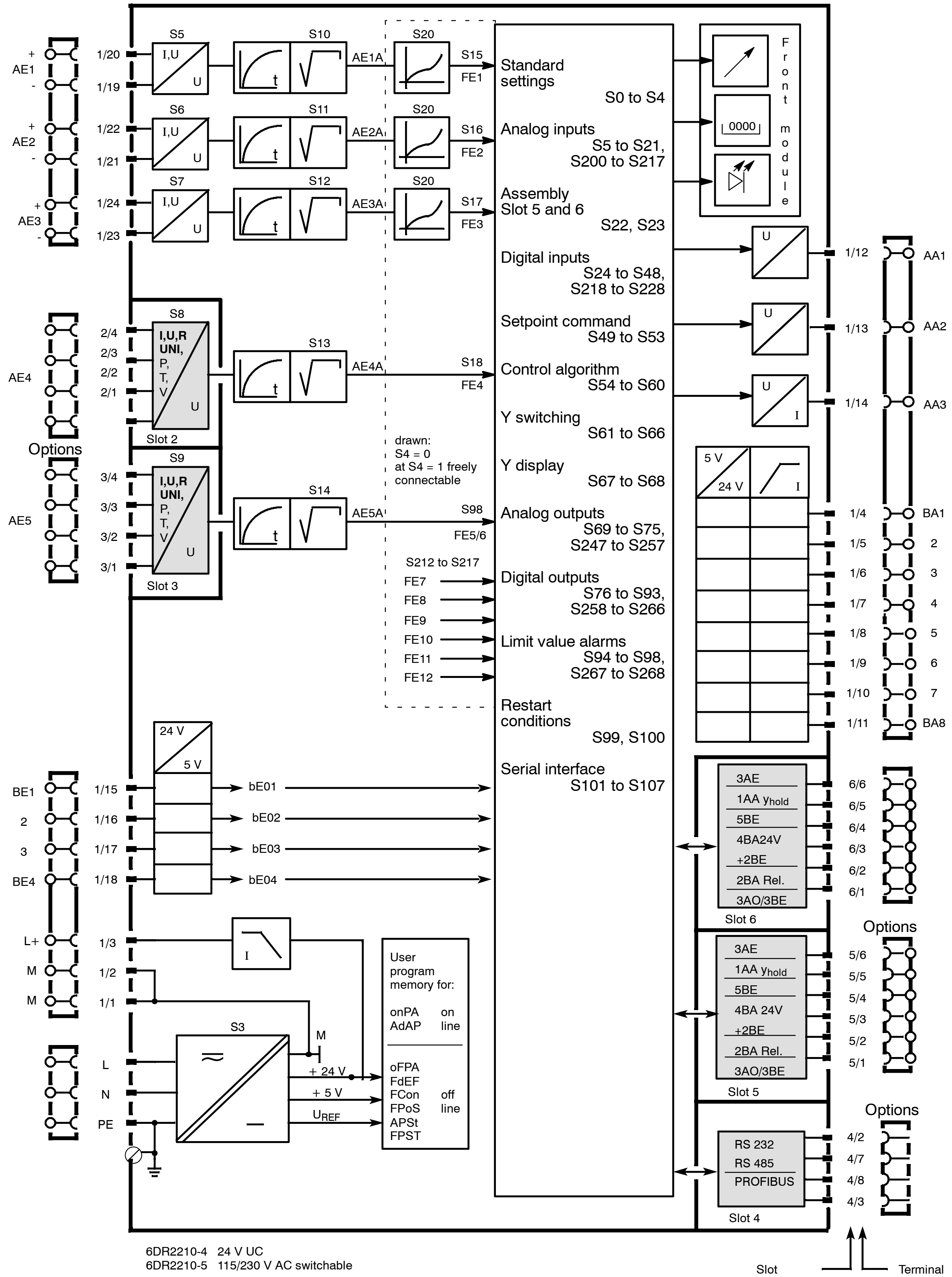
SIEMENS

SIPART DR22
6DR2210

Edition 08/2010

Manual

Block diagram



6DR2210-4 24 V UC
6DR2210-5 115/230 V AC switchable

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.

WARNING
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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Contents

1 Technical Description

1.1 Safety notes and scope of delivery

WARNING

This device is electrically operated. 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 conservant 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 contains:

1 Controller as ordered
1 three-pin plug at 115/230 V AC or special plug at 24 V UC
2 Clamps, pluggable
1 CD ROM with documentation

- **Basic equipment**

The following variants of the SIPART DR22 are available:

Order number	Power Supply
6DR2210-4	24 V UC
6DR2210-5	115/230 V AC, switchable

- **Option modules**

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

- **Subject to change**

  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.

1.2 Range of Application

The SIPART DR22 is a digitally operating device in the top class range. Its program memory contains a large number of prepared function blocks for calculating, controlling, regulating in technical processes which the user can implement without programming knowledge and additional tools.

In addition a robust adaptation procedure is available in this device which makes it much easier to commission even critical controlled systems. The controller determines the optimized control parameters independently on request without the user being expected to have any prior knowledge of how the control loop may respond. The applied procedure is suitable for systems with compensation and aperiodic transient behavior; even greater dead times are taken into account.

For more complicated applications the fixed connection of the individual functions can be canceled in the input range and replaced by a free structuring. The user can easily add extra analog function blocks and connect them to each other and to the interfaces of the input range with the software. This achieves optimum adaptation even to complex problems.

The named programming possibilities guarantee a great flexibility in the use of the controller and allow fast, easy adapting of the device to the problem so that the SIPART DR22 can be used universally for control jobs in processing engineering, e.g. as

- fixed setpoint controller for one, two or three-component control, optionally with two setpoints
- DDC fixed setpoint controller for one-, two- or three-component control
- follow-up controller (synchronized controller, SPC controller) with internal/external switching
- fixed or commanded ratio controller with Internal/External switching
- cascade controller (double controller)
- ratio-cascade controller (double controller)
- override controller with Min or Max selection of the manipulated variable (double controller)
- double controller with two independent control channels

The extensive hardware equipment of the instrument by which numerous interfaces are available for connecting the field cables is of advantage for the universal utilization. The instrument can also be connected to master systems via a plug-in serial interface or operated and monitored centrally by a Personal Computer.

The SIPART DR22 can be used alternatively as a continuous controller with a current output signal or as a three-position step controller for controlling electric motor drives without changing the hardware equipment.

1.3 Design (Hardware)

The process controller SIPART DR22 has a modular structure and is therefore maintenance friendly and easy to convert and retrofit. Other signal convertors can be installed in the generously equipped, fully functional standard controller to expand the range of application. These modules are inserted in backplane slots of the enclosed instrument (Fig. 1-2, page 11).

The standard controller consists of

- the front module with the control and display elements
- the main board with CPU and terminal strips
- the plastic casing with an interface board
- the power supply unit.

The electrical connections between the modules are made by an interface board screwed into the casing. The main board is pushed into rear slot 1 and locked. It holds a 10-pin and a 14-pin terminal strip to which all inputs and outputs of the standard controller are connected. Five other slots can be equipped with option modules if the number of terminals to the process available in the standard controller are not sufficient for the planned task.

The standard controller always has three permanently installed analog inputs (AE) with electronic potential isolation which can be wired alternatively with standardized voltage signals (0/0.2 to 1 V or 0/2 to 10 V) or current signals (0/4 to 20 mA). There are also four digital inputs (BE, 0/24 V) and eight digital outputs (BA, 0/24 V, 50 mA) which can be used for different functions depending on the configuration.

The SIPART DR22 also has three analog outputs (AA) which can all supply a current signal from 0 to 20 mA or 4 to 20 mA and be assigned to different variables.
A short-circuit-proof L+–output (DC 24 V, 100 mA) is available for supplying transmitters.

The power supply unit is located in a fully enclosed metal casing and is screwed tightly to the plastic casing of the controller. This power supply is available in two different versions so that two types of SIPART DR22 are available:

6DR2210-4 for power supply connection UC 24 V
6DR2210-5 for power supply connection AC 230 V, switchable to AC 115 V

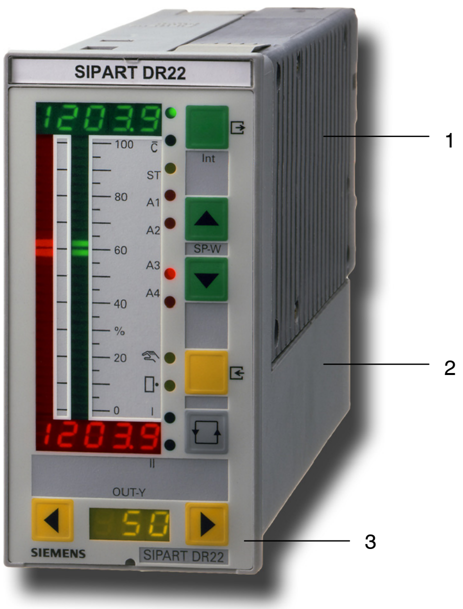
Many applications can be implemented with the three permanently available analog inputs of the standard controller alone. Two additional input modules can be inserted in slots 2 and 3 for complex jobs or for the connection of other input signals. These input modules are available in addition to for processing normalized current and voltage signals for the direct connection of resistance thermometers Pt100 and all common thermocouples and resistance sensors or potentiometers. In addition a module with 3 analog inputs (equipment as in the standard controller) can be inserted in slots 5 and 6. This increases the number of inputs to a total of 11.

Slot 4 serves to accommodate an interface module (SES) with V.28-point-pointoutput or SIPART bus interface for serial communication with a master system. A PROFIBUS interface module can be equipped optionally here.

The slots 5 and 6 can accommodate signal convertors of different functions and can be equipped optionally with modules for expanding digital inputs or digital outputs.

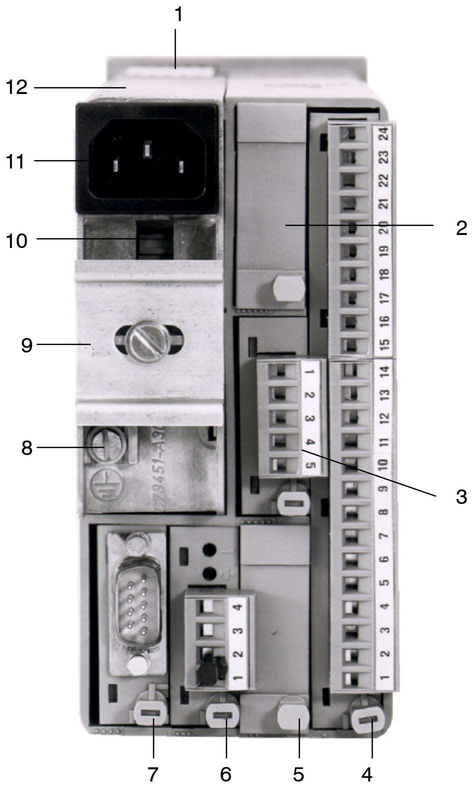
The following assemblies are possible:

2 relays
4 digital outputs/2 digital inputs
5 digital inputs
3 analog outputs/3 digital inputs
1 analog output with digital fault output (y_{hold}function) with remote supply
3 analog inputs



1 Power supply unit
2 Casing
3 Front module

Figure 1-1 Front view of the SIPART DR22



Legend:
1 PE conductor – contact spring
2 Slot 6
3 Slot 5
4 Slot 1 (basic board)
5 Slot 2
6 Slot 3
7 Slot 4 (SES: RS 232/ RS 485, Profibus DP)
8 Grounding screw
9 DIN rail (delivered with the interface relay)
10 Selector switch Mains voltage
11 Mains plug
12 Power supply unit

Figure 1-2 Rear view of the SIPART DR22

1.4 Function principle

1.4.1 Standard controller

The standard controller consists of three function blocks:

- Power supply unit
- Front module
- Main board

Power supply unit

Primary clocked power supply plug with high efficiency for AC 115/230 V (switchable) or for UC 24 V. It generates the secondary internal supply voltages +24 V and +5 V from the power supply. The metal body is mounted on PE conductors (protection class I). The power supply and internal supply voltages are isolated from each other by safe separation by a protective shield. The internal supply voltages are functional extra-low voltages due to overvoltage cutoff in the event of an error. Since no other voltages are generated in the instrument, these statements apply for all field signal cables (used standards, see chapter 1.6, page 127). A total of 450 mA are available for the outputs L+, AA and BA due to the design for a high power output.

Front module

The front module contains the control and display elements and the appropriate trigger components for the displays.

All display elements are designed in LED technology which provides a longer service life and higher light density as well as a good viewing angle. The control elements are short-stroke switches with a tangible ”pressure point” and high return force.

Main board

The main board contains the field signal conditioning of the standard controller, the CPU (Central Processing Unit) and the connections (through the interface board) to the module slots.

The field signals are fed through protective circuits for external static or dynamic overvoltages and then adapted to the signal levels of the CPU by the appropriate circuits. This adaptation is performed for the analog inputs, the analog outputs and the digital outputs by modern thick-film circuits.

The microcontroller used has integrated AD- and DA converters and operates with 32k battery-backed RAM. The user-specific configuration is stored in an user program memory with a serial 4k EEPROM. When replacing the main board the user memory can be plugged from the old onto the new module. The whole CPU is designed in C-MOS technology.

A process image is generated at the start of every routine. The analog and digital inputs and actuation of the front buttons is included and the process variables received from the serial interface are accepted. All calculations are made with these input signals according to the configured functions. Then the data are output to the display elements, the analog outputs and the digital outputs as well as storage of the calculated variables on standby for the serial interface transmitter. The interface traffic runs in interrupt mode.

A large number of prepared functions for controlling processing plants as well as machines and apparatus is stored in the set value memory of the SIPART DR22. The user programs the instrument himself by selecting the desired functions by setting structure switches. The total functioning of the instrument is given by the combination of the individual structure switches. Programming knowledge is not necessary for the settings. All settings are made without an additional programming unit exclusively through the front panel of the SIPART DR22 or through the serial interface. The job-specific program written in this way is saved in the non-volatile user program memory.

1.4.2 Description of the option modules

The following option modules are described in this chapter

6DR2800-8A	Module with 3 AE, U- or I-input
6DR2800-8J	I/U module
6DR2800-8R	R module
6DR2800-8V	UNI module
6DR2805-8A	Reference junction terminal
6DR2805-8J	Measuring range for TC, internal connector
6DR2801-8D	Module with 2 BA (relays)
6DR2801-8E	Module with 2 BE and 4 BA
6DR2801-8C	Module with 5 BE
6DR2802-8A	Analog output module with y-hold function
6DR2802-8B	Module with 3AA and 3BE
6DR2803-8P	Serial interface PROFIBUS-DP
6DR2803-8C	Serial interface RS 232 / RS 485
6DR2804-8A	Module with 4 BA relays
6DR2804-8B	Module with 2 BA relays

6DR2800-8A Module with 3 AE, U- or I-input

- Inputs for current and voltage

To expand the analog inputs.
For a description of the module and technical data, see chapter 1.6.2, page 129 (Inputs standard controller).

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 input amplifier of the module is designed as a differentiating amplifier with jumperable 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. At voltage inputs this circuit technique makes it possible to suppress the voltage dips on the ground rail by two−pole wiring on non floating voltage supplies. We refer to an electronic potential isolation.

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. Resistances are switched parallel to the potentiometer by a slide switch on the module and a rough range selection made. Range start and end are set with the two adjusting pots on the back of the module.

This fine adjustment can be made by the displays on the front module (with the appropriate structuring). 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 potentiometers 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 of 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 HdeF level (AE4/AE5); the range and the other parameters are set in the CAE4/CAE5 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 terminals. When using thermocouples with internal reference junction terminal, this terminal block must be replaced by the terminal 6DR2805-8A. With the measuring for TC, internal connector 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 up to 10 V or 0/4 up 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.

6DR2805-8A reference junction terminal

- Terminal with internal reference junction terminal for thermocouples

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

6DR2805-8J measuring for TC, internal connector

- measuring for TC, internal connector for current 0/4 to 20 mA or voltage 0/2 to 10 V

The measuring for TC, internal connector is used in connection with the UNI module to measure current orvoltage. The input variable is reduced to 0/20 to 100 mV by a voltage divider or shunt resistors in the measuring for TC, internal connector.

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 for TC, internal connector is used.

6DR2801-8D Module with 2 BA 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.

WARNING

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 Module with 2 BE and 4 BA

- Digital signal module with 2 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 for the 24 V logic and are non-floating. The functions are assigned to the inputs and outputs by the configuration of the controller.

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

6DR2801-8C Module with 5 BE

- 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 for the 24 V logic and are non-floating. The function is assigned to the input by the configuration of the controller.

6DR2802-8A Analog output module with y-hold function

For auxiliary control device function when servicing and for extending the analog outputs AA1 to AA3 existing in the standard controller.

Can be inserted in slot 5/6, S22/S23=4 to be set in the structure mode StrS,
Start value of the outputs S72/S249 can be set in StrS.

The y_{hold}module contains a microprocessor which maintains serial data communication with the processor on the main board through the Rxd/Txd lines. The processor feeds the U/I converter and the CPU fault message output $\overline{\text{St}}$ through its analog output. The module can be externally supplied through an auxiliary voltage input which is OR−linked with the controller power supply. The analog output of the module is freely available.

– **y_{hold}-function**

  If data communication to the y_{hold} processor is interrupted, the analog output receives its last value. The processor reads the current variable first when data traffic is recovered. The output current is maintained if:

- the self diagnostics of the CPU (see chapter 1.4.3, page 20) responds.
- the supply voltage of the SIPART DR22 fails and the y_{hold}-module is powered externally.
- all modules except the power supply unit are removed (if the y_{hold} module is powered externally).
- the y_{hold} module is removed (Attention: electrostatically sensitive module! Observe the safety precautions!), if it is powered externally (error message on the front module oP. *.6 Err/oP.*.5, see chapter 5, page 227). *.6 Err/oP.*.5, see chapter 5).

In this way it is possible to perform all maintenance work right up to replacing the instrument whilst maintaining the controller controlled variable.
Handling during module replacement, see chapter 5 ”Maintenance”.

- **$\overline{\text{St}}$ Fault message output**

  This digital output is always high when there is no error and becomes low in the event of an error. It responds when:

  - the self diagnostics of the CPU (see chapter 1.4.3, page 20) responds.
  - the controller power supply fails,
  - the Y_{hold} module is removed,
  - the main board is removed.

6DR2802-8B Module with 3AA and 3BE

To extend the analog outputs (0/4 to 20 mA) and digital inputs

can be inserted	in slot 5:	AA7, AA8, AA9	BE5, BE6, BE7
and	in slot 6:	AA4, AA5, AA6	BE10, BE11, BE12

6DR2803-8P Serial interface PROFIBUS-DP

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

This optional card can be inserted in all SIPART-DR controllers in slot 4. The following settings must be made with the appropriate configurations for the serial interface:

- Interface on
- Even parity
- LRC without
- Baud rate 9600
- Parameters/process values writable (as desired)
- Station number according to selection 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 configuring 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 writes process data to the slave, these become active after a maximum 1 controller cycle.

The description and the controller base file (*.GSD) can be downloaded from Internet under www.fielddevices.com.

A technical description including the controller base file (*.GSD) is available for creating a master-slave linking software for interpreting the identifications and useful data from and to the SIPART controller.

The programs SIPART S5 DP and S7 DP are offered for certain hardware configurations.

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

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

Can be inserted in slot 4.

For connecting the controller SIPART DR22 to a master system for control and monitoring. All process variables can be sent, the external setpoint, tracking variable, operating modes, parameters and configurations sent and received.

The interface traffic can take place as follows:

RS 232	as point-to-point connection
SIPART Bus	The SIPART bus is no longer available. Therefore please implement multipoint connections 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 can be performed between RS 232, SIPART bus and RS 485 with a plug-in bridge.

A detailed technical description of the telegram traffic is available for creating an interface software.

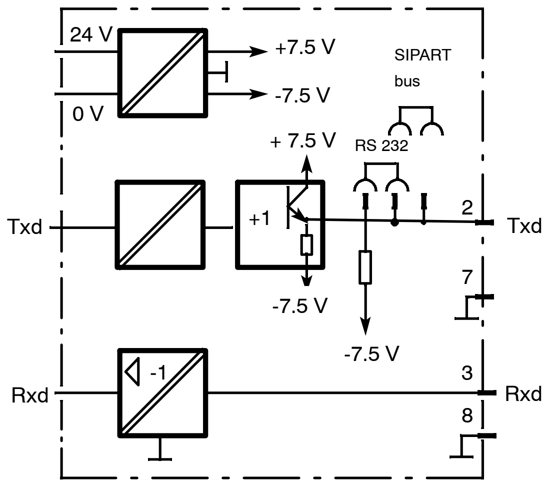


Figure 1-3 Block diagram serial interface for RS 232 / SIPART BUS

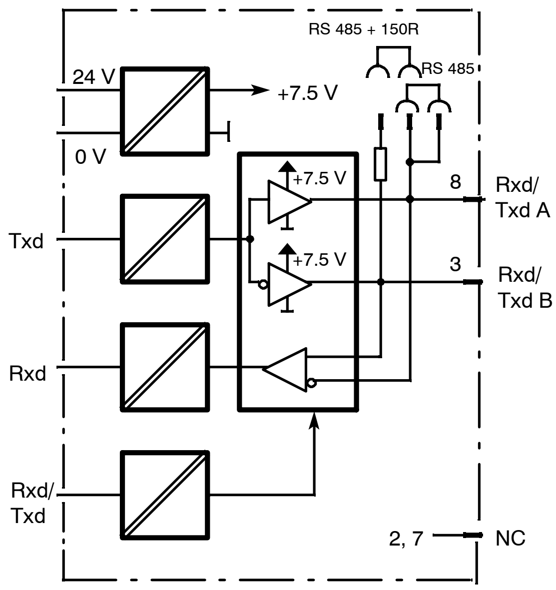


Figure 1-4 Block diagram serial interface for RS 485

6DR2804-8A Module with 4 BA relays
6DR2804-8B Module with 2 BA relays

- Interface relay module with 2 or 4 relays

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

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

One or two relay modules with 2 relays each are installed depending on the version. 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 fed to the plug terminals with 3 poles so that rest and working circuits can be switched. The relays can be controlled directly from the controller’s digital outputs by external wiring.

WARNING

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 twice 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.

1.4.3 CPU self-diagnostics

The CPU runs safety diagnostics routines which either can only after a reset or cyclically. The CPU is familiar with two different types of reset.

- **Power on reset**

  Power-On-Reset always takes 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 configurations are reloaded from the user program memory into the RAM.

  At S100 = 1 the digital x-display flashes as indication after a Power-On-Reset, it is acknowledged by the Shift key (12).

  Flashing is suppressed by S100 = 0.

- **Watch dog reset**

  When a watch-dog-reset occurs the parameters and configurations from the user program memory are reloaded into the RAM. The current process variables and the status signals are read out of the RAM for further processing.
  There are no flashing signals on the front module.

CPU-tESt appears in the digital displays dd1 and dd2 for a maximum 5 s after every reset. Every error detected by the self-diagnostics leads to a flashing error message on the digital displays dd1 and dd2 with defined states of the analog and digital outputs. The fault message output $\overline{St}$ of the y_{hold}module becomes low. The reactions listed in the table are only possible of course (since this is a self-test) if the errors occur in such a way that the appropriate outputs or the front module can still be controlled properly or the outputs themselves are still functioning.

There are other error messages for the input range which indicate defective structurings within this range (see chapter 1.5.6 ”Error messages”, page 99).
In addition error messages are output in the adaptation (see chapter 3.3.2 ”Parameterization mode AdAP”, page 173).

The digital displays flash in the case of error messages.

1.4.4 Data storage, User program memory

All data are written in the RAM first and then transfered to the user program memory (EEPROM) when returning to the process operation mode (manually or via the SES).

Writing time

The writing time after leaving the parameterization and configuring modes is up to 30 s. Then the data are stored in a non-volatile memory.

Error messages of the CPU

<table>
<tr><th rowspan="3">Error messages dd1 dd2</th><th rowspan="3">Monitoring of</th><th rowspan="3">Monitoring time</th><th colspan="7">Reactions</th><th rowspan="3">Primary Error cause/ Remedy</th></tr>
<tr><td colspan="3">y_{hold}-module</td><td colspan="2">Standard controller</td><td colspan="2">Options 2)</td></tr>
<tr><td>St</td><td>AA4/7 with U_H</td><td>AA4/7 without U_H</td><td>AA1 to 3</td><td>BA1 to 8</td><td>BA9 to 12</td><td>BA13 to 16</td></tr>
<tr><td rowspan="2">CPU Err</td><td rowspan="2">EEPROM, RAM EPROM</td><td>Power On-Reset</td><td rowspan="2">0</td><td rowspan="2">last value</td><td>0 mA</td><td rowspan="2">0 mA</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td>Monitored components of the CPU defective/change main board</td></tr>
<tr><td>Watch Dog-Reset</td><td>last value</td><td>User program memory not plugged or defective/plug or change</td></tr>
<tr><td rowspan="3">MEM Err</td><td rowspan="3">User program memory</td><td>Power On-Reset</td><td rowspan="3">0</td><td rowspan="2">last value</td><td>0 mA</td><td rowspan="2">0 mA</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td>Monitored components of the CPU defective/change main board</td></tr>
<tr><td>Watch Dog-Reset</td><td>last value</td><td rowspan="2">User program memory not plugged or defective/plug or change</td></tr>
<tr><td>when storing</td><td colspan="4" rowspan="2">continues operating with current data</td><td colspan="2">continues operating with current data</td></tr>
<tr><td>oP.5.*. 1)</td><td>Data communication µP-slot 5</td><td>cyclic</td><td>0</td><td>last state or undefined</td><td>continues operating with current data</td><td>Option not plugged, defective or setting in hdEF oP5 does not match the plugged option.
Plug option or replace or correct oP5 3)</td></tr>
<tr><td rowspan="2">oP.*.6. 1)</td><td rowspan="2">Data communication µP-slot 6</td><td rowspan="2">cyclic</td><td rowspan="2">0</td><td>pulled last value</td><td>pulled 0 mA</td><td colspan="2" rowspan="2">continues operating with current data</td><td rowspan="2">continues operating with current data</td><td rowspan="2">last state or undefined</td><td rowspan="2">Option not plugged, defective or setting in hdEF oP5 does not match the plugged option.
Plug option or replace or correct oP6 3)</td></tr>
<tr><td colspan="2">defective, undefined</td></tr>
</table>

1) Also double error display oP.5.6 possible,
* means digit dark.
2) At BE5 to 9 and BE10 to 14 the effect of the digital inputs (after inversion) are set to 0 in the event of an error.

Table 1-1 Error message of the CPU

1.5 Functional description of the structure switches

(S0 to S107, S200 to S268)

In the factory setting (setting when the device is delivered) most of the structure switches are set to 0. This corresponds to the most usual setting of the individual functions so that only few structure switches need to be set selectively during commissioning. However, it is recommendable to compare the individual structure switch settings with the task.

With structure switch S0 the user program can be identified by a number from 1 to 254 in the structuring mode Strs. The setting 0 corresponds to the factory setting and is regenerated automatically in the APSt function (All Preset). All changes in parameters or structures in relation to the factory setting automatically set S0 from 0 to 1.

The structure switches S1 and S2 are fundamentally significant. 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 follow–up variables as well as the manipulated variable output determined as a K- or S-output.

1.5.1 Analog input signal processing permanently connected

(S3 to S21, S200 to 205)

In the structure switch setting S4=0 the analog input range is permanently connected (see figure 1-5, page 24). With S4=1 the permanent connection is canceled and converted into a freely connectable input range (see chapter 1.5.2, page 25).

Every one of the maximum 11 analog inputs is fed through an AD converter which performs the 50 or 60 Hz interference suppression by averaging over 20 or 16 2/3 ms. After this the signal range 0 to 20 mA or 4 to 20 mA is normalized to 0 to 100% calculated value per channel with S5 to S9 or S200 to S205.

At the same time it is decided with S5 to S9 or S200 to S205 whether operation is to take place with or without range monitoring (transmitter fault). The monitor signals per channel on dropping below −2.5 % or exceeding +106.25 % with a hysteresis of 0.25 % to the digital x and w 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 chapter 1.5.8, page 121). 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 appropriate analog inputs are back in the working range.

After the range monitoring the 11 analog inputs are fed through a 1st order filter which can be set by the parameters tF1 to tFb in the range of oFF, 0.1 to 1000 s in the parameterization mode onPA. The factory setting is 1 s.

With S10 to S14 or S206 to S211 every channel can now be root extracted optionally. After root extraction, the 11 analog inputs are available for further processing as AEA1 to AEbA.

The function inputs FE1 and FE3 are preceded by a linearizer which enables non-linear process variables to be displayed physically correctly (for operating method see chapter 1.5.2, page 25) function block Fu, setting of the 13 vertex values, see chapter 1.5.4, figure 1-19, page 45 to figure 1-23, page 46).

The outputs of the analog inputs AE1A to AEbA are now assigned to the function inputs FE1 to FE12 by the structure switches S15 to S19 or S212 to S217. The outputs AE1A to AEbA and the function inputs FE1 to FE12 are available for the assignment to analog outputs, the limit value alarm and the parameter control and can be read through the SES. With this input structure most control tasks can be solved in connection with the different controller types and controller output structures.

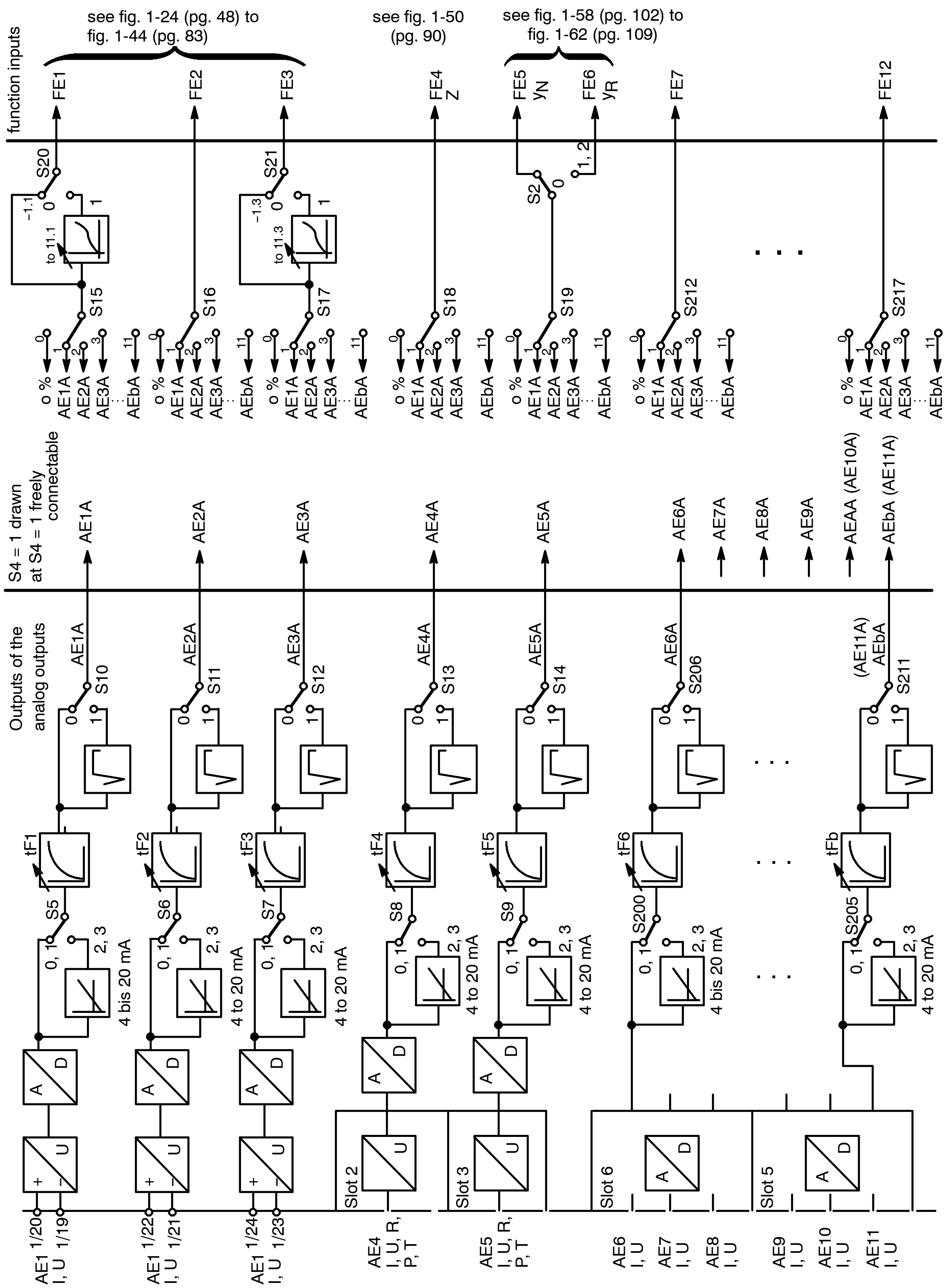


Figure 1-5 Analog input signal processing permanently connected (S4 = 0)

1.5.2 Analog input signal processing freely connected (S4 = 1)

The structure switch setting S4=1 cancels the permanent connection at S4=0 in the analog input range and replaces it with a freely connectable input range. The freely connectable input range basically represents a multifunctional unit, configuring takes place according to the same rules.

Up to the outputs AE1A to AEbA (AE11A), the signal processing is identical to that described in chapter 1.5.1, page 22. The function inputs FE1 to FE12 also operate in the same way with the difference that FE5 (follow-up input) and FE6 (position feedback input) can be used in parallel and with the difference that FE5 (follow–up input) and FE6 (position feedback input) can be used in parallel and connected with different signals.

Nine different function blocks which occur with different frequency can now be connected absolutely freely between the outputs AE1A to AEbA and the function inputs FE1 to FE12. The outputs AE1A to AEbA represent data sources whilst the function inputs FE1 to FE12 are data sources. Parallel to the outputs, 15 connectable linear parameters are arranged with a setting range of -1.999 to 19.999 (corresponding to -199.9 % to 1999.9 %), a number of normal constants as well as other variables gained from the controller as data source.

The function blocks have a different number of inputs (data sinks) and 1 output each (data source) depending on the function depth.

The function blocks ”function transmitter” and ”correction computer” have assigned parameters which can be set in the structuring mode oFPA. The connectable parameters P1 to P15 are set in the parameterization mode onPA.

By structuring on the front module the necessary functions are selected or defined (structuring mode FdEF), connected (structuring mode FCon) and correctly positioned in time in the cycle (structuring mode FPoS), see chapter 3.3.7, page 201 to 3.3.9, page 205. Connection is absolutely free, i.e. any data source can be connected with any data sink. The operating effort is minimized by fading the data sources and sinks from undefined function blocks. In addition the data sinks which are not obliagatory for a function are pre–occupied by constants which can be overwritten. The inputs pre–occupied with ncon (not connected) are absolutely essential for the function and must be connected. This very variable connection facility in the analog input range also enables complex control tasks to be solved.

No distinction is made between analog and digital signals. Digital inputs have a threshold value of 0.5. Digital outputs supply a value of 0 % (0) or 100 % (1).

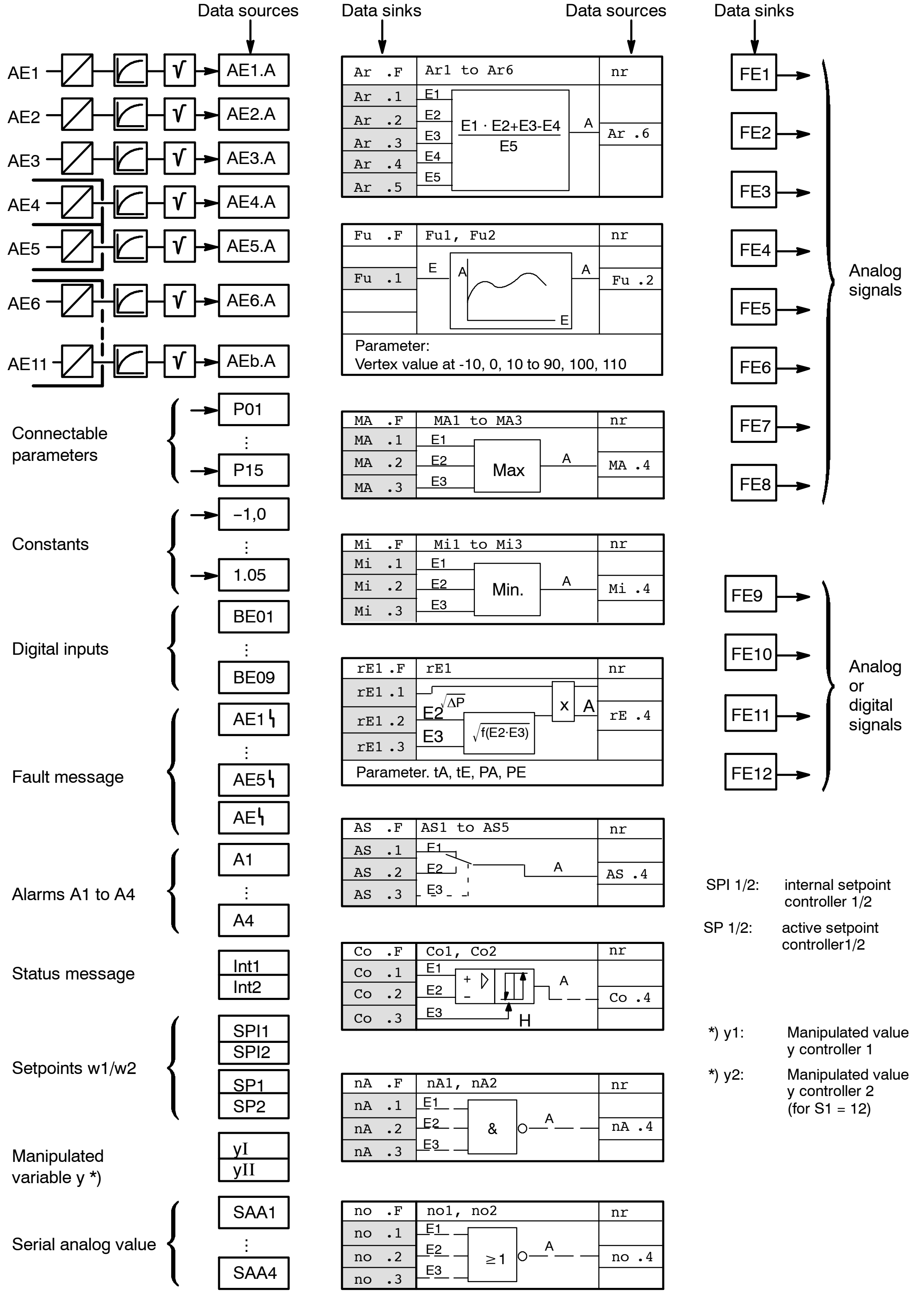
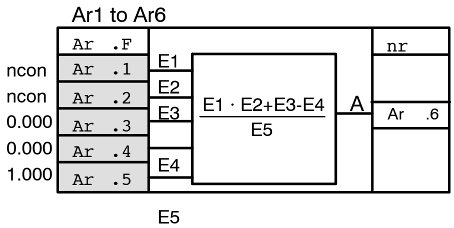


Figure 1-6 Analog input signal processing freely connectable (S4=1)

The individual function blocks are described below.

1.5.2.1 Arithmetic Ar1 to Ar6



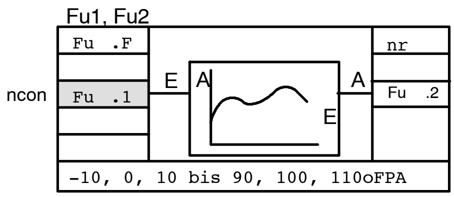
$$A = \frac{E1 \cdot E2 + E3 - E4}{E5}$$

E5 is limited to values ≥ 0.5 %.

Figure 1-7 Function block Arithmetic Ar1 to Ar6

- With this function block the four basic arithmetic functions are implemented with appropriate assignment of inputs 0 and 1 respectively. The preset E3=E4=0, E5=1 gives A = E1 $\times$ E2.
- Typical process-technical applications are dosing or evaluation (E1 $\times$ E2), range fade-outs (E1 $\times$ E2+E3) or differentiations (E3 - E4).

1.5.2.2 Function transmitter Fu1 and Fu2

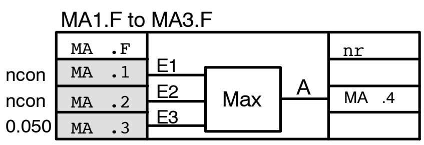


A = f(E)

Figure 1-8 Function block function transmitter

The function transmitter assigns every value of the input variable E in the range from -10 % to +110 % an output variable A in the range from -199,9 % to +199,9 % with the function entered by the user: A = f(E). The function is entered by the parameters ”vertex value 1 to 13” for -10 % to +110 % of E in intervals of 10 %. Parabolae are set by the computing program between these vertex values which interlink tangentially the vertex values so that a constant function is produced. The vertex values at -10 % and +110 % of E are required for the overflow. The last rise remains constant in the case of further overmodulation of E. When used as a linearizer for the displays, the linearization function is entered by the 13 vertex values so that the series circuiting of the sensor function gives a linear equation with the linearization function (see chapter 1.5.4, figure 1-20 to figure 1-23, page 46).

1.5.2.3 Maximum value selection MA1 to MA3



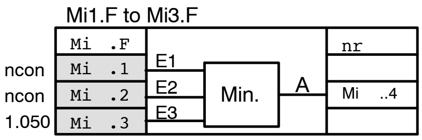
A = max (E1,E2, E3)
The greatest of the three input values is connected through to the output.

Figure 1-9 Function block maximum value selection

With the preset the greater value of E1 or E2 is connected through to A and at the same time limited to the value of E3 (-5 %). Typical applications are maximum value selection circuits and minimum value limitings.

If only 2 inputs are required, the 3rd input must be set outside the working range of the two inputs to a minimum value otherwise minimum value limiting takes place.

1.5.2.4 Minimum value selection Mi1 to Mi3

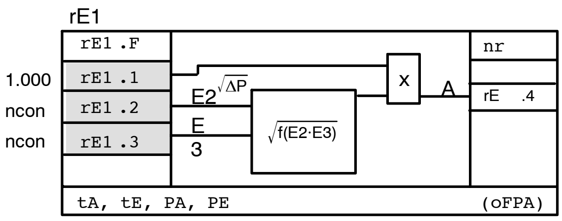


A = min (E1, E2, E3)
The smallest of the three input values is connected through to the output.

Figure 1-10 Function block minimum value selection

With the preset the smaller value of E1 or E2 is connected through to A and at the same time limited to the value of E3 (105%). Typical applications are minimum value selection circuits. If only 2 inputs are required, the 3rd input must be set outside the working range to a maximum value, otherwise a maximum value limiting takes place.

1.5.2.5 Correction computer for ideal gases rE1



$$A = \sqrt{\Delta p} \cdot \sqrt{f\,(E2,\; E3)}$$

$$f\,(E2,\; E3) = \frac{(PE - PA)\; E2 + PA}{(tE - tA)\; E3 + tA}$$

Figure 1-11 Function block correction computer rE1 for ideal gases

The rooted signal of the active pressure must be applied at input c**.1. The measuring ranges are normalized to the calculation state with the parameters PA, PE, tA, tE (correction quotients start/end for pressure and temperature).

Range of Application

The correction computer is used to calculate the flow of gases from the active pressure Δp depending on pressure and temperature. The medium must be in pure phase, i.e. so that no liquid separations may take place. This should be noted particularly for gases close to the saturation point.

Errors due to fluctuating status variables of the medium (pressure, temperature) are corrected by the flow correction computer here.

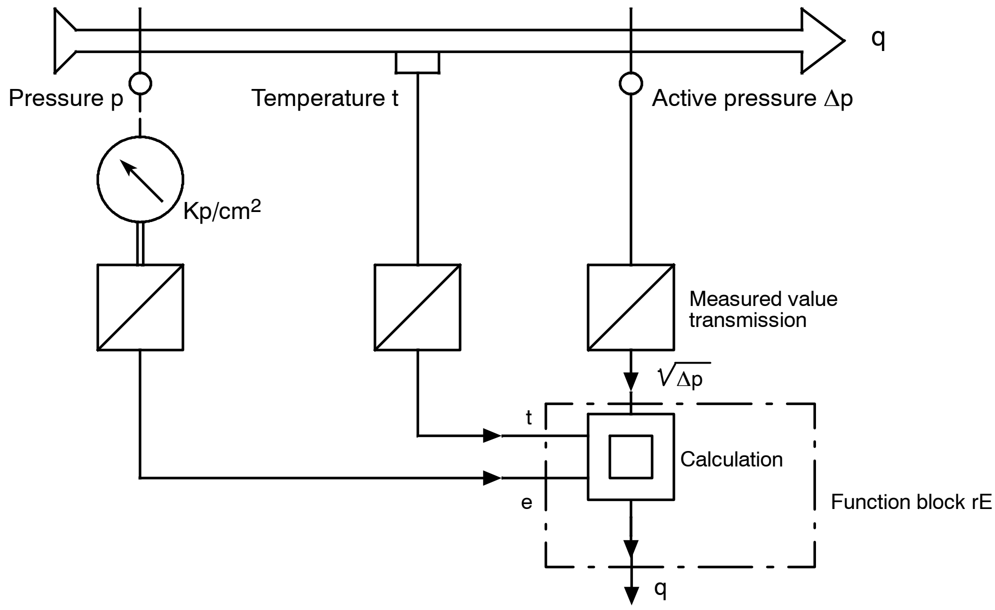


Figure 1-12 Active pressure measuring method, Principle

Physical notes

The active pressure measuring method is based on the law of continuity and Bernoulli's energy equation.
According to the law of continuity the flow of a flowing liquid in a pipe is the same at all places. If the cross-section is reduced at one point, the flow speed at this point should increase. According to Bernoulli's energy equation the energy content of a flowing material is made up of the sum of the kinetic energy (due to the speed) and the potential energy (of the pressure).
An increase in speed therefore causes a reduction in pressure.
This drop in pressure, the so-called "active pressure" Δp is a measure of the flow q.

The following applies: $q = c \cdot \sqrt{\Delta p}$

with c as a factor which depends on the dimensions of the pipe, the shape of the constriction, the density of the flowing medium and some other influences.
The equation states that the active pressure generated by the constriction is in the same ratio as the square of the flow.

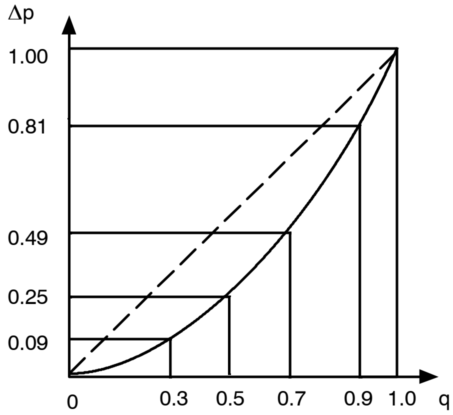


Figure 1-13 Relationship between flow q and active pressure Δp

To measure the flow, a choke is installed at the measuring point which constricts the pipe and has two connections for tapping the active pressure.
If the properties of the choke and the measuring material are known to the extent that the equation specified above can be calculated, the active pressure is a measure of the flow.

If you have chosen a certain choke, the flow can be described in the calculation state or operation state.

$$q_B = K \cdot \sqrt{\varrho_B} \cdot \sqrt{\Delta p} \text{ or } q = K \cdot \sqrt{\varrho} \cdot \sqrt{\Delta p}$$

Since the density is included in the measuring result according to the above equation, measuring errors occur when the density in the operating state differs from the value based on the calculation of the choke. Therefore a correction factor F is introduced for the density in operating condition.

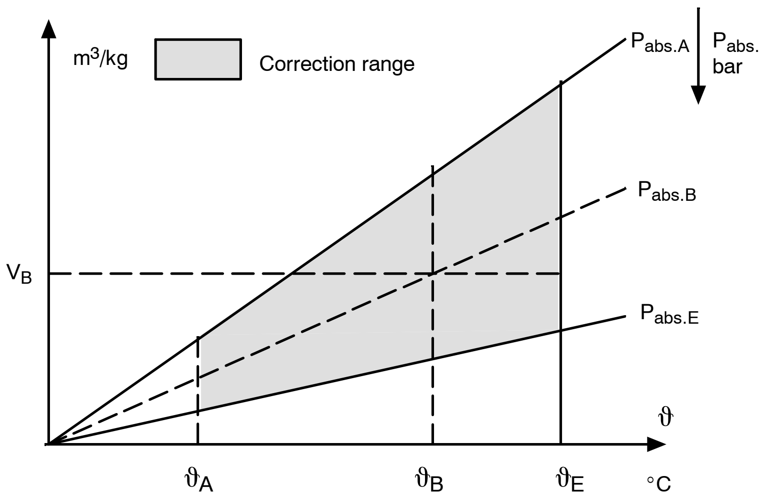
$$F = \sqrt{\frac{\varrho}{\varrho_B}} = \sqrt{\frac{V_B}{V}} \quad \text{with } V = \frac{1}{\varrho} \quad \text{as specific volume.}$$

as specific volume.

In order to be able to perform the correction with the factor F, the current specific volume must be determined first.
For the dry gases the densities change according to the laws for ideal gases:

$$V = R\frac{T}{p} = \frac{1}{\varrho}$$ The correction factor is then given as: $$F = \sqrt{\frac{T_B \cdot p}{p_B \cdot T}}$$

with p as absolute pressure and T as absolute temperature.



q	Flow
ϱ	Density
Δp	Active pressure
p	Pressure
ϑ	Temperature (°C)
T	Temperature (K)
V	Specific volume
R	Gas constant
F	Correction factor f (p, T)

Indices:

A	Start
E	End
B	Calculation state
abs	Absolute variable
m	Ground
v	Volume

$P_{abs.A}$ to $P_{abs.E}$	Range of pressure of the transmitter
ϑ_A to ϑ_E	Range of temperature of the transmitter

Figure 1-14 Display of the correction range

This gives for the corrected flow

$$q = F \cdot K \cdot \sqrt{\varrho_B} \cdot \sqrt{\Delta p} = K \cdot \sqrt{\varrho_B} \cdot \sqrt{\Delta p} \cdot \sqrt{\frac{T_B \cdot p}{P_B \cdot T}}$$

The factor contained in the formula $K \cdot \sqrt{\varrho_B}$ is already taken into account in the measurement of the active pressure and can therefore be ignored by the computer.

Related to the correction factor it follows:

$$A = \sqrt{\Delta p} \cdot \sqrt{f\,(E2,\ E3)} \text{ with } F = \sqrt{f\,(E2,\ E3)} = \sqrt{\frac{(PE - PA)\,E2 + PA}{(tE - tA)\,E3 + tA}}$$

The measuring ranges are normalized to the calculation state with the parameters PA, PE, tA, tE (correction quotients start/end for pressure and temperature).

