then lights up. The adjusting facility is marked by ↗ in the tables. Exceptions to this rule are expressly mentioned in the individual controller types. The adjustment operates incrementally, in the first step with a resolution of 1 digit and then an adjustment progression so that major changes can also be performed quickly. After every interruption in the adjustment by releasing the keys, the progression starts again with the smallest adjustment step.

- **Setpoint preset wi or nominal ratio preset wvi by the SES**

  Whenever the internal setpoint can be adjusted by the k.eys (7), (8), presetting is also possible parallel to this by the SES. Since the SES can only adjust absolutely and not incrementally, it is advisable to use the setpoint ramp tS to avoid steps.

  In addition the control signal Int and the automatic-manual switching with the manual manipulated variable adjustment can be set by the SES so that a complete parallel process operation through the SES is possible (see also chapter 3.6, page 101).

- **Source for the external setpoint (S93)**

  The external setpoint w_E may come from two different sources depending on the controller type.

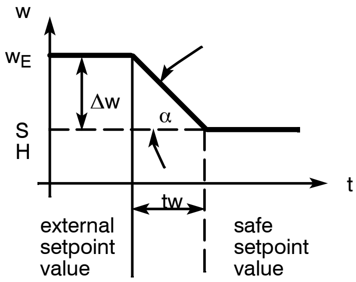
  external setpoint as absolute value via the analog inputs (w_{EA}) S93 = 0, 1, (4, 5)[1)] and
  external setpoint as an absolute value via the SES (w_{ES}) S93 = 2, 3

- **Setpoint ramp tS**

  With the parameter tS (oFPA), the adjustment speed of the active setpoint w (in the ratio controller S1 = 3 the active nominal ratio) can be set over 0 to 100 %. At tS = oFF the adjustment speed approaches ∞. With the control signal $\overline{\text{tS}}$ = 1 the set setpoint ramp is switched off (the setpoint then changes suddenly).

  With the setpoint ramp sudden setpoint steps to the untracked variables SH, wi, w_{ES} at S46 = 1 and w_{EA}, can be avoided.

1) as of software version –A5



$$\tan \alpha = \frac{100\ \%}{tS} = \frac{\Delta w}{tw}$$

$$t_w = \frac{\Delta w \cdot tS}{100\ \%}$$

Figure 3-4 Setpoint switching with ramp

- **Setpoint limits SA, SE**

  With the parameters SA and SE (oFPA) the effective setpoint w can be limited to minimum value (SA) and maximum value (SE) in the range from -10 to 110 %.

  Exception: Ratio controller (S1 = 3)

- **Tracking of the inactive setpoint to the active setpoint (S46)**

  Normally the ineffective setpoint is tracked to the effective setpoint so that the setpoint switching is bumpless. The internal setpoint (wi) and the external setpoint can be tracked via the SES (wES). The safety setpoint SH cannot be tracked.

  The external setpoint wEA through the analog inputs is only indirectly trackable by tracking the feeding instrument to the internal setpoint.

  Tracking is suppressed at S46 = 1. This switch position is always required especially in tracking controllers when the internal setpoint represents a kind of safety function or if a multiple setpoint mode is to be run in the fixed value controller (S1 = 0,1).

- **x-tracking (S44)**

  With the structure switch S44 = 1, x-tracking (ratio controller xv-tracking) can be switched on. This means that the setpoint is tracked to the actual value or the nominal ratio is tracked to the actual ratio and therefore a control difference xd is reset to 0. The tracking always takes place when there is no automatic operation ($\overline{A}$). This is the case in manual operation (H), tracking mode (N) and in operation with safety manipulated variable ys (Si).
  $\overline{A} = H \vee N \vee Si$

  x-tracking in direction-dependent blocking operation is not possible because the P-step produced by resetting the driving control error to blocking direction would immediately cancel the blocking.

  x-tracking takes place without the set setpoint ramp tS. By tracking the setpoint to the actual value (nominal ratio to actual ratio), the control difference xd = 0 and automatic operation starts absolutely bumplessly. Since it can normally be assumed, especially in manual mode, that the actual value has been driven to the desired value during manual operation, the tracked setpoint corresponds to the rated value.

  x-tracking is only fully effective when the tracking of the inactive setpoint is switched to the active setpoint (S46 = 0, 2) so that not only the active setpoint w but also the setpoint feed source after switching to automatic mode is tracked.

At S46 = 1 (without tracking) the control difference is 0 during the $\overline{A}$-operation but the old untracked setpoint becomes active again after switching to automatic mode. With the setpoint ramp tS this step-shaped setpoint change takes place via a time ramp.

This combination is always useful when it is not guaranteed during $\overline{A}$-operation (especially in safety mode) that the actual value will be driven to the desired rated value by the actuating manipulation and the tracking variable would not be correct in full x-tracking.

- **Constants c1 to c7**

Linking of the process variables with the constants is possible depending on the controller type, whereby the constants c1 to c3 are used for the control variable links, the constants c4 and c5 for the command variable links.

The constants are set in the parameterization mode onPA.

The constant c6 serves for proportioning the disturbance variable connection z to the controller output ya (see figure 3-9, page 71). It can be set in the parameterization mode onPA.

The constant c7 is used in P-controller operation as a factor for increasing the Kp-value. (P/PI-switchover, see figure 3-23, page 99).

- **Control signals for the setpoint switching**

If available in the individual controller types, the setpoint switching takes place depending on the control signals Int (internal/external key) and CB (computer standby) as an AND-function RC = $\overline{Int} \wedge CB$ and its negation. The status of the control signal CB and the internal key (13) is indicated by the $\overline{C}$ LED (14) and the internal LED (15).

In 5-setpoint operation (S1 = 1) the signal PU is used in an AND-operation in addition to the CB control signal to connect the values SHx.

With S43 the internal/external key (13) can be deactivated and blocked in the settings internal or external (see figure 3-3, page 57). The factory setting is S42 = 0 (only internal).

With S23, the CB-signal can be set to Low or High or assigned to a digital input, (see figure 3-2, page 56). The factory setting is S23 = 8, CB = High.

The setpoint switching can be varied freely with these structuring possibilities:

- **Actual value and setpoint display**

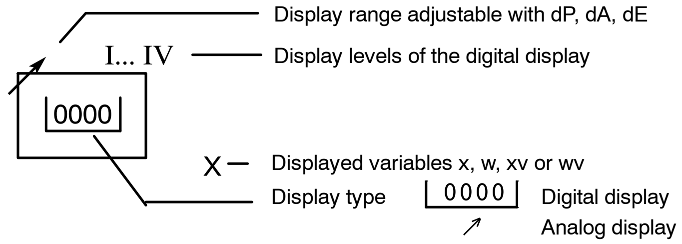
A red and a green 4-digit display are arranged on the front module. The red display is assigned to the actual value. The green digital display is used for displaying the setpoint, the manipulated variable y and the input variable x1 (S88). The display is switched over with the key (6) The scope of the display is set with structure switch S88. The type of displayed variable is indicated by the signal lamps (4) and (5) or the display Y.

The value before the setpoint ramp is displayed when presetting the setpoint with the keys (7), (8) and in x-tracking mode.

The difference between the active setpoint and the current actual value is the control difference xd or the control deviation xw = –xd. It is shown in the red analog display (3) as a column (S89). The display can be switched to other process values.

Certain display modes are assigned to the individual controlled types selected by S1. These are preset depending on S1 by S88. The meaning of the structure switch S88 is described assigned to the respective controller types.

The following symbols are used in the following block diagrams to simplify the representation for the “PV–X” and “SP-W”-digital display:



- **w-Display in operation with setpoint ramp**

The ring counter position I shows the momentary active w after the setpoint ramp. As long as the compensation between setpoint ramp input and output has not yet taken place, the decimal points indicate this as a moving direction-dependent display. During this phase, the valid decimal point can be read from the x-display.

By pressing both Δw-keys simultaneously the target setpoint (before the ramp) can be read. If the Δw-keys are active in the internal operating mode, the w-display before the setpoint ramp is switched with the first keypress, the adjustment action blocked for about 2 s in order to be able to read the value first. Then the normal progressive setting of wi is active. After releasing the Δw-key the value of the setpoint ramp is also displayed for approx. 2 s in order to give time to read the desired value for checking and to make fine adjustments if necessary. Otherwise a wrong target setpoint would be falsified by the current setpoint ramp.

At S1 = 4 the ±Δw-outputs are active without time delay.

- **Analog display**

  The red analog bar display can be assigned the control difference (or control error) or process variables (0 to 100 %) with the structure switch S89. The resolution of the control difference display can be set with S89. Since this variable is represented as a column and is bipolar, the zero value is displayed separately with a green LED.

  In the process variable display 1 or 2 marks/LEDs (caterpillar) light up alternately. The display has 20 light marks to 100 % which gives a resolution of 2.5 %.

- **Display range**

  The display range for the x- and w-display is set together with the parameter dP (decimal point), dA (start value) and dE (end value) in the structuring mode oFPA.

  With dA the numeric value to be displayed at calculated value 0 is set. With dE the numeric value to be displayed at calculated value 1 is set. With dP the decimal point is set as a fixed point. If the start value is set less than the end value, an increasing display is given with increasing arithmetic values and vice versa. The number range for the start and end values is -1999 to 9999, outside this range -oFL and oFL is displayed in overmodulation in the process operation level. The factory setting is 0.0 to 100.0 %.

  With the refresh rate parameter dr (onPA) the digital displays can be settled down in the case of restless process variables. Non-linear process variables can be represented physically correctly by the linearization.

  The display range set with dP, dA and dE is transferred depending on the controller type (S1) to the parameters and setpoints which can be assigned to the displayed variable:

  With the appropriate assignment, this also applies for the limit value alarms A1 to A4, see chapter 3.10.3, page 125.

y-display

The manipulated variable is displayed by the 4-digit green digital display “SP-W” (2). The value display has 3 digits. The first digit has a “y” for identification. The setting value is selected at Pos. II of the display using the Shift key or appears in manual mode (key (9) automatically (see also chapter 3.6, page 101).

When using as a process display (S1 = 4) the manipulated variable can also be shown in Pos. II in 4 digits (y-identification is not applicable).

3.4.2 Fixed value controller with 2 independent setpoints (S1 = 0)

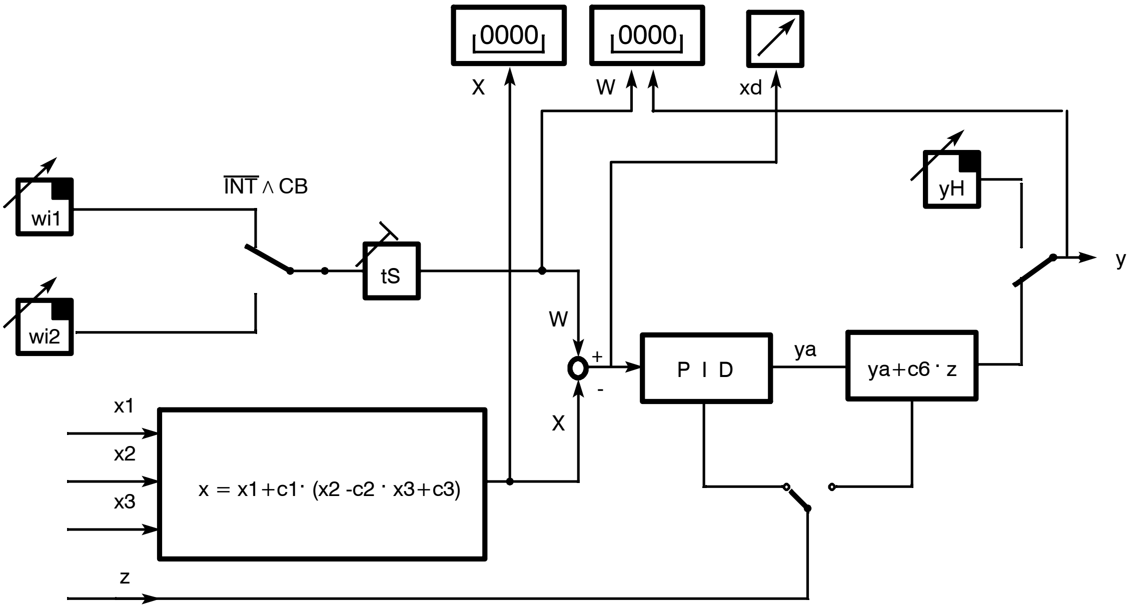


Figure 3-5 Principle representation S1 = 0

This controller type can be used as a fixed value controller with 2 independent setpoints (two batch operation) or by blocking the internal/external switching (factory setting) as a fixed value controller with one setpoint. By linking the inputs x1, x2, x3 with the constants c1, c2, c3 it can be used as a one-, two- or three-component controller.

Switching between the two setpoints which can be set separately on the front panel takes place dependent on the control signals Int and CB according to table 3-1, page 65. The effective setpoint is signalled by the LEDs internal and $\overline{C}$. wi2 becomes active as soon as a LED lights.

Control commands: Digital inputs		Control commands: Front	Alarm signals: Front LED			Alarm signals: Digital outputs			Active w at S44=		Explanations
H ∨ N ∨ Si	CB	internal	internal	$\overline{C}$		$\overline{RB}$	$\overline{RC}$		0	1	
0	1	0	0	0		0	0		wi1	wi1 (n)[1]	switchover with CB, Int=0 [2]; switchover with Int,CB=1
0	0	0	0	1		0	1		wi2	wi2 (n)	
0	1	1	1	0		1	1		wi2	wi2 (n)	
0	0	1	1	1		1	1		wi2	wi2 (n)	
1	1	0	0	0		0	0		wi1	x	switchover with CB,Int=0 [2]; switchover with Int,CB=1
1	0	0	0	1		0	1		wi2	x	
1	1	1	1	0		1	1		wi2	x	
1	0	1	1	1		1	1		wi2	x	

1) Tracking takes place at S46 = 0 and S44 = 1 to the controlled variable x, the tracking does not apply for switching wi1/wi2
at S46 = 1 automatic mode starts with wi = x (xd=0) via the setpoint ramp tS which may be set the active setpoint runs to the old setpoint.

2) Factory setting, fixed value controller with 1 setpoint (S43 = 0: only internal, Int = 1, S23 = 8: CB = 1) $\overline{RB}$ = Int
$\overline{RC} = \overline{Int} \wedge CB = Int \vee \overline{CB}$

(shaded) Factory setting

Table 3-1 Switching between wi1 and wi2

With the Shift key (6) the digital SP-W-display can be switched between the display levels I to IV depending on the position of S88.

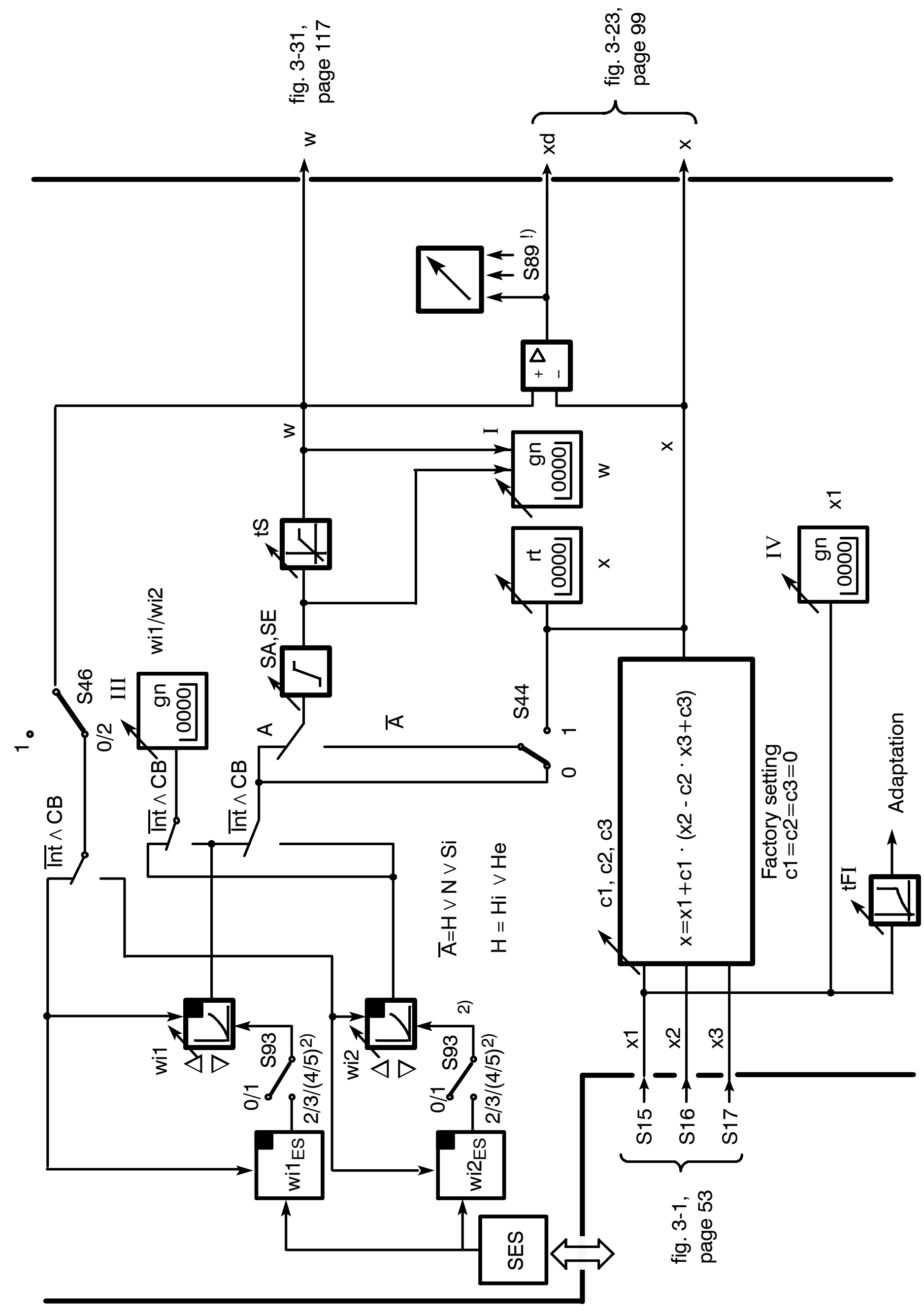
In display level II the active w can be displayed, in display level III the main control variable x1. The inactive setpoint is displayed in the display level IV. The displayed active or inactive setpoint can also be adjusted (see table 3-2).

The active setpoint- and actual value is displayed on the analog displays.

Structure switches		Position	Function				
	S88		**Order on the displays SP-W (2) and PV-X (1)**				
			Order on the display SP-W				Display PV-X
			I [1]	II	III [2]	IV	
		[0]	wi	y	–	–	x
		1	wi	y	wi	–	x
		2	wi	y	–	x1	x
		3	wi	y	wi	x1	x
			0	0	0	0.5	Signal lamp x
			1	0	0.5	0	Signal lamp w
			1 = steady, 0.5 = flashing, 0 = off				

1) Active wi1 or wi2
2) Inactive wi2 or wi1
The displayed setpoint wi can be adjusted. Switching of the active setpoint wi1/wi2, see table 3-1.

Table 3-2 Display functions SP-W and PV-X



Note: S52=4 is recommended for this controller

1) Other variables can be displayed analogly with S89

2) As of software version -A7

Figure 3-6 Block diagram S1 = 0, fixed setpoint controller with 2 independent setpoints

3.4.3 Fixed value controller with 5 independent internal setpoints (S1 = 1)

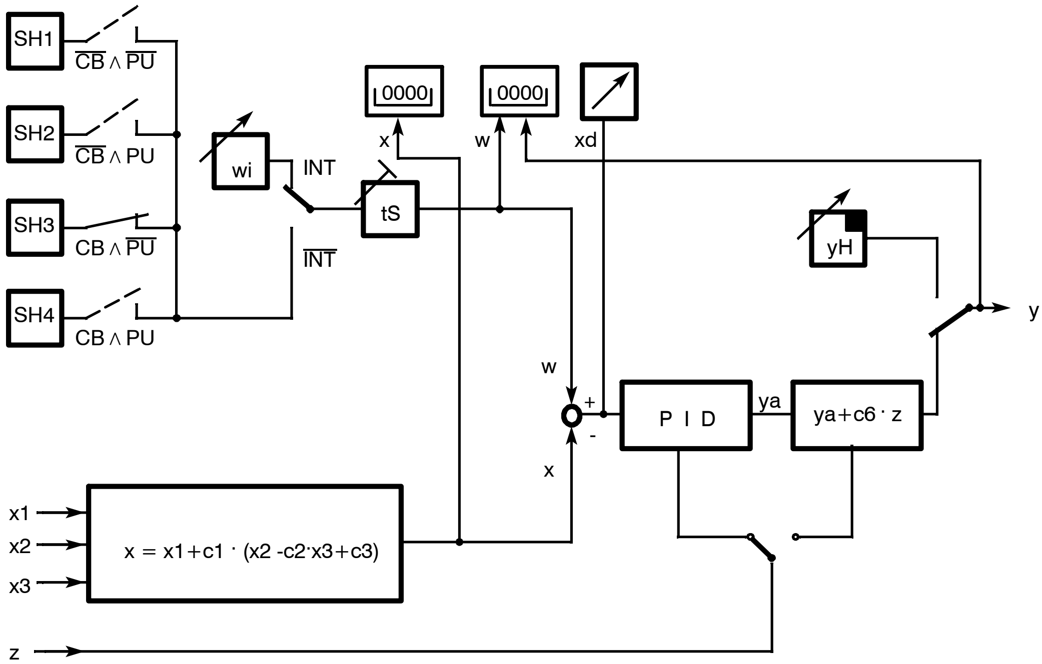


Figure 3-7 Principle representation S1 = 1

At PU = Low and CB = High (factory setting) you can switch between the setpoints wi and SH3 by internal/external switching. The AND-operation of the control signal CB with PU gives the 3 additional setpoints SH 1, 2, 4. The function of a fixed value controller with wi becomes active when internal/external switching is blocked. By linking the inputs x1, x2, x3 with the constants c1, c2, c3 it can be used as a one-, two- or three-component controller.

Switching between the two internal setpoints which can be set separately on the front panel takes place dependent on the control signals Int, CB and PU according to table 3-3, page 68. The active setpoint is signalled for wi by the LED internal. If S87 = 2 is structured, the setpoint SH1 to SH4 selected by the control signals CB and PU is displayed by LEDs L1 to L4. At LED Int off this setpoint is active.

Control signals				Message signals								active w at						Explanations	
Digital inputs			Front	Front LEDs						Digital outputs		S44 = 0			S44 = 1				
H ∨ N ∨ Si	CB	PU	Internal	Internal	$\overline{C}$	L1[4]	L2[4]	L3[4]	L4[4]	$\overline{RB}$	$\overline{RC}$	S46=0	S46=1	S46=2[1]	S46=0	S46=1	S46=2[1]		
0	0	0	1	1	1	1	0	0	0	1	1	wi(n,↗)	wi↗	wi(n,↗)	wi(n,↗)	wi↗	wi(n,↗)	Automatic-mode	wi
0	0	1	1	1	1	0	1	0	0	1	1	wi(n,↗)	wi↗	wi(n,↗)	wi(n,↗)	wi↗	wi(n,↗)		wi
0	1	0	1	1	0	0	0	1	0	1	1	wi(n,↗)	wi↗	wi(n,↗)	wi(n,↗)	wi↗	wi(n,↗)		wi
0	1	1	1	1	0	0	0	0	1	1	1	wi(n,↗)	wi↗	wi(n,↗)	wi(n,↗)	wi↗	wi(n,↗)		wi
0	0	0	0	0	1	1	0	0	0	0	1	SH1	SH1	SH1(n)	SH1	SH1	SH1		SH1
0	0	1	0	0	1	0	1	0	0	0	1	SH2	SH2	SH2(n)	SH2	SH2	SH2		SH2
0	1	0	0	0	0	0	0	1	0	0	0	SH3	SH3	SH3(n)	SH3	SH3	SH3		SH3
0	1	1	0	0	0	0	0	0	1	0	0	SH4	SH4	SH4(n)	SH4	SH4	SH4		SH4
1	0	0	1	1	1	1	0	0	0	1	1	wi(n,↗)	wi↗	wi(n,↗)	x	x[3]	x	Manual-, Tracking- or safety operation	
1	0	1	1	1	1	0	1	0	0	1	1	wi(n,↗)	wi↗	wi(n,↗)	x	x[3]	x		
1	1	0	1	1	0	0	0	1	0	1	1	wi(n,↗)	wi↗	wi(n,↗)	x	x[3]	x		
1	1	1	1	1	0	0	0	0	1	1	1	wi(n,↗)	wi↗	wi(n,↗)	x	x[3]	x		
1	0	0	0	0	1	1	0	0	0	0	1	SH1	SH1	SH1(n)	x[2]	x[3]	x		
1	0	1	0	0	1	0	1	0	0	0	1	SH2	SH2	SH2(n)	x[2]	x[3]	x		
1	1	0	0	0	0	0	0	1	0	0	0	SH3	SH3	SH3(n)	x[2]	x[3]	x		
1	1	1	0	0	0	0	0	0	1	0	0	SH4	SH4	SH4(n)	x[2]	x[3]	x		

1) Tracking of the auxiliary setpoints llows adjustment of SH1 = 4 in the process operation level. Select SH* by CB and PU, switch to Int and set wi to the desired value. Due to the tracking the adjusted wi is then active as a new auxiliary setpoint after sqwitching with Ext and is then also displayed in onPA with the new value.

2) x-tracking without tracking of the auxiliary setpoints in this case to x only sets the control difference during the $\overline{A}$-operation to zero, after switching to automatic mode, the auxiliary setpoints set in onPA are active again! (Only useful in connection with the setpoint ramp). In $\overline{A}$-operation and internal xd = 0 also becomes active after switching to automatic mode by tracking from wi to x.

3) x-tracking without tracking of the setpoints wi and SH* to x only sets xd during the $\overline{A}$-operation to zero, after switching to automatic mode, the untracked variables become active again!

4) Only if S87 = 2

(grey shading) Factory setting

Table 3-3 S1 = 1 fixed value-/three-component controller with 5 setpoints

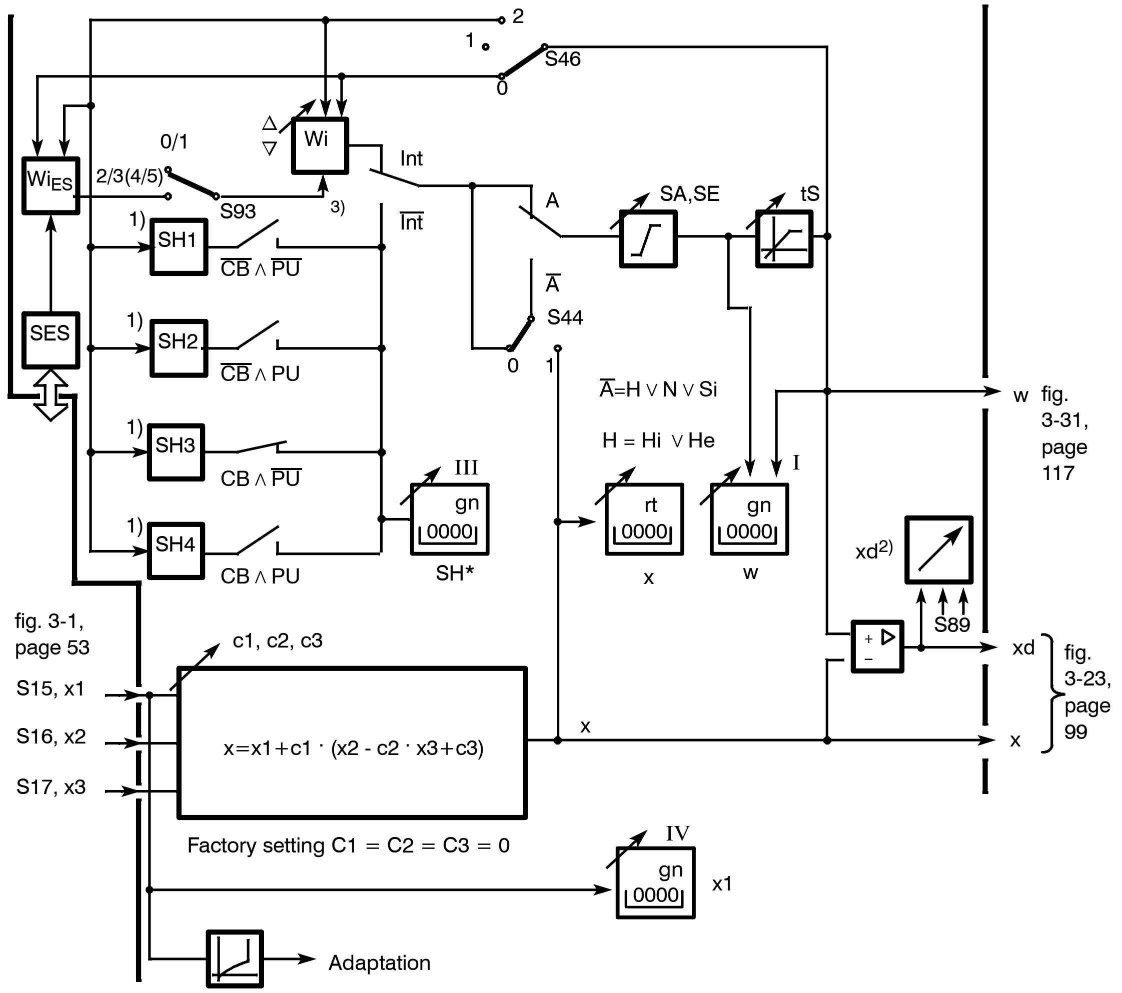
With the Shift key (6) the digital SP-W-display (2) can be switched between the display levels I to IV depending on the position of S88.

With S87 the display order of the SP-W-display can be extended by A1 to A4.

Structure switches		**Posi-tion**	**Function**				
	S88		**Order on the displays SP-W (2) and PV-X (1)**				
			Order on the display SP-W				Display PV-X
			I [1]	II	III [2]	IV	
		[0]	wi/SH*	y	–	–	x
		1	wi	y	SH*	–	x
		2	wi/SH*	y	–	x1	x
		3	wi/SH*	y	SH*	x1	x
			0	0	0	0.5	Signal lamp x
			1	0	0.5	0	Signal lamp w
			1 = steady, 0.5 = flashing, 0 = off				

[1] Active wi1 or wi2
SH* = the auxiliary setpoint SH1 to SH4 selected by CB and PU

Table 3-4 Display functions SP-W and PV-X



1) Tracked to w, only the SH* selected by CB and PU
2) Other variables can be displayed analogly with S89
3) As of software version -A7

Figure 3-8 Block diagram S1 = 1, fixed setpoint-/three component controller with 5 setpoints

3.4.4 Sequence controller, synchronized controller, SPC-controller with internal/external switching (S1 = 2)

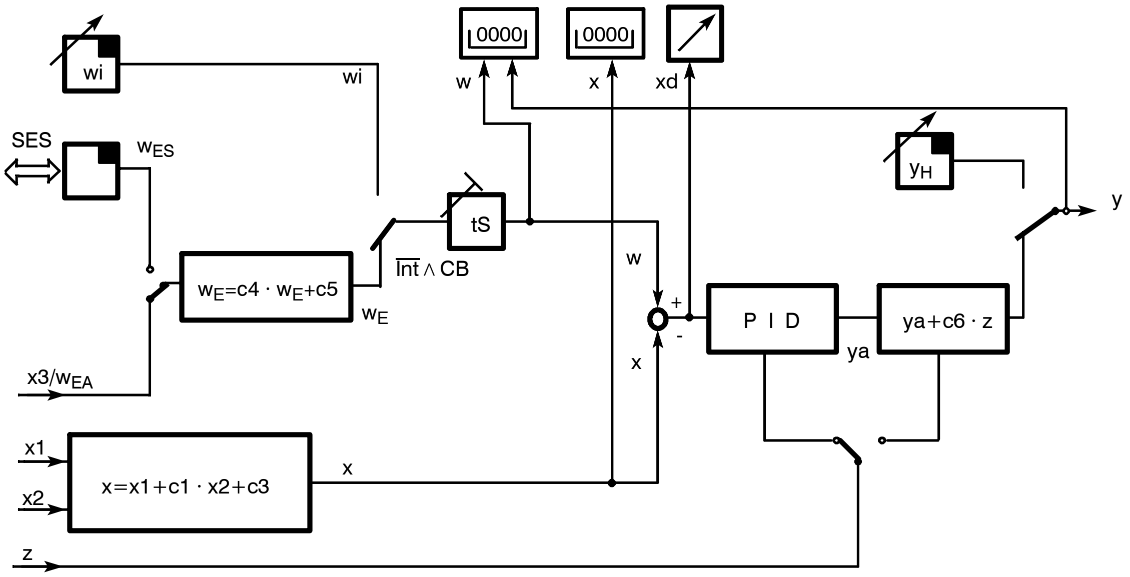


Figure 3-9 Principle representation S1 = 2

In this type of controller you can switch between the internal setpoint wi and the external setpoint w_E depending on the control signals CB and the internal/external key (13) (see table 3-5, Seite 73 and table 3-6, page 74).

The external setpoint can be preset by the analog input w_{EA} or by SES (w_{ES}) (selection by S93).

This controller type is used for cascade controls with 2 separate controllers (master and sequence controllers), for synchronized controls, fixed setpoint controls with external setpoint preset under console conditions with external setpoint potentiometer and SPC-controls (setpoint control).

- **SPC-controls**

  Here a process computer takes over command of the setpoint during computer operation RC = $\overline{Int} \wedge CB = 1$. In the case of computer failure (CB from 1 → 0) the controller adopts either the last computer setpoint (tracked wi) or the safety setpoint SH (selection by S45).

- **Cascade controls**

  A command controller, e.g. a fixed value controller (with the main control variable) feeds the external setpoint of a sequence controller (with the auxiliary control variable, disturbance variable) and this the actuator. This gives faster control of the main controlled variable in the event of changes in the auxiliary controlled variable, e.g. furnace temperature control (furnace temperature, main controlled variable) with different flow of the medium to be heated (auxiliary controlled variable).

- **Synchronized controls**

  A command controller feeds several synchronized controllers simultaneously whose individual setpoints can be set in a ratio to each other by the constants c4 and c5 and then drag the controlled variables accordingly (controlled variable synchronization).

- **Control signals for the setpoint switching**

  The setpoint switching takes place via the logic link RC = $\overline{\mathrm{Int}} \wedge \mathrm{CB}$ and its negation (see table 3-5, page 73 and table 3-6, page 74). Both control signals can be set in addition to their normal function as Shift key or control signal with the states 1 and 0 statically to 1 or 0 (Int via S43, CB via S23), see figure 3-2, page 56 and figure 3-3, page 57.

  The factory setting is Int = 1 (S43 = 0) and CB=1 (S23 = 8), **so that in the factory setting the internal setpoint wi is always active and cannot be switched!**

  This setting possibility enables you to perform the switching only dependent on Int (S43=2, S23=8) or only dependent on CB (S43=1, S23=1 to 7) as a sequence controller with internal/external switching. If the switching possibility is blocked in external position (S43=1, S23=8), the controller operates as a sequence controller without internal/external switching.

- **Display of the external setpoint w_E**

  With the Shift key (6) you can switch in display level III from digital SP-W-display to the external setpoint w_E and in display level IV to the main controlled variable x1. The active setpoint is displayed in display levelI (S88). The active actual value is displayed on the digital PV-X-display.

  The x/w LEDs signal the display level.

- **Operation with 2 or 3 setpoints**

  If the tracking of the inactive setpoint to the active setpoint has been suppressed with S46 = 1, a multiple setpoint operation is achieved (switching between wi, w_E and SH (see table 3-5, page 73 and table 3-6, page 74).

- **Controlled variable processing**

  A 2-component control is implemented (disturbance variable connection). With factors c1 and c3 the main controlled variable x1 can connect the auxiliary controlled variable x2 with weighting.

Control signals			Message signals				active w at				Explanations	Computer -failure
Digital inputs		Front	Front		Digital outputs							
H ∨ N ∨ Si	CB 1)	Internal	Internal LED	$\overline{C}$ LED	$\overline{RB}$ 4)	$\overline{RC}$ 4)	S44=0 S45=0	S44=1 S45=0	S44=0 S44=1	S44=1 S45=1		
0	1	0	0	0	0	0	$w_E(n)$ 2)		$w_E(n)$ 2)		Automatic mode, SPC-mode	↓
0	0	0	0	1	0	1	wi(n, ↗)		SH1 3) or wi(n, ↗)		Automatic mode, computer switched off, computer in SPC-standby	
0	1	1	1	0	1	1	wi(n, ↗)		wi(n, ↗)		Automatic mode, computer on standby, controller not in SPC-standby 5)	
0	0	1	1	1	1	1	wi(n, ↗)		wi(n, ↗)		Automatic mode, computer switched off, computer in SPC-standby	
1	1	0	0	0	0	0	w_E (n) 2)	x	w_E (n) 2)	x	Manual-, tracking- or safety mode 5)	
1	0	0	0	1	0	1	wi (n, ↗)	x	SH 3) or wi (n, ↗)	x		
1	1	1	1	0	1	1	wi (n, ↗)	x	wi (n, ↗)	x		
1	0	1	1	1	1	1	wi (n, ↗)	x	wi (n, ↗)	x		

1) The table is shown for static CB-switching without acknowledgement (S42 = 0).
2) Source for w_E at S93 = 0, 1, (4, 5 as of software version -A7) w_{EA} or at S93 = 2, 3 w_{ES} (SES). The external setpoint fed in through the SES (w_{ES}) is tracked. Tracking is not possible when the external setpoint is fed in via w_{EA}.
3) SH can only be reached after w_E, if Int = 0 and CB goes from 1 → 0 (computer failure). If CB = 0 and Int is switched from 1 → 0, wi is still active. Since SH is not tracked, SH1 can be switched to with the setpoint ramp tS.
4) By OR-linking with the digital outputs H, N and the control signal Si no computer standby or computer operation can be signaled in manual-, tracking- or safety operation.
5) Factory setting
(n) tracked to the value active before switching, therefore bumpless switching
↗ adjustable
(shaded) Factory setting

Table 3-5 Sequence-/synchronized-/SPC-controller with internal/external switching S1 = 2 with tracking of the inactive setpoint to the active S46 = 0

Control signals			Message signals				active w at				Explanations
Digital inputs		Front	Front		Digital outputs						
H ∨ N ∨ Si	CB [1]	Internal	Internal LED	$\overline{C}$ LED	$\overline{RB}$ [4]	$\overline{RC}$ [4]	S44=0 S45=0	S44=1 S45=0	S44=0 S45=1	S44=1 S45=1	
0	1	0	0	0	0	0	w_E[2]		w_E[2]		Automatic mode [5]
0	0	0	0	1	0	1	wi(↗)		SH1[3] or wi(↗)		
0	1	1	1	0	1	1	wi(↗)		wi(↗)		
0	0	1	1	1	1	1	wi(↗)		wi,↗)		
1	1	0	0	0	0	0	w_E[2]	x	w_E[2]	x	Manual-, tracking- or safety mode [5]
1	0	0	0	1	0	1	wi(↗)	x	SH[3] or wi(↗)	x	
1	1	1	1	0	1	1	wi(↗)	x	wi(↗)	x	
1	0	1	1	1	1	1	wi(↗)	x	wi(↗)	x	

1) The table is shown for static computer switching without acknowledgement (S42 = 0).
2) Source for w_E at S93 = 0, 1, (4, 5 as of software version -A7) w_{EA} or at S93 = 2, 3 w_{ES}. Switching between the setpoints can take place with the setpoint ramp tS.
3) SH can only be reached after w_E, if Int = 0 and CB goes from 1 → 0 (computer failure). If CB = 0 and Int is switched from 1 → 0, wi is still active. Since SH is not tracked, SH1 can be switched to with the setpoint ramp tS.
4) By OR-linking with the digital outputs H, N and the control signal Si no computer standby or computer operation can be signaled in manual-, tracking- or safety operation.
5) Factory setting
↗ adjustable
(shaded) Factory setting

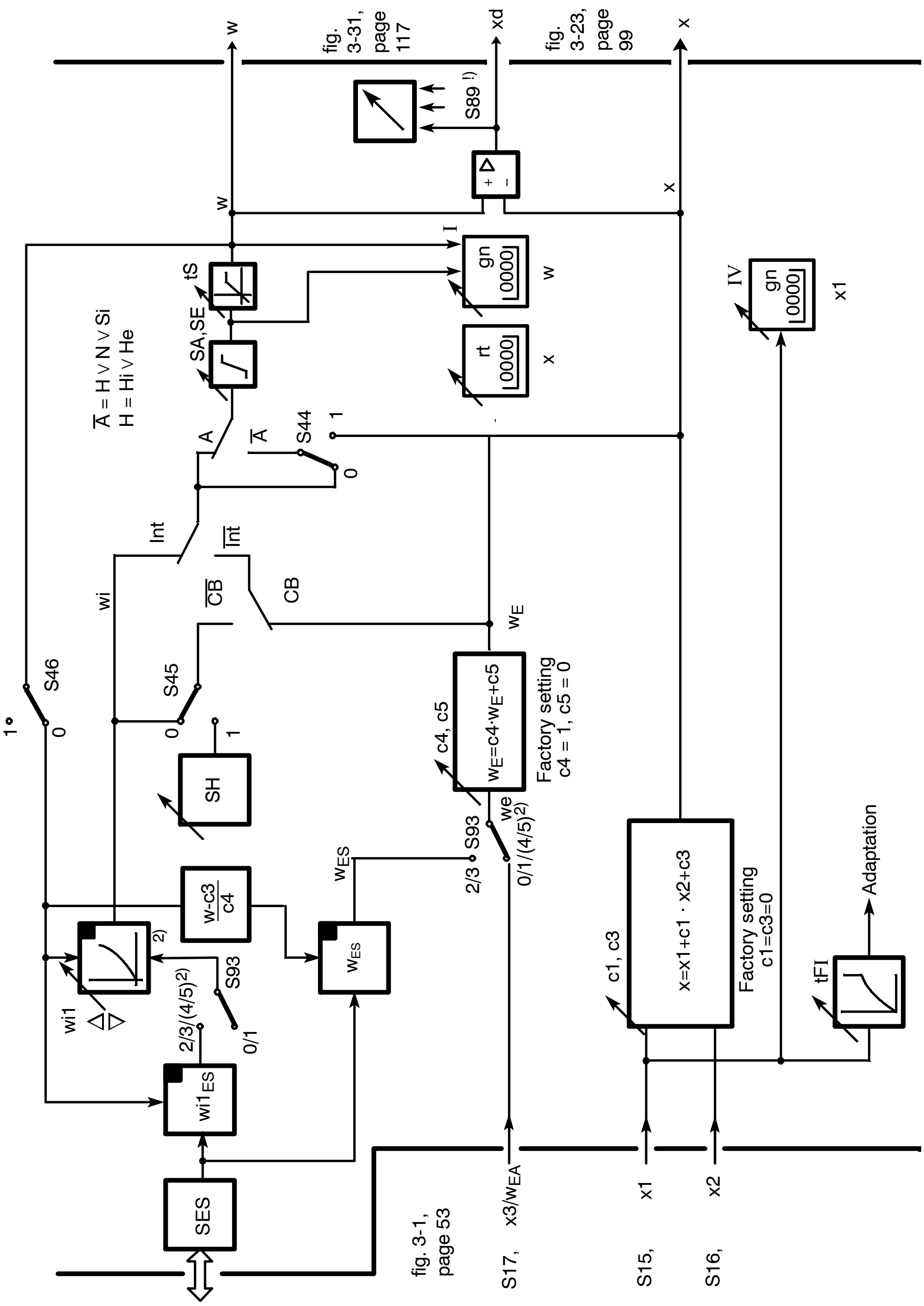
Table 3-6 Sequence-/synchronized-/SPC-controller with internal/external (SPC-controller), S1 = 2 without tracking of the active setpoint to the active S46 = 1, 2 or 3 setpoint operation

With the Shift key (6) the digital SP-W-display can be switched between the display levels I to IV depending on the position of S88. With S87 the display order of the SP-W-display can be extended by A1 to A4.

Structure switches		Position	Function				
	S88		**Order on the displays SP-W (2) and PV-X (1)**				
			Order on the display SP-W				Display PV-X
			I [1]	II	III [2]	IV	
		[0]	w	y	–	–	x
		1	w	y	w_E	–	x
		2	w	y	–	x1	x
		3	w	y	w_E	x1	x
			0	0	0	0.5	Signal lamp x
			1	0	0.5	0	Signal lamp w
			1 = steady, 0.5 = flashing, 0 = off				

1) active w

Table 3-7 Display functions SP-W and PV-X



Note: S52 = 4 is recommended for this controller

1) Other variables can be displayed analogly with S89
2) As of software version -A7

Figure 3-10 Block diagram S1 = 2 sequence controller, synchronized controller, SPC controller

3.4.5 Controlled ratio controller (S1 = 3)

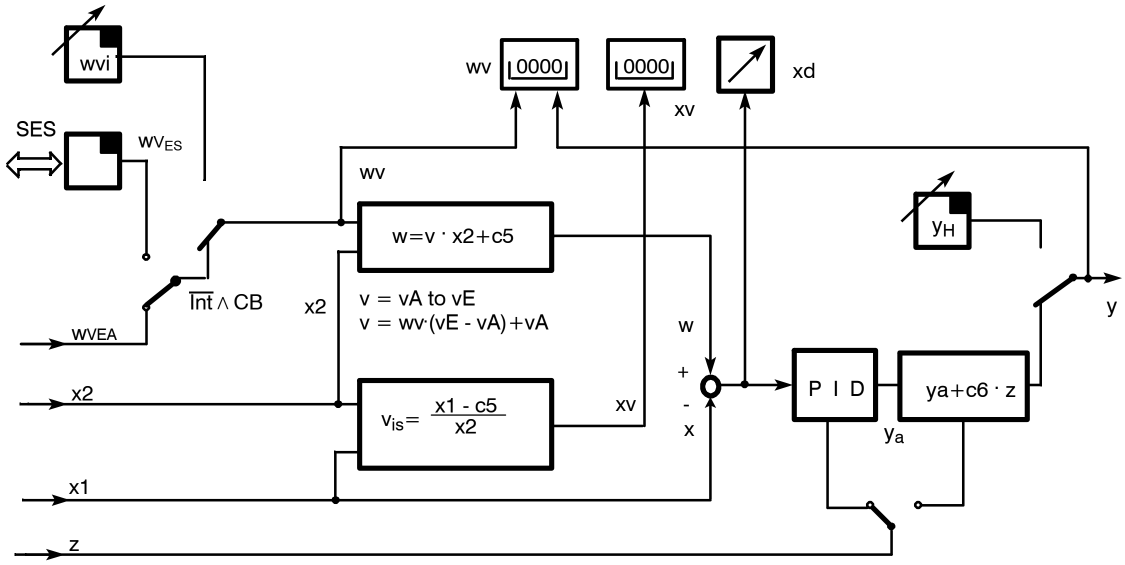


Figure 3-11 Principle representation S1 = 3

In a ration control the commanding process variable x2 is weighted with the adjustable ratio factor and a basic value c5 added if necessary. The result forms the setpoint w for the following controlled process variable x1.

$$w = v \cdot x2 + c5$$

With $xd = w - x1$ the result is $xd = v \cdot x2 + c5 - x1$

In the controlled state (xd = 0) the result is $v = \frac{x1 - c5}{x2}$, i.e. in the controlled state and at c5 = 0 $\frac{x1}{x2}$ behaves according to the set ratio factor v.

A typical application are combustion rules where a fuel volume x1 beongs to every air volume x2 to guarantee optimum combustion.

The ratio factor range v = vA to vE is determined with the parameters vA and vE in the structuring mode oFPA in the range from 0.0 to 9.999 (factory setting vA = 0, vE = 1). In addition a basic value c5 (parameterization mode onPA) can be connected in the range from -1.999 to 9.999 (factory setting = 0.0).

The standardized nominal ratio wv (wvi or wv_E) in the range from 0 to 1 is converted to the ratio factor range.

$$v = wv\ (vE - vA) + vA$$

With w = v · x2 + c5 w = [wv (vE - vA) + vA] x2 + c5 is given

With the Shift key (6) the digital SP-W-display can be switched between the display levels I to IV depending on the position of S88.

		Posi-tion	Function								
		S88	**Order on the displays SP-W (2) and PV-X (1)**								
			Order on the display SP-W				Display PV-X				
			I [1)]	II	III [2)]	IV	I [1)]	II	III [2)]	IV	
		[0]	wv	y	–	–	xv	xv	–	–	
		1	wv	y	–	w [1)]	xv	xv	–	x [1)]	
		2	wv	y	wv_E	–	xv	xv	xv	–	
		3	wv	y	wv_E	w [1)]	xv	xv	xv	x [1)]	
			0	0	0	1	0	0	0	1	Signal lamp x
			1	0	0.5	1	1	0	0.5	1	Signal lamp w
			1 = steady, 0.5 = flashing, 0 = off								

1) Display in xxx.x %

Table 3-8 SP-W and PV-X-display switching

(With structure switch S87 the display order of the SP-W-display can be extended by A1 to A4.)

In order to be able to display important variables for the process, both digital displays are switched together with the Shift key (6). In the ratio controller the standardized setpoint wy and the standardized actual ratio xy is displayed on the digital displays SP-W and PV-X in the display levels I. A physical display is possible with dA, dE, dP. The controlled variable x1 and the evaluated commanding process variable w can be displayed in the display level IV in percent. A direct control difference observation is possible with the analog display.

With the Shift key (6) the digital SP-W-display can be switched to the external nominal ratio wv_E (display level III). The digital PV-X-display shows the actual ratio xy in the display levels I to III Switching between wvi and wvE takes place in the same way as in the sequence controller S1 = 1.

The manipulated variable output y of the controller is shown in the display level II of the SP-W-display.

The actual ratio is gained by back calculating the ratio formula with the current process variables x1, x2:

$$v_{is} = \frac{x1\text{-}c5}{x2}$$

with $v_{ist} = xv\ (vE - vA) + vA$ the result is for $xv = \frac{v_{is}\text{-}vA}{vE\text{-}vA}$ or $xv = \frac{\frac{x1\text{-}c5}{x2} - vA}{vE\text{-}vA}$

xv is displayed and is required for x-tracking-mode. For the xv-display, x1 and x2 are limited to +0.5 % so that the display does not become too restless for small x1 and x2 or flip from positive to negative in the case of negative x2. The linearization of the commanding process variable x2 or the following process variable x1 is possible (S21).

The linearization then acts on the analog displays and the ratio formation and therefore also indirectly on the digital displays for nominal and actual ratio. The ratio controller has no nominal ratio limiting because the ratio factor range already marks the limit.

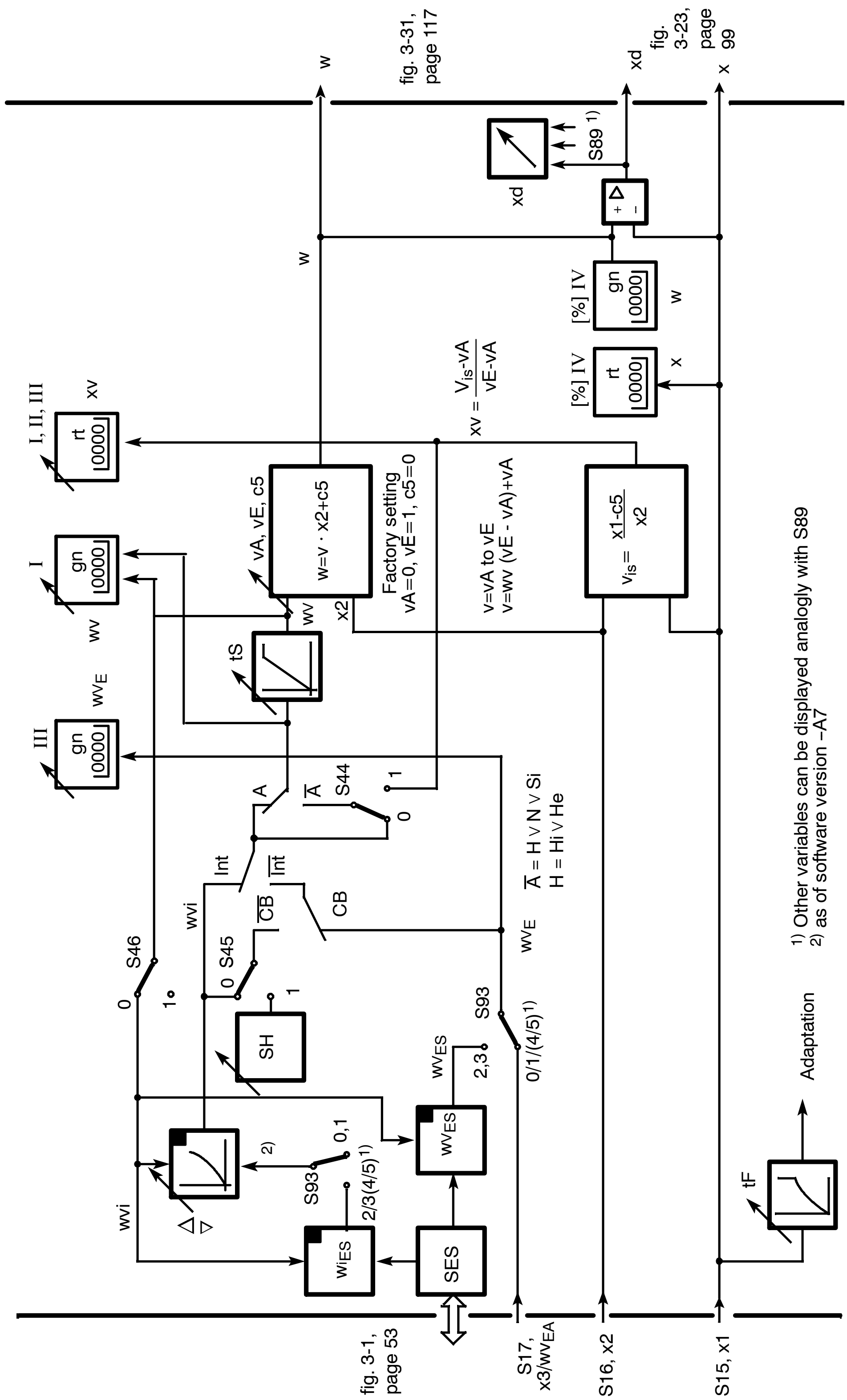


Figure 3-12 Block diagram S1 = 3 controlled ratio controller

The ratio controller behaves like the sequence controller S1 = 1 with respect to switching of the setpoint ratio wv so that the information and tables there apply accordingly. The variables wi and w_E must be replaced by wvi and wv_E. This controller type can therefore be used as a ratio controller with a fixed ratio (manually adjustable) or with commanded ratio factor.

A fixed ratio factor is used for example in simple combustion controls (see example) where the ratio factor is reset manually when fuels are changed. If it is possible to measure the effects of the ratio factor (combustion quality, pollutants in the flue gas) a commanded ratio controller is used. Here a master controller adjusts the ratio factor (ratio cascade) with the combustion quality as a control variable.

Another application for ratio cascades are concentration controls, e.g. pH value controls. The pH value is the controlled variable of the command controller, the supply of alkali and acid the commanded process variable and the following (controlled) process variable of the ratio controller.

- **Example of a ratio control**

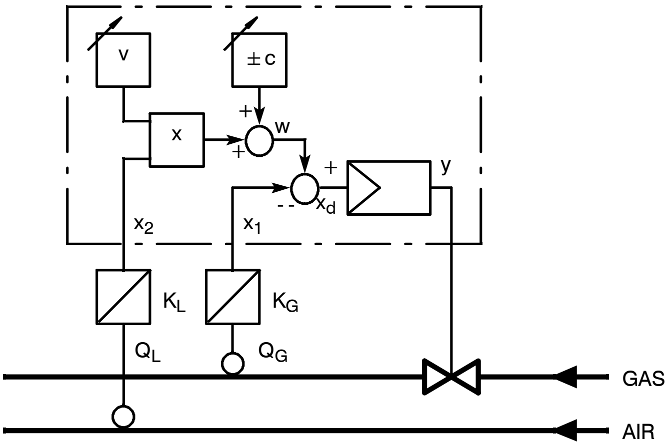


Figure 3-13 Control diagram ratio control

In a combustion control the air/gas flow should be in a constant ratio. The command variable (commanding process variable) is the air flow Q_L which is preset in the range 0 to 12000 m^3/h as a signal 4 to 20 mA. The controlled variable (following process variable) is the gas flow Q_G with a measuring range 0 to 3000 m^3/h which is also available as a 4 to 20 mA signal. In an ideal combustion the air-/gas ratio is

$$L_{\emptyset\, ideal} = \frac{Q_L}{Q_G} = 4.$$

$$\frac{Q_L}{Q_G} = L_\emptyset \cdot \lambda$$

The air factor λ is then 1 and should be adjustable in the range from 0.75 to 1.25 on the controller.

The ratio factor v (at xd = 0) is determined partly by the transmission factors K of the transmitters (measuring ranges).

$x_1 = Q_G \cdot K_G$ with the values from the example $K_G = \dfrac{100\ \%}{3{,}000\ m^3/h}$

$x_2 = Q_L \cdot K_L$ $\qquad K_L = \dfrac{100\ \%}{12{,}000\ m^3/h}$

$$v = \frac{x_1}{x_2} = \frac{Q_G}{Q_L} \cdot \frac{K_G}{K_L} \quad \text{with} \quad \frac{Q_G}{Q_L} = \frac{1}{L_\emptyset \cdot \lambda}$$

$$v = \frac{1}{L_\emptyset \cdot \lambda} \cdot \frac{K_G}{K_L}$$

With the values from the example

$$v = \frac{1}{\lambda} \cdot \frac{1}{4} \cdot \frac{100\ \% \cdot h \cdot 12{,}000\ m^3}{3{,}000\ m^3 \cdot 100\ \% \cdot h}$$

is given $v = \frac{1}{\lambda}$ i.e. the transmitter measuring ranges have been chosen so that

$\dfrac{K_G}{K_L} = \dfrac{1}{L_\emptyset}$ corresponds to.

The desired adjustment range of λ gives:

$$vA = \frac{1}{\lambda_E} = \frac{1}{1.25} = 0.8 \qquad vE = \frac{1}{\lambda_A} = \frac{1}{0.75} = 1.333$$

vA and vE are set in the structuring mode oFPA. By setting the nominal ratio wv from 0 to 1 the ratio factor v can now be adjusted from 0.8 to 1.33 or the air factor λ from 1.25 to 0.75.

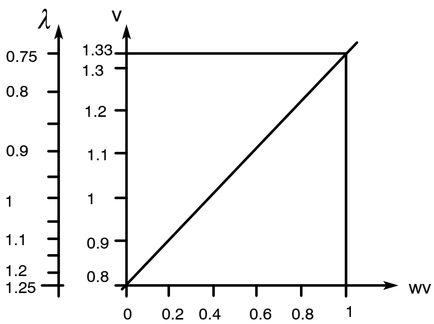
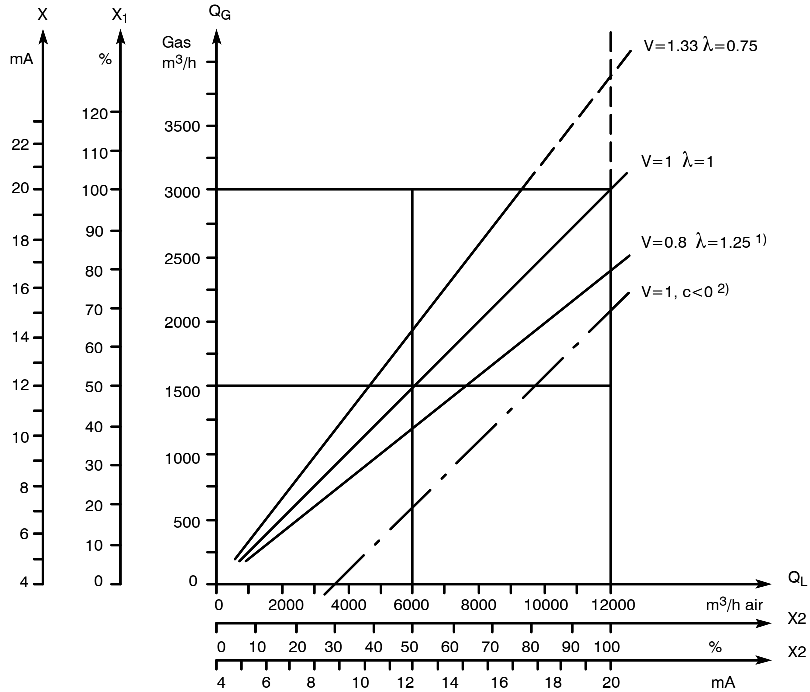


Figure 3-14 Relationship ratio factor v and air factor λ to standardized nominal ratio wv

If the combustion is also to take place at small flow volumes with excess air, the constant c must be set negative. Figure 3-15 shows the gas/air ratio in the controlled state at different air factors λ and c = 0 as well as at λ = 1 and c < 0, i.e. with excess air.



1) Constant gas/air-ratio
2) Gas/air-ratio with additional excess air

Figure 3-15 Display of gas-/air ratio in controlled status

3.4.6 Control unit/process display (S1 = 4)

The following functions are possible in this configuration: Process display and control unit. The configuration is identical for both applications. The input wiring for both is illustrated in figure 3-16.

- **Process display, two-channel digital display**
  (S93 = 0/1 and S43 = 1) see figure 3-16, page 83
  A process variable is assigned to the green SP-W-digital display by w_{EA} and the other variable to the red PV-X-digital display by x1. S88 = 2 must be configured to ensure both variables are displayed. The variables are displayed as physical values. If you want the value displayed in % instead of the physical display, the variable is assigned at S88 = 3 to the SP-W-display through the y_R-input.

  The physical display is determined for both displays together with the offline parameters dP, dA, dE.

  The linearizer (S21) which can be assigned to an analog input has a direct effect on the display.

  The control difference xd is displayed in factory setting on the red analog display, other variables can be displayed with S89.

- **Process display, single-channel digital display and displayed limit values**
  see fig. 3-16, page 83

  In the structure switch position S88 = 4, the green SP-W-display is dark. It is useful here to call the limit values [%] additionally in the display with the Shift key, e.g. via S87 = 3 to 6. The limit value no. and exceeding of the limit value are indicated by LEDs (17).

  The display in the red PV-X-display is fed through the x2 input. The change in the characteristic which is possible by linearization is also displayed here.

  The control difference xd is displayed in factory setting on the red analog display, other variables can be displayed with S89.

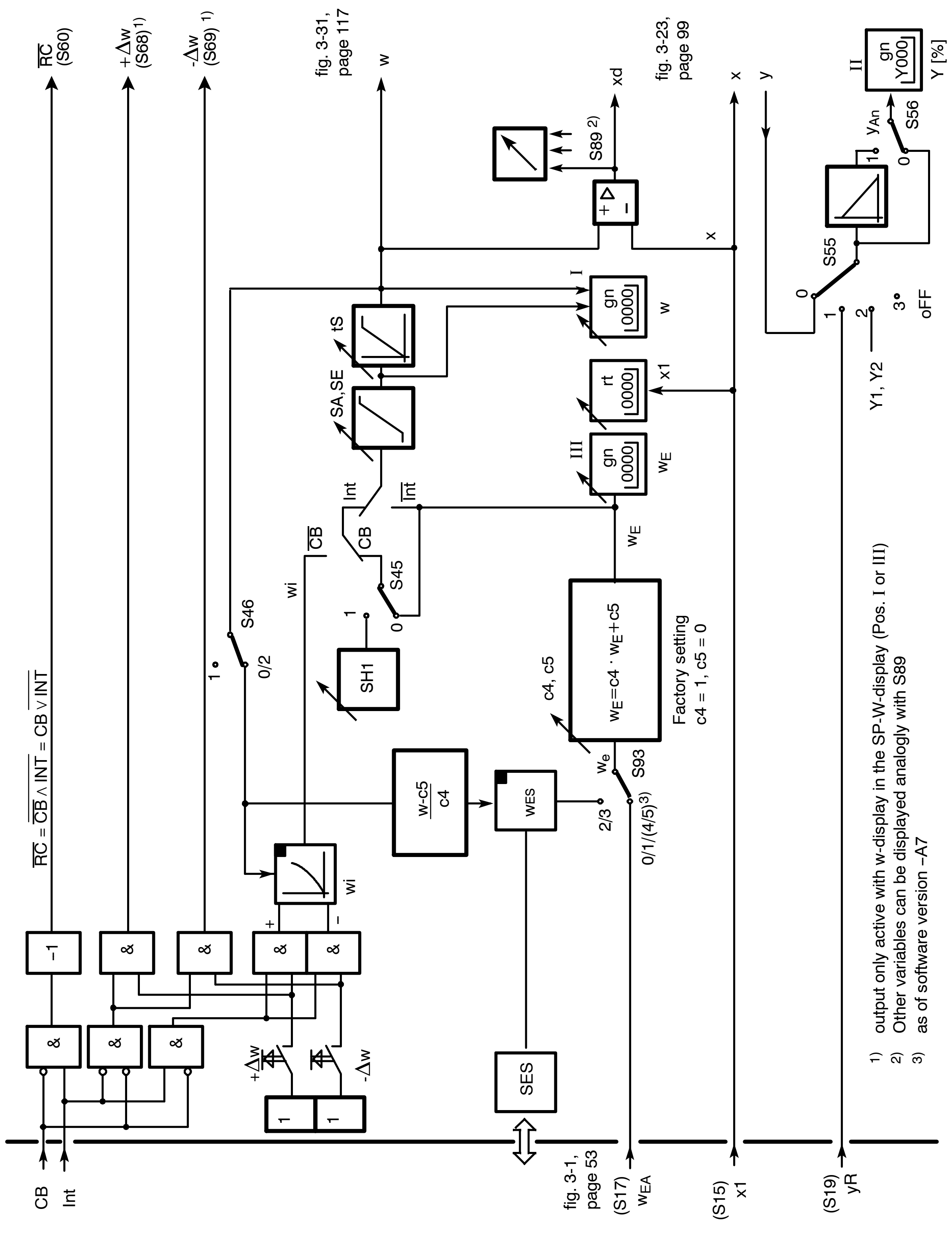


Figure 3-16 Block diagram control unit/process display (S1 = 4) setpoint potentiometer S/K, manual control instrument S/K

- **Control units**

The integrated control unit function always includes a setpoint potentiometer and a manual control instrument in the following versions:

– trackable K-setpoint potentiometer
– S-setpoint potentiometer
– trackable K-manual control instrument (S2 = 0)
– S-two-position control unit with 2 outputs (heating/cooling) (S2 = 1)
– S-three-position manual control unit internal feedback (S2 = 2)
– S-three-position manual control unit external feedback (S2 = 3)

The ability to combine setpoint potentiometer and manual control instrument type depends on the application. Either the setpoint potentiometer or the manual control instrument can use the K-output, the remaining function must have an S-output.

- **Setpoint potentiometer**
see fig. 3-16, page 83

S- and K-setpoint potentiometers are installed parallel. In the S-setpoint potentiometer the switching outputs $\pm\Delta w$ can be locked depending on the internal key (13) and the control signal CB, the status message is indicated by the signal lamps Int and $\overline{C}$, see table 3-9, page 85. The setpoint adjusted incrementally by the switching outputs is fed back via the w-display (input w_{EA}, switching is blocked in position Ext, S43 = 1).

In the K setpoint potentiometer the tracking of the internal setpoint is controlled dependent on the internal key (13) and the control signal CB, see table 3-9. The tracking variable is fed in via w_{EA}. The active setpoint is output by the assignment of w to the analog output AO (S57 = 2/3).

It is also possible to display the actual value as in the normal controller.

Control signals		Message signals				active w at		Effect of the ± Δw-keys on		wired or Int ∨ CB
Digital inputs	Front	Front		Digital outputs						
CB[1]	Inter-nal	Inter-nal LED	$\overline{C}$ LED	$\overline{RB}$	$\overline{RC}$[5]	S45=0	S45=1	wi	± Δw/BA	
0	0	0	1	0	1	[3] we(n)[2]	[3] we(n)[2]	no	yes	0[7]
1	0	0	0	0	1	[3] we(n)[2]	[3] we(n)[2]	no	no	1
0	1	1	1	1	0	[3] wi(n, ↗)	[3] wi(n, ↗)	yes	no	1
1[6]	1[6]	1[6]	0[6]	1[6]	1[6]	[3] we(n)[2][6]	SH[4][6]	no[6]	no[6]	1[6]

1) The table is shown for static CB-switching without acknowledgement (S42 = 0).
2) Source for w_E at S93 = 0, 1, (4, 5 as of software version -A7) the analog value w_{EA}, which is assigned via S17 or at S93 = 2, 3 w_{ES} which is fed in through the SES.
3) Tracking only takes place at S46=0 and only w_{ES} and wi to the active setpoint. When feeding in via w_{EA} the feeding instrument must be tracked.
4) Only to be used as a flag pointer when no analog feedback is possible from the fed instrument.
5) $\overline{RC}$ = no K-setpoint potentiometer operation, wi not adjustable.
6) Factory setting
7) Wired-or-connection of Int = $\overline{RB}$ and CB supplies Int ∨ CB
No S-setpoint optentiometer operation, Δw-keys not active
(n) Tracked to the value active before switching
↗ adjustable

Table 3-9 Setpoint switching setpoint potentiometer S/K, S1 = 4 process display/control unit

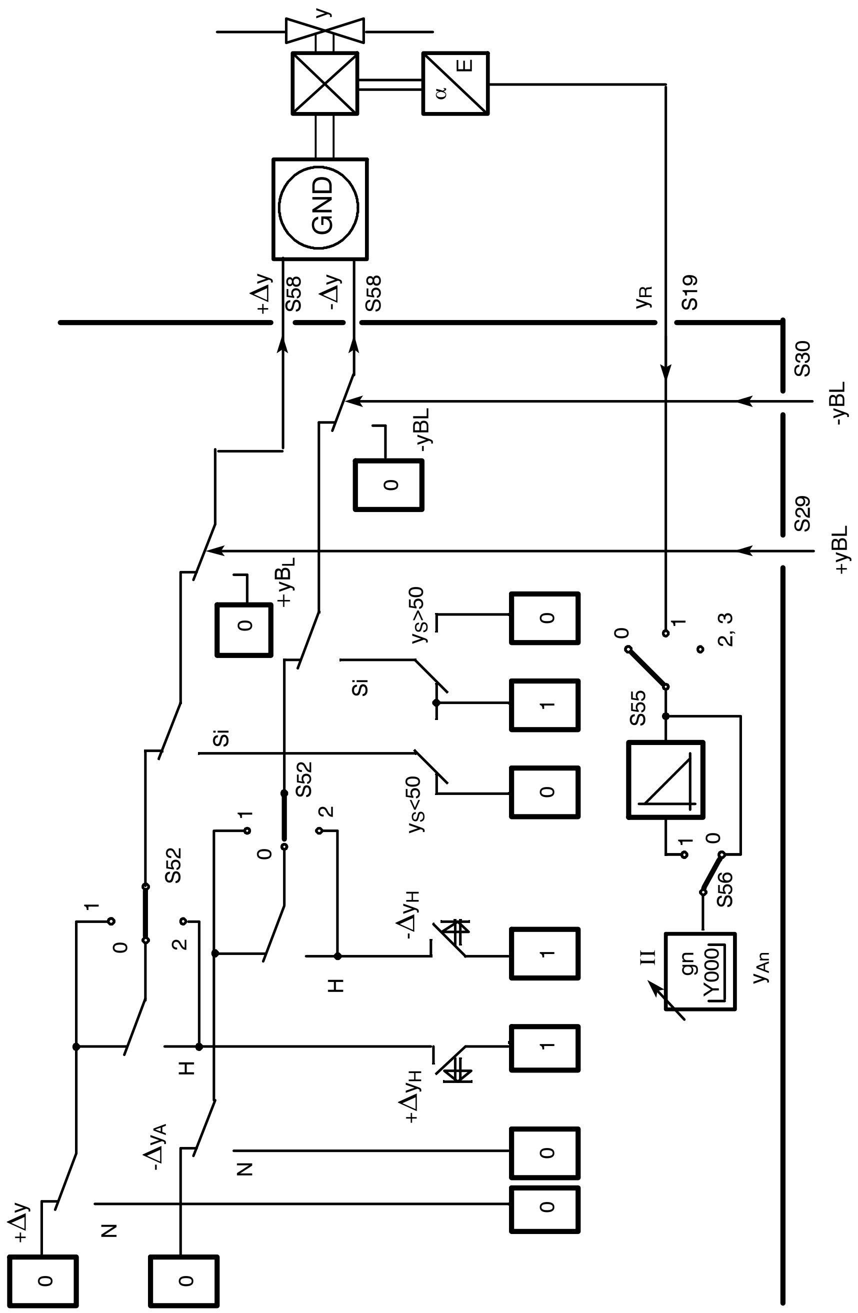
- **Manual control instrument (S2 = 0, 1, 2, 3)**

see figure 3-17, page 86 and figure 3-18, page 87

The controller output structures which can be configured by S2 are used for the manual control instrument function whereby automatic operation is replaced by the “Hold manipulated variable” mode. All other operating modes are identical with the controller functions. The last manipulated variable before switching to this operating mode is transferred to this hold operation and the ± Δ y-keys are inactive. If the manipulated variable output is to be tracked in this operating mode, e.g. in two-control station mode, tracking mode must be activated vy the control signal N and the input yN.

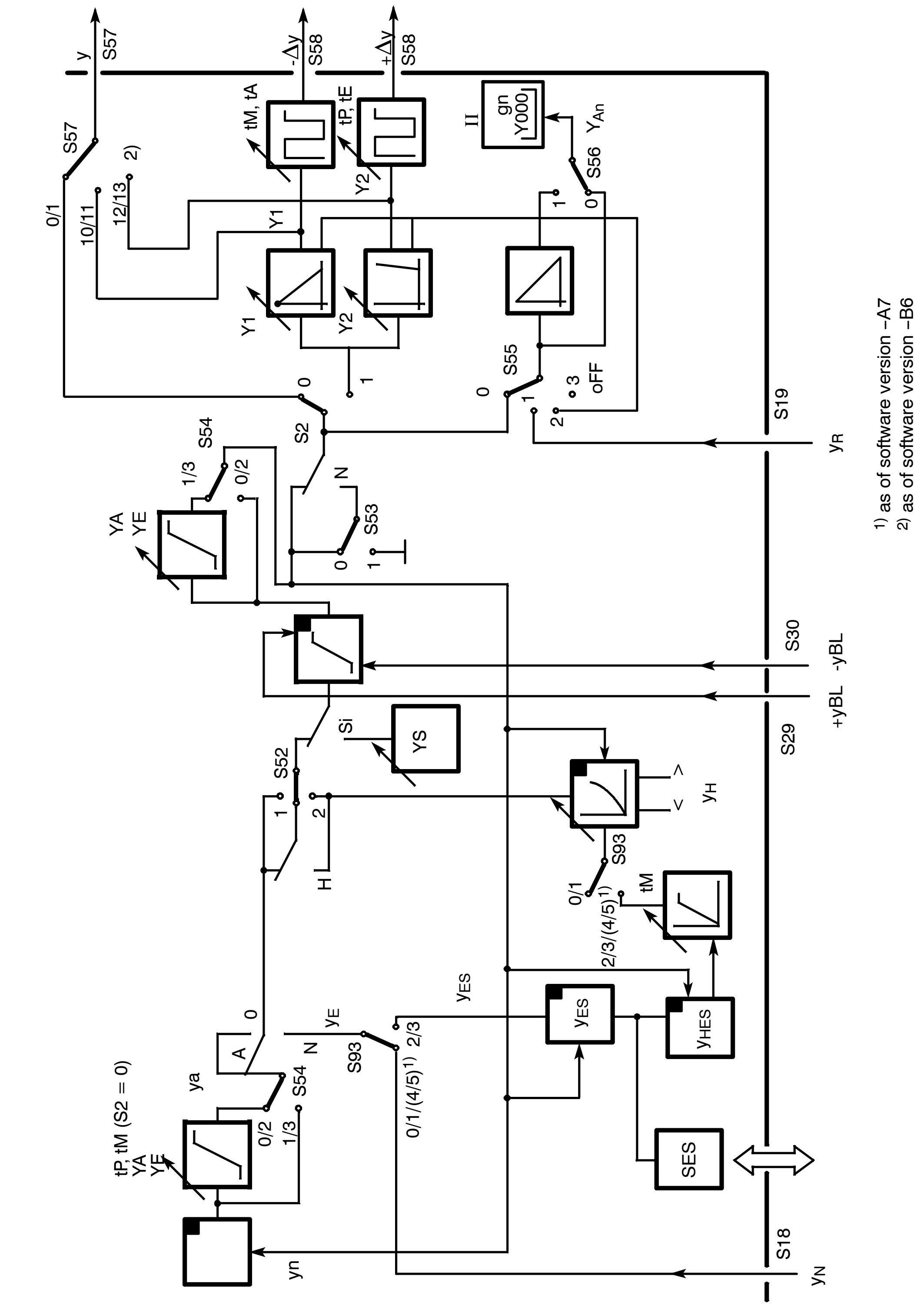
If only manual control function without switching is desired, the device must be blocked in maqnual mode with S52 = 2.

The following figures only show 2 examples. For the other variations, see the block diagrams of the controller-output structures (fig. 3-24, page 103, figure 3-25, page 104 and figure 3-27, page 107 to figure 3-30, page 112).



Block diagrams for S50 = 0 and manual control unit S with external feedback (S2=3) see controller output structures figure 3-29, page 111

Figure 3-17 Block diagram control unit/process display (S1 = 4)
Manual control unit S with internal feedback S2 = 2
Manual operation has priority over tracking S50 = 1



Block diagram for S50 = 0, see controller output structures figure 3-30, page 112

Figure 3-18 Block diagram control unit/process display S1 = 4
Manual control unit with K-output S2 = 0/
Two-position output S2 = 1 (manual operation has priority over tracking S50 = 1)

Control signals					Message signals				active y at	Explanations
Digital inputs				Front	Front		Digital outputs			
± yBL	Si	N	He[7)]	Hi[8)]	H LED	y-Ext. LED	H	Nw		
0	0	0	0	0	0	0	0	0	$y_a(n)$	Hold operation
0	0	0	1	0	0.9[4)]	0	1	0	$y_H(n, \nearrow)$	Manual mode
0	0	0	0	1	1	0	1	0	$y_H(n, \nearrow)$	Manual mode
0	0	0	1	1	1	0	1	0	$y_H(n, \nearrow)$	Manual mode
0	0	1	0	0	0	1	0	1	$y_E(n)$[1)]	Tracking operation
0	0	1	1	0	0.5[5)]	1	1	1	y_E (n)	Tracking operation
0	0	1	0	1	0.5[5)]	1	1	1	y_E (n)	Tracking operation
0	0	1	1	1	0.5[5)]	1	1	1	y_E (n)	Tracking operation
1	0				0.5[5)6)]	1		0	± yBL[2)]	± Blocking operation
1	1	as above			0.5[5)6)]	1	as above	0	± yBL[2)]	± Blocking operation
0	1				0.5[5)6)]	1		0	y_S[3)]	Safety operation

Table 3-10 Output switching manual control instrument S/K (S1 = 4)
Tracking mode has priority over manual mode (S50 = 0)

Control signals					Message signals				active y at	Explanations
Digital inputs				Front	Front		Digital outputs			
± yBL	Si	N	He[7)]	Hi[8)]	H LED	y-Ext. LED	H	Nw		
0	0	0	0	0	0	0	0	0	$y_a(n)$	Hold operation
0	0	0	1	0	0.9[4)]	0	1	0	$y_H(n, \nearrow)$	Manual mode
0	0	0	0	1	1	0	1	0	$y_H(n, \nearrow)$	Manual mode
0	0	0	1	1	1	0	1	0	$y_H(n, \nearrow)$	Manual mode
0	0	1	0	0	0	1	0	1	$y_E(n)$[1)]	Tracking operation
0	0	1	1	0	0.9[4)]	0.5	1	1	$y_H(n, \nearrow)$	Manual mode
0	0	1	0	1	1	0.5[5)]	1	1	$y_H(n, \nearrow)$	Manual mode
0	0	1	1	1	1	0.5	1	1	$y_H(n, \nearrow)$	Manual mode
1	0				0.5[5)6)]	1		0	± yBL[2)]	± Blocking operation
1	1	as above			0.5[5)6)]	1	as above	0	± yBL[2)]	± Blocking operation
0	1				0.5[5)6)]	1		0	y_S[3)]	Safety operation

1) Source for y_E at S93 = 0, 1, (4, 5 as of software version -A7) y_N is assigned as an absolute value via S18. At S93 = 2, 3 y_{ES} via the SES. The external manipulated variable fed in through the SES (y_{ES}) is tracked. When feeding in via y_N the feeding instrument must be tracked. At S-output with internal feedback, a y_E-secification is not possible, here the last y before switching is held.
2) Blocking operation acts direction-dependently, changes to the opposite direction are possible.
3) Function y_S in S-controllers with internal feedback (S2 = 1) drive open- or closed otherwise parameterizable safety setting value.
4) 0.9 flashing rhythm 0.1 off, 0.9 on
5) 0.5 = flashing rhythm 1:1
6) Only if Hi ∨ He = 1
7) For S52 ≠ 3, 4
8) As of software version -A7 the signals He_{BE} and He_{ES} with S52 = 3, 4 have dynamic effect (0/1-edge). They then act like the Hi-signal (see figure 3-3, page 57)
(n) tracked to the value active before switching, therefore bumpless switching
↗ adjustable

Table 3-11 Output switching manual control instrument S/K (S1 = 4)
Manual mode has priority over tracking mode (S50 = 1)

3.4.7 Program controller, program transmitter
(S1 = 5) (not 6DR1901/4)

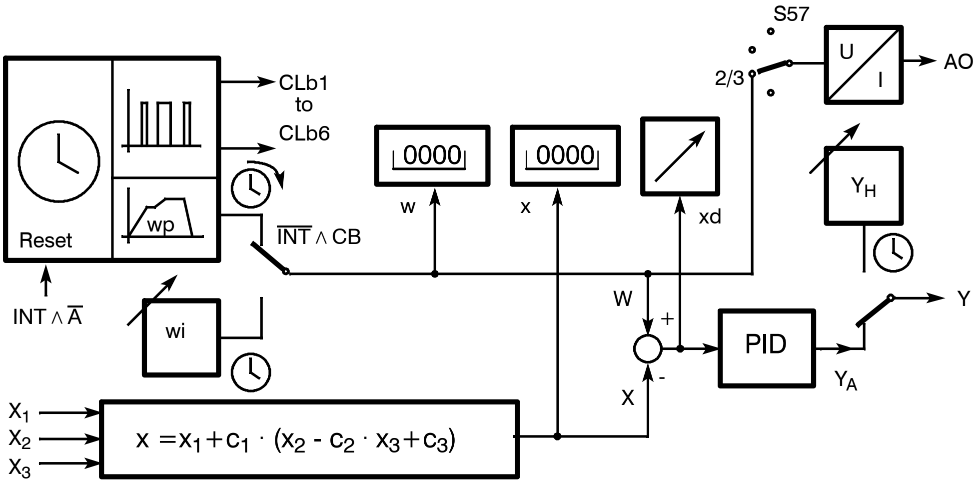


Figure 3-19 Principle representation S1 = 5

The program controller has a sequence controller switching structure whereby the external setpoint is replaced by the program setpoint wp. Whenever the external setpoint wp is active in automatic mode via the control signals Int and CB, the clock runs and with it the timing program. At internal setpoint wi which is tracked to the last program setpoint at S46 = 0/2, the clock is at a standstill. The controller operates as a fixed value controller. The reset function is triggered if you switch additionally to manual with internal setpoint. The clock stops in the start position.

The reset function can be triggered as of software version -B6 by the status signal $\overline{tS}$. The further program run depends on the control signals INT, CB and the automatic operating mode. (At /INT ∧ CB ∧ A: The clock is reset, the program run starts again from the start position.)

Starting can take place via the control signal CB at Int = 0 or via the front at CB = 1. The message signals RC and RB react as in the sequence controller.

The program transmitter itself allows 2 programs to run which are switched over either by the control signal PU or in the configuration mode CLPA. Cascading of both programs is also possible.

The two programs may be occupied by a maximum 10 or 5 time intervals which are entered as relative time Δt. In addition to the analog values for wp status messages of 6 digital outputs (time rails) can be assigned to the intervals.

Every time the clock is stopped, the active straight line equation is recalculated from the current setpoint wi, the target setpoint and the remaining time of the stopped interval. This and the tracking of wi ensures bumpless switching wp/wi in both directions.

- **Operating modes at the end of the program**

  At the end of the last interval at the end of the program the controller is automatically switches to wi and operates as a fixed value controller in automatic operation.
  If operation takes place via S42 = 0, 1 with static CB, this switching tykes place by setting the Int flip-flop stage to 1.

  If operation takes place via S42 = 2 with dynamic CB, the switching takes place by a reset of the CB flip-flop stage to 0. The restart then takes place by pressing the Int key or an edge at control input CB.

  Due to the tracking of wi the entered value at the end of the last interval is active at S46 = 0/2 in the program pause. At S45 = 1 the internal setpoint is tracked to the safety setpoint SH1 so that free cooling functions can also be implemented.

  An end of program message is also possible by the status message of a digital output CLb1 to CLb6.

- **Program transmitter**

  If you assign the current output Iy to the active w, operation as a program transmitter which can then feed several sequence controllers for example.

- **Cyclic program run**

  The cyclic program run is possible in the following operating modes:

  - **With external connection: Start/Stop function external or through device front**

    In dynamic CB (S42 = 2), assignment of a digital output CLbx (S70 to 75) with the status message “end of program” (x.PE.x, in CLPA) and external connection of the binary output with the binary input CB, the program run is started again by the positive edge at the end of the program.

    The cyclic program run can be ended by interrupting the external connection. By switching setpoint internal/external (internal key 13), the start/stop function is given through the device front.

  - **Device-internal Start/Stop-function only via device front**

    At CB = High (S23 = 8) and CB-setting dynamic (S42 = 2), the cyclic program run is possible without an external connection.

    The start/stop function takes place through the device front by internal/external switching (internal key 13). The free DI or DO can be used for other functions.

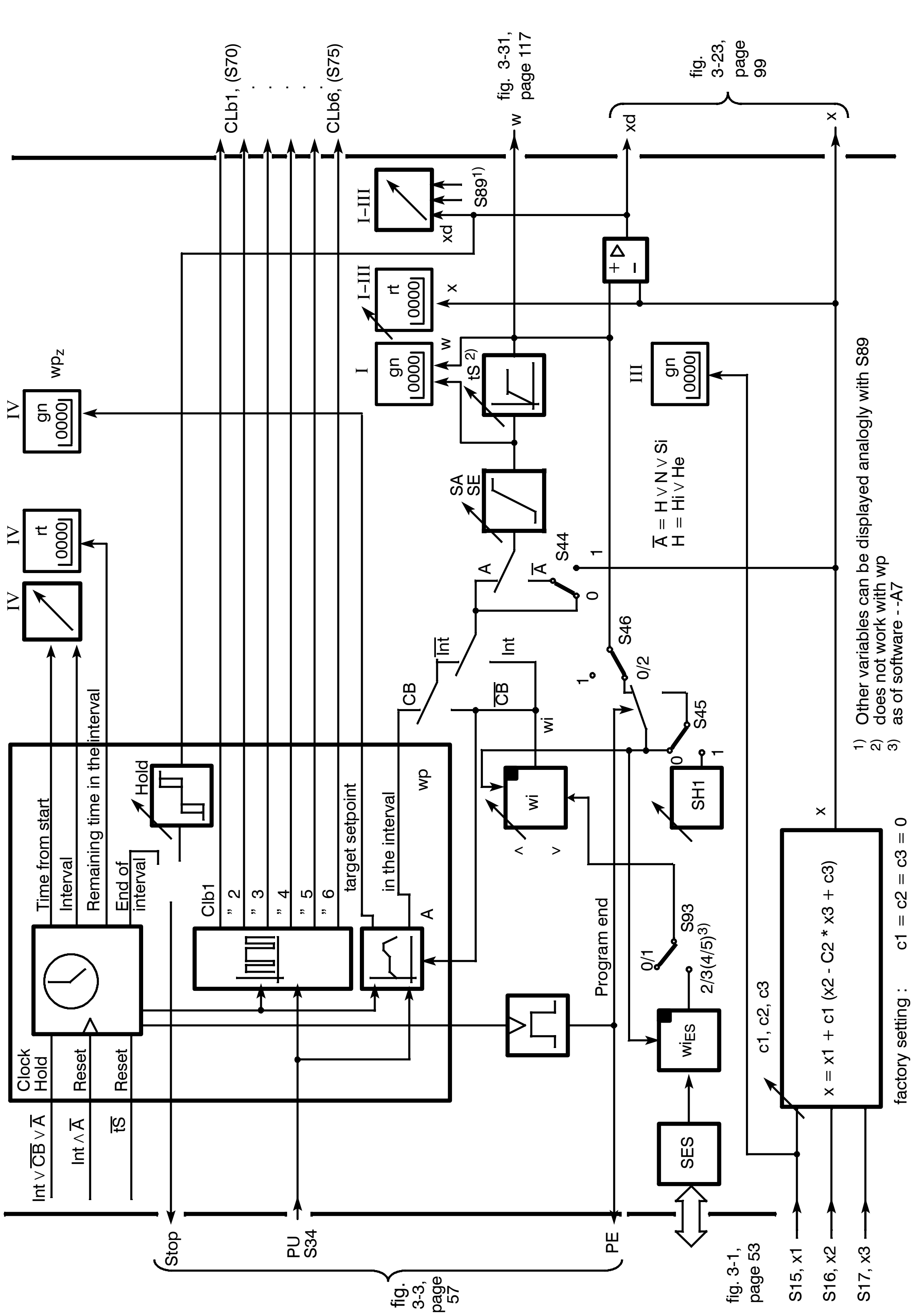


Figure 3-20 Block diagram S1 = 5 program controller/program transmitter

Control signals				Message signals				active w at		Status clock	Explanations
Digital inputs			Front	Front		Digital outputs					
$\overline{tS}$ [8]	H ∨ N ∨ Si	CB [5]	Internal	Internal LED	$\overline{C}$ LED	$\overline{RB}$	$\overline{RC}$ [3]	S44=0	S44=1		
0	0	1	1[2]	1	0	1	1	wi(n,↗)[7]		stops	Automatic mode with internal setpoint
0	0	1[1]	0	0	0	0	0	wp		running	Automatic mode with Program-setpoint
0	0	0	0	0	1	0	1	wi(n,↗)[7]		stops	Automatic mode with internal setpoint
0	0	0[4]	1[4]	1	1	1	1	wi(n,↗)		stops	Automatic mode with internal setpoint
0	1	1	1	1	0	1	1	wi(n,↗)	x	stopped, reset	Manual-, tracking- or safety mode
0	1	1	0	0	0	0	0	wp	x	stops	
0	1	0	0	0	1	0	1	wi(n,↗)	x	stops	
0	1	0	1	1	1	1	1	wi(n,↗)	x	stopped, reset	
1	x	x	x	x	x	x	x	x	x	reset	Program is reset to start position. Program run depends on the other control signals

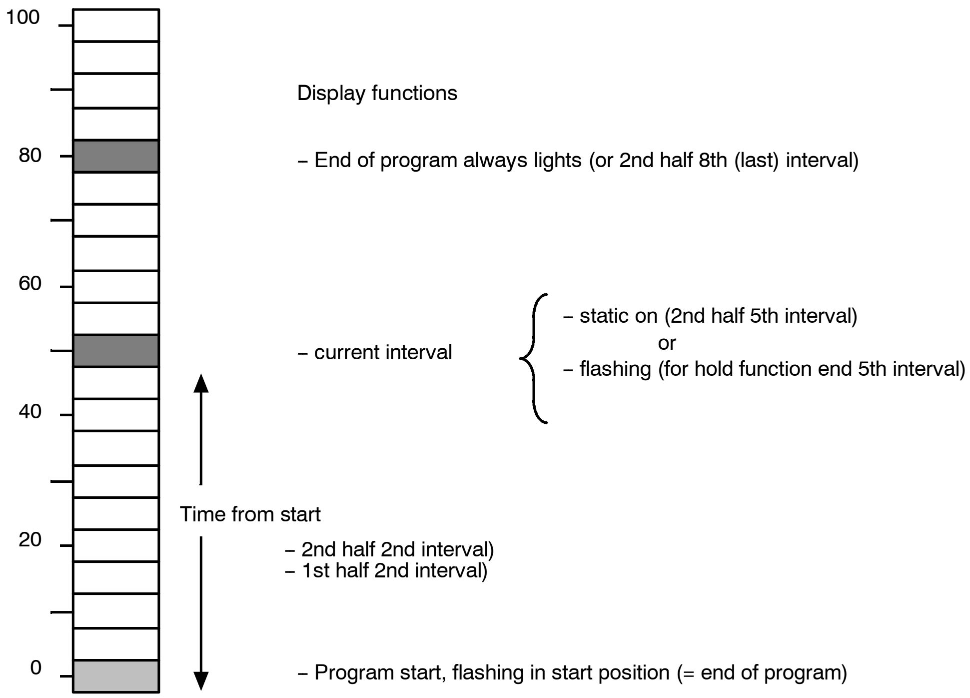
1) Start program run with CB 0 → 1 (Int = 0). Automatic reset at end of program at dynamic CB (S42 = 2)
2) Start program run with INT 1 → 0 (CB = 1). Automatic reset at end of program at static CB (S42 = 0/1)
3) Alarm signal "no program controller operation" (clock stops), by OR operation with the control signals (H ∨ N ∨ Si "no program controller operation" can be signaled in these operating modes either.
4) Factory setting
5) The table is shown for static CB-switching without acknowledgement.
6) At S46 = 1 tracking of the internal setpoint wi is omitted.
7) At S45 = 1 wi is tracked to the safety setpoint SH at the end of the program which is then active as an adjustable internal setpoint.
8) $\overline{tS}$ with reset-function as of software version –B6
↗ adjustable

Table 3-12 Program controller S1 = 5 / program transmitter with tracking[6] of the internal setpoint to the active setpoint.

- **Time- and interval display**

  Via the x/y-display cyclic counter the PV-X-display and the bargraphs can be switched over to time and interval display with the Shift key (6) in position IV. The PV-X-display shows the remaining time in the interval analogously to the target setpoint in the interval. The display is in h, min or min, s according to the selected clock format. The *bargraph* supplies the information “Time from Start”, “Current interval” and “Hold functions effective” according to the following scheme. Up to 10 intervals can be displayed.

  Example: 8 intervals, current state, 2nd half 5th interval



- **Program display**

  If LEDs 1 and 2 (17) are not occupied with the alarms by the structure switches S87 = 1/2/3/5, the program selected by the clock parameter PrSE or the binary input PU is indicated by the lit LED. In cascaded programs switching LED1/2 takes place after changing from the 10th interval of the 1st program to the 1st interval of the 2nd program.

CLPA Clock-parameter

- **PrSE Program selection**

  In the positions P1 or P2 the program selected by digital input PU runs. A program switching after the start has no influence on the program selection.

- **Hold** **Hold function**

The Hold function is activated with the clock parameter Hold. It is switched off in the oFF position. With the setting of a value the control difference is checked at the end of every interval whether it maintains this value. If the control difference has not yet reached the set value or has exceeded it (overshoots), the controller is switched over to wi and the clock is stopped until the value is reached (time-optimized heating function). The status of the digital outputs of the expired interval is held.

On reaching the set value, the program setpoint wp is switched to again automatically. Signaling takes place as for manual switching. In addition the bargraph shows the hold function by the flashing interval segment.

If the set value is not reached during the hold function (e.g. too low a heating power or disturbance variables) the program run can be continued in the next interval by manually switching the internal key (13) to Ext.

- **CLFo** **Clock format**

With CLFo the desired clock format is preset commonly in h, min or min, s for both programs.

- **t.01.1 to t.05.2 Duration per interval**

With the set clock format the times are assigned to the maximum 10 intervals of the 1st program and the maximum 5 intervals of the 2nd program. If not all intervals are required, the time 00.00 must be assigned to the other intervals.

This means

```
t.xx.x
│││ └──── 1st or 2nd program
│└┴────── Interval no.
└──────── Time interval
```

- **A.01.1 to A.05.2** **Analog value at the end of the interval**

The amplitudes are set according to the display format (dA, dE, dP) at the end of the interval. The set wi is active at the beginning of the 1st interval (start position) The polygon chain is calculated with these values and the times set in t.xx.x, whereby the final value of an interval is identical with the start value of the following interval. If nop (no operation) is assigned to an interval, the appropriate straight line equation is calculated from the adjacent vertex points. In this way a status message can be assigned to an interval in which the analog value should change further linearly.

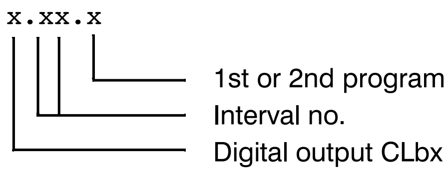
This means

```
A.xx.x
│││ └──── 1st or 2nd program
│└┴────── Interval no.
└──────── Analog value wpz
```

- **(CLb)1.01.1 to (CLb)6.05.2 Binary output signal during the interval**

  A maximum 6 digital outputs CLb1 to CLb6 per interval can be occupied with status messages Low and High. The entered status is active during the whole interval. The status at the end of the program is defined with x.PE.x in the start position. This enables the end of program alarm to be generated as an edge or a status message.

  This means



3.4.8 Fixed setpoint controller with one setpoint (control system coupling) (S1 = 6) 2)

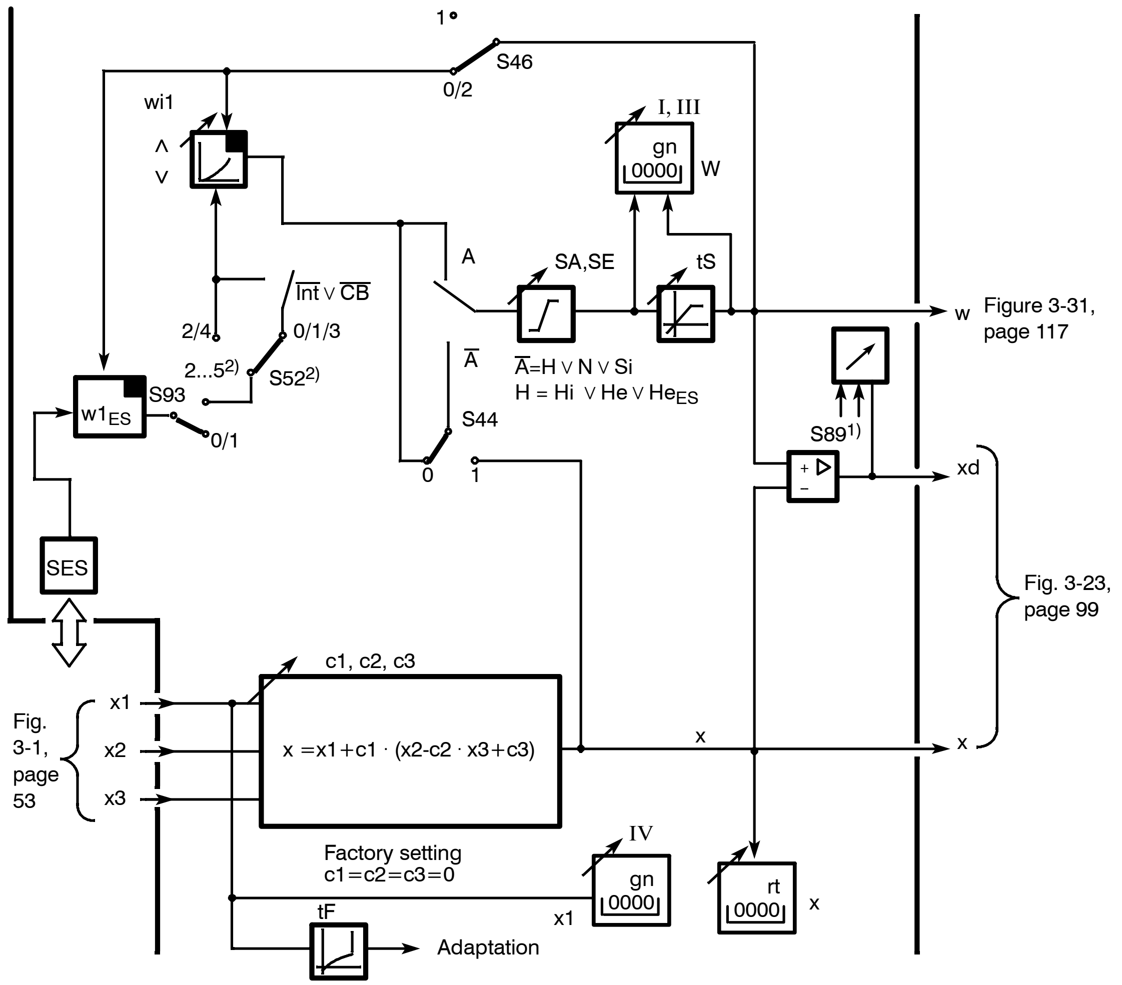


Figure 3-21 Block diagram S1 = 6, fixed value controller with one setpoint for control system coupling

This fixed setpoint controller is designed specially for coupling to the control system. The control signals Int and CB are available for locking the control system operation through the SES. With Int ∨ $\overline{CB}$ the setpoint signal wi_{ES} is separated and manual intervantion through He_{ES} at S52 = 3 is prevented.

The other wiring of the input function is almost identical with the structure S1 = 0 (see chapter 3.4.2, page 64).

S52 = 3 is expressly recommended for this wiring.

1) Other variables can be displayed analogly with S89
2) as of software version –A7

3.4.9 Sequence controller without Int/Ext-switching (control system coupling) (S1 = 7) [2)]

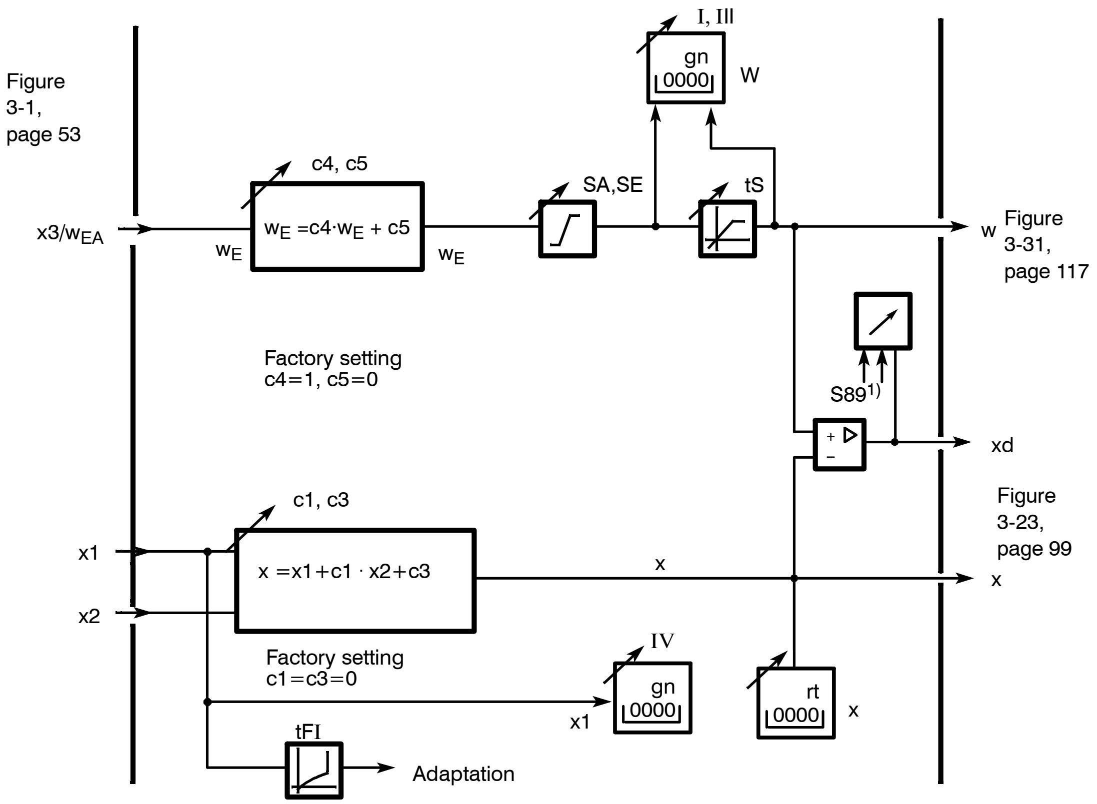


Figure 3-22 Block diagram S1 = 7, sequence controller for control system coupling

This sequence controller is designed specially for the control system coupling. It differs from the structure S1 = 2 (see chapter 3.4.4, page 71) in that the setpoint switching to via Int and CB is omitted and thus these control signals are available for locking the control system operation via the SES. With Int $\vee$ $\overline{CB}$ manual intervention through He_{ES} at S52 = 3 is prevented.

The other functions are unchanged in relation to S1 = 1. S52 = 3 is expressly recommended for this wiring.

1) Other variables can be displayed analogly with S89
2) As of software version –A7

3.5 Control algorithm

- **Control algorithm**

The PID control algorithm is implemented as an interaction-free parallel structure and follows the ideal controller equations whilst neglecting the filter constants and the cycle time.

- **P-controller**

$$ya = \pm Kp \cdot xd + yo \quad \text{or} \quad \frac{ya}{xd} = \pm Kp$$

- **PI-controller**

$$ya = \pm Kp\ (xd + \frac{1}{Tn}\int_0^t xd\ dt) + yo(t) \quad \text{or} \quad \frac{ya}{xd} = \pm Kp\ (1 + \frac{1}{j\omega \cdot Tn})$$

- **D-element-connection (zD-part)**

The D-element connection can be added optionally.

$$\frac{ya}{E} = \pm Kp \frac{j\omega \cdot Tv}{1 + j\omega \cdot \frac{Tv}{vv}}$$

The input variable E for the D-element is S48 xd, x, x1, -z, or +z depending on the position of S48.

- **z-connection**

The z-part can be added optionally to the controller output ya.

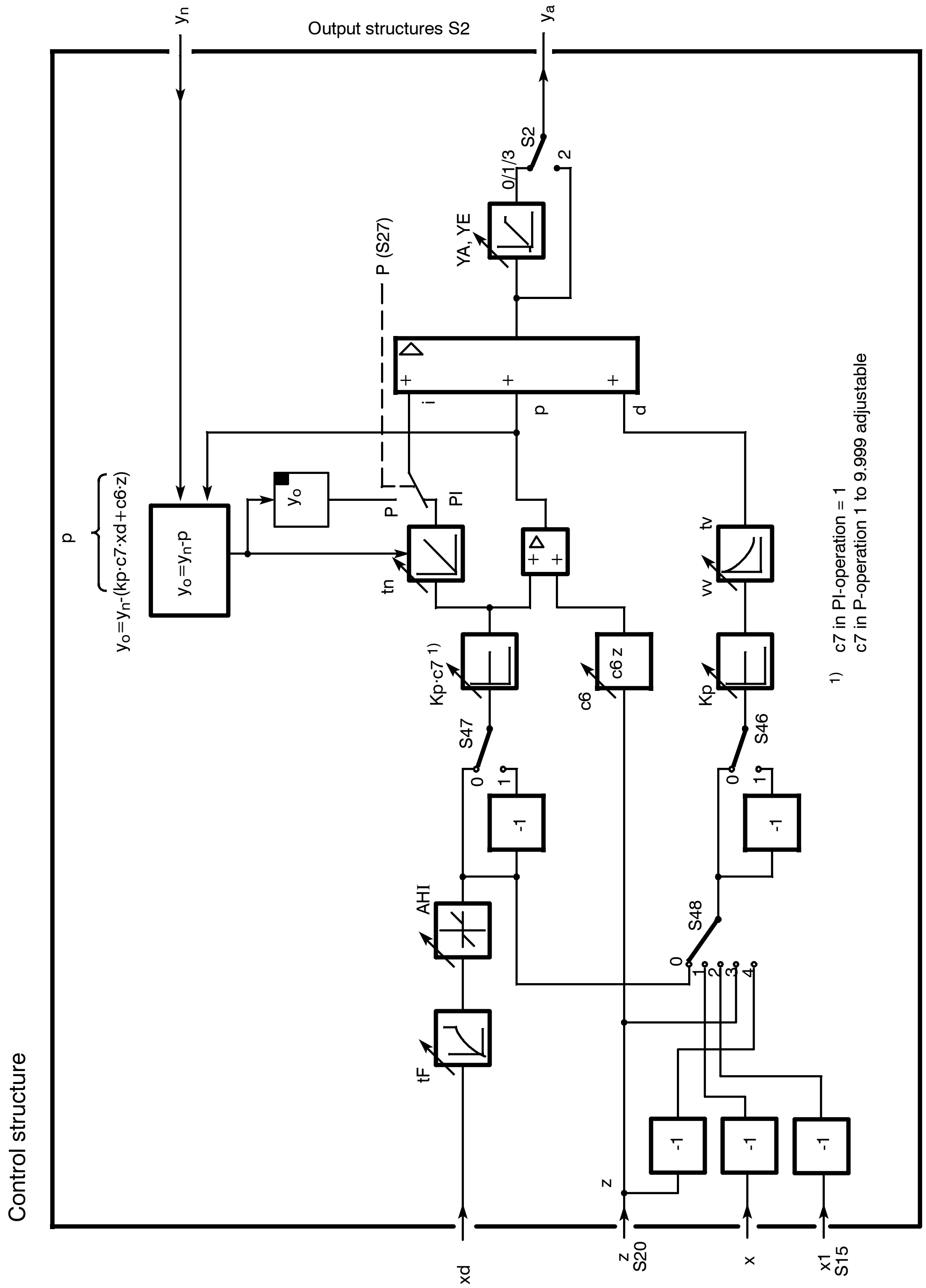
$$ya = \pm c6 \cdot z \quad \text{or} \quad \frac{ya}{z} = \pm\ c6$$

- **Controller direction of effect**

The controller direction of effect is set with S47. It must always have the opposite behavior (negative follow-up) to the controlled system (including actuator and transmitter).

S47= 0, normal direction controller (+Kp, rising x causes falling y) for normal direction controlled systems (rising y causes rising x),

S47= 1, reverse direction controller (−Kp, rising x causes rising y) for reverse direction controlled systems (rising y causes falling x),



Input signal processing figure 3-1, page 53 and controller types S1 (see chapter 3.4, page 59 controller types)

Figure 3-23 Block diagram controller structure

- **Operating point yo for P-controllers**

The operating point yo of the P-controller can be set either automatically or as a parameter (onPA).

Automatic working point (Yo = Auto)

Whenever there is no automatic operation (manual-, tracking-, safety- or blocking operation) the operating point yo is tracked so that switching to automatic operation is bumpless.
This gives an automatic setting of the operating point yo in manual mode:

$yo = y_H - (Kp \cdot c7 \cdot (w - x_H) + c6 \cdot z)$

If the actual value in manual mode (x_H) is driven to the desired setpoint w by the appropriate manual manipulated variable y_H, the operating point yo is identical to the manual manipulated variable y_H.

yo = yH or yo = yH + c6 · z.

Fixed working point (Yo = 0 to 100 %)

The controller operates in all operating modes with the working point set as a permanent parameter.

- **Manipulated variable limit YA, YE**

The manipulated variable limiting with parameters YA and YE is active depending on the switch position of S54 only in automatic operation or in all operating modes. The limits of these parameters are at -10 and +110 %. However, it should be taken into account that the controller neither outputs negative actuating currents nor detects any negative position feedback signals.

If the manipulated variable y_a reaches one of the limits YA or YE in the limited operating mode, further integration is aborted to avoid integral saturation. This ensures that the manipulated variable can be changed immediately after reversing the polarity.

In manual-, tracking- (DDC) or safety mode the manipulated variable y can be driven out of the limiting range at S54 = 0 (limiting only in automatic mode). When switching to automatic operation the last manipulated variable is then transferred bumplessly but only changes in the manipulated variable in the direction of the YA to YE range are subsequently executed.

The manipulated variable limiting is possible in K-, two-position and three-position stepper controllers with external position feedback (S2 = 0, 1, 3).

- **Bumpless switching to automatic mode**

  If there is no automatic operation (manual, tracking, safety or active blocking operation) the I-part or the operating point yo (only at Yo = Auto) is tracked so that the switching to automatic operation is bumpless. Any still active D-part is set to zero.

- **P-PI-switching**

  With the control signal P = 1, the controller is switched from PI- to P-behavior, at Yo = Auto, the switching is bumpless.

3.6 Controller output structures (S2, S50 to S56)

The controller structures follow four different controller output structures depending on structure switch S2.

S2=0 K-controller
S2=1 two-position controller with 2 S-outputs heating/cooling, optionally 1 K-output
S2=2 three-position-(S)-controller with internal feedback
S2=3 three-position-(S)-controller with external feedback

- **S2=0: Continuous (K) controller** (figure 3-24, page 103 and figure 3-25, page 104)

  To control proportional active actuators (e.g. pneumatic actuators or I/P-transformers) or as command controllers in cascades.

  Actuating time tP, tM (onPA)

  The setting speed of the automatic manipulated variable is set with the parameters tP and tM. In the oFF position, no limiting takes place, in positions 1 to 1000 s the minimum actuating time for 0 to 100 % manipulated variable is preset. Whereby tP acts during increase and tM during decrease of the manipulated variable. The P-, I- and D-part as well as the disturbance variable z is limited in the rise speed.
  This setting speed limit is used:

  - to avoid integral saturations in the floating times of the following actuator >1 s
  - to avoid hard output surges of the P-, D- and z-part.

  In this case it must be taken into account that the control time is greater.

- **S2 = 1: two-position controller with two S-outputs heating/cooling; optionally with one K-output**

This output structure is identical to the K-output structure in its switching options (see figure 3-24, page103 and figure 3-25, page104).

The output variable can only adopt two states for every switching output + Δy, -Δy. Switching on or switching off. The relationship between switching on- and switching off is defined as

$$\text{setting ratio} = \frac{\text{switch-on duration}}{\text{switch-on duration + switch-off duration}}$$

Switch on duration and switch off duration together give the period duration.

The setting range y from 0 to 100 % can be divided into two sub-ranges. The range Y1 with a falling characteristic for cooling, the range 100% Y2 with rising characteristic for heating. Two pulse stages are connected in series which transform the two sub manipulated variables into pulse-pause ratio. It is possible to use the manipulated variable limiting of y with the parameters yA and yE, the setting ratio 1 is then not reached. Since the minimum pulse duration or pause can be set by tA or tE, further limiting is not normally necessary. A dead zone can be set between these two sub manipulated variables. By changing Y1 or Y2 (oFPA) the dead zone is preset and the slope adapted to the cooling or heating aggregate.

Factory setting Y1 = Y2 = 50 % corresponds to dead zone = 0 %.

Every sub manipulated variable can be assigned a different period duration tP and tM (onPA). The setting ratio 0 to 1 is run through in every section, whereby the shortest turn-on or turn-off time is set with tE and tA (onPA). The period duration must be set so that the respective best compromise between the minimum permissible switch on duration of the actuator (e.g. contactor, solenoid valve, fan, cooling compressor), the switching frequency and the resulting curve of the controller variable is found.

One of the partial manipulated variables Y1 or Y2 can be output as an analog manipulated variable by structure switch S57 (as of software version –B5).