Mass flow computer, m²

$$A = q_m,\ E2 = p,\ E3 = \vartheta$$

$$PA = \frac{P_{absA}}{P_B},\quad PE = \frac{P_{absE}}{P_B},$$

$$tA = \frac{T_A}{T_B},\qquad tE = \frac{T_E}{T_B} \text{ with } T_{A/E/B}\ [K]$$

Volume flow computer related to the operating status q_V

Since the volume is reciprocally proportional to the density, a volume flow computer can be made out of this mass flow computer by changing the inputs E2 and E3.

$A = q_v,\ E2 = \vartheta,\ E3 = p$

$PA = \frac{T_A}{T_B}, \quad PE = \frac{T_E}{T_B}$ with $T_{A/E/B}$ [K],

$tA = \frac{P_{absA}}{P_B}, \quad tE = \frac{P_{absE}}{P_B}$

Volume flow computer related to the standard status q_{VN}

Since the output signal is now related to the volume flow in the standard status, T_N = 273. 15 K, P_N = 1.01325 bar_{abs} and no longer to the operating state, it must be corrected accordingly.

$A = q_{VN},\ E2 = p,\ E3 = \vartheta$

$tA = \frac{T_A}{T_B}, \quad tE = \frac{T_E}{T_B}$ with $T_{A/E/B}$ [K],

$PA = \frac{P_{absA}}{P_B}, \quad PE = \frac{P_{absE}}{P_B}$

The following applies for all computers:

p_{absA} to p_{absE}	Transmitter range absolute pressure (bar)
T_A to T_E	Transmitter range absolute temperature (K) is formed from the transmitter range ϑ_A to ϑ_E by conversion: T(K) = 273, 15 + ϑ (°C)
p_B, T_B	Pressure and temperature range of the calculation state of the measuring panel (absolute values)

p_B and T_B must be within the range of the transmitter; and may not be more than the factor 100 away from the range limits.

PA, tA = 0.01 to 1

PE, tE = 1 to 99.99

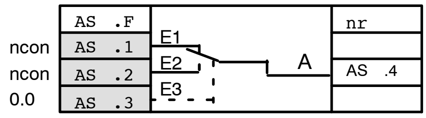
The input rE1.1$\sqrt{\Delta p}$ is limited to values ≥ 0.

If the adjustable ranges for PA, PE, tA, tE are not sufficient a linear equation can be switched in front of the appropriate input for adaptation (function block Ar).

1.5.2.6 Switch for analog variables AS1 to AS5

E3	A
0 (<0,5)	E1
1 (≥0,5)	E2

AS1.F to AS5.F

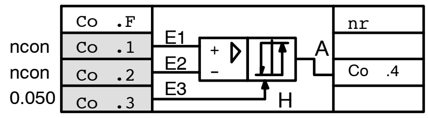


1.5.2.7 Comparator with adjustable hysteresis Co1, Co2

(two-position switch, e.g. limit value sensor)

Inputs	Output A
E1 ≥ (E2 + H/2)	1 H = ∣E3∣ = hysteresis)
E1 < (E2 − H/2)	0

Co1.F to Co2.F

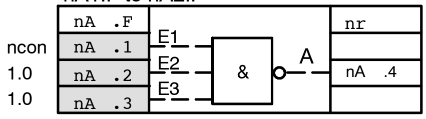


1.5.2.8 AND NOT function (NAND) nA1, nA2

$A = \overline{E1 \wedge E2 \wedge E3} = \overline{E1} \vee \overline{E2} \vee \overline{E3}$
with default: A = E1 (Negation of E1)

E1	E2	E3	A
0	0	0	1
1	0	0	1
0	1	0	1
1	1	0	1
0	0	1	1
1	0	1	1
0	1	1	1
1	1	1	0

nA1.F to nA2.F

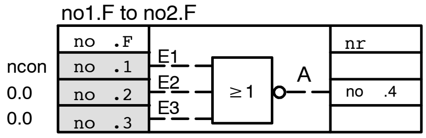


1.5.2.9 OR NOT function (NOR) no1, no2

$A = \overline{E1 \vee E2 \vee E3} = \overline{E1} \wedge \overline{E2} \wedge \overline{E3}$
with default: $A = \overline{E1}$ (Negation of E1)

E1	E2	E3	A
0	0	0	1
1	0	0	0
0	1	0	0
1	1	0	0
0	0	1	0
1	0	1	0
0	1	1	0
1	1	1	0

no1.F to no2.F



1.5.3 Digital input signal processing

(S24 to S48, S219 to S230)

1.5.3.1 Digital inputs BE1 to BE14

The inputs BE1 to BE4 are located on the basic board. BE5 to 9 and 10 to 14 are connected to the module 6DR2801-8C at the slots 5 or 6. The digital output modules 6DR2801-8E also contain another two digital inputs in addition to the outputs so that in this case the two digital inputs BE5/BE6 or BE10/BE11 can be used.

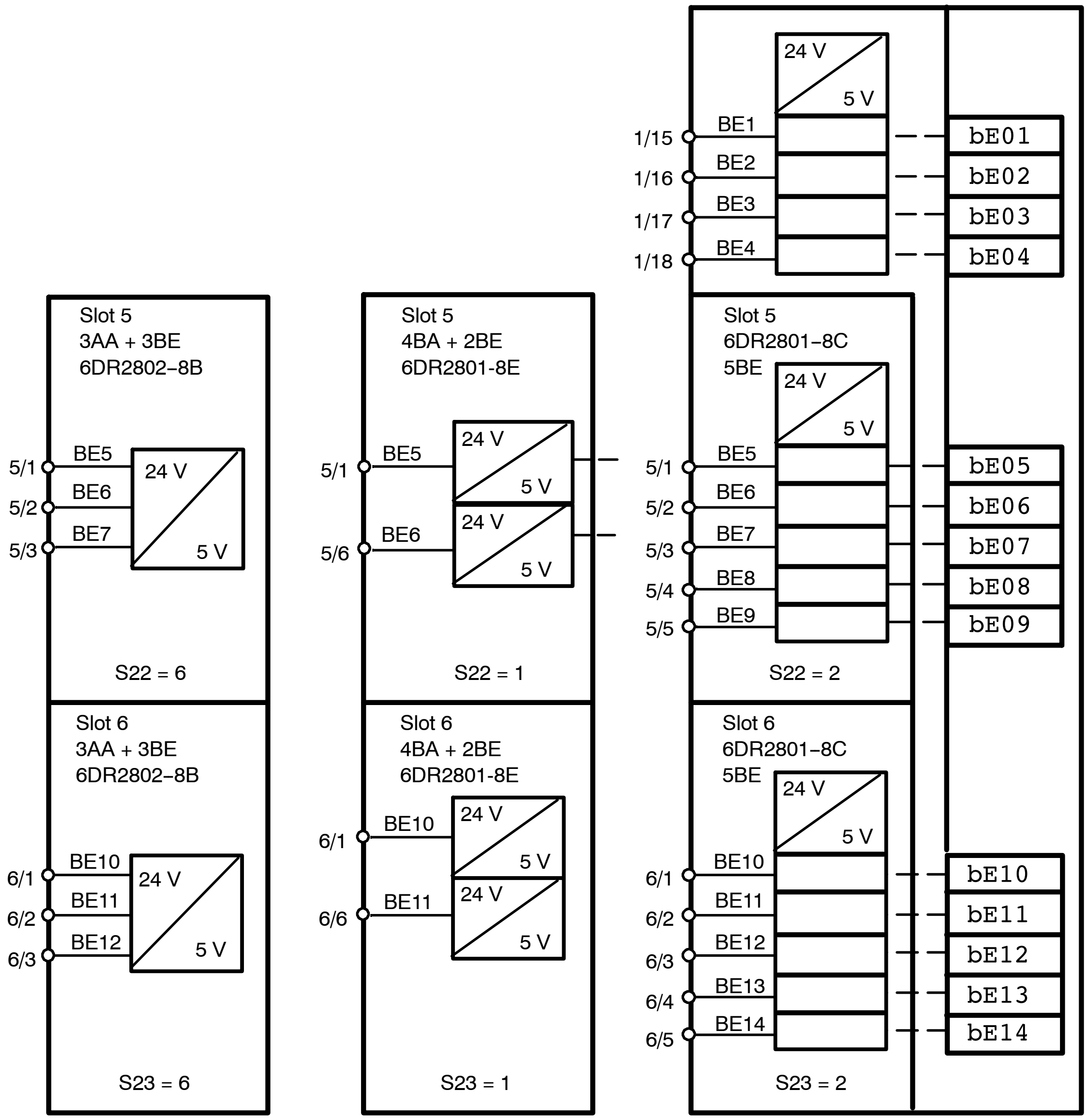


Figure 1-15 Input function digital inputs

1.5.3.2 Assignment and direction of effect of the digital inputs

see fig. 1-16, page 37
The control signals CB, He ...+yBLII, -yBLII are assigned by the structure switches S24 to S38 and S219 to S228 to the digital inputs BE1 to BE14 or the status Lo. In the assignment of CB (S24), CBII (S219), PI (S30), PII (S31), wSLI (S225) and wSLII (S226) the High status (S** = −1) is also possible. The control signals can be negated optionally by the structure switches S39 to S46 and S229 to S230.

The digital inputs BE1 to BE4 of the standard controller can be extended with the option modules 6DR2801-8C, 6DR2801-8E, 6DR2802-8B in slot 5 and in slot 6.

When using option modules in slots 5 and 6 the structure switches S22 and S23 must be set according to the assembly, otherwise it will lead to error messages (see chapter 1.4.3, page 20). All digital inputs can be read by the SES.

1.5.3.3 Linking the digital inputs BE1 bis BE14 to the control signals via the SES (S47 to S49, S101)

see fig. 1-17, page 38
The control signals CB and N may be available optionally as static signals or as a pulse (key operation on consoles) at the digital inputs. The setting is made by S47 for CB and S48 for N. On selecting the pulse input, every positive edge flips the flip-flop. In the following descriptions the output status of the flip−flop is assumed as CB or N.

All control signals except $\pm\Delta w$ and $\pm\Delta y$ can also be preset by the SES at S101 = 2, 3, 4, 5 and OR linked with the appropriate control signals through the digital inputs. The incremental adjustment of w or y by the SES is not advisable on account of the bus run times. Since the top operation hierarchy in a computer link should be with the autarcic single controller, the control signals can be switched off by the SES by rounding with $RC = \overline{Int} \wedge CB$ via the Internal/External key (2) of the controller or via CB_{ES} (optionally time-monitored) or via CB_{BE} (central Computer Fail line).

In addition the internal flip-flop can be activated at S101 = 2 to 5 parallel to pressing the keys via Int_{ES}.

The CB signal is formed at S101 = 2, 4 as an OR function of CB_{ES} via the serial interface and CB_{BE} via a digital input so that operation can take place optionally with one signal.

At S101 = 3, 5 the OR function is replaced by an AND function so that the CB set by the SES can be reset via a central Computer Fail line.

The function $RC = \overline{Int} \wedge CB$ (computer operation) also controls the command variable switching in all controller types, i.e. also in SPC-mode or manipulated variable switching in DDC mode (see chapter 1.5.4, page 40). The two controller types S1 = 10/11 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 coupling to control systems).

At S47 = 0 static switching takes place due to the logic function $RC = \overline{Int} \wedge CB$. In the case of the preset to $\overline{Int}$ (Internal LED (1) off) you can switch statically with CB between controller values and computer values (command and manipulated variables). The computer standby CB is displayed negated by the $\overline{C}$-LED (3) ($\overline{C}$ = CB, CB = 1 = $\overline{C}$ LED off). The computer standby of the controller is signaled negated as a message signal $\overline{RB}$ = Int. The computer mode is also signaled negated as a message signal $\overline{RC} = \overline{\overline{Int} \wedge CB}$.

At S47 = 1 static switching with acknowledgement takes place. Every time the computer is recovered (CB from 0 → 1) the internal flip–flop is set to 1 (Internal LED on, $\overline{C}$ LED off) so that the computer mode $RC = Int \wedge \overline{CB}$ only becomes active after pressing the Internal key (Int=0). With S49 the Internal/External key can be switched out of function and only internal or external operation preselected.

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 S64 Automatic-/Manual switching can be blocked in the positions only Automatic (H = 0) or only Manual (H = 1). The Manual LED (8) always indicates the active status (see also chapter 1.5.6, page 99).

At S64 = 0 to 2, He is connected statically by both the SES and the digital inputs. At S64 = 3/4 the connection is made dynamically, i.e. every positive edge causes manual-automatic-manual opeeration switching. Additionally interlocking of He_{ES} with $\overline{RC} = Int \vee \overline{CB}$ is canceled at structure switch S64 = 4.

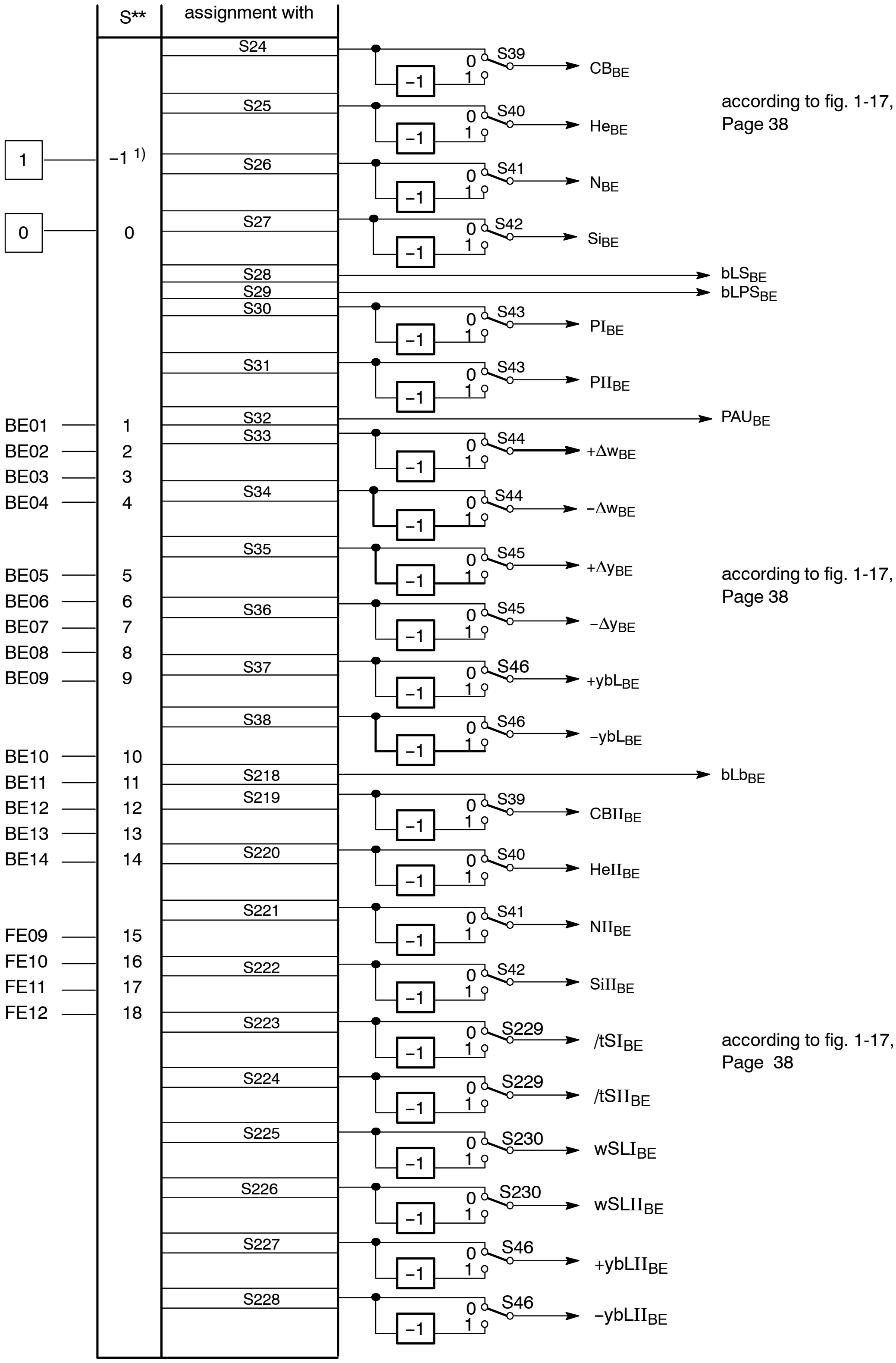
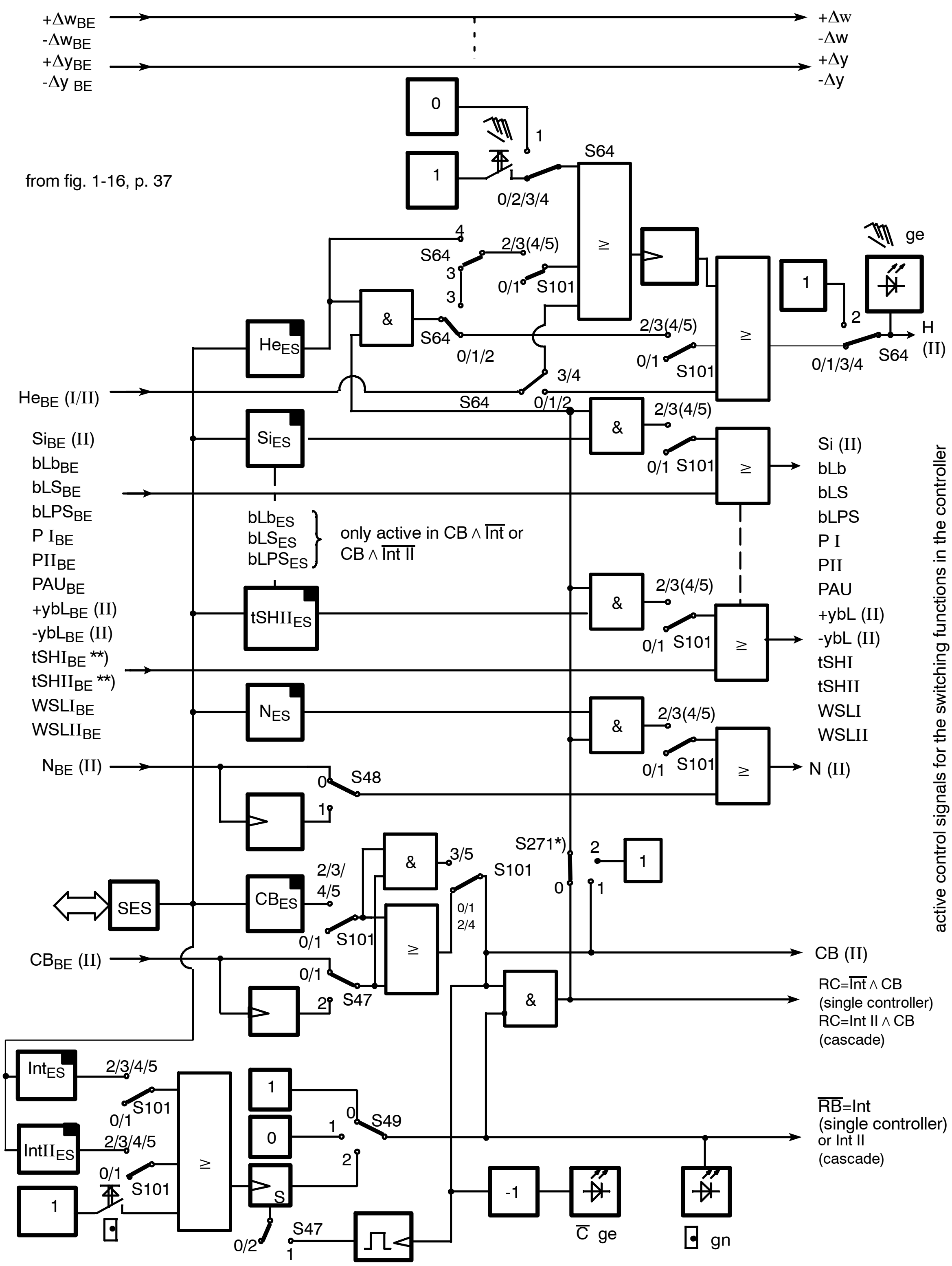


Figure 1-16 Assignment and direction of effect S24 to S38 and S218 to S228



*) as of software version –D06 **) as of software version –C09

Figure 1-17 Linking the digital inputs BE1 to BE14 with the control signals via the SES (S47, S48, S49, S101)

1.5.3.4 Functional explanation of the digital control signals

bLb
Blocking operation
Blocking the entire device operation and configuring.
Exception: Display of circuit

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 the adaptation can be selected. Structuring is blocked.

bLPS
Blocking parameterization and structuring
The entire configuring of the device 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 effects either switching in the setpoint range or DDC operation begins. Central computer fail line in SPC and DDC operation.

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
Follow-up
With this signal the output of the K–controller and the three-position step controller with external position feedback is followed up to the follow-up signal y_N.

Si
Safety operation
In K-controllers and three-position step controllers with external position feedback, the manipulated variable adopts the parameterized safety value. In three-position step controllers with internal position simulation, the manipulated variable runs defined to 0 or 100 %.

tSHI/II
Setpoint ramp/Setpoint changes
Setpoint changes via the setpoint ramp can be stopped by a binary input.

w_{SL}I/II
External setpoint – preselection
Preselect whether external setpoint via analog input or SES/incremental.

PI
P-operation controller I
With this signal the controller I (parameter set I) is switched to P-operation.

PII
P-operation controller II
With this signal the controller II (parameter set II) is switched to P-operation.

PAU
Parameter switching
The programmable controller types include single controllers and double controllers (meshed controllers). Single controllers operate with the parameter set I and can be switched by this digital signal to the parameter set II. Double controllers are permanently assigned to the parameter sets I and II; the switching possibility is then omitted.

± Δw *Incremental setpoint adjustment*
External setpoint or nominal ratio preset for incremental adjustment via digital inputs

± Δy *Incremental manipulated variable adjustment*
External manipulated variable default for incremental adjustment through digital inputs in follow-up operation.

± 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.

Signals with identification II relate logically to controller II at S1 = 12. Corresponding SES signals are only effective when CBII=1 and IntII=0.

1.5.4 Controller types (S1, S49 to S53)

1.5.4.1 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 ± Δw-keys (6 Fig. 3-1) when the green internal LED (1) 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 fast enough. 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**
  Every time the internal setpoint can be adjusted by the keys (6) on the control front panel, it is also possible to make a preset with the SES. Since only absolute and not incremental adjustment is possible with the SES, it is advisable to use the setpoint ramp tS to avoid steps.

  In addition the control signal Int and the automatic/manual switching can be preset with the manual manipulated variable adjustment with the SES so that a complete parallel process operation is possible with the SES (see also chapter 1.5.6 ”Controller output structure”, section ”Control system coupling via the serial interface” on page 113).

- **Source for the external setpoint S53 and S101**
  The external setpoint wE can come from a maximum of three different sources in the different controller types:

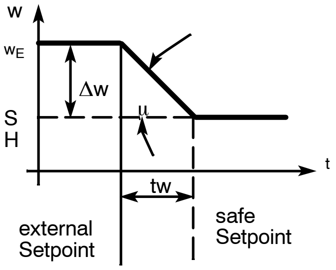
  external setpoint as an absolute value via the analog inputs (w_{EA})
  external setpoint incremental via the control signals ± Δw ($w_{E\Delta}$) } Selection with S53
  external setpoint as an absolute value via the SES (wES) SES (w_{ES})selection with S101
  In double controllers (S1 = 12) you can switch between w_{ES} and w_{EA} respectively with control signal w_{SLI} or w_{SLII}.

- **Setpoint ramp tS**
  (accordingly tSII at S1 = 12)

  With the parameter tS (oFPA) the adjusting speed of the effective setpoint w (in ratio controller S1 = 4 the effective nominal ratio) can be set in the range of oFF, 0.1 to 9984 min over

0 to 100%. At the same time, tS presets the floating time for 0 to 100% change in incremental setpoint adjustment via the control signals $\pm\Delta w$. At tS = oFF the adjustment speed goes to ∞.

With the setpoint ramp, setpoint switchings can be effected to non-followed-up variables SH and wi, $w_{E\Delta}$, w_{ES} at S52 = 1 and w_{EA}, if the supplying controller has not been followed up not suddenly but with the set ramp.



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

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

Figure 1-18 Setpoint switching with ramp

With the control signals $\overline{tS}$ and $\overline{tSII}$ the set setpoint ramps can be switched off.

- **Setpoint limits SA, SE**
  (accordingly SAII, SEII at S1 = 12)

  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 = 4) and ratio cascade, commanded ratio controller (S1 = 6)

- **Follow-up of the ineffective setpoint to the active setpoint (S52)**
  (accordingly S235 at S1 = 12)

  Normally the ineffective setpoint is followed up to the effective setpoint so that the setpoint switching is bumpless. The internal setpoint (wi), the external setpoint incrementally adjustable via $\pm\Delta w$ ($w_{E\Delta}$) and the external setpoint via the SES (w_{ES}) can be followed up. The safety setpoint SH cannot be followed up. The external setpoint w_{EA} via the analog inputs can only be followed up indirectly by following up the supplying device on the output side. To do this the effective w is used as a follow-up variable, assigned to an analog output and as a follow–up control signal the OR-operation $H \vee N \vee Si$, assigned to a digital output.

  At S52 = 1 the follow-up is suppressed. This switch setting is always required especially in follow-up controllers if the internal setpoint represents a kind of safety function or if multiple setpoint operation is to be run in follow-up controller (S1 = 3).

- **x-tracking (S50)**
  (accordingly S233 at S1 = 12)

  With the structure switch S50 = 1, x-tracking (ratio controller xv-tracking) can be switched on. This means that the setpoint is followed up to the actual value or the nominal ratio is followed up to the actual ratio and therefore a control difference xd is reset to 0. The follow up always takes place when there is no automatic operation (A). This is the case in manual mode (H), follow-up mode (N), DDC mode and in operation with safety manipulated variable (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 following up the setpoint to the actual value (nominal ratio to actual ratio), the control difference xd = 0 and automatic operation starts absolutely bumplessly. Since one can usually assume in manual mode and DDC mode that the actual value has been driven to the desired value, the followed up setpoint corresponds to the rated value.

x-tracking only takes full effect if the follow-up of the inactive setpoint is locked onto the active setpoint (S52 = 0) so that not only the active setpoint w but also the setpoint source which is supplying after switching to automatic operation is followed up.

At S52 = 1 (without follow-up) the control difference is 0 during the $\overline{A}$-operation but after switching to the automatic mode the old non-followed up setpoint is immediately active again. 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 follow-up variable would not be correct in full x-tracking.

- **Constants c1 to c7**

In the individual controller types the process variables are partially linked with each other whereby the constants c1 to c3 are used for the controlled variable links and constants c4 and c5 for the command variable links. The constants are set in the parameterization mode onPA in the range from -1.999 to 9.999.

The constants c6, c7 serve to dose the disturbance variable connection to the controller output yI or yII (see chapter 1.5.5.1, figure 1-50, page 90 and figure 1-51, page 91). They can be set in the parameterization mode onPA in the range from -19.99 to 19.99.

- **Control signals for the setpoint switching**

If available in the single 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 = $\overline{\text{Int}} \wedge$ CB and its negation. The status of the control signal CB and the Internal key (2) is indicated by the $\overline{C}$ LED (3) and the Internal LED (1).

With S49 the Internal/External key (2) can be set out of function and can block in the positions Internal or External (see chapter 1.5.3, figure 1-17, page 38). The factory setting is S49 = 0 only Internal. With S24 the CB signal can be set to Lo or Hi or a digital input assigned, (see chapter 1.5.3, figure 1-16, page 37). The factory setting is S24 = -1, CB = 1.

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

Switching to Dependence on	Int	S49	CB	S24	active setpoint w S1=3, 4, 5, 6, 7, 8	active setpoint w S1 = 0/1
Int and CB	0 ∨ 1	2	0 ∨ 1	1 to 14	wi (SH) or w_E	wi1 or wi2
only Int	0 ∨ 1	2	1	-1	wi or wE	wi1 or wi2
only CB	0	1	0 ∨ 1	1 to 14	wi (SH) or w_E	wi1 or wi2
only external } no Switching	0	1	1	-1	w_E	wi1
only internal } no Switching	1	0	any	any	wi	wi2

Table 1-2 Possibilities of setpoint switching depending on S24 and S49

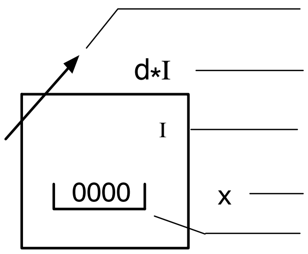
- **Actual value and setpoint display**

A red and a green analog display with 1.7% resolution and a red and a green $4^1/_2$digit digital display are arranged on the front panel. The green displays are assigned to the setpoint, the red displays to the actual value. In addition there is a 3-digit yellow digital display for the y-display. The corresponding adjustment keys and status-LED's are assigned in color and position to the displays.

The two analog displays always indicate the active actual value. The difference between the two displays is the control difference xd or the control error xw = −xd. The digital actual value display also indicates the current actual value except in the ratio controllers (ratio controller: actual ratio). The digital setpoint display indicates the setpoint before the setpoint ramp except in ratio controllers (ratio controller: nominal ratio before the setpoint ramp).

Depending on the controller type the displays, the Internal/External-key (2) and the ±Δw-adjustment keys (6) are switched by the Shift key (12) controller I/controller II.

The following symbols are used in the block diagrams below to simplify the representation:



Adjustable display range (digital displays only)

Parameter set dP, dA, dE, I or II for setting the display format

Display level I or II, no identification means only 1 level or both levels the same

Displayed variables x, w, xv or wv

Display type

⌊ 0000 ⌋	Digital display
↗	Analog display
↗ ⌊ 0000 ⌋	Digital and analog display

– Display range

The digital displays are four-digit 7-segment displays, the display range of which can be set in double controllers and process displays (S1>4) for the x- and w-display together, for the two display levels I and II separately, with the parameter dP (decimal point), dA (start value) and dE (full scale) in the structuring mode oFPA.

In single controllers (S1 ≤ 4) the parameters of the display level II are followed up to the parameters of the display level I and are not adjustable.

With dAI or dAII the numeric value is set which is to be displayed at arithmetic value 0 (corresponding to 0 % display in the analog displays). With dEI or dEII the numeric value is set which is to be displayed at arithmetic value 1 (corresponding to 100 % display in the analog displays). With dPI or dPII the decimal point is set as a fixed point. If the starting point is set less than the full scale, a rising display is given with increasing arithmetic values and vice versa. The numeric range for the start and end values goes from -1999 to 19999, beyond these numbers -oFL and oFL is displayed in the case of 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 calmed 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:

S1	Display format accordingly						Parameter range referenced to dE*-dA* = 100 %
	-1.1 to 11.1	-1.3 to 11.3	SA, SE, SH	Sb	wi/wiI	wiII	
0	d*I	d*I	d*I	–	d*I	–	-10 % to 110 %
1	↓	↓	↓	–	↓	–	↓
2	↓	↓	↓	–	↓	–	↓
3	d*I	d*I	↓	–	↓	–	-10 % to 110 %
4	%	%	d*I	–	↓	–	-199.9 to 199.9 %
5	d*II	d*I	d*II	–	↓	d*II	-10 % to 110 %
6	%	%	d*II	–	↓	d*II	-199.9 to 199.9 %
7	d*I	d*II	d*I	d*II	↓	–	-10 % to 110 %
8	d*I	d*II	d*I	d*II	d*I	–	↓
9	d*I	d*II	–	–	–	–	-10 % to 110 %
10	d*I	–	d*I	–	d*I	–	
11	d*I	–	d*I	–	d*I	–	
12	d*I	d*II	d*I	–	d*I	d*II	-10 % to 110 %

Table 1-3 Display format of parameters and setpoints assigned to the displays

With the appropriate asisgnment, this also applies to the limit value alarms A1 to A4, see chapter 1.5.9, page 124.

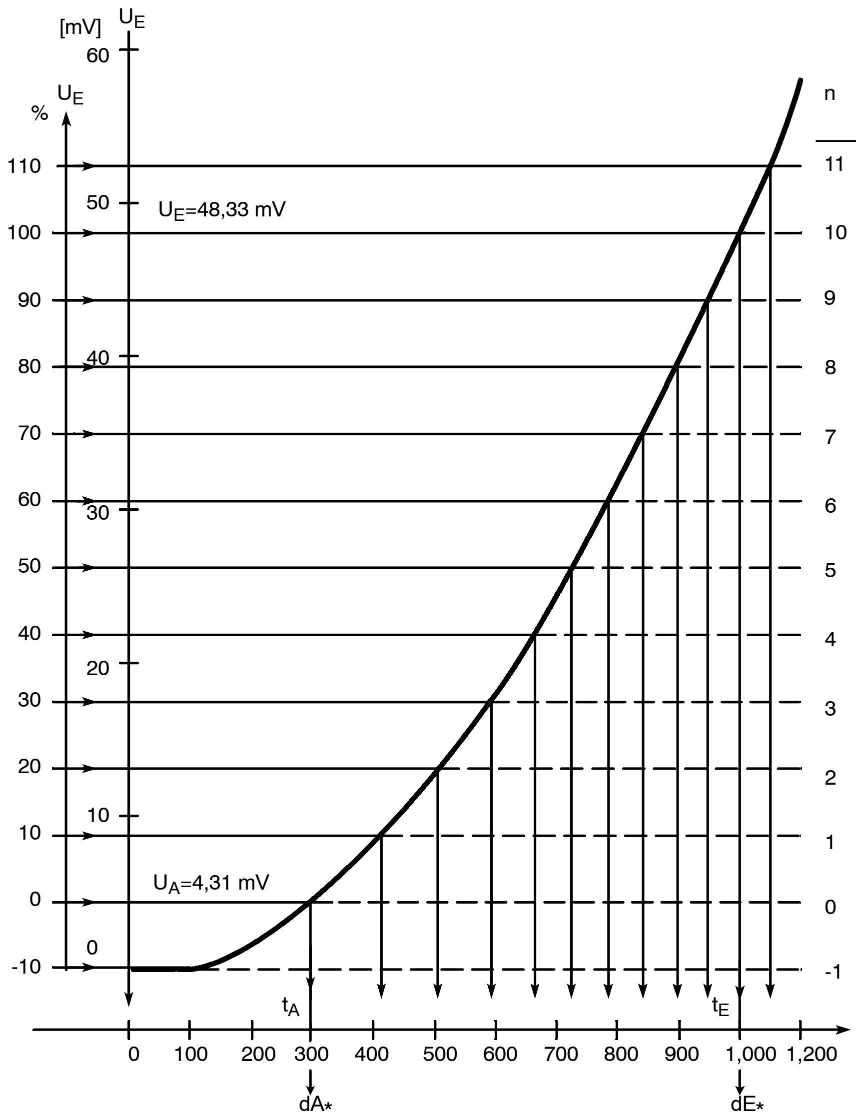
The analog displays have a fixed display range of 0 to 100 %. The overshoot or undershoot is displayed by the flashing 100 % or 0 %-LED. Display is by one or two alternately flashing LEDs. The center of the illumination field represents the "pointer". This display technique doubles the resolution. If a falling characteristic is set for the digital displays (d*E < d*A), the analog displays are switched in direction of effect except for the ratio controllers.

– Setting of the linearizer at S4 = 0

Set start and end of measuring with dA* and dE* and the decimal point dP* in the structuring mode oFPA for the display.
Divide measuring range U_A to U_E including ± 10 % overflow in 10 % sections and determine partial voltages.

$$U_n = \frac{U_E - U_A}{h10} \; n + U_A \text{ with n = -1 to 11}$$

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



n	Un [mV]	Vertex value	t [°C]
11	52.732 →	11*	1,048
10	48.33 →	10*	1,000
9	43.928 →	9*	951
8	39.526 →	8*	900
7	35.124 →	7*	846
6	30.722 →	6*	790
5	26.32→	5*	729
4	21.918 →	4*	664
3	17.516 →	3*	593
2	13.114 →	2*	514
1	8.712 →	1*	420
0	4.31 →	0*	300
-1	-0.092 →	-1*	0

Figure 1-19 Example of linearization of a thermocouple type B Pt30Rh/Pt6, measuring range 300 to 1000 °C

– Setting the function transmitter for linearizing at S4 = 1

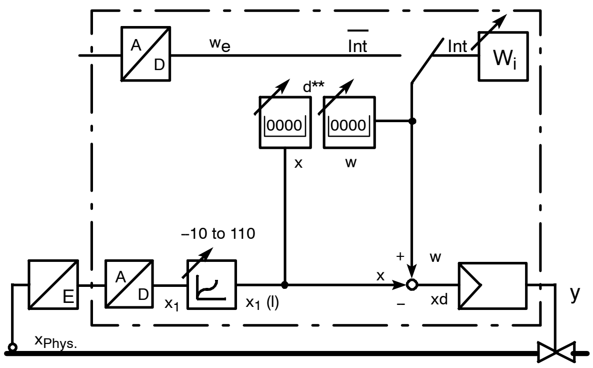


Figure 1-20 Using the function transmitter to linearize non-linear process variables for the display and control

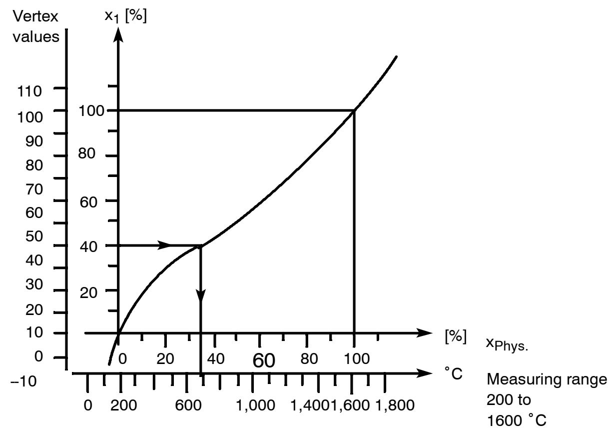


Figure 1-21 Sensor function, e.g. from table

The vertex values of the function transmitters are given in % and not physically here because of their free utilization.

Setting takes place in the structure mode oFPA in the range from −199.9 to +199.9 %.

The vertex values 0 and 100 are set with 0 % or 100 % so that x_1 (l) is available again as a standard variable and the reference junction terminals for determining the display range of the digital display are correct. The display range is set with the parameters dA*, dE* and dP* according to the physical measuring range.

To determine the vertex values, apply the sensor function as shown in fig. 1-21 and divide the range into 10% steps (x_{phys} in %). Then read off the % values in the vertex positions −10 to 110 on the x_{phys}-axis and enter one after the other in the structuring mode oFPA.

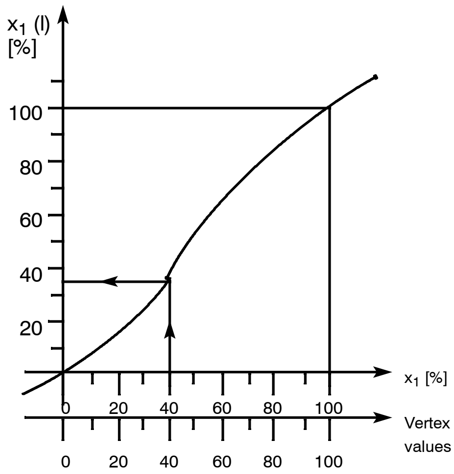


Figure 1-22 Linearization function

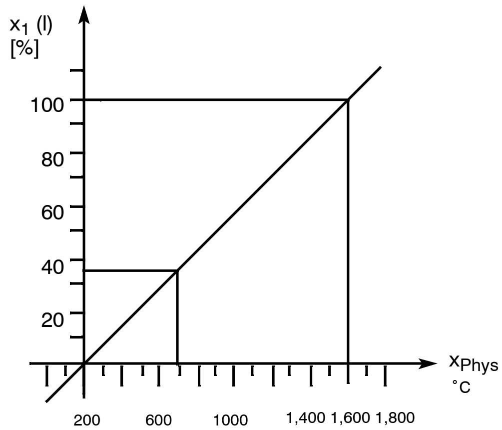


Figure 1-23 Linearized controlled variable x1(l)

– Function inputs FE1 to FE12

S1	FE1 (linearizable)	FE2	FE3 (linearizable)
0 Fixed setpoint controller 2 independent setpoints	x1 main controlled variable	x2 auxiliary controlled variable	x3 auxiliary controlled variable
1 Fixed setpoint controller 2 dependent setpoints	"	"	"
2 DDC fixed setpoint controller	"	"	"
3 Follow-up, synchronized, SPC controller	"	"	w_E external command variable
4 Ratio controller	x1 commanded process variable	x2 commanded process variable	wv_E external command variable for ratio factor
5 Cascade control	x1II main controlled variable master controller	x2II auxiliary control variable master controller	xI controlled variable slave controller
6 Ratio cascade control	xII main controlled variable master controller	x2I commanding process variable slave controller	x1I commanded process variable slave controller
7/8 Override control	x1I main controlled variable main controller	x2I auxiliary controlled variable Main controller	xII controlled variable limiting controller
9 Process display	xI process variable 1	–	xII process variable2
10 Fixed setpoint controller (control system coupling)	x1 main controlled variable	x2 auxiliary controlled variable	x3 auxiliary controlled variable
11 Follow-up controller (control system coupling)	x1 main controlled variable	"	w_E external command variable
12 Double controller	x1I main controlled variable	w_{EA}I external setpoint	x1II main controlled variable

Table 1-4 Control technical function of the inputs FE1 to FE3

Function inputs FE4 to FE12 have the following control-technical function:

- FE4 disturbance variable connection (z) for the D-element or for the manipulated variable y (selection by S55)
- FE5 Follow-up input (y_N) for the manipulated variable follow–up in K-controllers (S2 = 0) and in S-controllers with external follow-up (S2 = 2)
- FE6 Manipulated variable feedback supply (y_R) for the y display in S-controllers with internal feedback (S2 = 1) or the manipulated variable feedback input (y_R) in S-controllers with external feedback (S2 = 2); Process display (S1 = 9) with XIII
- FE7 Manipulated variable connection (z) selection S57
- FE8 External setpoint w_EII
- FE9 Follow-up input y_NII
- FE10 Manipulated variable feedback supply y_RII
- FE11 manipulated variable connection setpoint

The function inputs FE1 to FE3 have different control-technical functions depending on the controller type (S1).

1.5.4.2 S1 = 0: Fixed setpoint controller with 2 independent setpoints

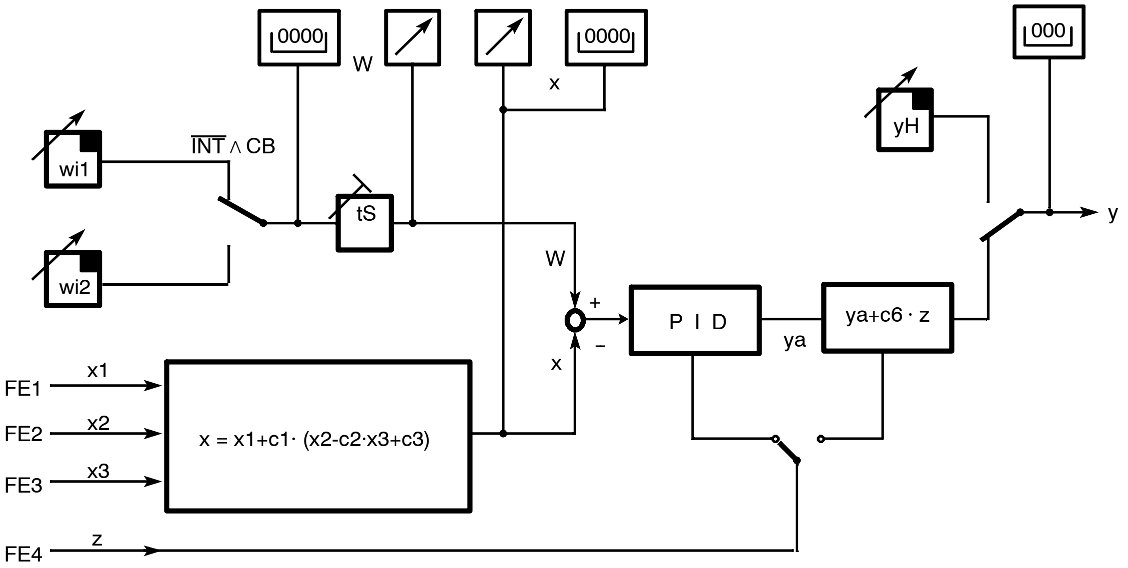


Figure 1-24 Principle representation S1 = 0

This controller type can be used as a fixed setpoint controller with 2 independent setpoints (two batch mode) or as a fixed setpoint controller with 1 setpoint, by blocking the Internal/External switching (factory setting). By linking the inputs x1, x2, x3 with the constants c1, c2, c3, it can be used as a three-component controller.

Switching between the two internal setpoints which are adjustable on the front separately as one, two or three component takes place depending on the control signals Int and CB according to table 1-5. Signaling of the active setpoint takes place on the LEDs Internal and $\overline{C}$. As soon as a LED lights, wi2 is active.

Control commands Digital inputs		Front	Message signals Front LED		Digital outputs			Effective w at S50=		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]	switching	switching
0	0	0	0	1	0	1		wi2	wi2 (n)	mit CB, Int=0	with Int,CB=1
0	1	1	1	0	1	1	2)	wi2	wi2 (n)		
0	0	1	1	1	1	1		wi2	wi2 (n)		
1	1	0	0	0	0	0		wi1	x	switching	switching
1	0	0	0	1	0	1		wi2	x	with CB,Int=0	with Int,CB=1
1	1	1	1	0	1	1	2)	wi2	x		
1	0	1	1	1	1	1		wi2	x		

1) follow up takes place at S52 = 0 and S50 = 1 to the controlled variable x, follow–up does not apply for the switching wi1/wi2
at S52 = 1 automatic mode starts with wi=x (xd=0), the active setpoint runs to the old set value via the possibly set setpoint ramp tS

2) factory setting, fixed setpoint controller with 1 setpoint (S49 = 0: only Internal, Int = 1, S24 = -1: CB = 1) $\overline{RB}$ = Int
$\overline{RC}$ = $\overline{\overline{Int} \wedge CB}$ = Int ∨ $\overline{CB}$

Table 1-5 Switching between wi1 and wi2

With the Shift key (12) the digital w display can be switched in the display level II to the inactive setpoint and the digital x display to the main controlled variable x1 (display range I must be set, display range II is automatically set the same). The active setpoint and the active actual value x are still shown on the analog displays.

Selection by Shift key	effective wi [1]	LED controller I	LED controller II	displayed w [2]		displayed x	
				digital	analog	digital	analog
I	wi1	1	0	wi1 ↗ [4]	wi1	x	x
II	wi1	0	0.5 [3]	wi2 ↗	wi1	x	x
I	wi2	1	0	wi2 ↗	wi2	x	x
II	wi2	0	0.5 [3]	wi1 ↗	wi2	x1	x
III [5]	wi1 or wi2	0	0	wI	wI	x	x

1) via CB and Int accordingly 5
2) only if there is no x-tracking
3) 0.5 = flashing rhythm 1:1
4) ↗ = adjustable
5) only at C8 $\neq 0$

Table 1-6 Switching the display levels

The setpoint displayed with the digital w-displays can also be set with the $\pm\Delta$w-adjustment keys (6.1/6.2 Fig. 3-1, p. 168). The LEDs Controller I/ Controller II signal the display level. Flashing light
signals that the displayed setpoint is not identical with the active setpoint.

Steady light signals that the displayed and active setpoints are identical.

If switching between wi1 and wi2 is blocked via S49 (Int) and S24 (CB), switching of the digital w display to the display level II is omitted. Only the digital x-display is switched over. Signaling of the display level II is with a steady light.

With the constants c8 and c9 a disturbance variable connection of FE11 can be made in the setpoint branch.

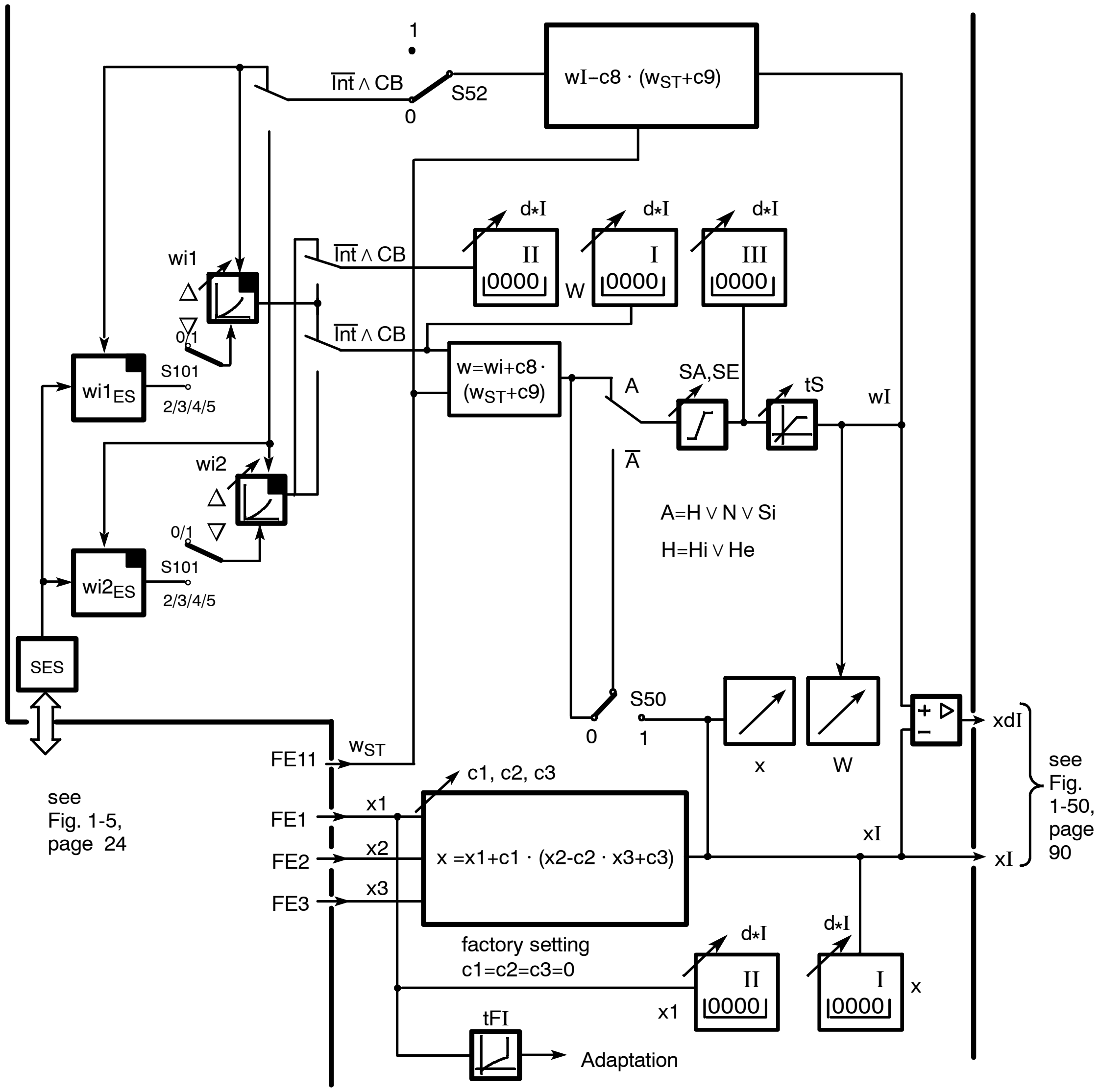


Figure 1-25 Block diagram S1 = 0, fixed setpoint controller with 2 independent setpoints

1.5.4.3 S1= 1: Fixed setpoint controller with 2 dependent setpoints

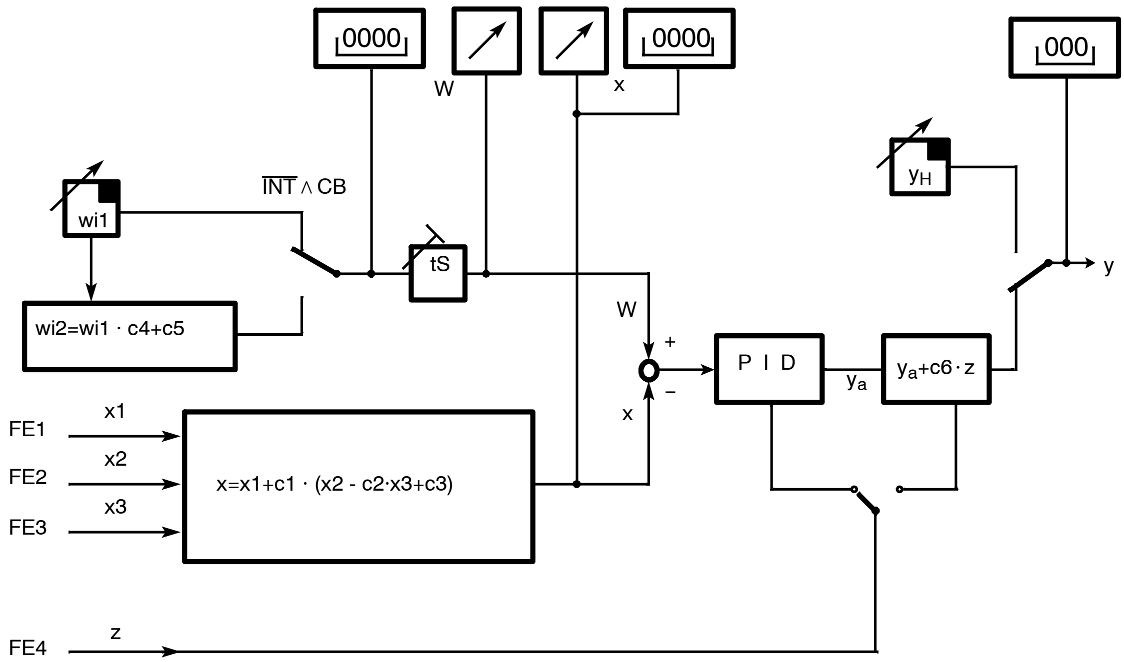


Figure 1-26 Principle representation S1 = 1

This controller type is always used when for example in two batch mode the second setpoint needs to be in a specific ratio to the first. The ratio is set by the constants c4 and c5.