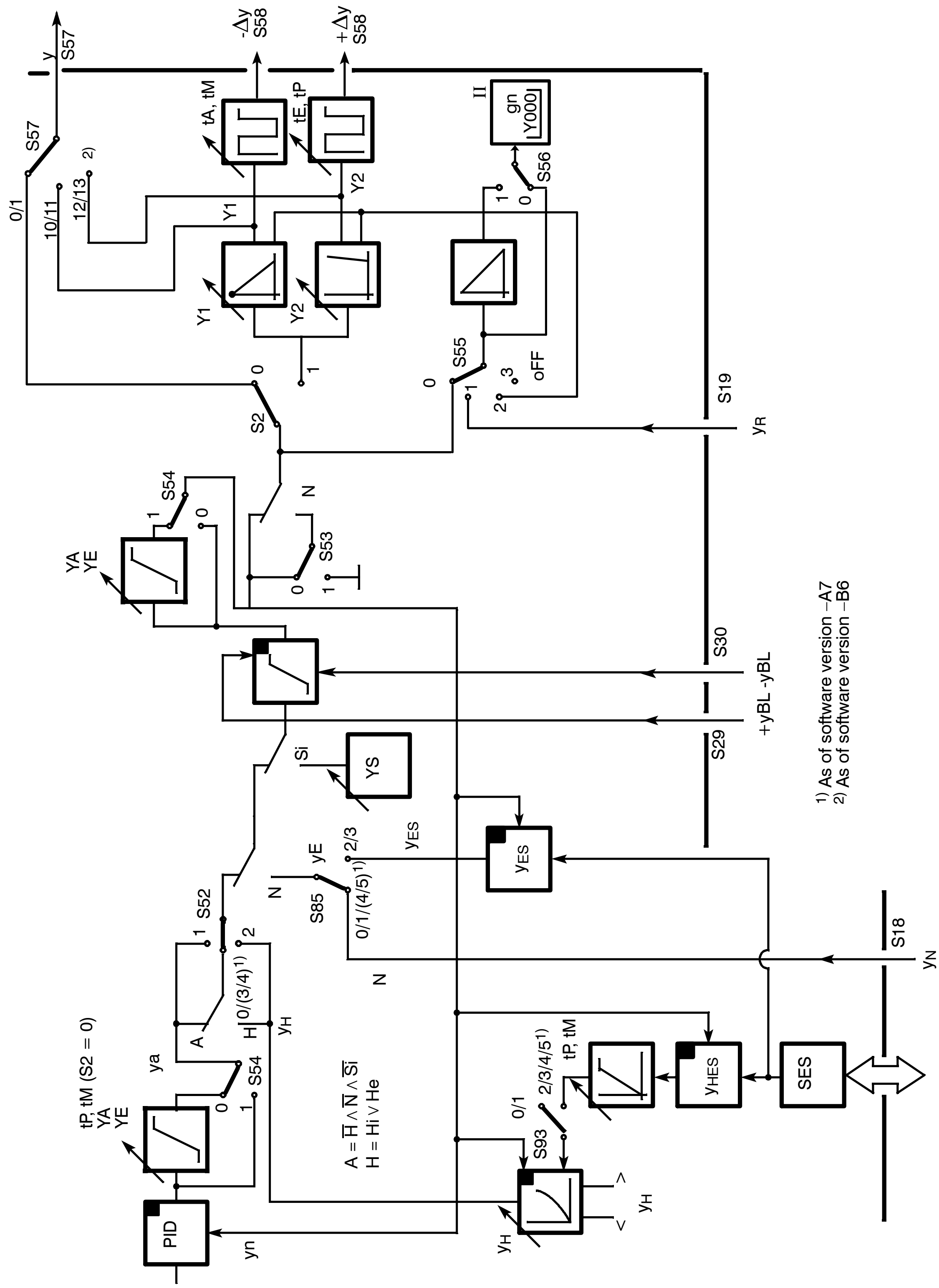


Figure 3-24 Block diagram K-controller S2 = 0 or two-position output S2 = 1
Tracking mode (DDC) has priority over manual mode S50 = 0

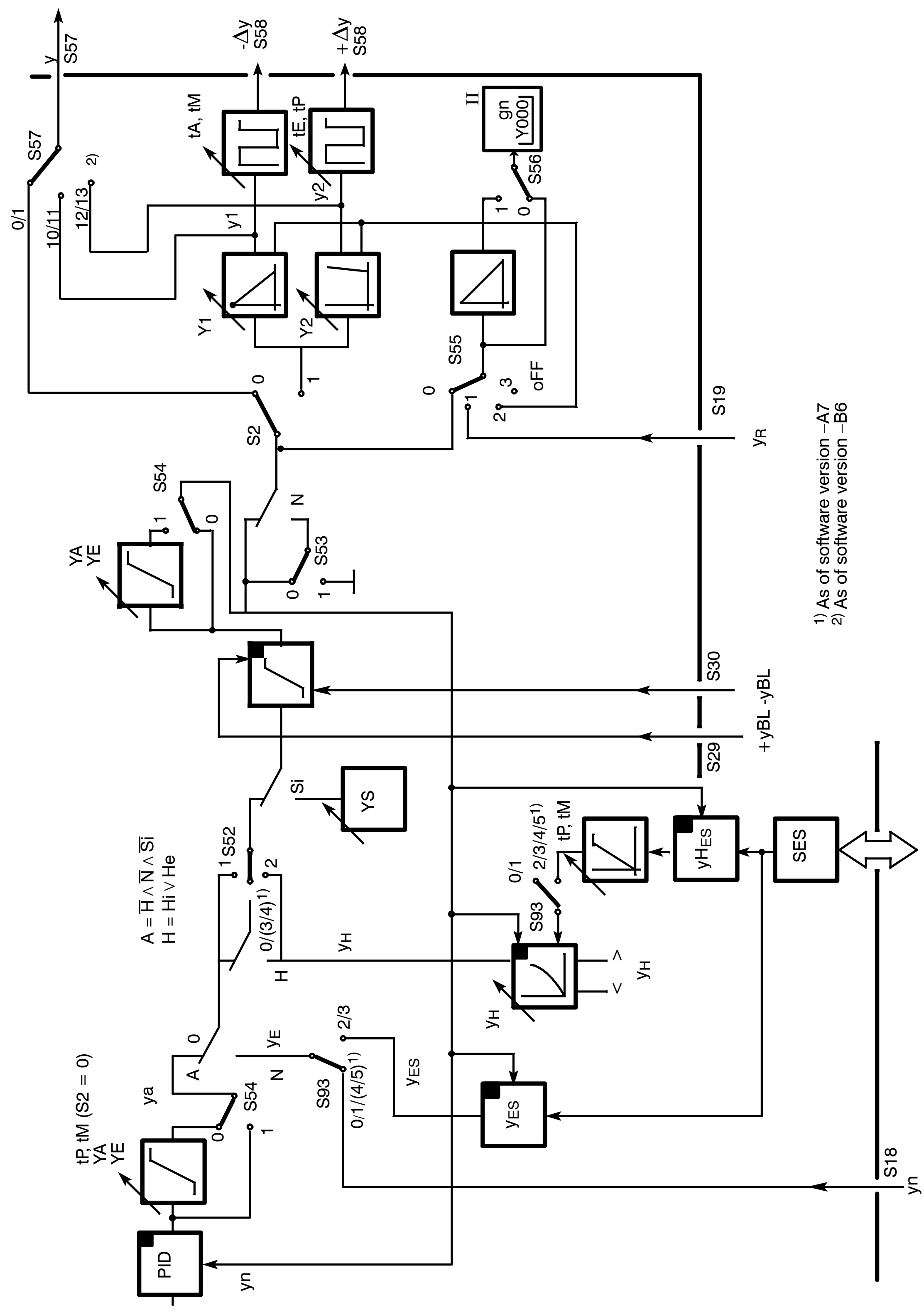


Figure 3-25 Block diagram K-controller S2 = 0 or two-position output S2 = 1 manual operation has priority over tracking S50 = 1

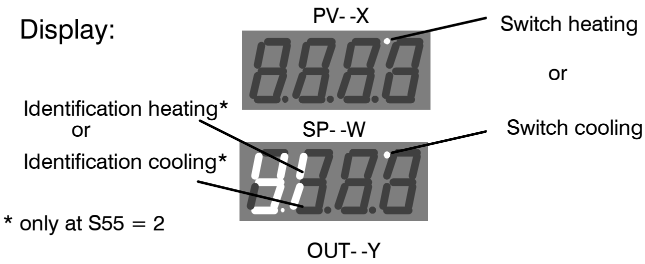
Y-display:

In switch position S55 = 2 the heating/cooling setting ranges are displayed with their setting ratio. Switching of the output stages is visible as a raised point in the x-display (for heating) or w/y-display (for cooling). One segment each in the w/y-display indicates which range is currently active.

The ±Δy-outputs can be assigned to the appropriate digital outputs with the structure switch S58.

The analog output is assigned by structure switch S57.

Display:



section y = 0 to Y1 (cooling, −Δy)
period duration tM from 0 to 1000 s
minimum pulse pause, -length: tA

section y = Y2 to 100% (heating, +Δy)
period duration tP from 0 to 1000s
minimum pulse pause, -length: tE

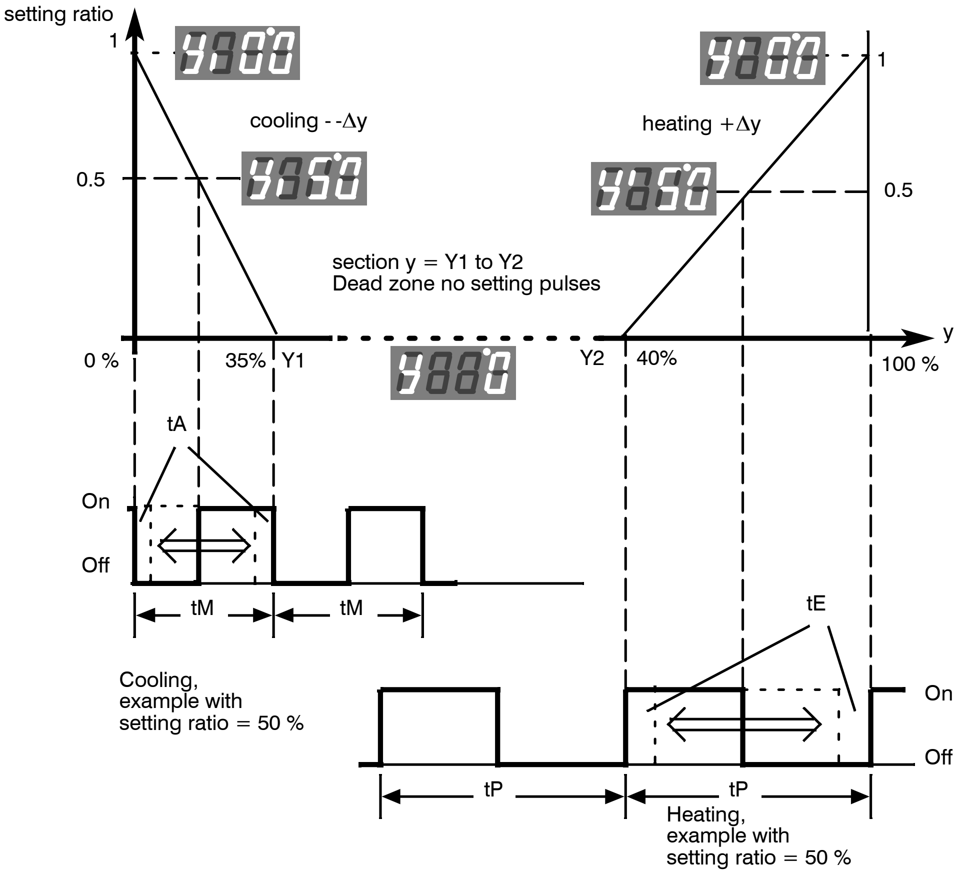


Figure 3-26 Setting ratio, actuating pulses two-position controller

- **S2 = 2: Three-position stepper-(S)-controller with internal feedback**

see figure 3-27, page 107 and figure 3-28, page 108

To control I-acting motorized actuating drives.

In S-controllers with internal feedback the K-controller is followed by an internal position controller. The positioning control circuit consists of a comparator with following three-position switch with hysteresis and an integrator in the feedback. The I-function of the actuator is simulated by the integrator with adjustable floating time tY (parameterization mode onPA) which replaces the position feedback. To ensure the internal integrator and the K-controller output do not drift apart or into saturation in time, both are set back rhythmically by the same amount (synchronized). The y-output is only a relative manipulated variable. It is therefore not possible to perform a manipulated variable limiting of YA and an absolute value preset of YE und YS. The safety manipulated variable YS is specified as a direction-dependent continuous contact. At $Y_S \leq 50$ % (oFPA) -Δy switches, at YS > 50 %, +Δy switches to continuous contact so that the end positions of the actuator represent the safety position. The position controller has an adjustable minimum pulse length (tE) and-pause (tA) with which the response threshold of the position controller is set indirectly:

- Switching on $A_{ee} = 2 \dfrac{100\,\% \cdot tE}{tY}$
- Switching off $A_{ea} = \dfrac{100\,\% \cdot tE}{tY}$
- Hysteresis $A_{ee} - A_{ea} = \dfrac{100\,\% \cdot tE}{tY}$
- Pause $A_a = \dfrac{100\,\% \cdot tA}{tY}$
- tY = tP, tM set floating time (parameterization mode onPA)

A_{ee} must be set up after a pulse pause at least as a deviation until an actuating pulse with length tE is output. A_{ea} can remain as a constant control error of the position control circuit.

A_a can be set up after an actuating pulse as a deviation until an actuating pulse is output in the same or opposite direction. When time tA has expired, the position controller reacts accordingly to the set tE.

Setting criteria of tA and tE, see chapter 6.3, page 205.

The position feedback y_R is only used to display the manipulated variable in S-controllers with internal feedback. If they are not connected, S55 is set to 3, the manipulated variable display is then dark.

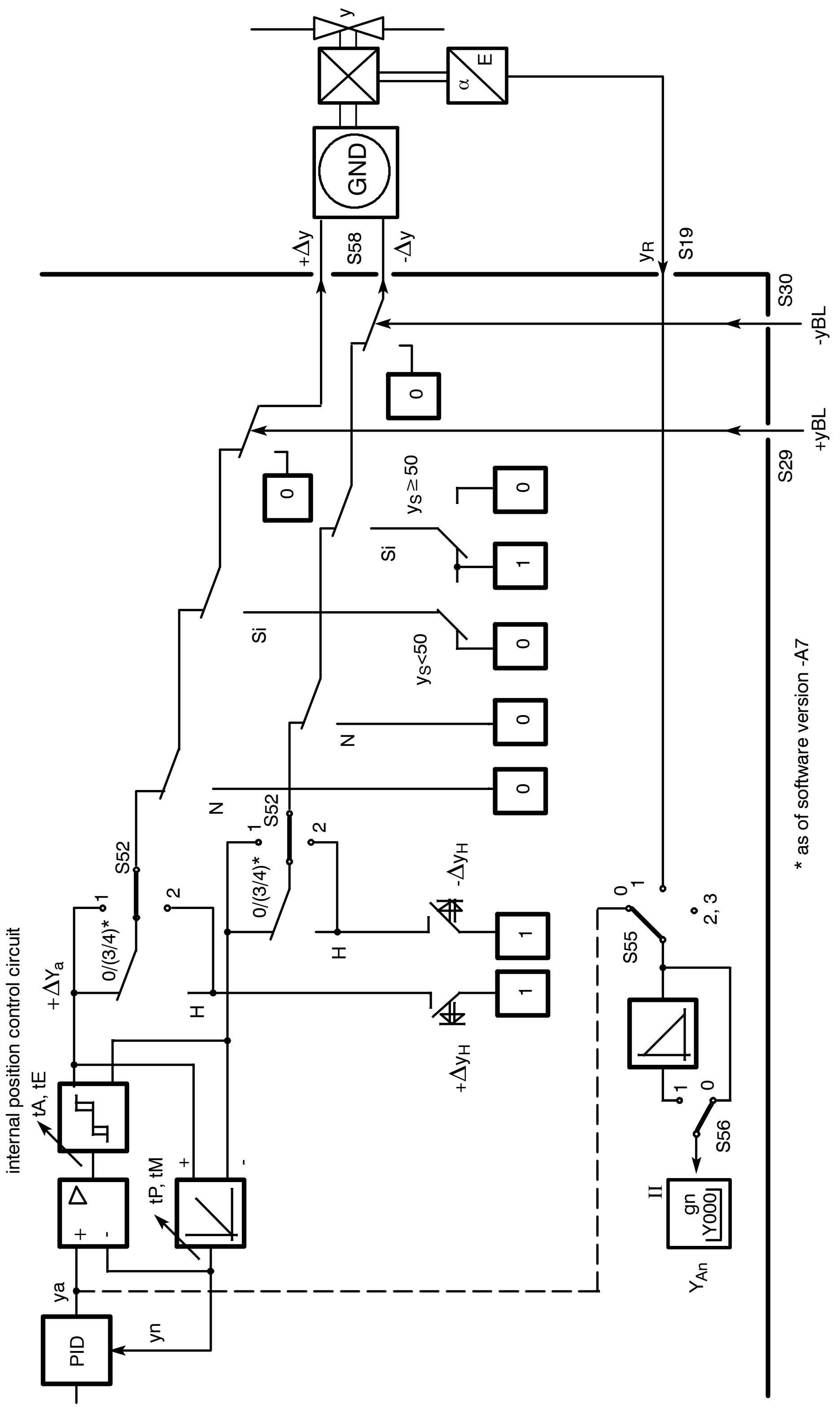


Figure 3-27 Block diagram S-controller with internal feedback S2 = 2
Tracking has priority over manual operation S50 = 0

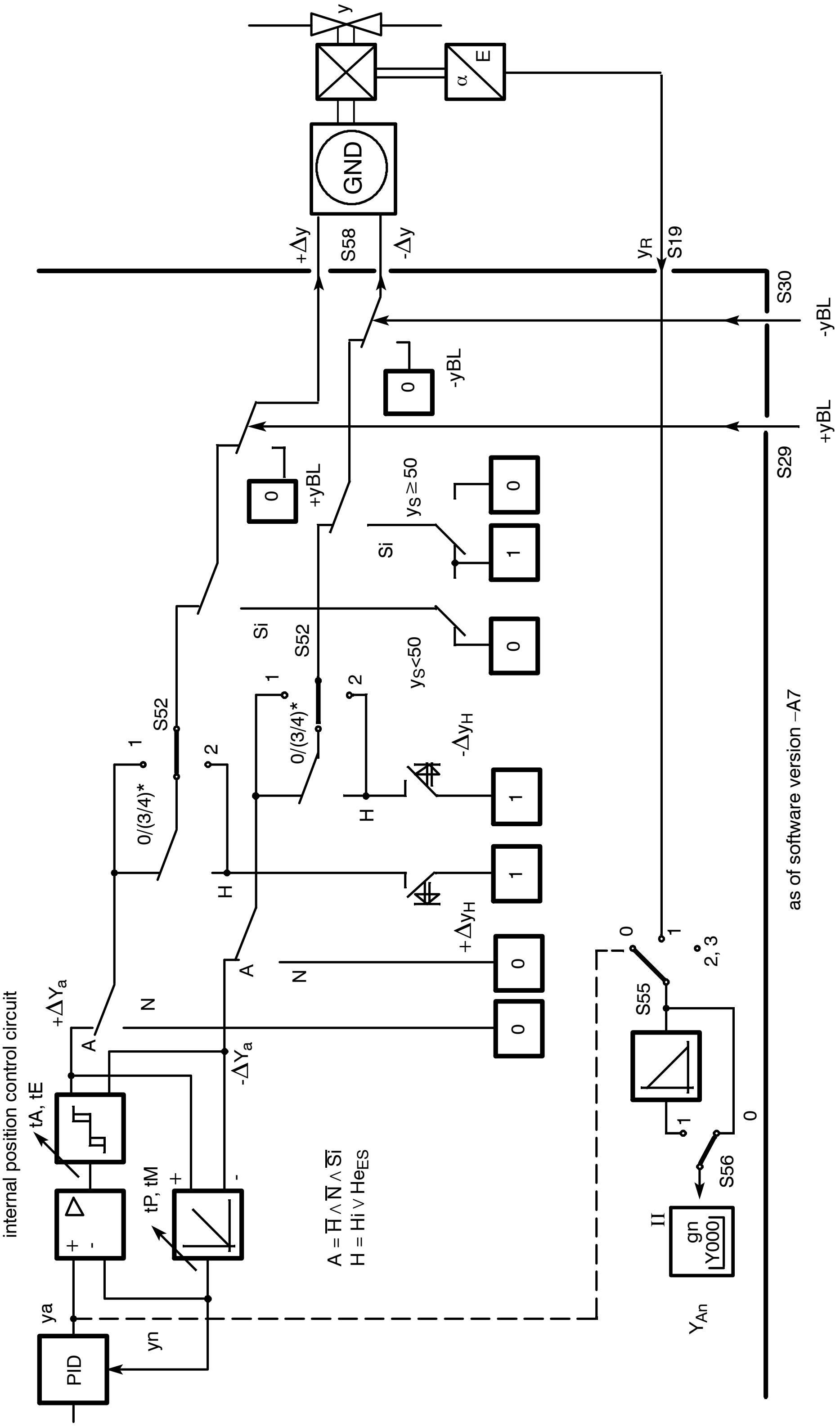


Figure 3-28 Block diagram S-controller with internal feedback S2 =2
Manual operation has priority over tracking S50 = 1

- **S2 = 3: Three-position stepper-(S)-controller with external feedback**

see figure 3-29, page 111 and figure 3-30, page 112

To control I-acting motorized actuating drives.

In S-controllers with external feedback the “internal position control circuit” is replaced by a real position controller (with the K-controller output y as a setpoint and the position feedback y_R as an actual value). As a result a manipulated variable limiting of ya and an absolute value preset of y_E and ys are now possible.

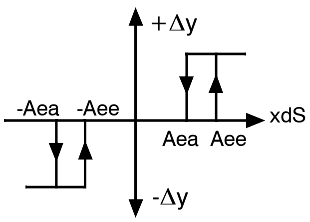
With the absolute value preset of y_E it is also possible to preset the manual manipulated variable via the SES as an absolute value y_{ES} in tracking operation.

Here too the response threshold of the position controller is preset with the parameters tE (minimum turn-on duration) and tA (minimum turn-off duration) in connection with tP and tM (floating time positive/negative direction) which are all set in the parameterization mode onPA.

- Switching on $A_{ee} = 4 \frac{100\,\% \cdot tE}{tY}$
- Switching off $A_{ea} = 3 \frac{100\,\% \cdot tE}{tY}$
- Hysteresis $A_{ee} - A_{ea} = \frac{100\,\% \cdot tE}{tY}$
- Pause $A_a = \frac{100\,\% \cdot tA}{tY}$

tY = tP, tM set floating time (parameterization mode onPA)

If a control deviation of xds ≥ Aee is set up, the three-position switch switches direction-dependently to continuous contact. xds is reduced by the negative follow-up of the position control circuit until xds < Aea is reached. The continuous contact is now switched off. After the pause time tA pulses of length tE are output with subsequent pause time tA until xds ≤ Aee is reached.



These single pulses are also output if xds coming from zero does not reach Aee. These single pulses which are not fully transformed into the path change (rotational movement) additionally settle the control circuit, i.e. in theory (without lag) the single pulses would switch off at 0.25 or 0.5 Aee. The opposite direction can only occur at appropriate control deviation after the pause time tA.

The control difference of the position control circuit xds can be measured at assigmment to an analog output.

The manual adjustment is made as an incremental adjustment by far overranging of the three-position switch so that manual adjustment is also possible when the position feedback is interrupted.

To simplify commissioning of the position control circuit, the manual manipulated variable is preset absolutely at S55=0 (manipulated variable of the K-controller) so that at this structure switch position the setpoint of the position control circuit is changed continuously by the manual manipulated variable in order to perform optimization (see chapter 6.2, page 205). It should be taken into account here that the manual manipulated variable which is also displayed is changed faster by the floating time tY than the active manipulated variable on the actuator and a lag therefore takes place. The leveling state can be observed by the Δy-LEDs (12) in the x-display (1) and w/y-display (2). S55 must be set to 1 after optimization to display the active manipulated variable by the position feedback y_R.

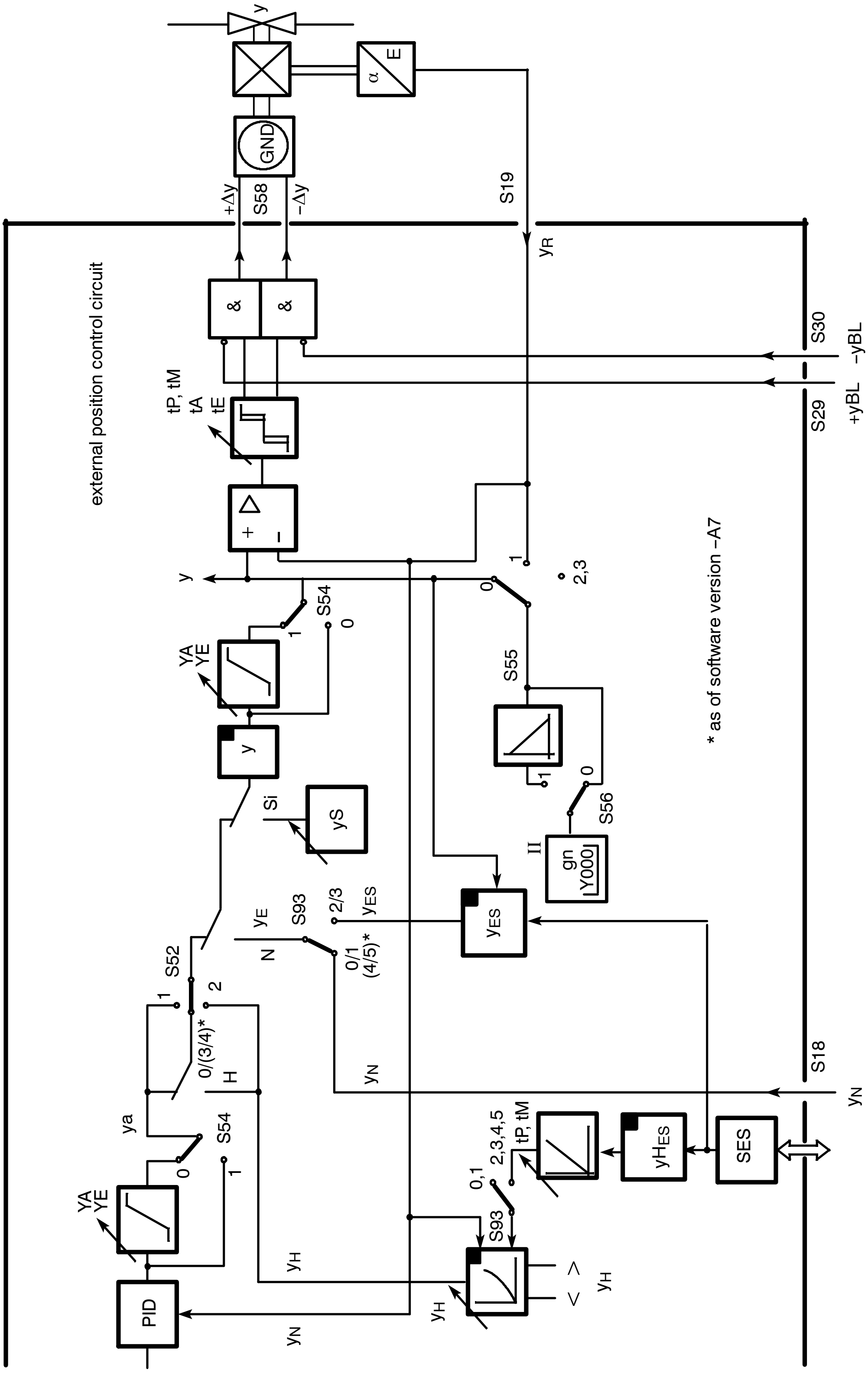


Figure 3-29 Block diagram S-controller with external feedback S2 = 3
Tracking has priority over manual operation S50 = 0

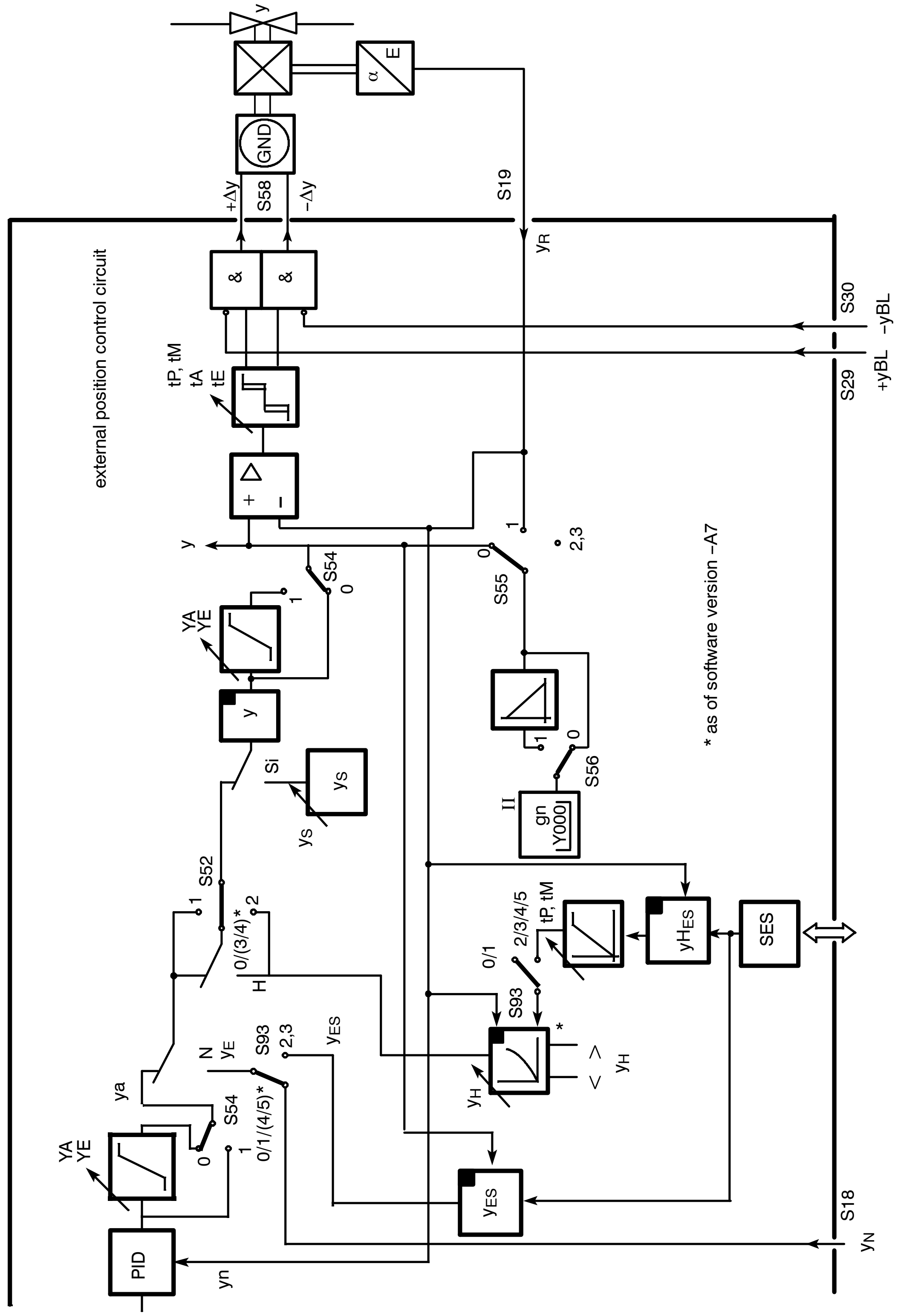


Figure 3-30 Block diagram S-controller with external feedback S2 = 3
Manual operation has priority over tracking S50 = 1

Control signals					Message signals				active y	Explanation
Digital inputs			Front		Front		Digital outputs			
± yBL	Si	N	He[7]	Hi[8]	H LED	y-Ext. LED	H	Nw		
0	0	0	0	0	0	0	0	0	y_a (n)	Automatic mode
0	0	0	1	0	0.9[4]	0	1	0	y_H (n), (↗)	Manual mode
0	0	0	0	1	1	0	1	0	y_H (n), (↗)	Manual mode
0	0	0	1	1	1	0	1	0	y_H (n), (↗)	Manual mode
0	0	1	0	0	0	1	0	1	y_E (n) [1]	Tracking operation
0	0	1	1	0	0.5[5]	1	1	1	y_E (n)	Tracking operation
0	0	1	0	1	0.5[5]	1	1	1	y_E (n)	Tracking operation
0	0	1	1	1	0.5[5]	1	1	1	y_E (n)	Tracking operation
1	0	as above			0.5[5][6]	1	as above	0	± yBL [2]	± Blocking mode
1	1				0.5[5][6]	1		0	± yBL [2]	± Blocking mode
0	1				0.5[5][6]	1		0	y_S [3]	Safety operation

Table 3-13 Output switching of all controller types
Tracking mode has priority over manual mode (S50 = 0)

Control signals					Message signals				active y	Explanation
Digital inputs			Front		Front		Digital outputs			
± yBL	Si	N	He[7]	Hi[8]	H LED	y-Ext. LED	H	Nw		
0	0	0	0	0	0	0	0	0	y_a (n)	Automatic mode
0	0	0	1	0	0.9[4]	0	1	0	y_H (n), (↗)	Manual mode
0	0	0	0	1	1	0	1	0	y_H (n), (↗)	Manual mode
0	0	0	1	1	1	0	1	0	y_H (n), (↗)	Manual mode
0	0	1	0	0	0	1	0	1	y_E (n) [1]	Tracking operation
0	0	1	1	0	0.9[4]	0.5[5]	1	0	y_H (n), (↗)	Manual mode
0	0	1	0	1	1	0.5[5]	1	0	y_H (n), (↗)	Manual mode
0	0	1	1	1	1	0.5[5]	1	0	y_H (n), (↗)	Manual mode
1	0	as above			0.5[5][6]	1	as above	0	± yBL [2]	± Blocking mode
1	1				0.5[5][6]	1		0	± yBL [2]	± Blocking mode
0	1				0.5[5][6]	1		0	y_S [3]	Safety operation

Table 3-14 Output switching of all controller types
Manual mode has priority over tracking mode (S50 = 1)

1) Source for y_E at S93 = 0, 1 (4, 5 as of software version -A7) y_N, at S93=2, 3 y_{ES} by the SES. The external manipulated variable fed in through the SES (y_{ES}) is tracked. When feeding in via y_N the feeding instrument must be tracked.
2) Blocking operation acts direction-dependently, changes to the opposite direction are possible.
3) Function y_S in S-controllers with internal feedback (S2 = 1) drive open- or closed otherwise parameterizable safety setting value.
4) 0.9 flashing rhythm 0.1 off, 0.9 on
5) 0.5 flashing rhythm 1:1
n Tracked to the value active before switching, therefore bumpless switching
↗ adjustable
6) Only if Hi ∨ He
7) For S52 ≠ 3, 4
8) As of software version -A7 the signals He_{BE} and He_{ES} with S52 = 3, 4 have dynamic effect (0/1-edge). They then act like the Hi-signal (see figure 3-3, page 57)

- **Automatic mode ($y = y_a$)**

  Automatic mode is switched off / on with the automatic/manual key or in dynamic switching (S52 = 3,4)[1] by He (yellow Manual LED (11). All other control signals He, N, Si and ±yBL must be 0. The automatic manipulated variable is connected through to the controller output.

- **Manual mode ($y = y_H$)**

  Manual operation is switched on by the automatic/manual key (yellow manual LED(11) on) or the control signal He as an OR function. The control signal He acts statically in the structure switch settings S52 = 0,1. At S52 = 3,4 He acts dynamically, i.e. every positive edge causes a switching process. The control signals Si and ±yBL must be 0. If tracking mode has priority over manual mode (S50=0) the control signal N must also be Low. Otherwise tracking operation or safety- or blocking operation become active, the manual-LED then flashes in 0.5 rhythm as an identification. The manual manipulated variable is switched through to the controller output. The manual manipulated variable is preset in K-controllers as an absolute value, in S-controllers as a positioning increment.

- **Tracking mode ($y = y_E$)**

  The tracking operation is switched on by the control signal N. The control signals Si and ±yBL must be 0. If manual mode has priority over tracking mode (S50 = 1) the control signal $H = Hi \vee He$ must be = 0.

  The external manipulated variable y_E is connected through to the controller output. The source for y_E is preset at S93 = 0, 1, as an absolute value y_N. With S93 = 2, 3 the absolute value becomes active as an external manipulated variable via the SES (y_{ES}).

  In S-controllers with internal feedback (S2 = 2), absolute value presets of the manipulated variable and thus the tracking operation are not possible.

- **Safety operation (y = YS)**

  The safety operation is switched on by the control signal Si. The control signal ±yBL must be 0. The safety manipulated variable YS is through connected which can be set as a parameter in the structuring mode oFPA in the range from -10 to 110 %. In S-controllers with internal feedback (S2 = 2) absolute value preset of the manipulated variable is not possible. When safety operation is active, at YS ≤ 50 % -Δy continuous contact and at YS > 50 % +Δy continous contact is output so that the actuator drives to the end positions.

- **Direction-dependent blocking operation**

  The blocking operation is controlled by the control signals ±yBL. All other control signals have no function. If a control signal is applied the manipulated variable output is blocked direction-dependently, i.e. only changes in the opposite direction are allowed. If both control signals are applied simultaneously, the output is blocked absolutely. The direction-dependent blocking is necessary especially in S-controllers with internal feedback and actuators with limit stop switches to avoid integral saturation. If the control circuit is opened on reaching the

[1] as of software version –A7

end position of the actuator, further integration of the controller must be prevented in order to be able to react immediately in the event of control difference reversal.

As described above, the control signals ±yBL have priority over Si and H or N. The priority of H or N can be selected by S50. All these operating modes have priority over automatic operation.

The switching states are signaled by the LEDs Manual (11) and y-external (10). When manual mode is active or preselected (if the priority opeating modes are active), the manual LED lights up. He = 1 is signaled by a flashing rhythm of 0.9 (control signal) if Hi = 0 (i.e. is in automatic mode by the manual/automatic switching). When switching the control signal He from 1 → 0 the automatic mode becomes active.

Tracking, safety and blocking operation is signaled by the y-external LED. Flashing rhythm 0.5 indicates that in “manual operation priority over tracking operation”, manual operation is active but tracking operation is prepared and after switching to automatic operation also becomes active.

- **Blocking of the manual/automatic switching (S52)**

With S52 the manual/automatic switching can be blocked in operating modes automatic mode only or manual mode only. The other operating modes are still possible. Then, tracking mode is only possible if tracking has priority over manual mode (see figure 3-24, page 103).

- **Manual operation in case of transmitter fault (S51)**

With S51 you can switch over to manual operation in the event of a transmitter groups fault (see chapter 3.2, page 51). Manual operation begins at S51 = 1 with the last y or at S51 = 2 with the parameterized YS. In both cases the manual manipulated variable can be adjusted with the ± Δy keys after switching.

- **Source and direction of effect of the y-display (S55, S56)**

With S55 the y-display is switched to the different display sources or switched off. The absolute manipulated variable y or the split range-manipulated variables y_1 and y_2 in two-position controllers heating/cooling or the position feedback-signal y_R in three-position-S-controllers can be displayed.

With S56 the display direction of effect can be selected rising/falling (see chapter 6.1, page 203).

- **Control system coupling via the serial interface**

As of software version –A7 a parallel process operation is possible through the serial interface in addition to the SPC controller (S1 = 2) in all types of controller. The control signals Int and Hi (via He_{ES} at S52 = 3/4, see chapter 3.3, page 54) and the process variables wi and y_H can be written through the serial interface at S93 ≥ 2 so that the switching from internal to external setpoint and automatic/manual switching is possible in all types of controller. If the internal setpoint wi or the manual manipulated variable y_H is active it can also be changed by the SES or the adjusting keys on the front panel. Since the SES can only adjust absolutely and not incrementally, it is advisable to use the setpoint ramp (tS) or the dynamic manipulated variable with ty to avoid steps.

This parallel “operation” via the serial interface can be locked at S52 = 3 by $\overline{RC}$ = Int ∨ $\overline{CB}$ (see figure 3-3, page 57). This locking facility for the operation via SES on the controller front is only useful in the controller types fixed setpoint controller with a setpoint (S1 = 5) and follow-up controller without internal/external switching (S1 = 6) because in all other controller types both the internal key and the control signal CB have other additional functions.

At S52 = 4 the locking facility is omitted and operation is always parallel to the front keys.

To avoid simultaneous actuation via the controller front and the SES, the last switching action can be read on the process control system. For this, a status bit is set when writing IntES and He_{ES} which is only reset when the front keys Int or Hi are actuated. By requesting the status bit, the process control system can issue a warning when the last operation took place via the front.

At S92 = 1:

Writing of the status signals Si_{ES}... to ...tSH_{ES} is locked by $\overline{RC}$.

If the last operation was through the SES, the SES warning flashes for 3 s in the w/y-display on pressing the internal key. This initial pressing of the keys does not activate a switching function, only when the keys are pressed again is the desired switching function triggered.

At S92 = 2:

Writing of the status signals Si_{ES}... to ...tSH_{ES} is locked by CB.

At S92 = 3: *)

The status signals Si_{ES}... to ...tSH_{ES} are always accessible via the SES (see figure 3-3, page 57).

*) as of software version C4

3.7 Analog output signal processing (S57)

The controller-internal variables are assigned to the analog output AO/Iy by the structure switch S57 whereby every controller variable can be structured to 0 or 4 to 20 mA.

The bipolar process variable xd is output with an offset of 50 % (10 mA or 12 mA).

Analog output Iy assignment and current range

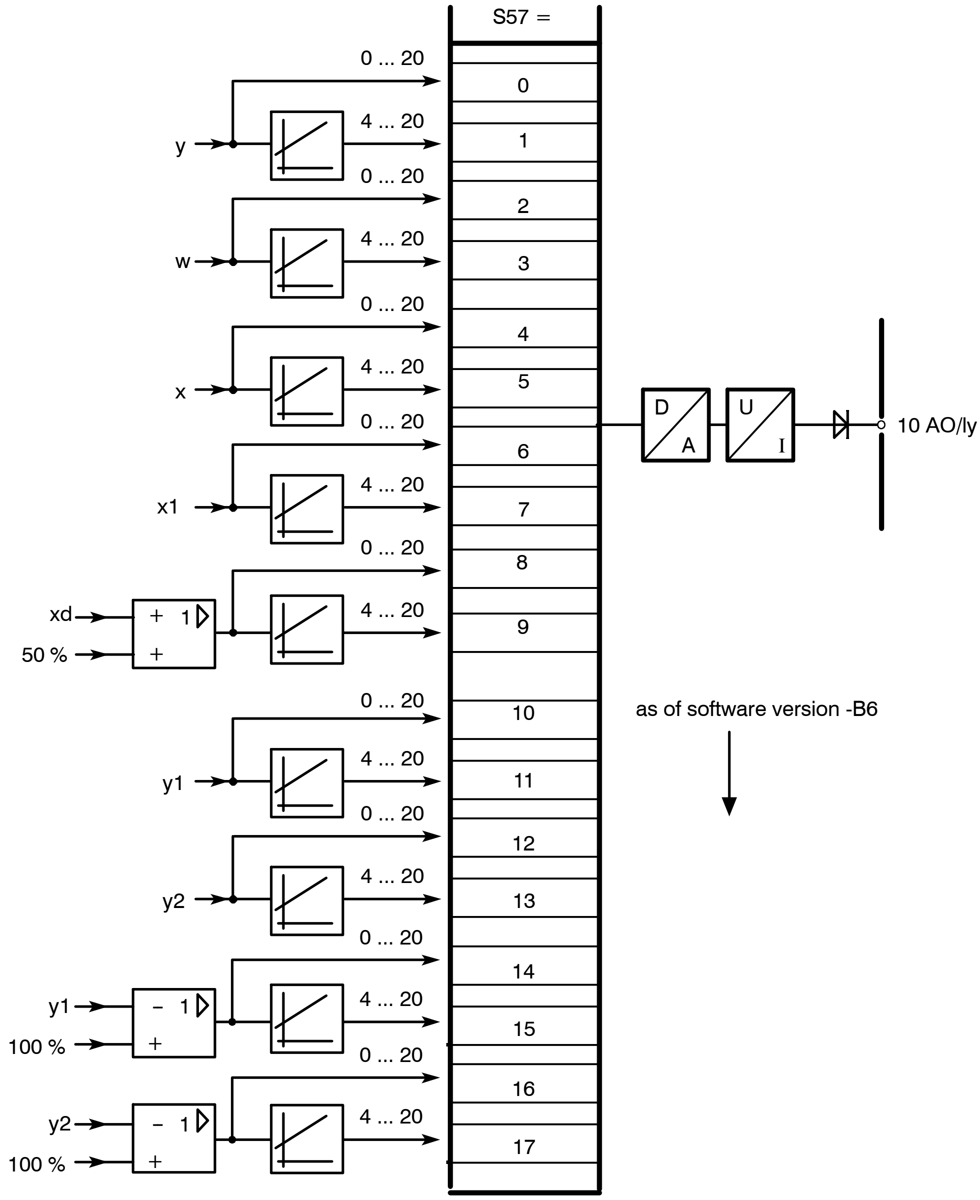


Figure 3-31

3.8 Digital output signal processing (S58 to S82)

The message signals $\overline{RB}$, $\overline{RC}$ ... MUF, +Δw and -Δw are assigned to the digital outputs DO1 to DO8 by the structure switches S59 to S69 and can be negated optionally with the structure switches S76 to S82 (except +Δw and -Δw).

At S1 = 5 (program controller) the message signals CLb1...6 are also available which can be assigned to the digital outputs with S70 to S75 (see figure 3-32, page 120).

The digital outputs DO1, DO2 and DO7, DO8 of the standard controller can be extended with the options modules 4DO 24 V +2DI (6DR2801-8E) or 2DO-relay 35 V (6DR2801-8D) in slot 3 to a maximum 6 or 8 digital outputs. When using 4DO 24 V +2DI in slot 3 by DO3 to DO6, when using 2BA-relay 35 V in slot 3 by DO3 and DO4.
When using options modules in slot 3, structure switch S22 must be set according to the assignment, other settings lead to error messages (see chapter 5.5, page 202).

The control signals ±Δy (positioning increments of the S-controllers) are not negatable but can be assigned optionally by S58 to one of the digital outputs DO1, DO2, DO7 or DO8. Setting of S58 has priority over assignments with S59 to S75. The assigned digital outputs for ±Δy are not stored in “ST5” and “BABE” (refresh-time approx. 20 ms). Decription of ST5 and BABE: see operating instructions “Serial SIPART 6DR190x Bus Interface”.

On assigning different control signals to the same digital output an OR-function of the control signals is produced (exception at ±Δy).

Unassigned digital outputs (switch position 0) are Low and can be set at S93 = 2 by the SES. All digital outputs have wired-or-diodes.

- **Functional explanation of the digital message signals.**

$\overline{RB}$ — *No computer standby of the controller*
This signal indicates that the controller is in internal operation, i.e. not in computer standby.

$\overline{RC}$ — *Computer operation*
This signal indicates the negated computer operation $\overline{RC} = \overline{Int \wedge CB}$ and controls the setpoint switching.

H — *Manual mode*
The controller is in manual mode, triggered either by the manual/automatic switching on the front of the device (Hi) or by the digital output signal He if the control signals Si, ±yBL and N (with priority of trackingmode over manual mode) Low.

Nw — *Tracking operation*
The controller is in tracking mode when the control signals Si, ±yBL and H (with priority of manual mode over tracking mode) are Low and the control signal N is High.

A1/A2 — *Alarm 1 and 2* indicate response of the limit value alarms A1 and A2.

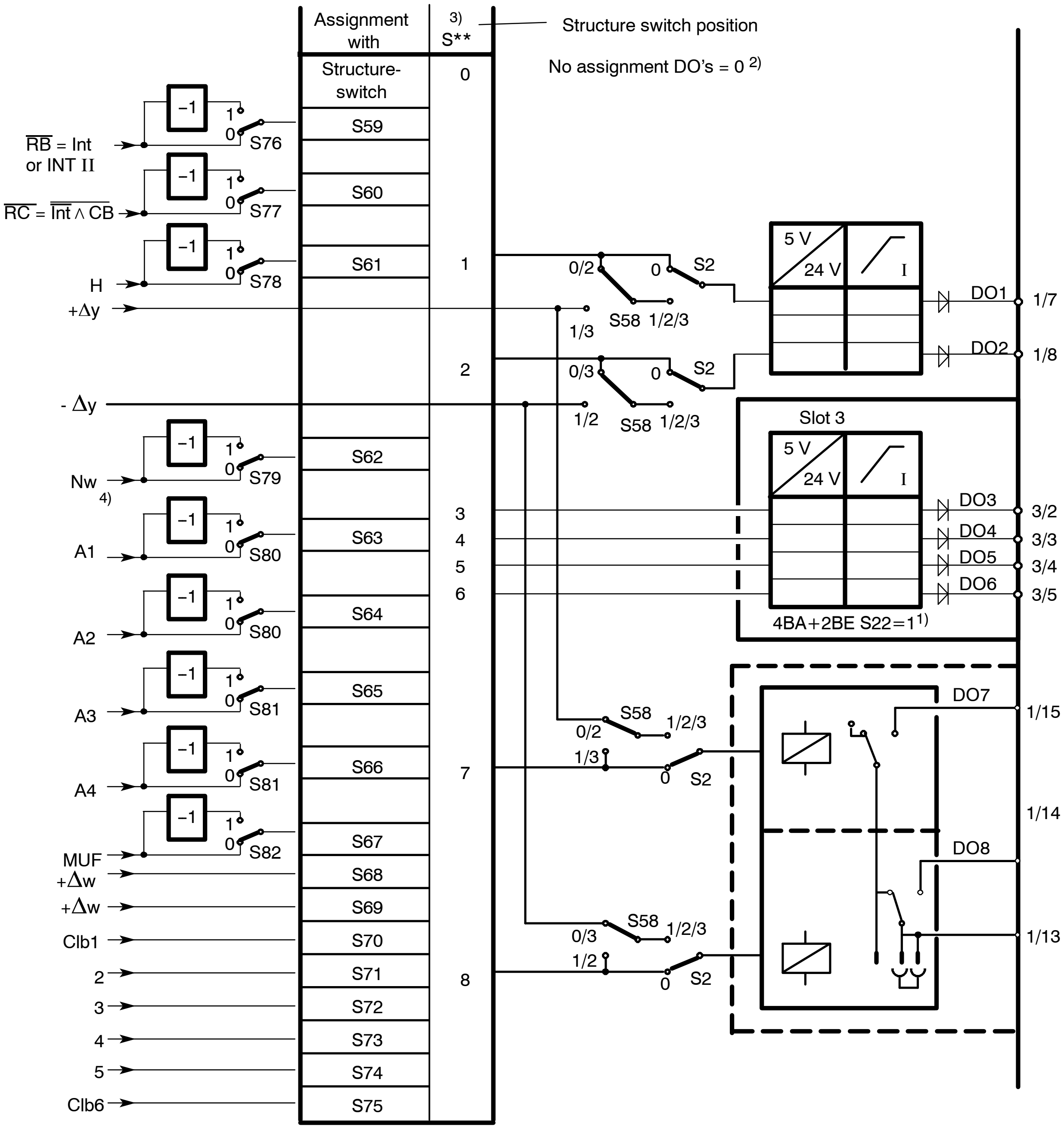
A3/A4 — *Alarm 3 and 4* indicates response of the limit value alarms A3 and A4.

MUF *Transmitter fault*
The instruments's analog input signals can be monitored for exceeding of the measuring range. This signal gives a group alarm if an error is detected.

± Δy *Positioning increments for the Δy-adjustment in S-controllers*

± Δw *Positioning increments for the Δw-adjustment*, only for control unit/process display (S1 = 4)

CLB1 to CLB 6 *Status messages of the program controller*
1 to 6 digital message signals can be generated per interval per program.



1) When using 2DO-relay 35 V, 6DR2801-8D (S22 = 3) only DO3 and DO4 are available.

[2] At S** = 0 there is no assignment, the digithal outputs are then 0 and can be set at S93 = 2 by the SES.
[3] Assignment of different control signals to one digital output causes an OR-function.
[4] Message signal active tracking mode see page 118.

Figure 3-32 Assignment of digital outputs (S58 to S82)

3.9 Adaptation (S49)

The adaptation procedure represents a reliable and easy to operate commissioning tool. The adaptation method is far superior to manual optimization especially on slow controlled systems (high system order). It is activated by the operator and can be aborted at any time in the event of danger. Overshoots are largely avoided during adaptation. The adaptation method can be aborted without danger at any time.

The controller parameters determined by adaptation become active automatically at the end of self setting.

In the parameterization mode AdAP, which is only accessible at S49>0, a preselection is made whether a PI- or a PID-controller is to be designed.

- **Adaptation requirements**

  In order to be able to identify the system reliably the controlled variable must run through at least 20 % of the control range. For this reason a target setpoint must be preset before starting adaptation which is at least 20 % away from the controlled variable's starting value.

  When operating as a two-position controller (S2 = 1), e.g. for operating mode "Heating/Cooling", the split range-foot points Y1, Y2 (oFPA-parameter) must be set according to the following instructions.

Y1=0.0	and	Y2>0.0	heating only
Y1<100.0	und	**Y2=100.0**	cooling only
0.0<Y1	and	**Y2<100.0**	heating and cooling

- **Adaptation principle**

The adaptation is based on a limit oscillation analysis according to Aström/Hägglund. 100% and 0% manipulated variable is applied alternately to the controlled system according to figure 3-33. If the target setpoint is below the controlled variable starting value, the adaptation starts with output of the minimum manipulated variable.

NOTE

The trigger for the adaptation can be limited by YE for critical systems.

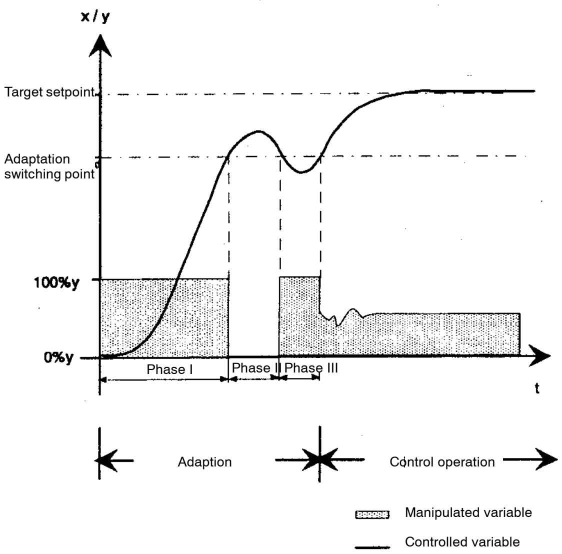


Figure 3-33

The controlled variable performs a control oscillation below the target setpoint which is evaluated with respect to the period duration and the oscillation amplitude. The necessary controller parameters (Kp, Tn and also Tv in the PID controller) can be determined from these oscillation characteristic values with a modified Ziegler/Nichols method.

An aperiodically damped command control is usually achieved with the parameter settings. At preselection of S49 = 2 the determined controller parameters are additionally weakened.

Adaptation is ended after completing one oscillation period. The control process with the newly determined parameters starts with a manipulated variable which allows as fast a settling of the remaining control difference as possible. If manual mode is activated during adaptation, the controller manipulated variable remains at its initial value at the end of self setting.

- **Special case: Systems without settling:**

  No control oscillation can be generated within a controller-internal monitoring time in systems without or with low settlling. Here adaptation is ended in phase II. The system knowledge from phase I is used for a PI controller design according to the “symmetrical optimum” (figure 3-34).

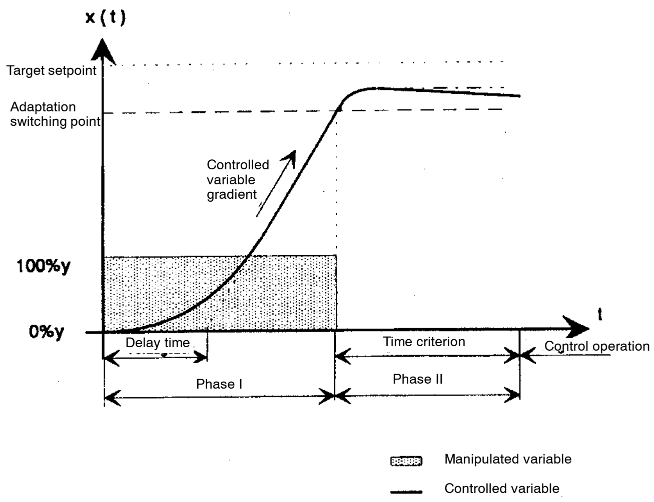


Figure 3-34

- **Special case: 2 actuators at S2 = 1**

  When 2 actuators are controlled, the described adaptation algorithm is extended by two further excitement phases (figure 3-35). A cooling and then a heating excitement phase follow phase III (heating). From the comparison of the heating and cooling system gain the split range foot points Y1 and Y2 are set automatically so that the different performance data of the two actuators are taken into account in the control. The onPA-parameter tP (heating period duration) and tM (cooling period duration) are adapted to the system by the adaptation algorithm.

  Adaptation requires no stationary start state of the controlled variable. The error messages which are possible in connection with adaptation are listed in chapter 5.4.3, page169 together with the operating instructions.

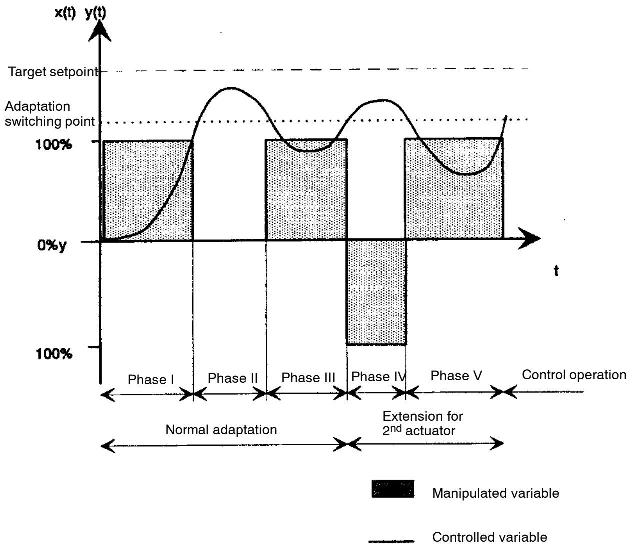


Figure 3-35

3.10 Other functions of the standard controller

3.10.1 Adaptive filter

The control difference xd is fed through an adaptive filter. By adjusting tF (onPA) from oFF to 1 s the filter is switched on. By further increases to tF* the filter can be adapted to a low-frequency disturbance frequency (seconds-to hours time-constant). Within a band in which changes occur repeatedly, changes are interpreted as a fault by the filter and filtered with the preset time constant tF, changes in a direction out of the band are passed unfiltered to the PI(D)-algorithm to enable a faster control. If the disturbance level changes in time, the filter is automatically adapted to the new level.

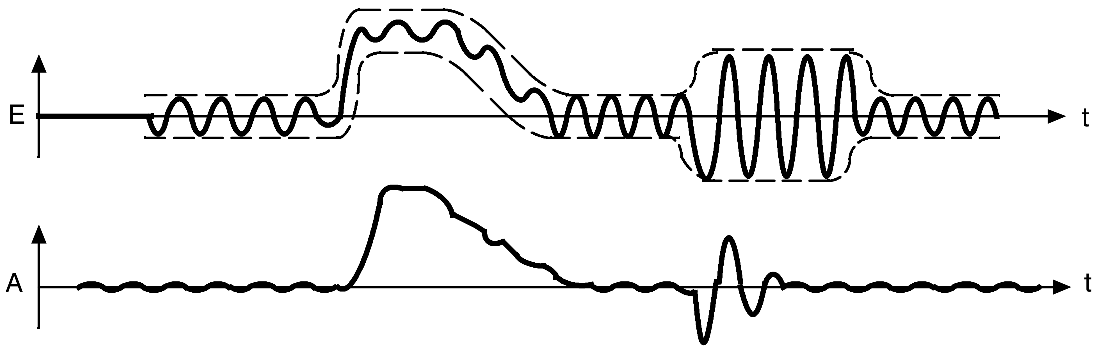


Figure 3-36 Effect of the adaptive non-linear filter

The factory setting of tF is 1 s. In controllers with D-part it should be set as great as possible because of the input noise amplified by vv · kp and in the adaptation.

3.10.2 Response threshold AH

The response threshold AH (dead zone element) is in the control difference connected after the adaptive filter.

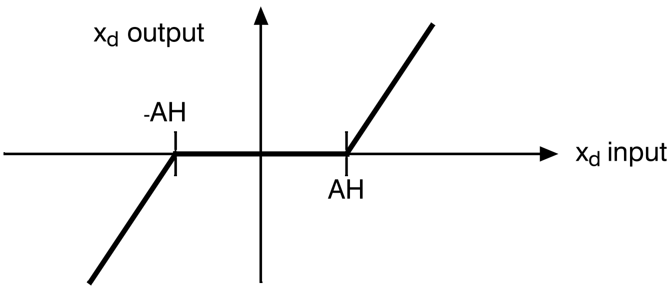


Figure 3-37 Effect of the dead zone element

The dead zone element lends the controller a progressive behavior, at small control differences the gain is low or even 0, at larger control differences the specified Kp is reached. It should be taken into account that the remaining control difference can adopt the value of the set response threshold AH.