Factory setting is c4 = 1 and c5 = 0.

The switching and display functions are the same as at S1 = 0. Only the internal setpoint (wi1) can be adjusted if it is displayed.

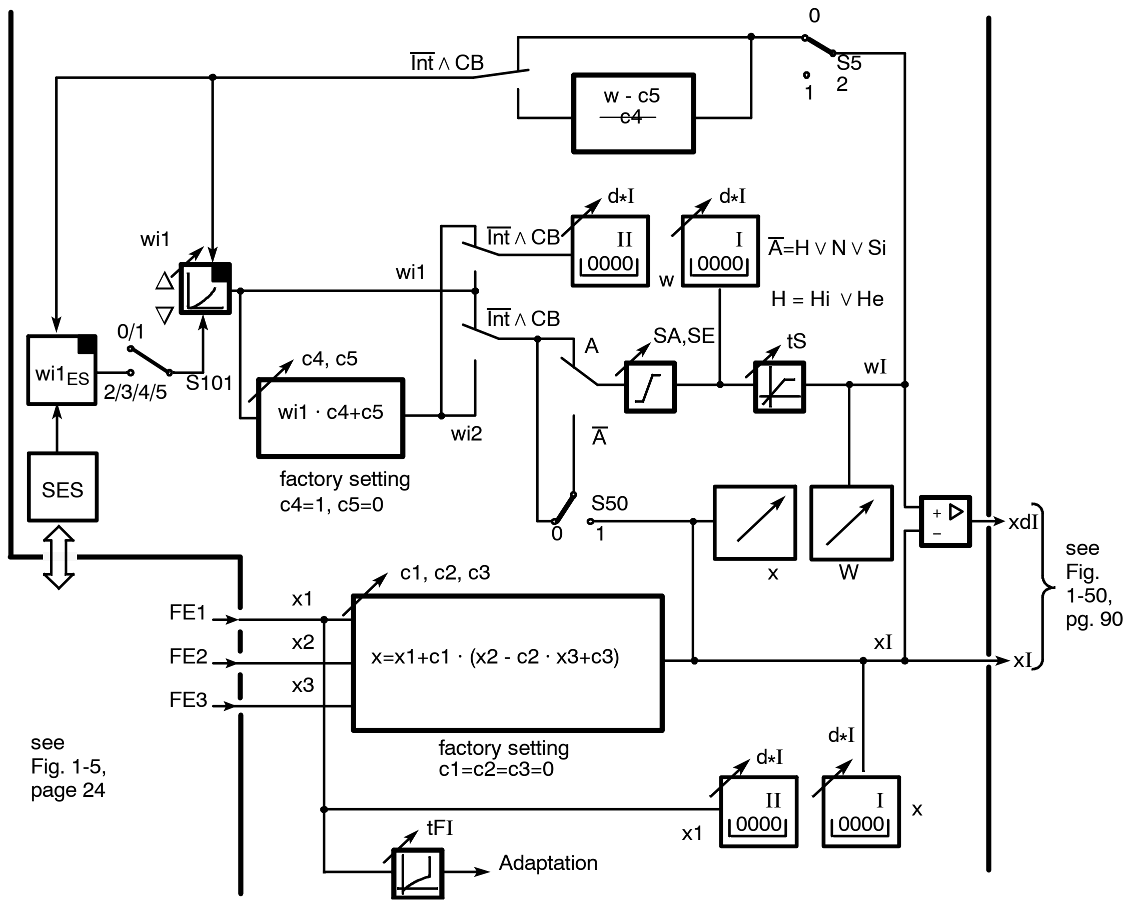


Figure 1-27 Block diagram S1 = 1, fixed setpoint controller with 2 dependent setpoints

1.5.4.4 S1 = 2: DDC fixed setpoint controller

The DDC controller has the job of taking over the control circuit as bumpless as possible in the case of a computer failure. During the DDC operation the process computer takes over the control function, the controller is on standby, i.e. it is followed up to the computer manipulated variable; the control difference is reset to zero for absolutely bumpless switching by x-tracking if necessary.

In K-controller circuits, the actuating current can be output parallel by the computer periphery to achieve full redundancy. In this case the actuating current of the K-controller is switched off during computer operation (S66 = 1). If the actuating current of the computer is also to be switched off during controller operation, the two currents simply need to be added by OR diodes. This OR diode is integrated in the current outputs of the SIPART controllers.

If the UI-converter of the K-controller is to be used during computer operation to feed the final control element, the actuating current cutoff must be canceled (S66 = 0).

The DDC mode corresponds to follow-up mode of the other controller types with the difference that the switching to follow-up mode takes place not via the control signal N but as a function of

the control signal CB and the Internal/External key:
DDC operation ≙ RC=$\overline{\text{Int}} \wedge$ CB = 1

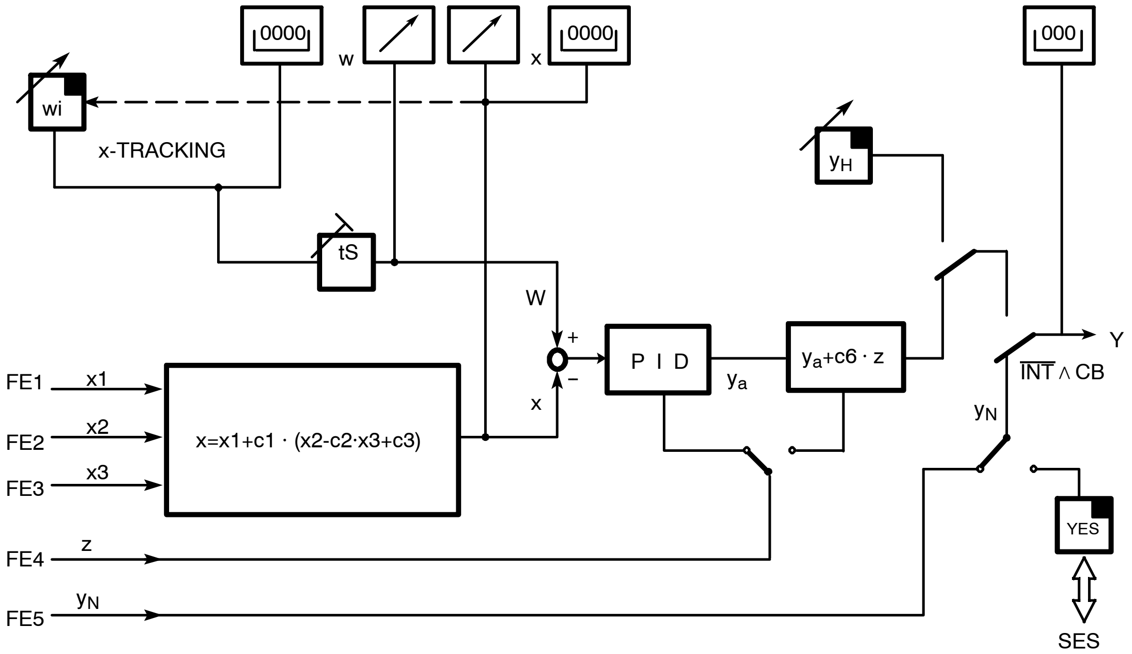


Figure 1-28 Principle representation S1 = 2

The DDC mode is signaled like the follow-up mode in the other controller types by the lit y-External LED. The status of the control signal CB and the Internal/External key is displayed by the LEDs $\overline{\text{C}}$ and Internal. During the DDC mode the setpoint is prepared by follow-up to the computer failure. The setpoint is always displayed which would become active after the computer failure.

With S50 a choice is made between x-tracking and wi, with S51 the safety setpoint is preset.

With S61 the priority between DDC-mode and manual mode is determined. If DDC-mode has priority over manual mode, you can select with the manual-automatic switching whether operation is to continue after a computer failure in automatic or manual mode. If manual intervention is necessary in computer operation, switching to Internal operation is necessary in addition to switching to manual operation; the LEDs Internal (1) and Manual (8) light, the LED y-External (10) goes out, the dark LED $\overline{\text{C}}$ (3) stil indicates computer standby.

If manual mode has priority over DDC-mode you can switch directly from computer operation to manual operation. Then the manual LED (8) lights, the y-External LED (10) goes out, the dark LEDs Internal (1) and $\overline{\text{C}}$ (3) still indicate computer standby of the controller or computer standby.

Automatic mode is always switched to here in the event of a computer failure.

Control Signals: Digital inputs				Control Signals: Front	Signals: Front LED			Signals: Digital outputs		Working y	Working w when				Comments	Computer failure
±yBL	Si	H [1]	CB[3]	Local	Local	$\overline{C}$	y remote	$\overline{RB}$[4]	$\overline{RC}$[4]		S50 = 0 S51 = 0	S50 = 1 S51 = 0	S50 = 0 S51 = 1	S50 = 1 S51 = 1		
0	0	0	1	0	0	0	1	0	0	y_E (n)[2]	wi (n,↗)[7]	x	SH	SH	DDC mode, automatic mode ready	
0	0	0	0	0	0	1	0	0	1	y_a (n)	wi (n,↗)[7]	wi (n,↗)[7]	wi (n,↗)[7]	wi (n,↗)[7]	Automatic mode, computer switched off, controller ready	
0	0	0	1	1	1	0	0	1	1	y_a (n)	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Automatic mode, computer ready, controller not ready	
0	0	0	0	1	1	1	0	1	1	y_a (n)	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Automatic mode, computer switched off, controller not ready	
0	0	1	1	0	0	0	1	0	0	y_E (n) [2]	wi (n,↗)[7]	x	SH	x	DDC mode, manual mode ready	
0	0	1	0	0	0	1	0	0	1	y_H (n)	wi (n,↗)[7]	x	wi (n,↗)[7]	x	Manual mode, computer switched off, controller ready	
0	0	1	1	1	1	0	0	1	1	y_H (n)	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Manual mode, computer ready controller not ready	
0	0	1	0	1	1	1	0	1	1	y_H (n)	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Manual mode, computer switched off, controller not ready	
0	1	0	1	0	0	0	1	0	0	y_S	wi (n,↗)[7]	x	wi (n,↗)[7]	x	Safety mode, computer ready, controller ready	
0	1	0	0	0	0	1	1	0	1	y_S	wi (n,↗)[7]	x	wi (n,↗)[7]	x	Safety mode, computer switched off, controller ready	
0	1	0	1	1	1	0	1	1	1	y_S	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Safety mode, computer ready, controller not readyt	
0	1	0	0	1	1	1	1	1	1	y_S	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Safety mode, computer switched off, controller not ready	
0	1	1	1	0	0	0	1	0	0	y_S	wi (n,↗)[7]	x	wi (n,↗)[7]	x	Safety mode, computer ready, controller ready	
0	1	1	0	0	0	1	1	0	1	y_S	wi (n,↗)[7]	x	wi (n,↗)[7]	x	Safety mode, computer switched off controller ready	
0	1	1	1	1	1	0	1	1	1	y_S	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Safety mode, computer ready, controller not ready	
0	1	1	0	1	1	1	1	1	1	y_S	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Safety mode, computer switched off, controller not ready	
1	as above						1	as above		yBL	as above but without x-tracking				Blocking mode, as above	

Table 1-7 DDC controller, S1 = 2, DDC operation has priority over manual operation S61 = 0

Control Signals: Digital inputs				Front	Signals: Front LED					Working y	Working w when				Comments	Computer failure
±yBL	Si	H 1)	CB3)	Intern	Intern	$\overline{C}$	y-Extern	$\overline{RB}$4)	$\overline{RC}$4)		S50 = 0 S51 = 0	S50 = 1 S51 = 0	S50 = 0 S51 = 1	S50 = 1 S51 = 1		
0	0	0	1	0	0	0	1	0	0	y_E (n)2)	wi (n,↗)7)	x	SH	SH	DDC mode, automatic mode ready	↲
0	0	0	0	0	0	1	0	0	1	y_a (n)	wi (n,↗)7)	wi (n,↗)7)	wi (n,↗)7)	wi (n,↗)7)	Automatic mode, computer switched off, controller ready	
0	0	0	1	1	1	0	0	1	1	y_a (n)	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Automatic mode, computer ready controller not ready	
0	0	0	0	1	1	1	0	1	1	y_a (n)	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Automatic mode, computer switched off, controller not ready	
0	0	1	1	0	0	0	0,5 5)	0	0	y_H (n) 2)	wi (n,↗)7)	x	wi (n,↗)	x	Manual mode, computer ready, controller ready	
0	0	1	0	0	0	1	0	0	1	y_H (n)	wi (n,↗)7)	x	wi (n,↗)7)	x	Manual mode, computer switched off controller ready	
0	0	1	1	1	1	0	0	1	1	y_H (n)	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Manual mode, computer ready controller not ready	
0	0	1	0	1	1	1	0	1	1	y_H (n)	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Manual mode, computer switched off controller not ready	
0	1	0	1	0	0	0	1	0	0	y_S	wi (n,↗)7)	x	wi (n,↗)7)	x	Safety mode, computer ready, controller ready	
0	1	0	0	0	0	1	1	0	1	y_S	wi (n,↗)7)	x	wi (n,↗)7)	x	Safety mode, computer switched off, controller ready	
0	1	0	1	1	1	0	1	1	1	y_S	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Safety mode, computer ready, controller not ready	
0	1	0	0	1	1	1	1	1	1	y_S	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Safety mode, computer switched off, controller not ready	
0	1	1	1	0	0	0	1	0	0	y_S	wi (n,↗)7)	x	wi (n,↗)7)	x	Safety mode, computer ready, controller ready	
0	1	1	0	0	0	1	1	0	1	y_S	wi (n,↗)7)	x	wi (n,↗)7)	x	Safety mode, computer switched off, controller ready	
0	1	1	1	1	1	0	1	1	1	y_S	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Safety mode, computer ready controller not ready	
0	1	1	0	1	1	1	1	1	1	y_S	wi (n,↗)	wi (n,↗)	wi (n,↗)	wi (n,↗)	Safety mode, computer switched off, controller not ready	
1	as above						1	as above		yBL	as above but without x-tracking				Blocking mode, as above	

Table 1-8 DDC controller, S1 = 2, manual operation has priority over DDC operation S61 = 1

[1] manual operation can be achieved by

Control signals		Message signals	
digital input He	Front Hi	Front manual LED	digital output H
0	0	0	1
1	0	0.9 [6]	1
0	1	1	2
1	1	1	2

Table 1-9 Generation of the control signal H = Hi ∨ He

[2] In DDC mode the actuating current of the controller is switched off at S66 = 1. The source for y_E at S62 = 0 is y_N (FE5) or at S62=1 $y_{N\Delta}$ ($\pm\Delta y$), if S101 < 2. At S101=2 y_{ES} is active (SES). The external manipulated variable is followed up which is fed in via $\pm\Delta y$ ($y_{N\Delta}$) and via the SES (y_{ES}). When feeding in via FE5 (y_N) the feeding controller must be followed up.

[3] The table is shown for static computer switching without acknowledgement, S47 = 0.

[4] By OR linking of the digital output H with the control signal Si no computer standby or computer operation can be signaled in manual or safety mode.

[5] 0.5 = Flashing rhythm 1 : 1

[6] 0,9 = Flashing rhythm 0.1 off, 0.9 on

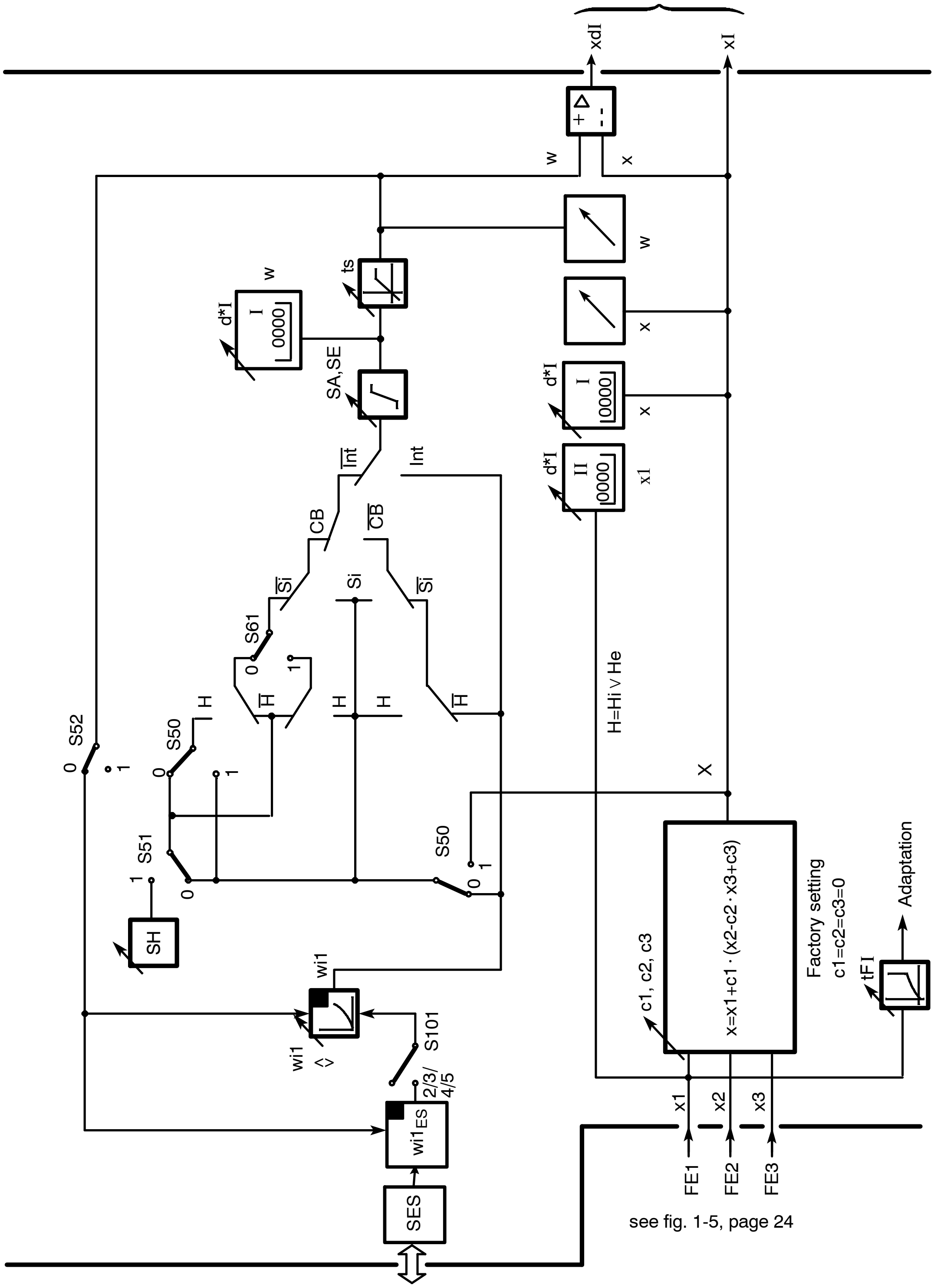
(↗) = adjustable

(n) = is followed up to the value active before switching, therefore bumpless switching.

The control signal Follow up (N) has no function in DDC controllers. The tables apply for S52 = 0 (with follow up of the inactive setpoint to the active setpoint). At S52 = 1 (without follow-up) and x-tracking automatic operation starts with wi = x (xd = 0), the active setpoint runs to the old set value wi via the possibly set setpoint ramp tS.

With the Shift key (12) the digital x display can be switched to the main controlled variable x1 in the display level II. Signaling of the display levels takes place via the LEDs Control I/Control II by a steady light.

see fig. 1-50, page 90



see fig. 1-5, page 24

Figure 1-29 Block diagram S1 = 2, DDC fixed setpoint controller

1.5.4.5 S1 = 3: Follow-up controller, synchronized controller, SPC-controller

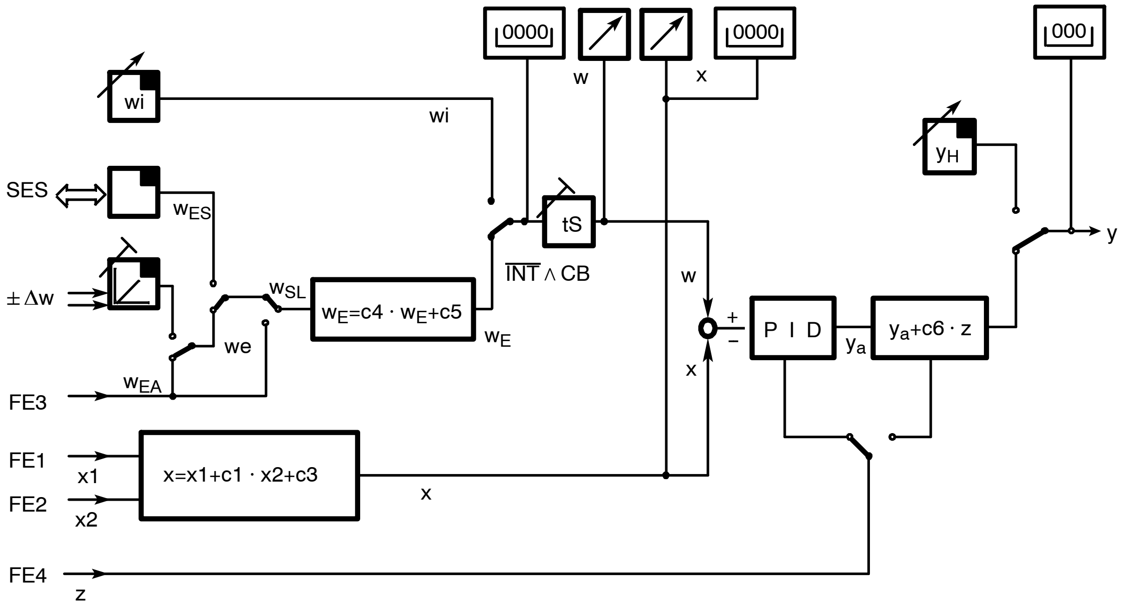


Figure 1-30 Principle representation S1 = 3

In this controller type 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 (2) (see table 1−11, page 61 and table 1−12, page 62).

The external setpoint can be preset via the analog output FE3 (w_{EA}) or via the digital signals $\pm\Delta w$ as an incremental setpoint ($w_{E\Delta}$) (selection via S53) or via the SES (w_{ES}) (selection by S101). The active setpoint w can be fed back by an appropriately assigned analog output to the feeding controller for follow up when using w_{EA} or for displaying when using $w_{E\Delta}$.

This controller type is used for cascade controls with 2 separate controllers (master and follow-up controllers), for synchronized controls, fixed setpoint controls with external setpoint preset (e.g. under console conditions via the incremental $\pm\Delta$w-inputs) and SPC-controls (setpoint control). This controller type attains special importance when coupled with the SIPART software for operation and monitoring. Here this controller type is used for fixed setpoint control with external setpoint preset (w_{ES}) and Automatic/Manual switching via the follow-up signal N_{ES} and the input y_{ES} (see chapter 1.5.6, page 99).

- **SPC controls**

  Here a process computer takes over the setpoint command during computer operation RC = $\overline{\text{Int}} \wedge$ CB = 1, in the event of a computer failure (CB from 1 → 0) the controller takes over either the last computer setpoint (followed up wi) or the safety setpoint SH (selection via S51).

- **Cascade control**

  A command controller, e.g. a fixed setpoint controller (with the main controlled variable) feeds the external setpoint of a slave controller with its manipulated variable (with the auxiliary controlled 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 master 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).

- **Internal/External switching**

  The setpoint switching takes place via a logic link RC = $\overline{\text{Int}} \wedge$ CB and its negation (see table 1−11, page 61 and table 1−12, page 62). Both control signals can be set statically to 1 or 0 (int via S49, CB via S24) in addition to their normal functions as Shift key or control signal with the states 1 and 0, see chapter 1.5.3 fig. 1-16, page 37 and fig. 1-17, page 38. The factory setting is Int = 1 (S49 = 0) and CB=1 (S24 = -1), **so that in the factory setting the internal setpoint wi is always active and cannot be switched!**

  With this setting facility it is possible to perform the switching only dependent on Int (S49=2, S24= -1) or only dependent on CB (S49=1, S24=1 to 14) as a slave controller with Internal/External-switching. If the switching facility is blocked in External position (S49=1, S24=-1), the controller operates as a follow-up controller without Internal/External-switching (see table 1-2, page 43).

- **Display of the external setpoint w_E**

  With the Shift key (12) the digital w-display can be switched to the external setpoint w_E and the digital x-display to the main controlled variable x1 in the display level II (display range I must be set, display range II is automatically set the same). The active setpoint and the active actual value are still indicated on the analog displays.

  The LEDs Controller I/Controller II signal the display level.

  Flashing signals that the displayed external setpoint is not identical with the active setpoint. Steady light signals that the displayed and active setpoints are identical.

Selection by Shift key	active w [1]	LED controller I	LED controller II	displayed w [3]		displayed x	
				digital	analog	digital	analog
I	wi/SH	1	0	wi/SH	wi/SH	x	x
II	wi/SH	0	0.5 [2]	w_E	wi/SH	x1	x
I	w_E	1	0	w_E	w_E	x	x
II	w_E	0	1	w_E	w_E	x1	x

1) via CB and Int according to table 1–11 and 1– 12
2) 0.5 = flashing rhythm 1:1
3) only if there is no x-tracking

Table 1-10 Switching the display level

If the switching possibility between internal and external setpoint is blocked through S49 and S24, switching of the digital w-display to the display level II is no longer used. Only the digital x-display is switched. The display level II is signaled by a steady light.

- **Operation with 2 or 3 setpoints**

If follow-up of the inactive setpoint to the active setpoint is blocked with S52 = 1, a multiple setpoint operation (switching between wi, w_E and SH is achieved (see table 1–12, page 62).

- **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: Digital inputs H ∨ N ∨ Si	Control signals: Digital inputs CB [1]	Control signals: Front In-ter-nal	Message signals: Front Inter-nal LED	Message signals: Front $\overline{C}$ LED	Message signals: Digital outputs $\overline{RB}$ [4]	Message signals: Digital outputs $\overline{RC}$ [4]	active w at S50=0 S51=0	active w at S50=1 S51=0	active w at S50=0 S51=1	active w at S50=1 S51=1	Explanations	Com-puter fail
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,↗)		SH[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, controller not in SPC standby	
1	1	0	0	0	0	0	w_E (n)[2]	x	w_E (n)[2]	x	Manual, follow up 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 computer switching without acknowledgement (S47 = 0).
2) Source for w_E at S53 = 0 is w_{EA} (FE3) or at S53 = 1 $w_{E\Delta}$ ($\pm\Delta$w), when S101 < 2. At S101 = 2 $w_{ES}$is active (SES). The external setpoint fed in via $\pm\Delta$w ($w_{E\Delta}$) and via the SES (w_{ES}) is followed up. When feeding in the external setpoint via FE3 (w_{EA}) the feeding controller must be followed up.
3) SH can only be reached after w_E if Int = 0 and CB goes from 1 → to 0 (computer failure). If CB = 0 and Int is switched from 1 → 0, wi is still active. Since SH is not followed up, switching over to SH can take place 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, follow-up or safety operation.
5) Factory setting
(n) followed up to the value active before switching, therefore bumpless switching
↗ adjustable

Table 1-11 Follow-up/synchronized/SPC controller with Internal/External switching S1 = 3 with follow up of the inactive setpoint

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)	S50=0 S51=0	S50=1 S51=0	S50=0 S51=1	S50=1 S51=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(↗)		SH 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, follow up 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 (S47 = 0).

2) Source for w_E at S53 = 0 is w_{EA} (FE3) or at S53 = 1 $w_{E\Delta}$ ($\pm\Delta$w), when S101 < 2. At S101 = 2 $w_{ES}$is active (SES).
The external setpoint fed in via $\pm\Delta$w ($w_{E\Delta}$) and via the SES (w_{ES}) is followed up. When feeding in the external setpoint via FE3 (w_{EA}) the feeding controller must be followed up.

3) SH can only be reached after w_E if Int = 0 and CB goes from 1 → to 0 (computer failure). If CB = 0 and Int is switched from 1 → 0, wi is still active. Since SH is not followed up, switching over to SH can take place 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, follow-up or safety operation.

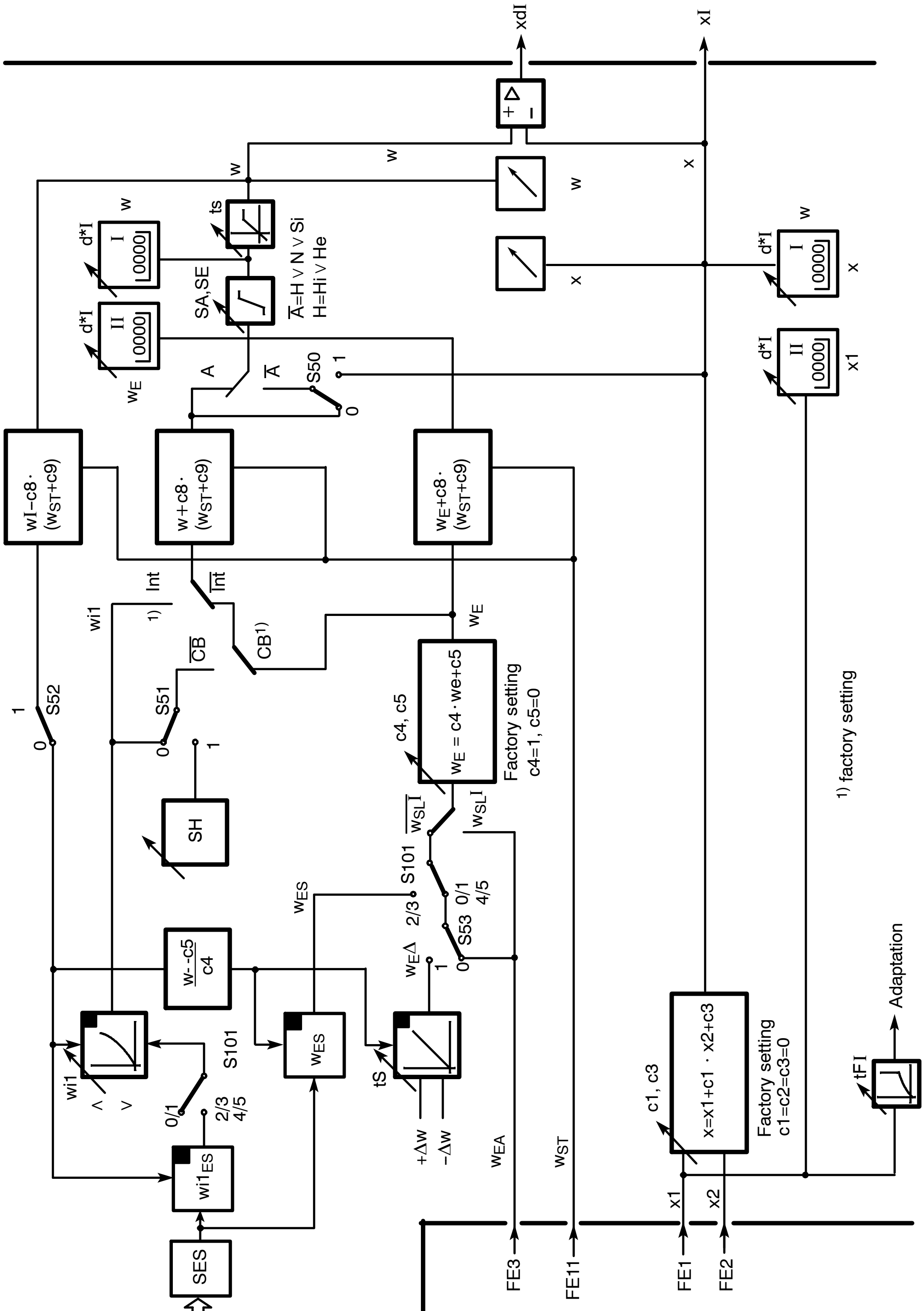
5) Factory setting

(n) followed up to the value active before switching, therefore bumpless switching

↗ adjustable

Table 1-12 Follow-up/synchronized/SPC controller with Internal/External switching (SPC controller), S1 = 3 without follow-up of the active setpoint to the active setpoint S52 = 1, 2 or 3 setpoint operation

see chapter 1.5.5, figure 1-50, page 90



see chapter 1.5.1, figure 1-5, page 24

Figure 1-31 Block diagram S1 = 3 slave controller, synchronized controller, SPC controller

1.5.4.6 S1 = 4: commanded ratio controller

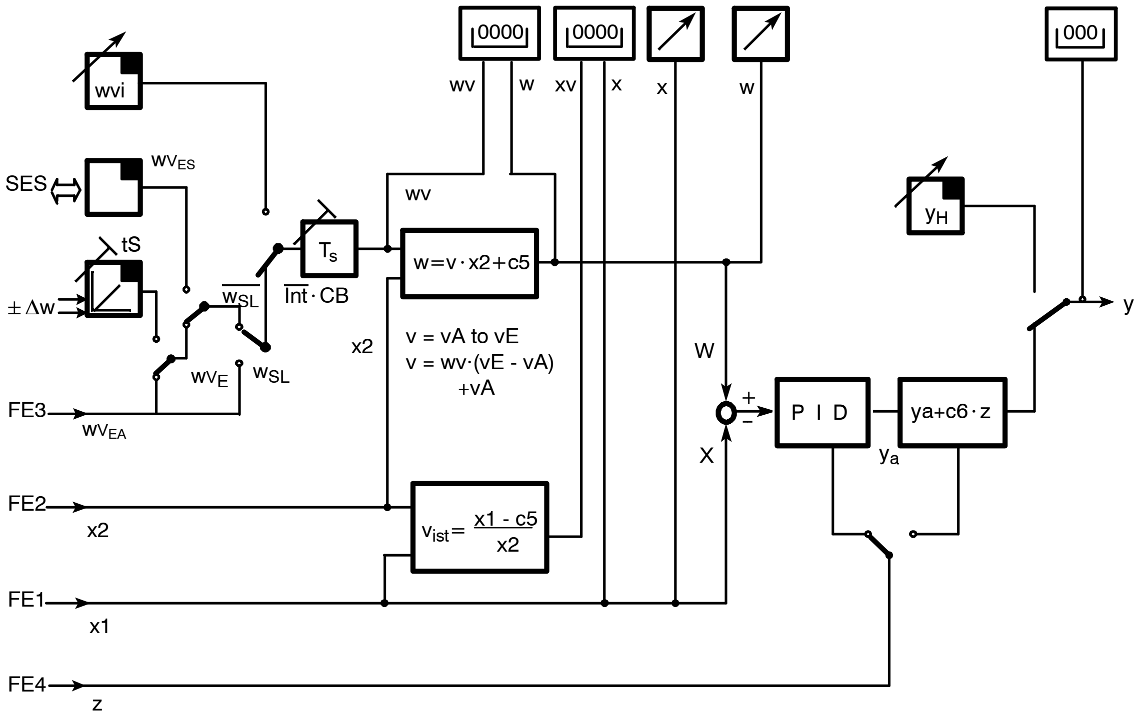


Figure 1-32 Principle representation S1 = 4

In a ratio control the commanding process variable x2 is evaluated with the adjustable ratio factor and a basic value c5 added if necessary and forms the setpoint w for the following controlled process variable x1:

$w = v \cdot x2 + c5$

With $xd = w - x1$, $xd = v \cdot x2 + c5 - x1$ is given

In the controlled status (xd = 0), the following is given $v = \frac{x1 - c5}{x2}$ i.e. in the controlled status 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 $w = v \cdot x2 + c5$, $w = wv\,[(vE - vA) + vA]\,x2 + c5$ is given.

In the ratio controller the standardized nominal ratio wv and the standardized actual ratio xv are displayed on the digital w and x displays respectively. Via d*I a physical display is possible. The controlled variable x1 and the evaluated commanding procesan be switched to the external nominal ratio (display level II) (display level I must be set, display level II is automatically set the same). Signaling of the display levels, see S1 = 3, fos variable w are displayed on the analog x and w displays respectively so that a direct control difference monitoring is possible at all times.

With the Shift key (12) the digital w-display cllow-up controller. The digital x-display shows the actual ratio xv in both display levels.

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

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

$$v_{ist} = xv\,(vE - vA) + vA \quad \text{gives for} \quad xv = \frac{v_{is} - vA}{vE - vA} \quad \text{or} \quad xv = \frac{\frac{x1 - c5}{x2} - vA}{vE - vA}$$

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 linearizers can be used for linearization of the commanding process variable x2 (via FE2 in the freely connectable input range) and the following process variable x1 (via FE1 also in permanently connected input range).

The linearization then acts on the analog displays and the ratio formation and therefore 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. The commanding process variable x2 can be limited by the freely connectable range (S4 = 1) if necessary.

The ratio controller behaves like slave controller S1 = 3 in 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 also be used as a ratio controller with fixed ratio (manually adjustable) or with commanded ratio factor.

A fixed ratio factor is used for example in simple combustion rules, (see example in figure 1-33) where the ratio factor is reset manually if necessary for varying fuels. 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 master controller, the flow of alkali and acid the commanded process variable and the following (controlled) process variable of the ratio controller.

– Example of a ratio control

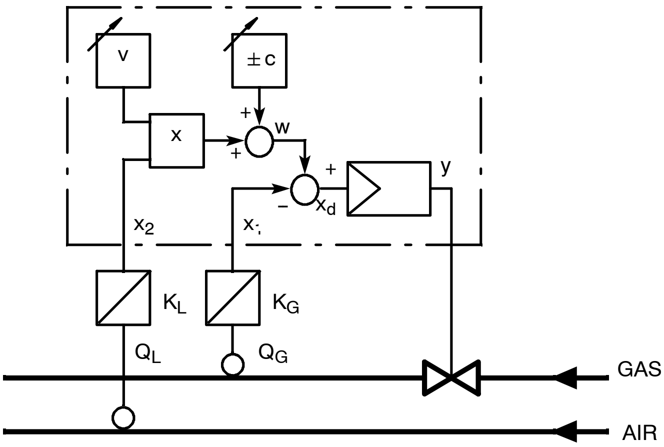


Figure 1-33 Control diagram ratio control

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 12,000 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 3,000 m^3/h which is also available as a 4 to 20 mA signal. In an ideal combustion the air/gas ratio is

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

$\frac{Q_L}{Q_G} = L_{\oslash} \cdot \lambda$ 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 (bei xd = 0) is determined partly by the transmission factors K of the transmitter (measuring ranges).

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

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

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

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

With the values from the example

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

gives $v = \frac{1}{\lambda}$ i.e. the choice of the transmitter ranges has been made so that

$$\frac{K_G}{K_L} = \frac{1}{L_{\oslash}} \quad .$$

The desired adjustment range of λ gives:

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

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.

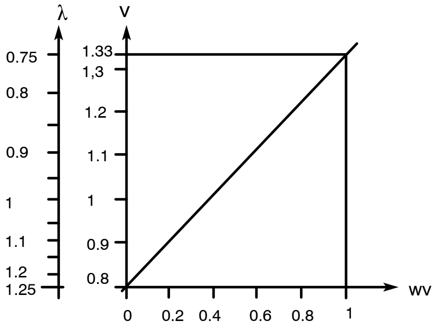
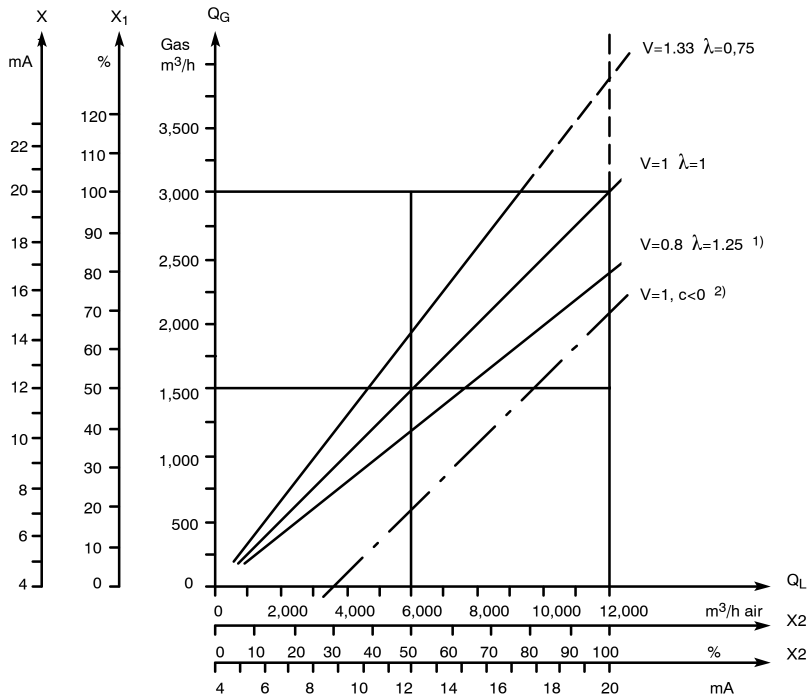


Figure 1-34 Relationship ratio factor v and air factor λ to standardized nominal ratio wv

If the combustion is also to take place at small flow volumes with excess air, the constant c must be set negative. Figure 1-35 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 air excess

Figure 1-35 Display of gas/air ratio in controlled status

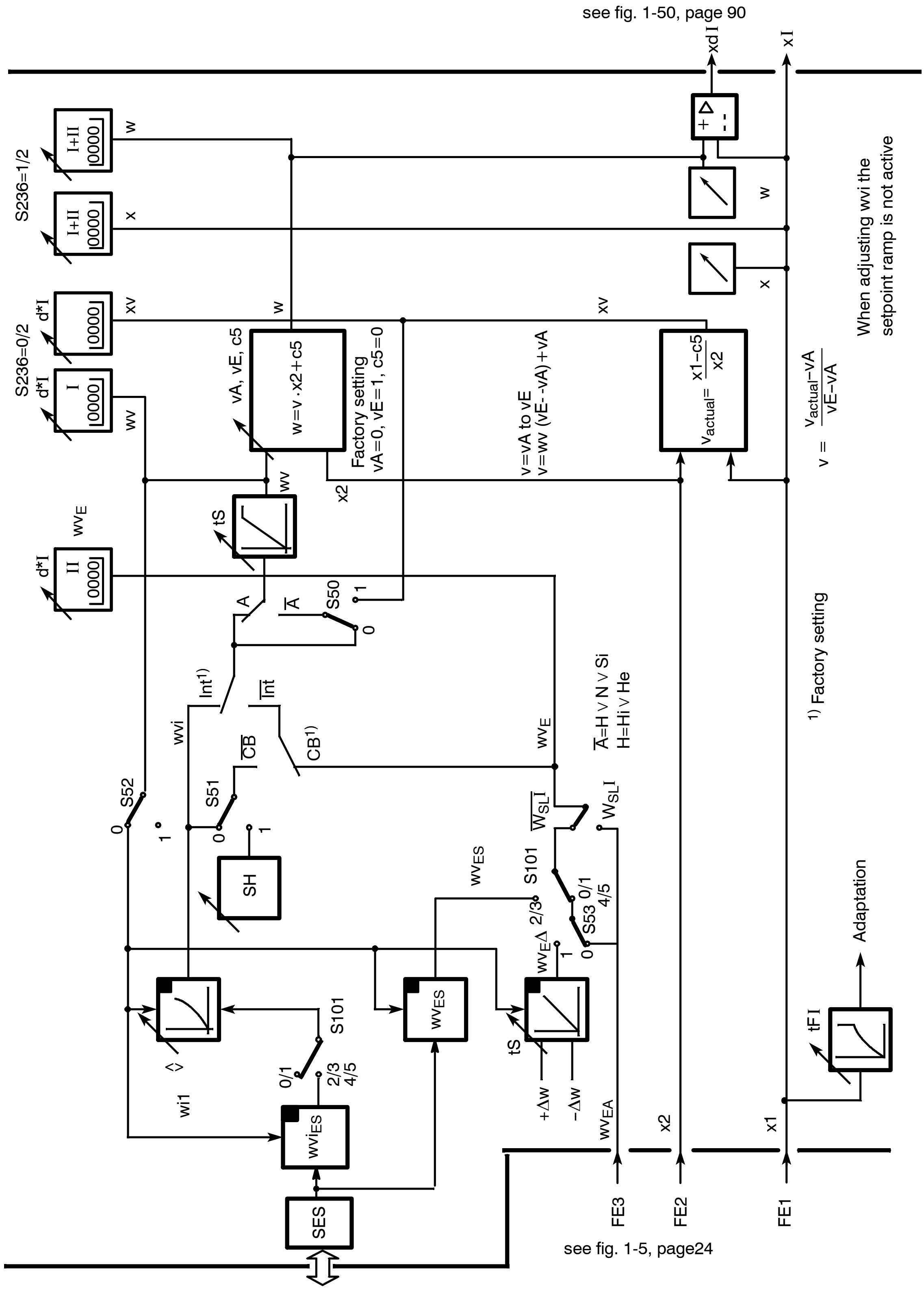


Figure 1-36 Block diagram S1 = 4 commanded ratio controller

1.5.4.7 S1 = 5: Cascade control

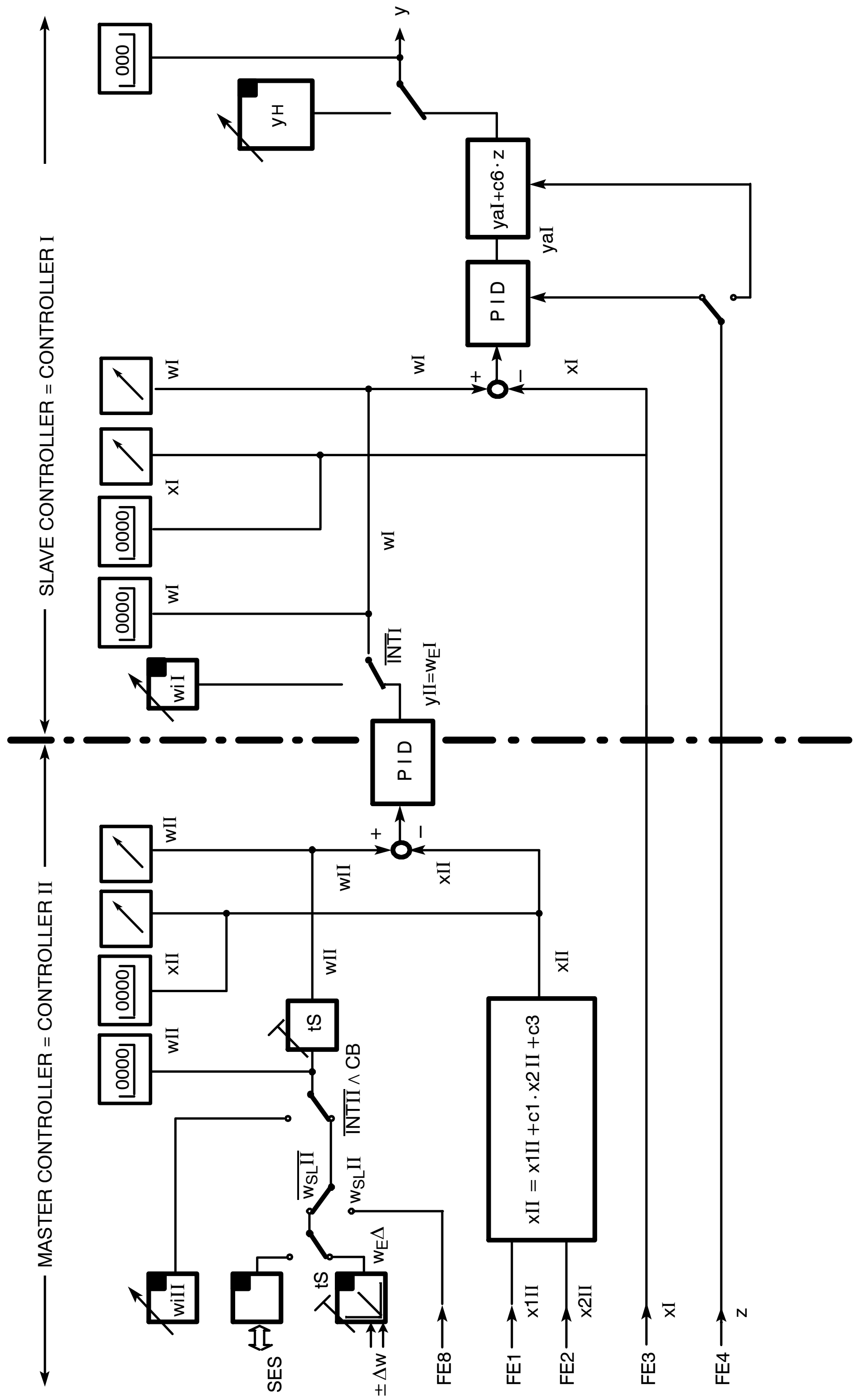


Figure 1-37 Principle representation S1 = 5

In this controller type a master controller (Controller II) and a follow-up controller (Controller I) are interconnected in one controller in a cascade (application, see S1 = 3).