The factory setting of AH is 0 % and can be set up to 10 % in the parameterization mode onPA.

In S-controllers the minimum necessary setting of AH is given by the minimum Δ x=ks Δ y (see chapter 6.3, page 205) and can be increased for further settling of the controlled system. In K-controllers a small threshold value is advisable for settling the control circuit and reducing wear on the actuator.

3.10.3 Limit value alarms (S83 to S87)

The limit value alarm pairs A1, A2 and A3, A4 are assigned to the controller-internal variables xd, x ... AE2A, AE3A, |xd| by the structure switches S83 and S84. Every limit value alarm pair can be set to the monitoring functions Max/Min, Min/Min or Max/Max by S85 (A1, A2) or S86 (A3, A4).

The response thresholds A1 to A4 and the hysteresis HA are set in the structuring mode oFPA.

According to the switch position of S87 only the display or the display and adjustment of A1 to A4 is possible in the process operation level. In this case the switching cycle of the Shift key (6) is extended by the response thresholds A1, A2 or A1 to A4:

Example display order switching key (6): w - y - A1 - A2 - A3 - A4 - x . . .

The respective limit value is displayed by lamps L1 to L4 flashing in 0.5 rhythm. When a limit value has been selected and addressed, the appropriate lamp flashes in 0.9 rhythm. The value of the limit value is displayed on the x/y digital display (2) and depending on the assignment is set physically or in % according to the display format of the digital x/w display.

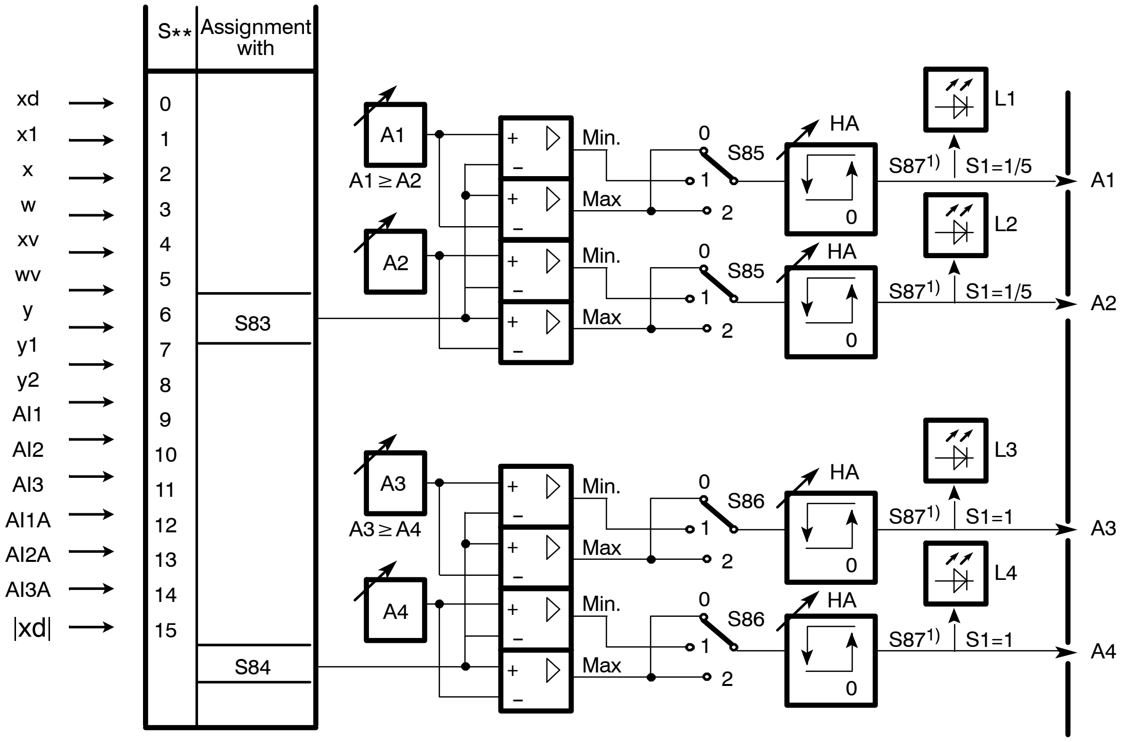
S1	S83, S84	assigned to	Display format w/y-display (2) S87 > 0	Parameter range w/y-display (2)
0 1 2 4 5 6 7	0 ↓ 5/15	xd ↓ wv |xd|	according to dA to dE -1999 to 9999	-110 % to 110 % referenced to dE - dA = 100 %
	6 ↓ 16	y ↓ AI3A	%	- 110 % to 110 %
3	0 ↓ 3/15	xd ↓ w |xd|	%	- 110 % to 110 %
	4 ↓ 5	xv ↓ wv	according to dA to dE -1999 to 9999	-110 % to 110 % referenced to dE - dA = 100 %
	6 ↓ 16	y ↓ AI3A	%	- 110 % to 110 %

Table 3-15 Display format of the limit values A1 to A4

A2 cannot be set greater than A1 and A4 not greater than A3.

The hysteresis HA is set in % in the range from 0.1 to 10 % and applies for all 4 limit values.

The function of the limit values (Min or Max) always relates to the display, i.e. in the case of a falling characteristic (dE< dA) the direction of effect is reversed. The set Min-function for example becomes a Max-function related to the field signal.



1) The autmatic assignment by S1 = 1 (signaling of the active auxiliary setpoints SH1 to SH4) and by S1 = 5 (signaling program 1 or 2) is only effective at S87 = 2 or S87 = 1)

Figure 3-38 Assignment and function of the limit value alarms (S83 to S87).

3.10.4 Linearizer (S21, oFPA)

The linearizer is freely assignable to an input AI1 or AI3 or to the main controlled variable x1. If the main controlled variable is linearized, the range dA to dE is decisive, otherwise there is a percentage reference to the measuring range. The curve is rounded at the support points.

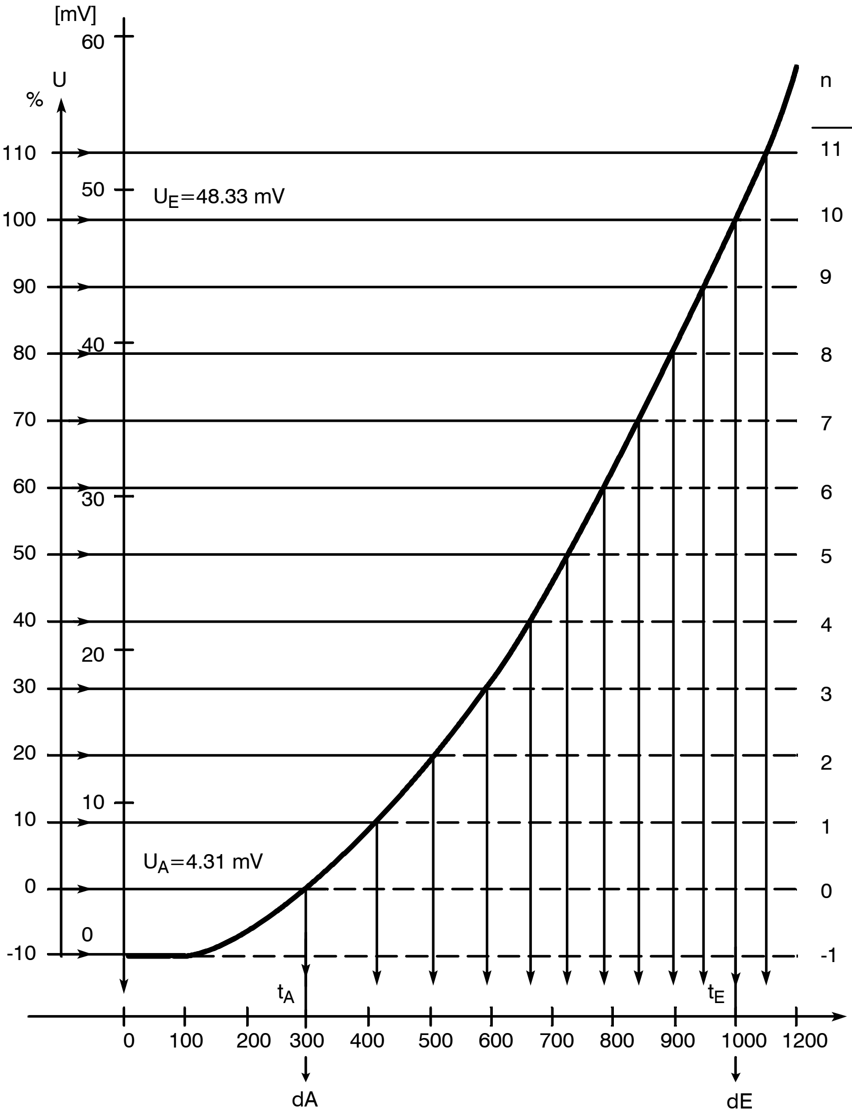
Example: Thermocouple 300 to 1000 °C with transmitter without linearizer (AI1 is already temperature-linearized)

Set start of scale and full scale dA and dE and the decimal point dP in the structuring mode oFPA for the display. Divide the measuring range UA to UE including ± 10% overrun in 10 % steps and determine the partial voltages. L_{-1} to L_{11} are equidistant support points with 10 %-steps.

UA = 4.31 mV
UE = 48.33 mV

$$U_n = \frac{U_E - U_A}{10} \; n + U_A \quad \text{with n = −1 to 11}$$

Determine the respective physical value from the appropriate function tables for every U_n or graphically from the corresponding curve (interpolate if necessary) and enter the value for the respective vertex value (L_{-1} to L_{11}) in physical variables in the structuring mode oFPA.



n	Un [mV]		vertex-value	t [°C]
11	52.732	→	L11	1048
10	48.33	→	L10	1000
9	43.928	→	L9	951
8	39.526	→	L8	900
7	35.124	→	L7	846
6	30.722	→	L6	790
5	26.32	→	L5	729
4	21.918	→	L4	664
3	17.516	→	L3	593
2	13.114	→	L2	514
1	8.712	→	L1	420
0	4.31	→	L0	300
-1	0.092	→	L-1	0

Figure 3-39 Example of linearization of a thermocouple type B Pt30Rh/Pt6, measuring range dA to dE from 300 to 1000 °C

3.10.5 Restart conditions (S90, S91)

The restart conditions after mains recovery are determined with S90. With S90 = 0 the controllers restarts after mains recovery and after a watchdog reset with the oeprating mode and the y which existed before the power failure. This variation must be used when temporary mains failures are to be expected in slow control circuits.

With S90 = 1 starting is effected after mains recovery in manual and internal mode with ys in the K-controller (S2 = 0) and two-position controller (S2 = 1) or with the last y in the three-position controller (S2 = 2, 3). If only external operating mode has been selected by S43 = 1 or only automatic mode by S52 = 1, restarting is effected in these modes.

With S91 the optical signaling of mains voltage recovery and reset is determined by flashing of the digital x display. The flashing is acknowledged by pressing the Shift key (6) or by an alarm request via SES.

3.10.6 Serial interface and PROFIBUS-DP (S92 to S99)

The structure switch S92 determines whether operation is with SES (S92 = 1/2/3*) or without SES (S92 = 0).

With S93 the depth of SES intervention is specified. Generally all available set data are read. In position 0 no transmission and reception of data to the controller is possible. In position 1 only parameters and structures can be transmitted. In positions 2 to 5 the process variables w_{ES} (external setpoint via the SES), wi_{ES} (internal setpoint via the SES), y_{ES} (external manipulated variable via the SES), yH_{ES} (manual manipulated variable via the SES) and all control signals can be sent additionally via the SES. At the same time the sources for the external setpoint w_{ES} or w_{EA} and the tracking manipulated variable y_{ES} or y_N are switched with S93. This makes it possible to preset the process variables and the control signals only via the SES or the process variables analogly and only the control signals via the SES.

With S92 = 1/2/3 writing of the status signals Si_{ES}... to ...tSH_{ES} is locked optionally by $\overline{RC}$ or CB (see page 116).

The structure switches S94 to S99 determine the transmission procedure through the serial interface. For further details, see the operating instructions “Serial SIPART DR190x Bus Interface”, Internet address www.fielddevices.com [Edition 05.2000].

Settings for PROFIBUS-DP see table 5-5, page 190 (structure switch list).

[1] as of software version –C4

4 Assembly

4.1 Mechanical Installation

- **Selecting the Installation Site**

  Maintain an ambient temperature of 0 to 50 °C. Don't forget to allow for other heat sources in the vicinity. Remember that if instruments are stacked on top of each other with little or no gap between them, additional heat will be generated. The front and rear of the controller should have good accessibility.

4.1.1 Work prior to installation

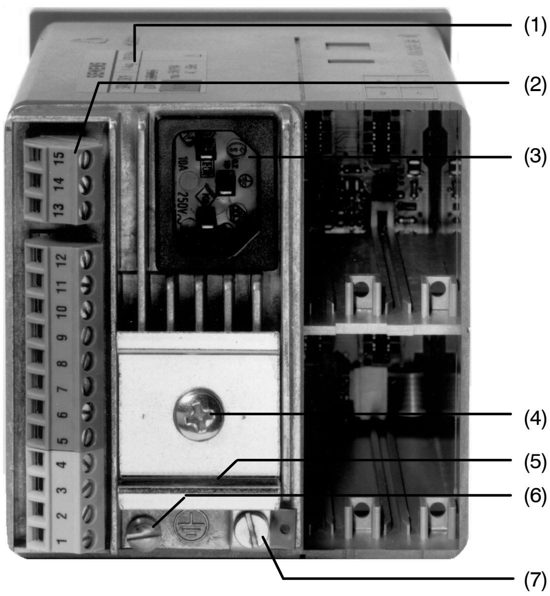
In the as-delivered state the controller 6DR1900-5 is set to 230 V AC mains voltage. The switching contacts are locked. The backplane module must be removed to change the mains voltage setting or to unlock the relay contacts.

- **Removing the backplane module**

CAUTION

The backplane module may only be removed when the mains plug and, if available, the 3-pin ±Δy-plug have been removed!

Loosen the fastening screw (6) and pull the module out from the back.



1 Type plate (example with 2 labels 115 V~) (as-delivered state 230 V~)
2 Plug ±Δy-outputs
3 Mains plug
4 Fastening screw for DIN rail
5 DIN rail 35 mm (DIN EN 50022) for mounting the coupling relay-modules 6DR2804-8A and 6DR2804-8B
6 Fastening screw for backplane module
7 PE conductor connecting screw

Figure 4-1 Rear of controller

- **Switching mains 230 V to 115 V**

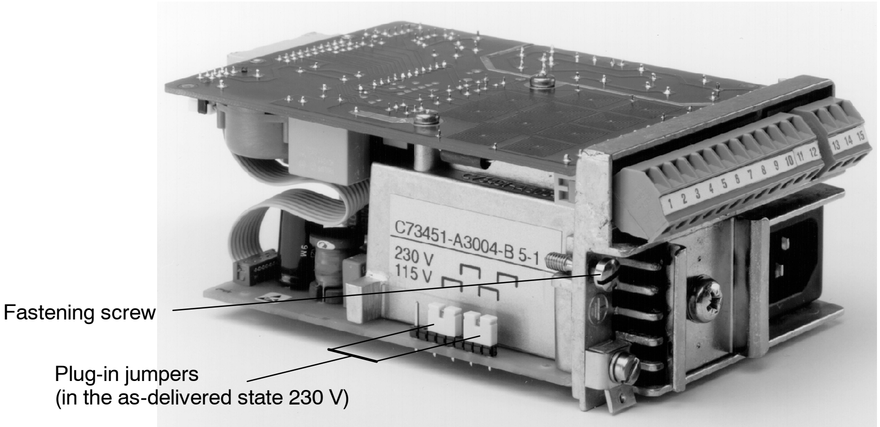


Figure 4-2 Setting the mains voltage

Re-plug jumpers as shown in the diagram in figure 4-2.
Stick the two labels provided (115 V power supply) to the rating plate in the field 230 V AC and on the housing to the right of the mains plug vertically to the rear of the housing (see figure 4-1). Re-install the backplane accordingly.

- **Unlock the relay contact**

Re-plug the plug-in jumper (figure 4-4, page 131) to unlock.

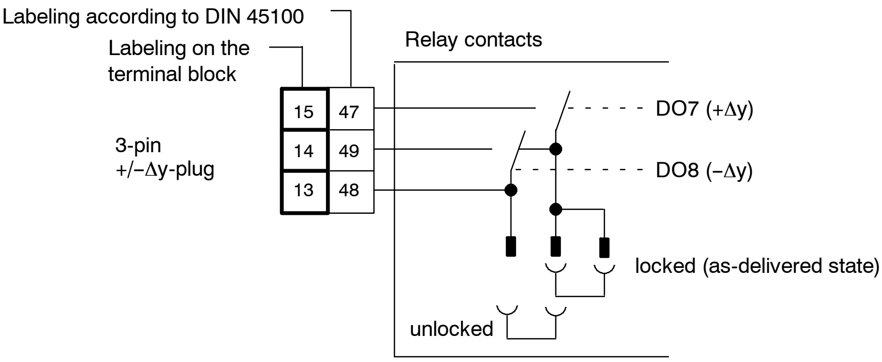
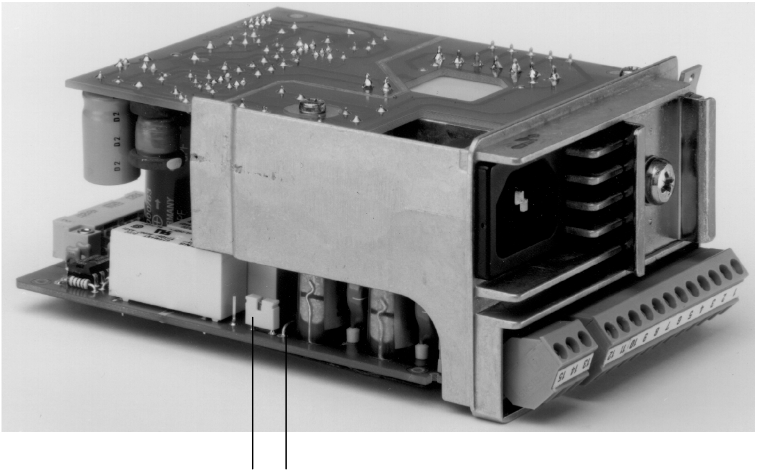


Figure 4-3 Circuit



(1) (2)

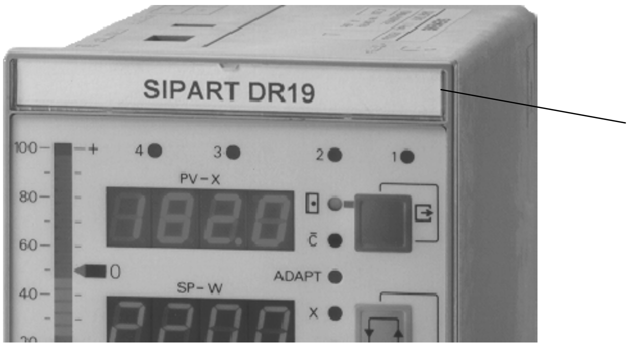
(1) As-delivered state (locked)
(2) Spark quenching element. Adapt resistance to connected contacts or servo motors if necessary.

Figure 4-4 Relay contact locking

Re-install the backplane accordingly.

- **Changing the tag plate**

The tag plate can be individually labeled with a smear-proof pen.



(1)

(1) Tag plate cover

Figure 4-5 Tag plate

Carefully lever out the tag plate cover with a screwdriver at the cutout at the top and snap the cover out of the bottom hinge points by bending slightly.

4.1.2 Installing the controller

- **Panel mounting**

The SIPART DR19 controllers are installed either in single panel cut-outs or in open tiers (see fig. 2-6, page 38 for dimensions).

Procedure:

- Insert the controller into the panel cut-out or open tier from the front and fit the two clamps provided to the controller unit from the rear so that they snap into the cut-outs in the housing.
- Align the controller and do not tighten the locking screws too tight. The tightening range is 0 to 40 mm.

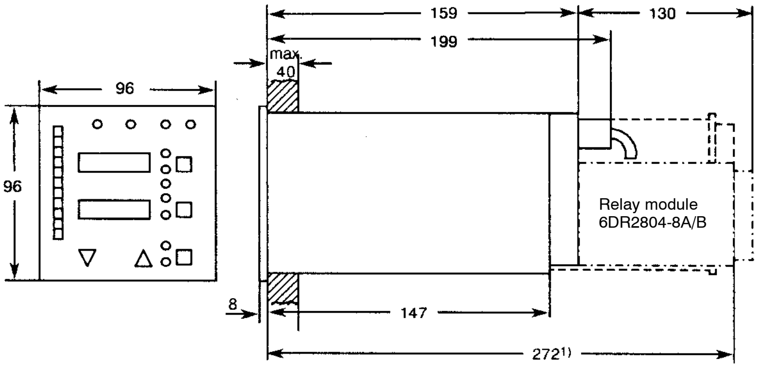
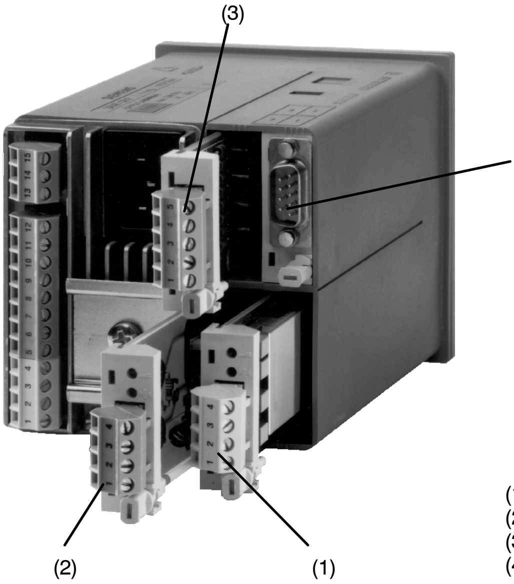


Figure 4-6 Dimensions SIPART DR19, dimensions in mm

4.1.3 Installation of the options modules

General

Signal converter modules can be inserted in the slots provided in the SIPART DR19 controllers from the rear. The slots are coded to avoid plugging the modules incorrectly.



(1)	Slot 1	AI3 (UNI, I/U, R)
(2)	Slot 2	AI2 (UNI, I/U, R)
(3)	Slot 3	5DI; 2DI 4DO; 2DO rel.
(4)	Slot 4	SES (RS 232/485, PROFIBUS DP)

Figure 4-7 Rear of controller

Jumper settings

Jumper settings may have to be made on the I/U, R, SES modules (see chapter 4.2 “Electrical Connection”, page 134 before inserting in the controller.

4.2 Electrical Connection

4.2.1 Warnings and block diagram

The arrangement of the connecting elements can be seen in fig. 4-7, page 133.

WARNING

The "Regulations for the installation of power systems with rated voltages under 1000 V" (VDE 0100)" must be observed in the electrical installation!

- **PE conductor connection**

  Connect the PE conductor to the ground screw (see figure 4-8), page 136 on the back of the controller. When connecting to 115 V or 230 V AC-mains the PE conductor connection can also be fed via the three-pin plug (see figure 4-9, page 137). The controller's ground-connection may also be connected with the PE conductor (grounded extra low voltages).

WARNING

Disconnection of the PE conductor while the controller is powered up can make the controller potentially dangerous. Disconnection of the PE conductor is prohibited.

- **Power supply connection**

  The power supply is connected for 115 V AC or 230 V AC by a three-pin plug IEC 320/V DIN 49457 A, at 24 V UC the power supply iy connected by a special 2-pin plug (any polarity). The mains plugs are part of the scope of delivery.

WARNING

Set the mains voltage plug-in jumpers (see figure 4-2), page 130 in the no-voltage state to the existing mains voltage.
It is essential to observe the mains voltage specified on the rating plate or by the mains voltage jumpers (115/230 V AC) or on the voltage plate (24 V UC)!
Lay the power cable through a fuse; limit the rating (fire protection EN 61010-1) to ≤ 150 VA. Limit the mains voltage alternatively to 30 V at 24 V UC.

- **Connection of measuring- and signal lines**

The process signals are connected via plug-in terminal blocks that can accommodate cables of up to 1.5 mm^2 (AWG 14) cross-section.

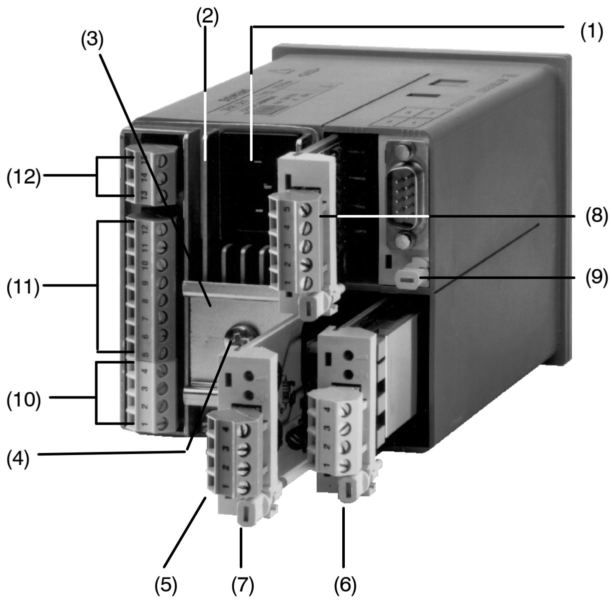
Standard controller	Terminal block 1, 2, 3	3-pin 4-pin 8-pin	S-outputs AI1 AO, DI, DO, L_+, GND
Options modules	Slot 1 and 2 Slot 3 Slot 4	4-pin 6-pin 9-pin	for analog input modules for digital I-O-modules for interface module

The coupling relay module should be snapped onto the DIN rail (figure 4-8, page 136) and wired to the digital outputs.

Slots 1 to 4 must be identified in the circuit diagrams. Makes sure that the module-terminal blocks are not switched.

Measuring lines should be laid separately from power cables to avoid the risk of interference couplings. If this is not possible, or – due to the type of installation – the controller may not function properly as a result of interference on the measuring lines, the measuring lines must be shielded. The shield must be connected to the PE conductor of the controller or one of the ground-connections, depending on the fault source's reference point. The shield should always only be connected to one side of the controller when it is connected to the PE conductor to prevent creation of a ground loop.

The SIPART DR19 is designed for a large electromagnetic compatibility (EMC) and has a high resistance to HF interference. In order to maintain this high operational reliability we automatically assume that all inductances (e.g. relays, contactors, motors) installed in the vicinity of or connected to the controllers are assembled with suitable suppressors (e.g. RC-combinations)! To dissipate interference, the controller must be connected at the PE-terminal of the cast body (figure 4-1, page 129 item 7) with good HF-conductance.



(1)	Mains plug	
(2)	Power supply module	
(3)	DIN rail, not included in the scope of delivery (accessories coupling relay module)	
(4)	Fastening screw for DIN rail	
(5)	Grounding and fastening screw of the backplane module	
(6)	Slot 1	AI3 (UNI, I/U, R)
(7)	Slot 2	AI2 (UNI, I/U, R)
(8)	Slot 3	
	DO, 24V+2BE:	DO3 to DO6, DI3 to DO4
	2DO relay:	DO3, DO4
	5DI:	DI3 to DI7
(9)	Slot 4	SES (serial interface, PROFIBUS)
(10)	Terminal strip 1	AI1 (TC, RTD, R, mV)
(11)	Terminal block 2	AO; DI1 to DI2; DO1 to DO2 24 V; L+; M
(12)	Terminal block 3	Digital outputs $\pm\Delta y$

Figure 4-8 Controller backplane with terminal assignment of the standard controller

NOTE

The screw terminal blocks for connecting the process signals to the controller are of the plug-in type.

- **Zero-Volt-system**

The SIPART DR19 controllers have only one 0 V conductor (ground, GND) on the field side which is fed double to the terminals 11 and 12 of the standard controller. If these GND-connections are not sufficient, additional proprietary terminals can be snapped onto the DIN rail on the power pack. The controller uses a common GND-conductor for both inputs- and outputs, all process signals are referred to this point.

The GND-connection is also connected to vacant terminal modules. These may only be used if practically no input current flows through this connection (see e.g. figure 4-21, page 143).

The power supply connection is electrically isolated from the process signals. In systems with unmeshed control circuits the SIPART DR19 do not need to be interconnected. In meshed control circuits the GND-connections of all controllers must be fed singly to a common termination or the continuous GND-rail with a large cross-section. This start point may only be connected at one point with the PE conductor of the system.

The signal current is tapped at the analog signal inputs by a four-pole measurement on the input measuring resistor. Voltage dips on the supply lines therefore have no effect. In the case of digital signals, the signal-to-noise ratio is so great that voltage dips on the GND-rail can be ignored.

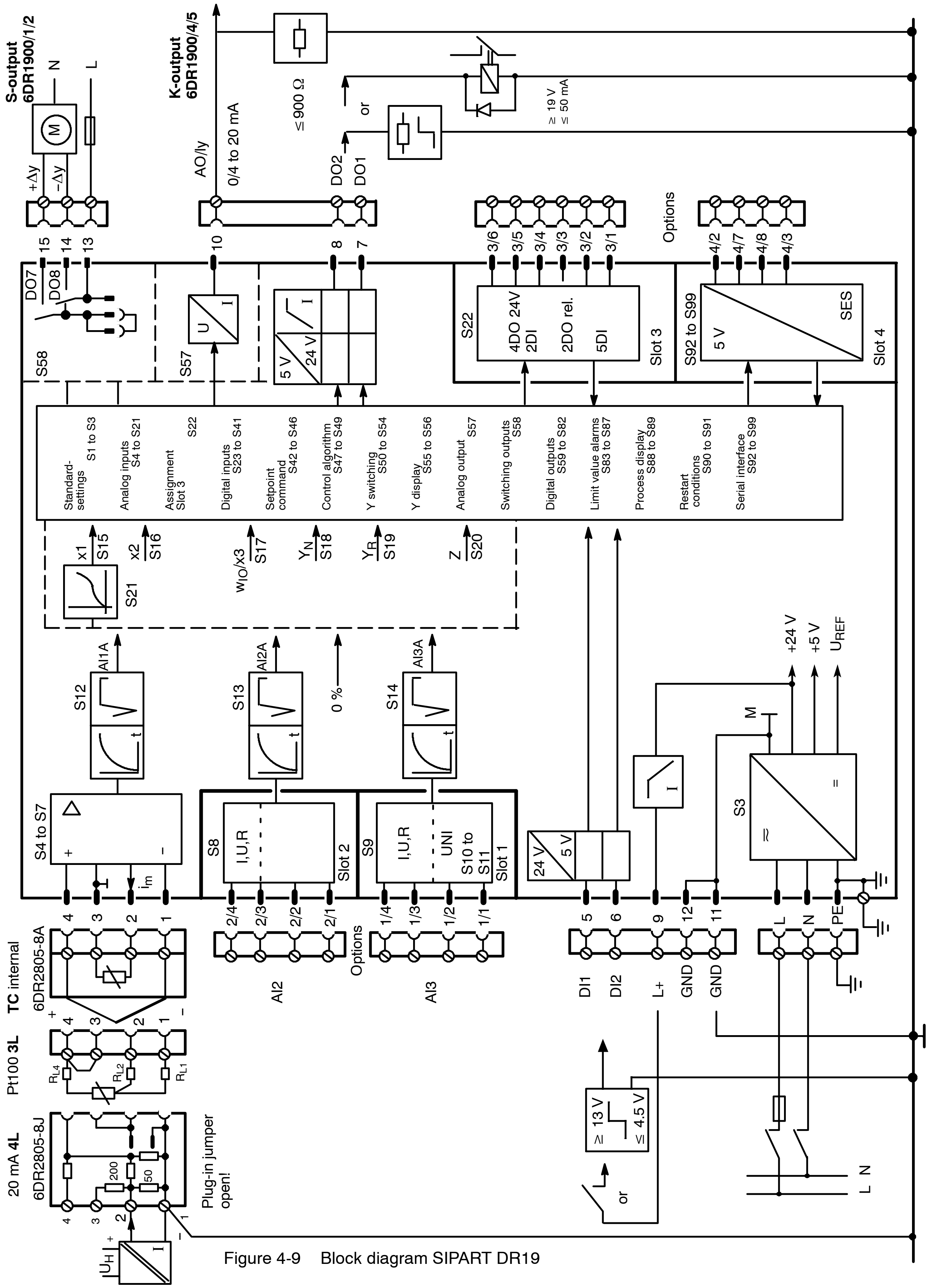


Figure 4-9 Block diagram SIPART DR19

4.2.2 Connection standard controller

- **Power supply connection**

CAUTION

Pay attention to mains jumpering (see figure 4-2, page 130)!

- **6DR190x-5 (115/230 V AC)**

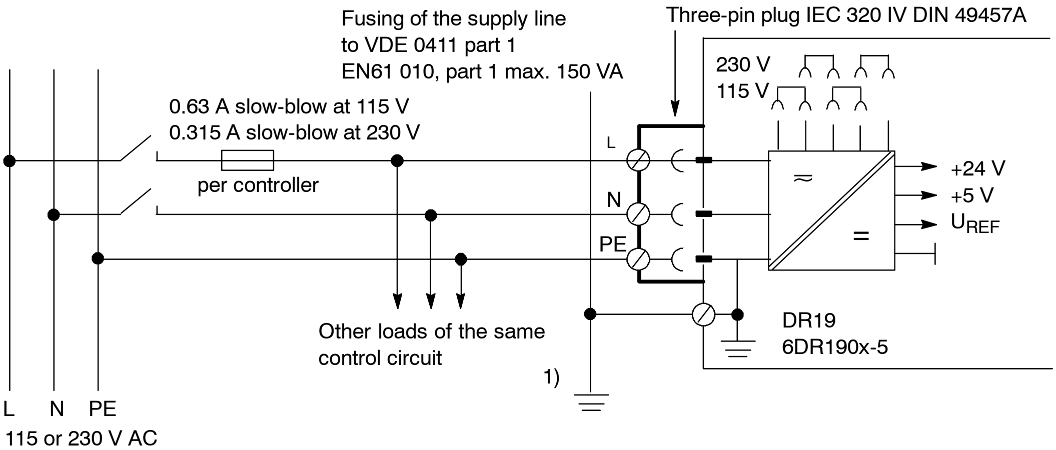


Figure 4-10 Connection 115/230 V AC power supply

- **6DR190x-4 (24 V UC)**

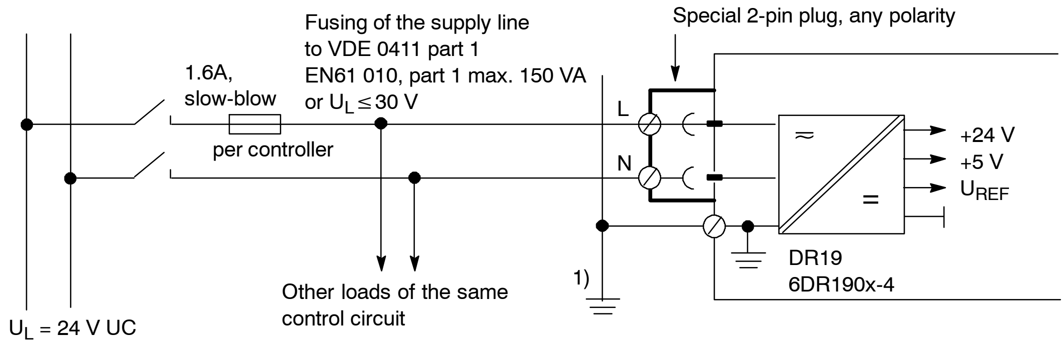


Figure 4-11 Connection 24 V UC power supply

1) The connection between the PE conductor screw (figure4-8, item 5, page136) to ground must be established additionally for high electromagnetic compatibility (EMC) in 115/230 V-controllers.
This connection must also be low resistive for high frequencies (Cu-band or Hf-strand). Alternatively at least 2.5 mm^2 strand should be used.

- **Connection of measuring and signal lines**

  The universal input AI1 is structured with S4, S5, S6 and S7. The measuring ranges are set with the menu CAE1 (see chapter 5.4.7, page 191).

  - **Connector pin assignment for mV-transmitter S5=0**

    Direct input U_{max} = ± 175 mV

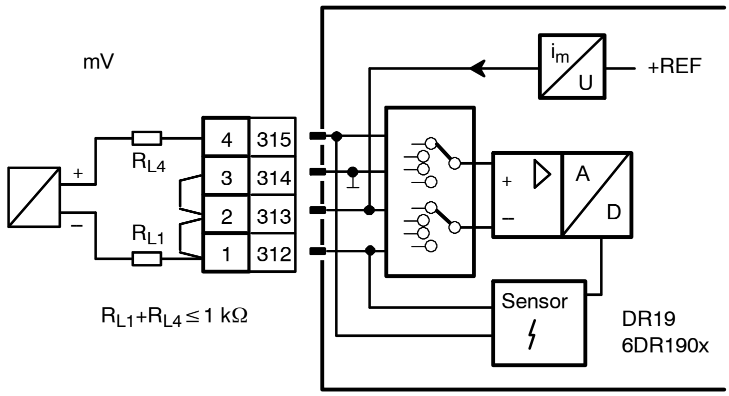
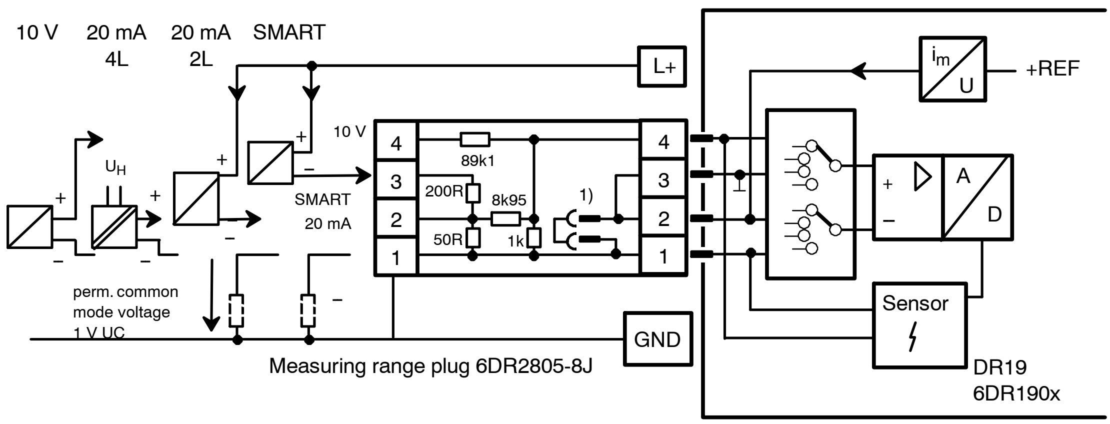


Figure 4-12 Wiring AI1 S5=0

  - **Connector pin assignment measuring range plug 6DR2805-8J for U or I S5 = 0**



1) The bridge must be open when the electronic potential isolation is used by other loads. In the closed state it replaces the connection 1–12.

Figure 4-13 Wiring AI1 S5=0 with measuring range plug

- Connector pin assignment for thermocouple TC S5 = 1, 2

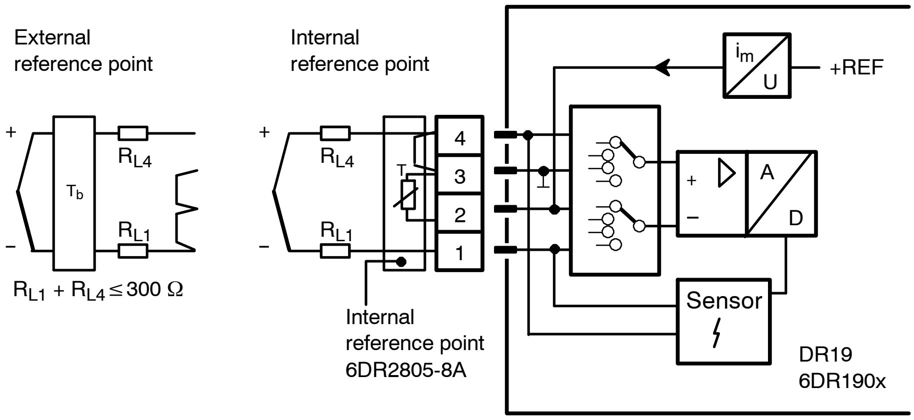


Figure 4-14 Wiring AI1 S5 = 1, 2

- Pin assignment for Pt100-sensor RTD S5 = 3, 4, 5

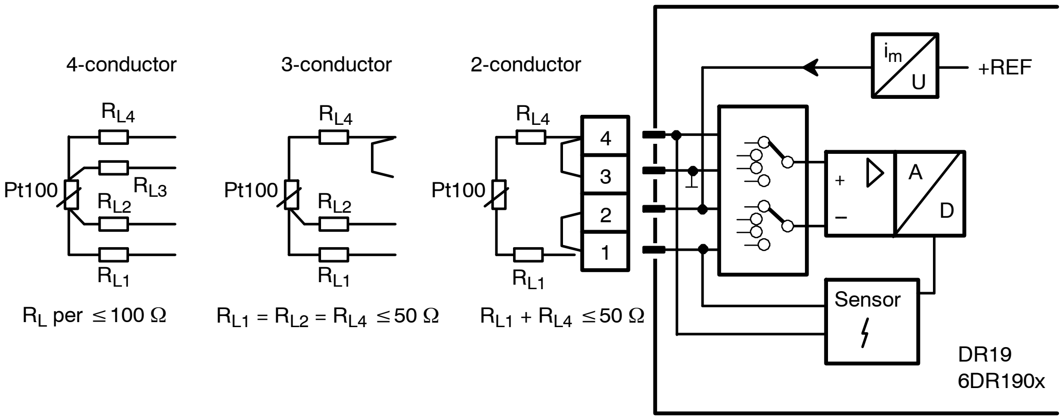
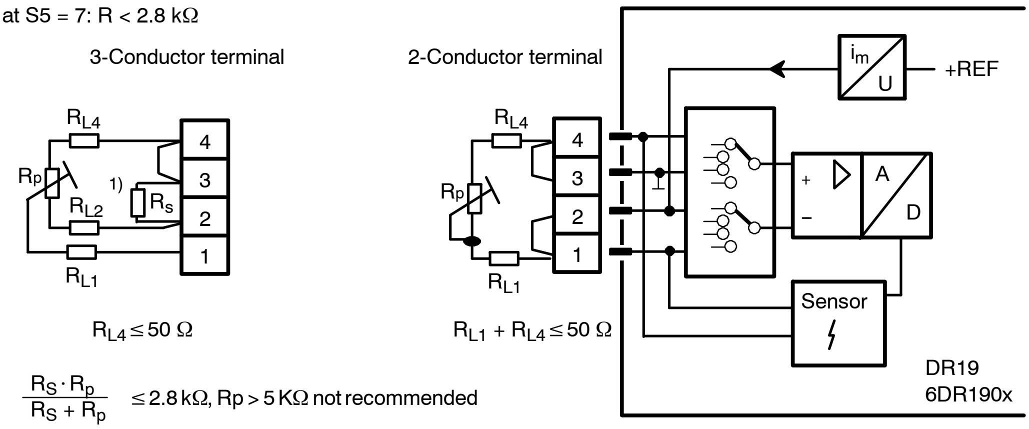


Figure 4-15 Wiring AI1 S5 = 3, 4, 5

- Connector pin assignment for resistance potentiometer R S5 = 6, 7

at S5 = 6: R < 600 Ω
at S5 = 7: R < 2.8 kΩ

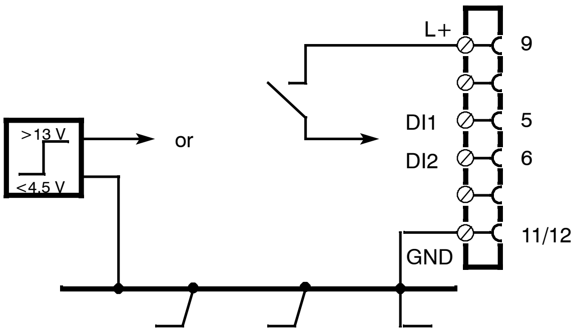


$\frac{R_S \cdot R_p}{R_S + R_p} \leq 2.8\,k\Omega$, Rp > 5 KΩ not recommended

1) R_s Shunt impedance only necessary if 2.8 kΩ < R ≤ 5 kΩ

Figure 4-16 Wiring AI1 S5 = 6, 7

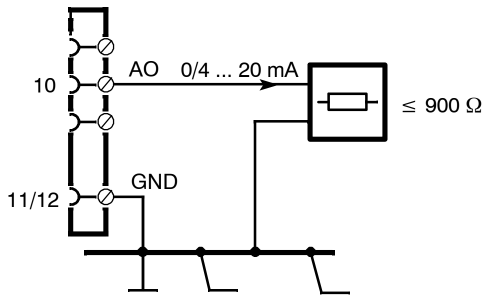
● DI1 to DI2



Set function with S23 to S34
Set direction of effect with S35 to S41

Figure 4-17 Connection DI1 to DI2

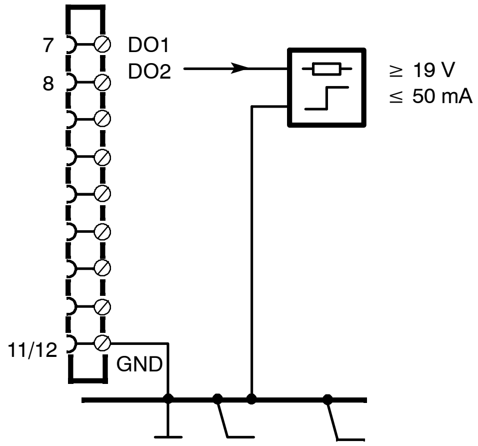
● AO



Function
Set 0/4 to 20 mA with S57

Figure 4-18 Connection AO

- **DO1 to DO2**



Set function with S59 to S75
Set direction of effect with S76 to S82

Figure 4-19 Connection DO1 to DO2

- **L+ (auxiliary voltage output)**

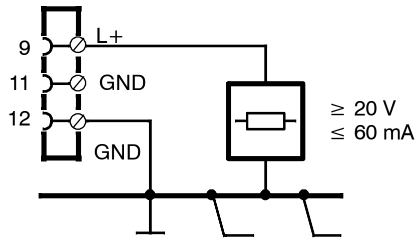


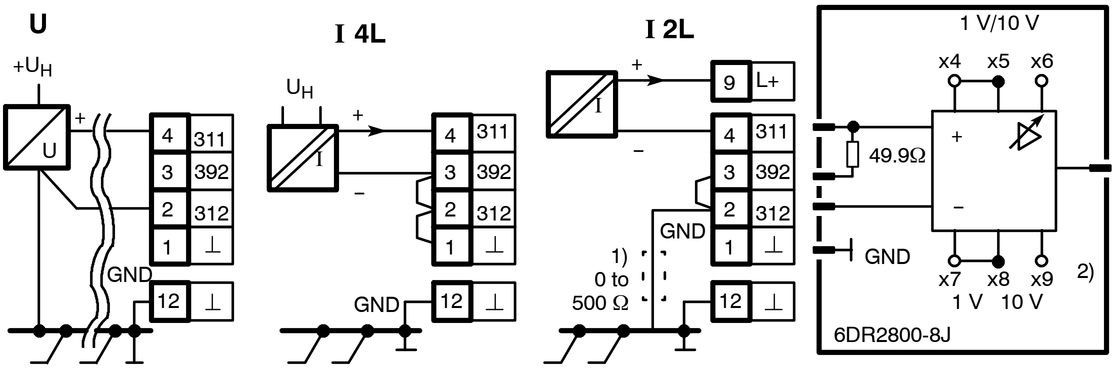
Figure 4-20 Connection L+

4.2.3 Connection of the options modules

4.2.3.1 Modules for analog measuring inputs

- **6DR2800-8J (U or I-input)**

AI2 in slot 2 with S8 / Set AI3 in slot 1 with S9 } Measuring range 0 to 1 V, 10 V, 20 mA or 0.2 V, 2 V, 4 mA to 1 V, 10 V, 20 mA



0/2 ... 10 V
x5=x6/10 V
(x8=x9)

0/0.2 ... 1 V
x4=x5/1 V
(x7=x8)

0/4 ... 20 mA
x4=x5/1 V
(x7=x8)

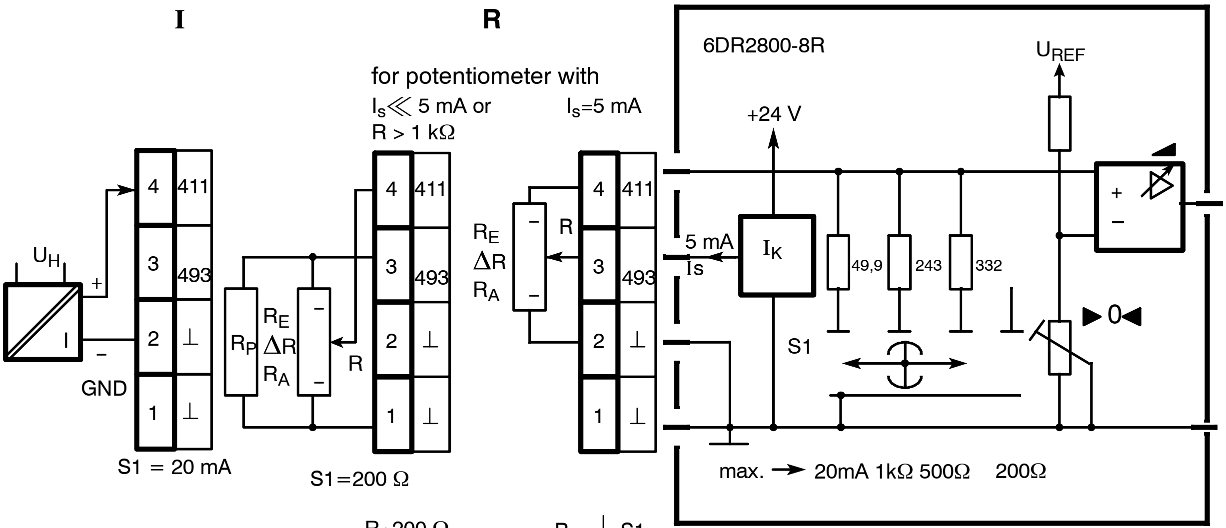
1) possible load resistances of other controllers
2) x7, x8, x9 omitted from the circuit board C73451–A3000-L106

Factory setting 1 V, x4=x5 (and x7=x8)

Figure 4-21 Connection U/I-module 6DR2800-8J

- **6DR2800-8R (Resistor input)**

  Set AI3 ≙ slot 1; S9 = 0 or 1
  Set AI2 ≙ slot 2; S8 = 0 or 1



$$R_p = \frac{R \cdot 200\ \Omega}{R - 200\ \Omega}$$

R	S1
≤200 Ω	200 Ω
≤500 Ω	500 Ω
≤1 kΩ	1 kΩ

Factory setting S1 = 200 Ω

Figure 4-22 Connection R-module 6DR2800-8R

- **Calibration**

1. Set slide switch S1 according to measuring range
2. Set R_A with ▶0◀ display or analog output (structured accordingly) to start value or 4 mA.
3. Set R_E with ◢ display or analog output to full scale value or 20 mA.

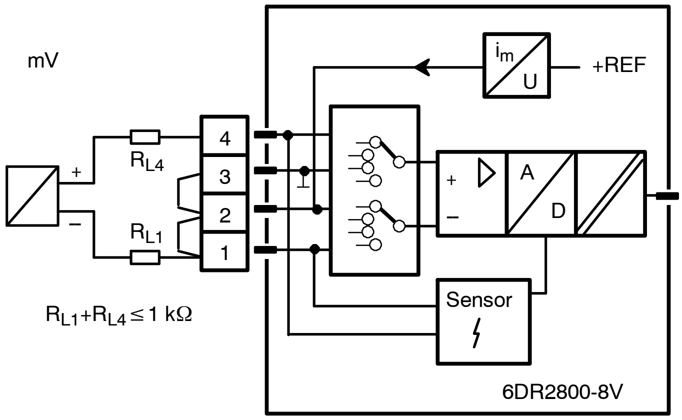
- **6DR2800-8V (universal module for analog input)**

  The universal module can only be inserted in slot 1. It is assigned to AI3 with S9 > 3 and structured with S7, S10, S11.

  The measuring ranges are set with the menu CAE3 (see chapter 5.4.8, page 196).

  - **Connector pin assignment for mV-transmitter S10=0**

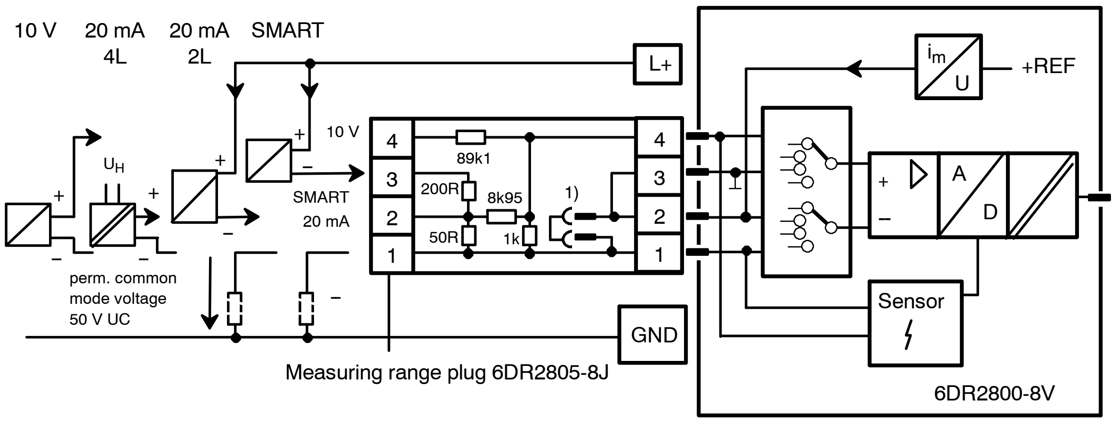
    Direct input U_{max} = ±175 mV



Block diagram mV-module 6DR2800-8V

Figure 4-23 Wiring UNI-module AI3 S10=0

  - **Connector pin assignment measuring range plug 6DR2805-8J for U or I S10 = 0**



1) DR19: Jumper must be plugged

Block diagram mV-module 6DR2800-8V

Figure 4-24 Wiring UNI-module AI3 S10=0 with measuring range plug

- **Connector pin assignment for thermocouple TC S10 = 1, 2**

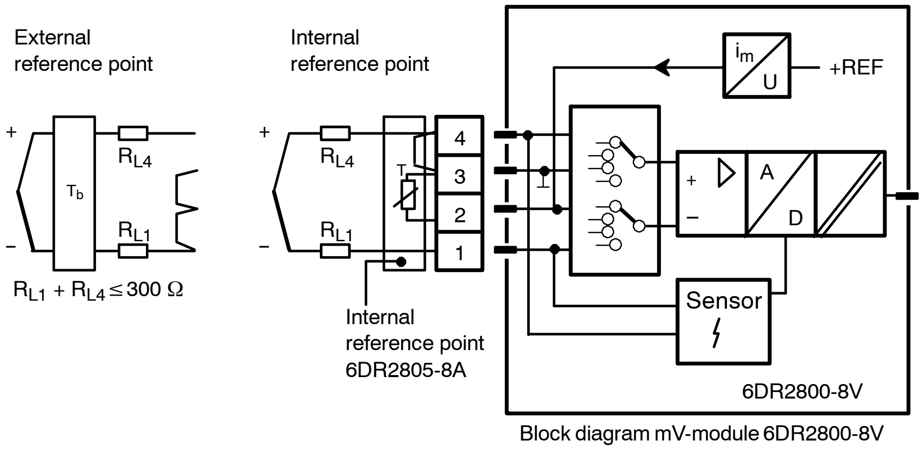


Figure 4-25 Wiring UNI-module AI3 S10 = 1, 2

- **Pin assignment for Pt100-sensor RTD S10 = 3, 4, 5**

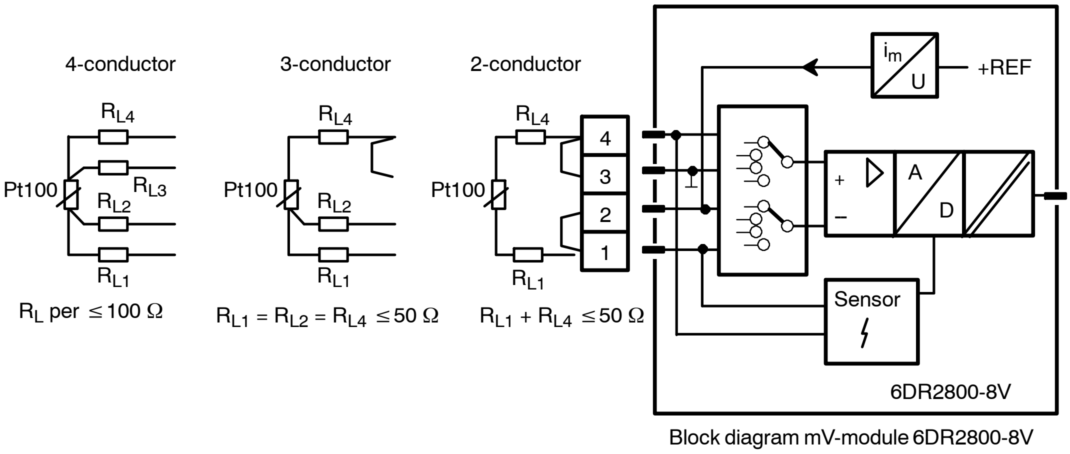
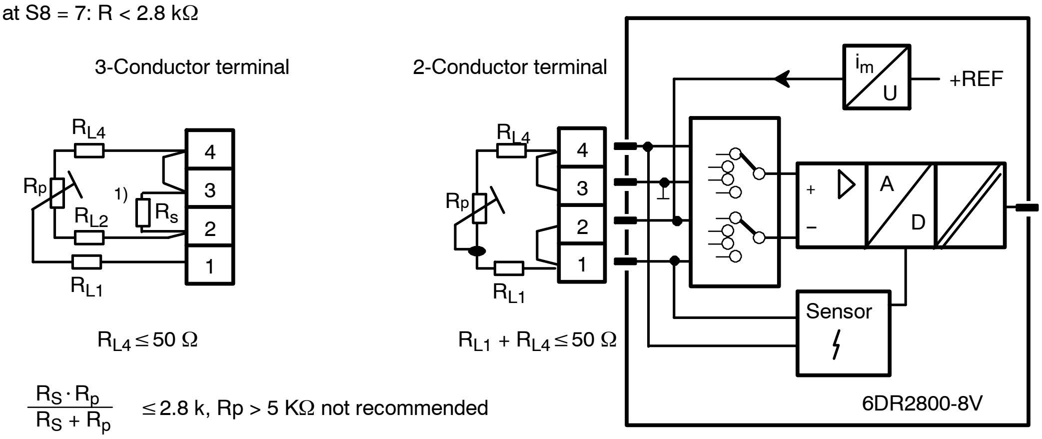


Figure 4-26 Wiring UNI-module AI3 S10 = 3, 4, 5

- **Connector pin assignment for resistance potentiometer R S10 = 6, 7**

at S8 = 6: R < 600 Ω
at S8 = 7: R < 2.8 kΩ



Block diagram of UNI-module 6DR2800-8V

1) R_s Shunt impedance only necessary if 2.8 kΩ < R ≤ 5 kΩ

Figure 4-27 Wiring UNI-module AI3 S10 = 6, 7

4.2.3.2 Connection examples for analog measuring inputs with the module 6DR2800-8J

Currents 0/4 to 20 mA

In current inputs the input load resistor is between terminal 4 (AI+) and terminal 3.