- **Master controller (controller II)**

  With respect to the setpoint switching the master controller has approximately the same structure as the follow-up controller S1 = 3. It is therefore a fixed setpoint controller with the possibility of external setpoint preset via analog signal, the serial interface or as an incremental setpoint via the control signals $\pm\Delta w$. Selection is made with $w_{SL}II$ and S101. In computer coupling it is also possible here, in the case of a computer failure (CB from 1 → 0) to continue working with the last computer setpoint (followed-up wi) or with the safety setpoint SH (selection by S51). The master controller cannot be switched to manual operation but the slave controller can be switched to the internal setpoint.

  Follow-up of the inactive setpoint to the active setpoint can be switched off with S52 = 1.

- **Follow-up controller (controller I)**

  The follow-up controller can be switched for disconnecting the cascade for startup procedures via the Internal/External key (2) (Int I) between the internal setpoint wiI and the external setpoint wEI which is equal to the manipulated variable of the master controller (yaII). The internal operation of the follow-up controller corresponds to manual operation of the master controller.

  Setpoint limiting of the follow-up controller can be implemented by the y-limiting of the master controller. The follow-up of the master controller in internal operation of the follow-up controller and x-tracking ($\overline{A}$) and the follow-up of the internal setpoint of the follow-up controller in external operation and x-tracking ($\overline{A}$) always takes place so that the switching Internal/External is bumpless.

- **Display and operating level switching**

  With the Shift key (12) the digital and analog x- and w-displays and the function of the Internal/External key (2) including the Internal LED (1) and the $\pm\Delta w$-adjustment keys (6) are switched to the selected controller. **The y-display (14), the Manual/Automatic key (9) and the $\pm\Delta y$-adjustment keys (13) are permanently assigned to the follow-up controller.**

The LED's Controller I/Controller II signal the display and operating level:

Selection by Shift key	Controll. II Master controller	Controll. I Slave controller	LED $\overline{C}$	LED Internal	LED Controll. I	LED Controll. II	displayed is Controll.	adjustable wi
	Int	Int	according	1	0	1	II	wi II ↗ [1]
Controller II	Ext	Int	to CB	0	0	0.5	II	–
Master contr.	Int	Ext		1	0	0.5[2]	II	wi II ↗ [1]
	Ext	Ext	$\overline{C}$=CB	0	0	1	II	–
	Int	Int	0	1	1	0	I	wi I ↗ [1]
Controller I	Ext	Int	0	1	0.5	0	I	wi I ↗ [1]
Slave contr.	Int	Ext	0	0	0.5[2]	0	I	
	Ext	Ext	0	0	1	0	I	

[1] only if there is no x-tracking
[2] 0.5 = flashing rhythm 1:1

Table 1-13 Switching the display levels

Flashing light signals that the status displayed by the Internal LED is identical with that in the unselected controller.

Steady light signals that the status displayed by the Internal LED is not identical with that in the selected controller.

Normally the display level switch will be in the position Controller II (master controller) so that the main controller variable xII can be monitored. The display level I is only used for startup procedures. The Automatic/Manual switch for the slave controller is possible in both display levels, depending on the selection of the display level the main controlled variable xII or the auxiliary controlled variable xI can be monitored. The display range of the digital x and w display can be adjusted separately for both controllers by the parameters d*I and d*II if necessary in connection with the linearizers so that both controllers can be displayed physically correctly.

– **x-tracking**

With S50 =1, x-tracking is selected for both controllers together (S50). The slave controller follows up the internal setpoint or the controller output to the auxiliary controlled variable xI in $\overline{A}$-operation. The master controller triggers this function in $\overline{A}$-operation or Internal of the follow-up controller (Int I corresponds like $\overline{A}$ to disconnected cascade).

Control signals				Signals						master controller working w II when				slave controller working w I when		Comments
digital inputs		front		front: Local LED when		5)	digital outputs									
H∨N∨Si 6)	CB 1)	Int II 7)	Int I 7)	Controller II	Controller I	$\overline{C}$ LED	$\overline{RB}$ 4)	$\overline{RC}$ 4)	Int I	S50 = 0 S51 = 0	S50 = 1 S51 = 0	S50 = 0 S51 = 1	S50 = 1 S51 = 1	S50 = 0	S50 = 1	
0	1	0	0	0	0	0	0	0	0	wE II (n) 2)		wE II (n) 2)		wE I (n)		
0	0	0	0	0	0	1	0	1	0	wi II (n, ↗)8)		SH 3)/wi II (n, ↗)8)		wE I (n)		cascade enabled,
0	1	1	0	1	0	0	1	1	0	wi II (n, ↗)		wi II (n, ↗)		wE I (n)		automatic mode
0	0	1	0	1	0	1	1	1	0	wi II (n, ↗)		wi II (n, ↗)		wE I (n)		
0	1	0	1	0	1	0	0	0	1	wE II (n) 2)	xII	wE II (n) 2)	x II	wi I (n, ↗)	wi I (n, ↗)	cascade disabled by Local
0	0	0	1	0	1	1	0	1	1	wi II (n, ↗)8)	xII	SH 3)/wi II (n, ↗)8)	x II	wi I (n, ↗)	wi I (n, ↗)	on slave controller,
0	1	1	1	1	1	0	1	1	1	wi II (n, ↗)	xII	wi II (n, ↗)	x II	wi I (n, ↗)	wi I (n, ↗)	automatic mode
0	0	1	1	1	1	1	1	1	1	wi II (n, ↗)	xII	wi II (n, ↗)	x II	wi I (n, ↗)	wi I (n, ↗)	
1	1	0	0	0	0	0	0	0	0	wE II (n) 2)	x II	wE II (n) 2)	x II	wE I (n)	x I	cascade disabled by manual
1	0	0	0	0	0	1	0	1	0	wi II (n, ↗)8)	x II	SH 3)/wi II (n, ↗)8)	x II	wE I (n)	x I	mode or remote manipulated
1	1	1	0	1	0	0	1	1	0	wi II (n, ↗)	x II	wi II (n, ↗)	x II	wE I (n)	x I	variable on slave controller
1	0	1	0	1	0	1	1	1	0	wi II (n, ↗)	x II	wi II (n, ↗)	x II	wE I (n)	x I	
1	1	0	1	0	1	0	0	0	1	wE II (n)	x II	wE II (n)	x II	wi I (n, ↗)	x I	cascade disabled by both Local
1	0	0	1	0	1	1	0	1	1	wi II (n, ↗)8)	x II	SH 3)/wi II (n, ↗)8)	x II	wi I (n, ↗)	x I	on slave controller and manual
1	1	1	1	1	1	0	1	1	1	wi II (n, ↗)	x II	wi II (n, ↗)	x II	wi I (n, ↗)	x I	mode or remote manipulated
1	0	1	1	1	1	1	1	1	1	wi II (n, ↗)	x II	wi II (n, ↗)	x II	wi I (n, ↗)	x I	variable on slave controller

At S52=1 (without follow-up of the inactive setpoint to the active setpoint) the (n) is omitted at wII. If x-tracking is switched on (S50=1) automatic operation of the master controller begins with w=x (xd=0), via the set setpoint ramp tS, the active setpoint runs to the old set value of w.

1) The table is shown for static computer switching without acknowledgement (S47=0).
2) Source for w_EII at S101< 2 ist $w_E\Delta$ ($\pm\Delta$w), at S101=2 w_{ES} via the SES.
3) SH can only be reached after $w_E\Delta$, if IntII=0 and CB go from 1 to 0 (computer failure). If CB=0 and Int is switched from 1 to 0, wiII is still active. Since SH is not followed up, you can switch to SH with the setpoint ramp tS.
4) By OR-linking with the digital outputs H, N, IntI and the control signal Si no computer standby or computer operation can be signaled at disconnected cascade.
5) When selecting controller I is $\overline{C}$ LED = 0
6) Manual operation or operation with external manipulated variable is always possible irrespective of the selection Controller I/ControllerII.
7) Switching only possible in the respective selected controller. Operating states are retained.
(n) followed up to the value active before switching, therefore bumpless switching
↗ adjustable

Table 1-14 Cascade control S1 = 5 with follow-up of the inactive setpoint to the active setpoint S52=0

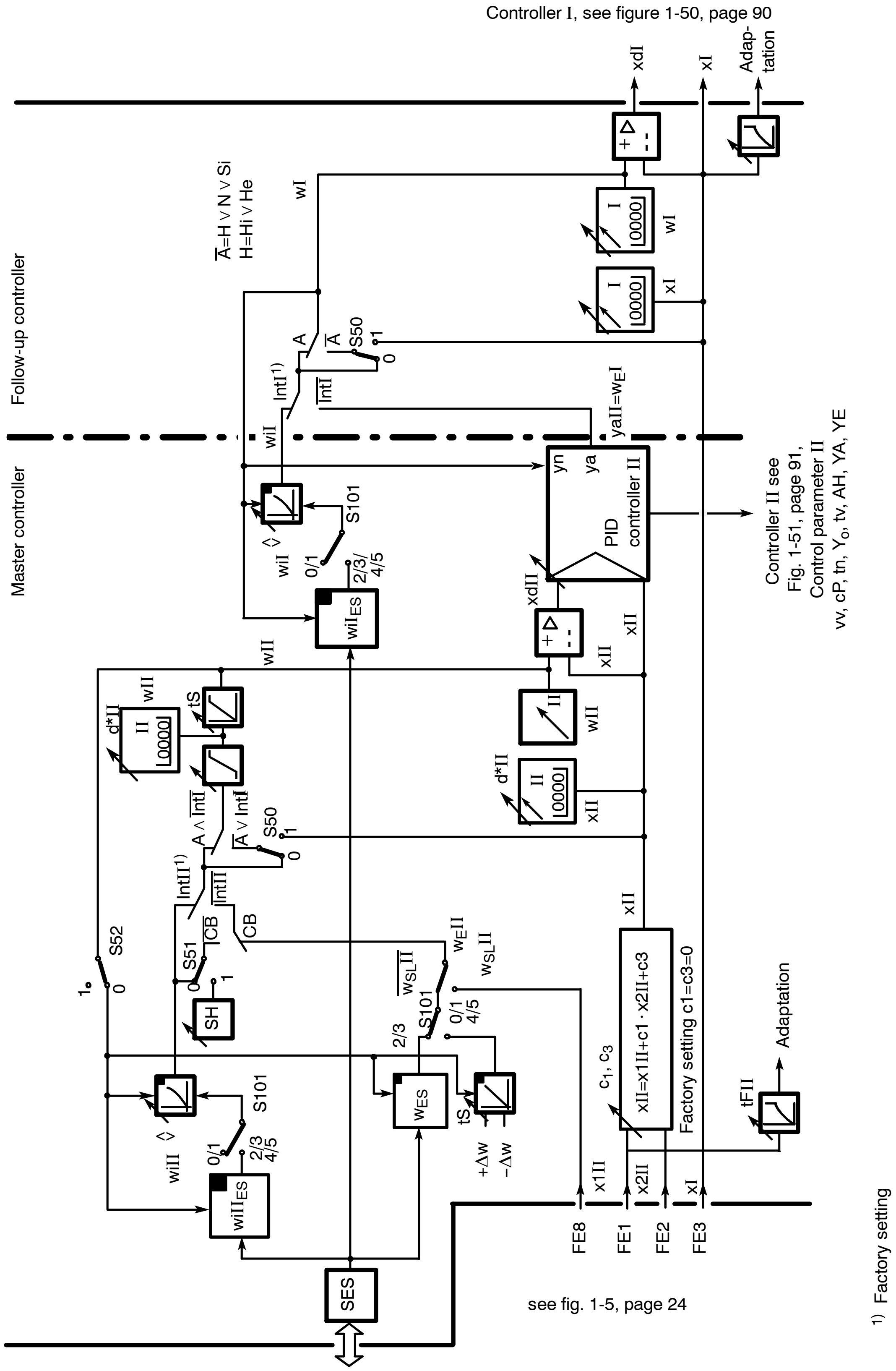


Figure 1-38 Block diagram S1 = 5 cascade control

1.5.4.8 S1 = 6: Ratio-cascade control

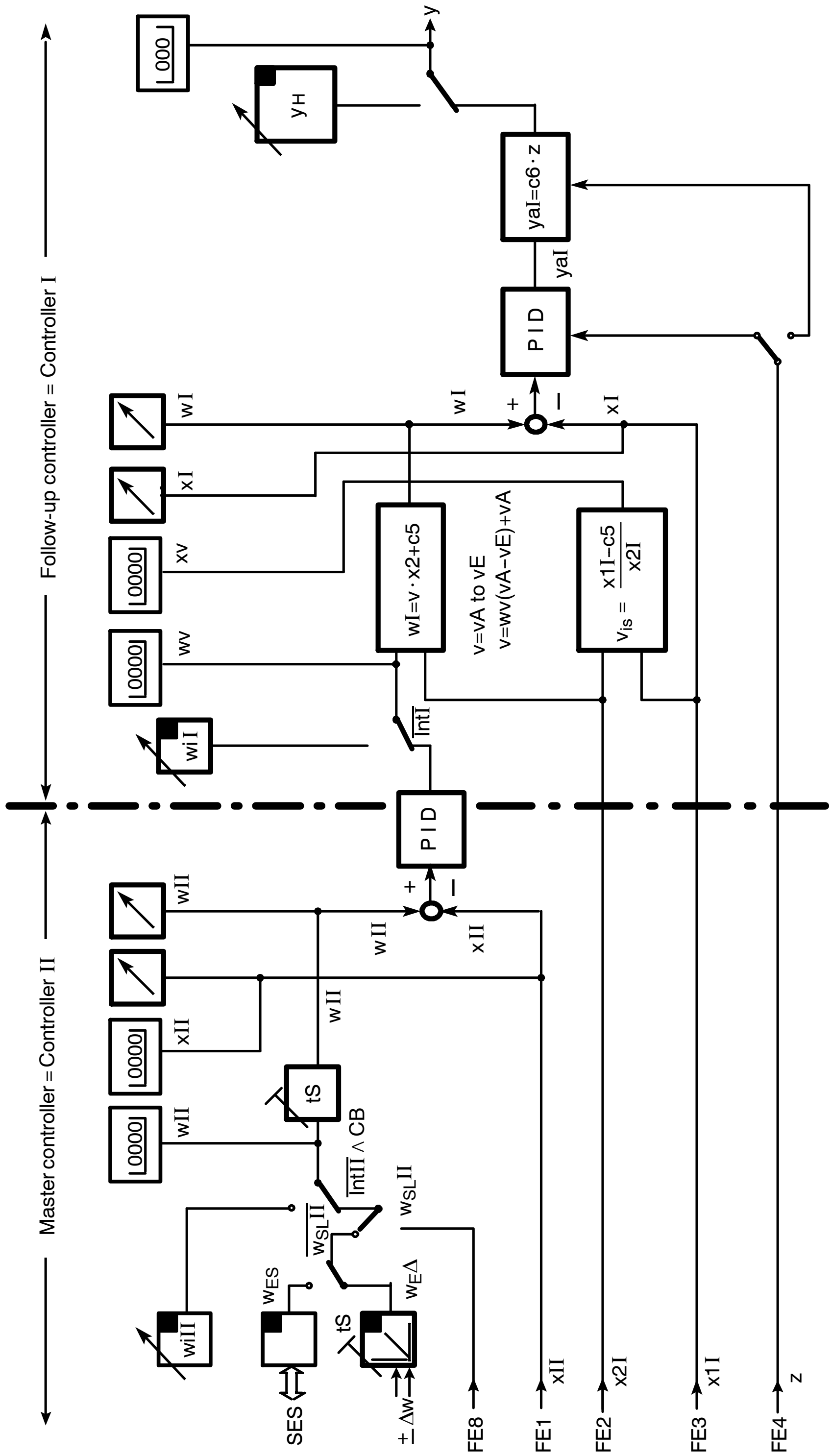


Figure 1-39 Principle representation S1 = 6

In this controller type a master controller (Controller II) and a follow-up controller as a commanded ratio controller (Controller I) are interconnected in a ratio cascade.
(Applications see S1 = 4)

- **Master controller**

  The master controller has the same structure with respect to the setpoint switching as the follow-up controller S1 = 3. It is therefore a fixed setpoint controller with the possibility of external setpoint preset via the analog signal, the serial interface or as an incremental setpoint via the control signals $\pm\Delta w$. Selection is made with $w_{SL}II$ and S101. In computer coupling it is also possible here, in the case of a computer failure (CB from 1 → 0) to continue working with the last computer setpoint (followed-up wi) or with the safety setpoint SH (selection by S51). The master controller cannot be switched to manual operation but the follow-up controller can be switched to the internal setpoint. x-tracking in $\overline{A}$-operation is possible by selection with S50 = 1. The follow-up of the inactive setpoint to the active setpoint can be switched off by S52 = 1.

- **Follow-up controller**

  The follow-up controller is a ratio controller as described under S1 = 4. To disconnect the cascade the Internal/External key (2) (Int I) can be used to switch between the internal ratio factor wvi and the external ratio factor wv_E, which is equal to the manipulated variable of the master controller (yaII). The internal operation of the follow-up controller corresponds to manual operation of the master controller.

  xv-tracking is possible in $\overline{A}$-operation by selection with S50 = 1. Setpoint limitings can be performed via limiting of the manipulated variable of the master controller and possibly by limiting the commanding process variable x2 I in the freely connectable input range (S4 = 1). The follow-up of the master controller and xv-tracking in $\overline{A}$-operation and the follow-up of the internal ratio factor wvi in external operation and in x-tracking ($\overline{A}$) always takes place so that switching is bumpless.

  Table 1-14, page 72 and the statements on x-tracking of the cascade controls apply accordingly when wi is replaced by wvi and w_E by wv_E.

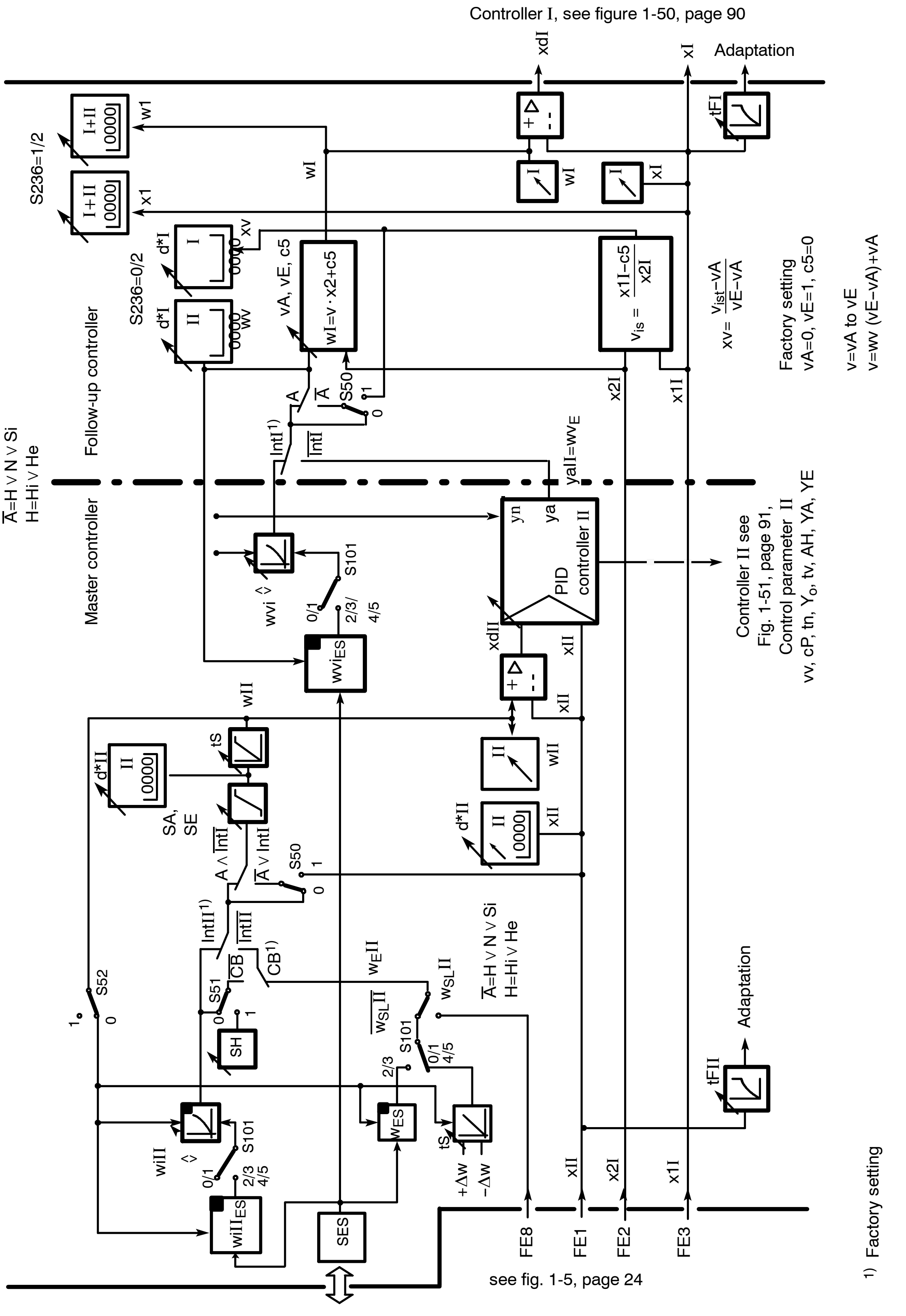


Figure 1-40 Block diagram S1 = 6 ratio cascade control

1.5.4.9 S1 = 7/8: Override control

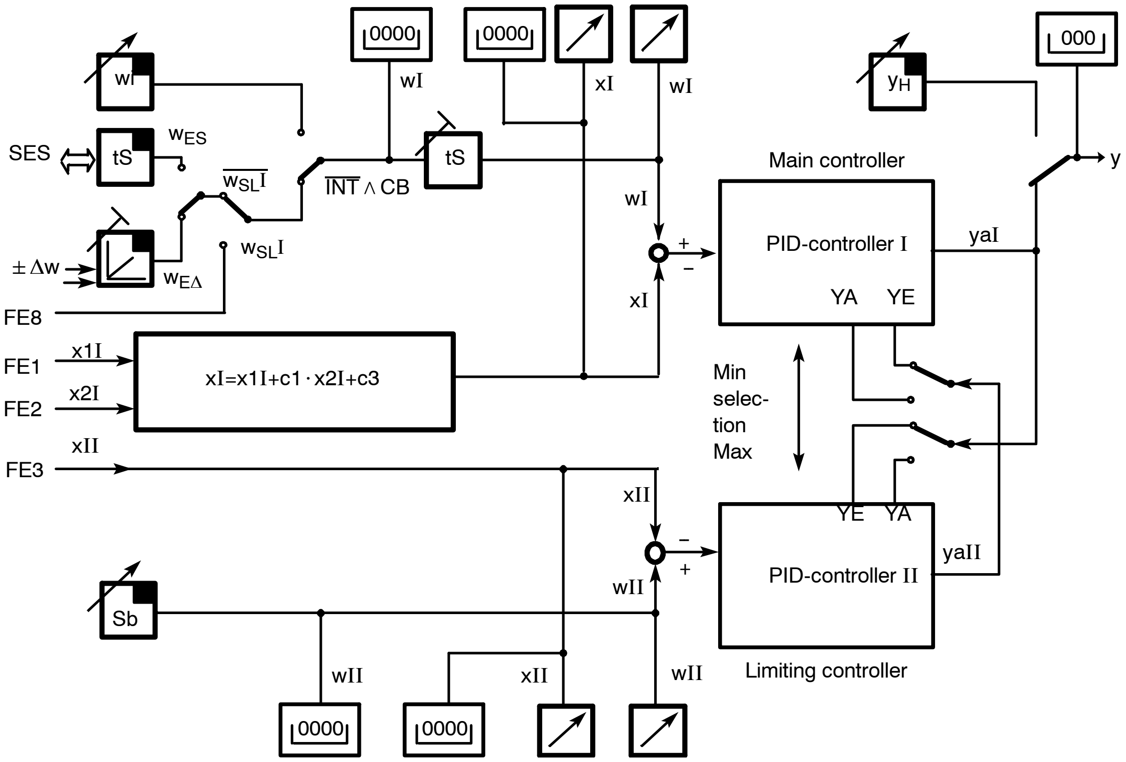


Figure 1-41 Principle representation S1 = 7/8

In the override control (limiting control, disconnecting control) two controllers are connected parallel, the main controller (Controller I) and the limiting controller (Controller II) which act on a common actuator. The manipulated variables of both controllers are mutually limited by the in this case controlled parameters YA (S1=7) or YE (S1=8). This gives a controlled variable limiting related to the setpoint set or active in both controllers.

One of the two controllers – preferably the main controller – is always intervening and controls the process. The non-intervening controller then has a control difference which controls it to the limited manipulated variable. In this case all further integration is prevented so that no integral saturation takes place. Disconnection always takes place at the latest when the control diffrence in the non-intervening controller reverses. Changes in the controlled variable in the direction of the control difference reversal also lead to disconnection via the P-part (possibly also D-part). This gives a particularly good dynamic behavior.

By the arrangement of two controllers, better adaptation to the different time behaviors of the two controlled systems is achieved than with a Minimum- or Maximum selection of the control differences. The possible implementation by Minimum or Maximum selection of the manipulated variables can lead to dynamic problems due to integral saturation of the non-intervening controller.

- **Example: Core temperature control with maximum casing temperature limiting**

The core temperature of a reactor is to be controlled without the cooled casing of the reactor exceeding a specific temperature (limiting setpoint Sb).

In error-free operation the main controller (Controller I) controls the core temperature to the set setpoint w_{core}. Since the casing temperature is below the critical limiting setpoint Sb, the limiting controller (Controller II) has a positive control difference. The manipulated variable of the main controller is fed – increased by 1% – to the limiting controller as a maximum limiting variable and forms its maximum manipulated variable. The limiting controller is driven to this limit by the positive control difference.

Its manipulated variable is also fed to the main controller as a maximum manipulated variable limit but remains ineffective because it is an increase of 1% above the manipulated variable of the main controller.

In this situation the main controller can set its manipulated variable totally independently of the limiting controller and control the core temperature of the reactor.

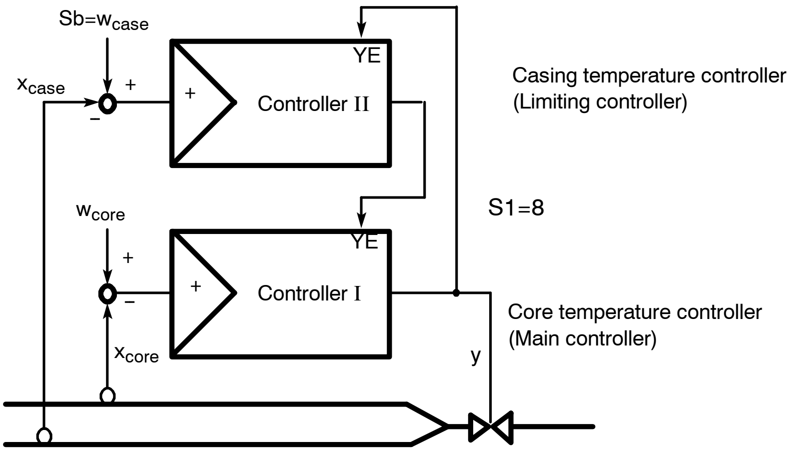


Figure 1-42 Core temperature control with max. casing temperature limiting

If the casing temperature rises above the set limiting value Sb, e.g. due to failure of the cooling water, the limiting controller gets a negative control difference. As a result its manipulated variable is released from the forced limit and the heating performance is reduced. The limiting controller then forces the reduced manipulated variable on the main controller as a maximum manipulated variable limit. Due to the reduced heating performance the main controller receives a positive control difference which drives it to the manipulated variable limit. Now the limiting controller controls the process to constant casing temperature.

When the cooling is reinstated, the casing temperature drops. The limiting controller will now increase the heating performance and maintain the casing temperature. With increasing heating performance the core temperature also increases and the control difference of the main controller becomes negative.

As a result the main controller controls down its manipulated variable and with it the heating performance and imposes the manipulated variable limit on the main controller. The case temperature drops below the limiting setpoint and the limiting controller drives to the manipulated variable limit via the now positive control difference. It is controlled to a constant core temperature.

The disconnection therefore always takes place when the controlled variable of the non-intervening controller becomes more positive than the set setpoint (xd negative), then the manipulated variable limited to maximum is dropped below, i.e. a maximum value limiting of the controlled variables takes place. The manipulated variable maximum value limiting corresponds in this example to a minimum value selection of the manipulated variables.

Depending on the structure switch position (S1 = 7 or 8) and the set controller direction of effect (normal: +Kp or reversed: -Kp) the limiting direction of the controlled variables is reversed (Minimum- or Maximum value limits):

S1	Manipulated variable limiting direction	corresponds to y-selection	Controller direction of effect		Disconnection at		Limiting of the controlled variables to	
			Main controller I	Limit ing controller II	Main controller I	Limiting controller II	xI	xII
7	yA	Max	norm +Kp	norm +Kp	xdI > 0, x I< wI	xdII > 0, xII < Sb	Min	Min
7	yA	Max	rev -Kp	rev -Kp	xdI < 0, xI > wI	xdII < 0, xII > Sb	Max	Max
8	yE	Min	norm +Kp	norm +Kp	xdI < 0, xI > wI	xdII < 0, xII > Sb	Max	Max
8	yE	Min	rev -Kp	rev -Kp	xdI > 0, xI < wI	xdII > 0, xII < Sb	Min	Min
7	yA	Max	norm +Kp	rev -Kp	xdI > 0, xI < wI	xdII < 0, xII > Sb	Min	Max
7	yA	Max	rev -Kp	norm +Kp	xdI < 0, xI > wI	xdII > 0, xII < Sb	Max	Min
8	yE	Min	norm +Kp	rev -Kp	xdI < 0, xI > wI	xdII > 0, xII < Sb	Max	Min
8	yE	Min	rev -Kp	norm +Kp	xdI > 0, xI < wI	xdII > 0, xII > Sb	Min	Max

Table 1-15 Limiting direction of the controlled variables depending on S1 = 7/8 and controller direction of effect

The direction of effect of the transmitter, actuator and controlled system are included in the determining of the controller direction of effect (see chapter 4.1, page 215). As a rule, limiting controllers and main controllers have the same direction of effect so that the second part of the table is irrelevant.

- **Main controller I**

  The main controller has the same structure with respect to the setpoint switching as the follow-up controller (S1 = 3) with the difference that the external setpoint w_E cannot be preset via the analog inputs as an absolute value. It is therefore a fixed setpoint controller with the possibility of external sepoint preset via the SES or as an incremental setpoint via the control signals ±Δw. Selection is made by S101. In computer coupling it is also possible here, in the case of a computer failure (CB from 1 → 0) to continue working with the last computer setpoint (followed–up wi) or with the safety setpoint SH (selection by S51).

  x-tracking in $\overline{A}$-operation is posssible by selection with S50 = 1. The follow-up of the inactive setpoint to the active setpoint can be switched off by S52 = 1.

- **Limiting controller II**

  The limiting controller has a normal fixed setpoint structure without x-tracking and setpoint switching possibilities. The limiting setpoint Sb is set physically in the structuring mode oFPA in the range from -10 to 110 % related to the display range dEII - dAII = 100 %.

- **Display and operating level switching**

  The display and operating level switching Controller I or Controller II takes place in all operating modes with the Shift key (12). The LEDs Controller I, Controller II signal which controller is displayed and which controller is intervening.

  The digital and analog x- and w-displays are switched. In the operating level II the Internal key (2) is inactive, the LED Internal (1) is off and the ±Δw adjusting keys (6) are inactive. **The y-display, the Manual/Automatic key (9) and the ±Δy-adjusting keys (13) are always permanently assigned to the common controller output and active in both display levels.**

Selection by Shift key	active controller	LED controller I	LED controller II	displayed is	adjustable setpoint
Main controller I	Main controller I	1	0	I	wi ↗ 1)
Limiting controller II	Main controller I	0	0.5 2)	II	–
Main controller I	Limiting controller II	0.5 2)	0	I	wi ↗ 1)
Limiting controller II	Limiting controller II	0	1	II	–

1) only if there is no x-tracking
2) 0.5 flashing rhythm 1:1
↗ adjustable

Table 1-16 Display level switching

Flashing of the Controller I/Controller II-LEDs signals that the displayed controller is not identical with the active controller. Steady light signals that the displayed controller is not identical with the active controller.

The process can be monitored at any time by manual switching. As a rule the display level switch is in position I (main controller) so that the main controller variable x1I can be monitored. Flashing of the Controller LED I signals that the limiting setpoint has been reached and requests switching to the display level II (limiting controller) with the controlled variable of the limiting controller.

The display range must be set separately for the digital x and w display for both controllers with the parameters d*I and d*II if necessary in connection with the linearizers so that both controllers can be displayed correctly.

– **Automatic/Manual switching**

Since both controllers only generate one common automatic manipulated variable y_a, the Automatic/Manual switching of both controllers is also common. In manual-, follow-up-, safety- or blocking operation, both controllers are followed up to the active y. The manipulated variable limit which is only active in automatic operation via the parameters YAI and YEI represents an absolute manipulated variable limit in automatic operation. The mutual follow-up of YA or YE can only take place up to the set limits. By setting YAI and YEI, YAII and YEII are set to the same value automatically on leaving the parameterization mode onPA.

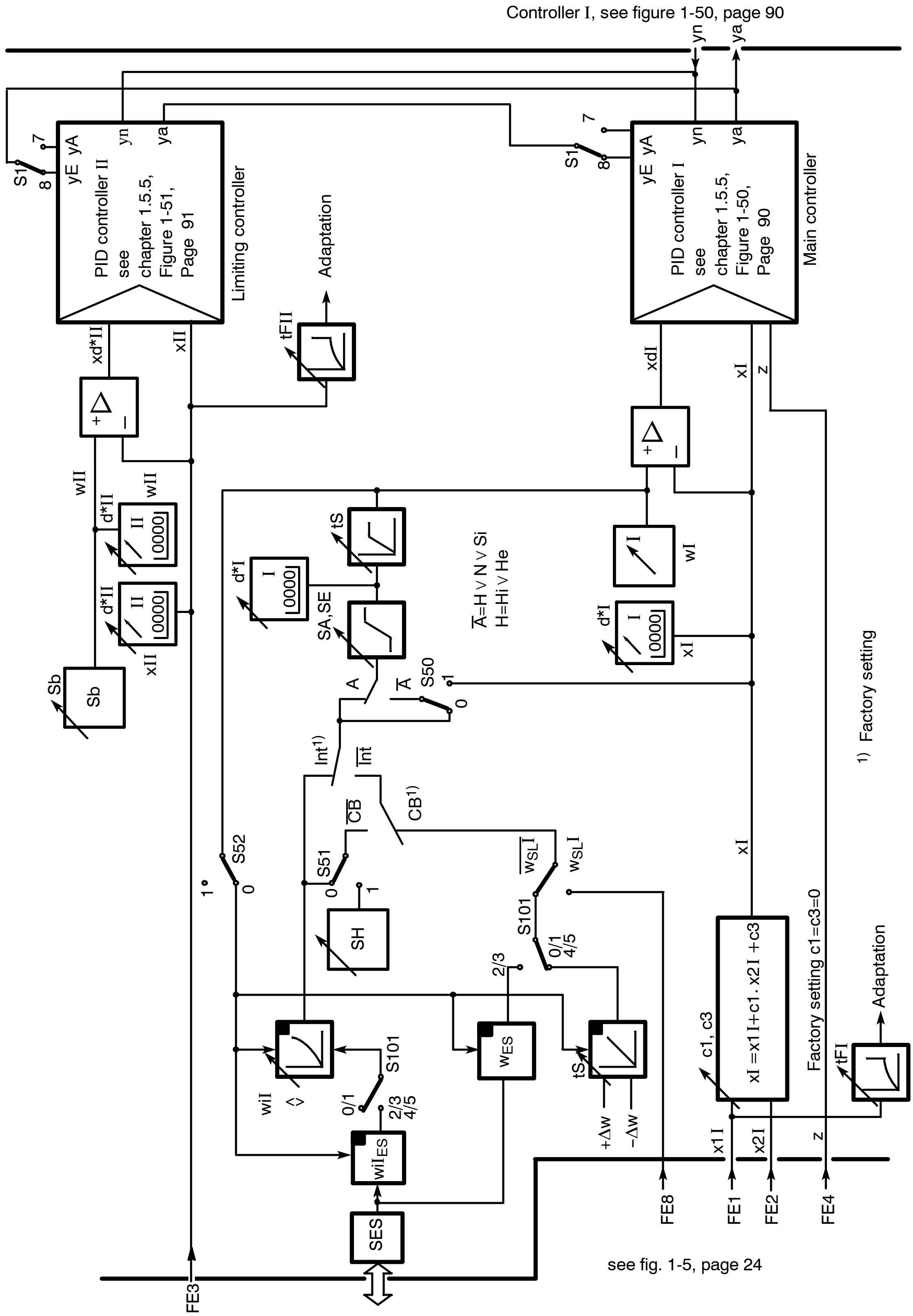


Figure 1-43 Block diagram S1 = 7/8, Override control

1.5.4.10 S1 = 9: Process display

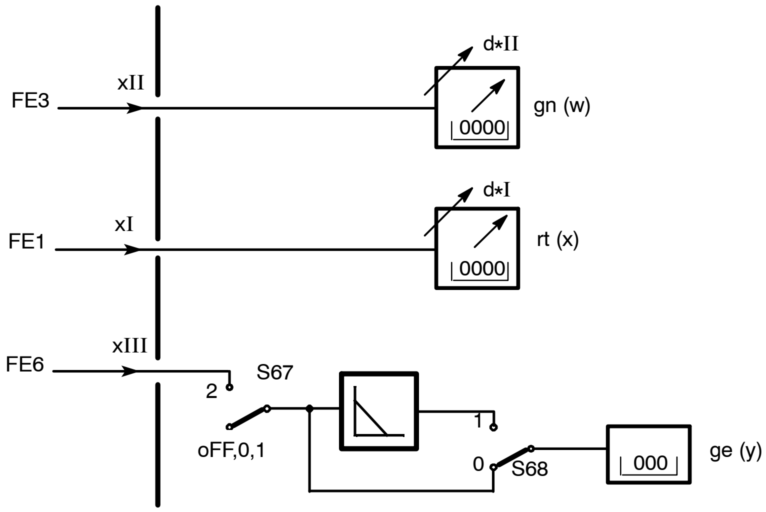


Figure 1-44 Block diagram, process display

The process display provides the possibility of displaying three process variables (xI to xIII).

The process variables xI and xII are indicated on the x- and w-display whereby the digital and analog displays are connected in parallel. With the parameters d*I and d*II, if necessary in connection with the linearizers, both process variables can be displayed separately physically correctly. The switching possibility of the display level is disabled. The LEDs Controller I/Controller II are dark.

The process variable xIII is indicated by the y-display and can be switched off by the structure switch S67 in the oFF position. The display range here is 0 to 100 %, according to the position of S68 mit rising or falling characteristic. The display overrun is -10 to 110 %. Alarm messages are possible by assigning the limit value alarms A1 to A4 to FE1, FE3 or FE6 (see chapter 1.5.9, page 124).

1.5.4.11 S1 = 10: Fixed setpoint controller with 1 setpoint (control system coupling)

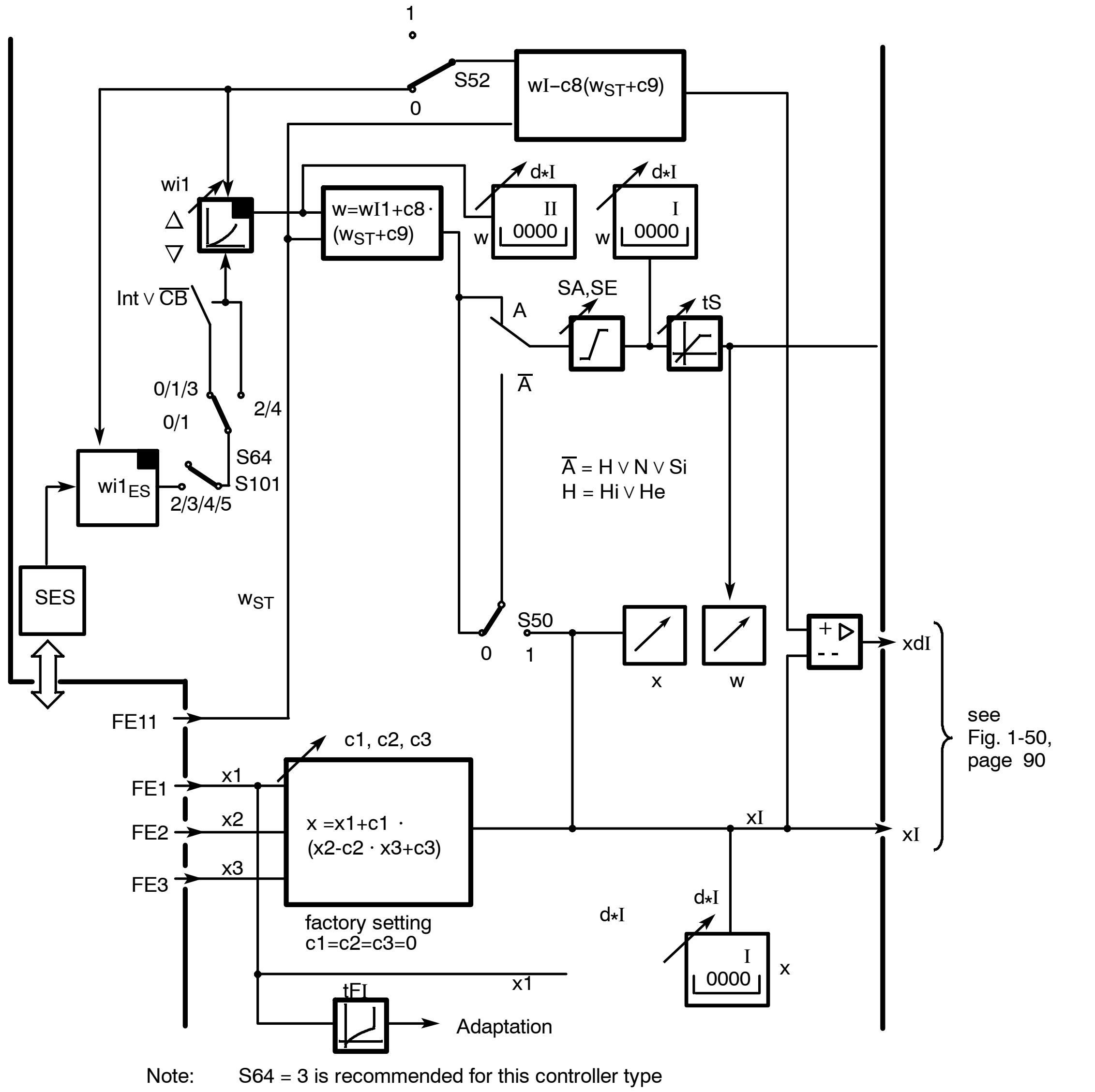


Figure 1-45 Block diagram S1 = 10, fixed setpoint controller for control system coupling

This fixed setpoint controller is designed specially for coupling to the control system.
The control interventions by the signals Int and CB which cannot be used otherwise in this controller type are available for locking the control system operation via the SES.

With Int ∨ $\overline{\text{CB}}$ the setpoint signal wi_{ES} is separated and the manual intervention via He_{ES} at S64 = 3 suppressed.

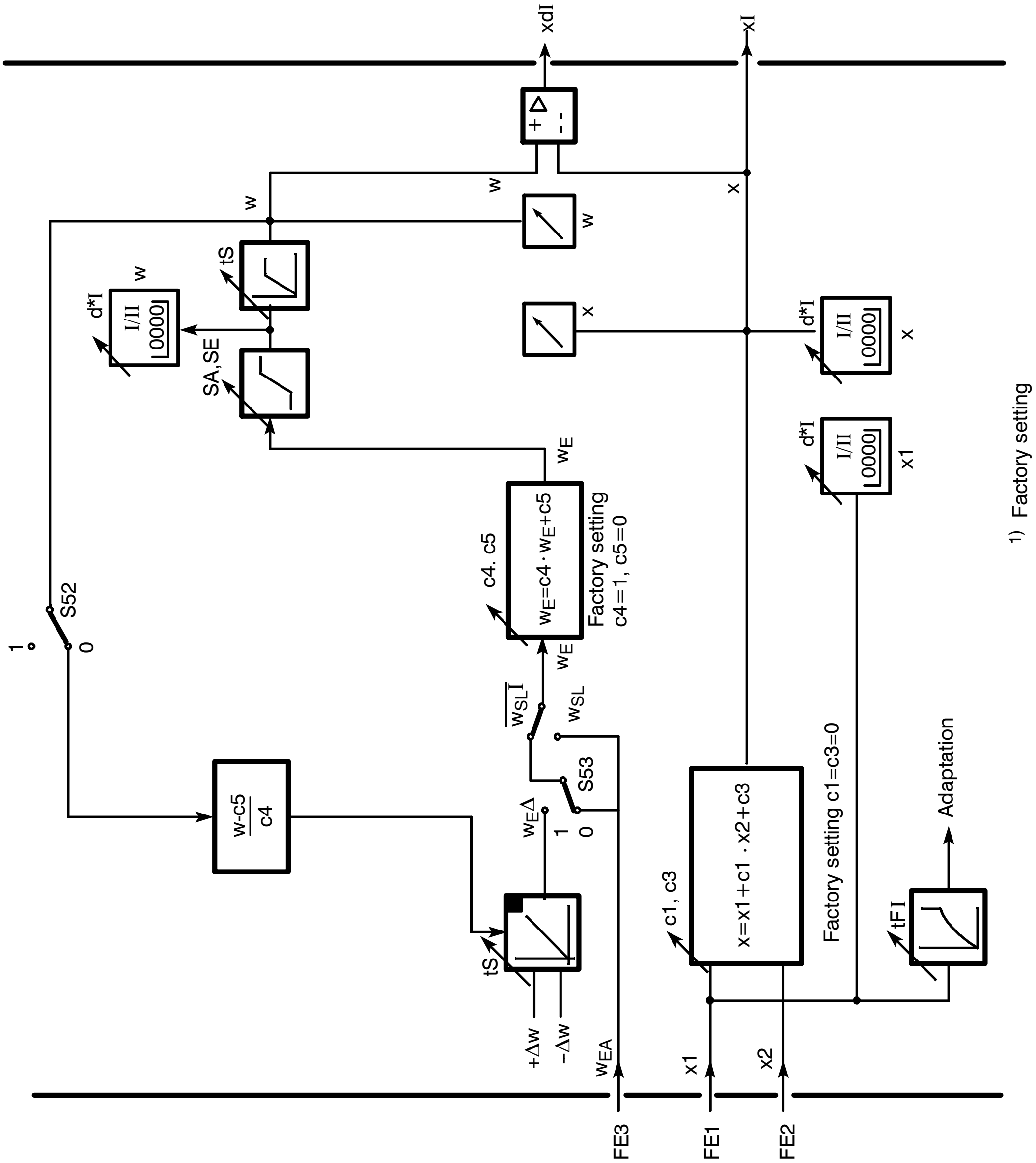
S64 = 3 is expressly recommended for this connection.
The other connection of the input function is almost identical with the structure S1 = 0.

1.5.4.12 S1 = 11: Follow-up controller without Int/Ext switching (control system coupling)

This follow-up controller is designed specially for the control system coupling. It differs from the structure S1 = 3 in that the setpoint switching to w_i via Int and CB is omitted and thus these control signals are available for locking the control system operation via the SES. With Int ∨ $\overline{CB}$ the manual intervention via He_{ES} at S64 = 3 is suppressed. S64 = 3 is expressly recommended for this connection.

Disconnection of a cascade control is made by manual manipulation at the master controller. The other functions are unchanged in relation to S1 = 3.

see fig. 1-50, page 90



see fig. 1-5, page 24

Figure 1-46 Block diagram S1=11 Follow-up controller for control system coupling

1.5.4.13 S1=12: Double fixed setpoint/follow-up controller

At S1=12, 2 independently operating controllers with fixed setpoint/follow-up controller function are available. With the Shift key the operating and display levels are switched completely between the two controllers.

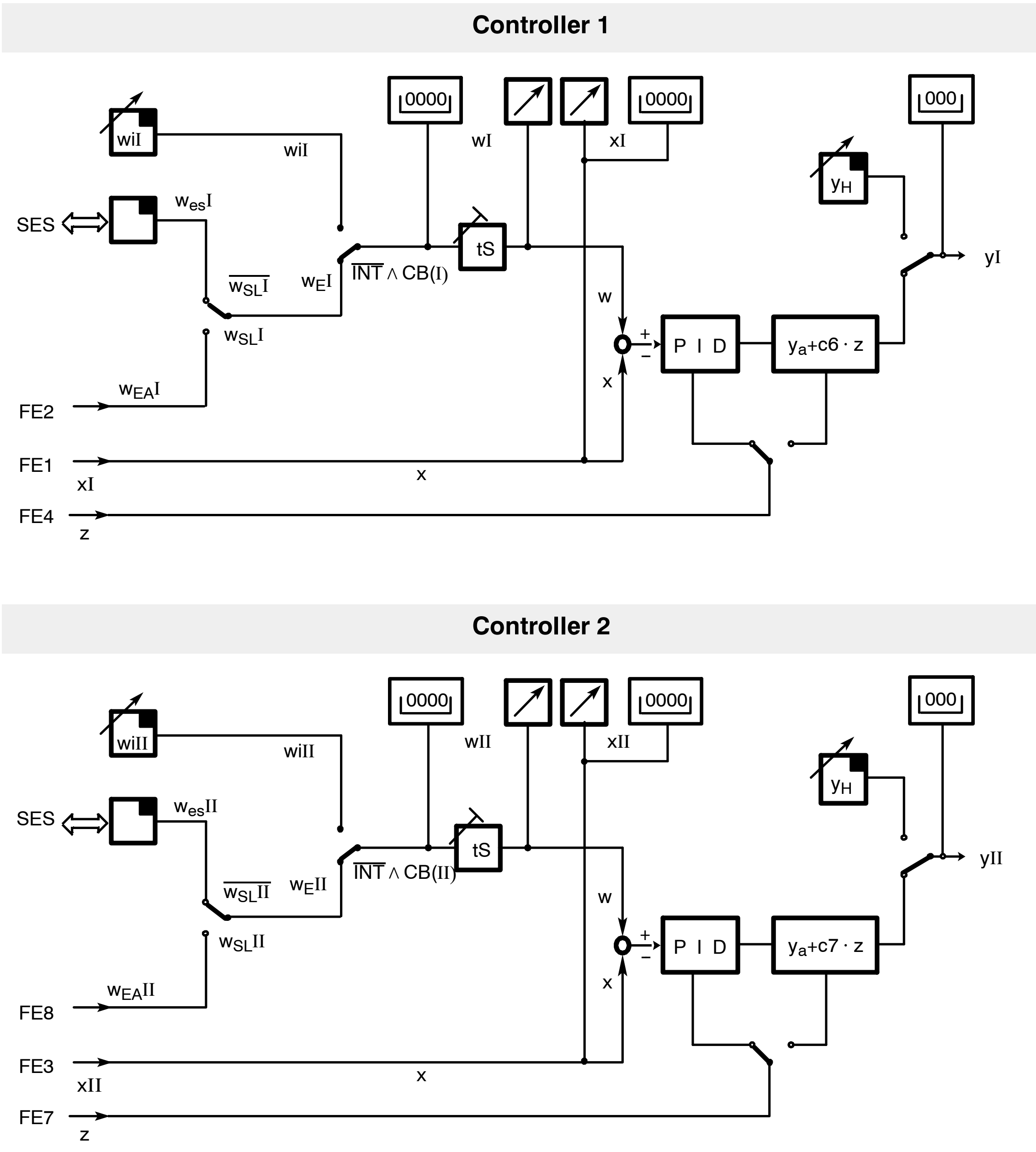


Figure 1-47 Principle representation S1 = 12 double controller

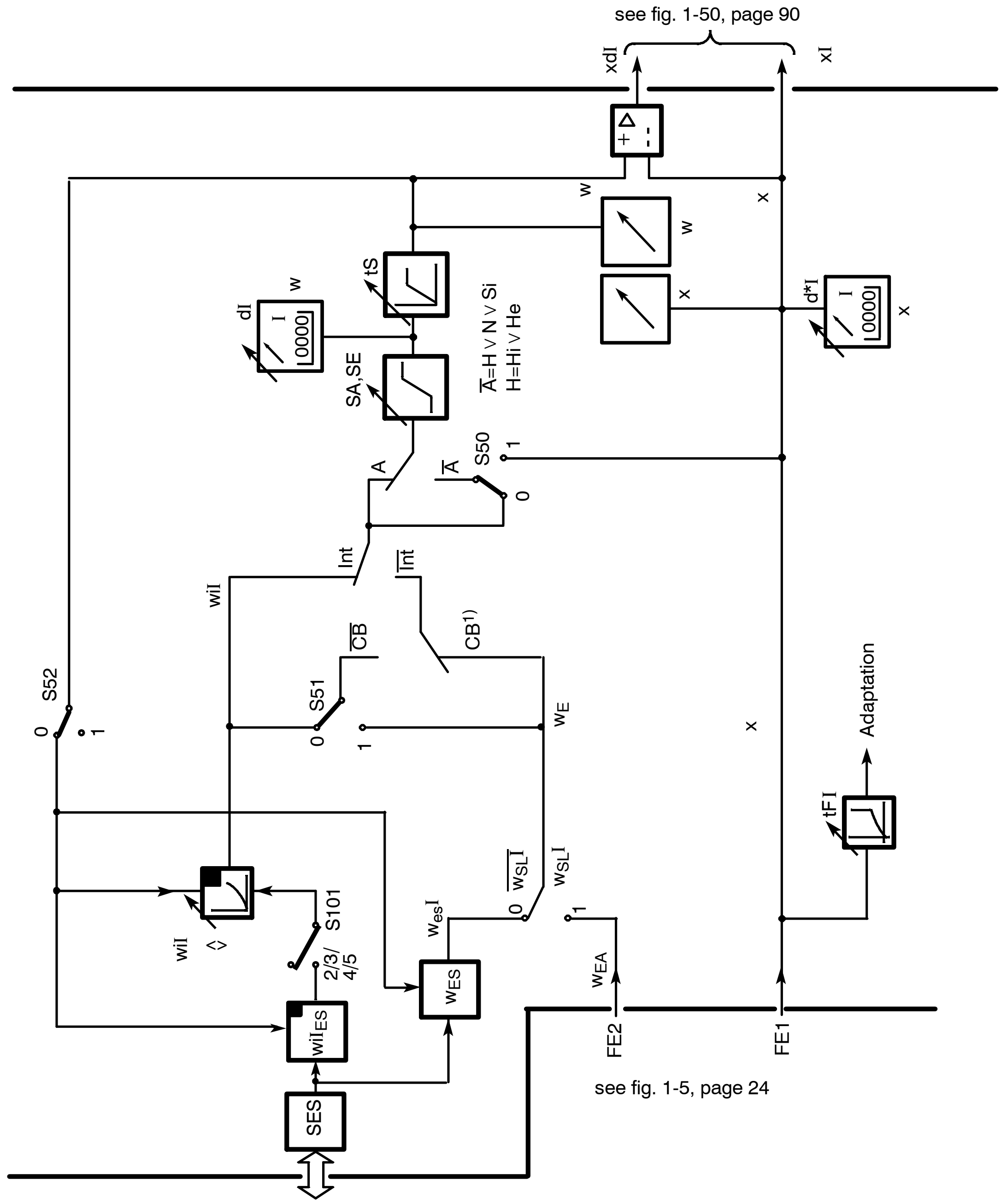


Figure 1-48 Block diagram controller I at S1=12

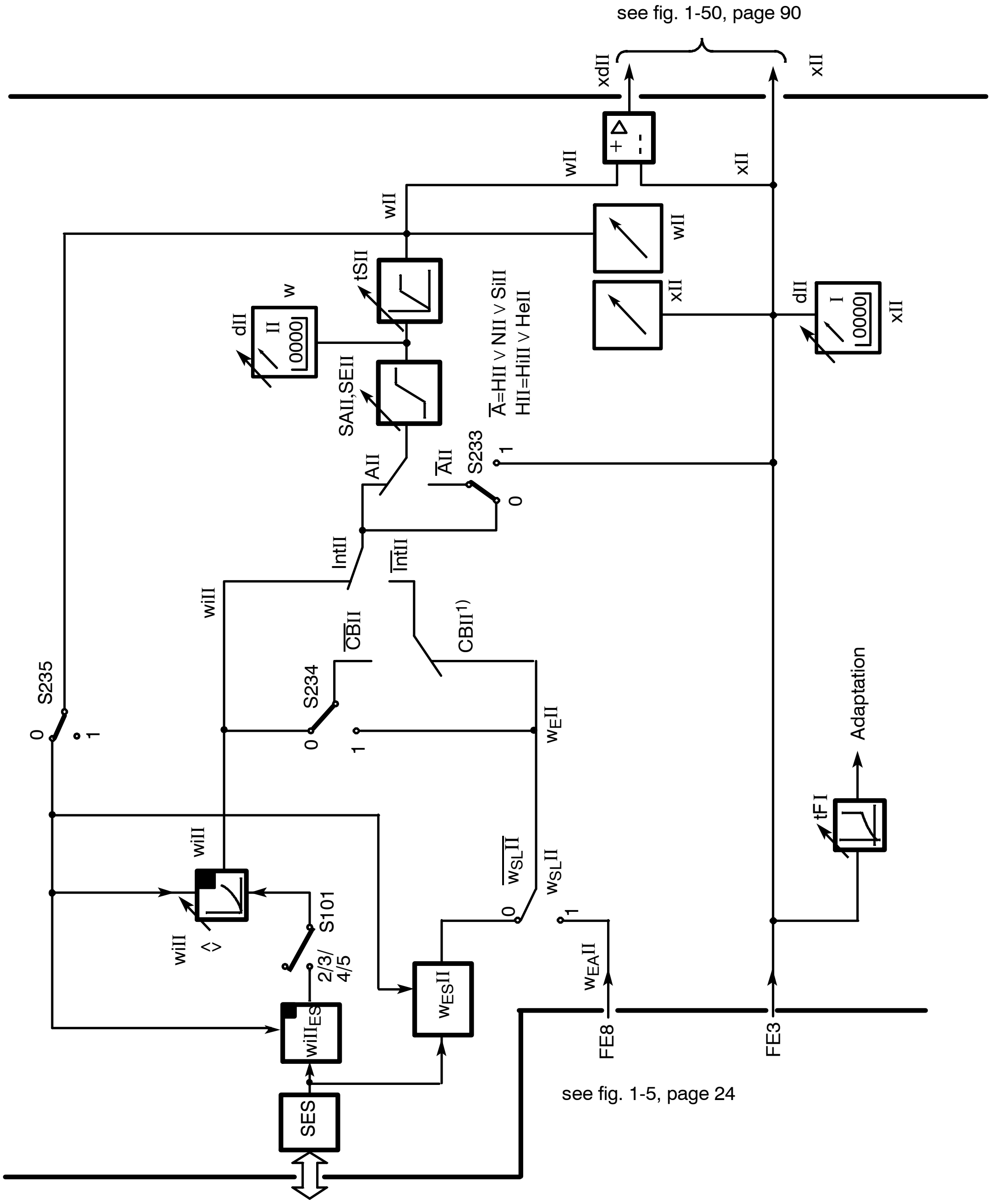


Figure 1-49 Block diagram controller II at S1=12

1.5.5 Control algorithm, parameter control, adaptation

(S54 to S60)

1.5.5.1 Control algorithm

The PiD control algorithm of controller I and II 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**

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

- **D-part (zD-part)**

The D-part can be added optionally.

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

The input variable E for the D-part is xd, x, -z, or +z depending on the setting of S55 or S57.

- **zy-part**

The z-part can be added proportionally or differentiated to the controller output ya.

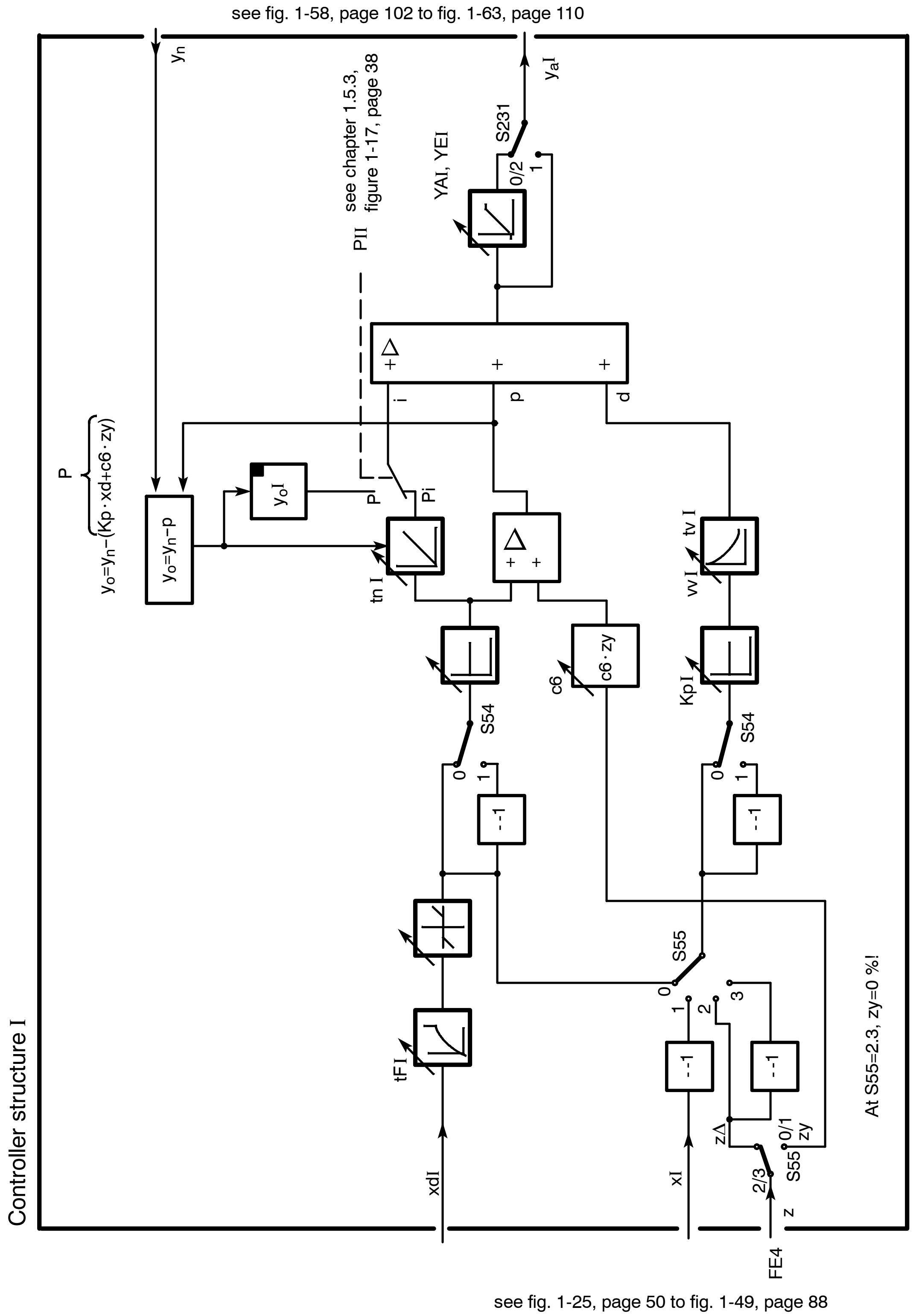
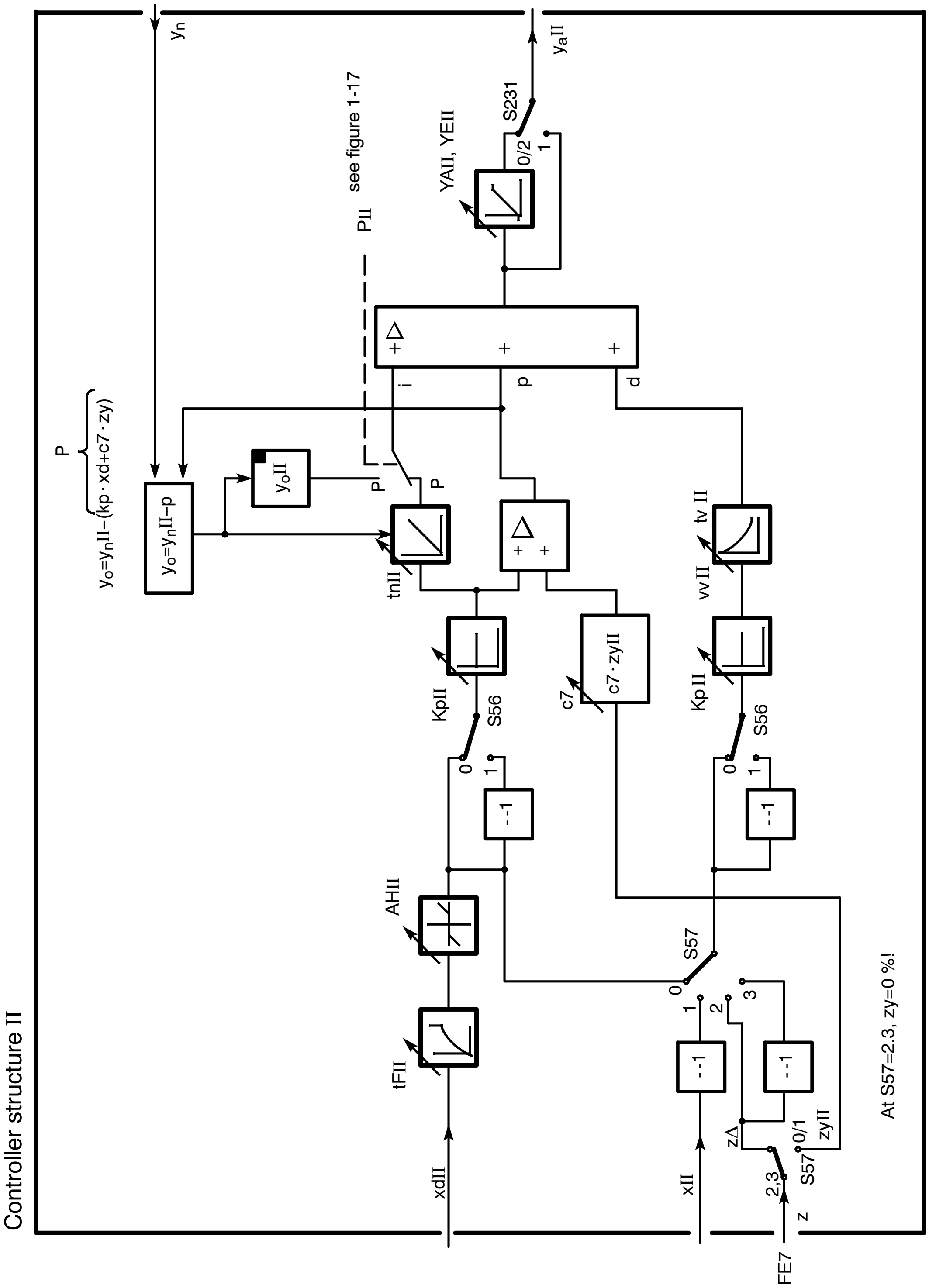


Figure 1-50 Block diagram controller structure I

see fig. 1-64, page 115 to fig. 1-68, page 119 or
Fig. 1-38 page 73 and fig. 1-40, page 76



see fig. 1-25, page 50 to fig. 1-49, page 88

Figure 1-51 Block diagram controller structure II

Controller direction of effect

The controller direction of effect is set with S54 (controller I) or S56 (controller II), it must always have an opposite behavior (reverse coupling) to the controlled system (including actuator and transmitter)
S54/56= 0, normally acting controller (+Kp, rising x causes falling y) for normally acting systems (rising y causes rising x)
S54/56=1, reversing controller (−Kp, rising x causes rising y) for reversing systems (rising y causes falling x).

Operating point yo for P-controller

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

  Whenever there is no automatic operation (manual, follow-up, safety or blocking operation) the operating point yo is followed up so that switching to automatic operation is bumpless.

  This gives an automatic setting of the operating point yo in manual mode:

  $yo = y_H \pm K_p (w - x_H) \pm c6 \cdot z_{yII}$ in controller II or
  $yo = y_H \pm K_p (w - x_H) \pm c6 \cdot z_y$ in controller I

  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).

  $yo = y_H$ or $yo = y_H \pm c6 \cdot z_y$.

- **Set operating point (Yo = 0 to 100 %)**
- The controller operates in all operating modes with the operating point set as a permanent parameter.

Bumpless switching to automatic mode

If there is no automatic operation (manual, follow-up, safety or active blocking operation) the I-part or the operating point yo (only at Yo = Auto) is followed up 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.

Manipulated variable limiting yA, yE (yAII, yEII at S1=12)

The manipulated variable limiting with the parameters YA and YE is active in automatic operation in any case. The limits of these parameters are at −10 and +110 %. However, it should be taken into account that the controllers neither output negative actuating currents nor detect any negative position feedback signals.

If the manipulated variable y_a reaches one of the limits YA or YE in automatic 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-, follow-up- (DDC) or safety operation the manipulated variable y can be driven out of the limiting range (only at S245=0 or S246=0). When switching to automatic mode the last manipulated variable is transfered bumplessly, then only changes in the manipulated variable in direction of the range YA to YE are executed.
In controller I the manipulated variable limiting is only possible in K-controllers and three-position step controllers with external position feedback (S2=0 and S2=3).

Adaptive filter

The control difference xd is fed through an adaptive filter. By adjusting tFI or tFII (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 repeatedly take place, changes are seen as disturbances by the filter and are filtered with the preset time constant tF*; Changes in a direction leading out of the band are passed unfiltered to the Pi(D) algorithm to enable fast control. If the disturbance level changes in time, the filter is automatically adapted to the new level.

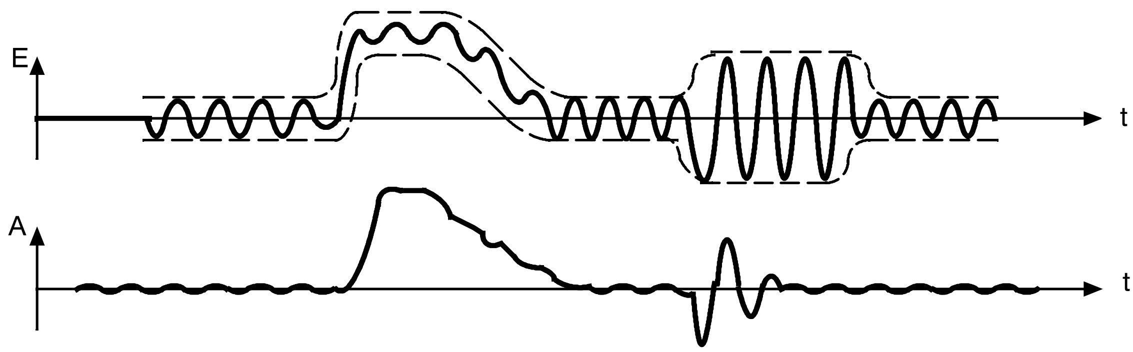


Figure 1-52 Effect of the adaptive non-linear filter

The factory setting of tFI and tFII 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 (see chapter 4.4, page 219).

Response threshold AH

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

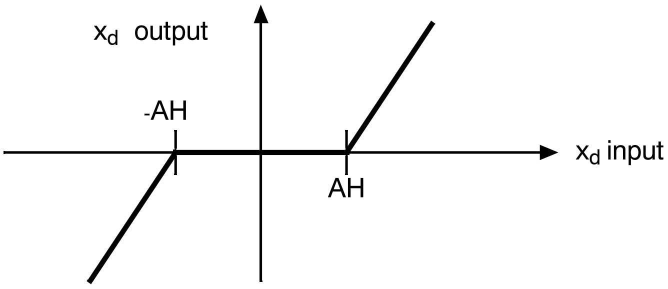


Figure 1-53 Effect of the dead zone element

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 $\Delta x = ks \cdot \Delta y$ (see chapter 4.3, page 218) and can be increased for further calming of the controlled system. In K-controllers a small threshold value is advisable for calming the control circuit and reducing wear.

Parameter switching

The single controllers, i.e. fixed setpoint controllers with two independent setpoints, fixed set-point controllers with two dependent setpoints, DDC-fixed setpoint controllers, follow-up controllers (synchronized controllers, SPC-controllers) and ratio controllers operate with the parameter set I and can be switched via the control signal PAU = 1 to the parameter set II . Both parameter sets are separately adjustable in the parameter mode onPA. Every parameter set contains the parameters vv, cP, tn tv, AH, Yo, YA and YE with the ID I or II. The switching facility is conceived for 2-batch mode and should be performed manually since it cannot be bumpless in automatic operation.

Double controllers (cascade control, ratio cascade control and override control) operate with the separately adjustable parameter sets I and II for the controllers I and II. There is no longer a possibility of parameter switching by the control signal PAU.

Parameter control

With the structure switch S59 the parameter sets I or II can be replaced by a controlled parameter set except for YA and YE. In double controllers one of the two controllers can operate with controlled parameters. In single controllers the controlled parameter set can be used for operation and additionally it can be switched to a fixed parameter set by the control signal PAU. The parameters cP (Kp), tn, tv, AH and Yo are controlled by a straight line with 5 vertex points at 10 %, 30 %, 50 %, 70 % and 90 % of the controlling variable. The controlling variable is selected by S60. All control-relevant, controller-internal variables are available.

S59	PAU	active parameter set
0	0	Parameter set I
0	1	Parameter set II
1	0	controlled parameter set
1	1	Parameter set II
2	0	Parameter set I
2	1	controlled parameter set

Table 1-17 active parameter sets for single controllers depending on S59 and control signal PAU

The parameters are set manually per vertex point (identified by the suffix 1, 3, 5, 7, 9 for 10 %, 30 %, 50 %, 70 %, 90 % of the controlling variable in structuring mode PAST. Beyond the marginal vertex points 10 and 90 % the set values remain constant. (Exception: Yo can be controlled over the whole range 0 to 100 %.)

For parameters which do not need to be controlled, same values are set for all vertex points. The derivative action gain vvc is not controllable but can be set in the range from 0.1 to 10.

When controlling tv a supplementary condition must be satisfied: tv.1 to tv.9 must either be all = oFF (Pi or P controller) or all ≠ oFF (PID or PD controller). Otherwise the error message tv/Err appears when jumping out of the structuring mode PAST with the Exit key (see chapter 3.3.3, page 175).

Yo is controllable in the range from 0 to 100 % and then acts like a ”fixed set” operating point. Yo = Auto can also be set, in this case no parameter control takes place but the operating point is set automatically in non–automatic operation (see operating point in P-controller).

Yo.1 to Yo.9 must either be set all = Auto or all ≠ Auto. Otherwise the error message Yo/Err appears when jumping out of the structuring mode PASt with the Exit key (see chapter 3.3.3, page 175).

Typical controlling variables are the control difference xd (it acts as 10|xd|) for progressive controls and x or y for operating point dependent controls (non-linear controlled systems).
If S60 = 17 is set, a controling variable of 10% is simulated in Pi operation and a controlling variable of 30% in P operation. In this way you can work with large Kp (cP.3) for example in P operation (control signal P=1) to reach the operating point quickly. After switching to Pi operation (control signal P=0) a reduced Kp (cP.1) is active for a stable control.
The parameter values and the value of the controlling variable can be gained by adaptation (see section ”Adaptation” on the next page).

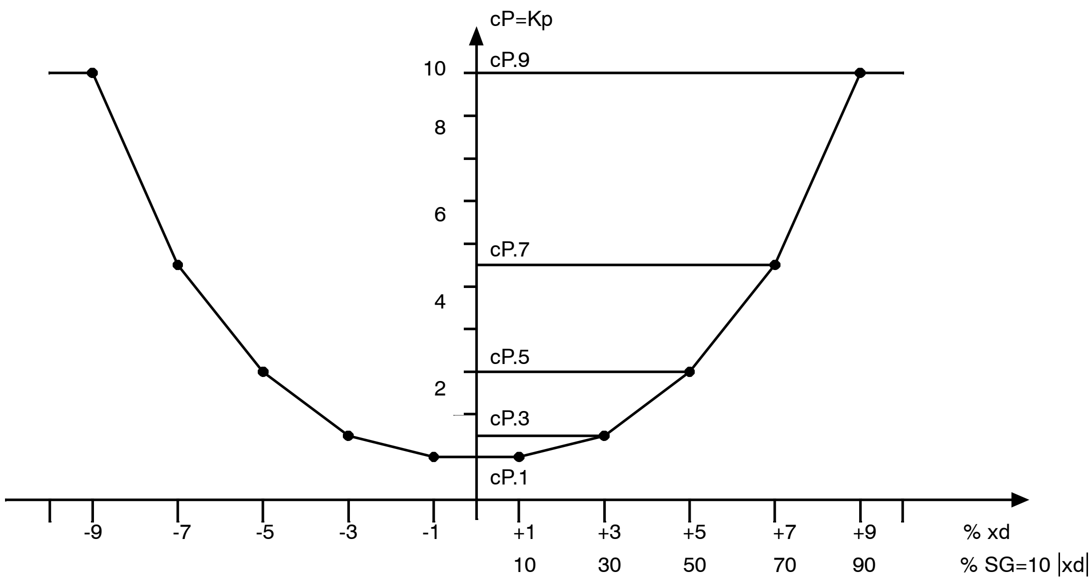


Figure 1-54 Example of a Kp control with 10|xd| as a controlling variable for progressive control

Adaptation (S58)

The adaptation procedure represents a reliable and easy to operate commissioning tool. The adaptation procedure is far superior to manual optimization especially in slow controlled systems and in PIC controller types. It is activated by the operator and can be aborted at any time in the event of danger. The parameters determined by the adaptation can be changed and accepted specifically by the user. Non-linear control lines can also be mastered in connection with the parameter control.

In the parameterization mode AdAP which is only accessible at S58 $\neq 0$, the following presettings are made for the adaptation procedure:

tU Monitoring time
dPv Direction of step command
dY Amplitude of step command

With the structure switch S58 the choice of the control behavior (with or without overshoot) is made.
The adaptation principle is divided into line identification and controller design.

- **Line identification**

  The controller is driven to the desired operating point manually. By pressing the Enter key the set manual manipulated variable is changed by a step adjustable in the direction (dPv) and amplitude (dY). The y-step is output at the end of 10 % of the set monitoring time (tU) if there was a fixed state of the controlled variable during this time. Otherwise there is an error message with abortion of the identification (see chapter 3.3.3, table 3–2, page 177).

The step response of the controlled system is then accepted with a max. 84 value pairs (time and amplitude). The respective main controlled variable of the different control types is filtered adaptively – (see figures 1-25, page 50 to figure 1-43, page 82) to use for controlled variable measurement. The measured values are read in with a scanning rate according to the cycle time. The noise level is suppressed by the adaptive filter. The storage procedure operates with cyclic data reduction and subsequent refilling so that slow controlled systems can be entered.

After the start ID has been run through (the controlled variable x must have left the start ID band within 50% of the set monitoring time tU), 95% of the full range must have been reached at the latest at $^{2}/_{3}$ of tU. The set monitoring time (tU) must be $\geq$ 2 T95 of the controlled system with safety reserve. The remaining time is required for the full scale identification. The full scale identification can also take place immediately after the start identification, but $^{1}/_{3}$ of the performed measurements are always required for the full scale identification. Recording of the measured value pairs is ended on identifying the full scale.

A comparison with the recorded transient function is now made based on the stored Ptn models with n = 1 to 8 and equal time constants T by variation of n and T. The determined line gain ks is transfered to the line models. The comparison is made over the minimum error area F (n, T)

Additionally a special entry of real dead times is made which then shifts the identified control line to higher orders.

Control lines with compensation and periodic transient of 1st to 8th order with a transient time T95 of 5 s to 12 h can be identified. Dead time parts are permissible. In S-controllers the transient time T95 should be twice the positioning time Ty.

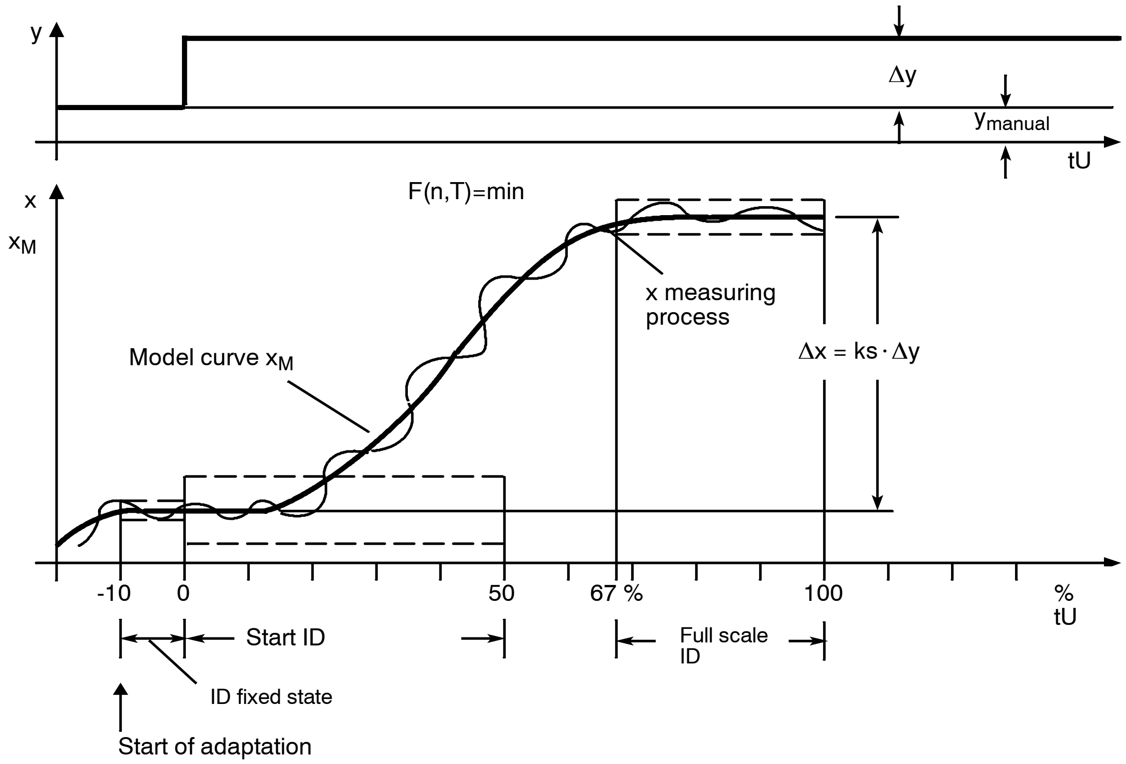


Figure 1-55 Time curve of an adaptation without error messages in which tU = 2 × T95

Error checks are made during line identification in order to be able to prematurely abort the identification. There are 13 control steps altogether which are displayed by flashing on the digital x- and w- displays when errors occur. As soon as an error message appears, the line identification is aborted and it must be restarted after correcting the presettings in the parameterization mode AdAP if necessary. Acknowledgement of the error messages, see table 3-2 ”Error messages of the adaptation procedure”, page 177.

- **Controller design**

The controller is designed according to the amount optimum method (S58=2). This setting method is very robust and also allows variation of the line amplification. However, it generates an overshoot of approx. 5 % in the event of changes in the command variables. If this is not wanted, you can also work with the controller design without overshoot (S58 = 1), Kp is reduced here to 80 %.

The controller is designed for PI and PID behavior, therefore kp, tn and for PID tv are calculated, whereby the derivative action gain is fixed at 5. A prerequisite is that the D-element is connected with xd or x (S55 = 0 or 1).

In S-controllers the response threshold AH is calculated in addition to kp, tn, tv. The parameters tA, tE and tY must be set beforehand according to the actuating drives used (see chapter 4.3, page 218). If the transient time T95 is near to 2 tY (floating time) overshooting may also occur in controller designs with D-part at S58=1.

In controlled systems of the 1st order a Pi or PID controller design cannot be implemented according to the amount optimum, in systems of 2nd order a PID controller design cannot be implemented because in these cases Kp goes to ∞. A controller design is made in which the ratio of system time constant to control circuit constant is 3 (S58 = 1) or 10 (S58 = 2).

After completion of adaptation the previously active old parameters (identified by .o) and the newly determined parameters (identified by .n) can be read in the parameterization mode AdAP. The new parameters for Pi-controllers and for PID-controllers are offered.

In addition the determined line order 1 to 8 is displayed as a suffix to the Pi or PID identification. The selected parameters **.0, **.n Pi.* or **.n PID.* (** = parameter name, * = line order 1 to 8) can be changed and accepted optionally.

The operating technique of the adaptation procedure is described in chapter 3.3.3, page 175, the commissioning explained in chapter 4.5, page 220.

1.5.6 Controller output structures (S2, S61 to S68)

Three different controller output structures are connected after the controller I depending on the structrue switch S2:

S2=0 K-controller
S2=1 S-controller with internal feedback
S2=2 S-controller with external feedback

1.5.6.1 S2 = 0: Continuous (K) controller

(Fig. 1-56, page 100 and fig. 1-57, page 101)

For activating P-action usually pnemumatic final control elements or as a master controller in cascades.

In the K-controller the automatic manipulated variable ya of the controller I can be processed directly without further conversion. The manipulated variable y is followed by two split range-outputs y1 and y2 for 2 actuator operation. The manipulated variable y is divided into two individual manipulated variables adjustable by the parameters Y1 and Y2 (structuring mode oFPA). Via S65 you can select the split range functions rising – falling (y1 actuator heating – y2 actuator cooling) or rising – rising (y1 actuator control range 1 – y2 actuator control range 2).

- **Split range function rising – falling (S65 = 0)**

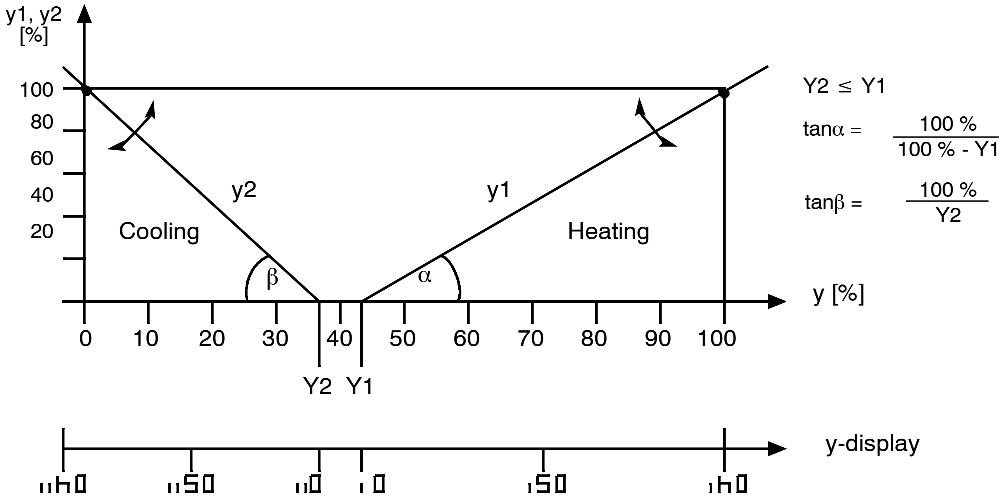


Figure 1-56 Split range function rising – falling

With the parameters Y1 and Y2, the point of intersection of the characteristics y1 and y2 is set with the 0 % line. Y1 can be set as you like in relation to Y2. As a rule a gap of 6 to 10% is left between cooling end and heating start to save energy. Depending on the design of the cooling and heating aggregate, related to the control range of the controlled variable, the different line gains can be compensated by different slope settings and good control results achieved in both branches. As a rule the cooling aggregate is underdimensioned for cost reasons so that the slope of Y2 needs to be greater than that of Y1.

The manipulated variable display at S67=1 is made for the outputs y1 and y2 by an ID I and II. Therefore only two positions are available for displaying the respective manipulated variable value so that values from 100 % are identified by h. In the center of the dead zone the display changes from y1 to y2.

When the characteristics Y1 and Y2 overlap, the display changes at Y = 50 %.

– Split range function rising – rising (S65 = 1)

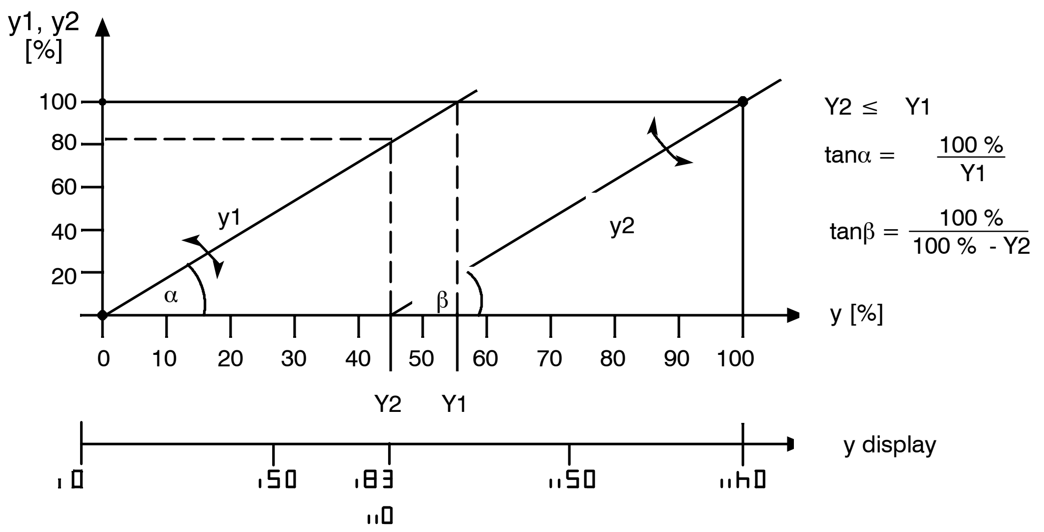


Figure 1-57 Split range function rising – rising

With the parameter Y1 the point of intersection of the manipulated variable y1 is set with the 100 % line, with parameter Y2 the point of intersection of the manipulated variable y2 of the 0 % line is set. Y1 can be set as you like in relation to Y2. Depending on the design of the actuators, related to the control range of the controlled variable, the different system gains can be compensated by different slope settings and good control results achieved over the whole control range.

The manipulated variable display at S67=1 is made for the outputs y1 and y2 by an ID I and II. Therefore only 2 positions are available for displaying the respective manipulated variable value so that values above 100 % are identified by h. The output y1 is displayed until the output Y2 has reached a value $\geq$ 0 %.

– Floating time tY

At S62 = 0 (absolute value preset of Y_N) the positioning speed of the automatic variable is set with tY. In the oFF position, no limiting takes place, in positions 1 to 1000 s the minimum floating time for 0 to 100 % manuipulated variable is preset. The P, I and D part as well as the disturbance variable Z is limited in the rise speed. This positioning speed limiting is always used when the following final control element has floating times $>$ 1 s to prevent integral saturations or when the process cannot stand the hard impacts of the P, D or Z-part. In this case it must be taken into account that the control time is greater.

At S62 = 1 (incremental preset of Y_N) tY is used for the positioning speed setting of the integrator. The floating time for 0 to 100 % change is preset. In the oFF position the integrator output changes suddenly.

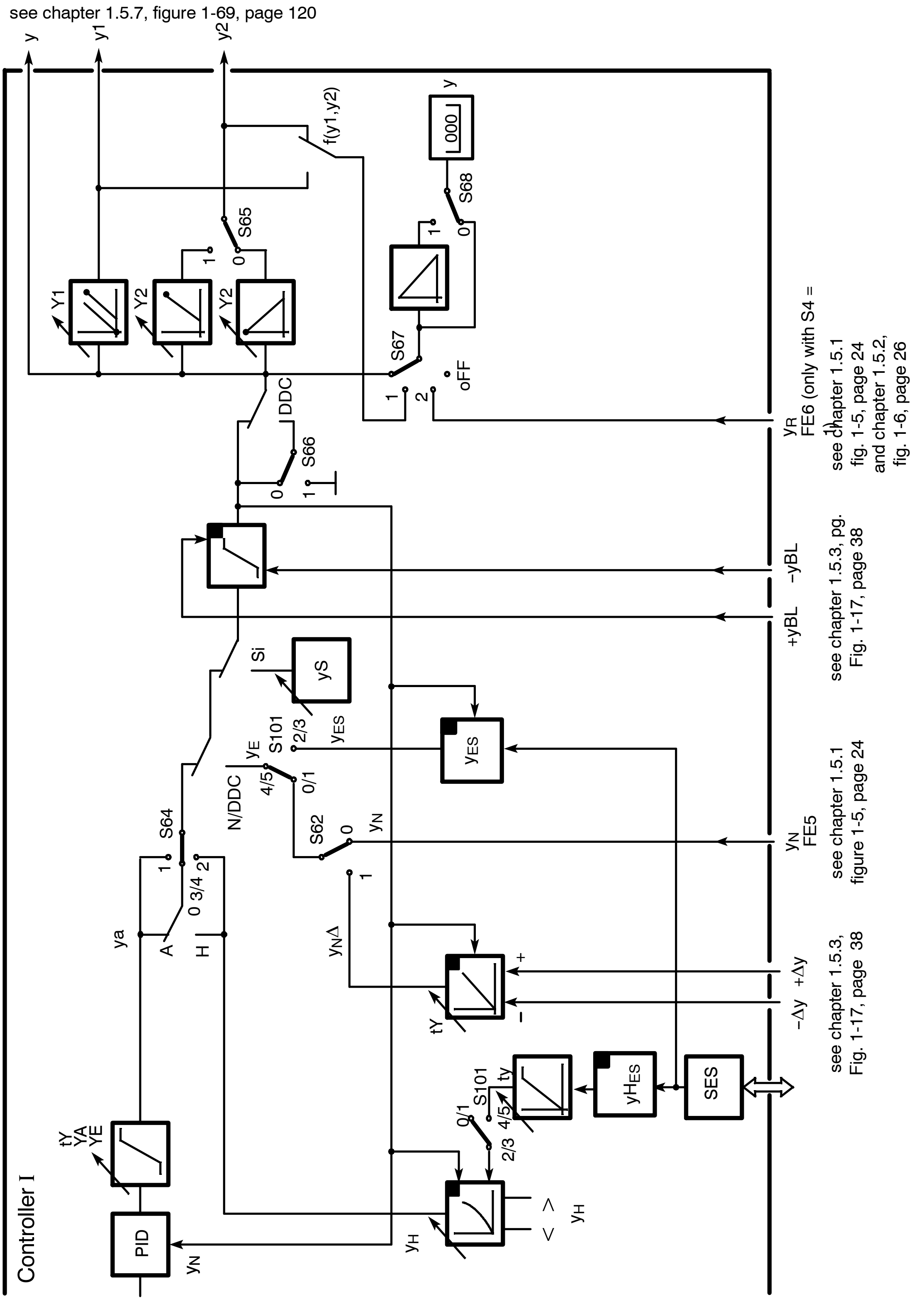


Figure 1-58 Block diagram K-controller S2 = 0
Follow-up (DDC) has priority over manual operation S61 = 0

see chapter 1.5.7, figure 1-69, page 120

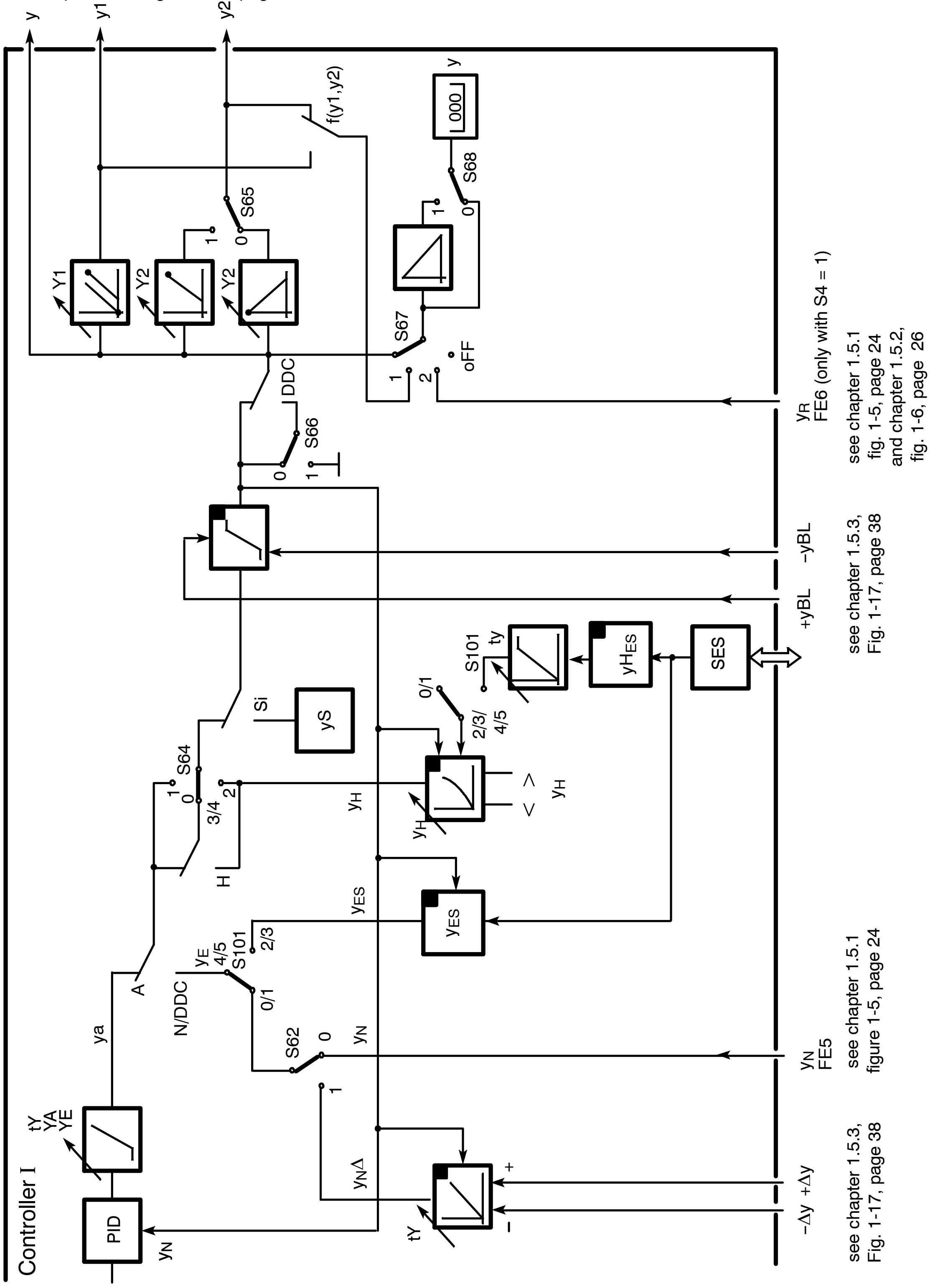


Figure 1-59 Block diagram K-controller S2 = 0
Manual operation has priority over follow-up (DDC) S61 = 1

1.5.6.2 S2 = 1: Three-position step (S) -controller with internal feedback

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 (y'). It is therefore not possible to perform a manipulated variable limiting of ya and an absolute value preset of y_E and ys. The safety manipulated variable ys is preset as a direction-dependent continuous contact. At YS < 50 % (oFPA), $-\Delta$y switches, at YS $\geq$ 50 %, $+\Delta$y switches to continuous contact so that the end positions 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 $A_{ee} = 2 \frac{100\,\% \cdot tE}{tY}$
- Switching off $A_{ea} = \frac{100\,\% \cdot tE}{tY}$
- Hysteresis $A_{ee} - A_{ea} = \frac{100\,\% \cdot tE}{tY}$
- Pause $A_a = \frac{100\,\% \cdot tA}{tY}$
- tY set floating time (parameterization mode onPA)

After a pulse pause A_{ee} must be set up 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 4.3, page 218.

The position feedback y_R via FE6 is only used to display the manipulated variable in S-controllers with internal feedback. If it is not connected, S67 is set to 0, the y-display (14) is then dark.