If the signal is still required during service work in which the terminal is disconnected, the input load resistance must be connected to the terminal between AE+ and AE–. The internal 49.9 Ω resistance must then be disconnected in 6DR2800-8J by appropriate rewiring.

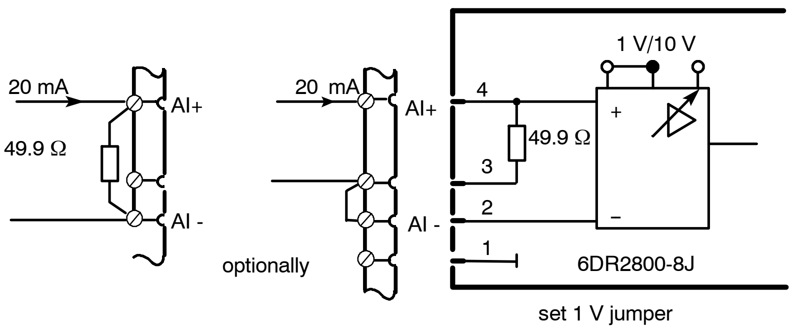


Figure 4-28 Current input via options modules, internal or external 49.9Ω resistance

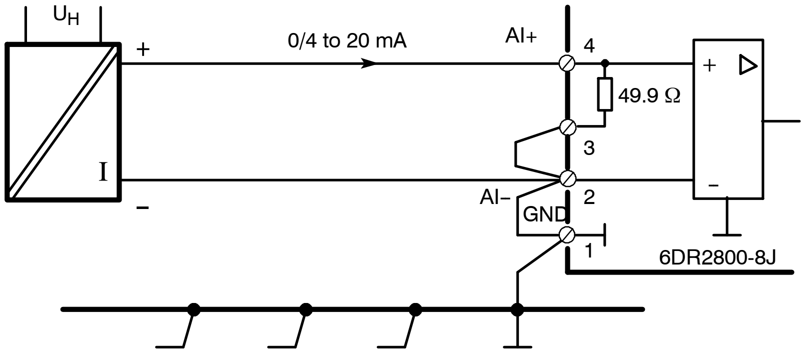


Figure 4-29 Connection of a 4-wire transmitter 0/4 to 20 mA with potential isolation

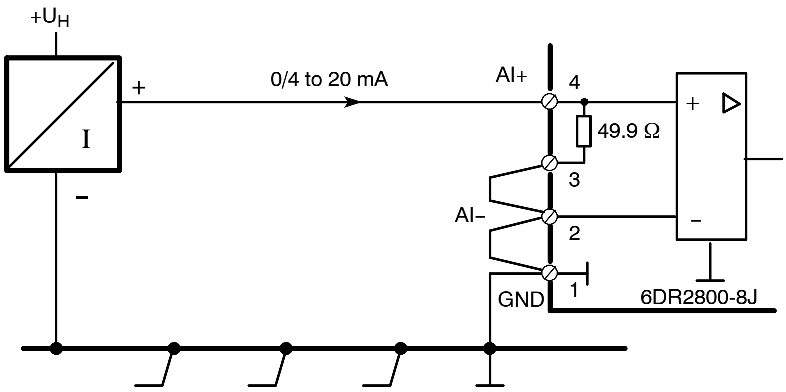


Figure 4-30 Connection of a 0/4 to 20 mA 3-wire transmitter with negative polarity to ground

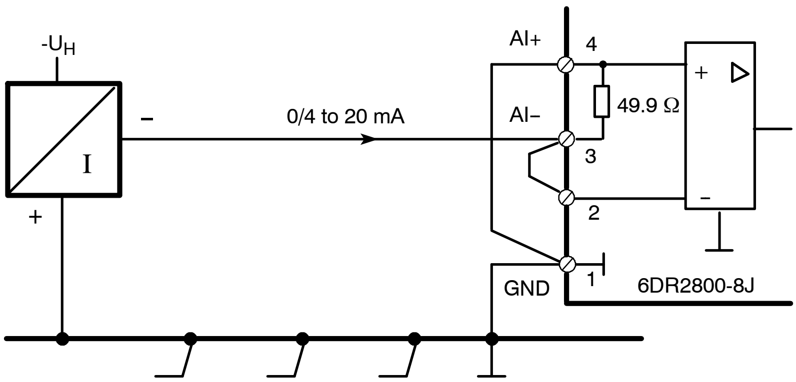


Figure 4-31 Connection of a 0/4 to 20 mA 3-wire transmitter with positive polarity to ground

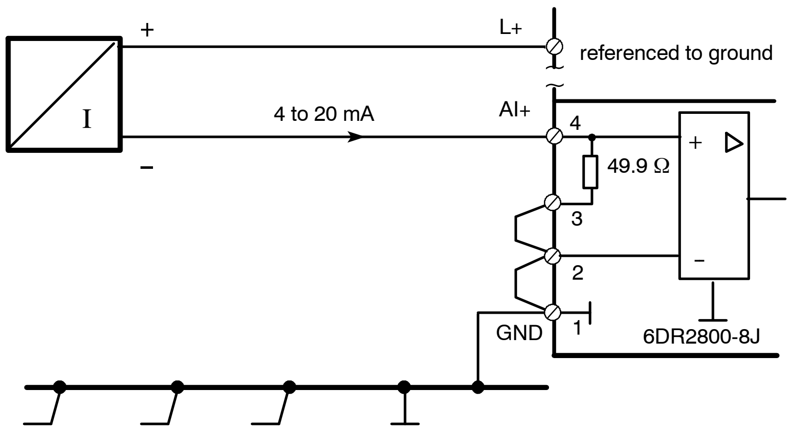


Figure 4-32 Connection of a 4 to 20 mA 2-wire transmitter supplied from controller's L+

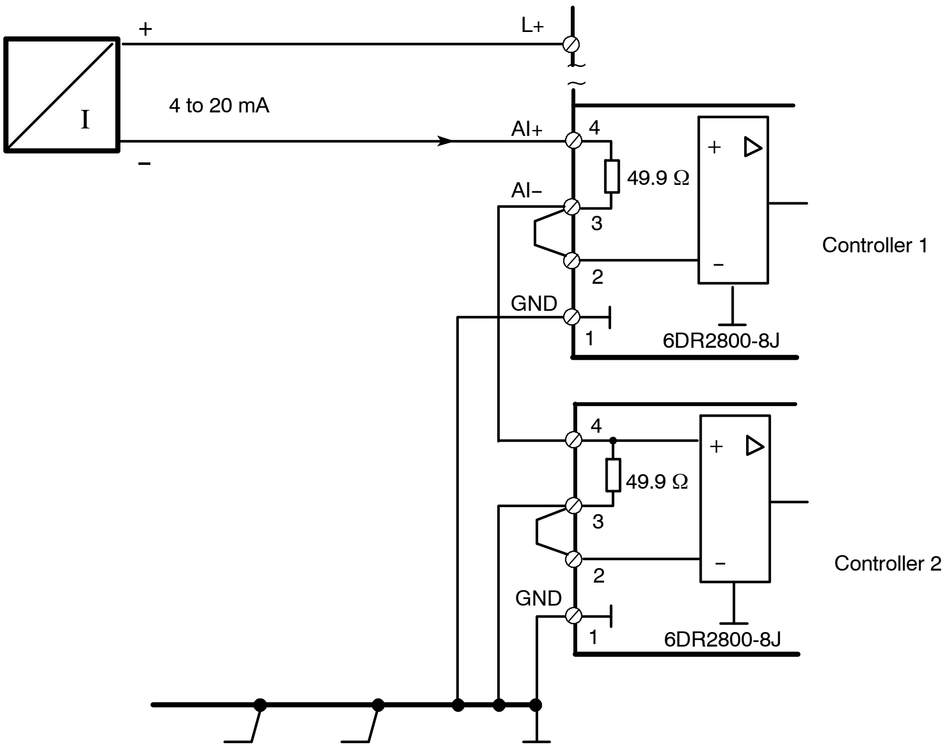


Figure 4-33 Connection of a 4 to 20 mA 2-wire transmitter to two instruments in series supplied by L+ from one of the instruments

Every input amplifier is supplied by a differential input voltage of 0.2 to 1 V. The input amplifier of controller 1 has an additional common mode voltage of 0.2 to 1 V which is suppressed. Several instruments with a total common mode voltage of up to 10 V can be connected in series. The last device referenced to ground may have an input load referenced to ground.

The permissible load voltage of the transmitter must be observed in series circuiting of load resistors.

- **Voltages 0/0.2 to 1 V or 0/2 to 10 V**

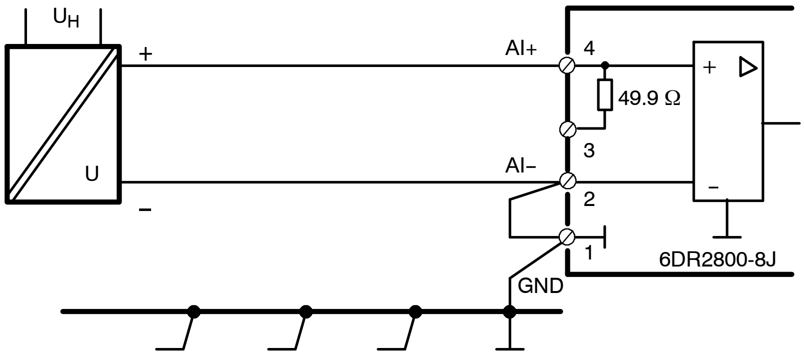


Figure 4-34 Connection of a floating voltage supply

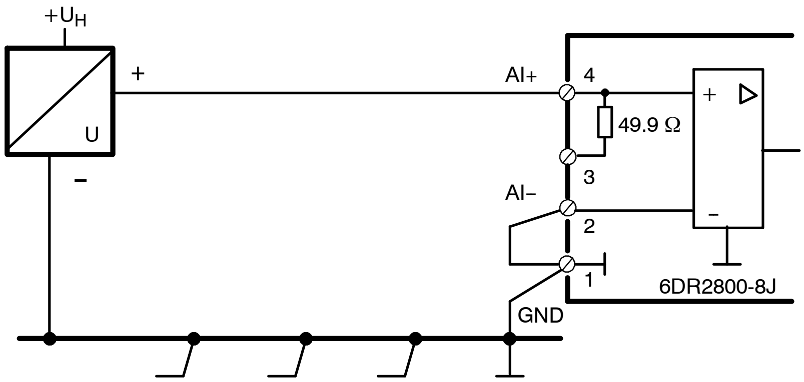


Figure 4-35 Single-pin connection of a non-floating voltage supply with negative polarity to ground

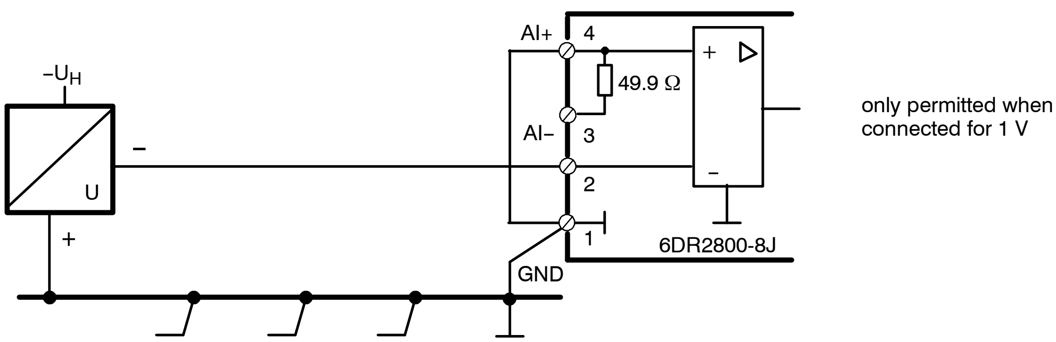


Figure 4-36 Single-pin connection of a non-floating voltage supply with positive polarity to ground

Figure 4-35 and figure 4-36:
The voltage dip on the ground-rail between the voltage source and the input amplifier appears as a measuring error. Only use when ground cables are short or choose a circuit configuration as shown in figure 4-37, page 151!

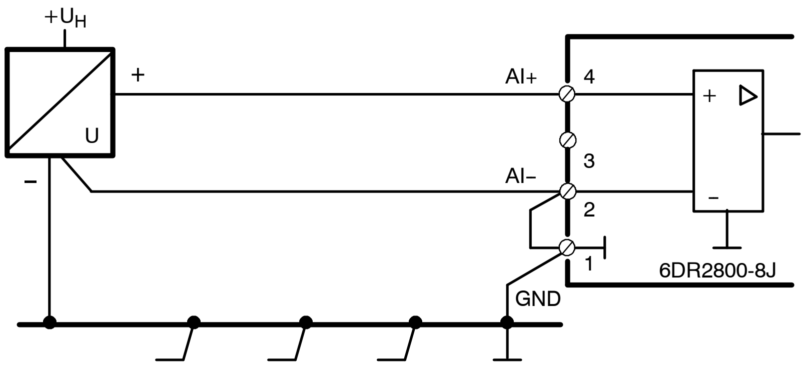


Figure 4-37 Double-pin wiring of a voltage source with negative polarity to ground

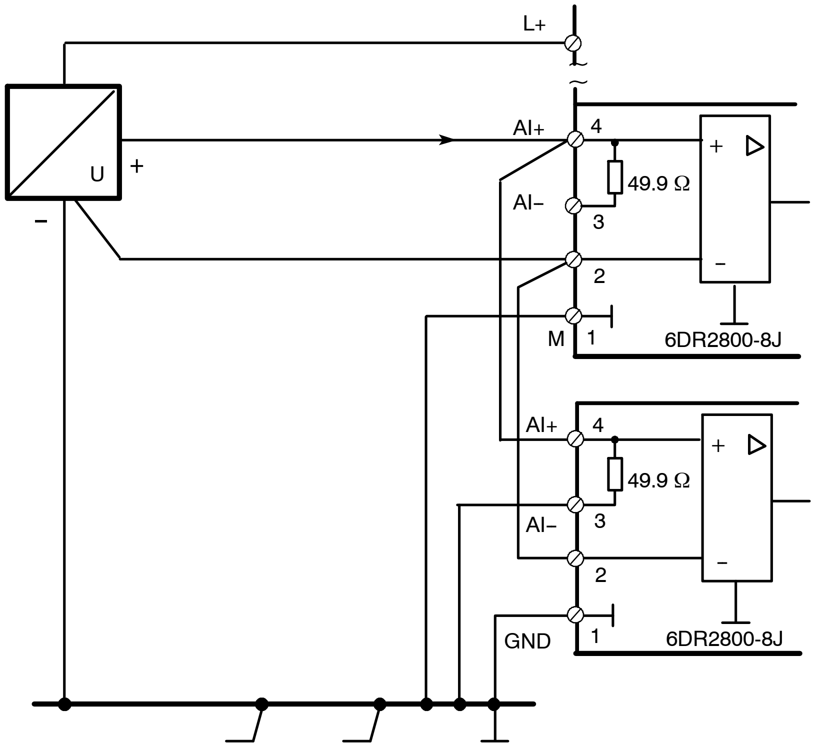


Figure 4-38 Parallel wiring of a non-floating voltage source to two instruments.
The voltage source is supplied by L+ of one of the instruments and negative is referred to ground.

Figure 4-37 and figure 4-38:
The voltage dip on the ground-rail between the voltage source and the input amplifier appears as a common mode voltage and is suppressed.

4.2.3.3 Modules for expanding the digital inputs and digital outputs

- **6DR2801-8C (5DI)**

DI3 to 7 in slot 3 (S22 = 2)

Set function with S23 to S34 einstellen
Set direction of effect with S35 to S41

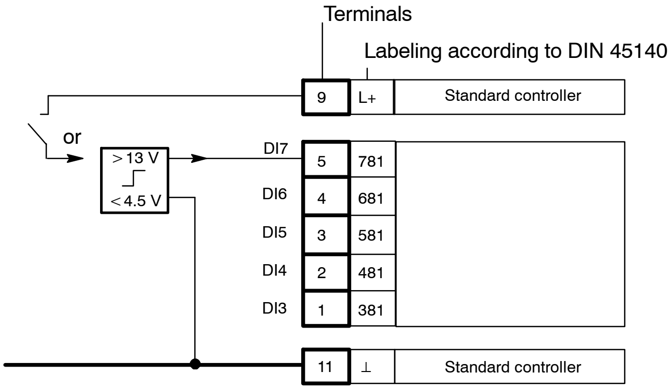


Figure 4-39 Wiring of 5DI module 6DR2801-8C

- **6DR2801-8E (4DO 24 V +2 DI)**

DO3 to DO6 in slot 3 (S22 = 1)

Set function	DO with S59 to S75
	DI with S23 to S34
Direction of effect	DO with S76 to S82
	DI with S35 to S41

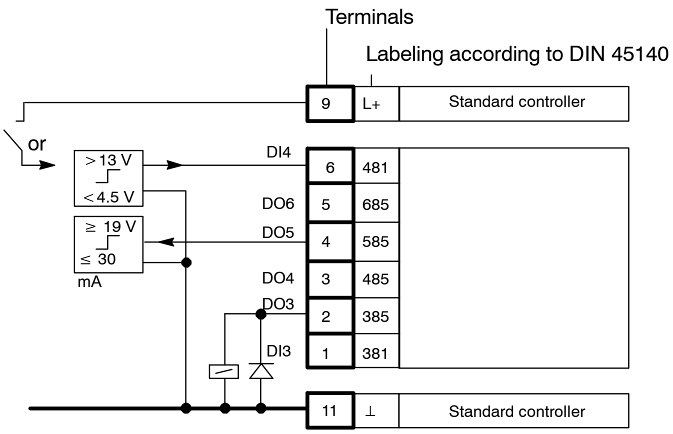


Figure 4-40 Connection of 4DO (24 V)-module 6DR2801-8E

- **6DR2801-8D 2DO relay 35 V**

WARNING

The relay contacts are only permitted for switching voltages up to UC 35 V.

DO3 and DO4 in slot 3 (S22 = 3) Set function with S59 to S75
Set direction of effect with S76 to S82

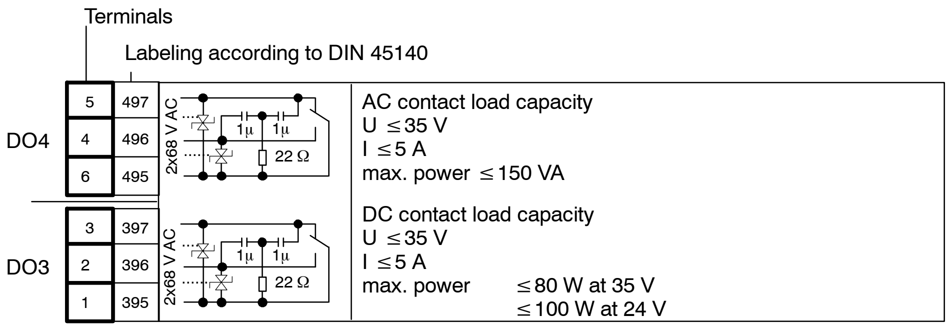


Figure 4-41 Connection of 2DO (relay)-module 6DR2801-8D

- **6DR2804-8A (coupling relay 230 V, 4 relays)**
  6DR2804-8B (coupling relay 230 V, 2 relays)

Can be snapped onto DIN rail on the back of the controller.
Wired externally to the desired digital outputs.
These must then be structured with S57 to S68.
e.g. connection for $\pm\Delta y$ outputs in the S-controller with coupling relay 230 V, 2 relays (6DR2804-8B)

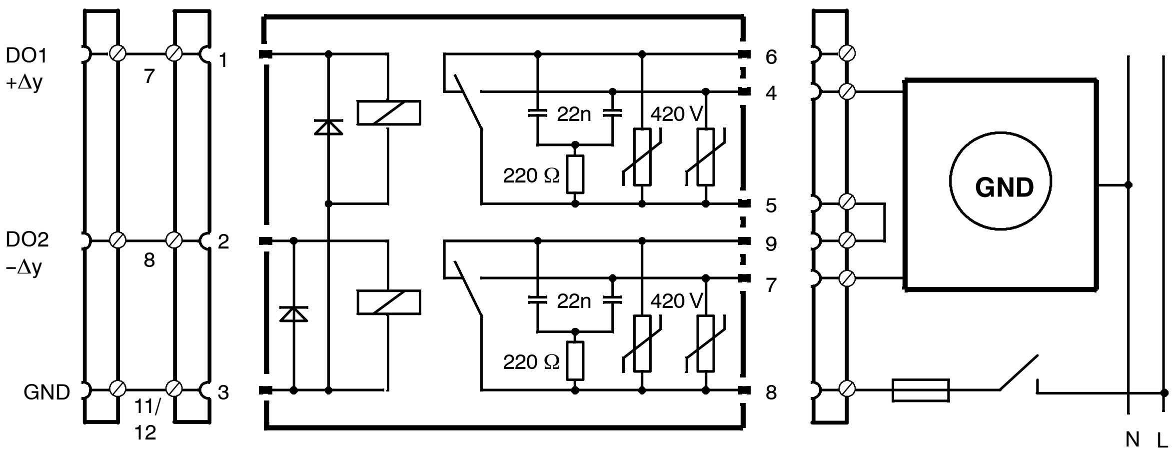


Figure 4-42 Connection of coupling relay 230 V 6DR2804-8B

Contacts in the connection are interlocked!

CAUTION

Observe the maximum switching voltage! (For excess resonance in phase shift motors, see warnings in chapter 2.5.2, page 31)

The coupling relay 6DR2804-8B (figure 4-42, page 153) contains 2 relays. The coupling relay 6DR2804-8A contains 4 relays. The terminals 1 to 9 are therefore available double.

AC	250 V	DC	250 V	
	8 A		8 A	
	1250 VA		30 W	at 250 V
			100 W	at 24 V

4.2.4 Connection of the interface module 6DR2803-8C

4.2.4.1 RS 232 point-to-point (END/END)

Can be inserted in slot 4, set structure switches S92 to S99 for transmission procedure.

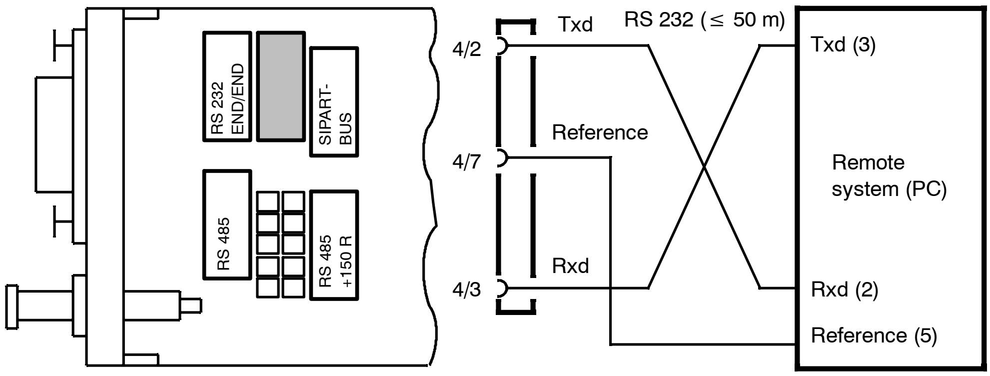


Figure 4-43 Setting on the SES-module 6DR2803-8C at RS 232 point-to-point connection

4.2.4.2 RS 485 bus

Can be inserted in slot 4, set structure switches S92 to S99 for transmission procedure.

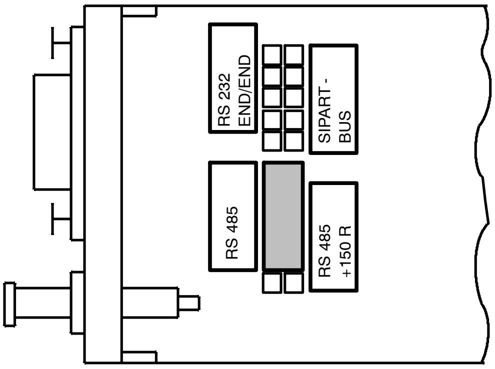


Figure 4-44 Jumper settings SES-module 6DR2803-8C in RS 485 bus

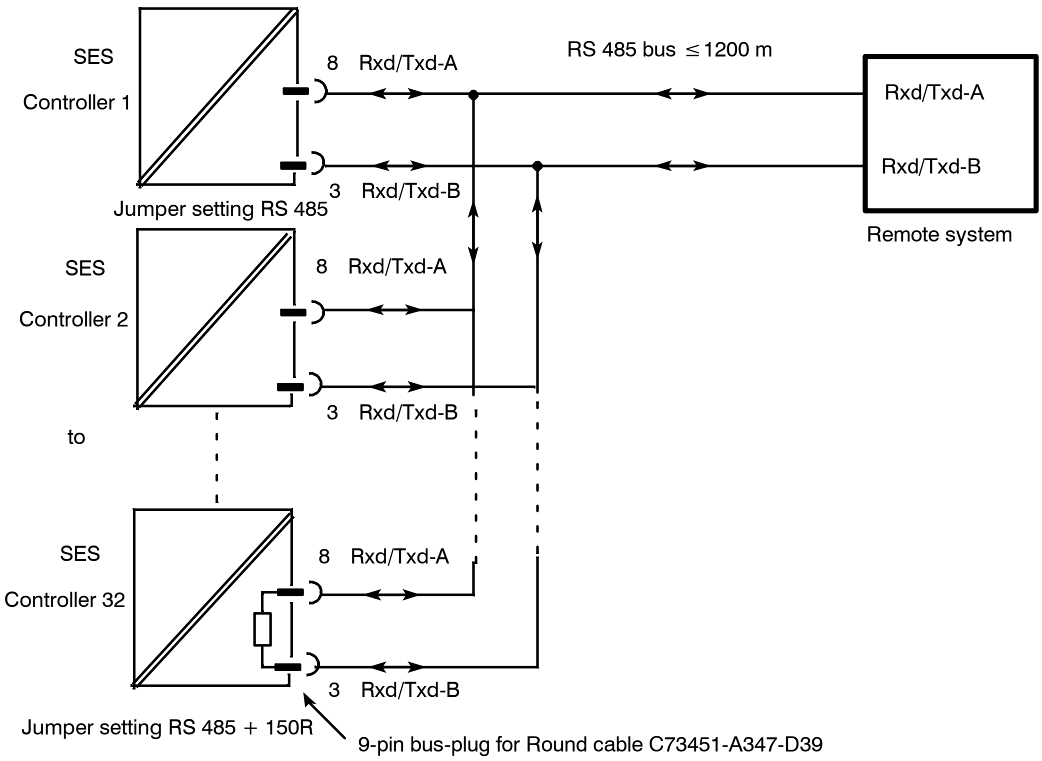


Figure 4-45 RS 485-bus connection

NOTE on the line termination

The RS 485-bus must be terminated with its characteristic impedance. To do this, the terminating resistor in the “last” bus user is switched by plugging the coding bridge appropriately.
See the SIMATIC S5-manual Distributed I/O System ET 200 for detailed descriptions and notes on cable and bus cable laying. “Distributed I/O system ET 200” to find. Order number EWA 4NEB 8126114-*

4.2.4.3 PROFIBUS-DP, 6DR2803-8P

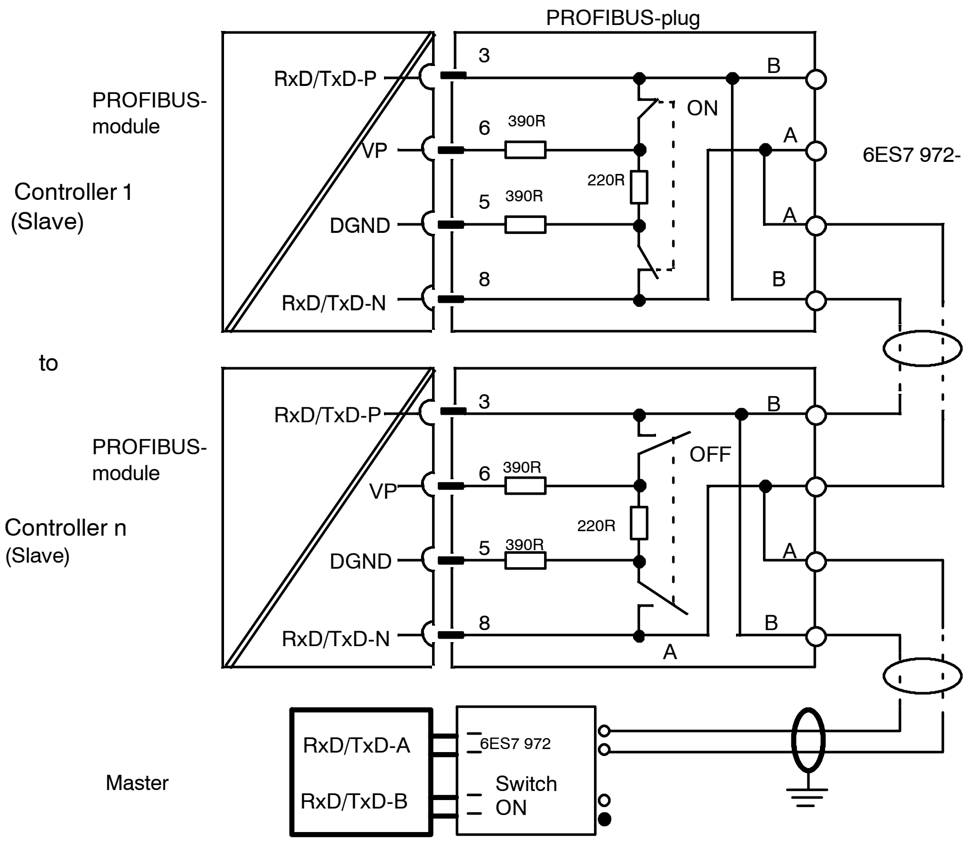
Technical Data

Transmittable signals	RS 485, PROFIBUS-DP-protocol
Transmittable data	Operating state, process variables, parameters and structure switches
Transmission procedure PROFIBUS-/-DP-protocol	According to DIN 19245, Part 1 and Part 3 (EN 50170)
Transmission speed	9.6 kbit/s to 1.5 Mbit/s
Station number	0 to 125 (note software version)
Time monitoring of the data traffic	Can be structured on the controller in connection with DP watchdog
Electrical isolation between Rxd/Txd-P/-N and the controller	50 V UC common mode voltage
Test voltage	500 V AC
Repeater-control signal CNTR-P	TTL-level with 1 TTL load
Supply voltage VP (5 V)	5 V −0.4/+0.2 V/+0.2 V, short-circuit proof
Line lengths, per segment at 1.5 MBit/s	200 m; for other data see ET 200 Manual 6ES5 998-3ES22

- **Connecting the interface PROFIBUS-DP, 6DR2803-8P**

Connection

Can be inserted in slot 4, set structure switches S92 to S99 for transmission procedure.



n max. number of controllers, dependent on master, max. 122

Figure 4-46 Principle representation SIPART DR19 via PROFIBUS-DP and bus connector to master

NOTE on the line termination

The RS 485-bus must be terminated with a characteristic impedance. To do this, the switch in the bus connector must be switched “ON” in the “first” and “last” bus users. The switch may not be “ON” in any of the other bus users. Detailed description and instructions for line laying and bus cabling can be found in the “Distributed I/O System ET 200” manual.
Order number 6ES5 998-3ES22.

5 Operation

5.1 General

- **Operating modes**

The SIPART DR19 is operated completely by the operating keys of the front module. The function of the operating panel can be switched between three main levels:

Process operation mode The process values x, w, y and the controller status are displayed, the process operation mode can be controlled by the operating keys.

Selection mode Here the list is selected which can be changed or activated in the configuration mode. These are the following lists:

onPA	Online parameters
(AdAP)	Start adaptation
oFPA	Offline parameters
(CLPA)	Program controller/transmitter
StrS	Structure switches
CAE1	Set analog input AI1
(CAE3)	Set UNI-module
APSt	all preset

The lists for onPA, oFPA, StrS, CAE1 and APST are always displayed in the selection level.
The lists for AdAP, CLPA and CAE3 only appear in the display when they have been selected by structure switches.

Configuration modes Settings are made in the selected list or functions are activated.

Some of the keys and displays on the front module are assigned different control and display functions when the operating mode is changed. See the description of the respective main level for details.

- **Operating locks**

Operation of the controller or access to the selection or configuration modes can be locked by digital signals. The following blocking steps are possible:

bLb *Blocking, Operation*
The complete operation of the controller is blocked. Exception: Switching of the digital display w/y (2). “bLb” appears in the display on pressing the operating keys.

bLS *Blocking, Structuring*
Blocking the lists **CLPA, oFPA, StrS, CAE1, CAE3** and **APSt.**
Only the list for **onPA** and **AdAP** is accessible. “bLS” appears in the display when the blocked mode is called

bLPS *Blocking, Parameterization and Structuring*
The complete selection and configuration mode is blocked. The process operation mode is free. “bLPS” appears in the display when the blocked mode is called

- **Behavior of the controller in the factory setting**

  SIPART DR19 operates as a fixed value controller in the factory setting.
  For safety reasons the online parameters, "proportional action factor Kp" and the "integral action time Tn" are preset to uncritical values.

  It is absolutely essential that these parameters be set to suit the requirements of your controlled system.

5.2 Process operation mode

5.2.1 General

- **Control elements**

  See page 5 for the control and display elements.

  Due to the design and color scheme of the operating front panel, the control elements and the labeling, operation of the SIPART DR19 in process mode requires no detailed explanation.

- **Actual value**

  The four-digit PV-X-digital displays (1) show the actual value.

- **Setpoint**

  The four-digit SP-W/OUT-Y-digital display (2) shows the active setpoint (when the green w-LED (5) lights steadily) (see structure switch S88). The green internal/external key (13) switches between the internal and external setpoint. The internal setpoint is set with the green Δw/Δy-adjusting keys (7), (8). The green internal LED (15) signals operation with the internal setpoint, the $\overline{C}$ LED (14) also lights green when there is no CB control signal.

  However, a setpoint setting is only possible when the green LEDs (5 and 15) signal that the SP-W/OUT digital display is showing the setpoint and internal mode is set.

- **Control difference**

  The analog display (3) shows the control difference xd in the factory setting (see structure switch S89).

- **Manipulated variable**

  Independently of the variable output at analog output AO, the four-digit SP-W/OUT-Y digital display (2) indicates the manipulated variable y (when the x-LED (4) and the w-LED (5) are out) or the position feedback y_R or split range y1/y2 according to the position of the structure switch S55.

The setpoint display is switched over to the manipulated variable display by pressing the Shift key (6) once (x-LED (4) and w-LED (5) are out) or in manual mode (manual-LED (11) lights up) or in y-external mode (y-external-LED (10) lights).

The M/A-key (9) switches between manual- and automatic operation. The yellow manual LED (11) signals by lighting steadily or flashing that manual operation has been activated. Lighting of the also yellow y-external LED (13) signals an external intervention in the manipulated variable, i.e. a tracking, safety or blocking operation. The manipulated variable can be adjusted in manual mode with the yellow $\pm\Delta$y-keys (7), (8) The $\pm\Delta$y-LEDs (12) show the output of the positioning increments in all operating modes of the S-controller.

- **Adaptation**

  The adaptation LED (16) signals the active adaptation procedure by flashing.

- **Lamp test**

  If the button (6) is kept pressed for longer than 5 s, all LEDs on the front of the controller are driven independently of the respective display until the button is released again. The original display position is restored after checking the lamp function.

- **Display of software version and controller type**

  The SIPART DR19 controller software will be improved in the course of new knowledge. The respective version of the software is stored in the EPROM with identification and can be called as follows:

  ▶ Run the lamp test with the button (6),

  ▶ Then press the button (13) additionally. On the digital displays (1) and (2) the identification can now be read off for the controller software version.

- **Alarms**

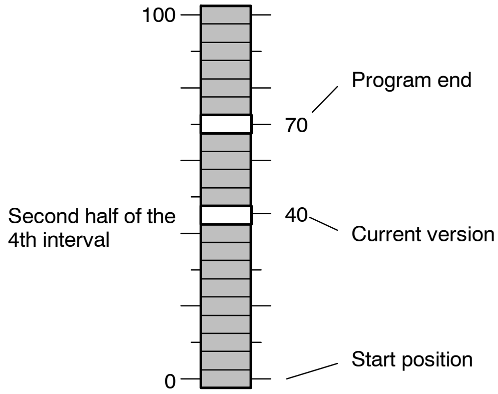
  The red alarm LEDs (17) signal exceeding or dropping below the limit values A1 to A4. The alarms A1 to A4 are set by the offline parameters. Assignment to the variables to be monitored is effected with the structure switches S83, S84, their function with S85, S86 and their display and setting with S87.

5.2.2 Operation and displays in the program controller setting (S1 = 5)

With the cyclic counter display (S88) the x-display (1) and the bargraphs (3) can be switched over to time and interval display. At S88 = 7, flashing x-LED (4) and w-LED (5) the x-display (1) shows the remaining time in the interval and the w/y-display (2) the target setpoint wpz of the currently running interval.

The bargraph (3) indicates the time from the start and the current interval. It also provides information whether the program has been stopped.

Bargraph example:
Program with 7 intervals, current version second half of the 4th interval



Program end:
- Always static on
- In cascaded programs (more than 10 intervals) the end of program is not indicated until the end of the first 10 intervals.

Current version:
- Static on in the current program
- Flashes when the program is stopped (e.g. stop or hold)

Start position:
- Flashes when the program has not started, after a reset or after the end of the program

Figure 5-1 Bargraph example

The current program can be started, stopped or reset by the front operating keys or digital signals. This may be effected for example by the INT/EXT-key (13) (S43 = 2), the H/A-key (9) or the N- or Si-signal.

It generally applies for “no automatic operation”: **/A = Hi** ∨ **He** ∨ **N** ∨ **Si**

Start: When the program has not started, the first bargraph LED (Start position) flashes. The bargraph LED of the second half of the last interval (program end) is static on, with more than 10 intervals the program end is only displayed at the end of the first 10 intervals.

The program is started with the condition /INT ∧ CB ∧ A.

Run: If the program is running (/INT ∧ CB ∧ A), the first bargraph-LED goes out Only the bargraph LED of the current interval half and the end of the program lights respectively. The INT-, /CB-, HAND- and y-ext-LEDs are off.

Stop: If the program has been stopped by the condition INT ∨ /CB ∨ /A, only the bargraph LED of the current interval-half lights until the condition is canceled.

Hold: If the Hold-function is active (Hold=OFF), compliance with the “Hold”-xd-limit values is checked at the end of every xd interval. If the limits are exceeded, the time process up to dropping below is stopped and only then is the next interval released. As long as the Hold-condition is not satisfied, the bargraph LEDs of the second half of the current interval and the Int-LED (15) flash until the condition is not longer satisfied or has been acknowledged with the internal key (13).

Reset: A reset is generated automatically at the end of the program or manually if INT and /A exist simultaneously and there is no Hold.

Reset by DI $\overline{tS}$ see chapter 3.4.7, page 89.

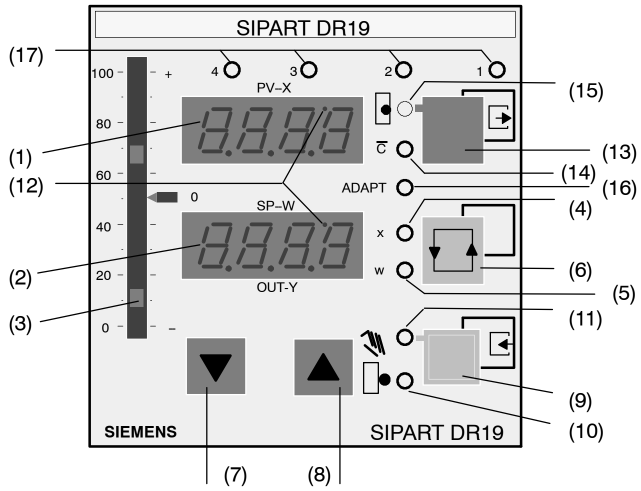
The program controller goes to the start position, the first bargraph LED flashes.

Behavior in the event of a power failure

S90 = 0 Program continues running smoothly with the stored program values if the operating status allows.

S90 = 1 Start position (Reset status)

Control and display elements in the process operation level during structuring:
S1 = 5 S43 = 3 S87 = 1, 2, 3, 5 S88 = 7



(1)	Digital display “PV–X”	Remaining time in the interval (unit CLFo)
(2)	Digital display “SP–W”	w_{pz}-display (program target setpoint) of the current interval
(3)	Analog display	Program run status, 2 segments per interval
(4), (5)	Signal lamps “x”, “w”	w steady lit display in (2) setpoint w w and x flashing display in (2) target setpoint w_{pz} Display in (1) remaining time in the interval
(6)	Shift key	SP-W-display (2) (cyclic counter, see S88 with S1 = 5)
(7), (8)	Setpoint adjustment wi	Setpoint falls/rises
(9)	Shift key H/A	The clock is stopped in manual (Stop). The program is reset with the link Int ∧ H (Reset).
(10)	Signal lamp	y-external mode (static on in N- or Si-operation)
(11)	Signal lamp	Manual mode, clock is stopped (Stop)
(12)	Signal lamp	DO in the S-controller
(13)	Shift key setpoint internal/external	The clock is stopped in Int (Stop). Restart after Hold function by switching to “ext”. The program is reset by Int ∧ H (Reset).
(14)	Signal lamp	“Computer (with w_{ext}) switched off”
(15)	Signal lamp	“Setpoint internal” (static on at Stop or adjustable setpoint flashes in Hold)
(16)	Signal lamp	Adapt
(17)	Signal lamp	Limit value display re-functioned: – 1 and 2 signal the executed program 1 = P1, 2 = P2 – 3 and 4 signal alarms

Figure 5-2 Control and display elements of the program controller in the process operation level

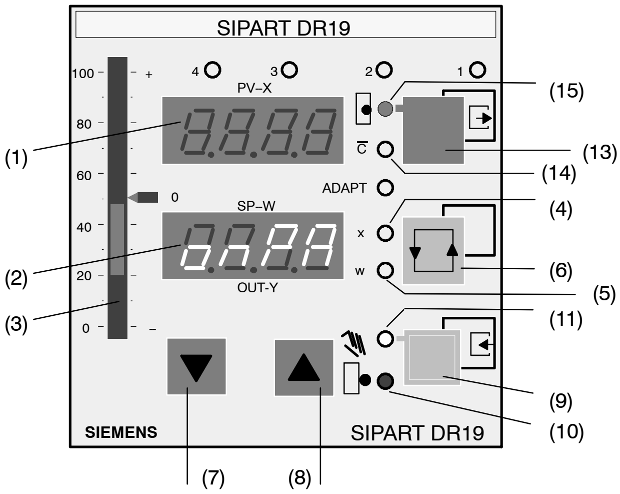
5.3 Selection mode

By pressing the Shift key (6) for longer (approx. 5 s) until “PS” flashes in the w/y-display, you enter the selection level for the different configuration menus.

Condition: Digital signal “Blocking-Operation” bLb = 0 and
“Blocking-Parameterization, Structuring” bLPS = 0

In the selection level the controller operates in online mode, i.e. ist last operating mode is retained, the curernt process variables can be monitored on the x-digital display (1) and the analog displays (3).

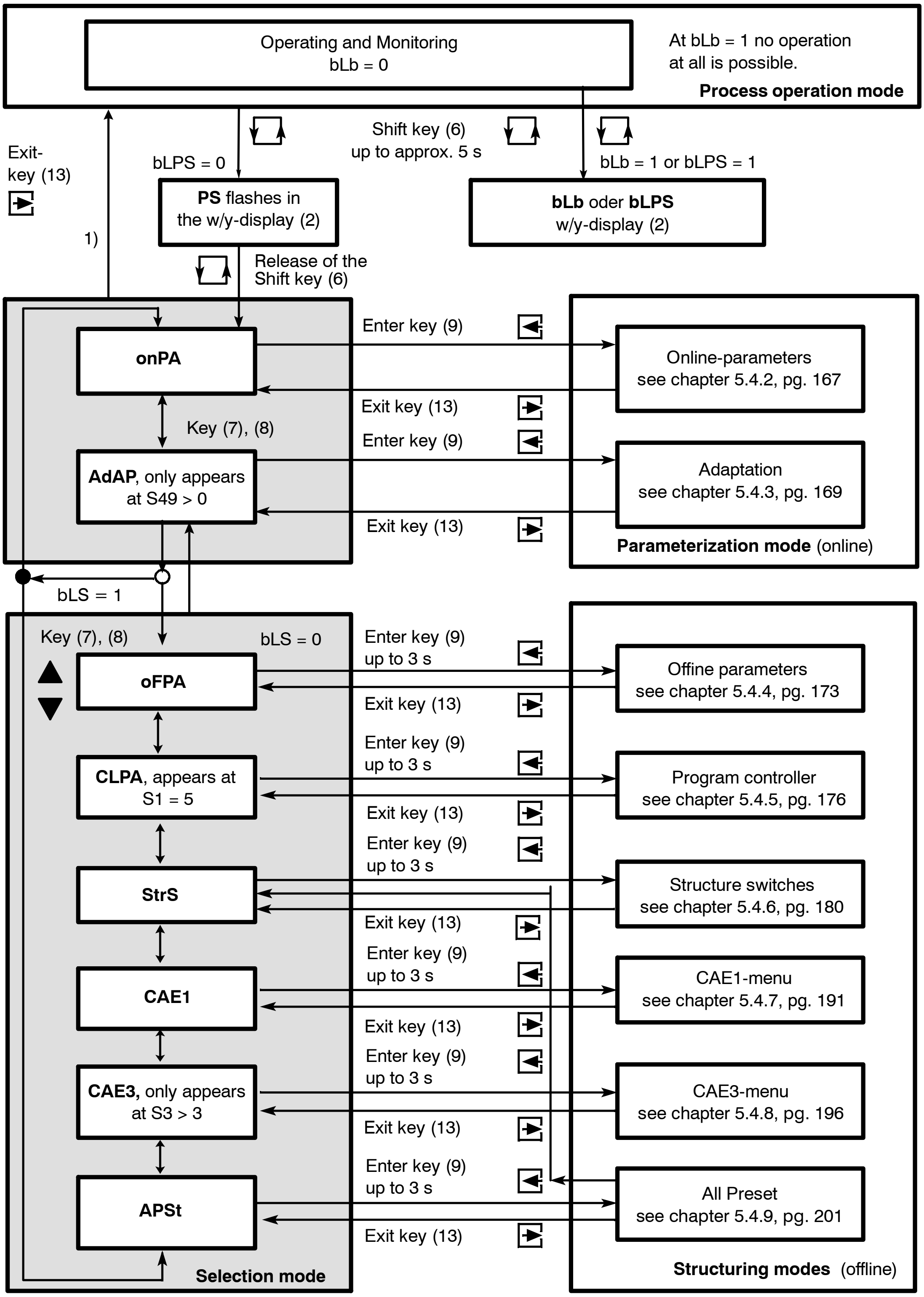
The configuration menus can be selected with the Δw/Δy-keys (7), (8). If none of these menus is called with the Enter key (9) within about 20 s (≙ enter the configuring mode), the controller automatically returns to the process operation mode.



Legend:

(1)	x-display	current version
(2)	w/y-display	Display of the current configuration level
(3)	Analog-display	current version
(4)	x-LED	off
(5)	w-LED	on
(6)	Shift key	Enter selection level
(7), (8)	Selection	onPA, (AdAP), oFPA, (CLPA), StrS, CAE1, (CAE3), APSt
(9)	Enter key	Jump to selected configuration level
(10)	Enter-LED	flashes
(11)	Manual-LED	current status
(13)	Exit key ↗	Return to process operation level
(14)	Exit-LED	flashes
(15)	Internal LED	current status

Figure 5-3 Control and display elements in the selection mode



1) Automatic return if no Enter function takes place in a parameterization or structuring mode within 20 s.

Figure 5-4 Overview selection mode

5.4 Configuration modes

5.4.1 General, Online and Offline modes

The settings in the configuration modes onPA and AdAP and the selection in the selection mode (see fig. 5-4, page 165 takes place in online mode, i.e. the controller continues operating in its last mode. Entry into the onPA and AdAP-levels takes place directly from the selection levels by pressing the Enter key (9). The analog xd-display (3) continues to display the process image so that the reaction of the controlled system to parameter changes can be read directly. The internal LED (15) and Manual LED (11) and the Alarm LEDs A1 to A4 indicate the current operating state. The internal/external key (13) becomes the Exit key, the corresponding $\overline{C}$–LED (14) indicates ready to exit, i.e. every time the LED flashes, pressing the Exit key jumps from the selected mode to the next level up in the hierarchy.

The automatic/manual key (9) becomes the Enter key, the corresponding y external LED (10) indicates ready to enter, i.e. whenever the LED flashes, pressing the Enter key jumps to the next level down in the hierarchy.

Pressing the Enter key (9) for 3 s switches from the pre-selection level to the offline level with the oFPA, StrS, CAE1, CAE3 and APSt menus. The user stays offline when returning (from offline level) to the pre-selection level. When subsequently entering another offline-level the three-second-time condition is omitted. The three-second time condition for entering an offline menu is only valid again after exiting the offline mode by selecting an online mode with the onPA and Adap menus or exiting the preselection mode. The controller switches into the **absolute manual mode** (offline mode), i.e. the last manipulated variable of the online mode is retained (in K-controllers the last manipulated variable, in S-controllers no positioning increments are output). A change in the manipulated variable with the $\pm\Delta$y-keys (7), (8) is not possible, the control signals N, Si and $\pm$yBL are inactive. The analog output, the digital outputs and the alarm LEDs A1 to A4 are held at the last value or status. To indicate the offline-mode, the analog xd-display (3) shows a striped pattern and the manual LED (11) lights up. The absolute manual mode is retained when returning to the parameterization preselection mode (online mode) or the process operation mode from the structuring preselection mode with the Exit key (16). This also applies when only automatic operation has been selected with S52 = 1. The controller must also be reactivated in the process operation mode for safety reasons by switching to automatic operation.

The internal LED (15) is out during offline operation. The Enter key (9) and Exit key (13) and the manual LED (11), the internal LED (15) and $\overline{C}$-LED (14) have the same function as in the online configuration levels.

If the control signal bLPS = 1, parameterization and structuring is blocked, after pressing the Shift key (6) bPLS appears in the w/y display (2).

If the control signal bLS = 1, structuring is blocked. Only onPA and AdAP appear in the selection mode.

NOTE

Please note that the changes parameters and structure switch settings are only accepted after returning to the process operation level to the non-volatile EEPROM.

5.4.2 Configuration mode online-parameters onPA

The parameters for which the effect on the process when they are adjusted must be observed directly are arranged in the parameterization mode onPA. The other parameters are arranged in the structuring mode oFPA. After pressing the Enter key (9) in the onPA-configuration level, the first parameter of table 5-1 Filter time constant tF appears in the w/y-display (2) with its curernt value in the x-display (1) the first time the mains power is switched on. Otherwise the parameter selected last the last time the onPA mode was exited appears. The green w-LED (5) lights (x-LED (4) is off) and the parameter name flashes, i.e. the parameter can be selected with the Δw/Δy-keys (7), (8). By pressing the Shift key (6) once, the red x-LED (4) lights up (w-LED (5) is out) and the parameter value flashes, then the parameter value can also be set with the Δw/Δy-keys (7), (8).

It generally applies in all configuration levels: The flashing display can be adjusted with the Δw/Δy-keys (7), (8), switch is effected by the Shift key (6).

The parameters with a large number range can be adjusted in fast mode. First select the adjustment direction with a Δw/Δy-key (7), (8) and then switch on the fast mode by simultaneously pressing the other Δw/Δy-key.

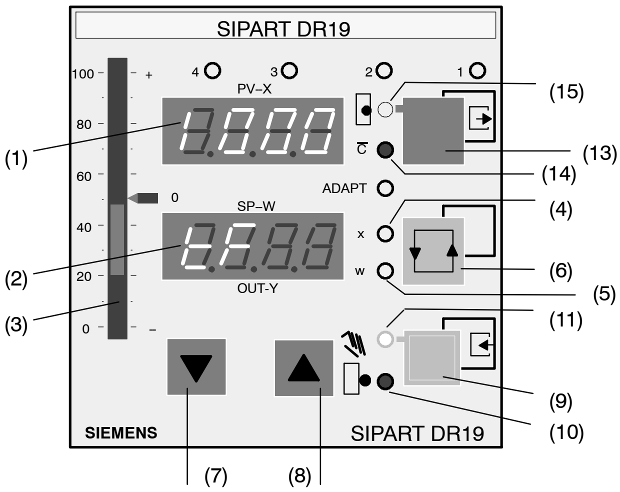
onPA Online Parameter list

Parameters	w/y-displ. (2)	w/x display (1)			Unit
	Parameter name	Min.	Max.	Factory setting	
Filter time constant for filter xd (adaptive)	tF	off / 1.000	1000	1.000	s
Derivative action gain Vv	uu	0.100	10.00	5.000	1
Proportional action factor Kp	cP	0.100	100.0	0.100	1
Integral action time Tn	tn	1.000	9984	9984	s
Derivative action time Tv	tv	off/1.000	2992	off	s
Response threshold	AH	0.0	10.0	0.0	%
Operating point	Y0	Auto/0.0	100.0	Auto	%
Safety setpoint 1	SH1	-10.0	110.0	0.0	%
Safety setpoint 2	SH2	-10.0	110.0	0.0	%
Safety setpoint 3	SH3	-10.0	110.0	0.0	%
Safety setpoint 4	SH4	-10.0	110.0	0.0	%
Output start (YA ≤ YE)	YA	-10.0	110.0	-5.0	%
Output end	YE	-10.0	110.0	105.0	%
y actuating time open/period heating	tP	off/0.100	1000	1.000	s
y actuating time closed/period cooling	tM	off/0.100	1000	1.000	s
Actuating pulse pause	tA [2]	20	[1] 600	200	ms
Positioning pulse length	tE [2]	20	[1] 600	200	ms
Filter time AI1	t1	off / 0.100	1000	1.000	s
Filter time AI2	t2	off / 0.100	1000	1.000	s
Filter time AI3	t3	off / 0.100	1000	1.000	s

Parameters	w/y-displ. (2)	w/x display (1)			Unit
	Parameter name	Min.	Max.	Factory setting	
Constant c1	c1	-1.999	9.999	0.000	
Constant c2	c2	-1.999	9.999	0.000	
Constant c3	c3	-1.999	9.999	0.000	
Constant c4	c4	-1.999	9.999	1.000	
Constant c5	c5	-1.999	9.999	0.000	
Constant c6	c6	-9.99	9.99	0.00	
Constant c7	c7	+1.000	9.999	1.000	
Display refresh rate	dr	0.100	9.900	1.000	s

1) At S2 = 1: max. 9980 ms
2) In two-position controllers: tA = shortest turn-on pulse and shortest pulse pause in the cooling branch
tE = shortest turn-on pulse and shortest pulse duration in the heating branch

Table 5-1 Online selection list



Legend:

(1)	x-display	Parameter value flashes if adjustable
(2)	w/y-display	Parameter name flashes if adjustable
(3)	Analog-display	current version
(4)	x-LED	on if parameter value is adjustable
(5)	w-LED	on if parameter name is adjustable
(6)	Shift key	Selection whether parameter name/value setting
(7), (8)	Δw/Δy-keys	Selection of parameters, setting of values in fast mode
(9)	Enter key	no function
(10)	Enter-LED	off
(11)	Manual-LED	current status
(13)	Exit key ↗	Return to selection level
(14)	Exit-LED	flashes
(15)	Internal LED	current status

Figure 5-5 Control and display elements in the configuration mode onPA

5.4.3 Configuration mode adaptation AdAP

This mode only appears in the selection level if S49 > 0 ist (with adaptation). In the parameterization mode AdAP the control circuit is open, the limit value alarms and digital control signals are active

- **Conditions for adaptation**

  - Structure switch S49 > 0 set.
  - The difference amount between the setpoint w and the actual value x must be greater than 20 % at the starting point.
  - There may be no tracking or safety operation by the control signals.

  Four different statuses are distinguished in the configuration level.

  - pre adaptation
  - During adaptation
  - Aborted adaptation
  - post adaptation

- **Pre adaptation**

  Adaptation can be started optionally in automatic or manual mode. In controlled systems with low gain and low or no overshoot, the structure switch setting S49 = 1 is recommended. S49 = 2 should be selected at large gain of the controlled system and greater overshoot.

  It is advisable to start in automatic mode because the controller operates automatically with the determined parameters at the end of adaptation. If adaptation is started and ended in manual mode, the controller outputs a manipulated value after adaptation which causes as small as possible a control difference xd. The parameters YA and YE have no effect on the adaptation procedure.

  Start of adaptation:

  2. Enter the selection level with the Shift key (6) and select the configuration level AdAP with the w/y-keys (7), (8). Enter-LED (10) flashes.
  3. Call AdAP with the Enter key (9) AdAP and select the controller structure PI or PID with the w/y-key (7), (8). Enter-LED (10) flashes as a start request.
  4. Start adaptation with the Enter key (9) (Adapt LED (16) starts to flash).

- **During adaptation**

  The AdAPT LED (16) flashes during adaptation. All the process variables can be observed. However, the w/y-keys (7), (8) are locked. The adaptation time depends on the delay time in the process.

  During the adaptation process you can switch from automatic to manual mode and vice versa. But this has no influence on the course of adaptation. The control circuit is open in any case. Only the status is determined which the controller adopts at the end of the adaptation process.

The controller outputs 100 % and 0 % of the manipulated variable y several times at the output during adaptation. This generates an oscillation of the controlled variable x within the target setpoint/start actual value band. The controller parameters are determined by the curve (oscillation time, amplitude) (see chapter 3.9, page120).

- **Aborted adaptation**

  If adaptation is aborted, the safety manipulated value YS is output, the controller goes into manual mode, the AdAPT-LED (16) goes off and the old control parameters are retained

  The manual abortion can be triggered at any time by pressing the Exit key (13). This returns you to the process operation level.

  Automatic abortion is accompanied by an error message (see table 5-2, page 172). The error messages are indicated in the digital x-display (1) and w/y-display (2). The Exit LED (14) flashes. The error message is acknowledged by pressing the Exit key (13), the controller returns to the process operation level.