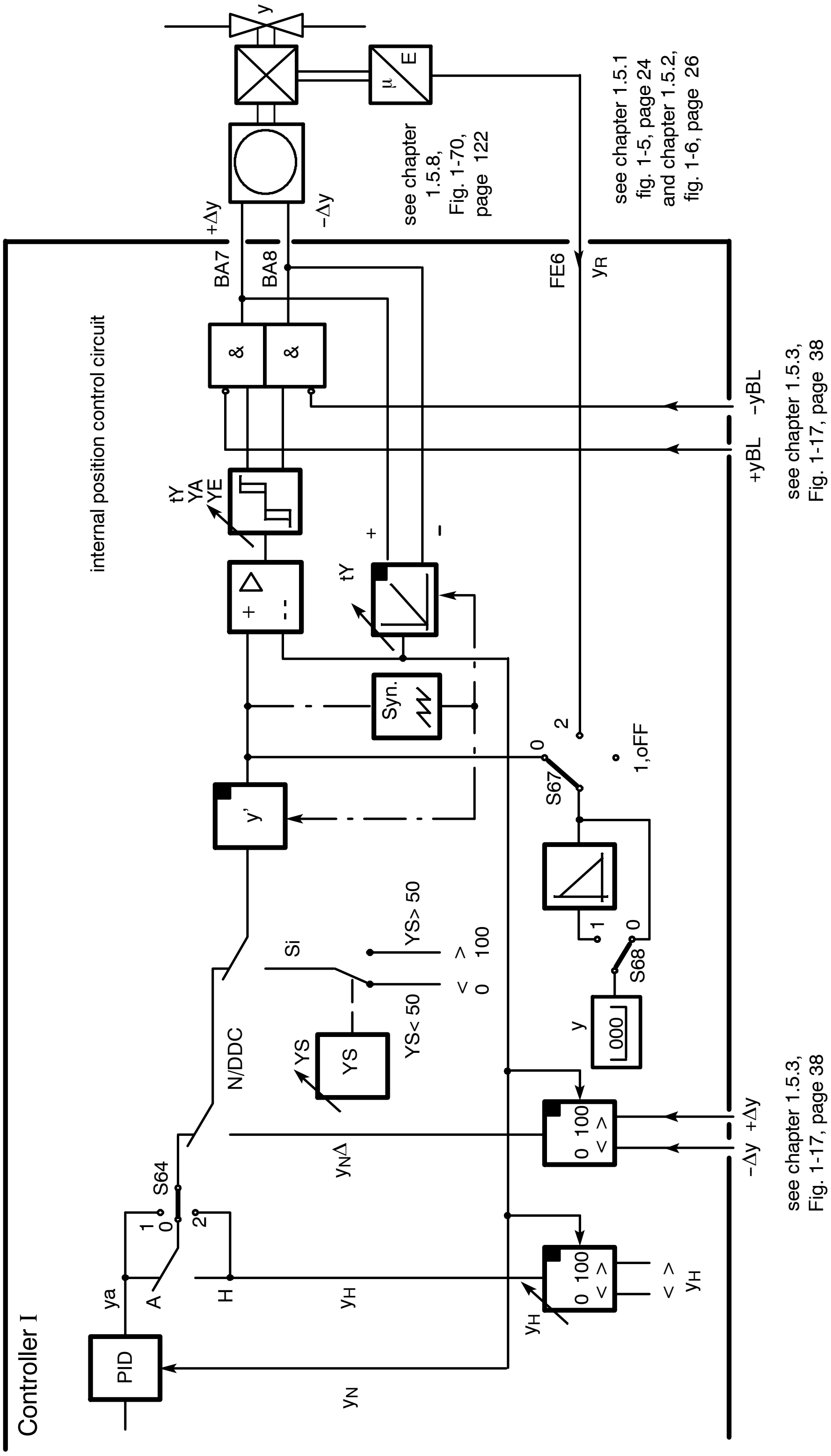


Figure 1-60 Block diagram S-controller with internal feedback S2 = 1
Follow-up (DDC) has priority over manual operation S61 = 0

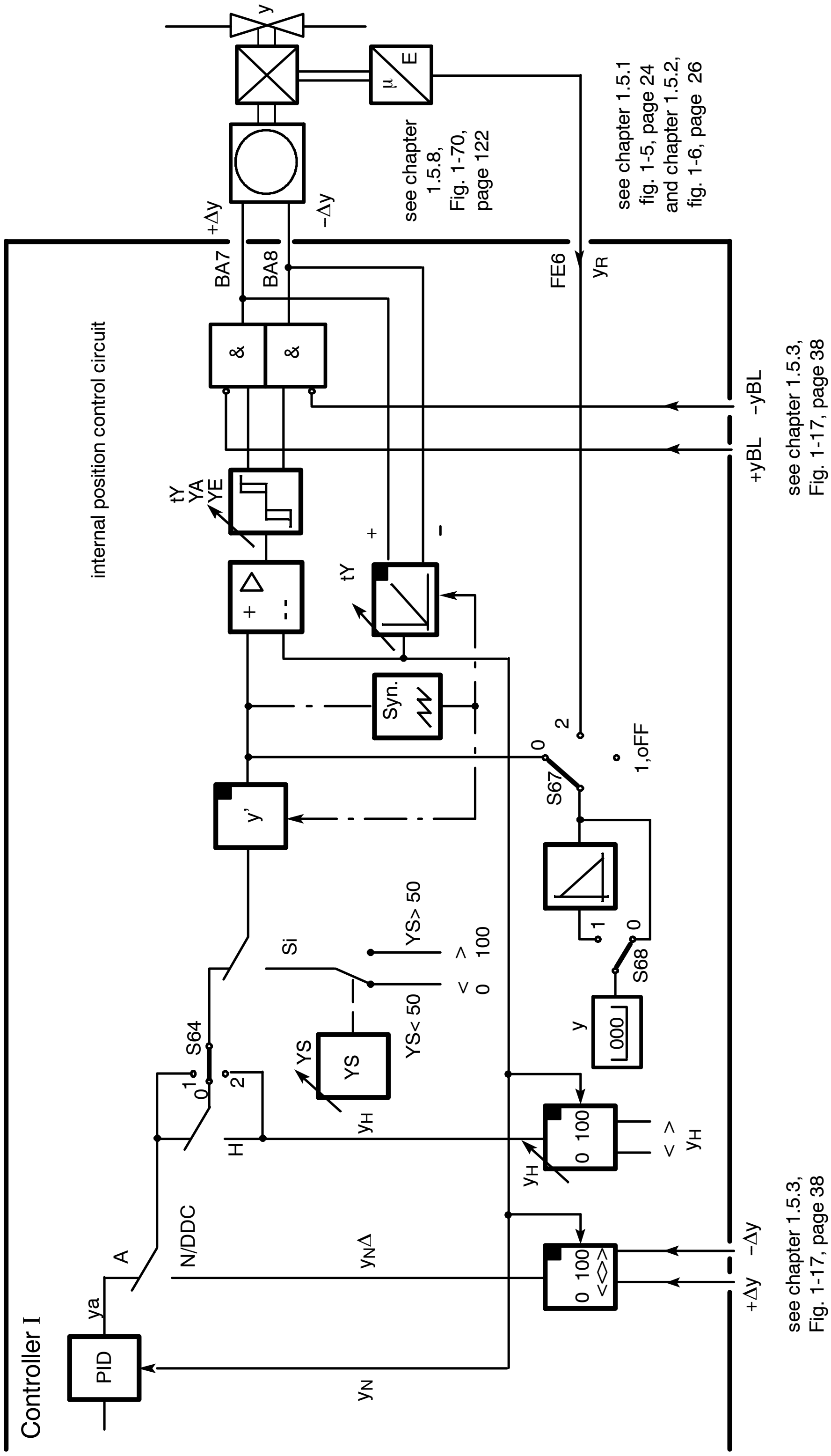


Figure 1-61 Block diagram S-controller with internal feedback S2 = 1
Manual operation has priority over follow-up (DDC) S61 = 1

1.5.6.3 S2 = 2: Three-position step (S) – controller with external feedback

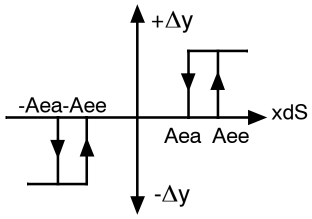
To control I-acting motorized actuating drives.
In S-controllers with external feedback the "internal position control circuit" is replaced by a real position controller (with the K-controller output y as a setpoint and the position feedback y_R via FE6 as an actual value). As a result a manipulated 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 follow-up operation. If y_E is preset via the follow-up input y_N (FE5), the freely connectable input range (S4=1) must be used because in the permanently connected input range, FE5 is not available at S2=2 (see fig. 1–14).

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 tY (floating time).

- 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 $A_a = \frac{100\,\% \cdot tA}{tY}$

If a control deviation of xds $\geq A_{ee}$ 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 $< A_{ea}$ is reached. The continuous contact is now switched off. After the pause time tA pulse of length tE are output with subsequent pause time tA until xds $\leq A_{ee}$ is reached.



These single pulses are also output if xds coming from zero does not reach A_{ee}. These single pulses which are not fully transformed into the path change (rotational movement) additionally calm the control circuit, i.e. in theory (without lag) the single pulses would switch off at 0.25 or 0.5 A_{ee}. 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.

Manual adjustment via the front panel is made at S67=2 here too as an incremental adjustment by overmodulating the three-position switch so that manual adjustment is possible even when the position feedback is interrupted.

To simplify commissioning of the position control circuit, the manual manipulated variable is preset absolutely at S67=0 (manipulated variable of the K-controller) so that the setpoint of the position control circuit is changed continuously in this structure switch position to enable optimization (see chapter 4.3). It should be taken into account here that the manual manipulated variable which is also displayed is changed faster by the floating time than the active manipulated variable on the actuator and a lag therefore takes place. The controlling status can be monitored on the Δy-LEDs (15) in the y-display. After optimization, S67 should be set to 2 to display the active manipulated variable via the position feedback y_R (FE6).

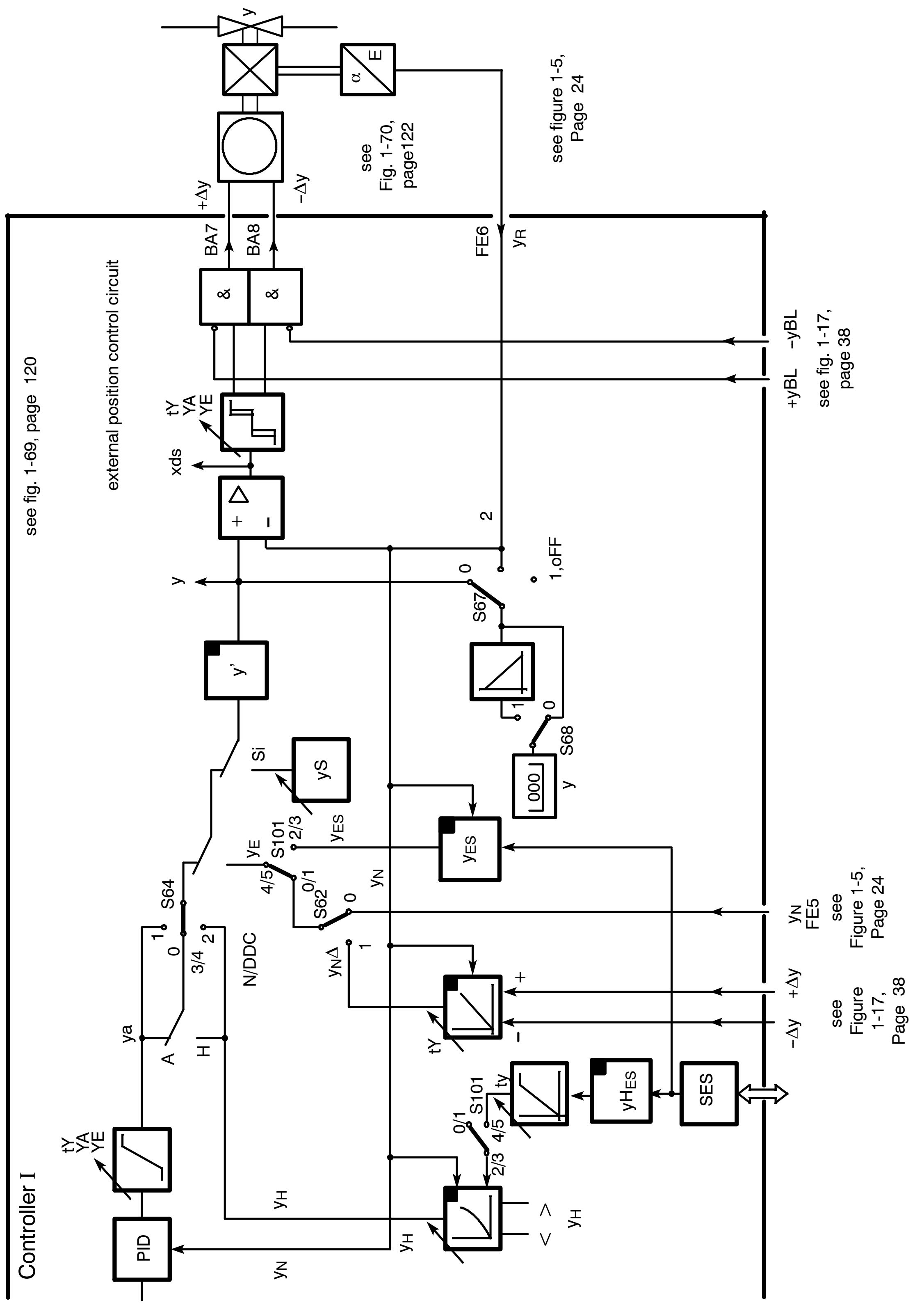


Figure 1-62 Block diagram S-controller with external feedback S2 = 2
Follow-up (DDC) has priority over manual operation S61 = 0

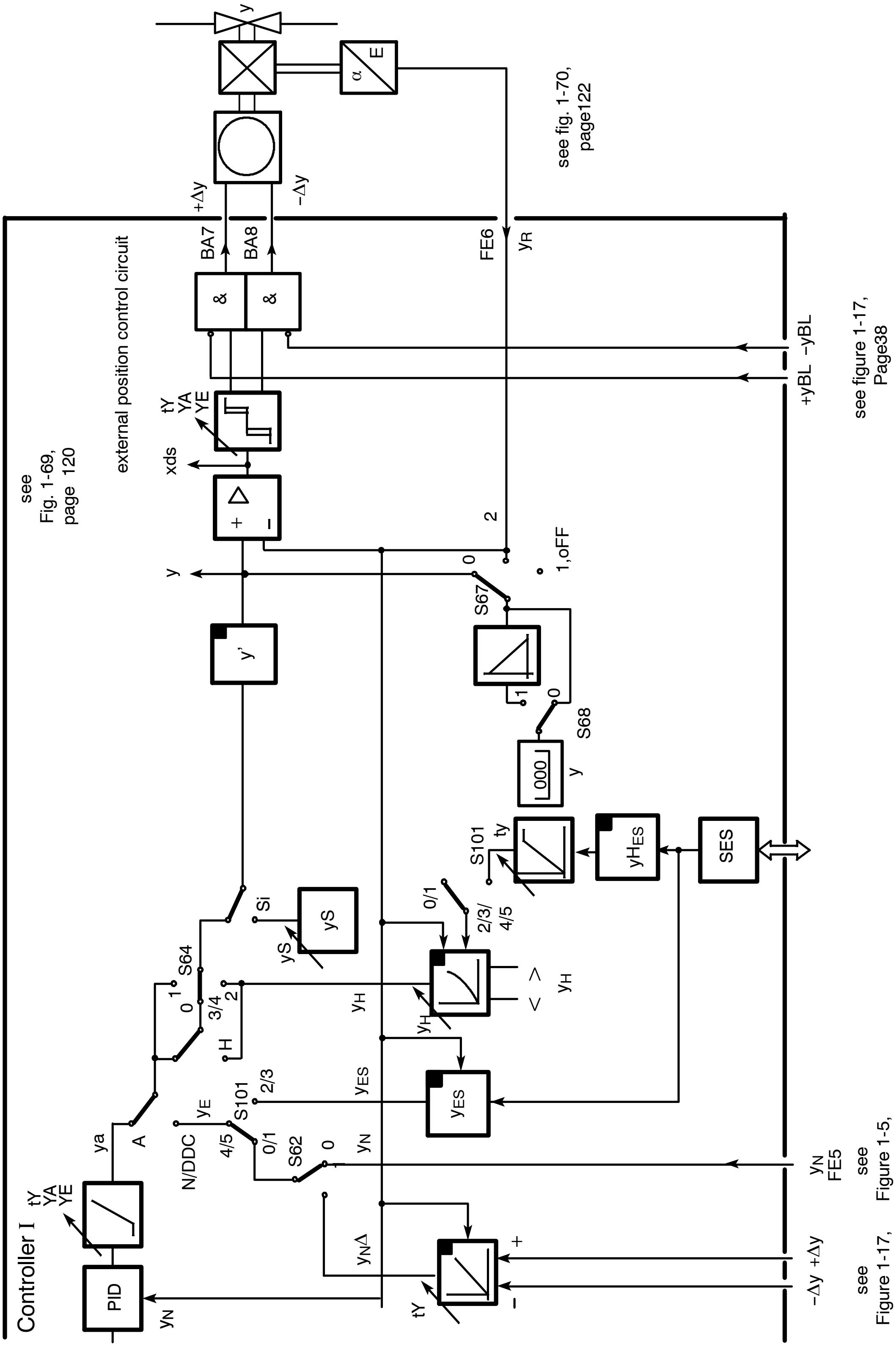


Figure 1-63 Block diagram S-controller with external feedback S2 = 2
Manual operation has priority over follow-up (DDC) S61 = 1

Control signals					Message signals				active y	Explanation
Digital inputs			Front		Front		Digital outputs			
± yBL	Si	N [1]	He	Hi	H LED	y-Ext. LED	H	N		
0	0	0	0	0	0	0	0	0	y_a (n)	Automatic mode
0	0	0	1	0	0.9[5]	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) [2]	Follow-up operation
0	0	1	1	0	0.9[5]	1	1	1	y_E (n)	Follow-up operation
0	0	1	0	1	1	1	1	1	y_E (n)	Follow-up operation
0	0	1	1	1	1	1	1	1	y_E (n)	Follow-up operation
1	0	as above				1	as above		$\pm y_{BL}$ [3]	± Blocking mode
1	1	as above				1	as above		$\pm y_{BL}$ [3]	± Blocking mode
0	1	as above				1	as above		y_S [4]	Safety operation

Table 1-18 Output switching of all controller types except DDC fixed setpoint controller (S1 = 2) Follow-up operation has priority over manual operation (S61 = 0)

Control signals					Message signals				active y	Explanation
Digital inputs			Front		Front		Digital outputs			
± yBL	Si	N [1]	He	Hi	H LED	y-Ext. LED	H	N		
0	0	0	0	0	0	0	0	0	y_a (n)	Automatic mode
0	0	0	1	0	0,9[5]	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) [2]	Follow-up operation
0	0	1	1	0	0,9[5]	0.5	1	1	y_H (n), (↗)	Manual mode
0	0	1	0	1	1	0.5[6]	1	1	y_H (n), (↗)	Manual mode
0	0	1	1	1	1	0.5	1	1	y_H (n), (↗)	Manual mode
1	0	as above				1	as above		$\pm y_{BL}$ [3]	± Blocking mode
1	1	as above				1	as above		$\pm y_{BL}$ [3]	± Blocking mode
0	1	as above				1	as above		y_S [4]	Safety operation

Table 1-19 Output switching of all controller types except DDC fixed setpoint controller (S1 = 2) Manual operation has priority over follow-up operation (S61 = 1)

1) The table is shown for static N−switching (S48 = 0)
2) Source for y_E is at S62=0 y_N via FE5, at S62=1 $y_{N\Delta}$ via $\pm\Delta y$ if S101 < 2, at S101=2 y_{ES} via the SES. The external manipulated variable is followed up which is fed in via $\pm\Delta y$ ($y_{N\Delta}$) and via the SES (y_{ES}). When feeding in via FE5 (y_N) the feeding controller must be followed up.
3) The blocking mode acts direction-dependently, changes in the opposite direction are possible.
4) Function y_S in S-controllers with internal feedback (S2 = 1) open or close otherwise parameterizable safety manipulated variable.
5) 0.9 flashing rhythm 0.1 off, 0.9 on
6) 0.5 flashing rhythm 1:1
n Followed up to the value active before switching, therefore bumpless switching
↗ adjustable

- **Automatic mode ($y=y_{a)}$**

  Automatic operation is switched on with the Automatic/Manual key (yellow manual LED(8) off). All other control signals He, N (DDC), 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(8) an) or the control signal He as an OR function. The control signals Si and ±yBl must be 0.
  If follow-up operation has priority over manual operation (S61=0), the control signal N (DDC) must also be 0. The manual manipulated variable is through connected to the controller output. The manual manipulated variable is preset in K-controllers as an absolute value, in S-controllers as a positioning increment.

- **Follow-up(DDC) mode ($y=y_{E)}$**

  The follow-up mode is switched on by the control signal N (in DDC mode by the control signal CB and the Internal/External key 1.5.4, page 40). The control signals Si and ±yBl must be 0. If manual mode has priority over follow-up mode (S61=1) the control signal H=Hi v 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 S101 = 0 or 1 as an absolute value (y_N) via the function input FE5 (S62=0) or as an external manipulated variable with incremental adjustment by the control signals $\pm\Delta y$ ($y_N\Delta_)$ (S62 = 1). The incremental adjustment runs at the adjustment speed 100 %/tY. With S101 = 2 the absolute value becomes active as an external manipulated variable via the SES (y_{ES}). In S–controllers with internal feedback (S2 = 1) absolute value presets of the manipulated variable are not possible, only the external manipulated variable with incremental adjustment ($y_N\Delta$) is available.

- **Safety operation ($y = y_{s)}$**

  The safety operation is switched on by the control signal Si. The control signal ±yBl must be 0. The safety manipulated variable y_s is through conenected 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 = 1) absolute value preset is not possible. When safety operation is active the output at YS$<$50 % is $-\Delta y$ continuous contact and at YS $\geq$ 50 % $+\Delta y$ continuous contact so that the actuator moves to the end positions.

- **Direction dependent blocking operation**

  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 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. Priority of H or N can be selected via S61. All these operating modes have priority over automatic operation.

Signaling of the switching states is made by the LEDs Manual (8) and y-external (10). If manual operation is active or preselected (if the prioritized operating modes are active), the Manual LED lights up. He = 1 (via control signal) is signaled by a flashing rhythm of 9.9 when Hi = 0 (via Manual/Automatic switch i.e. is in automatic operation). When switching the control signal He from 1→0 automatic operation becomes active.
Follow-up (DDC), safety and blocking operation is signaled by the y-External LED. Flashing rhythm 0.5 indicates that in manual operation priority over follow-up operation, manual operation is active but follow-up operation is prepared and after switching to automatic operation also becomes active.

- **Blocking of the manual/automatic switching (S64)**

  With S64 Manual/Automatic switching can be blocked in the operating modes only automatic or only manual (see figure 1-16, page 37). The other operating modes are still possible. The follow-up operation only if follow-up has priority over manual operation.

- **Manual mode in event of transmitter fault S63**

  With S63 it is possible to switch to manual mode when the transmitter group fault message occurs (see chapter 1.5.1, page 22). Manual operation starts at S63=1 with the last y or at S63 = 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 S67, S68**

  With S67 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 can be displayed in K-controllers or the position feedback message/command signal y_R via FE6 in S-controllers. With S68 the display direction rising – falling can be selected (see chapter 4.1).

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

  In addition to the DDC controller (S1 = 2) the SPC controller (S1 = 3) a complete parallel process operation is possible in all controller types via the serial interface. The control signals Int and Hi (via He_{ES} at S64 = 3/4, see chapter 1.5.3, page 34) and the process variables wi and yH can be written at S101 ≥ 2 via the serial interface so that switching from internal to external setpoint and Automatic/Manual switching is possible in all controller types. 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 "front operation" via the serial interface can be locked at S64 = 3 via $\overline{RC}$ = Int ∨ $\overline{CB}$ (see chapter 1.5.3). 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 = 10) and follow-up controller without Internal/External switching (S1 = 11) because in all other controller types both the Internal key and the control signal CB have other additional functions. At S64 = 4 this locking facility is omitted and operation is always parallel to the front keys.

To avoid simultaneous actuation by the controller front and the SES the last switching action can be read both on the process control system and the controller. For this, a status bit is set when writing IntES and HeES 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.

If the last operation took place via the SES the warning SES flashes for 3 s in the x/w display when the Internal key or the Manual key is pressed. 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.

- **Output structure controller II at S1 = 12**

  With S1 = 12 a second parallel independent control channel is released. Operation and monitoring of both control circuits take place on two levels which are selected with the Shift key and signaled by the displays I or II.

  The functions of the output structure of the controller II correspond to those of the controller I; only exception: incremental manipulated variable adjustment is not possible.

  The effect of the respective duplicated structure switches and parameters can be seen in the following block diagrams.

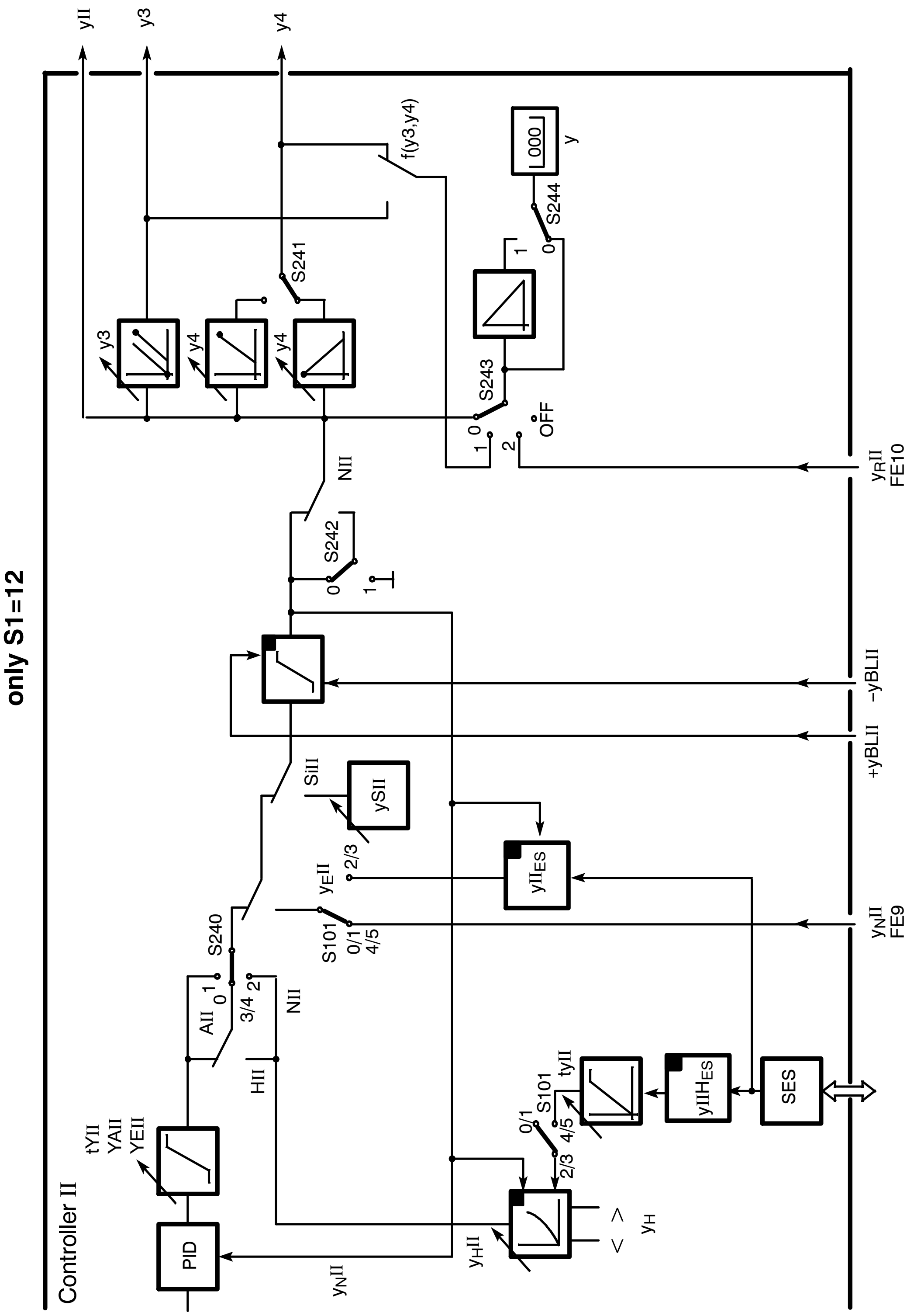


Figure 1-64 Block diagram K-controller S231 = 0
Follow-up has priority over manual operation S238 = 0

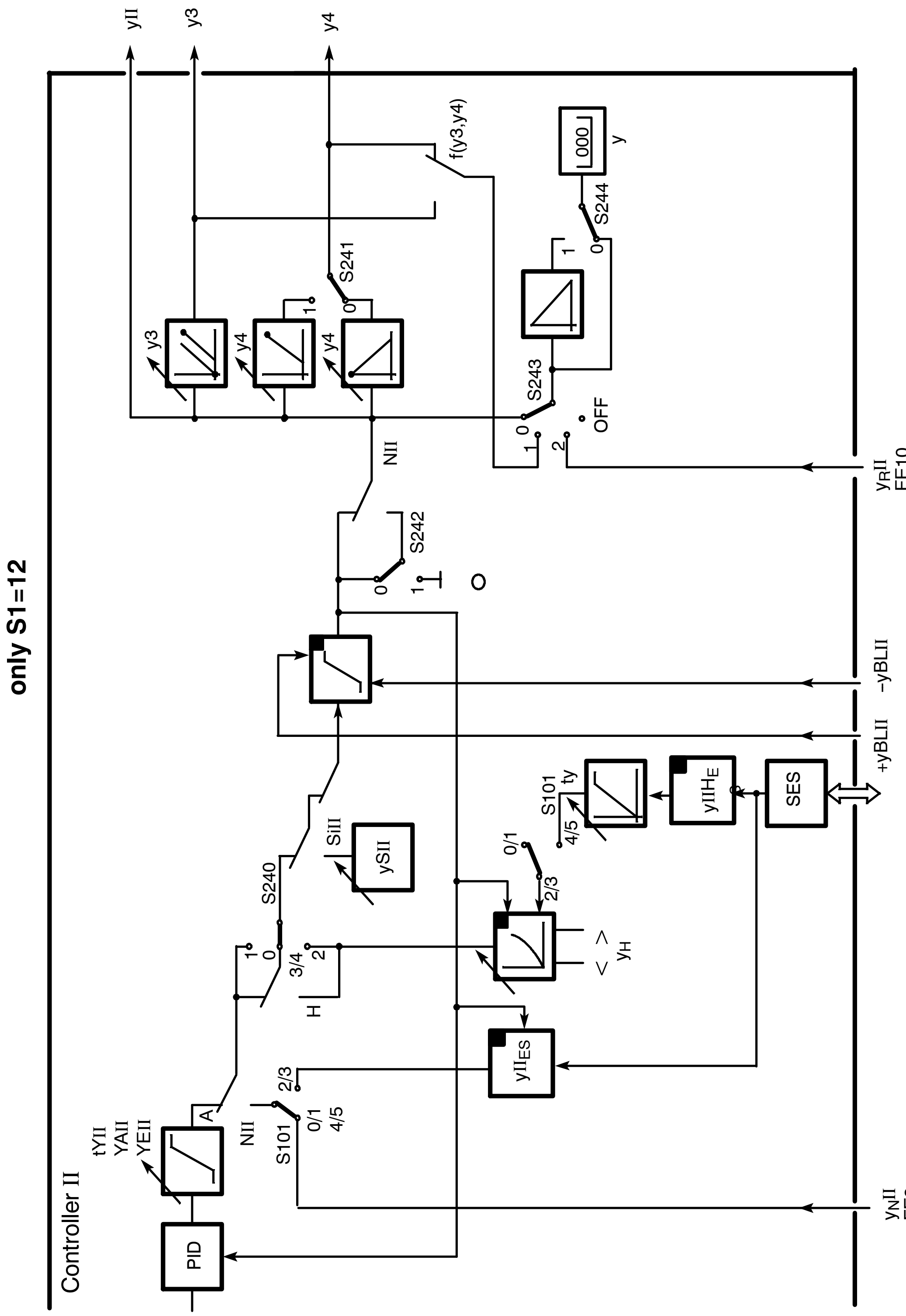


Figure 1-65 Block diagram K-controller S231 = 0
Manual operation has priority over follow-up S238 = 1

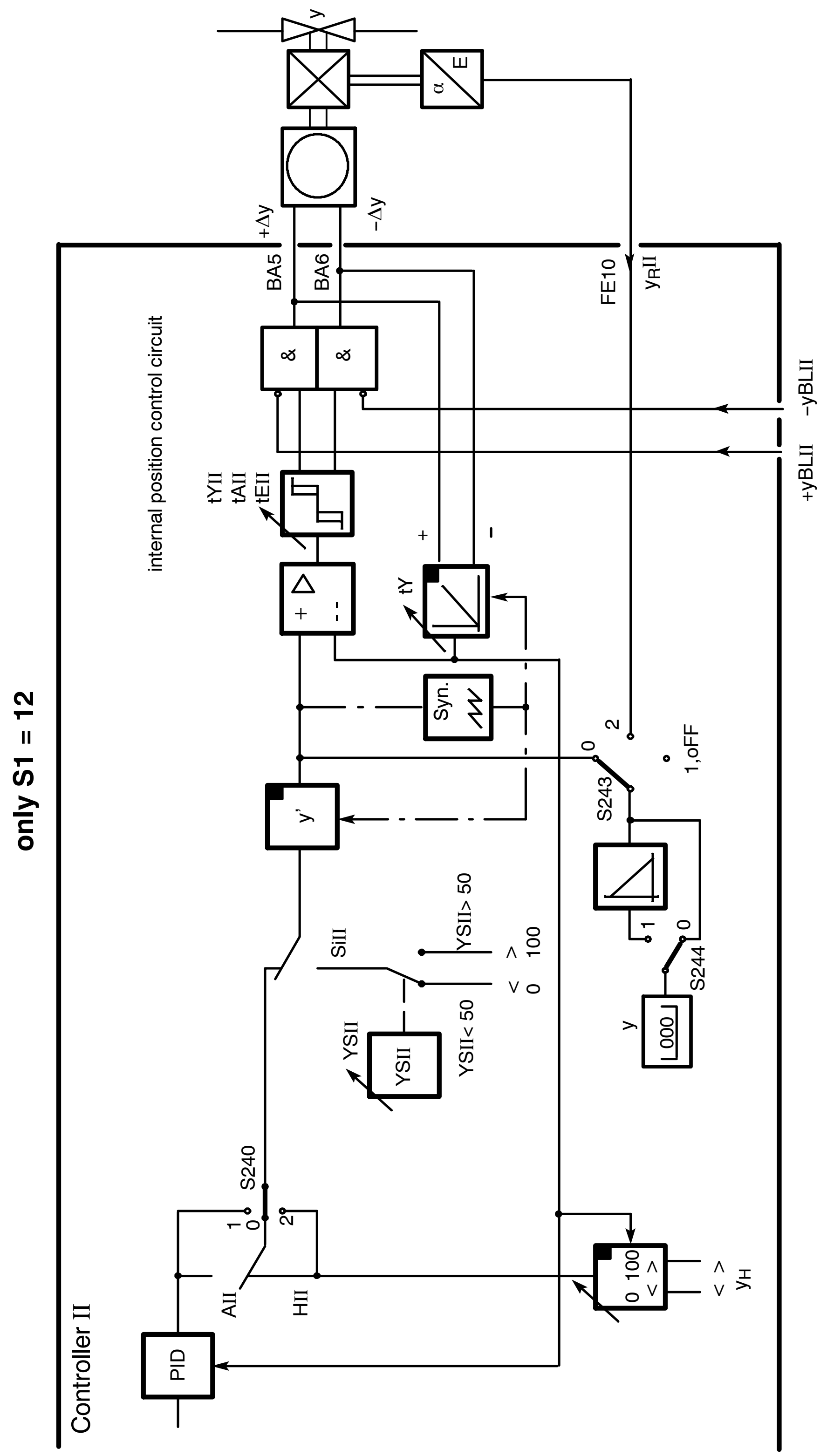


Figure 1-66 Block diagram S-controller with internal feedback S231 = 1

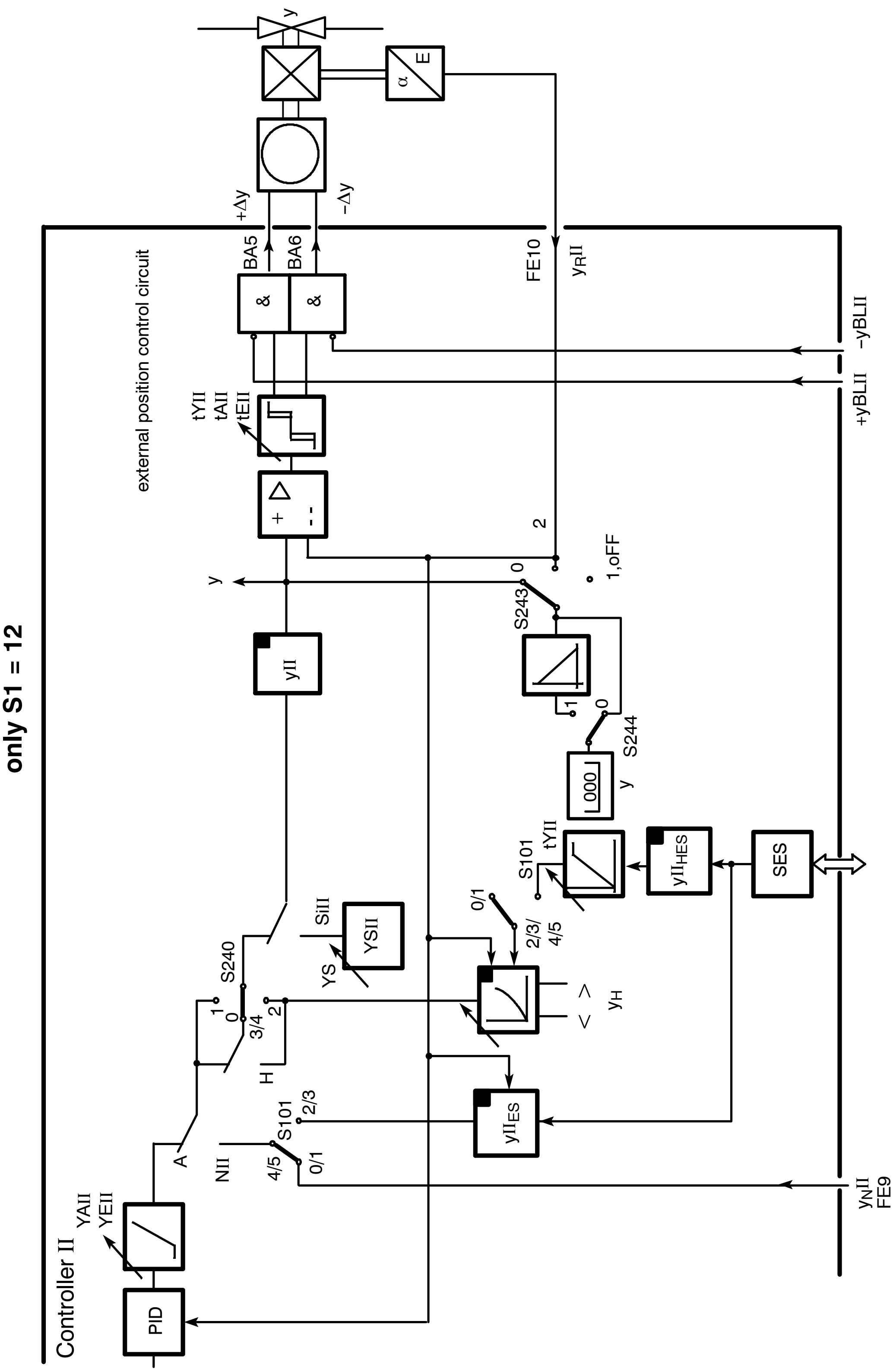


Figure 1-67 Block diagram S231 = 2
Manual operation has priority over follow-up S238 = 0

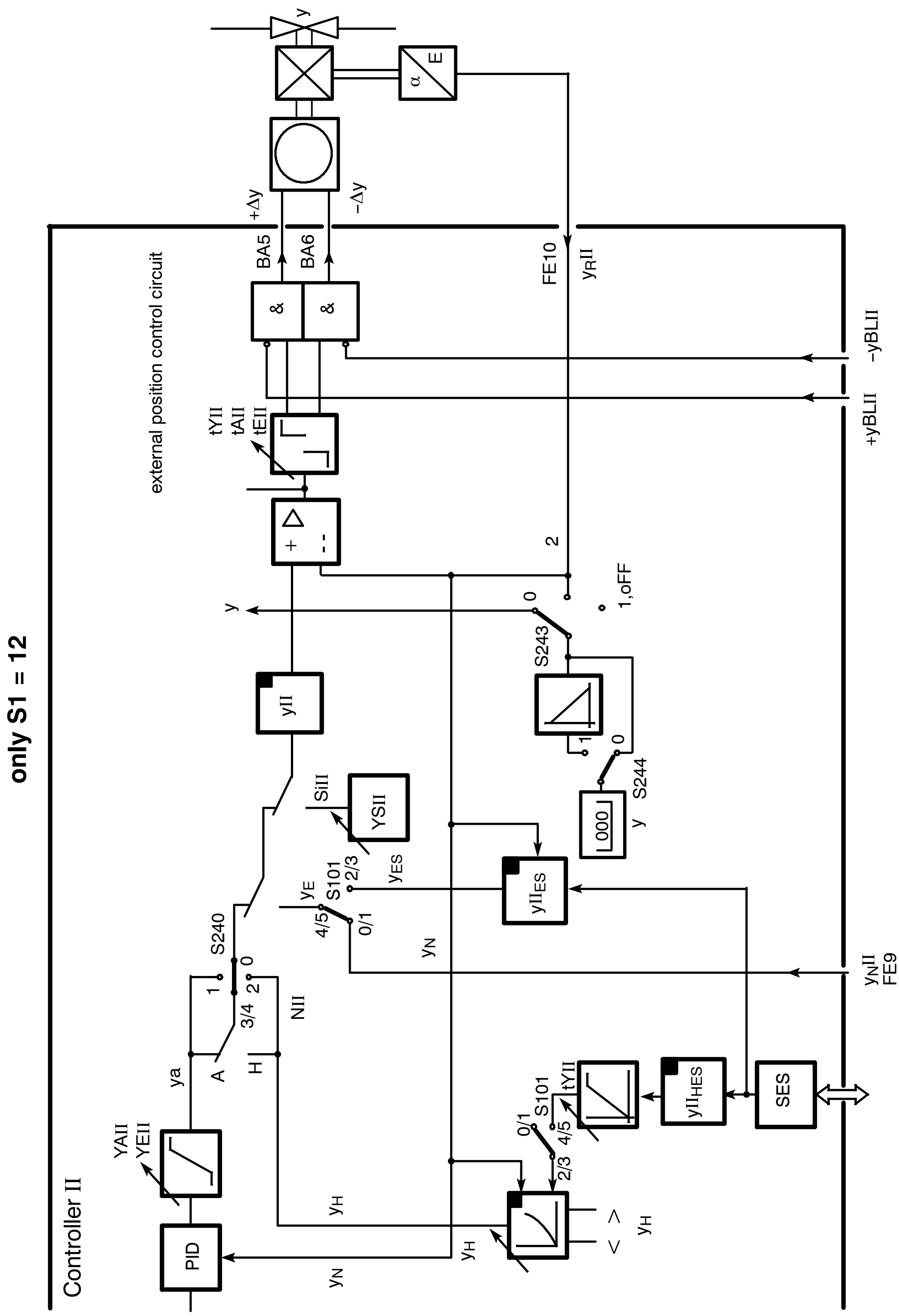


Figure 1-68 Block diagram S-controller with external feedback S231 = 2
Follow-up has priority over manual operation S238 = 1

1.5.7 Analog output signal processing (S69 to S75, S247 to S257)

The analog outputs AA1 to AA3 (standard controller) are assigned to the controller-internal variables by the structure switches S73 to S75. By using the modules 1AA (6DR2802-8A) or 3AA (6DR2802-8B) in the slots 5 (S22=4/6) and 6 (S23=4/6) the number of analog outputs can be increased to 9.

Every output can be structured alternatively to 0 or 4 to 20 mA.

The bipolar process variables xdI, xdII du xds are output with an offset of 50 % and optionally reversed direction.

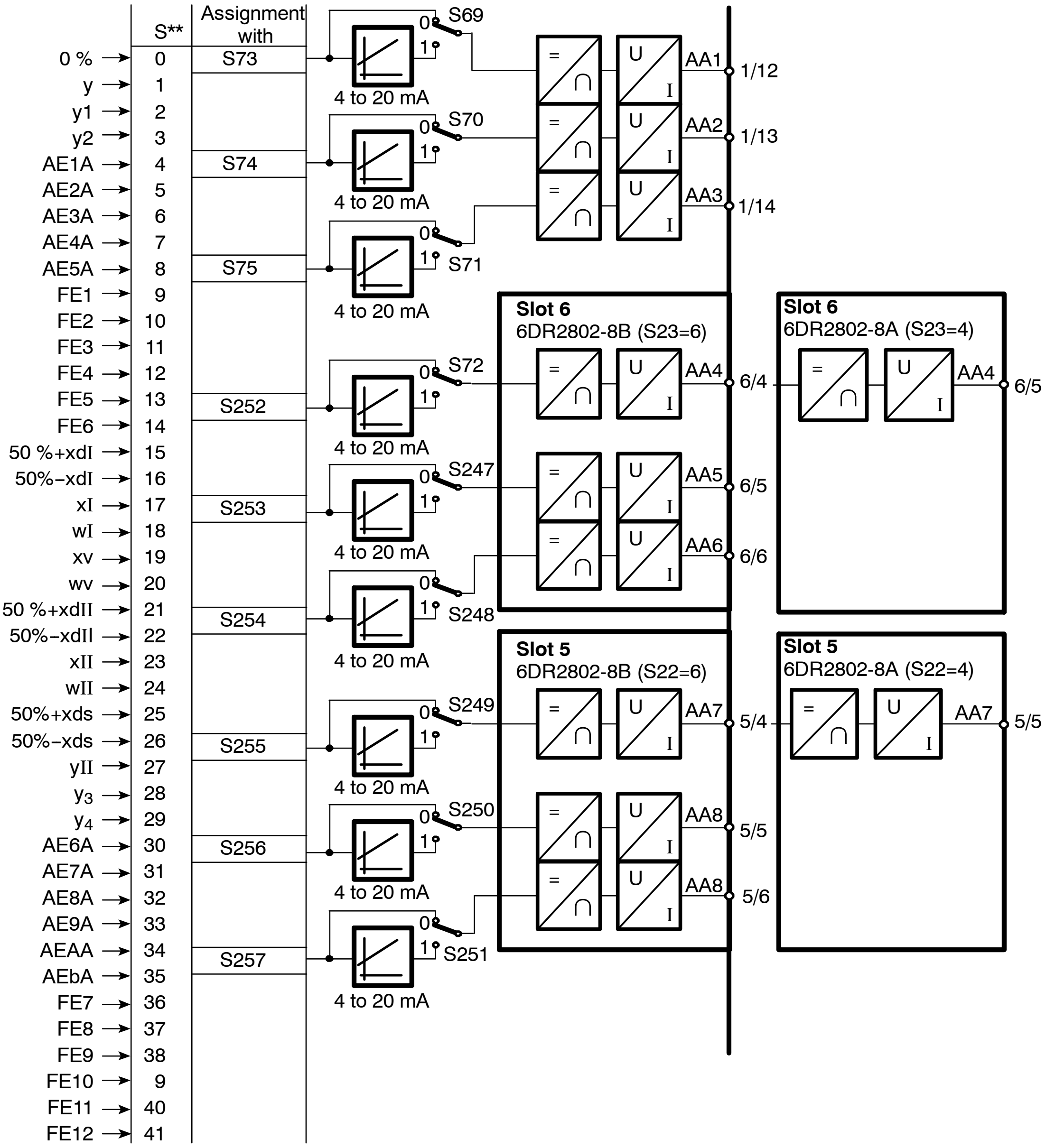


Figure 1-69 Assignment analog outputs

1.5.8 Digital output signal processing (S76 to S93 and S258 to S266)

see figure 1-70

The message signals $\overline{\text{RB}}$, $\overline{\text{RC}}$ to MUF, IntI, $\overline{\text{RB}}$II to IntII, FE9 to FE12 are negated by the structure switches S86 to S96 optionally and assigned to the digital outputs BA1 to BA16 by the structure switches S76 to S85 and S258 to S266.

The digital outputs BA1 to BA8 of the standard controller can be extended with the option modules 4BA 24 V+2BE (6DR2801-8E) or 2BA relay 35 V (6DR2801-8A) in the slots 5 and 6 to a maximum 16 digital outputs. When using 4BA 24 V+2BE in slot 5 by BA9 to BA12, in slot 6 by BA13 to BA16. When using 2BA relay 35 V in slot 5 by BA9 and BA10, in slot 6 by BA13 and 14.

When using option modules in the slots 5 and 6 the structure switches S22 and S23 are set according to the assembly, other settings lead to error messages (see chapter 1.4.3, page 20).

The control signals $\pm\Delta y$ (positioning increments of the S-controller) are not assigned and not negatable. When structuring S-controllers (S2 = 1 or 2) they are always at BA7 and BA8, i.e. BA7 and BA8 can only be assigned freely in K-controllers (S2 = 0).

At S1=12 and S231=1 or 2 the positioning increments of the S–controller II are output according to BA5 and BA6.

On assigning different control signals to the same digital output an OR function of the control signals is produced.

Unassigned digital outputs (switch position 0) are low and can be set by SES at S101 = 2.
All digital outputs have wired-or-diodes.

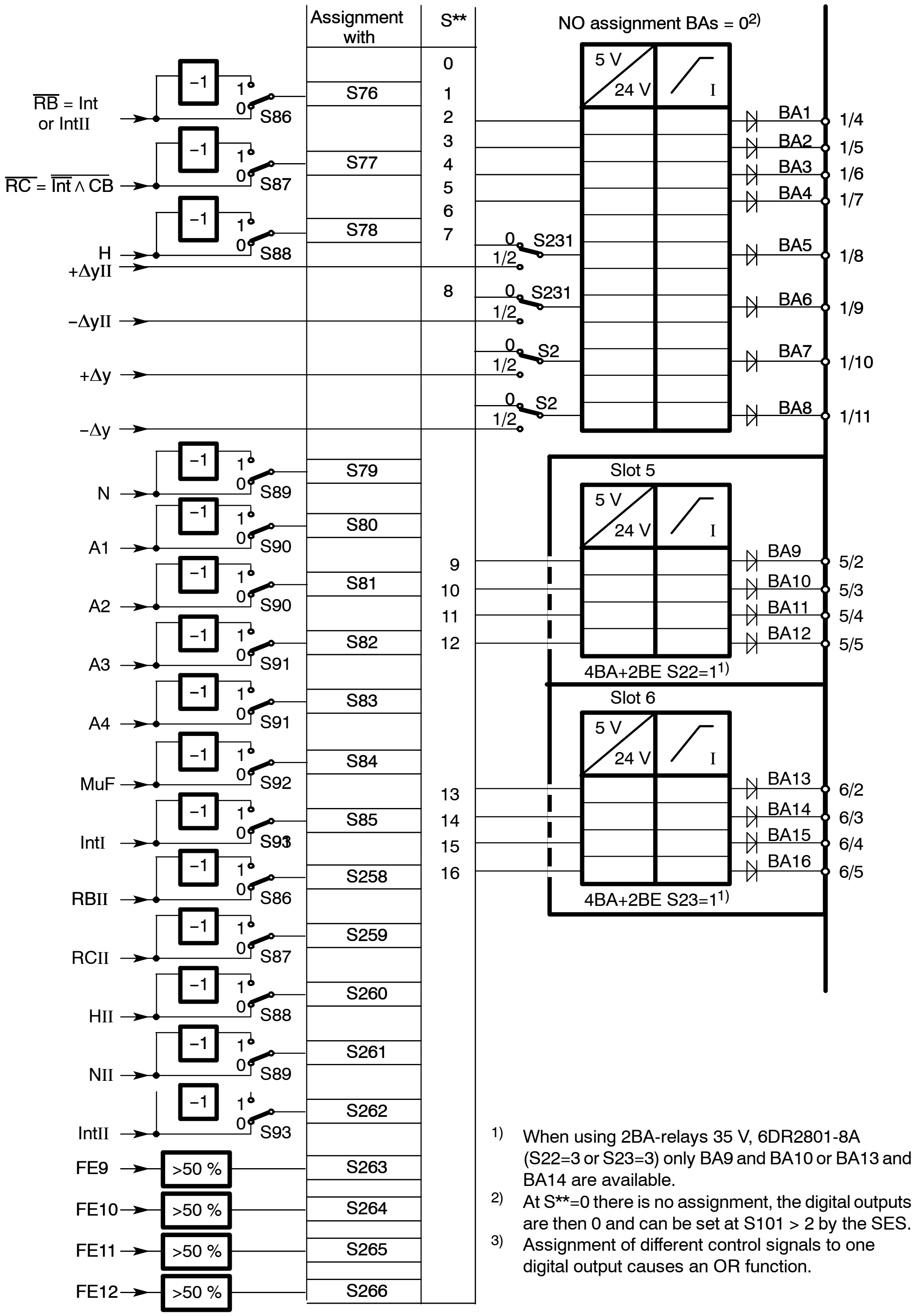


Figure 1-70 Assignment of digital outputs

1) When using 2BA-relays 35 V, 6DR2801-8A (S22=3 or S23=3) only BA9 and BA10 or BA13 and BA14 are available.

2) At S**=0 there is no assignment, the digital outputs are then 0 and can be set at S101 > 2 by the SES.

3) Assignment of different control signals to one digital output causes an OR function.

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. In cascade controllers (double controllers) this signal relates to the master controller, in override controls to the main controller.

$\overline{RC}$ — *No computer operation*
This signal indicates the negated computer operation $\overline{RC} = \overline{\overline{Int} \wedge CB}$ and controls the setpoint switching or the DDC operation. In cascade controllers this message relates to the master controller, in override controls to the main controller.

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

N — *Follow-up mode*
The controller is in follow-up mode when the control signals Si, ±yBL and H (in manual over follow-up operation priority) are Low.

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 analog input signals of the controller can be monitored for exceeding of the range. This signal gives a group alarm if an error is detected.

IntI — *Internal operation of the slave controller*
This signal indicates that the cascade in cascade controllers (double controllers) is disconnected to Internal by Internal/External switching of the follow-up controller.

±Δy — *Position increments for the Δy-adjustment in S-controllers*

Message signals RBII, RCII, HII, NII, IntII, ±ΔyII are only active at S1=12 and have the same meanings for controller II as above.

FE9 to FE12 The analog signals are converted by comparators into digital signals (> 50 % ≙ 1)

1.5.9 Limit value alarms (S94 to S100, S267 to S268)

Every limit value alarm A1, A2, A3, A4 is assigned by the structure switches S94, S95, S267, S268 to the controller-internal variables xdI, xI to FE12.

With S267 = −1 or S268 = −1 (factory setting), the limit value alarms A1, A2 or A3, A4 are combined as pairs.

In this case the assignment only takes place with S94 or S95, only hysteresis' H1.2 or H3.4 are active.

With S96 (A1, A2) or S97 (A3, A4) the monitoring function Max/Min, Min/Min, Max/Max, Min/Max can be set.

The response thresholds A1 to A4 and the hysteresis H1.2, H3.4, H2., H4. can always be set in the structuring mode oFPA. According to the switch position of S98 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 (12) is extended by the response thresholds A1 to A4, displayed on the y-display (14):

Controller I – Controller II - A1 - A2 - A3 - A4 – Controller I ...

The response thresholds are set depending on the assignment physically corresponding to the display format of the digital x or w display (see chapter 1.5.4, page 40) or in %:

S1	S94, S95 S267, S268	assigned to	Display format	Parameter range
≠4 ≠6	0 1 2	xdI xI wI	according to dAI bis dEI -1999 to 19999	maximum -110 % to +110 % related to dEI - dAI = 100 %
4 and 6	0 1 2 3 4	xdI xI wI xv wv	% % % according to dAI bis dEI -1999 to 19999	-110 % to +110 % maximum -110 % to +110 % related to dEI - dAI = 100 %
5 to 12	5 6 7	xdII xII wII	according to dAII bis dEII -1999 to 19999	maximum -110 % to 110% related to dEII - dAII = 100 %
0 to 12	8 ↓ 37	y ↓ FE12	%	-110 % to +110 %

Table 1-20 Display format of the limit values A1 to A4

The hysteresis H1.2, H3.4, H2., H4. is set in % in the range from 0.1 to 20 %.

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

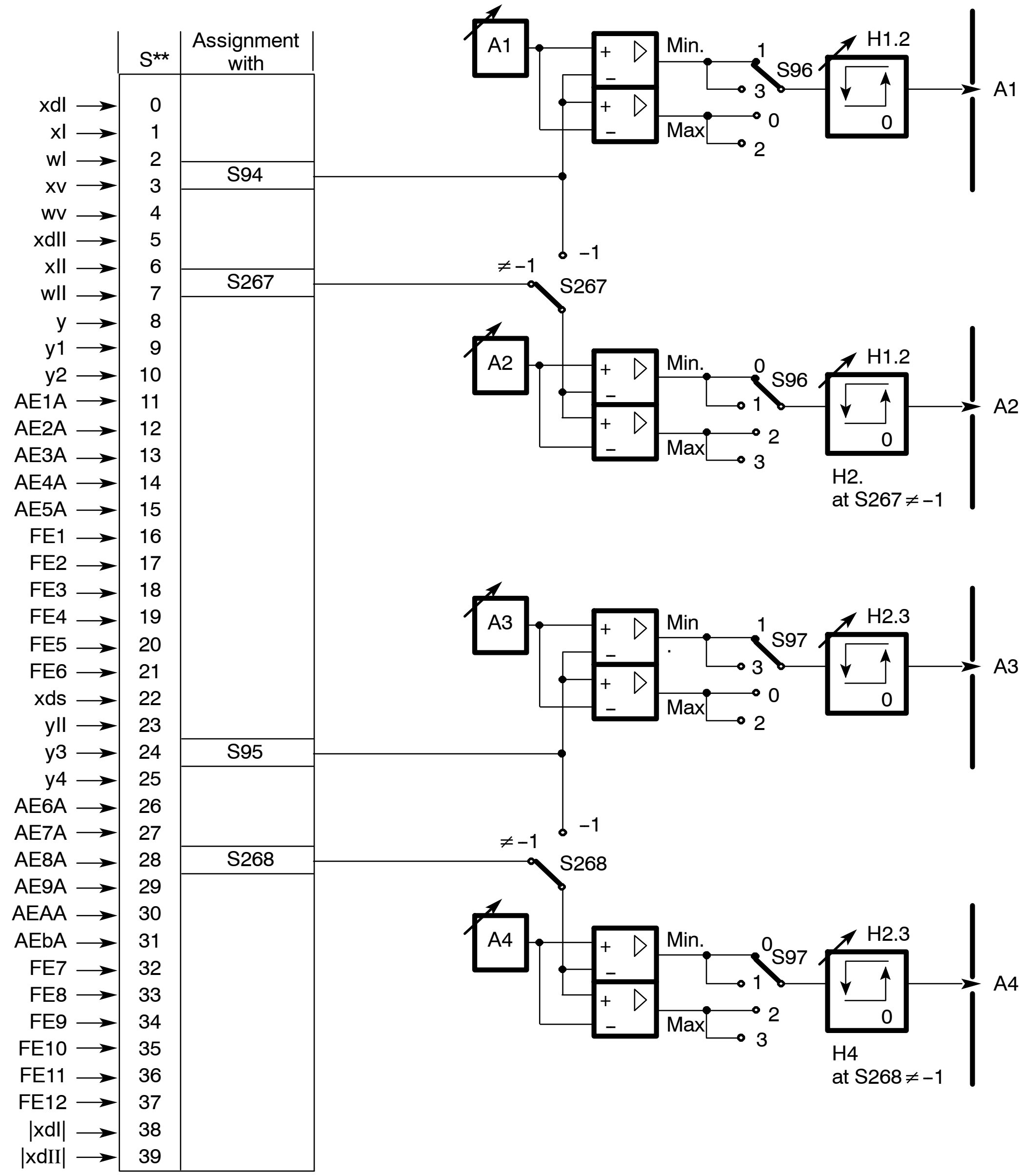


Figure 1-71 Assignment and function of the limit value alarms

1.5.10 Restart conditions (S99, S100)

With S99 the restart conditions after mains recovery and manual reset are determined. In position 0 the controller starts after mains recovery and after a watchdog reset with the operating mode and with the y which was active before the power failure. This variation must be used when temporary mains failures are to be expected in slow control circuits.

In position 1 start takes place after mains recovery in manual and Internal operation (in cascades also with IntI) with ys in the K-controller and with the last y in the S-controller. If only external operating mode or only automatic operation was selected by the structuring, the restart takes place in these operating modes.

With S100 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 (12) or by an alarm request via SES.

1.5.11 Serial interface and PROFIBUS-DP (S101 to S107)

With S101 the depth of the SES interventions is preset. Generally all available set data can be 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 the other positions the process variables wES (external setpoint via the SES) and yES (external manipulated variable via the SES) and all control signals can be transmitted by the SES. In this position the other possible sources for the external setpoint or the external manipulated variable are switched off.

The structure switches S102 to S107 determine the transmission procedure through the serial interface. For further details, see the description ”Serial SIPART DR22 V.28 bus interface”, order number C79000-B7476-C155.

Settings for PROFIBUS-DP: see table 3-8 ”Structure switch tables”, page 187.

1.6 Technical Data

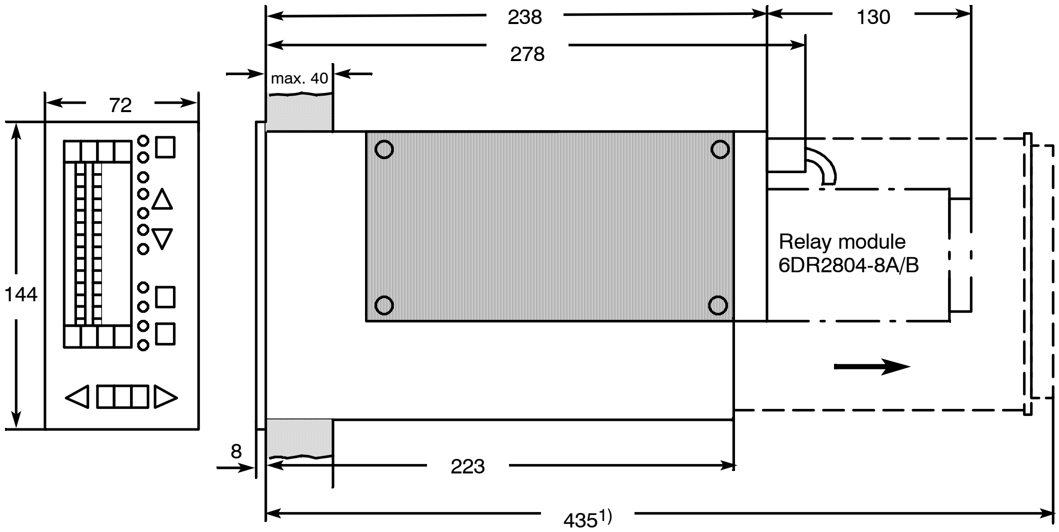
1.6.1 General data

Installation position	any
Climate class according to IEC721	
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

Controller design

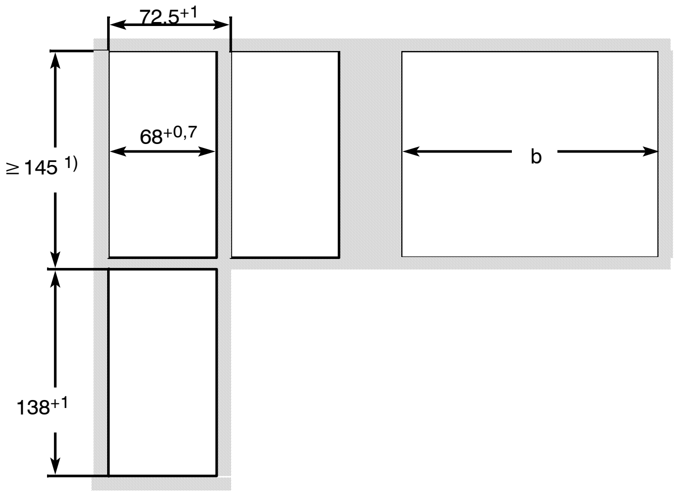
- Electrical safety
  - acc. to DIN EN 61 010 part 1,
  - Protection class I acc. to IEC 536
  - Safe disconnection between mains connection and field signals
  - Air and creep lines, unless specified otherwise, for overvoltage class III and degree of contamination 2
- EC declaration of conformity number 691.001
- CE mark conformity regarding:
  - EMC regulation 89/336/EWG and
  - LV regulation 73/23/EWG
- Spurious emission, interference immunity according to EN 61 326, NAMUR NE21 8/98

Weight, max. assembled	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
Rear panels, modules	Polybutylenterephthalate
Connection technique	
Power supply	
115/230 V AC	3-pin plug IEC320/V DIN 49457A
24 V UC	Special 2-pin plug
Field signals	plug-in terminals for 1.5 mm^2 AWG 14
Dimensions and panel cut-outs	see figure 1-72 and 1-73



1) Installation depth required to change the mainboard

Figure 1-72 Dimensions SIPART DR22, dimensions in mm



Nr. of controllers	Cut-out width b
2	140 +1
3	212 +1
4	284 +1
:	
:	
:	
10	716 +1

1) Installation close one above the other is allowed when the permissible ambient temperature is observed.

Figure 1-73 Panel cut-outs, dimensions in mm

1.6.2 Standard Controller

Power supply

Rated voltage	230 V AC (switchable)	115 V AC (switchable)	24 V UC	
Operating voltage range	187 to 276 V AC	93 to 138 V AC	20 to 28 V AC	20 to 35 V DC[1)]
Frequency range	48 to 63 Hz			– – –
External current I_{Ext}[2)]	450 mA.			
Power consumption				
Standard controller without options without I_{Ext} active power/apparent power (capacitive)	8 W/17 VA	8 W/13 VA	8 W/11 VA	8 W
Standard controller with options without I_{Ext} active power/apparent power (capacitive)	13 W/25 VA	13 W/20 VA	13 W/18 VA	13 W
Standard controller with options with I_{Ext} active power/apparent power (capacitive)	26 W/45 VA	26 W/36 VA	28 W/35 VA	28 W
Permissible voltage interruptions[3)]				
Standard controller without options without I_{Ext}	≤ 90 ms	≤ 70 ms	≤ 55 ms	≤ 30 ms
Standard controller with options without I_{Ext}	≤ 80 ms	≤ 60 ms	≤ 50 ms	≤ 25 ms
Standard controller with options with I_{Ext}	≤ 50 ms	≤ 35 ms	≤ 35 ms	≤ 20 ms

1) including harmonic
2) current transmitted from L+, BA, AA to external load
3) The load voltage of the AA is reduced hereby to 13 V, L+ to 15 V and the BA to 14 V

Table 1-21 Power supply standard controller

Analog inputs AE1 to AE3 and AE6 to AE11 (analog input module 3AE 6DR2800-8A)

Technical data under rated power supply conditions, +20 °C ambient temperature unless stated otherwise.

- **Voltage**

Rated signal range (0 to 100 %	0/199.6 to 998 mV or 0/2 to 10 V shuntable
Modulation range	≤ -4 to 110 %
Input resistance	
Difference	> 200 kΩ
Common mode	> 500 kΩ
Common mode voltage	0 to +10 V
Filter time constant	50 ms
Zero error	0.1 % + AD converter error
End value error	0.2 % + AD converter error
Linearization error	see AD converter
Common mode error	0.07 %/V
Temperature influence	
Zero point	0.05 %/10 K
Full scale	0.1 %/10 K
Static destruction limit	± 35 V

- **Current**

Rated signal range	0/4 to 20 mA
Modulation range	−1 to 21 mA
Input resistance	
Difference (load)	49.9 Ω ± 0.1 %
Common mode	> 500 kΩ
Common mode voltage	0 to +10 V
Filter time constant	50 ms
Zero error	see AD converter
End value error	see AD converter
Linearization error	see AD converter
Common mode error	0.07 %/V
Temperature influence	
Zero point	0.05 %/10 K
Full scale	0.1 %/10 K

Analog outputs AA1 to AA3

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	300 ms
Residual ripple 900 Hz	≤ 0.2 %
Resolution	11 bit

Load dependence	≤ 0,1 %
Zero error	≤ 0,3 %
End value error	≤ 0,3 %
Linearity	≤ 0.05 %
Temperature influence	
Zero point	≤ 0.1 %/10 K
Full scale	≤ 0.1 %/10 K
Static destruction limit	–1 to 35 V

Measuring transducer feed L+

Rated voltage	+20 to 26 V
Load current	≤ 100 mA, short–circuit–proof
Short-circuit current	≤ 20 mA clocking
Static destruction limit	–1 to +35 V

Digital inputs BE1 to BE4

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

Binary outputs BA1 to BA8 (with wired or diodes)

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

Cycle time adaptive 60 ms to 120 ms (typical 80 ms)

A/D-conversion

Procedure	Successive approximation per input >120 conversions and averaging of 20 or 16.67 ms
Modulation range	–4 to 110%
Resolution	11 bit ≙ 0.06 %
Zero error	≤ 0.2 %
Full scale error	≤ 0.2 %
Linearization error	≤ 0.2 %
Temperature influence	
Zero point	≤ 0.05 %/10 K
Full scale	≤ 0.1 %/10 K

D/A conversion See technical data ”Analog inputs AA1 to AA3”

Setpoint and manipulated variable adjustment		
Setting		With two keys (more – less)
Speed		progressive
Resolution	wi	1 digit
	y	0.1 %
Parameters		
Setting		With 2 keys (more – less)
Speed		progressive
Resolution		
Linear parameters, %		0.1 %
Linear parameters, physical		1 digit
Logarithmic parameters		128 values/octave
Accuracy		
Time parameters		± 1 %
All others		Resolution accordingly, absolute
Display technique		
– x and w display digital		$4^1/_2$digit 7-segment-LED
Color	x	red
	w	green
Digit height		7 mm
Display range		Adjustable start and end
Number range		–1999 to 19999
Overflow		<–1999: –oFL
		>19999: oFL
Decimal point		adjustable (fixed point) _.––– to ––––
Refresh rate		adjustable 0.080 to 8,000 s 1)
Resolution		1 digit but better than AD converter
Display error		corresponding to AD converter and analog inputs
– x and w display analog		
Color	x	red
	w	green
Display range		
Overflow		flashing first or last LED
Resolution		1.7 % by alternate glowing of 1 or 2 LEDs, the center of the illuminated field serves as a pointer
Refresh rate		cyclic
– y display (digital)		3-digit 7-segment LED
Color		yellow
Digit height		7 mm
Display range		0 to 100 %

Overflow	−10 to 110 %
Refrseh rate	adjustable 0.080 to 8.000 s [1]
Resolution	1 %

[1] typical cycle time

1.6.3 Technical data of the options modules

6DR2800-8A **3AE I/U module** Analog inputs AE6 to AE8 (slot 6), AE9 to AE11 (slot 5), see chapter 1.6.2, page 129, AE1 to AE3

6DR2800-8J/R Analog inputs AE4 (slot 2), AE5 (slot 3)

Signal transformer for **Order number:**	**1AE** **Current** **6DR2800-8J**	**1AE** **Voltage** **6DR2800-8J**	**1AE** **Resistance potentiometer** **6DR2800-8R**
Range start Min. span (100 %) Max. zero point suppression Range full scale Dynamic range	0 or 4 mA [1] 20 mA –4 to 110 %	0 V or 2 V[1] or 199.6 mV [1] 10 V, 998 mV –4 to 110 %	0 Ω ΔR ≥ 0.3 R [3] RA ≤ 0.2 R [3] RA + 1.1 R [3] –4 to 110 %
Input resistance Difference Common mode Permissible common mode voltage Supply current Line resistance Two-wire circuit Three-wire circuit Four-wire circuit	 49.9 Ω ±0.1 % 500 kΩ 0 to +10 V	 200 kΩ ≥ 200 kΩ 0 to +10 V	 5 mA ±5% – per < 10 Ω –
Filter time constant ±20 %	50 ms	50 ms	50 ms
Error [2] Zero point Gain Linearity Common mode	 ≤ 0.3 % ≤ 0.5 % ≤ 0.05 % ≤ 0.07 %/V	 ≤ 0.2 % ≤ 0.2 % ≤ 0.05 % ≤ 0.02 %/V	 ≤ 0.2 % ≤ 0.2 % ≤ 0.2 % –
Influence of temperature [2] Zero point Gain	 ≤ 0.05 %/10 K ≤ 0.1 %/10 K	 ≤ 0.02 %/10 K ≤ 0.1 %/10 K	 ≤ 0.1 %/10 K ≤ 0.03 %/10 K
Stat. destruction limit between the input referenced to M	 ±40 mA ±35 V	 ±35 V ±35 V	 ±35 V ±35 V

[1] Measuring start by structuring
[2] without errors of the A converter
[3] with R = RA +ΔR + RE adjustable in three ranges: R = 200 Ω, R = 500 Ω, R = 1000 Ω

Table 1-22 Technical data for I/U module 6DR2800–8J/R

6DR2800-8V UNI module: Analog inputs AE4 (slot 2), AE5 (slot 3)

Analog input AE4, AE5	**mV** 1)	**TC** 2)	**Pt100**	**R**	**R**
Slot 2, 3		°C		R ≤ 600 Ω	R ≤ 2.8 kΩ
Range start MA	≥-175 mV	≥-175 mV	≥-200 °C	≥0 Ω	≥0 Ω
Range 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
Measuring transducer 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 junction terminal	–	±0.5 K	–	–	–
Temperature error					
Transmission	±0.05 %/10 K 3)				
Internal reference junction terminal	–	±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 constant adaptive	<1.5 s	<2 s	<2 s	<1.5 s	<1.5 s

1) 20 mA, 10 V with measuring for TC, internal connector 6DR2805-8J
2) types see CAE menu, internal reference junction terminal (pluggable terminal block) 6DR2805-8A
3) Referenced to parameterizable span Δ = ME – MA

Table 1-23 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 between 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 2BO Relay 35 V+ Binary outputs BA9 and BA10 (slot 5) or BA13 and BA14 (slot 6)

– **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 for 24 V ≤ 80 W for 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	**4BA 24 V + 2BE**	Digital outputs BA9 to BA12 and digital inputs BE5 and BE6 (slot 5) or digital outputs BA13 to BA16 and digital inputs BE10 and BE11 (slot 6)

- **Digital outputs**

Signal status 0	≤ 1.5 V or open, residual current ≤ 50 μA
Signal status 1	19 to 26 V
Load current	≤ 30 mA
Short-circuit current	≤ 50 mA, clocking
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	≥ 2.4 kΩ
Static destruction limit	±35 V

6DR2801–8C	**5BE 24 V**	Digital inputs BE5 to BE9 (slot 5), BE10 to BE14 (Slot 6)

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

6DR2802-8A	**1AA(y_{hold})**	Analog outputs AA4 (Slot 6), AA7 (Slot 5)

- **Analog output AA4/AA7**

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	
for supply	
from controller	–1 to 18 V
by U_H > 22,5 V	–1 to 15 V
by U_H = 20 V	–1 to 12.5 V
No-load voltage	≤ 26 V
Inductive load	≤ 0.1 H
Time constant	300 ms
Residual ripple 900 Hz	≤ 0.2 %
Resolution	0.1 %
Load dependence	≤ 0.1 %
Zero error	≤ 0.2%
Full scale error	≤ 0.1 %
Linearity	≤ 0.05 %

Temperature influence	
Zero point	≤ 0,1 %/10 k
Full scale	≤ 0,1 %/10 k
Static destruction limit	–1 to +35 V

– Digital output $\overline{St}$

Signal status 0	≤ 1.5 V
Signal status 1	+19 to 26 V
Load current	≤ 30 mA, short-circuit-proof
Short-circuit current	≤ 50 mA clocking
Static destruction limit	–1 to +35 V

– Auxiliary voltage U_H

Voltage range	+20 to +30 V (including harmonic)
Current consumption	
for supply from controllers	≤ 6 mA
for supply by U_H	≤ 70 mA
Static destruction limit	± 35 V

6DR2802–8B **3AA and 3BE** Analog outputs AA7 bis AA9, digital inputs BE5 to BE7 (slot 5);
Analog outputs AA4 bis AA6 (slot 6),
digital inputs BE10 to BE12 (slot 5);

– Analog outputs

Rated signal range (0 to 100 %)	0 to 20 mA or 4 mA to 20 mA
Modulation range	0 to 20.5 mA or 3.8 mA 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	10 bit
Load dependence	≤ 0.1 %
Zero error	≤ 0.3 %
Full scale error	≤ 0.3 %
Linearity	≤ 0.05 %
Temperature influence	
Zero point	≤ 0.1 %/10 K
Full scale	≤ 0.1 %/10 K
Static destruction limit	–1 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

6DR2803-8P PROFIBUS-DP

Transferable signals	RS 485, PROFIBUS-DP-protocol
Transferable 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
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

Transferable signals	RS 232, RS 485 or SIPART BUS*) shuntable *) SIPART bus operation no longer possible. The bus driver is no longer offered.
Transferable data	Operating state, process variables, parameters and strucrture 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 bit/s
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 Rxd Signal level 0 Signal level 1 [1)] Input resistance	0 to +12 V [2)] -3 to -12 V [2)] 13 kΩ 100 kΩ ab Erzeugnisstand 8	$U_A > U_B$, +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 to -6 V
Load resistance	≤1.67 mA	54 Ω

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

Line capacitance or lengths
at 9600 bits/s

	Power 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	1000 m	1000 m

6DR2804-8A/B Coupling relay 230 V

1 relay module	6DR2804-8B
2 relay module	6DR2804-8A
per relay module	2 relays with 1 switching contact each with spark quenching element
– **Contact material**	silver-cadmium oxide
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**	silver-cadmium oxide
mechanical	2×10^7 switching cycles
electrical AC 230 V, ohmic	$2 \times 10^6/I(A)$switching cycles

– **Spark quenching element**	Series circuit 33 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	Safe isolation by reinforced isolation, air and creep lines for overvoltage class III and (6DR2804-8A) degree of contamination 2 (DIN EN 61010 Teil 1)
contact – contact of a relay module	Safe isolation by reinforced insulation, air and creep lines for overvoltage class II and degree of contamination 2 (DIN EN 61010 Teil 1)
– **Type of protection**	
Casing	IP50 according to DIN 40050
Connections (in plugged state)	IP20 according to DIN 40050
– **Casing material**	Polyamide 66
– Mounting rail assembly on	NS 35/7.5 DIN EN 50022 NS 35/15 DIN EN 50035 NS 32 DIN EN 50035
– **Dimensioned diagram**	see figure 1-74

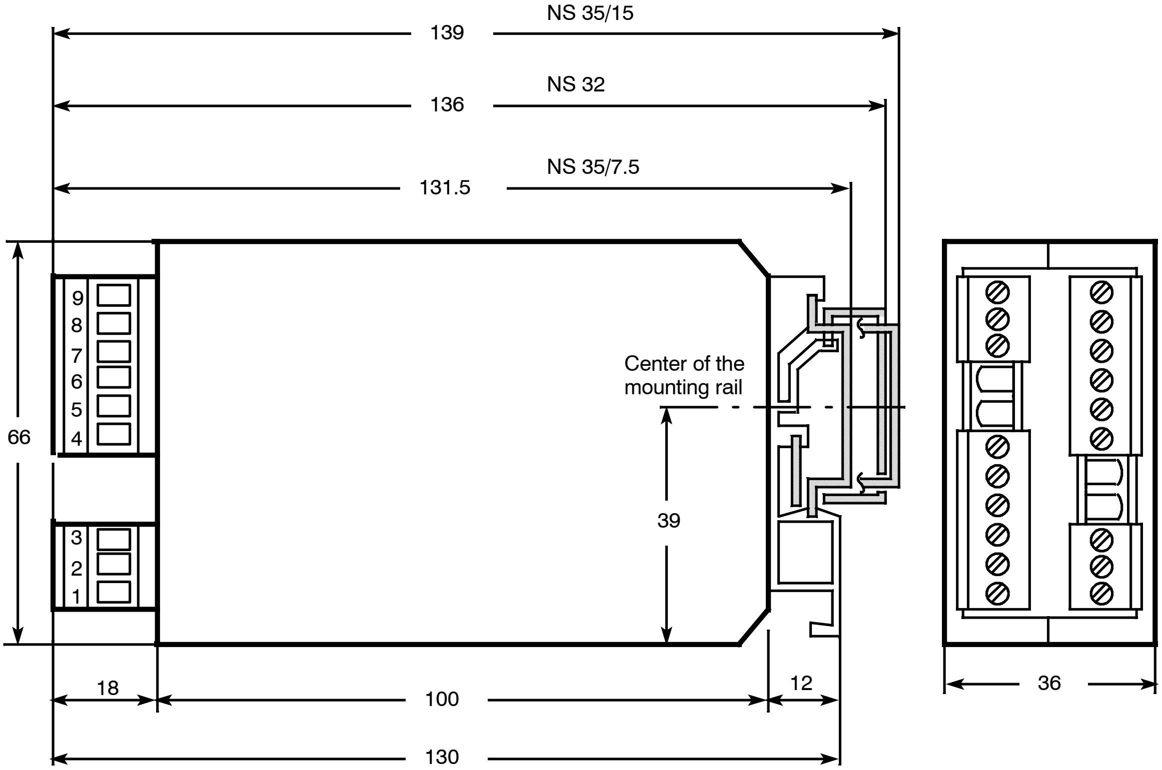


Figure 1-74 Dimensioned diagram coupling relay, dimensions in mm

2 Installation

2.1 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. Front and rear sides of the controller must be easily accessible.

- **Panel mounting**

  The SIPART DR22 is installed either in individual panel cutouts or in open tiers (for dimensioned diagram, see chapter 1.6.1, page 128 fig. 1-72, and fig. 1-73).

  - The upper edge of the panel cut-out must be left unpainted to ensure good interference suppression of the controller even at high frequencies. A good HF ground connection is established by the contact spring protruding from the top of the SIPART DR22.
  - If necessary: Push self-adhesive sealing ring for sealing front frame/front panel over the tube and stick to the tube collar (see chapter 5.2, page 231, item 2.6).
  - Insert SIPART DR22 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 casing.
  - Align SIPART DR22 and do not tighten the locking screws too tight. The tightening range is 0 to 40 mm.

2.2 Electrical Connection

The arrangement of the connecting elements can be seen in fig. 2-1, page 145.

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 2-1) on the back of the controller. When connecting to 115 or 230 V AC mains supply, the PE conductor can also be connected through the three-pin plug (see figure 2-1). 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 on 115 V or 230 V AC systems by a three–pin plug IEC 320/V DIN 49457 A , on 24 V UC systems by a special 2–pin plug (polarity irrelevant). The plugs are supplied with the unit.

WARNING

Set the mains voltage selection switch (see figure 2-1) in the no–voltage state to the existing mains voltage.
It is essential to observe the mains voltage specified on the rating plate or on the mains voltage switch (115/230 V AC) or on the voltage plate (24 V DC)!
Feed the power cables via a circuit breaker within easy reach (fire safety according to IEC 66E (sec) 22/DIN VDE 0411 Part 100). When connected to an unprotected power supply, the controller must be supplied via a circuit breaker. The circuit breaker is not required if one already exists (≤ 30 Vrms or ≤ 42,4 V DC and current ≤ 8 A or source under all load conditions ≤ 150 VA or fuse element which responds at ≤ 150VA).
The circuit breaker can be omitted if the 24 V UC power supply is protected by ≤ 4 A (35 V DC) (T 3,15 A is required at least).

- **Connection of measuring and signal lines**

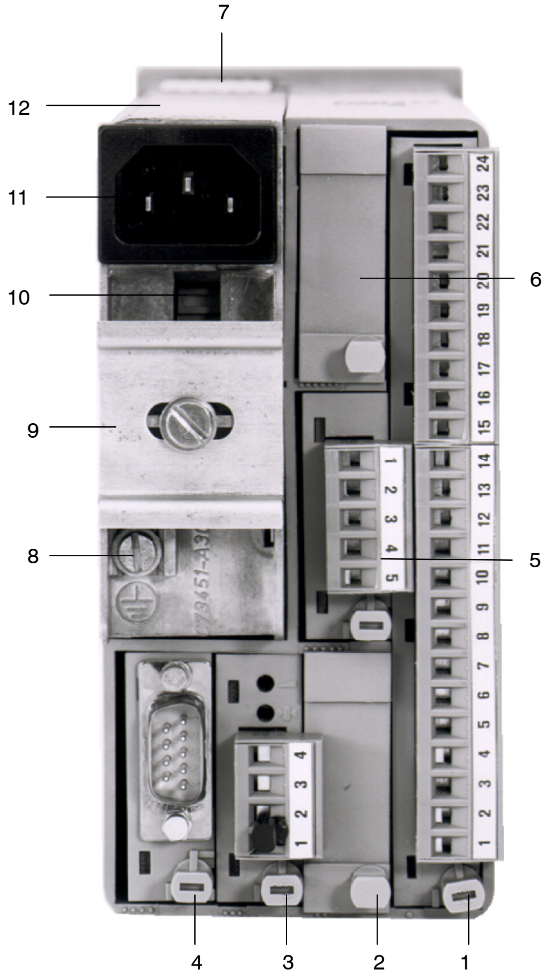
The process signals are connected via plug-in terminal blocks that can accommodate cables of up to 1.5 mm^2 (AWG 14) cross-section.

Standard controller	Slot 1	14- and 10-pin
Option modules	Slots 2 and 3	4-pin
	Slot 5 and 6	5- and 6-pin
Interface relays	”Slots” 7 and 8	3- and 6-pin

The slots 1 to 8 must be marked in the circuit diagrams and at the terminal blocks.

Signal 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 signal lines, the signal 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 junction terminal. The shield should only ever 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 DR22 is designed with a high electromagnetic compatibility (EMC) and has a high resistance to HF interference. In order to maintain this high operational reliability we recommend that all inductances (e.g. relays, contactors, motors) installed in the vicinity of or connected to the controllers should be assembled with suitable suppressors (e.g. RC combinations)!



1 Slot 1
Main board
AE1 to AE3 (I/U)
AA1 bis AA3
BE1 to BE4
BA1 to BA8 24 V
L+, M

2 Slot 2
AE4 (I/U, R, P, T, V)

3 Slot 3
AE5 (I/U, R, P, T,V)

4 Slot 4
Serial interface

5 Slot 5

4BA 24 V+2BE	BA9 to BA12, BE5 to BE6
2BA relay	BA9, BA 10
5BE	BE5 to BE9
1AA	AA7
3AE	AE9 to AE11
3AA+3BA	AA7 to AA9, BE5 to BE7

6 Slot 6

4BA 24 V+2BE	BA13 to BA16, BE10 to BE11
2BA relay	BA13, BA14
5BE	BE10 to BE14
1AA(y-hold)	AA4
3AE	AE6 to AE8
3AA+3BE	AA4 to AA6, BE10 to BE12

7 PE conductor contact spring

8 Grounding screw

9 Mounting rail
(contained in scope of delivery of relay module 6DR2804–8A/B)

10 Mains voltage selection switch

11 Mains plug

12 Power supply unit

Figure 2-1 Rear panel

- **Connection of the serial interface**

  For V.28 point-to-point connections of the SES, a 9-pin socket strip for round cables is available.

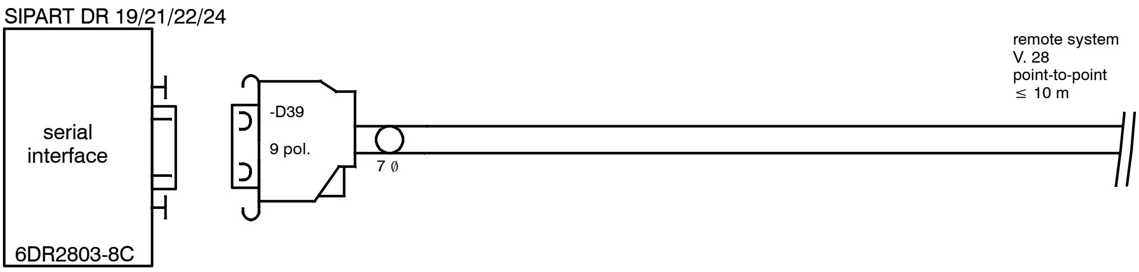


Figure 2-2 Plug for serial interface

9-pin socket strip for round cables (screw terminal)	C73451-A347-D39
Recommended cable: 4-core unshielded round cable	JE-LiYY 4x1x0.5 BdSi

- **Zero volt system**

  The SIPART DR22 controllers only have a 0V conductor (ground, GND) on the process side which is output double at terminals 1/1 and 1/2 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 reference for both inputs and outputs, all process signals are referred to this point.
  The reference line is also connected to vacant terminal modules. These may only be used if practically no current flows through this connection (see e.g. fig. 2-13, page 151, I 4L).

  The power supply connection is electrically isolated from the process signals. In systems with unmeshed control circuits, the SIPART DR22s need not 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 common termination may be connected with the system's PE conductor at one point.

  Since in analog signal exchange between the devices, only currents 0/4 to 20 mA are used and these are evaluated as a four-pole measurement (differential amplifiers with electronic potential isolation), voltage drops on the M-conductor are not interpreted as errors (see fig. 2-26, page 159 to fig. 2-32).

  The signal-to-noise ratio on digital signals is so great that voltage dips on the GND rail can be ignored.

2.2.1 Connection standard controller

- **Power supply connection**

  Attention:
  Set mains voltage selection switch (see fig. 2-1) in no-voltage state according to the available mains voltage!

  – **6DR2210-5 115/230 V AC, switchable**

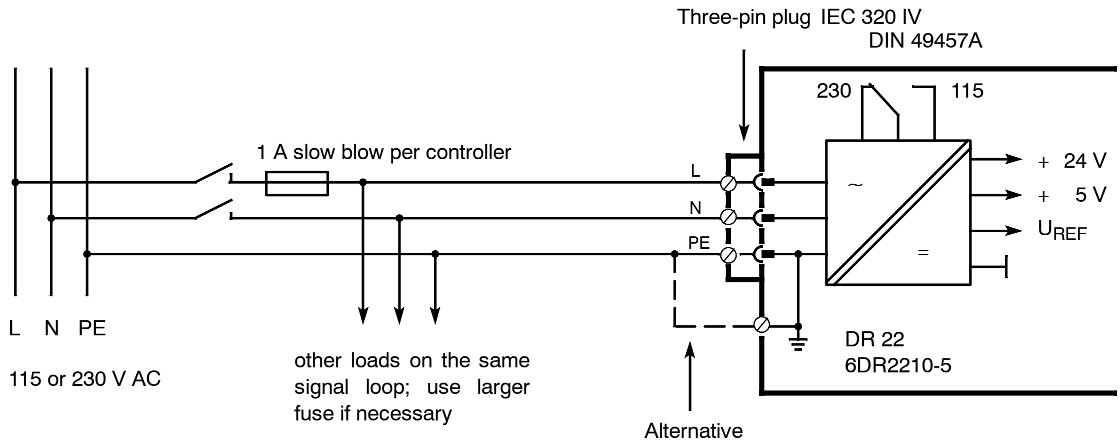


Figure 2-3 Connection 115/230 V AC power supply

  – **6DR2210-4 24V UC**

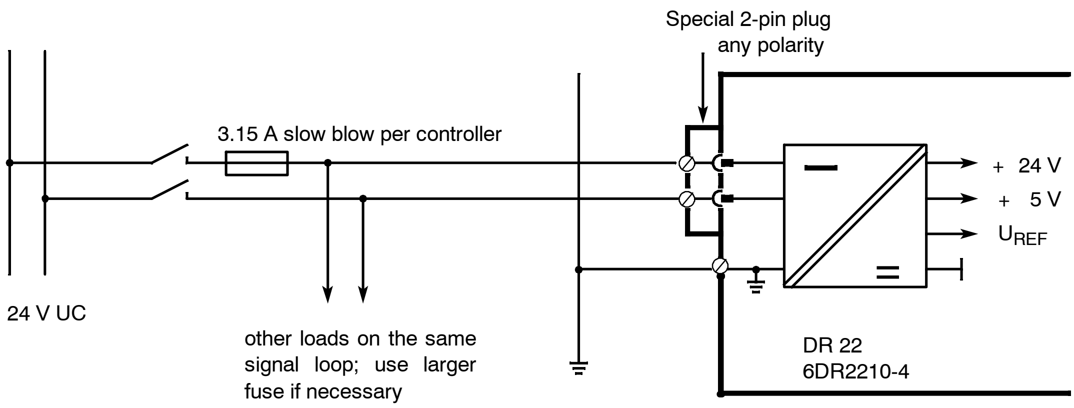
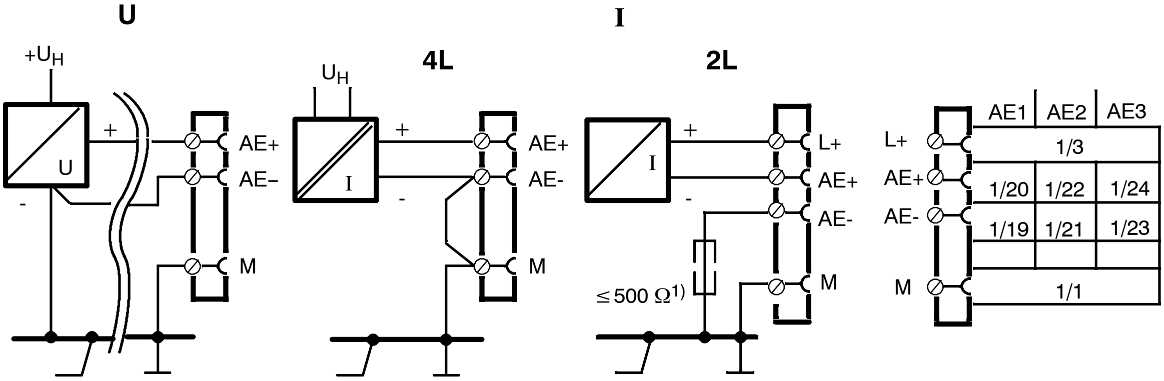


Figure 2-4 Connection 24 V DC power supply

- **AE1 to AE3**

  – **Wiring**



Other connection possibilities, see chapter 2.2.3, page 158

Set the analog inputs AE1 to AE3 to 0 or 4 mA with the stucture switches S5 to S7

1) potential load impedance from additional instruments

Figure 2-5 Connections AE1 to AE3 U or I

  – **Jumper settings**

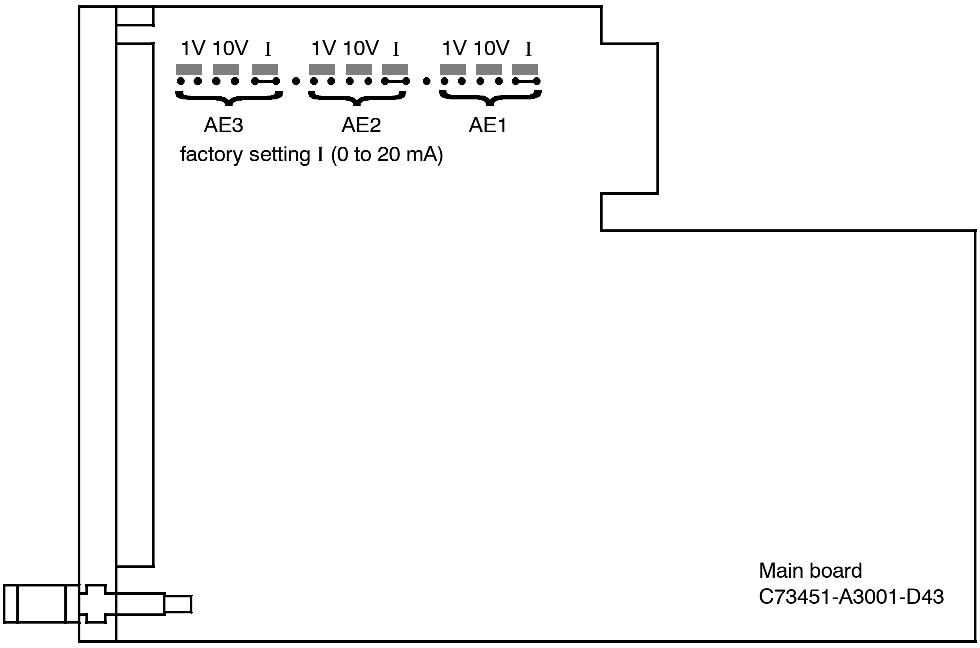


Figure 2-6 Jumper settings AE1 to AE3

- **BE1 to BE4**

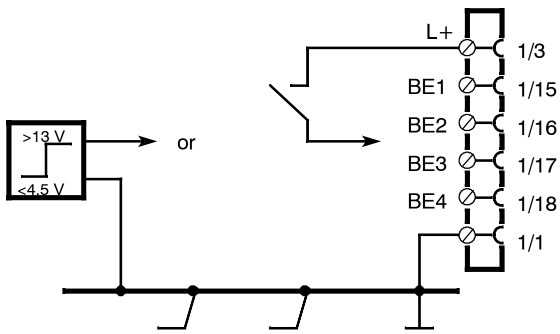


Figure 2-7 BE1 to BE4 connection diagram

- **BA1 to BA8**

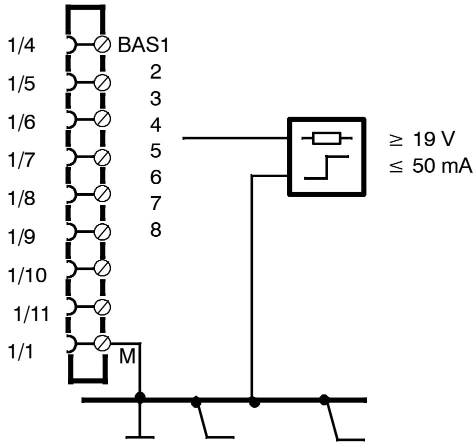
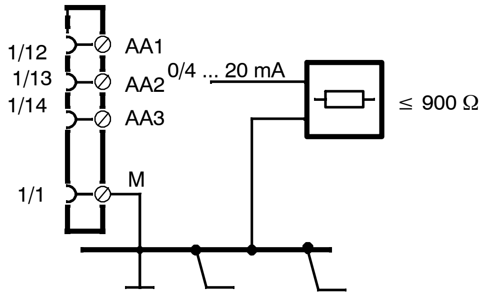


Figure 2-8 BA1 to BA8 connection diagram

If S-controllers are CSi* structured, the Δy-outputs of the S-controllers are permanently assigned to the digital outputs BA*.