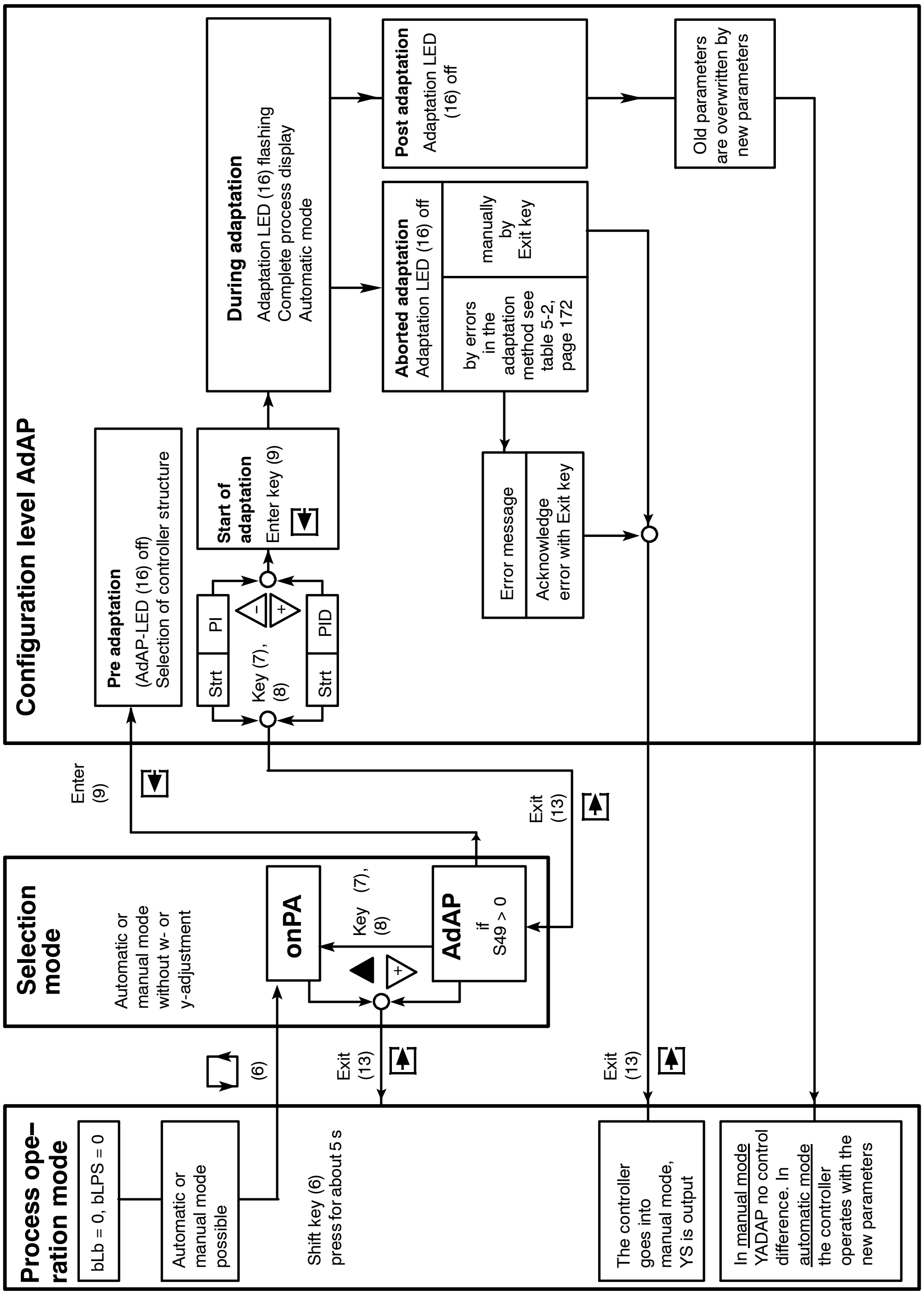


Figure 5-6 Overview configuration level AdAP

- **Error messages**

The following error messages are indicated in the digital x-display (1) and w/y-display (2):

Error message	Meaning	Remedy
SP.Pv SMAL	Control difference amount ǀxdǀ < 20 %	Change the controlled variable so that the control difference amount ǀxdǀ > 20 % wird.
ovEr Shot	Overshoot of the actual value past the target setpoint by more than 10 % during adaptation.	If the physical overshoot is not critical, the span dA-dE can be increased.
n ModE	There is tracking operation by the control signals.	Cancel tracking operation, Clear N-signal.
Si ModE	There is safety operation by the control signals.	Cancel safety operation, Clear Si-signal.

Table 5-2 Adaptation error messages

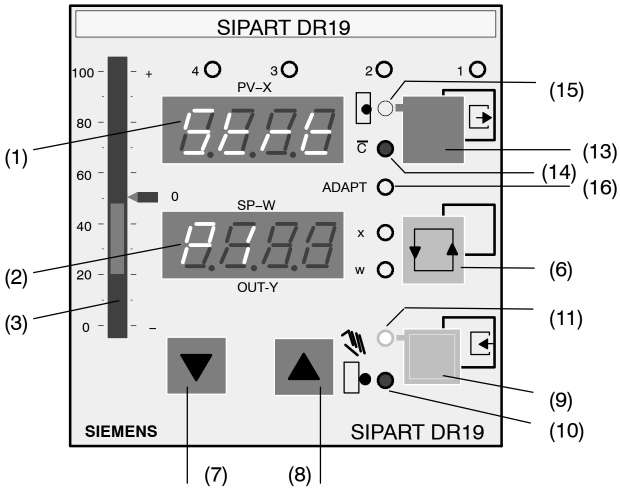
- **Post adaptation**

When the adaptation has been ended error-free (adaptation-LED (16) off),the controller returns automatically to the process operation level.

If the controller is in automatic mode, it controls with the newly determined parameters.

If adaptation is ended in manual mode, the output manipulated value causes as small a control difference as possible.

After switching to automatic, the controller operates with the new parameters.



Legend:

(1)	x-display	Pre adaptation: PI or PID During adaptation: Process parameter Aborted adaptation: Error message
(2)	w/y-display	Pre adaptation: PI or PID During adaptation: Process parameter Aborted adaptation: Error message
(3)	Analog-display	current version
(6)	Shift key	Pre adaptation: no function During adaptation: w/y-switching
(7), (8)	Δw/Δy-keys	Pre adaptation: Selection PI or PID During adaptation: disabled
(9)	Enter key	Pre adaptation: Start of adaptation During adaptation: Manual/automatic switching
(10)	Enter-LED	Pre adaptation: flashes During adaptation: off
(11)	Manual-LED	current status
(13)	Exit key ↗	Pre adaptation: Return to selection level During adaptation: Manual abort
(14)	Exit-LED	flashes
(15)	Internal LED	current status

Figure 5-7 Control and display elements in the configuration mode AdAP

5.4.4 Configuration level offline parameters oFPA

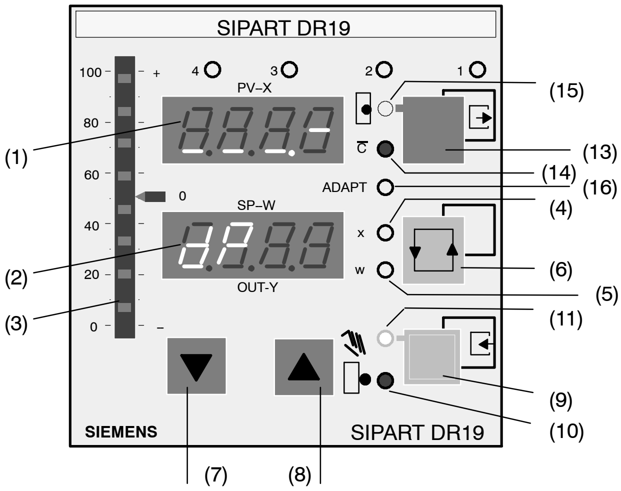
The offline parameters determine basic functions such as display ranges, limit values, safety values and transmission function of the input variables.

After pressing (approx. 3 s) the Enter key (9) in the oFPA-configuration level, the first parameter of table 53, page 175 “dP” appears in the w/y-display (2) with its current value in the x-display (1) the first time the mains power is switched on. Otherwise the parameter selected last the last time the oFPA mode was exited appears. The green w-LED (5) lights (x-LED (4) is off) and the parameter name flashes, i.e. the parameter can be selected with the Δw/Δy-keys (7), (8). By pressing the Shift key (6) once, the red x-LED (4) lights up (w-LED (5) is out) and the parameter value flashes, then the parameter value can also be set with the Δw/Δy-keys (7), (8).

It generally applies in all configuration levels: The flashing display can be adjusted with the Δw/Δy-keys (7), (8), switch is effected by the Shift key (6).

The parameters with a large number range can be adjusted in fast mode. First select the adjustment direction with a Δw/Δy-key (7), (8) and then switch on the fast mode by simultaneously pressing the other Δw/Δy-keys (7), (8).

The oFPA display reappears after pressing the Exit key (13) once. From this state you can change to any other offline configuration level without the 3 s wait necessary for a new entry by tapping the Enter key (9). This applies accordingly for all offline configuration modes.



Legend:

(1)	x-display	Parameter value flashes if adjustable
(2)	w/y-display	Parameter name flashes if adjustable
(3)	Analog-display	Striped pattern (offline identification)
(4)	x-LED	on if parameter value is adjustable
(5)	w-LED	on if parameter name is adjustable
(6)	Shift key	Selection whether parameter name/value setting
(7), (8)	Δw/Δy-keys	Selection of parameters, setting of values in fast mode
(9)	Enter key	no function
(10)	Enter-LED	off
(11)	Manual-LED	on (manual operation)
(13)	Exit key ↗	Return to selection level
(14)	Exit-LED	flashes
(15)	Internal LED	off

Figure 5-8 Control and display elements in the configuration mode oFPA

oFPA Offline parameter list

Parameter/function	w/y-displ. (2) param. name	x-display (1) Min.	Max.	Factory setting	Unit
Decimal point w/x display	dP	_.–––	––––	_ _ _.–	–
Start of scale	dA	–1999	9999	0.0	
Full scale	dE	–1999	9999	100.0	
Alarm 1	A1	–110% to 110%		5.0	
Alarm 2 (A2 ≤ A1)	A2	from dA, dE		–5.0	
Alarm 3	A3	at S83 / S84 =		5.0	
Alarm 4 (A4 ≤ A3)	A4	0/2/3/4/5		–5.0	
Hysteresis alarms	HA	0.1	10.0	1.0	%
Setpoint start	SA	–10,0% to 110%		–5.0	
Setpoint end	SE	from dA, dE		105.0	
Setpoint ramp time	tS	oFF/0.100	9984	oFF	min
Ratio factor start	vA	0.000	9.999	0.000	1
Ratio factor end	vE	0.000	9.999	1.000	1
Safety manipulated variable	YS	–10.0	110.0	0.0	%
Split range left (Y1 ≤ Y2)	Y1	0.0	100.0	50.0	%
Split range right	Y2	0.0	100.0	50.0	%
Output values of the linearizer L–1 (–10%) to L11 (110%) are equidistant input vertex points	L–1	–10.0	110.0	–10.0	% 1)
	L0	–10.0	110.0	0.0	% 1)
	L1	–10.0	110.0	10.0	% 1)
	L2	–10.0	110.0	20.0	% 1)
	L3	–10.0	110.0	30.0	% 1)
	L4	–10.0	110.0	40.0	% 1)
	L5	–10.0	110.0	50.0	% 1)
	L6	–10.0	110.0	60.0	% 1)
	L7	–10.0	110.0	70.0	% 1)
	L8	–10.0	110.0	80.0	% 1)
	L9	–10.0	110.0	90.0	% 1)
	L10	–10.0	110.0	100.0	% 1)
	L11	–10.0	110.0	110.0	% 1)

1) **Note**: At S21 = 4, values standardized to dA to dE.

Table 5-3 Offline parameter list

5.4.5 Configuration level program controller CLPA

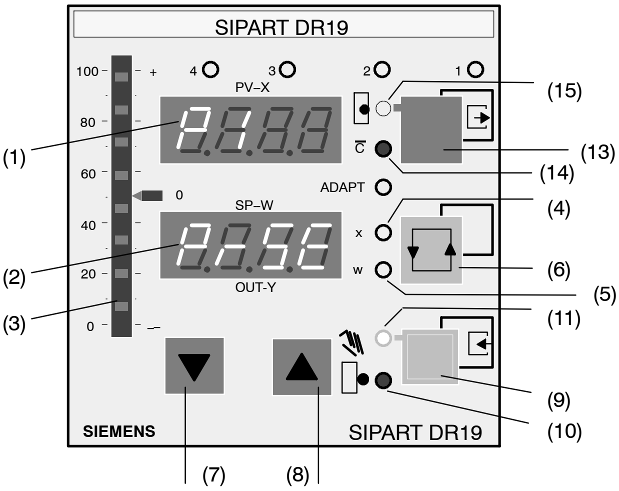
The CLPA-menu of the program controller or time plan transmitter is offered in the selection level if the structure switch S1 = 5 is set (at 6DR1900/2/5).

The program controller allows 2 timing programs P1 and P2 to run which are selected with the parameters PrSE (CLPA-menu) and the control signal PU (S34) (P1 with PU=Low, P2 with PU=High) and are cascadable.

The indicators L1 and L2 are available for the **program display** (in structure switch S87 = 1,2,3,5).

Program P1 can be occupied with a maximum 10, program P2 with a maximum 5 time intervals. A maximum of 15 time intervals are possible in cascaded programs.

In every time interval the time t.xx.x, the analog value (program target setpoint wpz) at the end of the interval A.xx.x and up to 6 digital outputs CLb1 to CLb6 are determined (see also chapter 3.4.7, page 89).



Legend:

(1)	x-display	Parameter value flashes if adjustable
(2)	w/y-display	Parameter name flashes if adjustable
(3)	Analog-display	Striped pattern (offline identification)
(4)	x-LED	on if parameter value is adjustable
(5)	w-LED	on if parameter name is adjustable
(6)	Shift key	Selection whether parameter name/value setting
(7), (8)	Δw/Δy-keys	Selection of parameters, setting of values in fast mode
(9)	Enter key	no function
(10)	Enter-LED	off
(11)	Manual-LED	on (manual operation)
(13)	Exit key ↗	Return to selection level
(14)	Exit-LED	flashes
(15)	Internal LED	off

Figure 5-9 Control and display elements in the configuration mode CLPA

CLPA parameter list

Parameter setting	Display SP-W (2) param.-name	Display PV-X (1) Parameter setting	Factory setting
Program selection (Program selection)	PrSE	P1 only program 1 P2 only program 2 P1.P2 P1 or P2 via PU (DI) [1)] CASC P1 and P2 cascaded [2)]	P1
Hold and comparison at the end of the interval	Hold	oFF, 0,1 to 10 [% of dA, dE] [3)]	oFF
Clock format	CLFo	h.' hr, min '." min, sec	h . '
Interval times [4)], Program 1 (10 intervals) Interval times [4)], Program 2 (5 intervals)	t.o1.1 to t.10.1 t.o1.2 to t.o5.2	00.00 to 23.59 or 00.00 to 59.59 00.00 to 23.59 or 00.00 to 59.59	00.00 00.00
Analog values [5)] at the end of the intervals, in program 1 Analog values [5)] at the end of the intervals, in program 2	A.01.1 to A.10.1 A.01.2 to A.05.2	−10 % to +110 % of dA, dE, noP [6)] −10 % to +110 % of dA, dE, noP [6)]	0.0 0.0
Program 1			
Digital output signal CLb1 during the intervals 1 to 10 to Digital output signal CLb6 during the intervals 1 to 10	1.01.1 to 1.10.1, 1.PE.1 to 6.01.1 to 6.10.1, 6.PE.1	Lo/Hi x.PE.x Status of the digital outputs at the end of the program and at the start of the program in the start position Lo/Hi x.PE.x Status of the digital outputs at the end of the program and at the start of the program in the start position	Lo Lo
Program 2			
Digital output signal CLb1 during the intervals 1 to 5 to Digital output signal CLb6 during the intervals 1 to 5	1.01.2 to 1.05.2, 1.PE.2 to 6.01.2 to 6.05.2, 6.PE.2	Lo/Hi x.PE.x Status of the digital outputs at the end of the program and at the start of the program in the start position Lo/Hi x.PE.x Status of the digital outputs at the end of the program and at the start of the program in the start position	Lo Lo

Table 5-4 CLPA-Parameter list

1) Switching via PU-signal (S34). At PU = Low P1 is active, at PU = High P2 is active. The control signal must have attained the desired level before starting. A switching during the program run has no influence on the program selection.

2) P1 and P2 cascaded. First P1 then P2 is processed.

3) Hold: The next interval does not start until the control difference is smaller than the set value (specification in % of dA, dE) The control difference is checked at the end of every interval for compliance with the set value.

4) If no all intervals are needeöed, the time 00.00 (factory setting) must be assigned to the other time intervals.

5) The set wi is active at the beginning of the 1st interval (start position) The end value of an interval is identical with the start value of the next interval.

6) With specification "noP" the analog value at the end of the interval is given by straight line calculation between the adjacent vertex points.
Practical application at:
- Change in a digital signal output during the ramp runtime
- Time prolongation of an interval beyond the maximum interval time value
- Periodic hiding of an interval during the test phase

NOTE

For the program to function at least the parameters PrSE, CLFo, t... and A... must be defined in the CLPA-menu and the structure switches S43 = 2 (INT and EXT) and S23 = 8 (CB = High) set.

Example: Program controller with 6 intervals

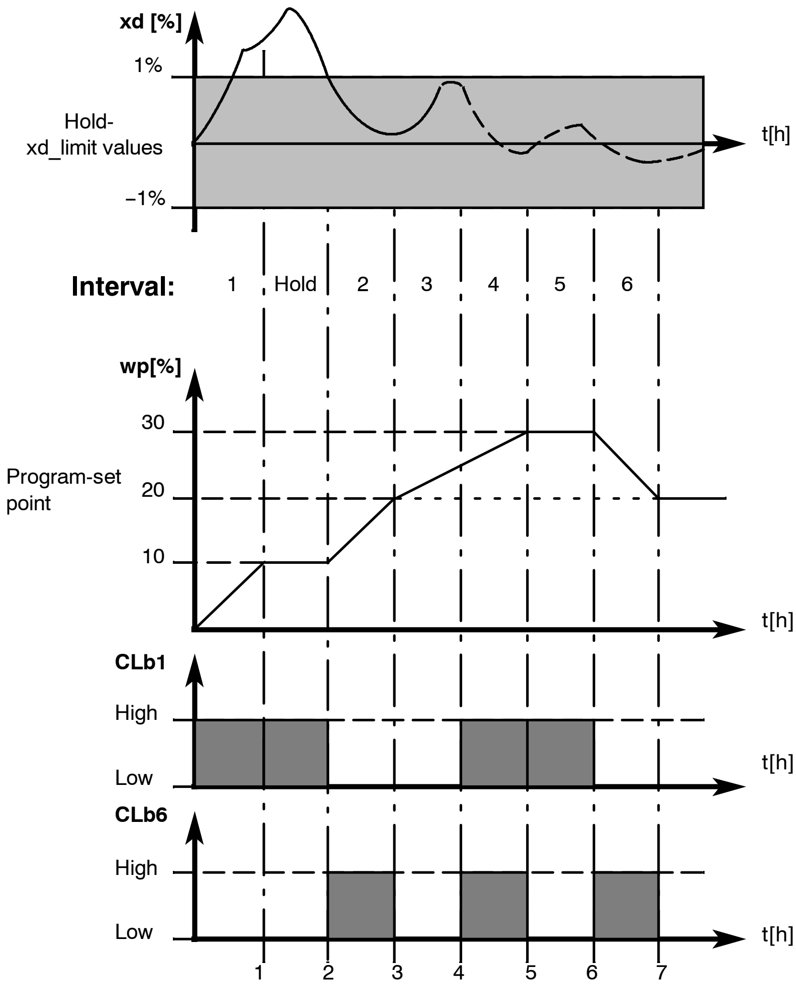


Figure 5-10 Program controller example

Parameters	Setting
PrSE	P1
Hold	1.0
CLFo	h. ’
t.01.1	01.00
t.02.1	01.00
t.03.1	01.00
t.04.1	01.00
t.05.1	01.00
t.06.1	01.00
A.01.1	10.0
A.02.1	20.0
A.03.1	noP
A.04.1	30.0
A.05.1	30.0
A.06.1	20.0

Parameters		Setting
CLb1	1.01.1	Hi
	1.02.1	Lo
	1.03.1	Lo
	1.04.1	Hi
	1.05.1	Hi
	1.06.1	Lo
	1.PE.1	Lo
CLb6:	6.01.1	Lo
	6.02.1	Hi
	6.03.1	Lo
	6.04.1	Hi
	6.05.1	Lo
	6.06.1	Hi
	6.PE.1	Lo

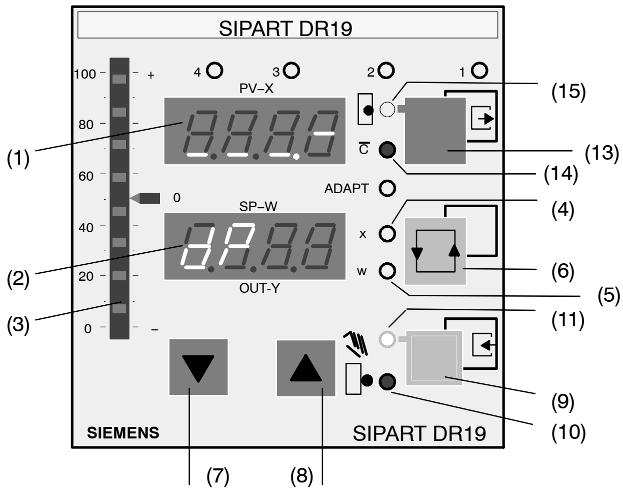
All other parameter settings according to the factory settings.

5.4.6 Configuration mode structure switch StrS

The structure switches are software switches which determine the function and structure of the controller. They are set in the offline mode.

Starting from the selection level and display StrS, the structure switch S1 appears in the w/y-display with its current setting in the x-display after pressing (approx. 3 s) the Enter key (9) the first time the mains power supply is switched on. Otherwise structure switch selected last the last time the StrS-mode was exited appears. The green w-LED (5) lights (x-LED (4) is off) and the structure switch name flashes, i.e. the structure switch can be selected with the Δw/Δy-keys (7), (8).

If you select the adjustment direction with a Δw/Δy-key (7), (8), tens steps of the counter can be generated by simultaneously pressing the other Δw/Δy-key. By pressing the Shift key (6) once you can switch between the structure switch selection (green w/y-display (2) flashes) and setting of the selected structure switch (red x-display (1) flashes).



Legend:

(1)	x-display	Structure switch adjustment flashes if adjustable
(2)	w/y-display	Structure switch number flashes if adjustable
(3)	Analog-display	Striped pattern (offline identification)
(4)	x-LED	on if structure switch position is adjustable
(5)	w-LED	on if structure switch number is adjustable
(6)	Shift key	Selection whether parameter name/value setting
(7), (8)	Δw/Δy-keys	Adjustment of the structure switch position/number with fast action
(9)	Enter key	no function
(10)	Enter-LED	off
(11)	Manual-LED	on (manual operation)
(13)	Exit key ↗	Return to selection level
(14)	Exit-LED	flashes
(15)	Internal LED	off

Figure 5-11 Control and display elements in the configuration mode StrS

StrS – structure switch list

[ ] corresponds to the factory setting

Structure switch		switch position	Function
Basic setting	S1		**Controller type**
		[0]	Fixed value/three-component controller/controller with 2 internal setpoints
		1	Fixed value/three-component controller with 5 internal setpoints
		2	Sequence/synchronized/SPC controller with Int/Ext switching
		3	Ratio controller
		4	Control unit S/K, process display
		5	Program controller
		6	Fixed value controller with 1 setpoint for control system coupling (as of software version A7)
		7	Sequence controller without internal/external switching for control system coupling (as of software version A7)
	S2		**Output structure**
		[0]	K-output:
		1	S-output: two-position controller with 2 outputs heating/cooling *)
		2	S-output: three-position controller for motorized drives, internal feedback *)
		3	S-output: three-position controller for motorized drives, external feedback *)
	S3		**Mains frequency suppression**
		[0]	50 Hz
		1	60 Hz
	S4		**Standard input AI1 (I, mV, R, P, T) – transmitter fault message**
		[0]	UNI-input AI1 Min at sensor break without MUF
		1	UNI-input AI1 Min at sensor break with MUF
		2	UNI-input AI1 Max at sensor break without MUF
		3	UNI-input AI1 Max at sensor break with MUF
Analog inputs	S5		**Input signal AI1**
		[0]	mV (linear), with measuring range plug I [mA] or U [V]
		1	Thermocouple with internal reference point
		2	Thermocouple with external reference point
		3	PT100 four-wire connection
		4	PT100 three-wire connection
		5	PT100 two-wire connection
		6	Resistance potentiometer with R < 600 Ω
		7	Resistance potentiometer with R < 2.8 kΩ
	S6		**Thermocouple type AI1 (only active at S5 = 1 / 2)**
		[0]	Type L
		1	Type J
		2	Type K
		3	Type S
		4	Type B
		5	Type R
		6	Type E
		7	Type N
		8	Type T
		9	Type U
		10	any type (without linearization) – only useful with S5 = 2
	S7		**Temperature unit AI1 and AI3 with UNI-module (only active at S5 or S10 = 1/2/3/4/5)**
		[0]	Degrees Celsius
		1	Degrees Fahrenheit
		2	Kelvin

*) See chapter 6.3 “Adapting the S-controller to the actuating drive”, page 205

Structure switch		switch position	Function				
Analog inputs	S8		**Input signal AI2 (slot 2) and transmitter fault message**				
		[0]	I [0 to 20 mA]	or U, R, P, T	without MUF		
		1	I [0 to 20 mA]	or U, R, P, T	with MUF		
		2	I [4 to 20 mA]	or U	without MUF		
		3	I [4 to 20 mA]	or U	with MUF		
	S9		**Input signal AI3 (slot 1) and transmitter fault message**				
		[0]	I [0 to 20 mA]	or U, R, P, T	without MUF		
		1	I [0 to 20 mA]	or U, R, P, T	with MUF		
		2	I [4 to 20 mA]	or U	without MUF		
		3	I [4 to 20 mA]	or U	with MUF		
		4	UNI-module	Min. at sensor break	without MUF		
		5	UNI-module	Max. at sensor break	without MUF		
		6	UNI-module	Min. at sensor break	with MUF		
		7	UNI-module	Max. at sensor break	with MUF		
	S10		**Input signal AI3 (slot 1) with UNI-module (only active at S9 = 4/5/6/7)**				
		[0]	U [mV] (linear), with measuring range plug I [mA] or U [V]				
		1	Thermocouple with internal reference point				
		2	Thermocouple with external reference point				
		3	PT100 four-wire connection				
		4	PT100 three-wire connection				
		5	PT100 two-wire connection				
		6	Resistance potentiometer with R < 600 Ω				
		7	Resistance potentiometer with R < 2.8 kΩ				
	S11		**Thermocouple type AI3 (slot 2) with UNI-module (only active at S10 = 1 / 2)**				
		[0]	Type L				
		1	Type J				
		2	Type K				
		3	Type S				
		4	Type B				
		5	Type R				
		6	Type E				
		7	Type N				
		8	Type T				
		9	Type U				
		10	any type (without linearization)				
			Root extraction AI1 to AI3				
				no	yes		
	S12		AI1	[0]	1		
	S13		AI2	[0]	1		
	S14		AI3	[0]	1		
			Assignment of x1, x2, x3, yN, yR, z to AI1A to AI3A				
				0 %	AI1A	AI2A	AI3A
	S15		x1	0	[1]	2	3
	S16		x2	0	1	[2]	3
	S17		x3/w_E	0	1	2	[3]
	S18		y_N	[0]	1	2	3
	S19		y_R	[0]	1	2	3
	S20		z	[0]	1	2	3

Structure switch		switch position	Function
Analog inputs	S21		**Assignment of the linearizer (see ofPA) open**
		[0]	none
		1	AI1
		2	AI2
		3	AI3
		4	x1
Slot 3	S22		**Configuration of slot 3**
		[0]	not used
		1	4 DO / 2 DI (DO3 to DO6 / DI3, DI4)
		2	5 DI (DI3 to DI7)
		3	2 relays (DO3, DO4)

Digital inputs

Assignment of the control signals to digital inputs

Structure switch		Standard controller			Slot 3						
		Low	DI1	DI2	DI3	DI4	DI5	DI6	DI7	High	
S23	CB	0	1	2	3	4	5	6	7	[8]	
S24	He	[0]	1	2	3	4	5	6	7	–	
S25	N	0	[1]	2	3	4	5	6	7	–	
S26	Si	0	1	[2]	3	4	5	6	7	–	
S27	P	[0]	1	2	3	4	5	6	7	8	
S28	$\overline{\text{tS}}$ 2)	[0]	1	2	3	4	5	6	7	–	
S29	+yBL	[0]	1	2	3	4	5	6	7	–	
S30	−yBL	[0]	1	2	3	4	5	6	7	–	
S31	bLb	[0]	1	2	3	4	5	6	7	–	
S32	bLS	[0]	1	2	3	4	5	6	7	–	
S33	bLPS	[0]	1	2	3	4	5	6	7	–	
S34	PU 1)	[0]	1	2	3	4	5	6	7	8	
S100	tSH	[0]	1	2	3	4	5	6	7	–	3)

1) PU = Low: Program P1 at PrSt = P1.P2
PU = High: Program P2 at PrSt = P1.P2

2) as of software version −B6; Reset-function at S1 = 5

3) as of software version −B9

Direction of effect of the control signals

Structure switch		24 V = High	0 V = High
S35	CB	[0]	1
S36	He	[0]	1
S37	N	[0]	1
S38	Si	[0]	1
S39	P	[0]	1
S40	$\overline{\text{tS}}$	[0]	1
S41	+/−yBL	[0]	1

Structure switch	switch position	Function
S42		**Control signal CB**
	[0]	static without acknowledgement
	1	static with acknowledgement
	2	dynamic as pulse (flip-flop-effect)

Structure switch		switch posi-tion	Function
Setpoint switching	S43		**Blocking the switching setpoint internal / external**
		[0]	internal only
		1	external only
		2	no blocking
	S44		**x-tracking at H or N or Si**
		[0]	no
		1	yes
Setpoint switching	S45		**Setpoint at CB failure**
		[0]	last wi
		1	Safety setpoint SH1
	S46		**Tracking of wi or SH1/SH2/SH3/SH4 to the active setpoint w**
			wi / SH1 to SH4
		[0]	yes / no
		1	no / no
		2	yes / yes at S1 = 1
Control algorithm	S47		**Direction of effect referenced to xd (w – x)**
		[0]	normal (Kp > 0)
		1	reversed (Kp < 0)
	S48		**D-element connection**
		[0]	xd
		1	x
		2	x1
		3	z direction of effect opposite to x (connection to manipulated variable y)
		4	z direction of effect with x (connection to manipulated variable y)
	S49		**Adaptation selection**
		[0]	no adaptation
		1	Normal control behavior
		2	Control behavior damped
Output switching	S50		**Priority N or H**
		[0]	N
		1	H
	S51		**Manual operation in event of transmitter fault**
		[0]	no switching (display only)
		1	Manual operation starting with last y
		2	Manual operation starting with ys
	S52		**Switching manual / automatic via**
			Manual key Hi / Control signal He / Locking He_{ES}
		[0]	yes / yes / static / with
		1	no / yes / static / with
		2	no switching manual operation
		3 [1]	yes / yes / dynamic / with
		4 [1]	yes / yes / dynamic / without
			[1] as of software version -A7
	S53		**ly-switch off in tracking mode (K-controllers only)**
		[0]	without
		1	with
	S54		**Manipulated variable limit YA / YE**
		[0]	Only active in automatic operation
		1	Active in all operating modes

<table>
<tr><th colspan="2">Structure switch</th><th>switch posi-tion</th><th>Function</th></tr>
<tr><td rowspan="2">y display</td><td>S55</td><td>
[0]
1
2
3</td><td>Manipulated variable display
Controller output y
Position feedback y_R
Split range y1/y2, in two position controllers heating/cooling
no display</td></tr>
<tr><td>S56</td><td>
[0]
1</td><td>Direction of effect of the manipulated variable display yAn
normal: yAn = y
reversed: yAn = 100% − y</td></tr>
<tr><td>Analog outputs</td><td>S57</td><td>
[0]
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17</td><td>Assignment of controller variables to the analog output
y 0 to 20 mA
y 4 to 20 mA
w 0 to 20 mA
w 4 to 20 mA
x 0 to 20 mA
x 4 to 20 mA
x1 0 to 20 mA
x1 4 to 20 mA
xd + 50% 0 to 20 mA
xd + 50% 4 to 20 mA
y1 0 to 20 mA as of software version −B6
y1 4 to 20 mA as of software version −B6
y2 0 to 20 mA as of software version −B6
y2 4 to 20 mA as of software version −B6
1−y1 0 to 20 mA as of software version −B6
1−y1 4 to 20 mA as of software version −B6
1−y2 0 to 20 mA as of software version −B6
1−y2 4 to 20 mA as of software version −B6</td></tr>
<tr><td>Digital outputs</td><td>S58</td><td>

[0]
1
2
3</td><td>Assignment +/−Δy
<table><tr><th>DO1</th><th>DO2</th><th>DO7 (relay)</th><th>DO8 (relay)</th></tr><tr><td>−</td><td>−</td><td>+Δy</td><td>−Δy</td></tr><tr><td>+Δy</td><td>−Δy</td><td>−</td><td>−</td></tr><tr><td>−</td><td>−Δy</td><td>+Δy</td><td>−</td></tr><tr><td>+Δy</td><td>−</td><td>−</td><td>−Δy</td></tr></table>Note:
S58 has priority over S59 to S75</td></tr>
</table>

Structure switch		switch position	Function

Digital outputs

Assignment of alarm signals to digital outputs

Structure switch		none	Stand. contr.		Slot 3				Standard controller	
		none	DO1	DO2	DO3	DO4	DO5	DO6	DO7 (relay)	DO8 (relay)
S59	RB	[0]	1	2	3	4	5	6	7	8
S60	RC	[0]	1	2	3	4	5	6	7	8
S61	H	[0]	1	2	3	4	5	6	7	8
S62	Nw	[0]	1	2	3	4	5	6	7	8
S63	A1	0	[1]	2	3	4	5	6	7	8
S64	A2	0	1	[2]	3	4	5	6	7	8
S65	A3	[0]	1	2	3	4	5	6	7	8
S66	A4	[0]	1	2	3	4	5	6	7	8
S67	MUF	[0]	1	2	3	4	5	6	7	8
S68	+Δw	[0]	1	2	3	4	5	6	7	8
S69	−Δw	[0]	1	2	3	4	5	6	7	8

Notes:

- If DO1/2 or DO7/8 is occupied by S58 with +/−Δy, no double assignment is necessary!
- Assignment of different control signals to one digital output causes an OR-function.

Digital outputs

Assignment of time slot / status messages of the program controller to digital outputs

Structure switch		none	Stand. contr.		Slot 3				Standard controller	
		none	DO1	DO2	DO3	DO4	DO5	DO6	DO7 (Relay)	DO8 (Relay)
S70	Clb1	[0]	1	2	3	4	5	6	7	8
S71	Clb2	[0]	1	2	3	4	5	6	7	8
S72	Clb3	[0]	1	2	3	4	5	6	7	8
S73	Clb4	[0]	1	2	3	4	5	6	7	8
S74	Clb5	[0]	1	2	3	4	5	6	7	8
S75	Clb6	[0]	1	2	3	4	5	6	7	8

Notes:

If DO1/2 or DO7/8 are occupied by S58 with +/−Δy, no double assignment is possible!

Digital inputs

Direction of effect of the DO on assigned control signals

Structure switch		24 V = High	0 V = High
S76	RB	[0]	1
S77	RC	[0]	1
S78	H	[0]	1
S79	Nw	[0]	1
S80	A1/A2	[0]	1
S81	A3/A4	[0]	1
S82	MUF	[0]	1

Limit value alarms

Assignment of A1/A2 and A3/A4 to process variables

Structure switch		xd	x1	x	w	xv	wv	y	y1	y2	AI1	AI2	AI3	AI1A	AI2A	AI3A	|xd|*)
S83	A1/A2	[0]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
S84	A3/A4	[0]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

*) as of software version −B9

<table>
<tr><th colspan="2">Structure switch</th><th>switch posi-tion</th><th>Function</th></tr>
<tr><td rowspan="3">Limit value alarms</td><td>S85</td><td>
[0]
1
2</td><td>Function of the limit value alarms A1/A2
A1 max / A2 min
A1 min / A2 min
A1 max / A2 max</td></tr>
<tr><td>S86</td><td>
[0]
1
2</td><td>Function of the limit value alarms A3/A4
A3 max / A4 min
A3 min / A4 min
A3 max / A4 max</td></tr>
<tr><td>S87</td><td>[0]
1
2
3
4
5
6</td><td>Display and setting of the limit values A1 to A4 in the process operation mode
<table>
<tr><th>Display to SP-W (2) 1)</th><th>Parameter switchable</th><th>Signaling of the addressed limit values via L1 to L4 1)</th></tr>
<tr><td>no</td><td>no</td><td>A1/A2/A3</td></tr>
<tr><td>no</td><td>no</td><td>A3/A4 (e.g. for S1 = 5)</td></tr>
<tr><td>no</td><td>no</td><td>no (e.g. for S1 = 1 or 5)</td></tr>
<tr><td>A3/A4</td><td>no</td><td>A3/A4 (e.g. for S1 = 5)</td></tr>
<tr><td>A1/A2/A3/A4</td><td>no</td><td>A1/A2/A3/A4</td></tr>
<tr><td>A3/A4</td><td>yes</td><td>A3/A4 (e.g. for S1 = 5)</td></tr>
<tr><td>A1/A2/A3/A4</td><td>yes</td><td>A1/A2/A3/A4</td></tr>
</table>
Notes:
In switch position 1, 2, 3 and 5 the lamps L1 and L2 are free for signaling a running program 1 or 2 (in S1 = 5)
1) The parameter name is displayed in this case by signal lamps L1 to L4 flashing in a 0.5 rhythm. With selected and addressed alarm lamp in 0.9 rhythm.</td></tr>
<tr><td>w/x display</td><td>S88
with S1=0
1
2
6
7</td><td>[0]
1
2
3
x-LED
w-LED</td><td>Order in the displays PV-X (1) and SP-W (2), when <u>S1 = 0/1</u> (fixed value-) or <u>S1 = 2</u> (sequence controller)
<table>
<tr><th colspan="4">Order in the display SP-W</th><th>Display PV-X</th></tr>
<tr><th>I</th><th>II</th><th>III</th><th>IV</th><th></th></tr>
<tr><td>w</td><td>y</td><td>–</td><td>–</td><td>x</td></tr>
<tr><td>w/wi 1)</td><td>y</td><td>wE/wi 2)</td><td>–</td><td>x</td></tr>
<tr><td>w</td><td>y</td><td>–</td><td>x1</td><td>x</td></tr>
<tr><td>w/wi 1)</td><td>y</td><td>wE/wi 2)</td><td>x1</td><td>x</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0,5</td><td></td></tr>
<tr><td>1</td><td>0</td><td>0,5</td><td>0</td><td></td></tr>
</table>
1 = steady, 0.5 = flashing, 0 = off
Note:
The display order on display SP-W can be extended by A1 to A4 by S87.
1) active wi
2) Inactive wi in fixed value controllers with two or five setpoints</td></tr>
</table>

Structure switch		switch position	Function
w/x display	S88 *with S1=3*		**Order in the displays PV-X (1) and SP-W (2), if S1 = 3**

switch position	Order in the display SP-W I	II	III	IV	Display PV-X I	II	III	IV
[0]	wv	y	–	–	xv	xv	–	–
1	wv	y	–	w[1)]	xv	xv	–	x[1)]
2	wv	y	wvE		xv	xv	xv	–
3	wv	y	wvE	w[1)]	xv	xv	xv	x[1)]
x-LED	0	0	0	1	0	0	0	1
w-LED	1	0	0.5	1	1	0	0.5	1

1 = steady, 0.5 = flashing, 0 = off

Note:
The display order can be lengthened by A1 to A4 by S87.

1) display in xxx.x %

Structure switch		switch position	Function
w/x display	S88 *with S1=4*		**Order in the displays PV-X (1) and SP-W (2), when S1 = 4**

switch position	Order in the display SP-W I	II	III	Display PV-X I to III	Recommended application
[0]	w	y	–	x1	Setpoint potentiometer + control unit
1	w	y	wE	x1	Setpoint potentiometer + control unit
2	w[2)]	–	–	x1	Dual–channel process display (physical)
3	–	y[1)]	–	x1	Dual–channel process display ($x1_{phy}$, y in %)
4	–[3)]	–	–[3)]	x1	Process display with limit value display in the SP-W (S87)
x-LED	0	0	0		
w-LED	1	0	0,5		

1 = steady, 0.5 = flashing, 0 = off

Note:
The display order can be lengthened by A1 to A4 by S87.

1) display in xxx.x %
2) Signal lamp w off
3) Signal lamp w off
Display SP-W dark

Structure switch		switch position	Function
w/x display	S88 with S1=5		**Order in the displays PV-X (1) and SP-W (2), when S1 = 5**

switch position	Order in the display SP-W I	II	III	IV	Display PV-X I	II	III	IV	Analog display I–III	IV
[0]	w	y	–	–	x	x	x	–	Process variable, according to S89	–
1	w	y	x1	–	x	x	x	–	Process variable, according to S89	–
2	w	y	–	–	x	x	x	–	Status of the program run	–
3	w	y	x1	–	x	x	x	–	Status of the program run	–
4	w	y	–	wpz	x	x	x		Process variable, according to S89	
5	w	y	x1	wpz	x	x	x		Process variable, according to S89	
6	w	–	–	–	Remaining time in the interval				Program run status	
7	w	–	–	wpz	Remaining time in the interval				Program run status	
x-LED	0	0	0.5	0.5				0.5		0.5
w-LED	1	0	0	0.5				0.5		0.5

1 = steady, 0.5 = flashing, 0 = off

Notes:
- wpz: Target setpoint of the interval
- The display order in display SP-W can be extended by A1 to A4 with S87.

Structure switch		switch position	Function
	S89		**Analog display (3) – assignment by controller variables**
		[0]	e(xd) ± 5 % column display
		1	e(xd) ± 10% column display
		2	e(xd) ± 20 % column display
		3	–e(xw) ± 5 % column display
		4	–e(xw) ± 10% column display
		5	–e(xw) ± 20 % column display
		6	x1 0 to 100 % light mark (caterpillar)
		7	x2 0 to 100 % light mark (caterpillar)
		8	x 0 to 100 % light mark (caterpillar)
		9	wE 0 to 100 % light mark (caterpillar)
		10	w 0 to 100 % light mark (caterpillar)
		11	y 0 to 100 % light mark (caterpillar)
Restart conditions	S90		**Restart after mains recovery**
		[0]	Last operating mode, last w, last y, program controller: – Time is saved. – Program continues running smoothly with the stored values if the operating status allows.
		1	Manual and internal mode, last w, program controller: Start position (Reset state) in K-controller YS, S-controller last y
	S91		**Optical signaling after mains recovery**
		[0]	without flashing of the PV-X- and SP-W-display
		1	with flashing of the PV-X- and SP-W-display
SES	S92		**Serial interface (slot 4)**
		0	without
		[1] 1)	with serial interface, with locking by RC
		2	with serial interface, with locking by CB 2)
		3	with serial interface, without locking 2)
			1) before software version –A6, 0 was the factory setting 2) as of software version –C4
Serial interface	S93		**Data transfer**

switch position	Reception by DR19	Control signal CB_{DI}/CB_{ES}	Source for w_E	Source for y_N
0	nothing	only CB_{DI}	w_{EA}	y_N
[1] 1)	Configuring			
2	Configuring	$CB_{DI} \vee CB_{ES}$	w_{ES}	y_{ES}
3	Proc. variables	$CB_{DI} \wedge CB_{ES}$		
4 2)	Status register	$CB_{DI} \vee CB_{ES}$	w_{EA}	y_N
5 2)		$CB_{DI} \wedge CB_{ES}$		

Sending all controlled variables is possible in all settings

1) as of software version –A7

2) as of software version –A9

Structure switch		switch position	Function
Serial interface	S94		**Data transfer rate**
		[0]	9600 bps
		1	4800 bps
		2	2400 bps
		3	1200 bps
		4	600 bps
		5	300 bps
	S95		**Cross parity**
		[0]	even
		1	odd
	S96		**Longitudinal parity position**
		[0]	without
		1	after ETX
		2	before ETX
	S97		**Longitudinal parity**
		[0]	normal
		1	inverted
	S98		**Station number**
		[0]	0
		to	to
		125	125 [1)]
			1) as of software version –A9
	S99		**Time monitoring CB (ES)**
		[0]	Off
		1	1 s
		to	to
		25	25 s
	S100		see structure switch S34

Table 5-5 Structure switch list

For operation on the PROFIBUS-DP the serial interface must be set on the DR19 as follows:

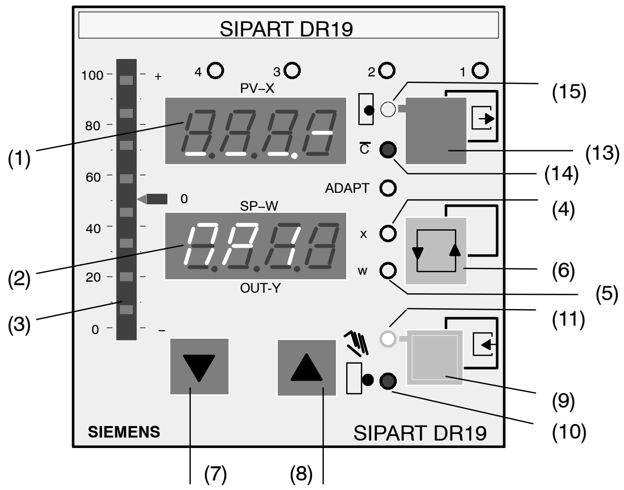
Structure switch	Setting
S92	1
S93	2
S94	0
S95	0
S96	0
S97	0
S98	3 to 125
S99	0 to 9

5.4.7 Set analog input AI1 CAE1

The measuring range for the different signal transmitters can be set with this menu and fine adjustment made (selection of the signal transmitters with structure switch S5 and S6).

- **Call, set and exit the CAE1-menu**

  - Press the Shift key (6) for about 5s until “PS” flashes in the w/yy-display (2)
  - Select the CAE1 menu with the Δw/Δy-keys (7), (8).
  - Press the Enter key (9) for about 3 s to enter the CAE1 menu.
  - The parameter name in the w/y display (2) flashes (w-LED (5) is on, x LED (4) is off).
  - Select the CAE1-parameter with the Δw/Δy-keys (7), (8).
  - Press the Shift key (6) 1x once, the parameter value flashes in the x-display (1) (w-LED (5) is off, x-LED (4) is on).
  - Set the CAE1-parameter with the Δw/Δy-keys (7), (8).
  - Return to the process operation level by pressing the Exit key (13) twice.



Legend:

(1)	x-display	Parameter value flashes if adjustable
(2)	w/y-display	Parameter name flashes if adjustable
(3)	Analog-display	Striped pattern (offline identification)
(4)	x-LED	on if parameter value is adjustable
(5)	w-LED	on if parameter name is adjustable
(6)	Shift key	Selection whether parameter name/value setting
(7), (8)	Δw/Δy-keys	Selection of parameters, setting of values in fast mode
(9)	Enter key	sets Cr = 0, PC = no or in controller CA = 0 % or CE = 100 %
(10)	Enter-LED	flashes if Cr or PC = yes
(11)	Manual-LED	on (manual operation)
(13)	Exit key ↗	Return to selection level
(14)	Exit-LED	flashes
(15)	Internal LED	off

Figure 5-12 Control and display elements in the configuration mode CAE1 and CAE3

- **The following parameters are available in the CAE1 menu for setting the measuring range and adjustment**

w/y-display parameter name	x-display setting range	Factory setting	Display unit	Parameter meaning -function	Display and function only at:
tb1 1)	0 to 400.0	50	°C, °F, K	Reference temperature external reference point	S5= 2
Mr1	0.00 to 99.99	10	Ω	**M**easuring of **R**Ln. (Pt100-2L)	S5= 5
Cr1	Difference value to Mr		Ω	**C**alibr. of **R**Ln. (Pt100-2L)	
MP1	_.––– to ____		physical Dimension depending on the measuring variable 4)	**M**easuring range decimal**p**oint	S5 = 0 to 7
MA1 2) 6)	–1999 to 9999	0,0		Measuring range start	
ME1 2) 6)	–1999 to 9999	100,0		Measuring range full scale	
CA1	act. measured value ± ΔA 3)			Calibr. Meas. range start	
CE1	act. measured value ± ΔE 3)			Calibr. Meas. range full scale	
PC1 5)	no, YES, no C	no C	–	**P**reset **C**alibration	S5 = 0 to 5

Table 5-6 CAE1-menu parameter list

1) If no preset thermocouple type is pre-selected with S6 = 10, parameter tb1 is inactive.

2) The set measuring range is transferred as a standardized number range from 0 to 1 to the controller. If the measured value operating display is to be made physically, the offline parameters dA = MA1 and dE = ME1 must be set.

3) For S5 = 0 to 5 : ΔA, ΔE do not appear as own parameters. The correction values for calibrating the start or full scale of the measuring range are arbitrary.

4) For S5 = 6, 7the unit of the CA1/CE1 display is in %.

5) For S5 = 0 to 5: With ΔA = ΔE = 0, PC1 = no C is displayed, switching with the Δw-keys (7), (8) to PC1 = YES is not possible. By adjusting CA1/CE1, PC1 = no is displayed, switching to PC1 = YES is possible. If PC1 = YES is displayed, ΔA = ΔE = 0 can be set by pressing the Enter key (9) for about 3 s where upon PC1 = no C is displayed.

6) For S6 = 10; MA/ME in mV

The corresponding settings of the CAE1 menu for the different signal transmitters are described below.

To compensate tolerances of transmitters or calibrate with other display instruments (for S5 = 0 to 5) the measuring range and the current measured value are corrected with the parameters CA1/CE1.

To avoid measuring errors, the assembly instructions in chapter 4.2.2, page 138 and especially the maximum permissible line resistances (see table 2-2, page 40 must be observed in the determination of the measuring range.

5.4.7.1 Measuring range for mV (S5 = 0)

- **MA1/ME1 – set measuring range**

  Call parameter MA1, ME1, set measuring range start band end:
  Measuring range limits -175 mV ≤ MA1 ≤ ME1 ≤ +175 mV

- **CA1/CE1 – fine adjustment**

  Call parameter CA1,
  set signal to start of scale,
  correct the display with CA1 if necessary.

  Call parameter CE1,
  set signal to full scale,
  correct the display with CE1 if necessary.

5.4.7.2 Measuring range for U, I (S5 = 0)

only with measuring range plug 6DR2805-8J

- **MA1/ME1 – set measuring range**

  Call parameter MA1, ME1, set measuring range start and end:
  Measuring range limits -175 mV ≤ MA1 ≤ ME1 ≤ +175 mV

  Initialization in the measuring range plug

0 to 10 V or 0 to 20 mA signal corresponds to	MA1 = 0 mV	ME1 = 100 mV
2 to 10 V or 4 to 20 mA signal corresponds to	MA1 = 20 mV	ME1 = 100 mV

- **CA/CE fine adjustment**

  Call parameter CA1,
  set signal to start of scale,
  correct the display with CA1 if necessary.

  Call parameter CE1,
  set signal to full scale,
  correct the display with CE1 if necessary.

5.4.7.3 Measuring range for thermocouple with internal reference point (S5 = 1)

- **MA1/ME1 – set measuring range**

  Call parameters MA1, ME1, start of scale and full scale according to the thermocouple type (S6) and the temperature unit (S7).

- **CA1/CE1 – fine adjustment**

  Call parameter CA1,
  set signal to start of scale,
  correct the display with CA1 if necessary.

  Call parameter CE1,
  set signal to full scale,
  correct the display with CE1 if necessary.

5.4.7.4 Measuring range for thermocouple with internal reference point (S5 = 2)

- **tb1 – external reference points-temperature**

  Set the external reference point temperature with tb1. Preset temperature unit with S7.
  Attention: tb1 has no effect at S6 = 10!

- **Set MA1 – ME1 measuring range**

  Call parameters MA1, ME1, start of scale and full scale according to the thermocouple type (S6) and the temperature unit.

- **CA1/CE1 – fine adjustment (only if required)**

  Call parameter CA1,
  set signal to start of scale,
  correct the display with CA1 if necessary.

  Call parameter CE1,
  set signal to full scale,
  correct the display with CE1 if necessary.

5.4.7.5 Measuring range for PT100 four-wire and three-wire connection (S5 = 3, 4)

- **MA1/ME1 – set measuring range**

  Call parameter MA1, ME1, set measuring range start and end:
  Measuring range limits -200 °C ≤ MA1 ≤ ME1 ≤ +850 °C

  Preset temperature unit with S7.

- **CA1/CE1 – fine adjustment (only if required)**

  Call parameter CA1,
  set signal to start of scale,
  correct the display with CA1 if necessary.

  Call parameter CE1,
  set signal to full scale,
  correct the display with CE1 if necessary.

5.4.7.6 Measuring range for PT100 two-wire connection (S5 = 5)

- **MR1/CR1 adjustment of the supply lead resistor**

  Path 1: The feed line resistance is known.
  - Enter the known resistance value with parameter MR1
  - CR1 is ignored

  Path 2: The feed line resistance is not known.
  - Short circuit PT100- sensor at the measuring point
  - Call parameter CR1 and press the Enter key (9) until 0.00 Ω is displayed
  - MR1 indicates the measured resistance value

- **Set MA1 – ME1 measuring range**

  Call parameter MA1, ME1, set measuring range start and end:
  Measuring range limits -200 °C ≤ MA1 ≤ ME1 ≤ +850 °C

  Preset temperature unit with S7.

- **CA1/CE1 – fine adjustment**

  Call parameter CA1,
  set signal to start of scale,
  correct the display with CA1 if necessary.

  Call parameter CE1,
  set signal to full scale,
  correct the display with CE1 if necessary.

5.4.7.7 Measuring range for resistance potentiometer (S5 = 6, 7)

Path 1 : The start and end values of the R-potentiometer are known.

- Call parameter **MA1, ME1**set start of scale and full scale:
  0 Ω ≤ MA1 ≤ ME1 ≤ 600 Ω / 2,8 kΩ
- Parameters **CA1/CE1** indicate at R = MA1 0% , at R = ME1 100 %.
  For the three-wire connection applies: $R = R_p + R_{L4}$
  For the four-wire connection applies: $R = R_p + R_{L1} + R_{L4}$

Path 2 : The start and end values of the R-potentiometer are not known.

- Call parameter **CA1**,
  Move final control element to position 0 %, press the Enter key (9) until 0.0 % is displayed.
- Call parameter **CE1**,
  Move final control element to position 100 %, press the Enter key until 100.0 % is displayed.
- Parameters **MA1/ME1** indicate the appropriate resistance values.
- **MP1** must be set so that the range is not exceeded (x-display (1): oFL)

5.4.8 Set UNI-module CAE3

The CAE3-menu is only offered in the selection level if the structure switch S9 = 4 to 7 is set (input signal for AI3 is generated by the UNI-module).

The measuring range can be determined for this menu for different signal transmitters (selection with S10 and S11) and fine adjustment made.

- **Call, set and exit the CAE3-menu**
  - Press the Shift key (6) for about 5s until “PS” flashes in the y-display (2)
  - Select the CAE3 menu with the Δw-keys (7), (8).
  - Press the Enter key (9) for about 3 s to enter the CAE3 menu.
  - The parameter name in the w/y display (2) flashes (w-LED (5) is on, x LED (4) is off).
  - Select the CAE3-parameter with the Δw/Δy-keys (7), (8).
  - Press the Shift key (6) 1x once, the parameter value flashes in the x-display (1) (w-LED (5) is off, x-LED (4) is on).
  - Set the CAE3-parameter with the Δw/Δy-keys (7), (8).
  - Return to the process operation level by pressing the Exit key (13) twice.

- **The following parameters are available in the CAE3 menu for setting the measuring range and adjustment**

y display parameter designation	w/x display setting range	Factory setting	Display unit	Meaning/function of parameter	Display and function only at:
tb3 [1]	0 to 400.0	50	°C, °F, K	Reference temperature external reference point	S10 = 2
Mr3	0.00 to 99.99	10	Ω	Measuring of RLn. (Pt100-2L)	S10 = 5
Cr3	Difference value to Mr		Ω	**C**alibr. of **R**Ln. (Pt100-2L)	
MP3	_.––– to ____		physical Dimension depending on the measuring variable [4]	Decimal point measuring range	S10 = 0 to 7
MA3 [2]	–1999 to 9999	0,0		Measuring range start	
ME3 [2]	–1999 to 9999	100,0		Measuring range full scale	
CA3	act. measured value ± ΔA [3]			Calibr. Meas. range start	
CE3	act. measured value ± ΔE [3]			Calibr. Meas. range full scale	
PC3 [5]	no, YES, no C	no C	–	**P**reset **C**alibration	S10 = 0 to 5

Table 5-7 CAE3-menu parameter list

1) If no preset thermocouple type is selected with S11 = 10, parameter tb3 is inactive.

2) The set measuring range is transferred as a standardized number range from 0 to 1 to the controller. If the measured value operating display is to be made physically, the offline parameters dA = MA3 and dE = ME3 must be set.

3) For S10 = 0 to 5 : ΔA, ΔE do not appear as own parameters. The correction values for calibrating the start or full scale of the measuring range are arbitrary.

4) For S10 = 6, 7 the unit of the CA3/CE3 display is in %.

5) For S10 = 0 to 5 : With ΔA = ΔE = 0, PC3 = no C is displayed, switching with the Δw-keys (7), (8) to PC3 = YES is not possible. By adjusting CA3/CE3, PC3 = no is displayed, switching to PC3 = YES is possible. If PC3 = YES is displayed, ΔA = ΔE = 0 can be set by pressing the Enter key (9) for about 3 s whereupon PC3 = no C is displayed.

Control and display elements in the configuration level CAE3, see figure 5-12, page 191

The corresponding settings of the CAE3 menu for the different signal transmitters are described below.

To compensate tolerances of transmitters or calibrate with other display instruments (for S10 = 0 to 5) the measuring range and the current measured value are corrected with the parameters CA3/CE3.

5.4.8.1 Measuring range for mV (S10 = 0)

- **MA3/ME3 – set measuring range**

  Call parameter MA3, ME3, set start of scale and full scale:
  Measuring range limits -175 mV ≤ MA3 ≤ ME3 ≤ +175 mV

- **CA3/CE3 – fine adjustment (only if required)**

  Call parameter CA3,
  set signal to start of scale,
  correct the display with CA3 if necessary.

  Call parameter CE3,
  set signal to full scale,
  correct the display with CE3 if necessary.

5.4.8.2 Measuring range for U, I (S10 = 0)

only with measuring range plug 6DR2805-8J

- **MA3/ME3 – set measuring range**

  Call parameter MA3, ME3, set start of scale and full scale:
  Measuring range limits -175 mV ≤ MA3 ≤ ME3 ≤ +175 mV

  Initialization in the measuring range plug:

0 to 10 V or 0 to 20 mA signal corresponds to	MA3 = 0 mV	ME3 = 100 mV
2 to 10 V or 4 to 20 mA signal corresponds to	MA3 = 20 mV	ME3 = 100 mV

- **CA3/CE3 – fine adjustment (only if required)**

  Call parameter CA3,
  set signal to start of scale,
  correct the display with CA3 if necessary.

  Call parameter CE3,
  set signal to full scale,
  correct the display with CE3 if necessary.

5.4.8.3 Measuring range for thermocouple with internal reference point (S10 = 1)

- **MA3/ME3 – set measuring range**

  Call parameters MA3, ME3, start of scale and full scale according to the thermocouple type (S11) and the temperature unit (S7).

- **CA3/CE3 – fine adjustment**

  Call parameter CA3,
  set signal to start of scale,
  correct the display with CA3 if necessary.

  Call parameter CE3,
  set signal to full scale,
  correct the display with CE3 if necessary.

5.4.8.4 Measuring range for thermocouple with internal reference point (S10 = 2)

- **tb3 – external reference points-temperature**

  Set the external reference point temperature with tb3. Preset temperature unit with S7.
  Attention: tb3 has no effect at S11 = 10!

- **MA3/ME3 – set measuring range**

  Call parameters MA3, ME3, start of scale and full scale according to the thermocouple type (S11) and the temperature unit.

- **CA3/CE3 – fine adjustment**

  Call parameter CA3,
  set signal to start of scale,
  correct the display with CA3 if necessary.

  Call parameter CE3,
  set signal to full scale,
  correct the display with CE3 if necessary.

5.4.8.5 Measuring range for PT100 four-wire and three-wire connection (S10 = 3, 4)

- **MA3/ME3 – set measuring range**

  Call parameter MA3, ME3, set start of scale and full scale:
  Measuring range limits -200 °C ≤ MA3 ≤ ME3 ≤ +850 °C

  Preset temperature unit with S7.

- **CA3/CE3 – fine adjustment (only if required)**

  Call parameter CA3,
  set signal to start of scale,
  correct the display with CA3 if necessary.

  Call parameter CE3,
  set signal to full scale,
  correct the display with CE3 if necessary.

5.4.8.6 Measuring range for PT100 two-wire connection (S10 = 5)

- **MR3/CR3-adjustment of the feed resistance**

  Path 1: The feed line resistance is known.

  - Enter the known resistance value with parameter MR3
  - CR3 is ignored

  Path 2: The feed line resistance is not known.

  - Short circuit PT100- sensor at the measuring point
  - Call parameter CR3 and press the Enter key (9) until 0.00 Ω is displayed
  - MR3 indicates the measured resistance value

- **MA3/ME3 – set measuring range**

  Call parameter MA3, ME3, set start of scale and full scale:
  Measuring range limits -200 °C ≤ MA3 ≤ ME3 ≤ +850 °C

  Preset temperature unit with S7.

- **CA3/CE3 – fine adjustment (only if required)**

  Call parameter CA3,
  set signal to start of scale,
  correct the display with CA3 if necessary.

  Call parameter CE3,
  set signal to full scale,
  correct the display with CE3 if necessary.

5.4.8.7 Measuring range for resistance potentiometer (S10 = 6, 7)

Path 1 : The start and end values of the R-potentiometer are known.

- Call parameter **MA3, ME3**, set start of scale and full scale:
  $0\ \Omega \leq MA3 \leq ME3 \leq 600\ \Omega$ / 2.8 kΩ
- Parameters **CA3**/**CE3** indicate at R = MA3 0% , at R = ME3 100 %.
  For the three-wire connection applies: $R = R_p + R_{L4}$
  For the three-wire connection applies: $R = R_p + R_{L1} + R_{L4}$

Path 2 : The start and end values of the R-potentiometer are not known.

- Call parameter **CA3** ,
  Move final control element to position 0 %, press the Enter key (9) until 0.0 % is displayed.
- Call parameter **CE3** ,
  Move final control element to position 100 %, press the Enter key until 100.0 % is displayed.
- Parameters **MA3**/**ME3** indicate the appropriate resistance values.
- **MP3** must be set so that the range is not exceeded (x-display (1): oFL)

5.4.9 APSt (All Preset) Reset to factory setting

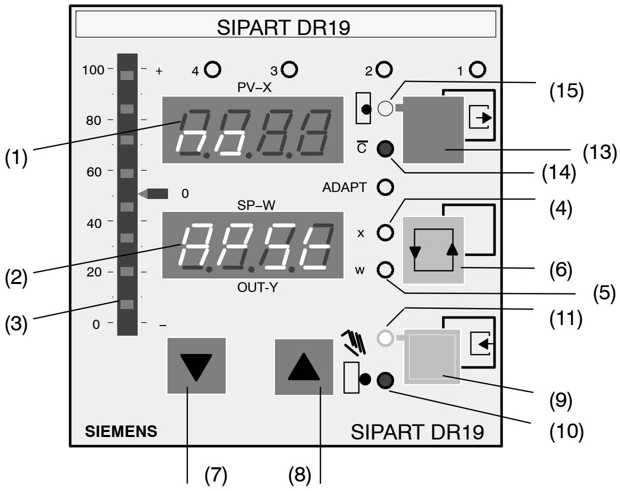
APSt serves to reset all controller functions (parameters and structures) to the factory setting. We recommend you to run the APSt function first if major changes are to be made to the configuration. The controller is in offline operation in the structuring mode.

NOTE

The APSt function cannot be canceled!

No appears after jumping to the structuring mode APSt with the Enter key (9). Set YES with the +Δw/Δy-key (7), (8) YES and press the Enter key (9) until the configuration level StrS appears. The Preset function is run. Select structuring mode Strs by pressing the Enter key and re-structure the controller.

The offline and online parameters must also be reset.



Legend:

(1)	x-display	YES or no
(2)	w/y-display	APSt
(3)	Analog-display	Striped pattern (offline identification)
(4)	x-LED	on
(5)	w-LED	off
(6)	Shift key	no function
(7), (8)	Δw/Δy-keys	Switching YES or no
(9)	Enter key	at no no function, at YES Resetting
(10)	Enter-LED	off when no, flashing when YES
(11)	Manual-LED	on (manual operation)
(13)	Exit key ↗	Return to selection level
(14)	Exit-LED	flashes
(15)	Internal LED	off

Figure 5-13 Control and display elements in the structuring mode APSt

5.5 CPU self-diagnostics

The CPU runs safety diagnostics routines which run after only one reset or cyclically. The CPU is familiar with two different types of reset:

Power On-Reset

always take place when the 5 V supply drops below 4.45 V, i.e. the power supply is interrupted for longer than specified in the technical data.
All parameters and structures are reloaded from the user program memory into the RAM. The current process variables and the controller status are reloaded from the EEPROM for these data.
At S91 = 1 the digital x-display (1) and w/y-display (2) flashes after a Power On reset.
This is acknowledged by the Shift key (6).
Flashing is suppressed with S91 = 0.

Watch_dog Reset

The processor has an integrated watchdog which monitors the cyclic program runs independently.
When a watch-dog reset occurs the parameters and structures from the user program memory are loaded into the RAM. The current process variables and the controller status are read out of the RAM for further processing.
There are no flashing signals on the front module.
After every reset CPU/tE appears in the digital x-display (1) and w/y-display (2) for a maximum 5 s CPU/tESt.
Every detected error of self-monitoring leads to a flashing error message on the digital x-display (1) with defined states of the analog and digital outputs. The reactions listed in the table are only possible of course (because it is a self-test) if the errors appear in the form that the corresponding outputs or front module is still controlled properly or the outputs themselves still work.

Error message x-display (1)	**Monitoring of**	**Monitoring time**	**primary cause of the error/remedy**
during monitoring CPU/tESt in the case of an error CPU ϟ	EEPROM, RAM, EPROM	after every reset	
MEM ϟ	EEPROM	when storing	monitored components of the CPU or EEPROM defective/change front module
OP.1.* [1)]	Data traffic slot 1: UNI-module	cyclic	Option not plugged, defective or S9 does not match the plugged option / plug or change option or correct S9.
OP.*.3 [1)]	Data traffic slot 3 4DO + 2DI or 5DI option	cyclic	Option not plugged, defective or S22 does not correspond to plugged option / plug or change option or correct S22 [2)]

1) also double error display OP.1.3 possible. * means digit dark
2) If 2DO relay is selected with S 22 = 3, no monitoring takes place.
At DI3 to DI7, S22 = 2 the effect of the digital inputs (after inversion) are set to 0 in the event of an error.

Table 5-8 Error message of the CPU

6 Commissioning

6.1 Adapting the controller direction of effect to the controlled system

- **Definitions**

  Normal control action system

  Rising y causes rising x, e.g. rising energy supply or rising mass flow cause rising temperature.

  Normal effecting actuator (valve):

  Rising current or positioning command +Δy cause the actuator to open (rising y), e.g. more energy supply or greater mass flow. $y_{displ.}$ is the displayed manipulated variable.

  The controller direction of effect is referred to the controlled variable x1. The following statements apply for normal action transmitters (rising physical variable causes rising transmitter current), rising process display (dE > dA) and no falling characteristic in the linearizers.

- **Direction of effect of system and actuator known**

  K-controller

The following is prescribed:			Select the desired effect here:				This gives the settings of S47 and S56 and functional mode of the controller			
Direction of effect of the system	Direction of effect of the actuator	Direction of effect of the system and the actuator	20 mA on	pressing the right key causes in manual operation: actuating current ly	Valve	Actual value/ controlled variable	S47	Kp (cP)	S56	$y_{displ.}$ =
normal	normal	normal	100 %	rises	opens	rises	0	pos.	0	y
	revers-ing	revers-ing	0 %	falls	opens	rises	1	neg.	1	100 % - y
revers-ing	normal	revers-ing	0 %	falls	closes	rises	1	neg.	1	100 % - y
			100 %	rises	opens	falls	1	neg.	0	y
	revers-ing	normal	100 %	rises	closes	rises	0	pos.	0	y
			0 %	falls	opens	falls	0	pos.	1	100 % - y

Two more lines could be added to the table which are useless in practice: normal effect system in which the actual values falls with a rising change in the manipulated variable.

Table 6-1 Controller direction of effect and y-display direction of effect of the system- and actuator direction of effect in K-controllers

S-controller

The following is prescribed:			Select the desired effect here:			This gives the settings of S47 and S56 and functional mode of the controller			
Direction of effect of the system	Direction of effect of the actuator	Direction of effect of the system and actuator	pressing the right key causes in manual operation: active switching output is	Valve	Actual value/ controlled variable rises	S47	Kp (cP)	S56	$y_{displ.}$ =
normal	+Δy opens	normal	+Δy	opens	rises	0	pos.	0	y_R
reversing	+Δy opens	reversing	–Δy	closes	rises	1	neg.	1	100 % - y_R
			+Δy	opens	falls	1	neg.	0	y_R

If the actuator is connected reversing as an exception (+Δy closes), the position feedback must also be reversed and the controller direction of effect (Kp) negated.

Table 6-2 Controller direction of effect and y-display direction of effect of the system- and actuator direction of effect in S-controllers

- **Direction of effect of system and actuator unknown**

  Start the controller in manual mode, leave the structure switches S47 and S56 in factory setting (0).

  - **Determine direction of effect of the actuator**

    The manipulated variable can be displayed in the w/y-display (2) (1. Left digit shows Y, see S88). Actuate the right manipulated variable adjustment key with the process switched off if possible or close to its safety position and observe whether the actuator opens or closes. If the actuator opens this means it has normal effect. If closing is determined in S-controllers, the connections +Δy and -Δy should be switched.

    The actuator can be observed as follows (if the direction of effect of the system is known):

    - normal system: rising x means normal direction of effect of actuator
    - reversing system: falling x means normal direction of effect of actuator
    - in S-controllers and already correctly connected position feedback rising y-display means normal effect actuator
    - The actuator can be monitored additionally at the installation location.

  - **Determine the direction of effect of the system**

    Press the right manipulated variable adjustment key and observe on the actual value display whether the controlled variable (actual value) rises or falls. Rising means normal effect system with normal effect actuator, reversing effect system with reversing actuator. Falling means reversing effect system with normal effect actuator, normal effect system with reversing actuator. With the direction of effect of actuator and system determined in this way, the controller can be set according to table 6-1, page 203 and table 6-2.

6.2 Setting of actuating time in K-controllers (S2 = 0)

- **Actuating time tP, tM**

Set the actuating time tP (open) or tM (closed) to the actuating time of the following actuator. If the control circuit is to be settled additionally, e.g. to avoid hard impact on the actuating drive, tP, tM can be further increased in automatic operation.

The value of tP is usually set identical to the value of tM.

6.3 Adaptation of the S-controller to the actuating drive

- **Output Two-position controller for heating/cooling (S2 = 1)**

  The setting range y can be divided into two sections. The offline-parameters Y1 and Y2 and the online-parameters YA and YE determine these steps.

  The period duration and the shortest turn-on and turn-off times are determined in the cooling branch (section [YA, Y1]) by the online -parameters tM and tA and in the heating branch (section [Y2, YE]) by the online-parameters tP and tE (see chapter 3.6, fig. 3-24, pg. 103)

  The period durations tP and tM should be chosen as great as possible, whereby the following should be observed:

  - Great values of tP and tM result in low wear of the internal and external switchgear.
  - Large values cause a periodic fluctuation of the controlled variable x which is greater the faster the controlled system is.

- **S-controller with internal feedback (S2 = 2)**

  Set the actuating time of the actuating drive (e.g. 60 s) with the online-parameters tP, tM (0.1 to 1000 s). **Attention:** the factory setting is 1 s!

  The online-parameter tE (minimum turn-on time) must be selected at least great enough that the actuating drive starts reliably under consideration of the series connected power switch. The greater the value of tE is set, the more wear-free and smoother the switching and drive elements connected after the controller operate. Large values of tE require a greater dead band AH in which the controller cannot control defined because the resolution of the controlled variable diminishes with increasing turn-on duration.

  The factory setting for tE is 200 ms. This corresponds to a y-resolution in a 60-s-actuating drive of:

$$\Delta y = \frac{100\ \% \cdot tE}{tP\ (or\ tM)} = \frac{100\ \% \cdot 200\ ms}{60\ s} = 0.33\ \%$$

  The minimum possible resolution is transferred with the system gain Ks to the controlled variable:

$$\Delta x = Ks \cdot \Delta y$$

The parameter tA (minimum turn-off time) should be selected great enough that the actuating drive is disconnected reliably under consideration of the series connected power switch before a new pulse arrives (especially in the opposite direction). The greater the value of tA, the more resistant to wear the switching- and drive elements connected after the controller operate and the greater the dead time of the controller under some circumstances. The value of tA is usually set identical to the value of tE.

tA = tE = 120 to 240 ms are recommended for 60-s-actuating drives. The more restless the controlled system, the greater the two parameters should be selected if this is reasonably justified by the controller result.

The response threshold AH must be set according to the set tE and the resulting Δy or Δx. The following condition must be met.

$$AH > \frac{\Delta x}{2} \quad \text{or} \quad AH > \frac{Ks \cdot tE \cdot 100\,\%}{2 \cdot tP\ (\text{or } tM)}$$

Otherwise the controller outputs positioning increments although the control deviation has reached the smallest possible value due to the finite resolution. Setting of AH, see chapter 5.4.2, pg. 167.

- **S-controller with external feedback (S2 = 3)**

The position control circuit is optimized with the online-parameters tP/tM. The same relationships apply as in the S-controller with internal position feedback whereby the dynamic of the position control circuit (non-linearities, follow-up) is added to the criteria of the processability of the positioning increments by the final control element. It will usually be necessary to select tP/tM and the resulting response threshold smaller than in the S-controller with internal position feedback for the above mentioned reasons.

The position control circuit is optimized in manual mode. For this the optimization phase S55 is set to 0 so that the manual manipulated variable is preset as an absolute value. It should be noted here that the active manipulated variable lags behind the manipulated variable display due to the actuating time of the actuator.

In the event of unlinearity in the position control circuit optimization must take place in the area of the greatest slope.

Procedure for optimization of the position control circuit (position controller also active in manual mode):

- Set S55 to 0
- Set tA and tE so that the actuating drive can **just** process the position increments (see S-controller with internal feedback).
- Set 1st order filter of the y_R-input (t1, 2 or 3) to 0.01 TP/TM (real travel time of the drive).
- Increase tP/tM until the position control circuit overshoots due to slight changes in the manual smanipulated variable (opposite pulse via the Δy-LEDs (12) in the w/y-display (2)).
- Reduce tP/tM slightly again until the position control circuit settles.
- Set S55 to 1 again.

6.4 Setting the filter and the response threshold

Set the structure switch S3 to the mains frequency 50 or 60 Hz existing in the system (factory setting 50 Hz) to suppress faults due to the mains frequency.

- **Filter of first order of analog inputs**

  The filter time constants (t1 to t3) for the input filters are set in the onPA parameterization mode to the greatest possible value which the control circuit permits without influencing the controllability (t1 to t3 < Tg). When using the adaptation method the appropriate input filters must be optimized.

- **Adaptive, non-linear filters of the control difference**

  Since the dead zone is set automatically and its variable is therefore unknown, the time tF (onPA) should be selected just so that the control circuit cannot oscillate when there is a large dead zone (tF less than Tg). When using the D-part (PD, PID) the use of the adaptive, non-linear filter is strongly recommended because the input noise amplified by Kp·vv can be suppressed.

  If the filters are required, these **must** be set before using the adaptation method.

- **Optimization of the response threshold AH**

  If the output of the controller is to additionally settled or the load on the actuator reduced, the necessary response threshold AH can be increased. The response threshold AH is given in three-position controllers (S2 = 2, 3) by the setting of tE (see chapter 6.3, page 205) and must be greater than zero. In K-controllers and two-position controllers (S2 = 0, 1) a response threshold of approx. 0.5 % is recommendable.

  It should be taken into account that the remaining control error can adopt the value of the set response threshold AH.

6.5 Automatic setting of control parameters by the adaptation method

See chapter 3.9 “Adaptation (S49)”, page 120 and chapter 5.4.3 “Configuration level adaptation”, page 169.

6.6 Manual setting of the control parameters without knowledge of the plant behavior

The control parameters for optimum control of the system are not yet known in this case. To keep the control circuit stable in all cases, the following factory settings must be made:

Proportional action factor	Kp	=	0.1
Integral action time	Tn	=	9984 s
Derivative action time	Tv	=	oFF

- **P-controller (control signal P = high)**
  - Set the desired setpoint and set the control difference to zero in manual operation.
  - The operating point necessary for the control difference is set automatically in manual operation at Yo=AUto (factory setting). The operating point can also be set manually by setting the online-parameter y_o to the desired operating point.
  - Switch to automatic operation.
  - Increase Kp slowly until the control loop tends to oscillate due to slight setpoint changes.
  - Reduce Kp slightly until the oscillations disappear.

- **PD-controller (control signal P = high)**
  - Set the desired setpoint and set the control difference to zero in manual operation.
  - The operating point necessary for the control difference is set automatically in manual operation at Yo = AUto (factory setting). The operating point can also be set manually by setting the online-parameter y_o to the desired operating point.
  - Switch to automatic operation.
  - Increase Kp slowly until the control loop tends to oscillate due to slight setpoint changes.
  - Switch Tv from oFF to 1 s.
  - Increase Tv until the oscillations disappear.
  - Increase Kp slowly until oscillations reappear.
  - Repeat the setting according to the two previous steps until the oscillations can no longer be eliminated.
  - Reduce Tv and Kp slightly until the oscillations are eliminated.

- **PI-controller (control signal P = Low)**
  - Set the desired setpoint and set the control difference to zero in manual operation.
  - Switch to automatic operation.
  - Increase Kp slowly until the control loop tends to oscillate due to slight setpoint changes.
  - Reduce Kp slightly until the oscillations disappear.
  - Reduce Tn until the control loop tends to oscillate again.
  - Increase Tn slightly until the tendency to oscillate disappears.

- **PID-controller (control signal P = Low)**
  - Set the desired setpoint and set the control difference to zero in manual operation.
  - Switch to automatic operation.
  - Increase Kp slowly until the control loop tends to oscillate due to slight setpoint changes.
  - Switch Tv from oFF to 1 s.
  - Increase Tv until the oscillations disappear.
  - Increase Kp slowly again until the oscillations reappear.
  - Repeat the setting according to the previous two steps until the oscillations cannot be eliminated again.
  - Reduce Tv and Kp slightly until the oscillations stop.
  - Reduce Tn until the control loop tends to oscillate again.
  - Increase Tn slightly until the tendency to oscillate disappears.

6.7 Manual setting of the control parameters according to the transition function

If the transient function of the controlled system is active or can be determined, the control parameters can be set according to the setting guidelines specified in the literature. The transient function can be recorded in the„ Manual operation" position of the controller by a sudden change in the manipulated variable and the course of the measured variable registered with a recorder. This will roughly give a transient function corresponding to the one shown in figure 6-1.

Good average values from the setting data of several authors give the following rules of thumb:

P-controller:

Proportional action factor $Kp \approx \frac{Tg}{Tu \cdot Ks}$

PI-controller:

Proportional action factor $Kp \approx 0.8 \cdot \frac{Tg}{Tu \cdot Ks}$

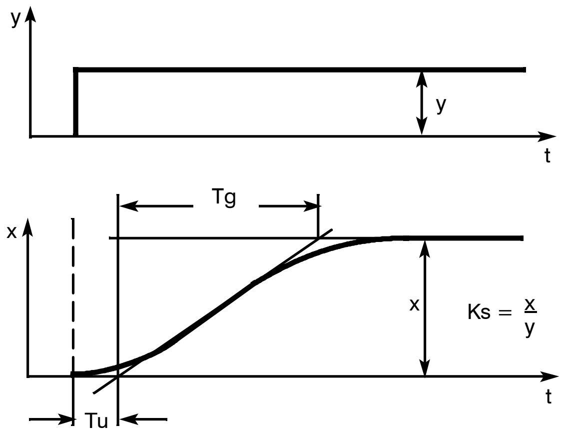
Integral action time $Tn \approx 3 \cdot Tu$

PID-controller:

Proportional action factor $Kp \approx 1.2 \cdot \frac{Tg}{Tu \cdot Ks}$

Integral action time $Tn \approx Tu$

Derivative action time $Tv \approx 0.4 \cdot Tu$



y Manipulated variable
w Measured variable
x Measured variable
t Time
Tu Delay time
Tg Compensation time
Ks Transmission factor of the controlled system

Figure 6-1 Transient function of a controlled system with compensation

7 Application examples for configuring the controller

7.1 General

Below frequent applications/connections of the SIPART DR19 devices are listed in the form of configuration examples. The circuits are sorted according to their application **S-**controller, **K**-controller or **t**wo-position controller. All input and output connections and the order numbers of the respective required controllers or accessory modules are stated. A principle circuit diagram of the control circuit and a short description make comprehension easier

We have purposely described the simple applications in very great detail to help the technician above all who only needs to design these circuits very occasionally.

Mains voltage

As shown, the power supply must be fused and the PE conductor connected. The permissible power supply range must be stated respectively with the type number of the controller.
Fuses and connecting leads are not supplied with the controllers.

Input connections

A wide variety of input circuits are shown. Please note that the measuring range plug is required when using the analog input AI1 and the input variable mA/V. Feeding can take place from the SIPART DR19 controller when using two-wire transmitters.

Output circuits

The output circuits are represented uniformly: for the K-output for load independent current signal 0 or 4 to 20 mA, for S-output the switching outputs are output via the relays which may be loaded with a maximum AC 250 V. If the setting outputs of the S-controller are desired with digital signals, the digital outputs DO1 and DO2 must be used.

NOTICE

If inductances (e.g. stepper motors, contactors, etc.) are switched with the available relay outputs, adequate protection against interference by wiring with RC-combinations or other suitable means must be provided on the system side in order to achieve EMC protection aims and because of wear on the contacts.

- **Configuration**

Structure switches S

All controllers are supplied with the specified factory settings and must be structured to suit the application during commissioning.

The necessary switch positions for the respective application in the examples but essential structure switches are named.

In addition other settings may be necessary due to system-specific criteria.

The following configuration examples have exclusively parallel circuits. Therefore the structure switches which relate to the serial interface are not specified.

Parameters onPA and oFPA

The controllers must be adapted in every case using the system data. The factory setting of the control parameters must be selected so that the control loop does not tend to oscillate even under worst case conditions (Kp = 0, 1, Tn = 9984 s). Kp and Tn or y0 and if necessary Tv and AH must be set.

UNI-input CAE1

For the measuring variables TC/RTD/R sensor direct connection at AI1 the measuring range and the reference point temperature or line resistance must be set in all cases by the CAE menu.
For measuring variables mA/V the use of the measuring range plug 6DR2805-8J is recommended.

Control algorithm

All configuration examples (except Z1) are shown for PI or PID behavior. Switching to P or PD behavior is possible with a digital input signal (structure switch S27). In the SIPART DR19 as an S-controller a P- or PD-controller operation is only possible with external position feedback (S2=3).

7.2 Working with different setpoints

Examples of operation with different setpoints is shown on the following pages. It is represented as a function diagram over the time axis with specification of the switching function/digital input. The following are used as switching function depending on the example:

- the internal/external key (13) (switching on the front of the device)
- control signal CB, assignment by structure switch S23 (switching from external)
- control signal PU in connection with CB, assignment by structure switch S34 and S23

The structure switches named next to the examples must be put in the specified positions for the illustrated functions. Structure switches not listed are in the factory setting.

Example 1	Two-setpoint operation in the fixed value controller (switching on the front of the device) (see chapter 3.4.2, pg. 64)

Switching from setpoint w1 to setpoint w2 takes place with the Shift key setpoint internal/external (13). The active setpoint is displayed on the digital display SP-W (2), whereby you can choose between display of w (active) and y.
At S88 = 1/3 the inactive setpoint can also be displayed with the Shift key (6). In the active setpoint display the signal lamp w (5) lights steadily and flashes when the inactive setpoint is displayed.
The displayed setpoint can be set with the input keys (7), (8).

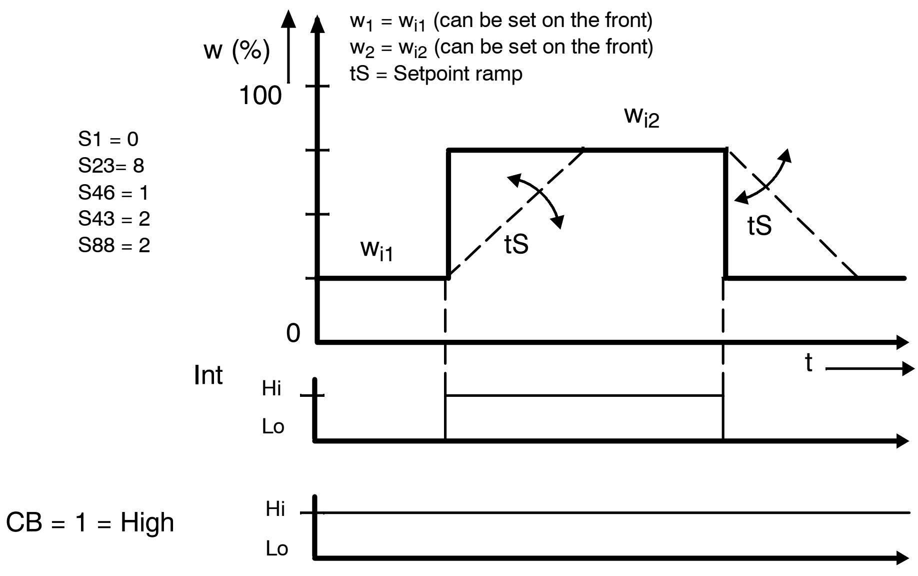


Figure 7-1 Setpoint curve with and without setpoint ramp (according to example 3).

Example 2

Three-setpoint-operation with a sequence controller (switching via DI and on the front of the device) (see chapter 3.4.4, pg. 71)

w_E is an external variable setpoint (via AI3)
SH1 safety setpoint permanently set by parameterization in onPA
wi is an internal setpoint which can be adjusted on the front

The external setpoint w_E is preset by AI3 (options module necessary, e.g. 6DR2800-8J). Switching between w_E/SH1 and wi takes place via the digital signal CB (Shift key internal/external (13) must be set to "external"). wi is switched to by the Shift key in "internal" position. This setting has priority over w_E and SH1.
The control signal CB is assigned to DI1 by structure switch S23. To avoid double assignment of DI1 the factory setting of the structure switch S25 must be changed (example S25 = 0). CB acts statically in the example (S42 = 0).

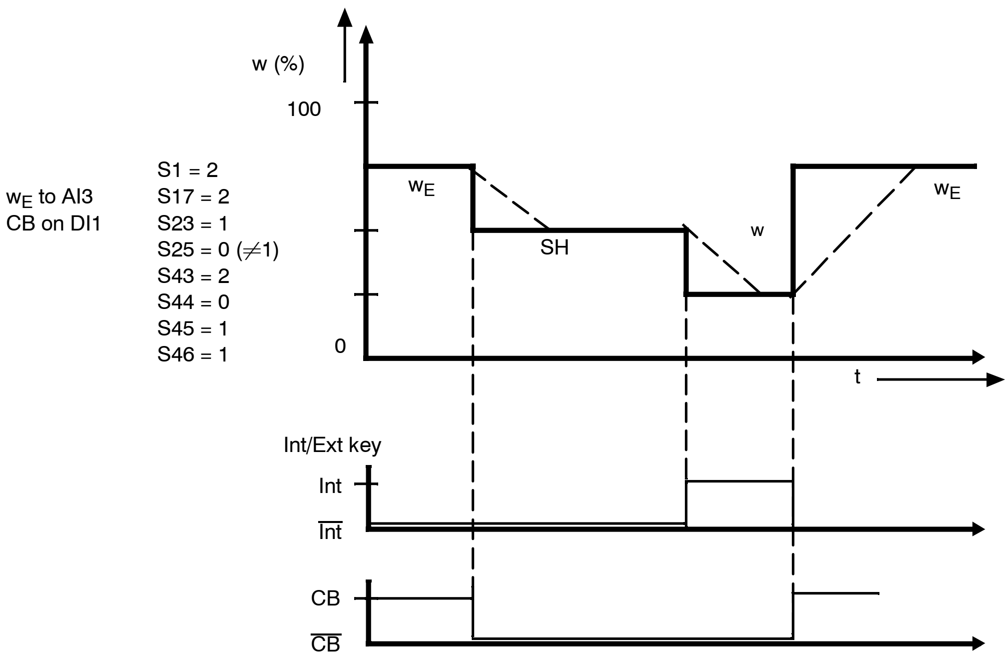


Figure 7-2 Setpoint curve with and without setpoint ramp (according to example 2)

Example 3 Four(five)-setpoint operation with the fixed value controller (S1 = 1)

The analog input AI2/w_E is overcontrolled to 0 or 100%:

wi internal setpoint adjustable on the front
SH1 safety setpoint permanently set by parameterization in onPA
SH2 safety setpoint permanently set by parameterization in onPA
SH3 safety setpoint permanently set by parameterization in onPA
SH4 safety setpoint permanently set by parameterization in onPA
CB Control signal DI1 (digital input)
PU Control signal DI2 (digital input)

The setpoint wi set at the front becomes active with the shift key internal/external (13) in the “internal” position. (Signal lamp “setpoint internal” (15) active). This setting has priority over SH1 to SH4.
In the “external” position (signal lamp “setpoint internal” (15) off) you can switch between the safety setpoints SH1 to SH4 by combining the control signals CB and PU.
The control signal CB is assigned by structure switch S23 to DI1, control signal PU by structure switch S34 to DI2. To avoid double assignment of DI1 and DI2, the factory setting of the structure switches S25 and S26 must be changed.

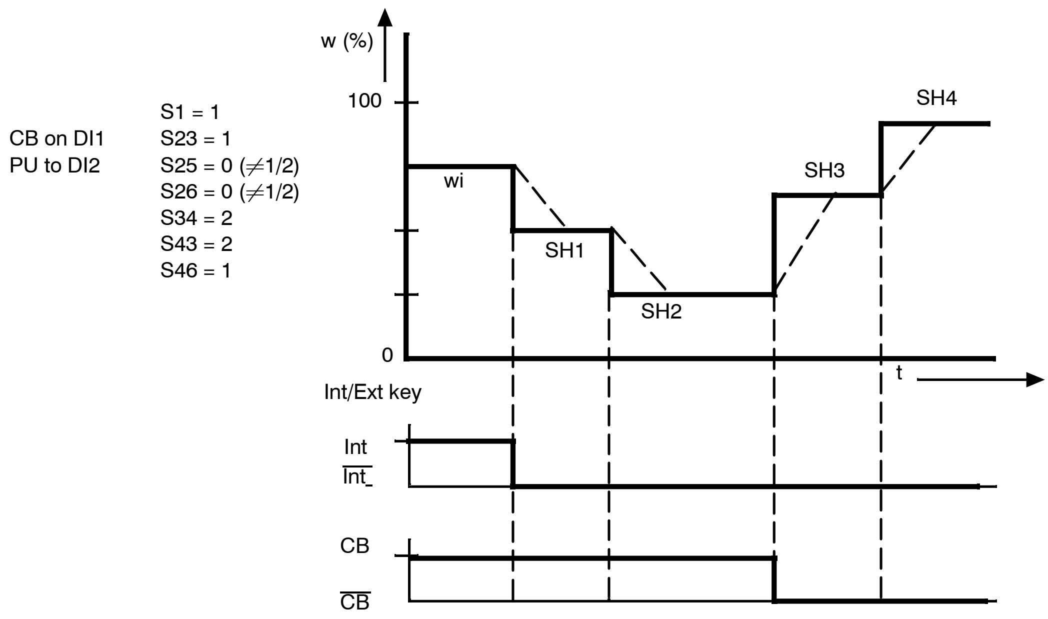


Figure 7-3 Setpoint curve with and without setpoint ramp (according to example 3)

Example 4

Four setpoint operation with the fixed value controller (S1 = 1), setting the active setpoint on the front operating panel

SH1 Safety setpoint, first preset by parameterization in onPA
SH2 Safety setpoint, first preset by parameterization in onPA
SH3 Safety setpoint, first preset by parameterization in onPA
SH4 Safety setpoint, first preset by parameterization in onPA

wi Setpoint SH1 to SH4 adjustable on the front

CB Control signal DI1 (digital input)
PU Control signal DI2 (digital input)

In the “external” position of the internal/external setpoint shift key (signal lamp “setpoint internal” (15) off) you can switch between the safety setpoints SH1 to SH4 by combining the control signals CB and PU.
After switching to “internal” (signal lamp “setpoint internal” (15) active) and display of the setpoint w (signal lamp w (5) active, the selected setpoint wi can be changed by the input keys (7), (8).
Attention: After changing the setpoint please switch back to “external” operating mode.
The control signal CB is assigned by structure switche S23 toDI1, control signal PU by structure switch S34 to BI2. To avoid double assignment of DI1 and DI2, the factory setting of the structure switches S25 and and S26 must be changed.
The number of the active setpoint SH1 to SH4 can be displayed on the lamps for “limit value addressed” (17) by structure switch S87 = 2.

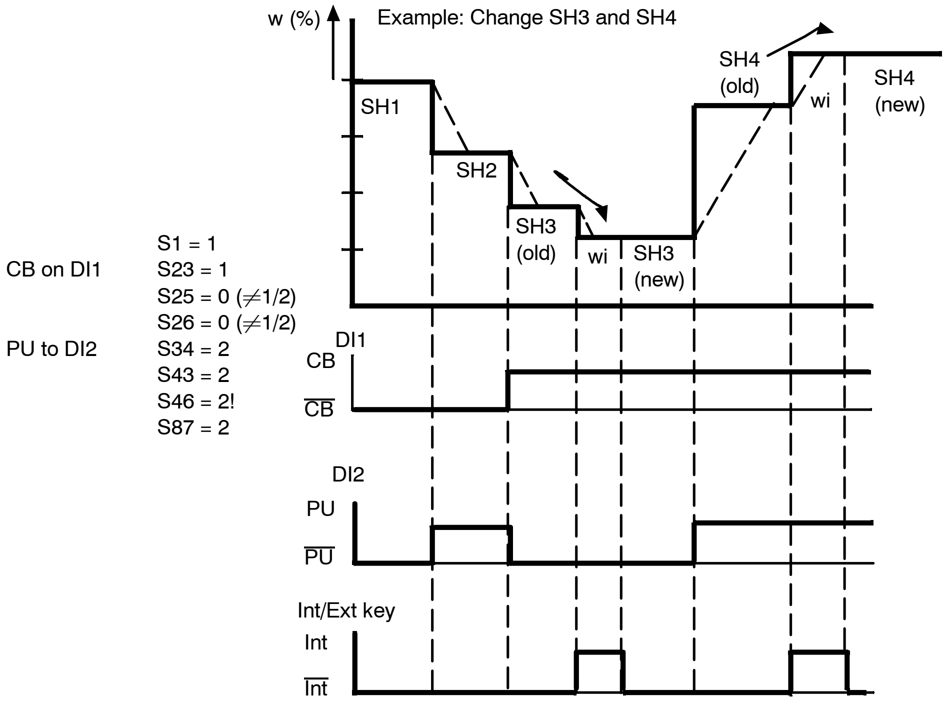


Figure 7-4 Setpoint curve with and without setpoint ramp according to example 4

7.3 Program controller, program transmitter

Examples of program configuration for program controller/program transmitter is shown on the following pages. It is represented as a function diagram over the time axis with specification of the switching function/digital input.
The following are used as switching function depending on the example:

- the internal/external key (13) (switching on the front of the device)
- Control signal CB, assignment by structure switch S23 (Start/Stop program)
- Control signal PU, assignment by structure switch S34 (switching program P1/P2) (switching from external)

The structure switches named next to the examples must be put in the specified positions for the illustrated functions. Structure switches not listed are in the factory setting.

When using as a program transmitter (prerequisite: K-standard controller) the setpoint w is assigned to the analog output by structure switch S57.

Example 1

Time program with program start on the front of the device, interval message by time slot, message end of program, setpoint at start and end of program permanently set.

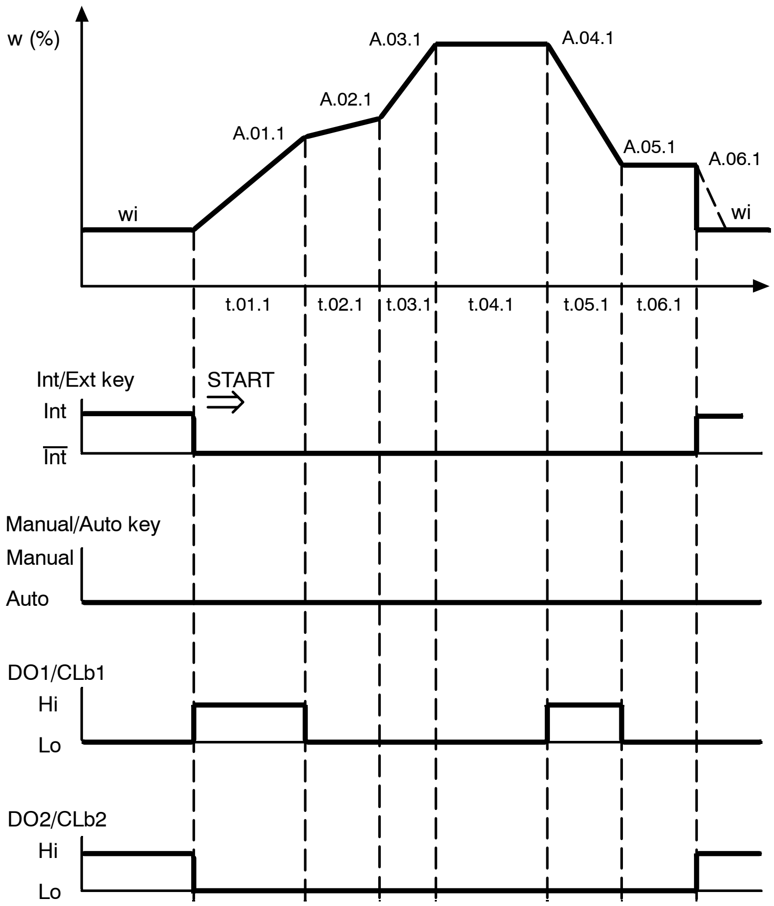
DO1 Message output for Clb1, time section t.01.1 or t.05.1 active
DO2 Message output for Clb2, program not started or program ended
wi internal setpoint adjustable on the front

The program is started by switching to external setpoint (Shift key setpoint internal/external (13)), message lamp “setpoint internal” (15) off). “setpoint” internal is switched back to automatically at the end of the program. The setpoint wi set on the front is active at the start and end of the program (S46 = 1). Assignment time slot CLb1 and CLb2 to DO1 and DO2 via S70 and S71. To avoid double assignment of DI1 and DI2, the factory setting of the structure switches S63 and S64 must be changed.

The display “PV-X” (1) shows the remaining time in the active interval. In the “SP-W” (2) display you can choose between the current setpoint or target setpoint at the end of the interval (S88) with the Shift key (6). The program status is displayed in the analog display (3) (scope of program, program step).

The program is reset by the combination switching “setpoint internal” (13) and “manual” (9) operating mode.

Six program steps are specified in the example.



StrS	**CLPA**	
S1 = 5	PrSE = P1	
S23 = 8	Hold = off	
S43 = 2	CLFo = '."	(as required)
S46 = 1	t.01.1 to t.06.1	(as required)
S63 = 0 (≠1/2)	A.01.1 to A.06.1	(as required)
S64 = 0 (≠1/2)	1.01.1 = Hi	
S70 = 1	1.05.1 = Hi	
S71 = 2	2.PE.1 = Hi	
S88 = 7		
S87 = 2		

Figure 7-5 Setpoint curve according to example 1 with specification of the status signals

Example 2

Time program with program start via DI without release on the front of the device, setpoint at start of program and end of program permanently set, use of “Hold function”

wi internal setpoint adjustable on the front
CB Control signal DI1 at the start of the program, dynamic
/C Signal lamp on the device front (14) “Program stopped”
/RC Message output DO1, signals program operation
Hold Monitoring of xd. On exceeding the value program run (time stopped)

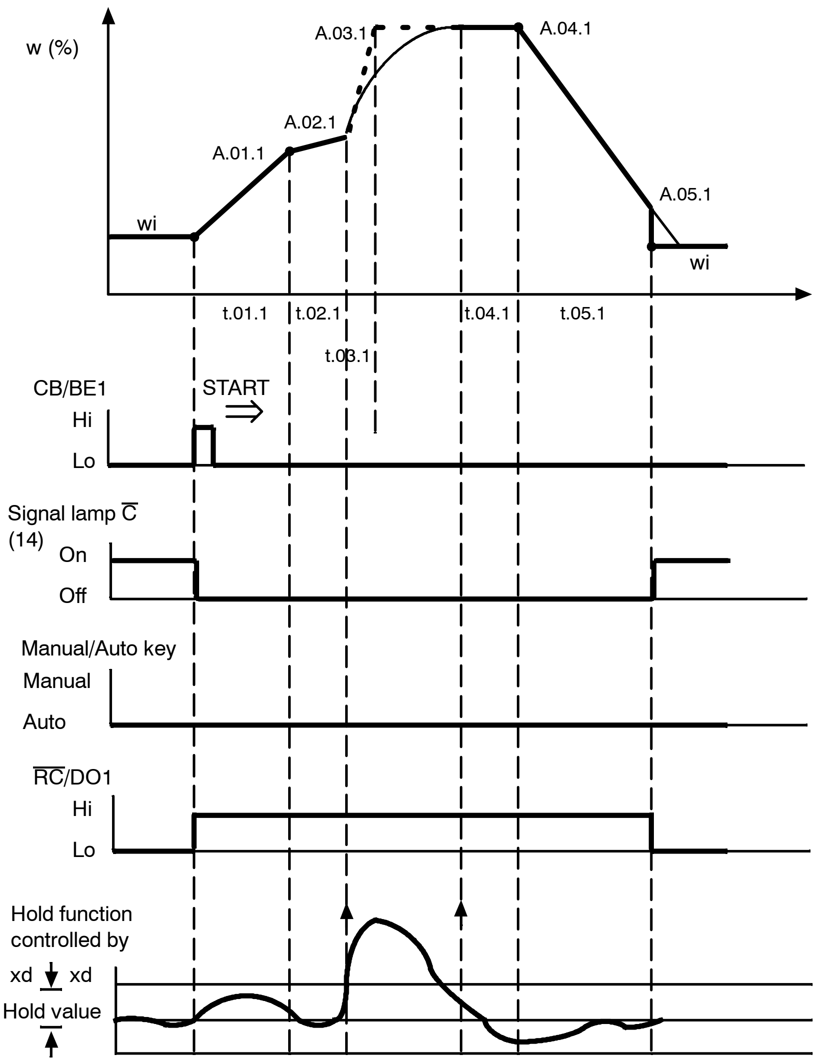
The program run is started with the positive edge CB (DI1) (signal lamp “Computer” (14) on). At the end of the program “not computer” (signal lamp (14) active) is automatically preset by the setting keys (7), (8).

The message signal /RC is used by DO1 (S60) to signal program operation. Positive signaling by reversal of the direction of effect (S77). To avoid double assignment of DI1 and DO1, the factory setting of the structure switches S25 and S63 must be changed.

The program run is halted by the Hold function on exceeding the control difference (signal lamp “internal setpoint” (15) active).

The display “PV-X” (1) shows the remaining time in the active interval. In the “SP-W” (2) display you can choose between the current setpoint or target setpoint at the end of the interval (S88) with the Shift key (6). The program status is displayed in the analog display (3) (scope of program, program step).

Five program steps are specified in the example.



StrS
S1 = 5
S23 = 1
S25 = 0 (≠1)
S42 = 2
S43 = 2
S46 = 1
S60 = 1
S63 = 0 (≠1)
S77 = 1
S88 = 7

CLPA

PrSE = P1	
Hold = 3	
CLFo = '."	(as required)
t.01.1 to t.05.1	(as required)
A.01.1 to A.05.1	(as required)

Figure 7-6 Setpoint curve according to example 2 with specification of the status signals

Example 3

Time program with program start via DI after release on the device front, setpoint at program start adjustable on the front or last program setpoint, tracking of the program setpoint to the internal setpoint

wi	internal setpoint adjustable on the front at the program start
wi (new)	wi is tracked at the end of the program to the last program setpoint
w2	Setpoint change in the “internal” mode of the controller
CB	Control signal DI1 at the program start, static

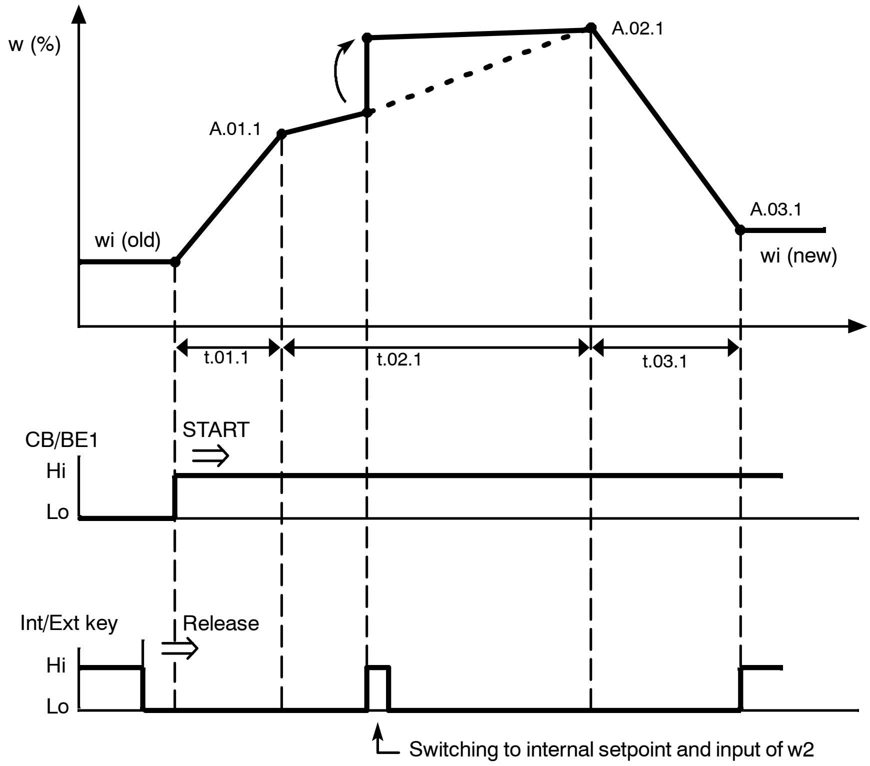
At external setpoint (13) (signal lamp “setpoint internal” (15) off) the program function is started with CB= high (DI1) (signal lamp “computer” (14) off). “setpoint internal” is switched to automatically at the end of the program (signal lamp “setpoint” internal (15) on). At the start of the program the setpoint wi set at the front is active. This is tracked to the last program setpoint A.03.1 at the end of the program (S46 = 0).

The program run can be interrupted by switching to setpoint internal (13) and the current setpoint changed by the input keys (7), (8). The switching is bumpless, starting from the set setpoint the target setpoint at the end of the current program section is driven to over the remaining time (S46 = 0).

To avoid double assignment of DI1 the factory setting of the structure switch S25 must be changed (example S25).

The display “PV-X” (1) shows the remaining time in the active interval. In the “SP-W” (2) display you can choose between the current setpoint or target setpoint at the end of the interval (S88) with the Shift key (6). The program status is displayed in the analog display (3) (scope of program, program step).

Three program steps are specified in the example.



StrS	**CLPA**	
S1 = 5	PrSE = P1	
S23 = 1	Hold = 3	
S25 = 0 (≠1)	CLFo = '.”	(as required)
S42 = 2	t.01.1 to t.05.1	(as required)
S43 = 2	A.01.1 to A.05.1	(as required)
S46 = 1		
S88 = 7		

Figure 7-7 Setpoint curve according to example 3 with specification of the status signals

Example 4

Time program with cyclic program run, program start on device front, scope of program: 15 steps (P1 and P2 connected), see chapter 3.4.3, pg. 67

wi internal setpoint adjustable on the front at the program start
P1 Program section P1, display on signal lamp 1 (17)
P2 Program section P2, display on signal lamp 2 (17)

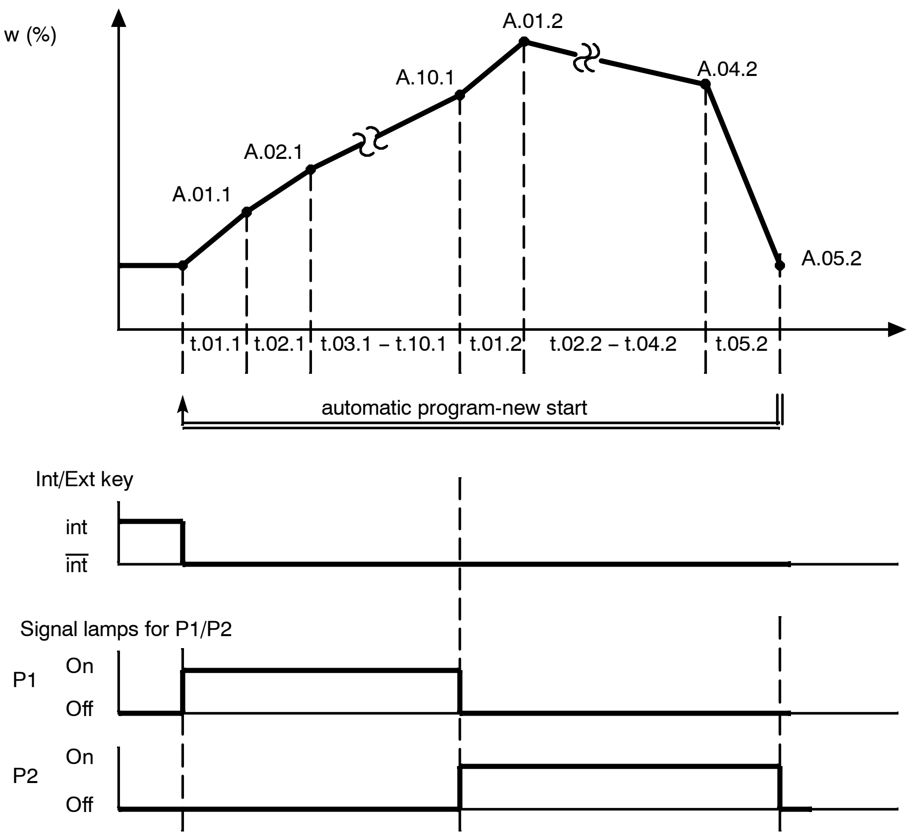
The program is started by switching to external setpoint (Shift key setpoint internal/external (13)), message lamp "setpoint internal" (15) off). The programs P1 and P2 are connected with each other (CLPA, PrSE = CASC).

The program run is repeated cyclically. Cancel by switching setpoint internal (13). At the start of the program the setpoint wi set at the front is active. This is tracked to the last program setpoint A.05.2 at the end of the program (S46 = 0).

The display "PV-X" (1) shows the remaining time in the active interval. In the "SP-W" (2) display you can choose between setpoint or target setpoint at the end of the interval (S88) with the Shift key (6). The program status is shown in the analog display (3) (current program step in P1, scope of program and current program step in P2).

The active program part P1/P2 is displayed on the signal lamps 1/2 (17).

Fifteen program steps are specified in the example.



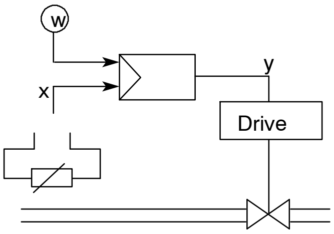
StrS	**CLPA**	
S1 = 5	PrSE = CASC	
S23 = 8	Hold = oFF	
S42 = 2	CLFo = '.”	(as required)
S43 = 2	t.01.1 to t.10.1	(as required)
S87 = 1	t.01.2 to t.05.2	(as required)
S88 = 7	A.01.1 to A.03.1	(as required)
	A.01.2 to A.05.2	(as required)

Figure 7-8 Setpoint curve according to example 4 with specification of the status signals

7.4 Configuration examples

Configuration example K1

fixed value controller, K-controller
Controlled variable by a three-wire-Pt100-sensor

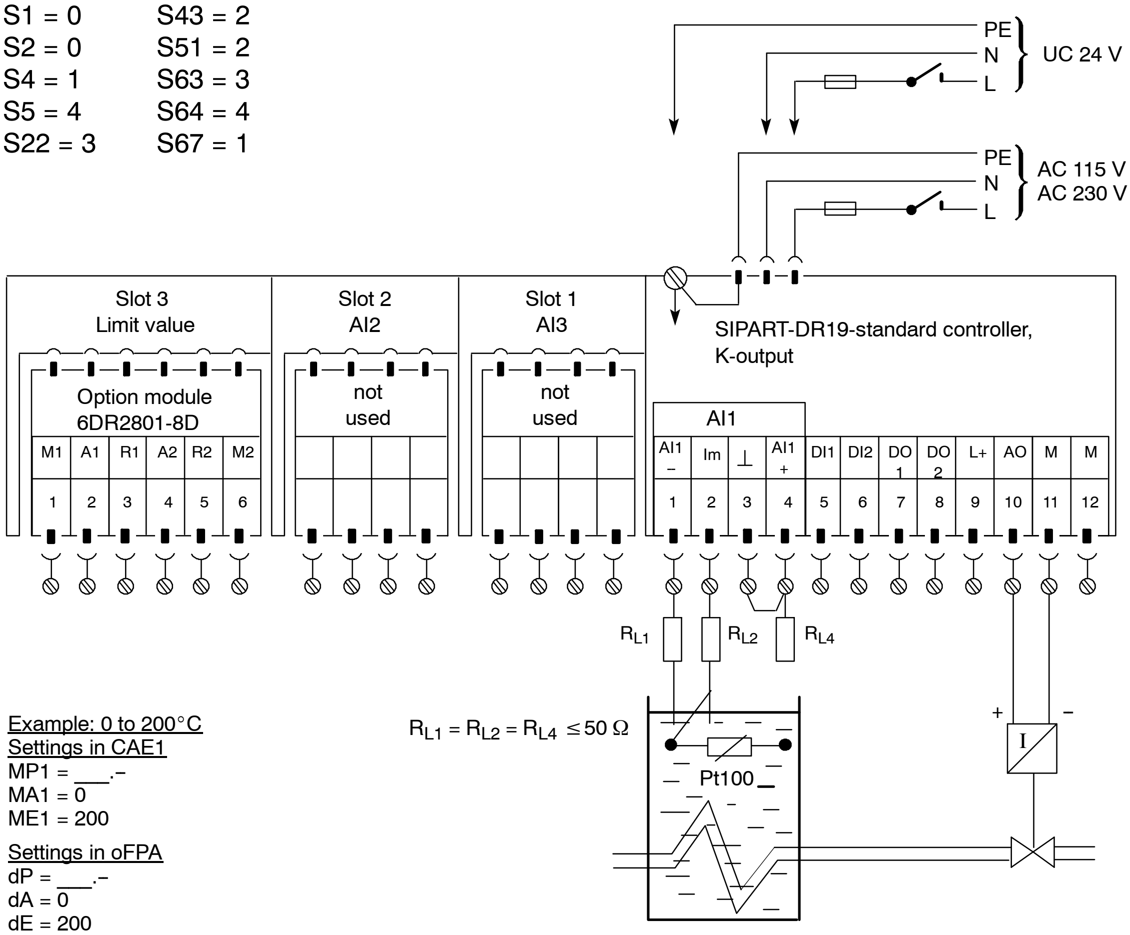


The controlled variable x from the sensor goes to the analog input AI1 of the controller. Line break alarm (MUF) is selected.
The manipulated variable is also 0 to 20 mA. Two different setpoints can be set. In the event of a transmitter fault (MUF) the controller goes into manual mode starting with the safety manipulated value ys.
The function of the limit value alarm in connection with the options module must be set with S63 to S66 and S83 to S87.

Please read the foreword to chapter 7.1, page 211

Setting the structure switches:

S1 = 0	S43 = 2
S2 = 0	S51 = 2
S4 = 1	S63 = 3
S5 = 4	S64 = 4
S22 = 3	S67 = 1

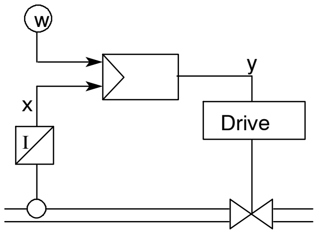


Example: 0 to 200°C
Settings in CAE1
MP1 = ___.–
MA1 = 0
ME1 = 200

Settings in oFPA
dP = ___.–
dA = 0
dE = 200

Configuration example K2

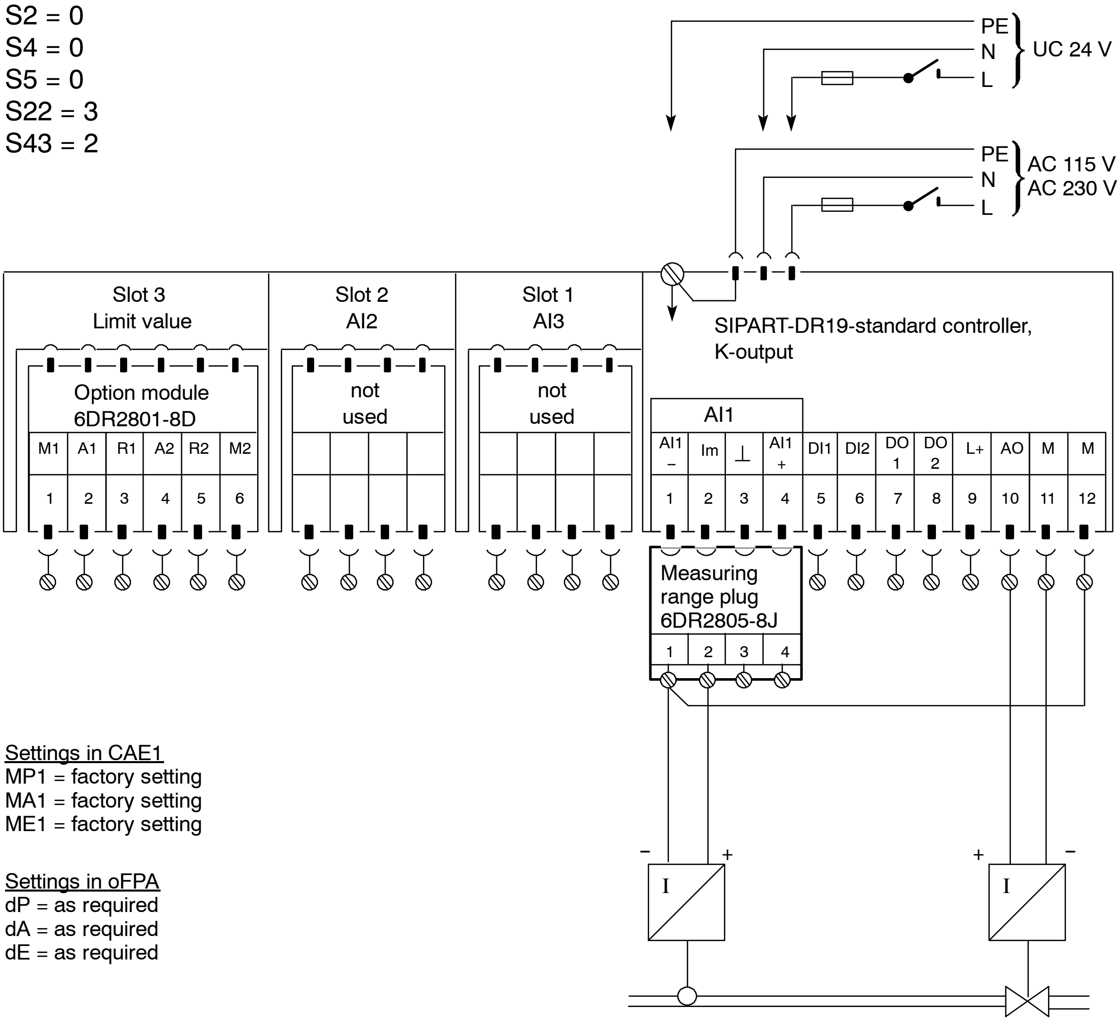
Fixed value control, K-controller
Controlled variable by a four-wire transmitter



The controlled variable x from the transmitter goes to the analog input AI1 of the controller. The input signal range is 0 to 20 mA and is converted to 0 to 100 mV in the measuring range plug.The manipulated variable is also 0 to 20 mA.
Two different setpoints can be set. The function of the limit value alarm in connection with the options module must be set with S63 to S66 and S83 to S87.

Please read the foreword to chapter 7.1, page 211

Setting the structure switches:
S1 = 0
S2 = 0
S4 = 0
S5 = 0
S22 = 3
S43 = 2

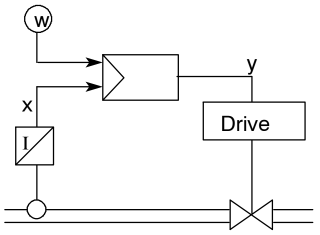


<u>Settings in CAE1</u>
MP1 = factory setting
MA1 = factory setting
ME1 = factory setting

<u>Settings in oFPA</u>
dP = as required
dA = as required
dE = as required

Configuration example K3

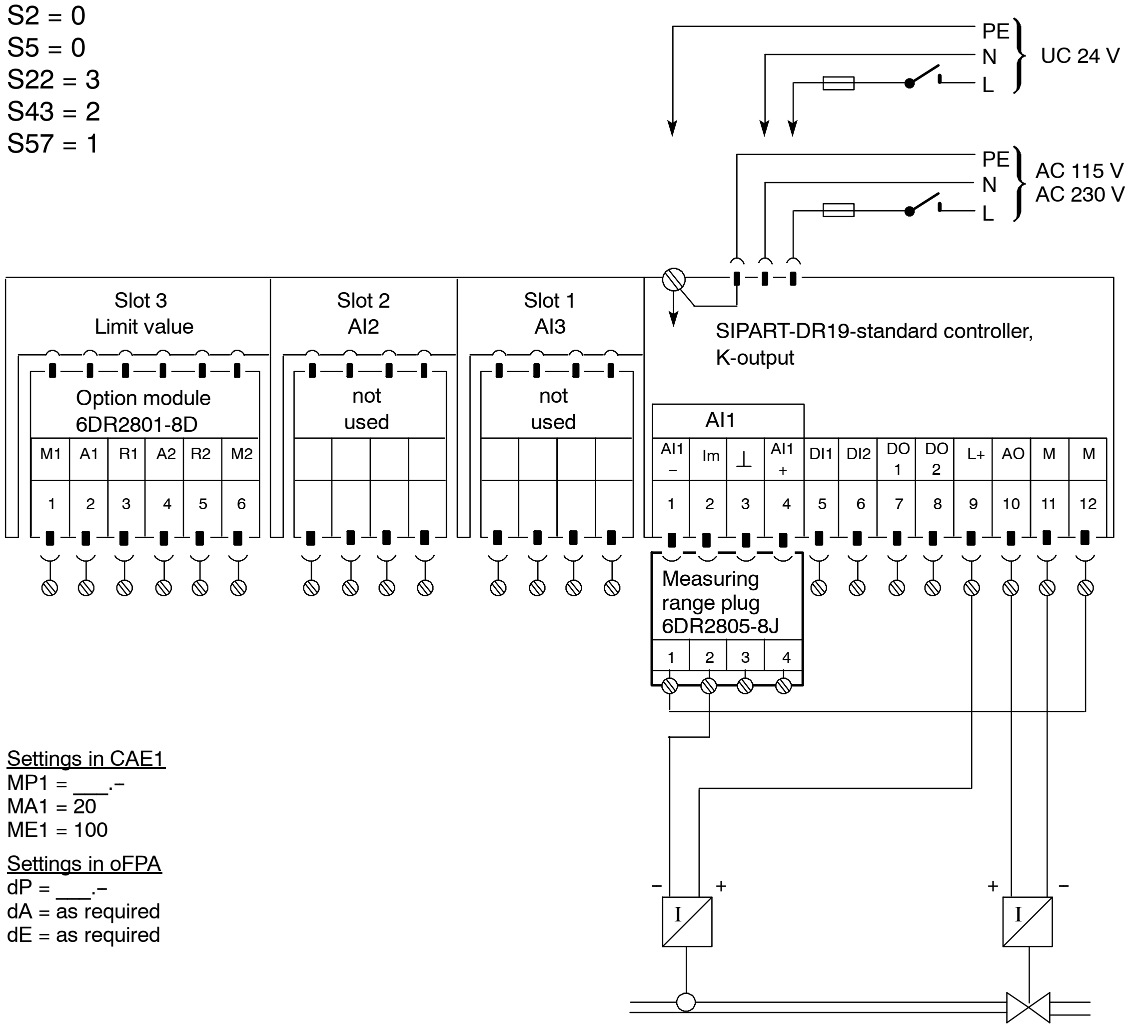
Fixed value control, K-controller
Controlled variable by a two-wire-transmitter with feeding from the controller



The controlled variable x from the transmitter goes to the analog input AI1 of the controller via the measuring range plug. The transmitter is fed by the same lines. The input signal range and the output manipulated variable of the controller are 4 to 20 mA.
The measuring range of the input AI1 is 10 to 100 mV. Two different setpoints can be set.
The function of the limit value alarm in connection with the options module must be set with S63 to S66 and S83 to S87.

Please read the foreword to chapter 7.1, page 211

Setting the structure switches:
S1 = 0
S2 = 0
S5 = 0
S22 = 3
S43 = 2
S57 = 1

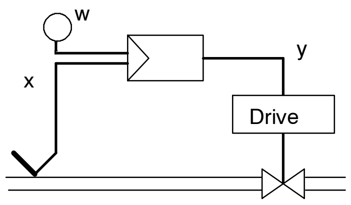


Settings in CAE1
MP1 = ___.–
MA1 = 20
ME1 = 100

Settings in oFPA
dP = ___.–
dA = as required
dE = as required

Configuration example S1 Sequence control, S-controller (internal feedback)

The controlled variable comes from a thermocouple with internal reference point.



The controlled variable from the thermocouple goes to the analog input AI1. The reference point terminal for TC internal, 6DR2805-8A, is used. Thermocouple type K, 0 to 800 °C. Two setpoints can be set on the operating front. Signal for transmitter fault is selected. In the case of a line break, the controller goes into manual mode with Ys as a safety manipulated value

The limit value alarms monitor the controlled variable x1 for max/min deviation (set parameters A2 and A1!).

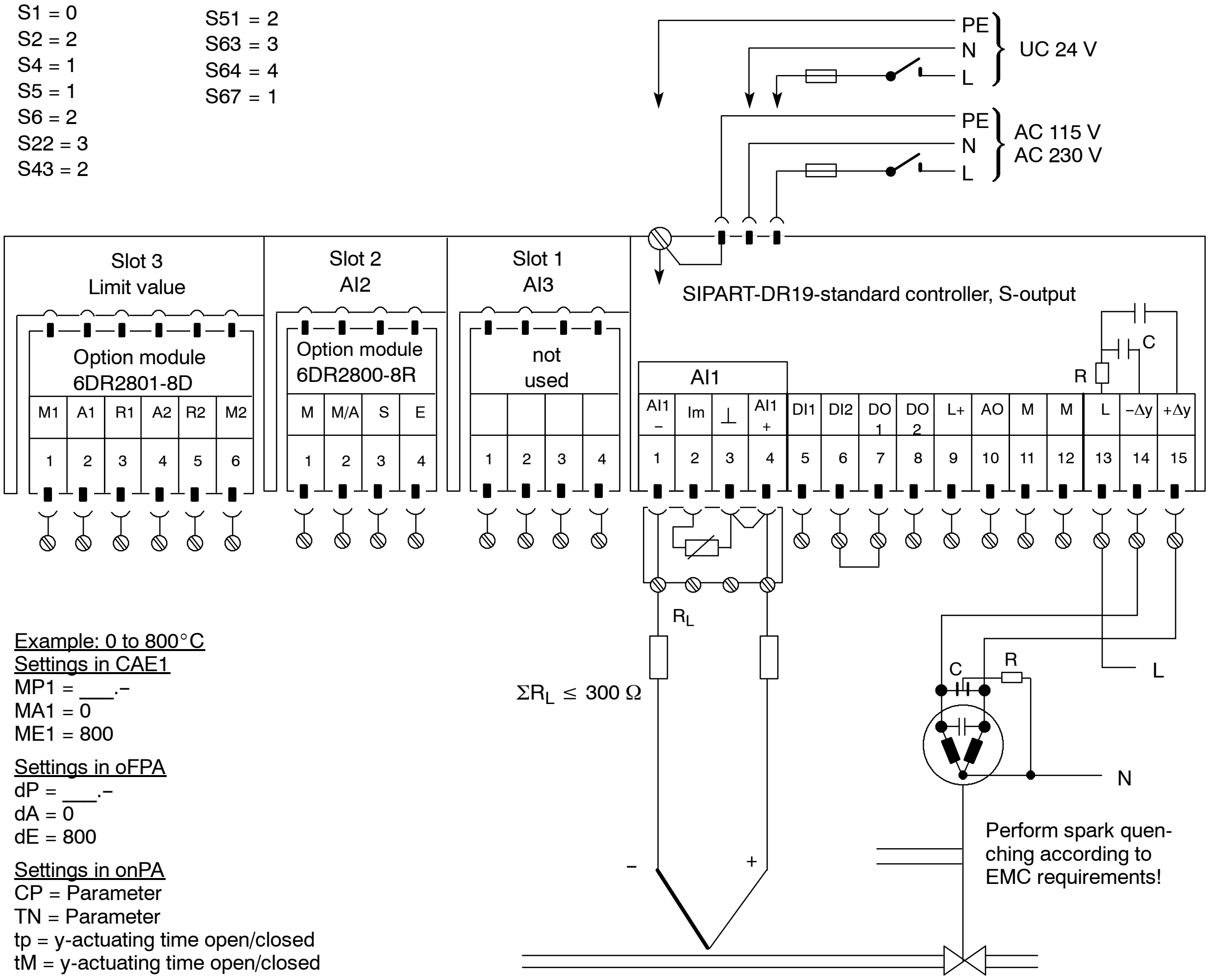
The function of the limit value alarm in connection with the options module must be set with S63 to S64 and S83 to S87.

Please read the foreword in chapter 7.1, page 211 and the warnings in chapter 2.1 (from page 19)

Setting the structure switches:

S1 = 0
S2 = 2
S4 = 1
S5 = 1
S6 = 2
S22 = 3
S43 = 2

S51 = 2
S63 = 3
S64 = 4
S67 = 1



Example: 0 to 800°C

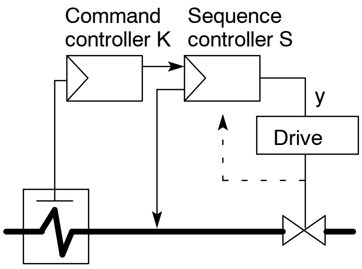
Settings in CAE1
MP1 = ___.–
MA1 = 0
ME1 = 800

Settings in oFPA
dP = ___.–
dA = 0
dE = 800

Settings in onPA
CP = Parameter
TN = Parameter
tp = y-actuating time open/closed
tM = y-actuating time open/closed

Configuration example S2

Cascade control, K-controller and S-controller (internal feedback)
The controlled variable of the command controller and the sequence controller come directly from resistance thermometers Pt 100

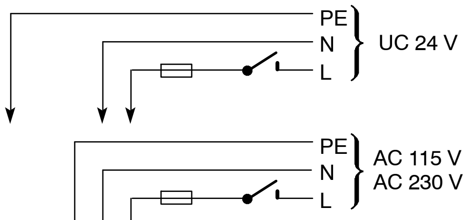


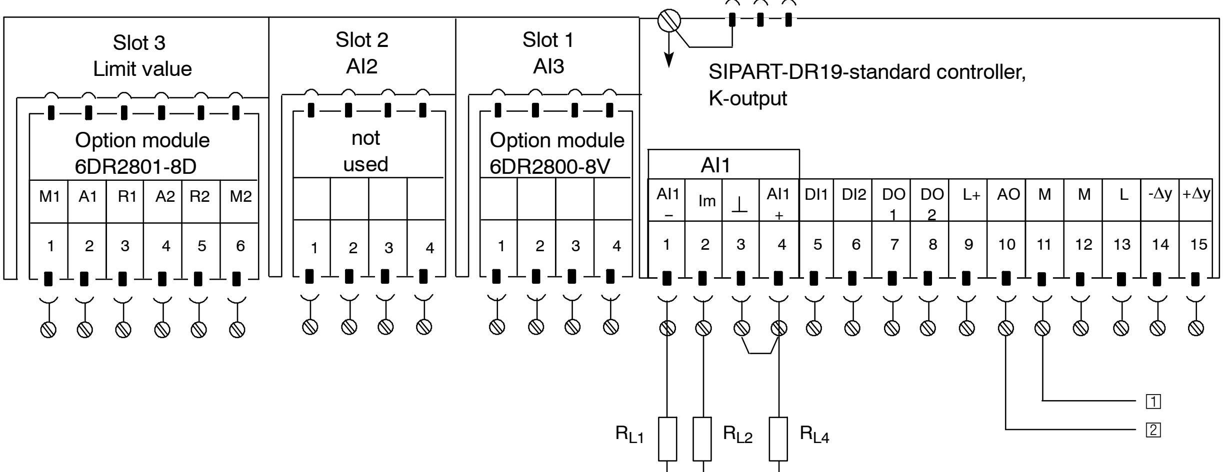
The command controller is a SIPART DR19 with K-output, the sequence controller is a SIPART DR19 with three-position step output.
The controlled varaible of both the command controller and sequence controller comes directly from resistance thermometers Pt100 and is connected at the analog input AI1 in both devices. The position feedback of the step-switching sequence controller comes from a potentiometer, connected at the analog input AI2. The output signal of the command controller is the setpoint for the sequence controller and is fed to its analog input.

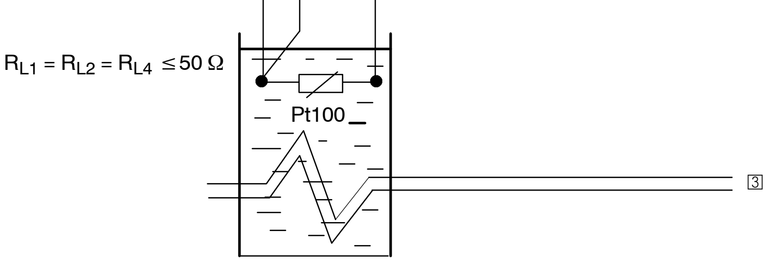
Please read the foreword in chapter 7.1, pg. 211 and the warnings in chapter 2.1 (from page 19)

Command controller

Setting the structure switches of the command controller:
S1 = 0
S2 = 0
S4 = 0 to 3
S5 = 4







Example: 0 to 800°C
Settings in CAE1
MP1 = ___.–
MA1 = 0
ME1 = 80

Settings in oFPA
dP = ___.–
dA = 0
dE = 80

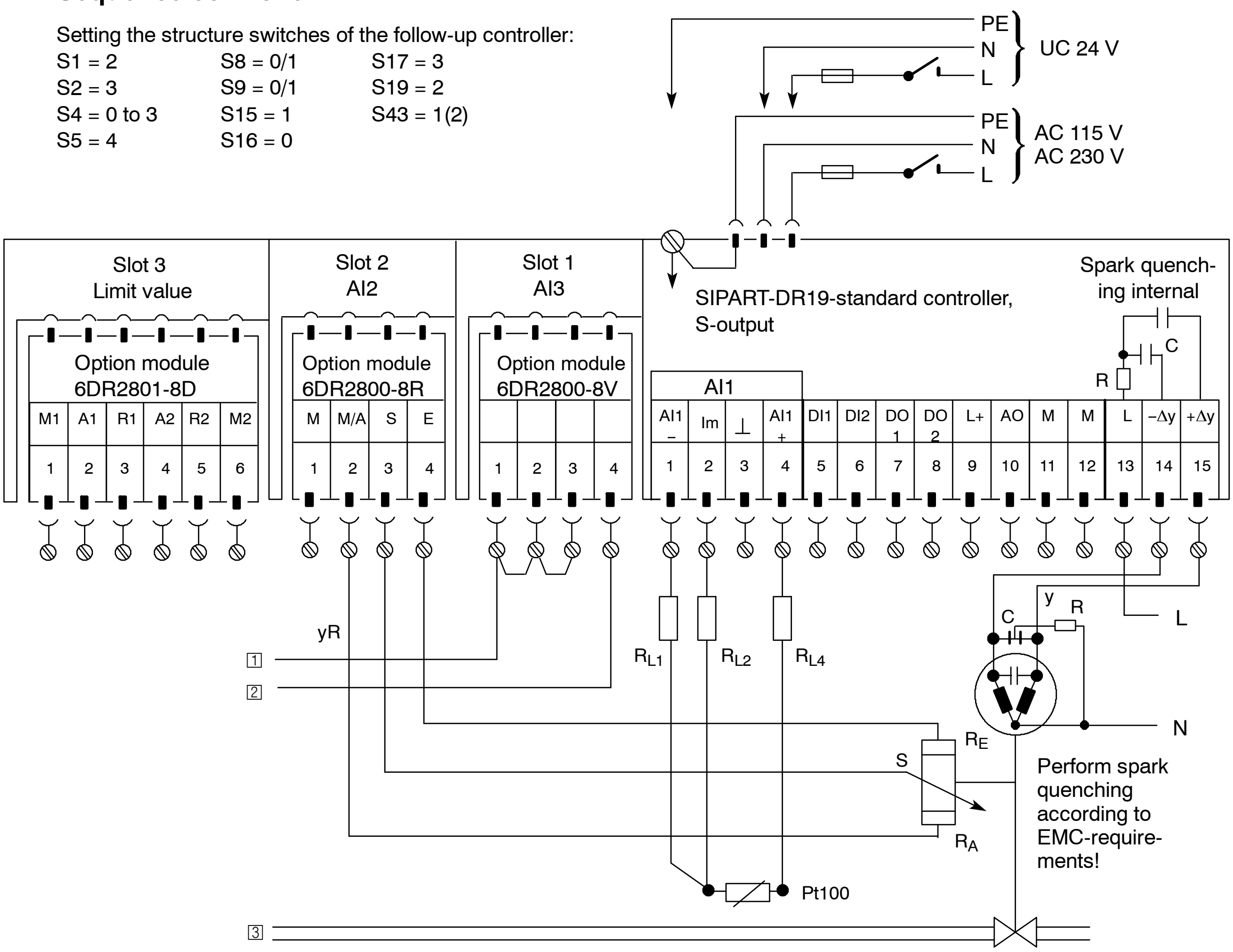
Settings in onPA
CP = Parameter
TN = Parameter
tp = y-actuating time open/closed
tM = y-actuating time open/closed

Configuration example S2 continued

Sequence controller

Setting the structure switches of the follow-up controller:

S1 = 2	S8 = 0/1	S17 = 3
S2 = 3	S9 = 0/1	S19 = 2
S4 = 0 to 3	S15 = 1	S43 = 1(2)
S5 = 4	S16 = 0	



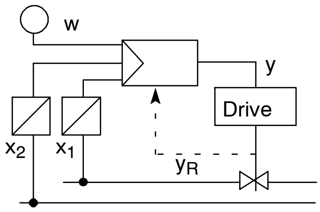
Example: 0 to 800°C
Settings in CAE1
MP1 = ___.–
MA1 = 0
ME1 = 100

Settings in oFPA
dP = ___.–
dA = 0
dE = 80

Settings in onPA
tp = (30 to 60 s)
tM = (30 to 60 s)

Configuration example S3

Ratio control, S-controller (internal feedback)
Commanded process variable and commanding variable directly from two-wire transmitter with feed from the controller



The commanded process variable x1 from the transmitter goes to analog input AI3, the commanding process variable is connected to the analog input AI2. The input signal ranges are 4 to 20 mA. The feedback of the actuator position yR comes from a resistance potentiometer to the analog input AI1.

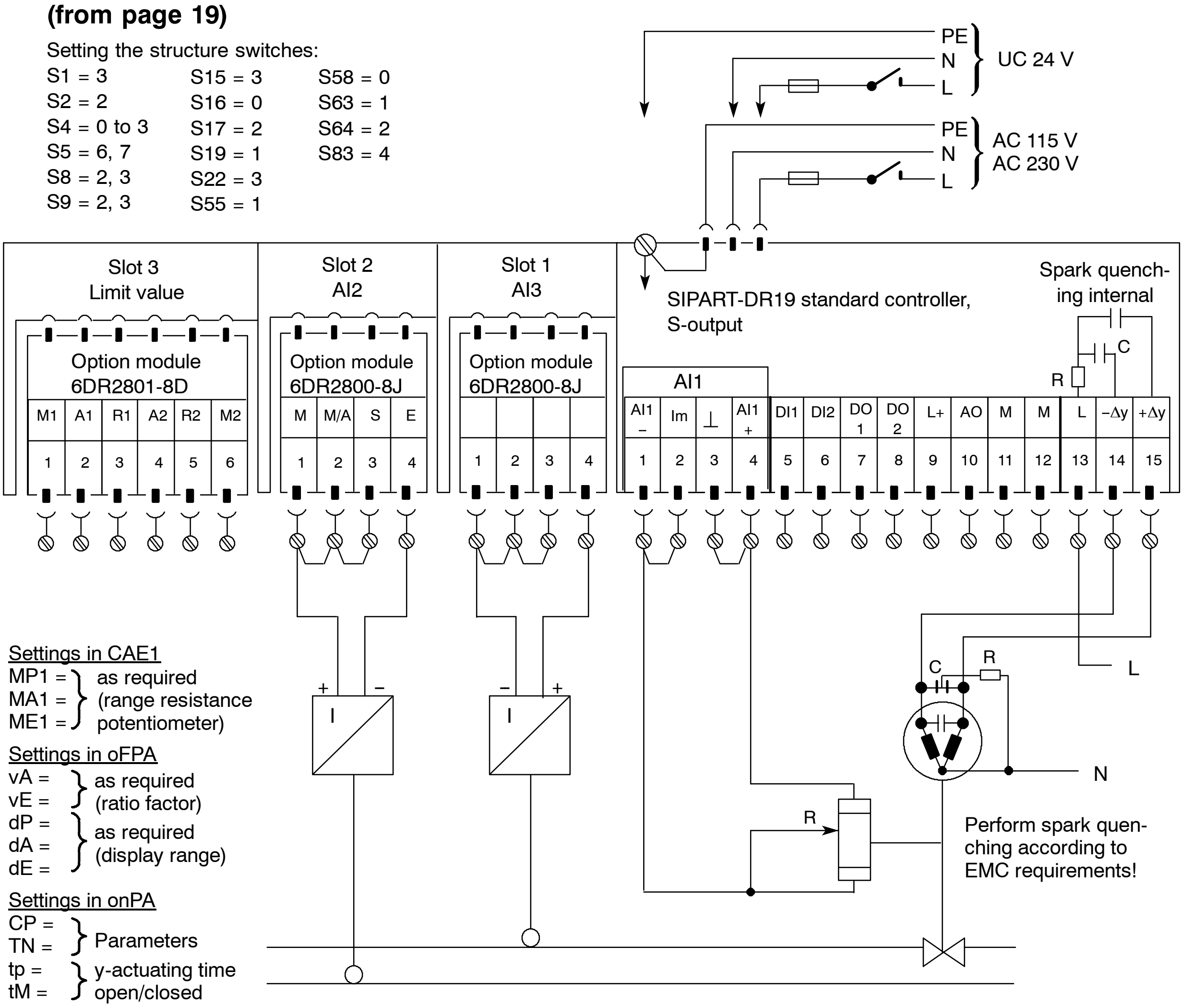
The limit values alarms monitor the actual ratio (parameters A2 and A1).

The function of the limit value alarms in connection with the options module must be set with S22, S62 to S66, S80, S81 and S83 to S86.

Please read the foreword in chapter 7.1, pg. 211 and the warnings in chapter 2.1 (from page 19)

Setting the structure switches:

S1 = 3	S15 = 3	S58 = 0
S2 = 2	S16 = 0	S63 = 1
S4 = 0 to 3	S17 = 2	S64 = 2
S5 = 6, 7	S19 = 1	S83 = 4
S8 = 2, 3	S22 = 3	
S9 = 2, 3	S55 = 1	



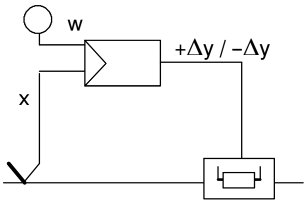
Settings in CAE1
MP1 =
MA1 =
ME1 =
} as required (range resistance potentiometer)

Settings in oFPA
vA =
vE =
} as required (ratio factor)
dP =
dA =
dE =
} as required (display range)

Settings in onPA
CP =
TN =
} Parameters
tp =
tM =
} y-actuating time open/closed

Configuration example Z1

Fixed value control with PD two-position controller
The controlled variable comes from a thermocouple with internal reference point.

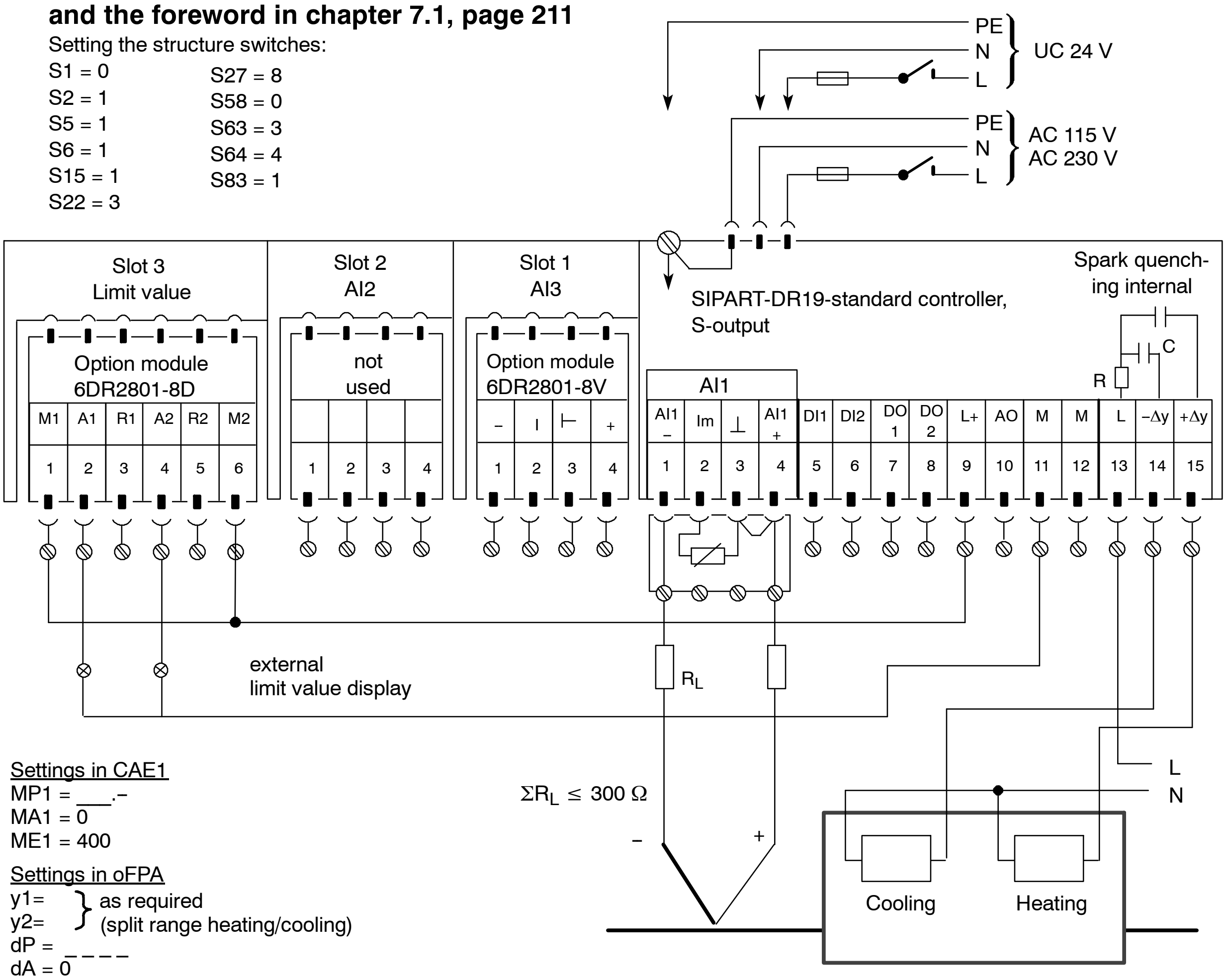


The controlled variable from the thermocouple goes directly to the analog input AI1. The reference point element for TC internal, 6DR2805-8A, is used. Thermocouple type J, 0 to 400 °C. The type of thermocouple is selected with S6. The measuring range is set with the menu CAE1 (see chapter 5.4.7, page 191).
The manipulated variable is output dependent on the setting of the parameters Y1 and Y2 (see Chapter 3.6, page 101).
The limit value alarms monitor the controlled variable for max/min deviation (parameters A2 and A1).

Please note the possibilities of setting the operating point in the P-controller (page 98) and the foreword in chapter 7.1, page 211

Setting the structure switches:

S1 = 0	S27 = 8
S2 = 1	S58 = 0
S5 = 1	S63 = 3
S6 = 1	S64 = 4
S15 = 1	S83 = 1
S22 = 3	



Settings in CAE1
MP1 = ___.–
MA1 = 0
ME1 = 400

Settings in oFPA
y1= } as required
y2= } (split range heating/cooling)
dP = _ _ _ _
dA = 0
dE = 400

Settings in onPA
CP =
TN = } as required
tp = } y0 = 50 %
tM =

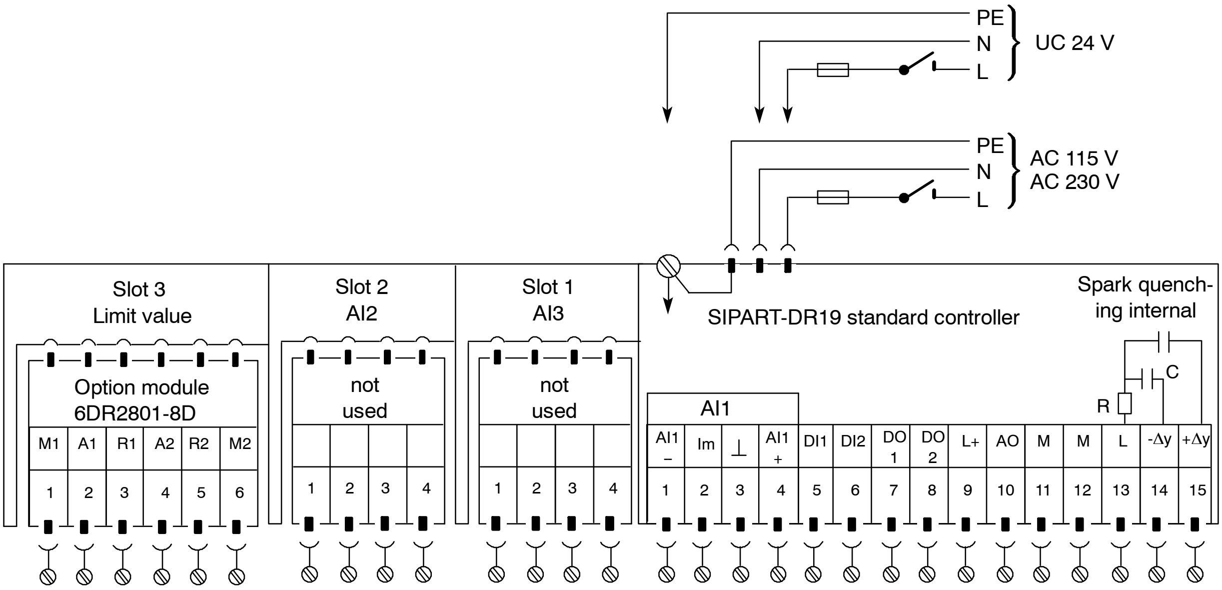
7.5 Configuring tool, forms

We recommend the following procedure for solving your controller problems:

- Determining the assembly of the controller.
- If necessary: Determine position of jumpers and switches of the backplane module and the signal transformer.
- Drawing the wiring diagram.
- Settings to be entered further down in the onPA, oFPA and Stru and CAE1 list (structuring, parameterization).
- The SIMATIC PDM user interface is available for PC-supported configurations.

For notes

Circuit design K- or S-output



Settings SIPART DR19, controller number / tag . . . .

Parameter **onPA**

Parameter meaning	Digital indication on display					Factory setting	Dimension
	w/y (2)	x (1) for preset					
Filter time constant xd (adaptive)	tF					1.000	s
Derivative action gain Vv	vv					5.000	1
Proportional action factor Kp	cP					0.100	1
Integral action time Tn	tn					9984	s
Derivative action time Tv	tv					oFF	s
Response threshold	AH					0.0	%
Operating point	YO					Auto	%
Safety setpoint 1	SH1					0.0	%
Safety setpoint 2	SH2					0.0	%
Safety setpoint 3	SH3					0.0	%
Safety setpoint 4	SH4					0.0	%
Manipulated variable limiting start	YA					–5.0	%
Manipulated variable limit end (YA ≤ YE)	YE					105.0	%
y actuating time open/period heating	tP					1.000	s
y actuating time open/period cooling	tM					1.000	s
min. actuating pulse pause	tA					200	ms
min. actuating pulse length	tE					200	ms
Filter time constant AI1	t1					1.000	s
Filter time constant AI2	t2					1.000	s
Filter time constant AI3	t3					1.000	s
Multiplicative constant	c1					0.000	1
Multiplicative constant	c2					0.000	1
Additive constant	c3					0.000	100 %
Multiplicative constant	c4					1.000	1
Additive constant	c5					0.000	100 %
Multiplicative constant	c6					0.0	1
Multiplicative constant	c7					1.000	1
Display refresh rate	dr					1.000	s

Settings SIPART DR19, controller number / tag . . . .

Parameter **oFPA**

Parameter meaning	Digital indication on display					Factory setting	Dimension
	w/y (2)	x (1) for preset					
Decimal point w/x display	dP					– – – . –	–
Start of scale	dA					0.0	–
Full scale	dE					100.0	–
Alarm 1	A1					5.0	–
Alarm 2 (A2 ≤ A1)	A2					–5.0	–
Alarm 3	A3					5.0	–
Alarm 4 (A4 ≤ A3)	A4					–5.0	–
Hysteresis alarms	HA					1	%
Setpoint limit start	SA					–5.0	–
Setpoint limit end	SE					105.0	–
Setpoint ramp time	tS					oFF	min
Ratio factor start	vA					0.000	1
Ratio factor end	vE					1.000	1
Safety manipulated variable	YS					0.0	%
Split range left y1 (y1 ≤ y2)	Y1					50.0	%
Split range right y2	Y2					50.0	%
Vertex value at –10 %	L–1					–10	%
Vertex value at 0 %	L0					0	%
Vertex value at 10 %	L1					10	%
Vertex value at 20 %	L2					20	%
Vertex value at 30 %	L3					30	%
Vertex value at 40 %	L4					40	%
Vertex value at 50 %	L5					50	%
Vertex value at 60 %	L6					60	%
Vertex value at 70 %	L7					70	%
Vertex value at 80 %	L8					80	%
Vertex value at 90 %	L9					90	%
Vertex value at 100 %	L10					100	%
Vertex value at 110 %	L11					110	%

Settings SIPART DR19, controller number / measuring point . . . .

Parameter CAE1

Parameter meaning	Digital indication on displays				
	16 (x)	19 (w)			
Sensor type	SEnS				
Temperature unit	unit				
Thermocouple type	tc				
Temperature reference point	tb				
Line resistance	Mr				
Decimal point measuring range	MP				
Range start	MA				
Range full scale	ME				

Parameter CAE3

Parameter meaning	Digital indication on displays				
	16 (x)	19 (w)			
Sensor type	SEnS				
Temperature unit	unit				
Thermocouple type	tc				
Temperature reference point	tb				
Line resistance	Mr				
Decimal point measuring range	MP				
Range start	MA				
Range full scale	ME				

Settings SIPART DR19, controller number / tag . . . .

Structure switch StrS

Digital indication on display:

w/y (2) switch-no.	x (1) preset				Factory setting
1					0
2					0
3					0
4					0
5					0
6					0
7					0
8					0
9					0
10					0
11					0
12					0
13					0
14					0
15					1
16					2
17					3
18					0
19					0
20					0
21					0
22					0
23					8
24					0
25					1
26					2
27					0
28					0
29					0
30					0
31					0
32					0
33					0
34					0
35					0
36					0
37					0
38					0
39					0
40					0
41					0
42					0
43					0
44					0
45					0
46					0
47					0
48					0
49					0
50					0
51					0

w/y (2) switch-no.	x (1) preset				Factory setting
52					0
53					0
54					0
55					0
56					0
57					0
58					0
59					0
60					0
61					0
62					0
63					1
64					2
65					0
66					0
67					0
68					0
69					0
70					0
71					0
72					0
73					0
74					0
75					0
76					0
77					0
78					0
79					0
80					0
81					0
82					0
83					0
84					0
85					0
86					0
87					0
88					0
89					0
90					0
91					0
92					0/1 [1]
93					0/1 [1]
94					0
95					0
96					0
97					0
98					0
99					0
100					0 [2]

[1] as of software version -A6
[2] as of software version -B9

8 Maintenance

8.1 General information and handling

The controller is maintenance-free. White spirit or industrial alcohol is recommended for cleaning the front foil and the plastic housing if necessary.

Be changed freely without readjustment with power supplied. The other modules may also be replaced without readjustment (procedure as described in chapter 8.2).

CAUTION

All modules contain components which are vulnerable to static. Observe the safety precautions!

S-final control elements on S-controllers remain in their last position.

WARNING

The backplane module may only be exchanged when the power supply has been safely disconnected!

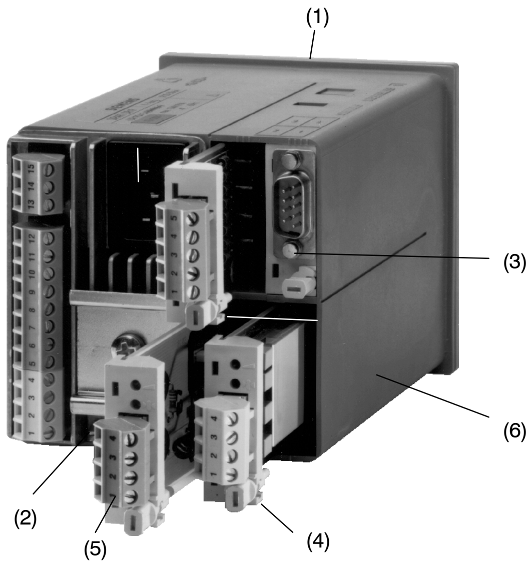
WARNING

Modules may only be repaired in an authorized workshop. This applies particularly to the backplane module because of the safety functions (safe disconnection and safety extra low voltages).

8.2 Exchanging components

- **Replacing the front module**
  - Pull out the mains plug
  - Remove the backplane module and any options modules which may be plugged in.
  - Carefully lever out the label cover with a screwdriver at the cutout at the top and snap the cover out of the bottom hinge points by bending slightly.
  - Loosen the fastening screw (captive) (see (1) fig. 8-1).
  - Tilt the top of the front module at the head of the screw and pull it out angled slightly forwards.
  - Install in reverse order. Make sure the sealing ring is positioned perfectly!

- **Replacing the options modules**
  - Pull off the plug terminals.
  - Release the lock and pull out the options module (see (5) figure 8-1).
  - Push in the new module to the stop and lock it (the modules are slot coded). Please note the slots provided for the various options (see chapter 2.4, pg. 25).
  - Plug in the terminal (pay attention to slot labeling!),

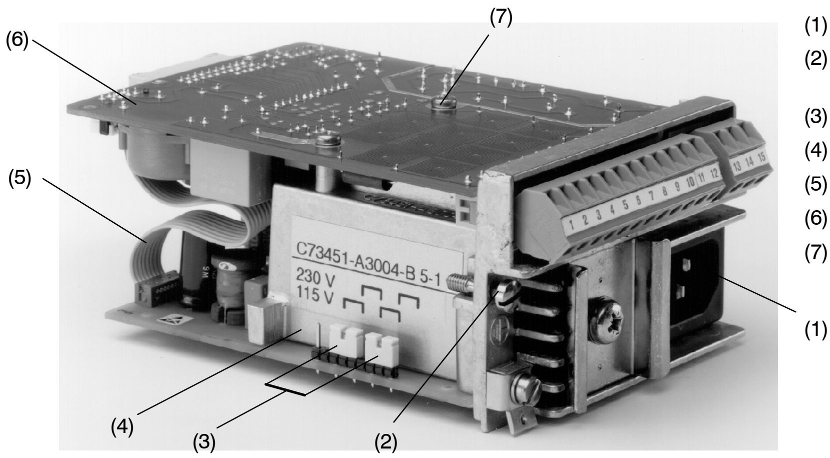


(1) Front module
(2) Fastening screw for the backplane module
(3) Module locked
(4) Module unlocked
(5) Terminals
(6) Plastic housing

Figure 8-1 Controller rear view

- **Replacement of the backplane module (power supply unit + basic circuit board)**
  - Pull out the mains plug!
  - Pull off the plug terminals
  - Disconnect the PE conductor
  - Loosen the fastening screw of the backplane module (see (2) 8-2) and pull out the module
  - Install in reverse order

- **Disconnect the power supply unit from the basic circuit board (Components of the backplane module)**
  - Pull out the backplane module (see replacement of the backplane module)
  - Pull out the ribbon cable plug (see (5) figure8-2)
  - Loosen the fastening screw of the basic circuit board (see (7) fig. 8-2).
  - Separate the basic circuit board and the power supply unit
  - Re-assemble in reverse order
    (Pay attention to correct plugging of jumpers (see (3) figure 8-2))



(1) Connecting plug
(2) Fastening screw for the backplane module
(3) Plug-in jumpers
(4) Power supply unit
(5) Plug ribbon cable
(6) Basic circuit board
(7) Fastening screws for the basic circuit board

Figure 8-2 Backplane module

8.3 LED-test and software state

If the Shift key (6) is pressed for about 10 s (“ PS” flashes on the manipulated variable display after about 5 s), this leads to the LED-test. All LEDs light up, the displays show “8.8.8.8.” and a 2 LED wide light mark runs on the bargraph from 0 to 100 % (on reaching 100 % the light marks starts again at 0 %).

If the internal/external key (13) is kept pressed permanently during the lamp guiding, “dr19” appears on the digital x/w display and the device software version appears on the digital w/y display.

During the LED-test and display of the software state the controller continues to operate online in its last operating mode.

8.4 Spare parts list

Item	Figure	Description	Comments	Order number
1		**Front module**		
1.1	(1) Figure 8-1	Front module complete, with program function	without tag plate	C73451-A3003-B112
1.3	–	Shaft screw M3		D7964-L9010-S3
1.4		Tag plate cover		C73451-A3003-C7
1.5		10 Tag plate labels		C73451-A3003-C11
2		**Housing**		
2.1		Housing		C73451-A3003-C3
2.2	(4) Figure 8-1	Dummy covers for unoccupied slots		C73451-A3000-C11
2.3	–	Clamps	order 2 pieces	C73451-A3000-B20
3		**Backplane module**		
3.1	(4) Figure 8-2	Power supply unit – 24 V UC	without mains plug	C73451-A3004-B8
3.2	"	. 115/230 V AC		C73451-A3004-B5
3.3	(6) Figure 8-2	Basic circuit board: – S- and K-controller		C73451-A3004-L105
3.4	(1) Figure 8-2	Terminal: – 4-pole		W73078-B1003-A904
3.5	"	– 8-pole		W73078-B1017-A908
3.6	"	– 3-pole		W73078-B1018-A903
		Mains plug:		
3.7		– 3-pin plug for 115/230 V AC IEC–230/V, DIN 49457A		C73334-Z343-C3
3.8		– Special 2-pin plug for 24 V UC		C73334-Z343-C6
4	–	**Options**	see chapter 8.5, ordering data	
		Terminals:		
4.1	–	– 4-pin for 6DR2800-8J/8R		W73078-B1001-A904
4.2	–	– 4-pin for 6DR2800-8V		W73078-B1003-A904
4.3	–	– 5-pin for 6DR2801-8C		W73078-B1001-A705
4.4	–	– 6-pin for 6DR2801-8D/8E		W73078-B1001-A906

- **Ordering information**

The order must contain:
- Quantity
- Order number
- Description

We recommend you to specify the controller order number to be on the safe side.

- **Ordering example**

2 units W73078-B1003-A904
Terminal 4-pole backplane module DR19

8.5 Ordering data

SIPART DR19 industrial controller 96 x 96, with program function as a program controller or program transmitter

with S- and K-output and power supply UC 24 V 6DR1900-4
with S- and K-output and power supply AC 230 V, switchable to AC 115 V 6DR1900-5

Options/accessories

Signal converter/analog signals
- for current input 0/4 to 20 mA or 0/0.2 to 1 V or 0/2 to 10 V (U/I-module) . . . 6DR2800-8J
- for resistance potentiometer (R-module) 6DR2800-8R
- for TC/RTD/R/mV-signals, programmable (UNI-module) 6DR2800-8V
- Reference point terminal for TC, internal; in connection with AI1 or 6DR2800-8V 6DR2805-8A
- Measuring range plug for I = 20 mA and U = 10 V; in connection with AI1 or 6DR2800-8V 6DR2805-8J

Signal transmitter/switching signals
- with 5 digital inputs (5DI-module) 6DR2801-8C
- with 2 relay outputs (35 V) (2 DO-relay-module) 6DR2801-8D
- with 4 digital outputs and 2 digital inputs (2DI 4DO-module) 6DR2801-8E

Interface for serial communication RS 232/RS 485 . . . . 6DR2803-8C

Interface module PROFIBUS DP 6DR2803-8P

Coupling relay module for mounting on a DIN rail on the back of the controller
- with 4 relays (AC 250 V) 6DR2804-8A
- with 2 relays (AC 250 V) 6DR2804-8B

Assembly- and installation instructions
- German/English C73000-M7474-C34
- French/Spanish/Italian C73000-M7450-C34

Brief instructions “Operation and Configuration”
- German/English C73000-B7474-C140
- French/Spanish/Italian C73000-B7450-C140

User’s Guide
- German C73000-B7400-C142
- English C73000-B7476-C142

SIPART DR19 Serial SIPART DR190x bus interface / the operating instructions can be downloaded from Internet. Internet address: www.fielddevices.com (version 05/2000)

9 General explanation of abbreviations for SIPART DR

$\overline{A}$ . . . . Control signal no automatic mode
A . . . . Parameter Alarms (limit values)
A.**.1 . . . . Analog values at the ends of intervals (wpz), program 1
A.**.2 . . . . Analog values at the ends of intervals (wpz), program 2
AdAP . . . . Parameterization mode Adaptation
AdAPT . . . . LED, adaptation mode
AI* . . . . Analog inputs
AI*A . . . . Outputs of the analog inputs
AH* . . . . Response threshold (dead zone)
AO . . . . Analog output
APSt . . . . Structuring mode All Preset (whole controller to factory setting)
Ar* . . . . Function block, Arithmetic
AUto . . . . automatic

bLb . . . . Control signal, block, operate
bLPS . . . . Control signal, Blocking, Parameterization/Structuring
bLPS$_{DI}$ . . . . Control signal, Blocking, Parameterization/Structuring via digital input
bLPS$_{ES}$ . . . . Control signal, Blocking, Parameterization/Structuring via SES
bLS . . . . Control signal, Blocking, Structuring
bLS$_{DI}$ . . . . Control signal, Blocking, Structuring via digital input
bLS$_{ES}$ . . . . Control signal, Blocking, Structuring via SES

c* . . . . Parameter, Constants
$\overline{C}$ . . . . LED, no computer standby
CA* . . . . Calibration, measuring range start
CAE1 . . . . Parameterization mode, analog input AI1
CAE3 . . . . Parameterization mode, UNI-module
CASC . . . . Program controller, program 1 and 2 cascaded
CB . . . . Control signal, Computer operation
CB$_{DI}$ . . . . Control signal, Computer operation via digital inputs
CB$_{ES}$ . . . . Control signal, Computer operation via SES
cP . . . . (Kp) Proportional action factor
CPU . . . . Central processing unit
Cr . . . . Calibration, adjustment of line resistances (R_L)

dA . . . . Parameter, display range, start
DDC . . . . Direct digital control
dE . . . . Parameter, display range, end
df . . . . Duty factor
DI** . . . . Digital inputs
DO** . . . . Digital outputs
dP . . . . Parameter, display decimal point
dPv . . . . Parameter direction of step command
dr . . . . Parameter, display refresh rate
dY . . . . Parameter amplitude of the step command

End .... Error message end
Err .... Error

FAST .... Error message for adaptation, system too fast

H .... Control signal manual mode
HA .... Parameter, hysteresis alarms
HE .... Error message manual external
He_{DI} .... Control signal manual external via digital input
He_{ES} .... Control signal manual external via SES
Hi .... Control signal manual internal
HOLD .... Program controller, comparison at end of interval with hold function

Int .... Control signal internal
Iy .... Analog output, current manipulated variable

Kp .... Proportional action factor
Ks .... Transmission factor of the controlled system

LED .... Light emitting diode
Lo .... Status LOW
L–1 to L11 .... Parameter vertex points linearizer

MA* .... Measuring range start of scale
ME* .... Measuring range full scale
MEM .... Memory
ModE .... Operating mode
MP .... Parameter measuring decimal point
MP* .... Parameter measuring range decimal point CAE*
Mr* .... Parameter measuring of (R_L) line resistors)
MUF .... Signal transmitter fault message

n .... Error message tracking
n.ddc .... Error message tracking or DDC
n.End .... Error message full scale value not reached
no .... no
no C .... Parameter setting (PC) nor calibrated
no.dY .... Error message, y-Step not correct
not .... none
nPoS .... not positioned
N .... Control signal tracking
N_{BE} .... Control signal tracking via digital input
N_{ES} .... Control signal tracking via SES
Nw .... Control signal tracking effective

oFF .... no effect
oFL .... overflow, positive overflow
-oFL .... -overflow, negative overflow
oFPA .... Structuring mode, offline-parameterization

onPA .... Parameterization mode, on–line- parameterization
OP** .... Error message option (slot)
OUT .... Output, manipulated variable y
ovEr Shot .... Error message overshoot

P .... Control signal- P–operation
P1 .... Program controller, only program 1
P2 .... Program controller, only program 2
P1 P2 .... Program controller, only program 1 or program 2 (switching with PU=)
P_{DI} .... Control signal P-operation via digital input
P_{ES} .... Control signal P-operation via SES
PASS .... Error message step response in wrong direction
PAU .... Control signal parameter switching
PAU_{DI} .... Control signal parameter switching via digital input
PAU_{ES} .... Control signal parameter switching via SES
PC* .... Parameter Preset Calibration
PE .... Program End
P.oFL .... Error message x above the span
PU .... Control signal program switching/setpoint switching
PV .... Process variable

$\overline{RB}$ .... Control signal, no computer standby
$\overline{RC}$ .... Control signal, no computer operation

S .... Structure switch
SA .... Parameter command variable limiting start
Sb .... Parameter limiting setpoint
SE .... Parameter command variable limiting end
SES .... Serial interface
SG .... Parameter controlling variable
SH* .... Parameter safety setpoint
Si .... Control signal safety operation, error message safety operation
Si_{DI} .... Control signal safety operation via digital input
Si_{ES} .... Control signal safety operation via SES
SMAL .... Error message small
SP .... Setpoint
SP.PV .... Error message small
SPC .... Set point control, command variable via process computer
StAt .... Error message, stationary, static
StrS .... Structuring mode, structure switch
StrU .... Parameterization preselection level select structuring

t* .... Filter time AI*
t.**.1 .... Interval times, program 1
t.**.2 .... Interval times, program 2
tA .... Parameter minimum turn–off duration
tb* .... Parameter reference temperature
tE .... Parameter minimum turn–on duration
tESt .... Self–test

tF .... Parameter filter time constant
tM .... Parameter y-floating time closed/cooling time
tn .... Parameter integral action time
tp .... Parameter y-floating time open/heating
tS .... Parameter setpoint ramp
tSH .... Parameter setpoint ramp "HALT"
to .... to
tU .... Monitoring time
tv .... Parameter derivative action value
tY .... Parameter floating time

v .... Setpoint ratio factor
v_{act} .... Actual ratio factor
vA .... Parameter ratio factor range start
vE .... Parameter ratio factor range end
vv .... Derivative action gain
vvc .... Derivative action gain uncontrolled

w .... Command variable w (setpoint)
w_E .... external command variable
w_{EA} .... external command variable via analog input
w_{ES} .... external command variable via SES
$w_{E\Delta}$ .... external command variable incremental
wi .... internal command variable (setpoint)
wp .... Program setpoint
wpz .... Program target setpoint
wv .... standardized nominal ratio factor

x .... Controlled variable x (actual value)
x* .... Auxiliary controlled variables, partial controlled variables
xd* .... Control difference
xds .... Control difference, position controller
xv .... Standardized actual ratio factor
xw .... Control error (–xd)

y .... Manipulated variable
y1 .... Partial manipulated variables in split range
y2 .... Partial manipulated variables in split range
Y1 .... Parameter manipulated variable range 1 in split range
Y2 .... Parameter manipulated variable range 2 in split range
YA .... Parameter manipulated variable limit start
YE .... Parameter manipulated variable limit end
y_E .... external manipulated variable
YES .... Reset parameter setting (PC) Calibration
y_{ES} .... external manipulated variable via SES
$y_{E\Delta}$ .... external manipulated variable incremental
y_H .... Manual manipulated variable
y_N .... external manipulated variable (tracking manipulated variable)
y_S .... Safety manipulated variable

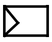
YS . . . . Parameter safety manipulated variable
Yo . . . . Parameter operating point
YBL . . . . Error message blocking mode
y.oFL . . . . Error message y outside the setpoint limits

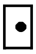
± yBL . . . . Control signal direction dependent y-Blocking
± yBL_{DI} . . . . Control signal direction dependent y-Blocking via digital inputs
± yBL_{ES} . . . . Control signal direction dependent y-Blocking via SES

± Δw . . . . Control signal incremental w-Adjustment
± Δw_{DI} . . . . Control signal incremental w-Adjustment by digital inputs
± Δw_{ES} . . . . Control signal incremental w-Adjustment by SES
± Δy . . . . Control signal incremental y-Adjustment
± Δy_{DI} . . . . Control signal incremental y-Adjustment by digital inputs
± Δy_{ES} . . . . Control signal incremental y-Adjustment by SES

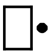
z . . . . Disturbance variable

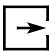
-1.1 to 11.1 . . . . Parameter vertex points linearizer FE1
-1.3 to 11.3 . . . . Parameter vertex points linearizer FE3

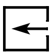
 . . . . Controller

 . . . . Internal

 . . . . Manual (internal manipulated variable preset)

 . . . . External (tracking)

 . . . . Exit

 . . . . Enter

ϟ . . . . Fault

ϟ AI** . . . . Error message Fault analog inputs

_ _ _ ._ . . . . Identification decimal point

↗ . . . . adjustable

**.o . . . . old parameters

**.n . . . . new parameters

* . . . . stands for counter number or parameter name

Index

D

E

F

S

T