Arithmetic block	+Δy / terminal	–Δy/terminal
S1=12 and S231>0	BA5 / 1/8	BA6 / 1/9
S2>0	BA7 / 1/10	BA8 / 1/11

- **AA1 to AA3**



Set the analog outputs AA1 to AA3 to 0 or 4 mA with the structure switches S69 to S71

Figure 2-9 AA1 to AA3 connection diagram

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

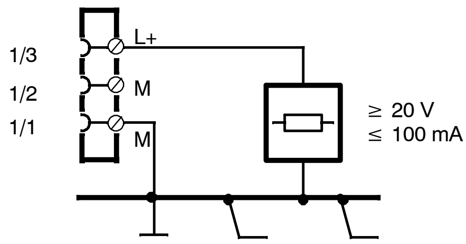


Figure 2-10 L+ connection diagram

2.2.2 Wiring of option modules

- **6DR2800-8A 3AE, U or I-input**

  Slot 5: AE9 to AE11 in StrS set S22 = 5

  Slot 6: AE6 to AE8 in StrS set S23 = 5

– Wiring

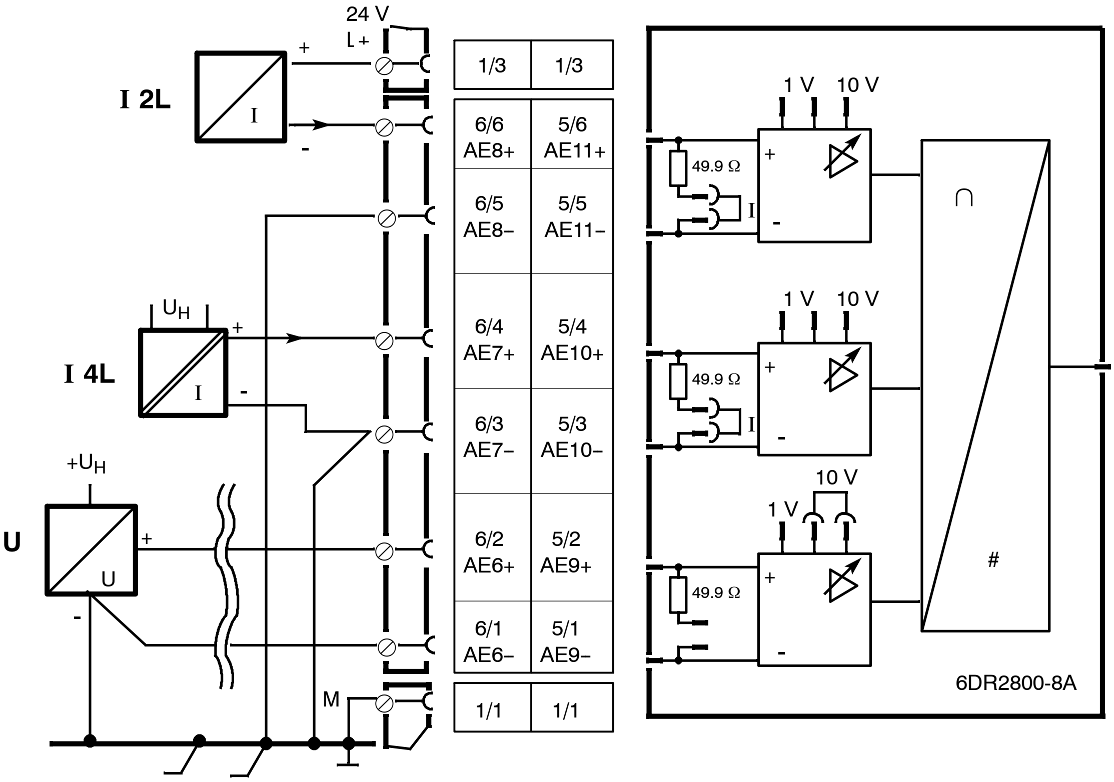


Figure 2-11 Connection of 3AE module 6DR2800-8A

– Jumper settings

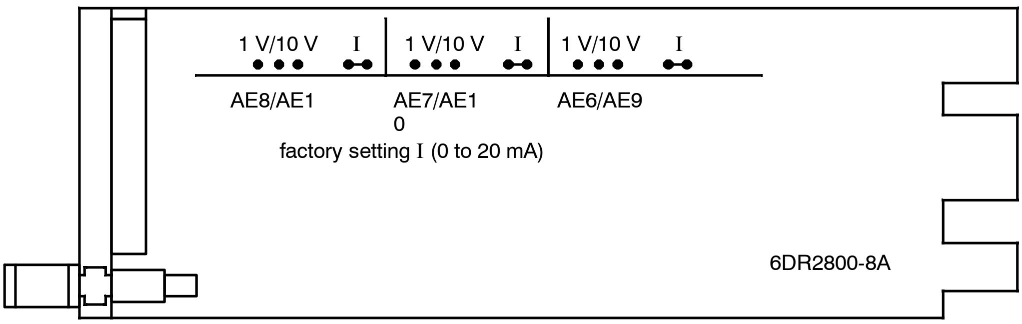
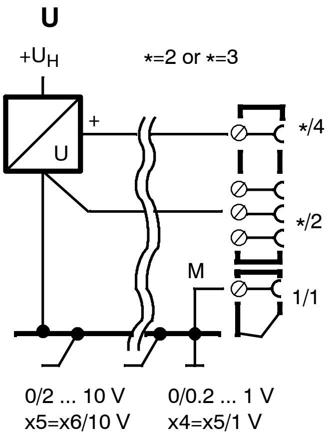


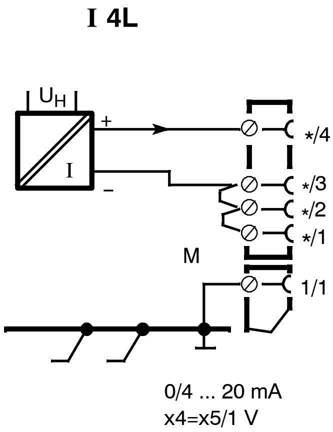
Figure 2-12 AE6 to AE8 or AE9 to AE11 jumper settings

- **6DR2800-8J 1AE, U or I-input**

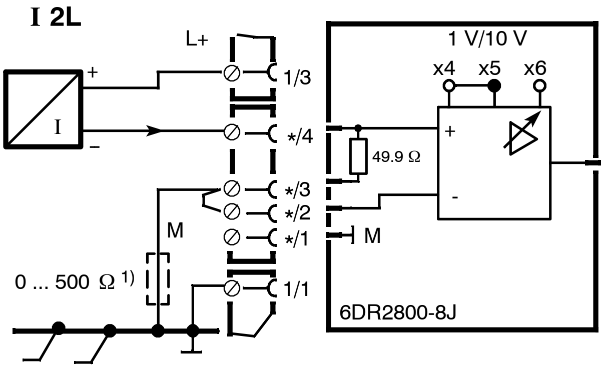
  AE4 in slot 2 in StrS S8 set 0 to 3
  AE5 in slot 3 in StrS S9 set 0 to 3

  Ranges:
  0 to 1 V/10 V/20 mA or
  0.2 V/2 V/4 mA to
  1 V/10 V/20 mA, plus 1 V/10 V
  using jumpers on board





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



[1] potential load impedance from additional instruments

Further connection possibilities see chapter 2.2.3, page 158

Figure 2-13 Connection U/I-module 6DR2800-8J

- **6DR2800-8R 1AE, resistance input**

  AE4 in slot 2; in StrS S8 set 0 or 1
  AE5 in slot 3; in StrS S9 set 0 or 1

– Connection

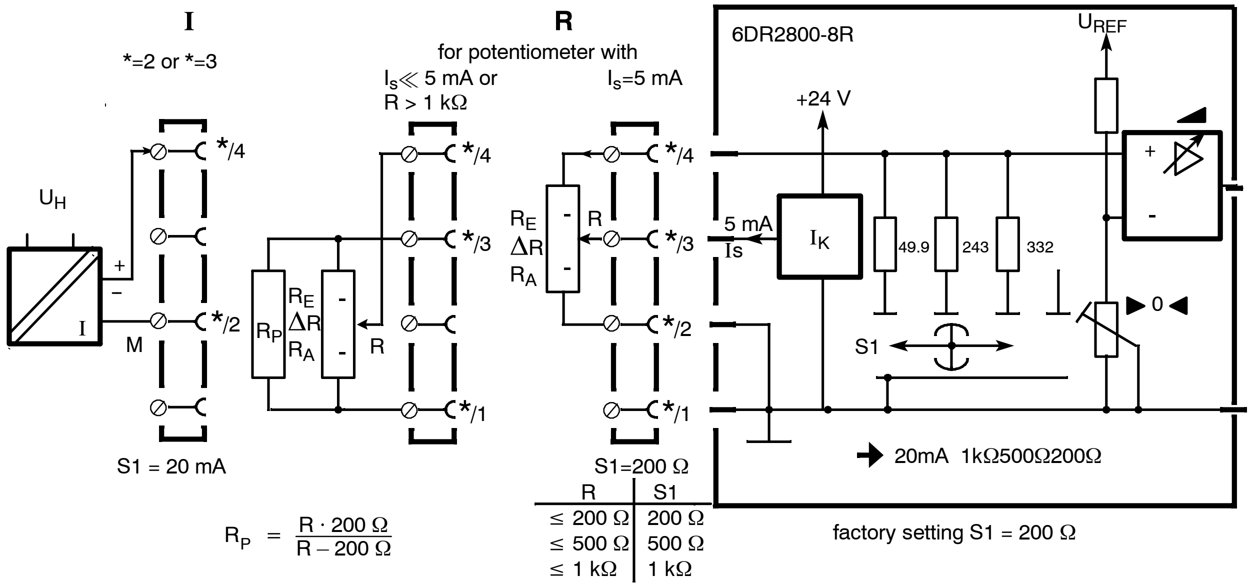


Figure 2-14 Connection of R module 6DR2800-8R

– Calibration

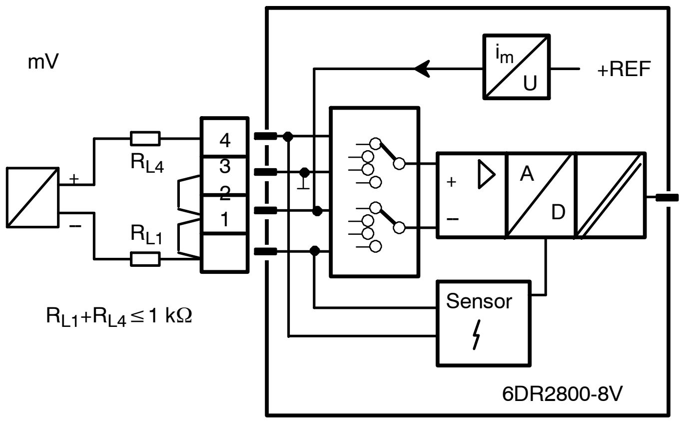
1. Set sliding switch S1 according to the measuring range.
2. Set R_A using ▶ 0 ◀ Set display or analog output (depending on the configuration) to start-of-scale value or 4 mA.
3. Set R_E using ◢ display or analog output to full-scale value or 20 mA.

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

  The universal module can be plugged into slot 2 (analog input AE4) and slot 3 (analog input AE5). The measuring ranges are set using the menu CAE4/CAE5.

  – **Pin assignment for mV transmitter**

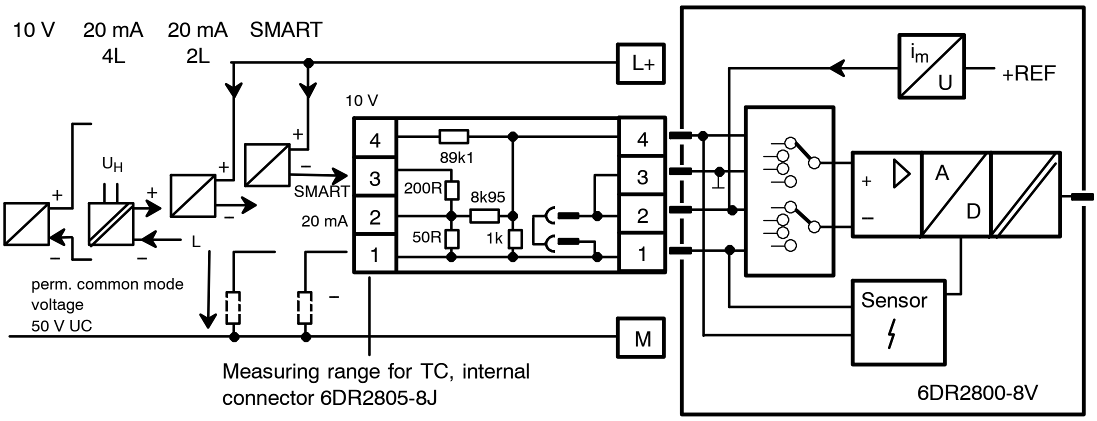
  Direct input $U_{max} = \pm 175$ mV



Block diagram of mV module 6DR2800-8V

Figure 2-15 Connection of UNI module

– **Pin assignment measuring range for TC, internal connector 6DR2805-8J for U or I**



Block diagram of mV module 6DR2800-8V

Figure 2-16 Connection of UNI module

– Pin assignment for thermocouple TC

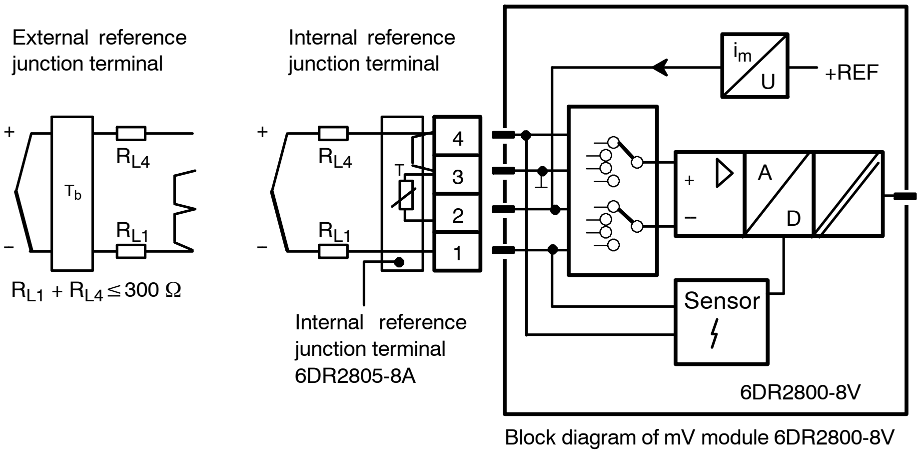


Figure 2-17 Connection of thermocouple TC

– Pin assignment for Pt100 sensor RTD

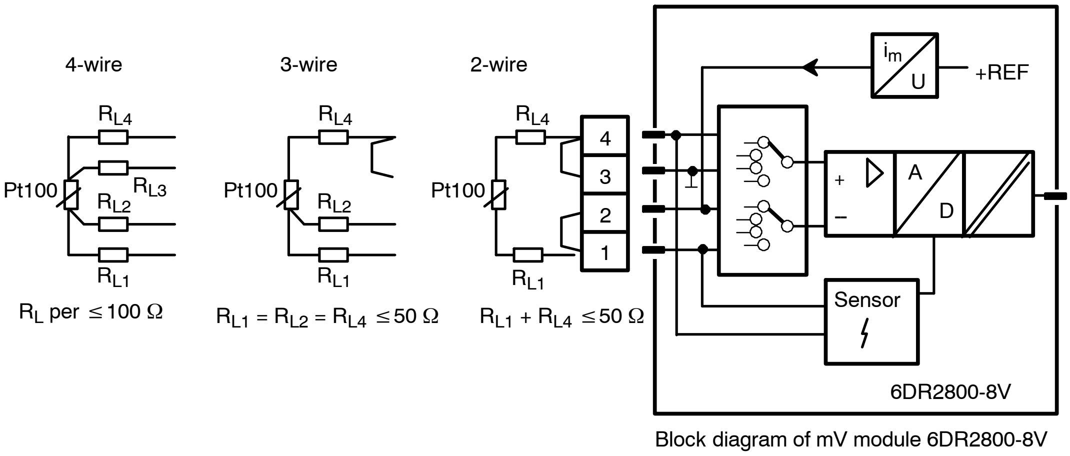
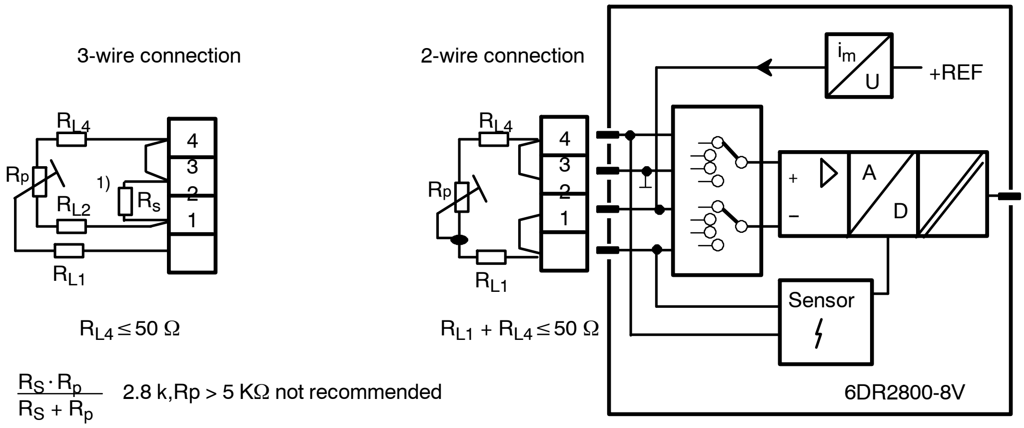


Figure 2-18 Wiring of PT100 sensor RTD

– Pin assignment for resistance potentiometer (R)



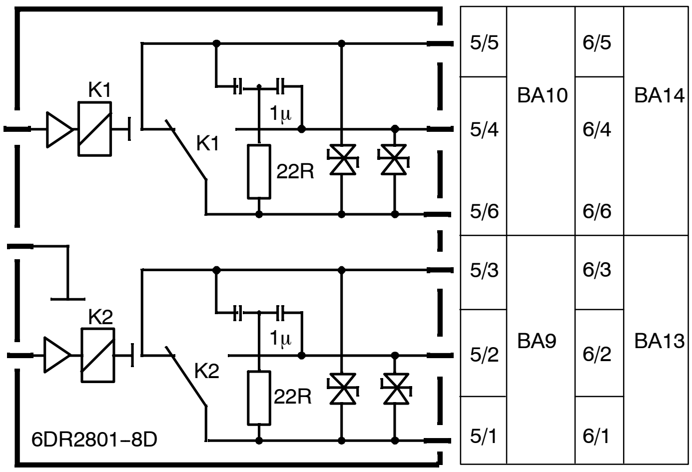
Block diagram of UNI module 6DR2800-8V

[1] R_s jumper impedance only necessary if 2.8 kΩ < R ≤ 5 kΩ

Figure 2-19 Connection of UNI module

- **6DR2801-8D 2BA relay 35 V**

BA9 and BA10 in slot 5 in StrS set S22 = 3
BA13 and BA14 in slot 6 in StrS set S23 = 3



AC	≤	35	V	DC	≤	35	V
	≤	5	A		≤	5	A
	≤	150	VA		≤	80	W at 35 V
						100	W at 24 V

Figure 2-20 Connection of 2BA (relay) module 6DR2801-8D

- **6DR2801-8E 4BA 24 V + 2BE**

  BA9 to BA12 and BE5 to BE6 in slot 5, in StrS set S22 = 1
  BA13 to BA16 and BE10 to BE11 in slot 6, in StrS set S23 = 1

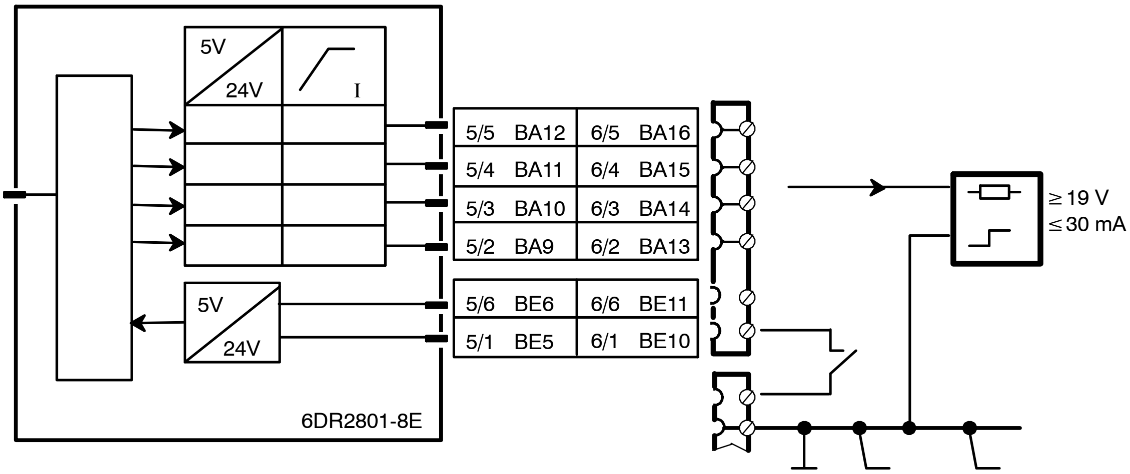


Figure 2-21 Connection of 4BA (24 V) module 6DR2801-8E

- **6DR2801-8C 5BE**

  BE5 to BE9 in slot 5, in StrS set S22 = 1
  BE10 to BE14 in slot 6, in StrS set S23 = 1

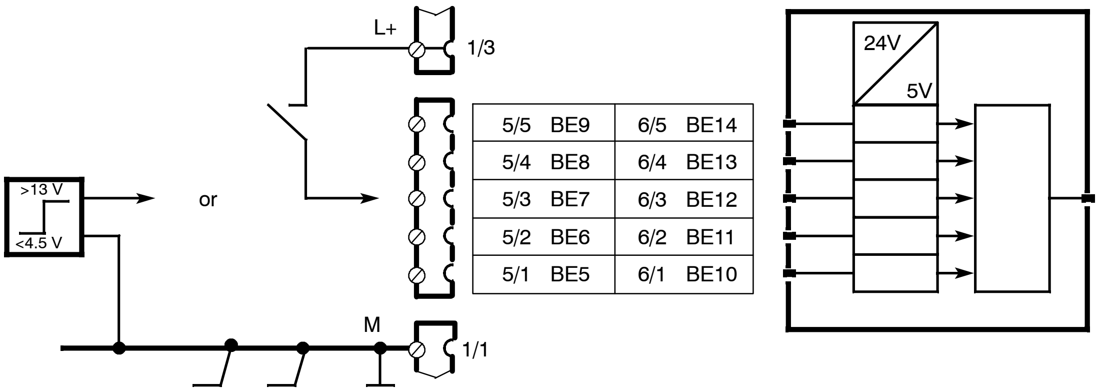
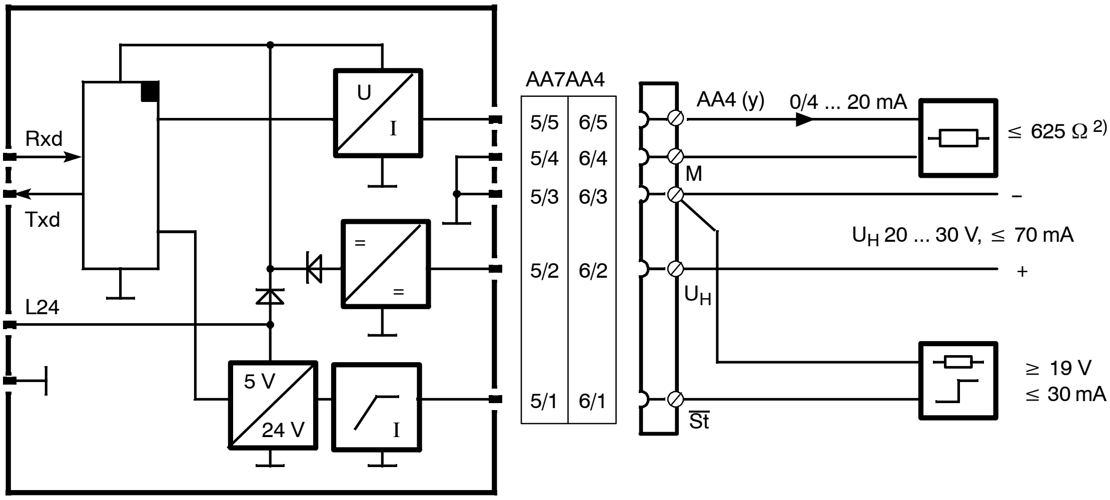


Figure 2-22 Wiring of 5BE module 6DR2801-8C

- **6DR2802-8A (1AA, y_{hold})**

AA7 in slot 5 in StrS set S22 = 4
AA4 in slot 6 in StrS set S23 = 4



1) UH need only be connected if the output current is to be maintained even in the event of a power failure in the controller or when removing the module for service work.
2) depending on the supply up to 900 Ω possible (see chapter 1.6.3, page 133).

Figure 2-23 Connection of y_{hold} module 6DR2802-8A

- **6DR2802-8B 3AA + 3BE**

AA7 to AA9 and BE5 to BE7 in StrS set S22 = 6
AA4 to AA6 and BE10 to BE12 in StrS set S23 = 6

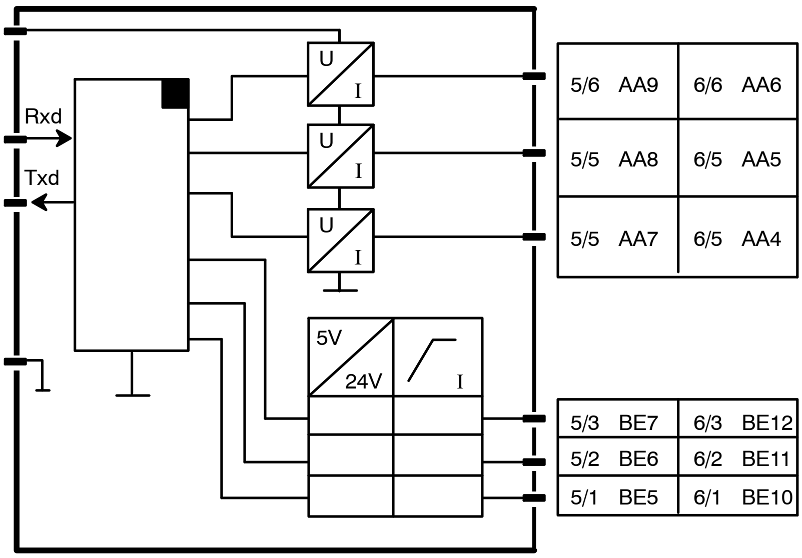


Figure 2-24 Connection 3AA/3BE module 6DR2802–8B

- **6DR2804-8A (interface relay 230 V, 4 relays)**
  6DR2804-8B (interface relay 230 V, 2 relays)

E.g. connection for $\pm\Delta y$ outputs in the S controller with interface relay 230 V, 2 relays (6DR2804-8B)

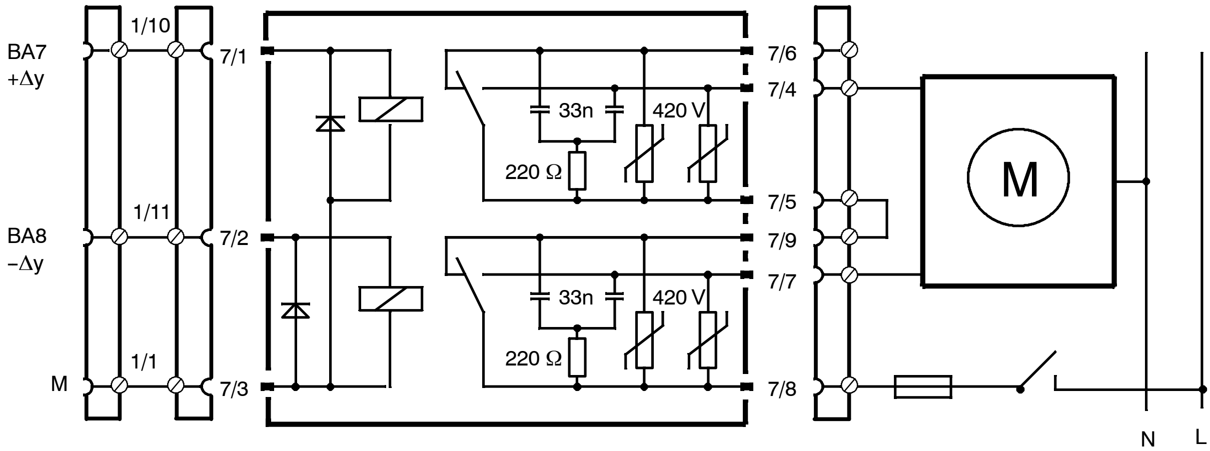


Figure 2-25 Connection of interface relay 230 V 6DR2804-8B

The interface relay 230 V, 4 relays (6DR2804-8A) contains 4 relays. Terminals 8/1 to 8/9 must then be connected accordingly in addition to the terminals 7/1 to 7/8.

Attention: Observe the max. switching voltage! (excessive increases in resonance in phase shift motors, see chapter 1.4.2, page 13)

AC	250	V	DC	250	V
	8	A		8	A
	1,250	VA		30	W at 250 V
				100	W at 24 V

2.2.3 Alternative connection for I- and U-input

- **0/4 to 20 mA signals**

  The 49.9 Ω input impedance is connected across the input signals AE+ and AE- (AE1 to AE3 in the standard controller and in module 6DR2800-8A by means of jumper settings and by external wiring on the option module for AE4 and AE5).
  If the signal is still required during service work in which the terminal is disconnected, the input 49.9 Ω input impedance ±0.1 % must be connected to the terminal between AE+ and AE–. The internal 49.9 Ω resistance must then be disconnected by appropriate jumper settings or by rewiring.

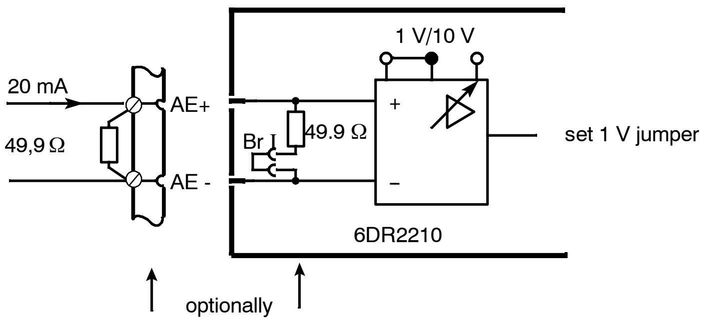


Figure 2-26 Signal input AE1 to AE3 of the standard controller, internal or external 49.9 Ω resistance or signal input AE6 to AE8 via module 3AE, 6DR2800-8A

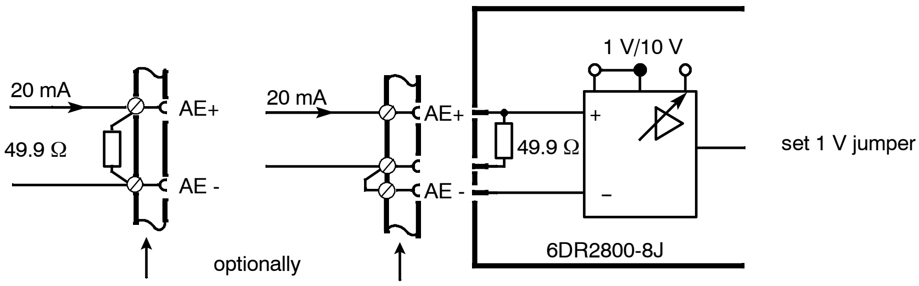


Figure 2-27 Signal input AE4, AE5 via option module 6DR2800-8J, internal or external 49.9 Ω resistance

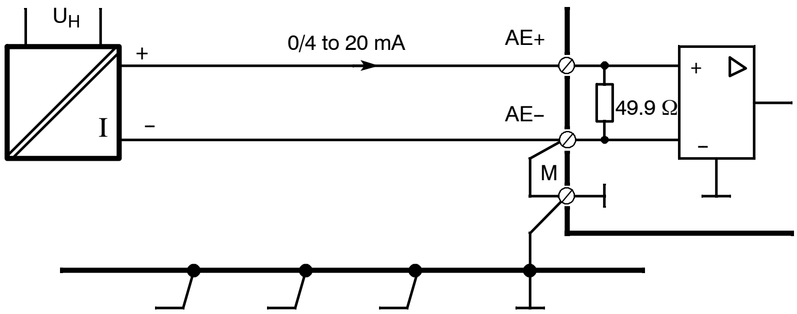


Figure 2-28 Connection of a 0/4 to 20 mA transmitter 0/4 to 20 mA with potential isolation

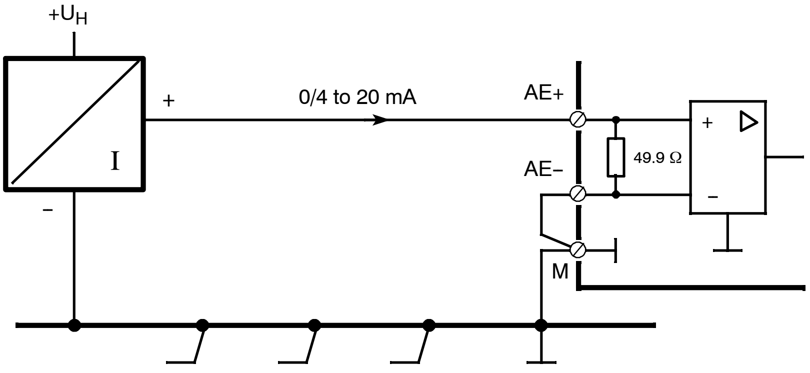


Figure 2-29 Connection of a 0/4 to 20 mA transmitter with negative polarity to ground

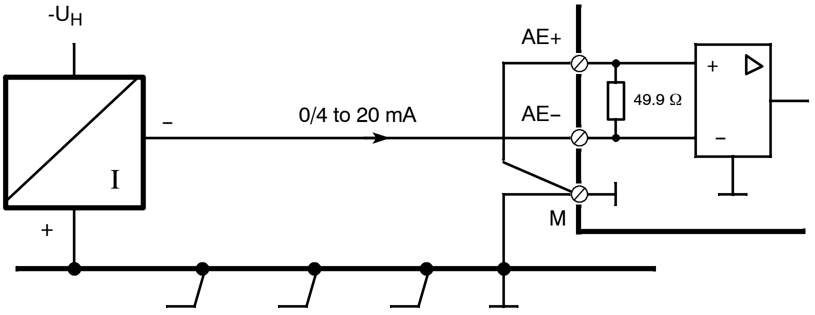


Figure 2-30 Connection of a 0/4 to 20 mA 3-wire transmitter 0/4 to 20 mA with positive polarity to ground

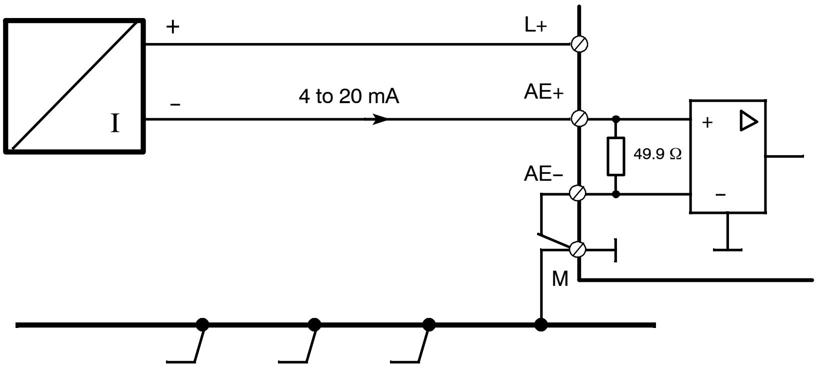


Figure 2-31 Connection of a 4 to 20 mA 2-wire transmitter supplied from controller's L+

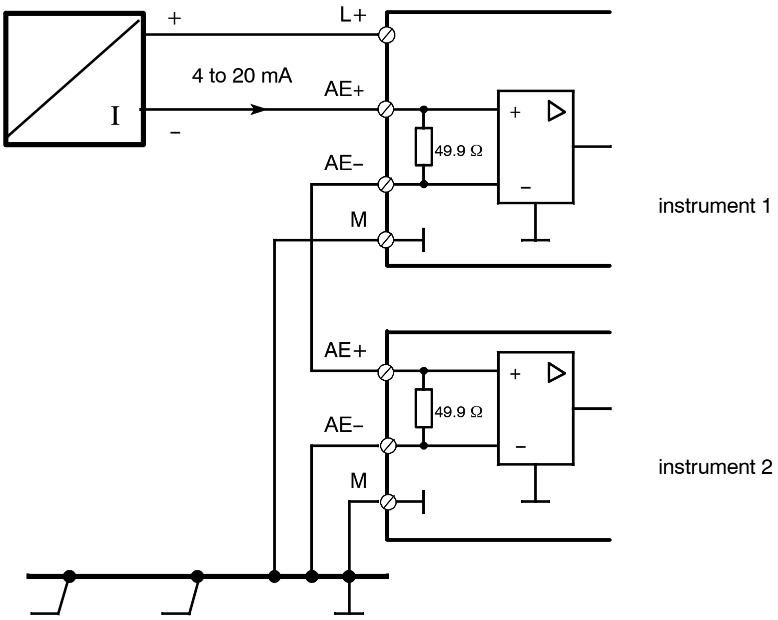


Figure 2-32 Connection of a 4 to 20 mA 2-wire transmitter to two instruments in series supplied by L+ from one of the instruments

Every input amplifier is supplied by a differential voltage of 0.2 to 1 V. Instrument 1 also has a 0.2 to 1 V common-mode voltage that is suppressed in this case. Several instruments with a total common-mode voltage of up to 10 V can be connected in series. As the last instrument's input is connected to ground, its input impedance is referred to ground.

As there will be an increased impedance (maximum permissible common-mode voltage +10 V), the permissible impedance voltage of the transmitter or the on-load voltage may not be exceeded!

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

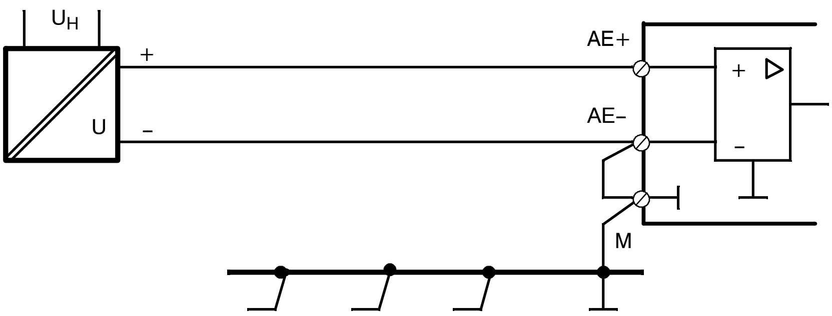


Figure 2-33 Connection of a floating voltage supply

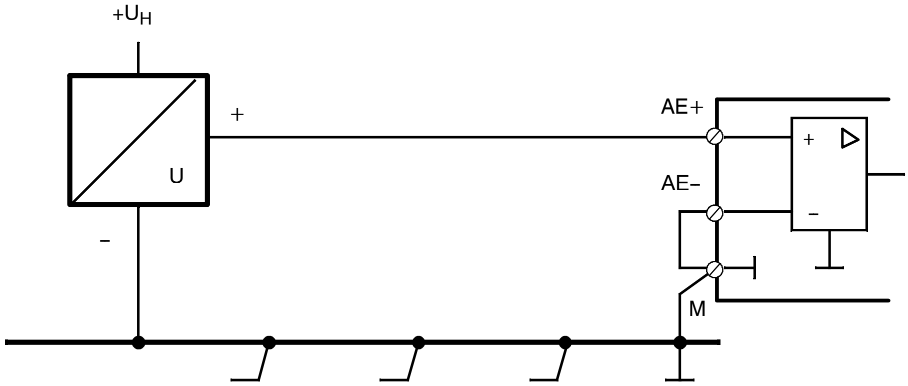


Figure 2-34 Single-pin connection of a non-floating voltage supply with negative polarity to ground

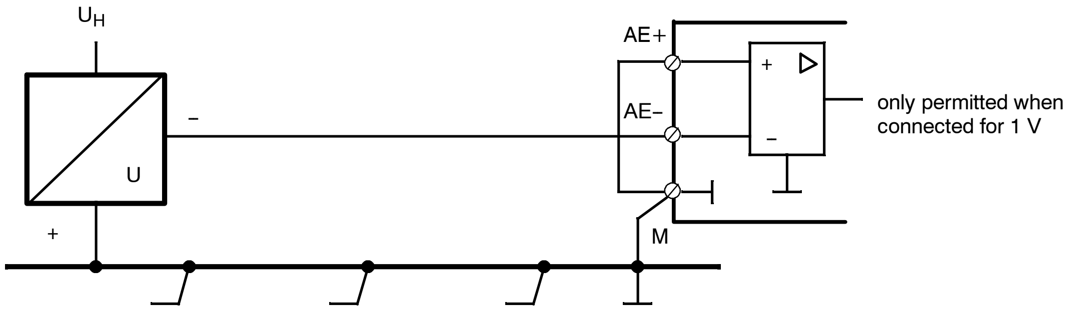


Figure 2-35 Single-pin connection of a non-floating voltage supply with positive polarity to ground

Figure 2-34 and Figure 2-35:
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 2-36!

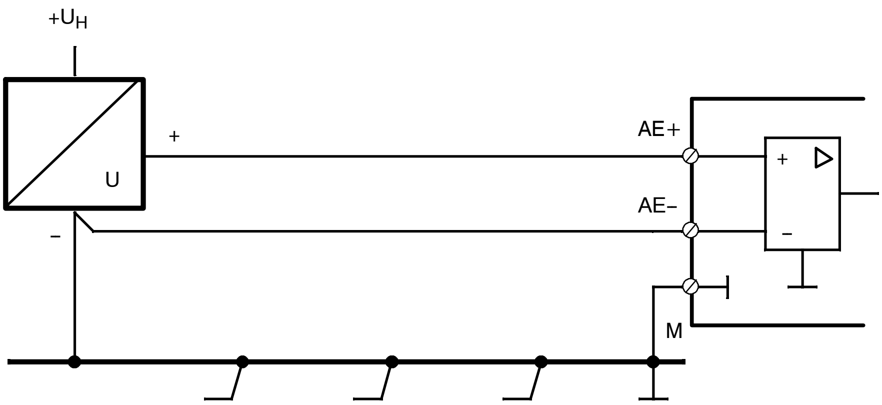


Figure 2-36 Double-pin wiring of a voltage source with negative polarity to ground

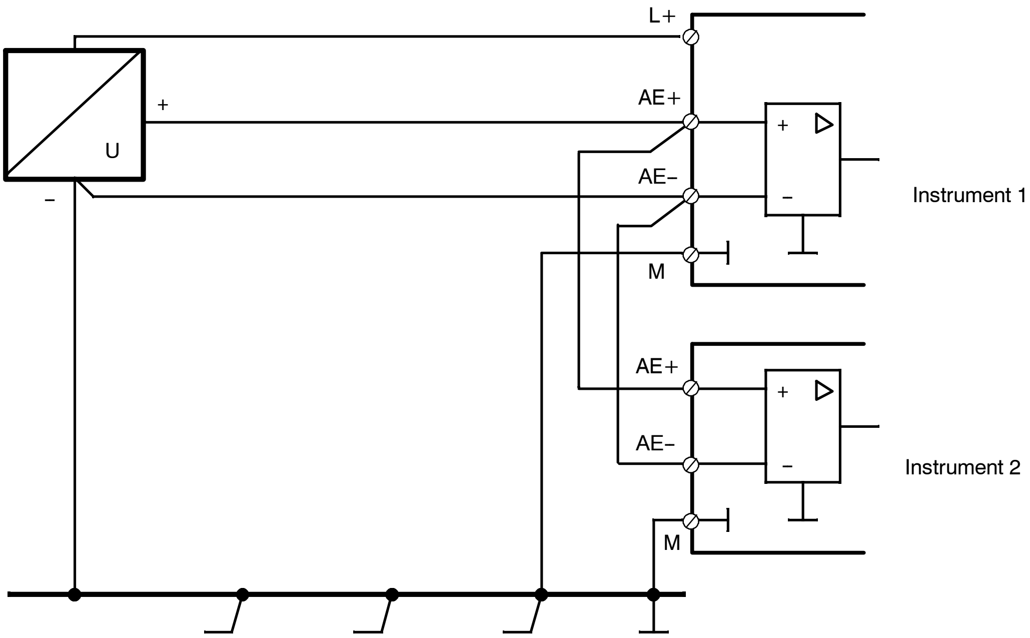


Figure 2-37 Parallel wiring of a non-floating voltage source to two instruments. The voltage source is supplied by L+ of one of the instruments and negative is referred to ground.

Figure 2-36 and Figure 2-37:
The voltage dip on the ground rail between the voltage source and the input amplifier appears as a common mode voltage and is suppressed.

2.2.4 Connection of the interface

- **Connection of the interface module 6DR2803-8C**
  - **RS 232 point-to-point**
    Can be inserted in slot 4

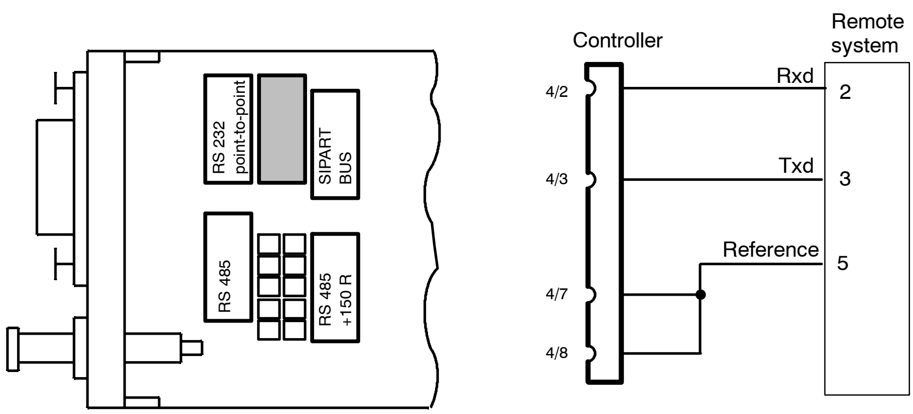


Figure 2-38 Setting on the SES module 6DR2803-8C with RS 232 point-to-point

- **RS 485 bus**
  Can be inserted in slot 4

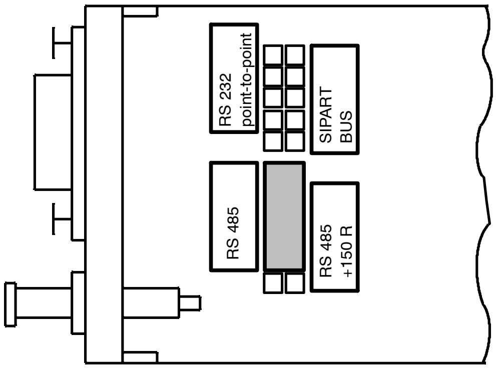
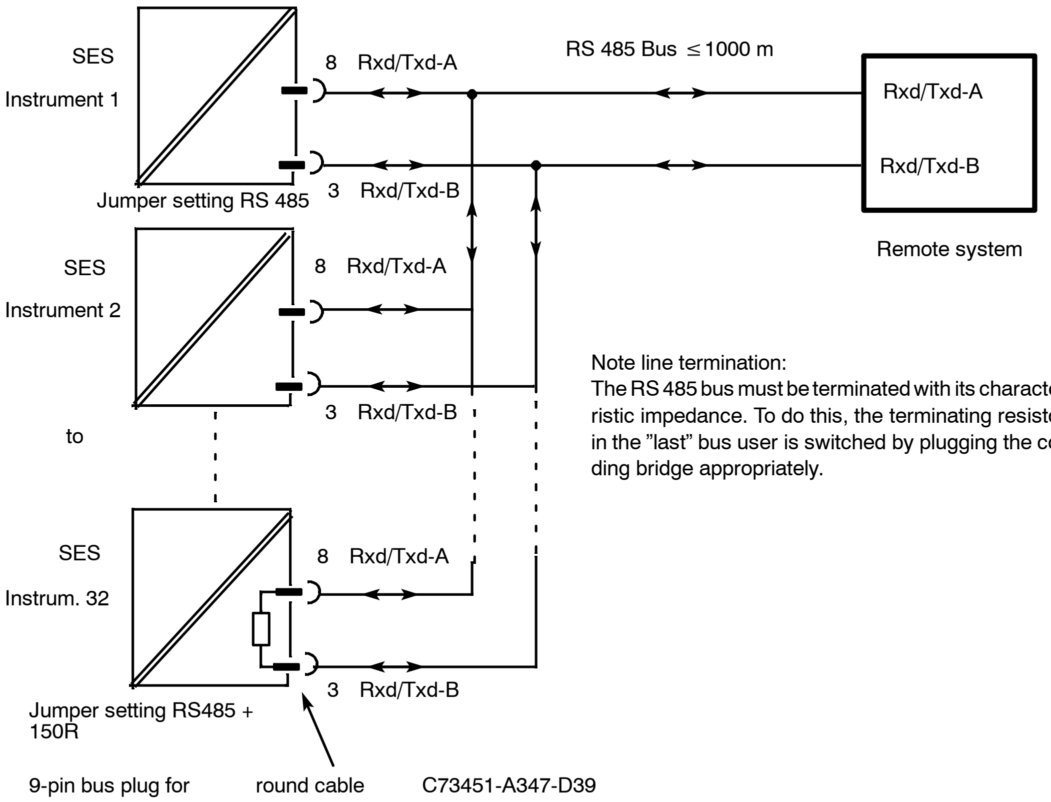


Figure 2-39 Jumper settings serial interface module 6DR2803-8C in RS 485 bus



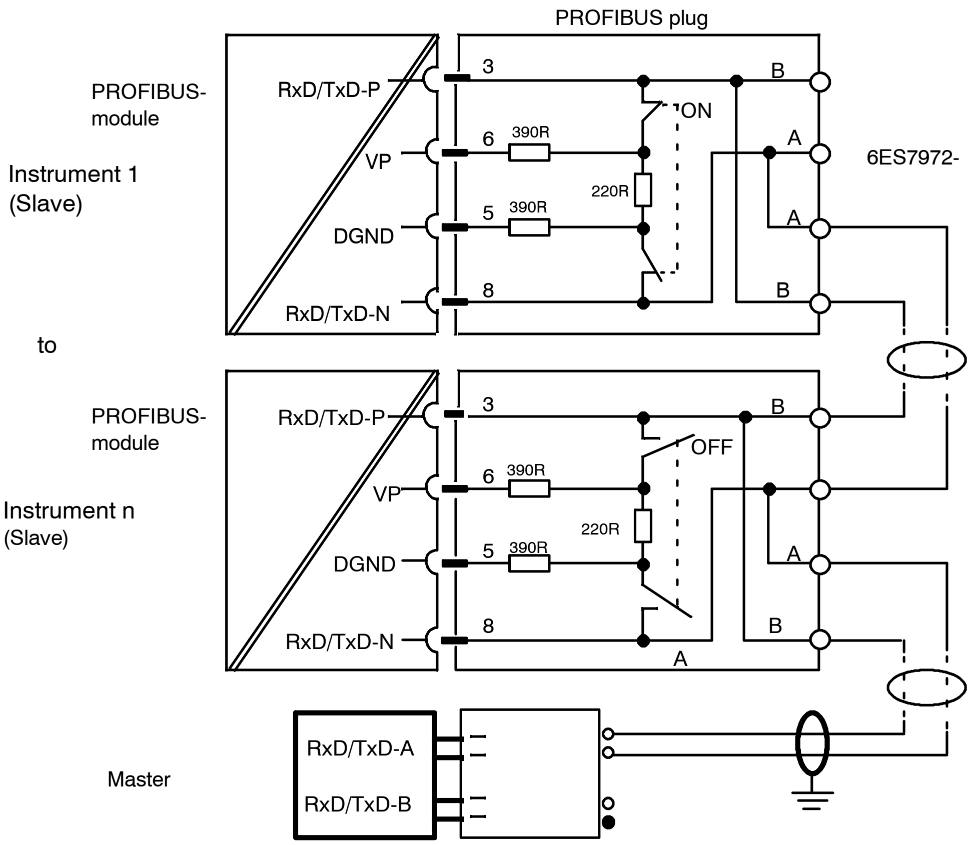
Note line termination:
The RS 485 bus must be terminated with its characteristic impedance. To do this, the terminating resistor in the "last" bus user is switched by plugging the coding bridge appropriately.

Figure 2-40 RS 485 bus connection diagram

- **Connecting the interface PROFIBUS-DP, 6DR2803-8P**

Connection

Can be inserted in slot 4



max. number of instruments, without repeater: 32
max. number of bus users (Slave + Master): 126

Figure 2-41 Principle diagram SIPART DR22 via PROFIBUS-DP and bus plug to Master

Note 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. A detailed description and notes on cable laying and bus cable laying can be found in the user’s guide Decentral Peripheral System ET200.
Order number 6ES5 998-3ES12.

3 Operation

The SIPART DR22 is operated exclusively and fully with the operating keys on the front module. The function of the operating panel can be switched between three main levels:

- Process operation level
- Selection level
- Configuring level (structuring and parameterization modes)

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.

3.1 Process operation

The operation of the SIPART DR22 in process mode requires no detailed explanation due to the design and colour scheme of the operating panel, the control elements and the labeling. (Fig. 3-1):

Red is the color of the actual value:
The four-digit red digital display (16) and the red vertical LED bargraph (17) display the actual value.

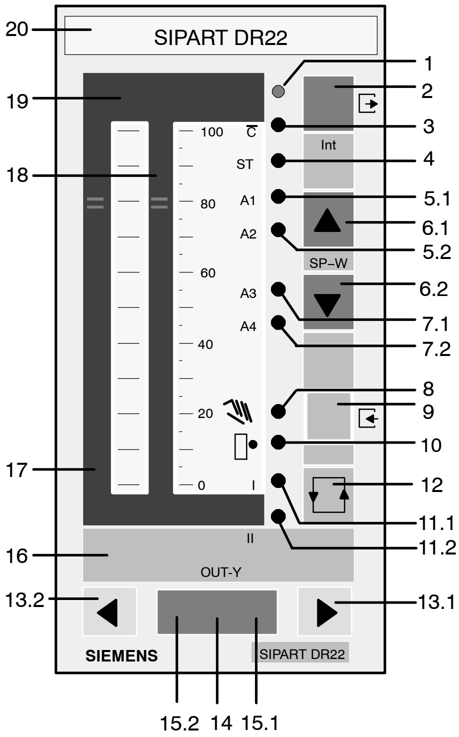
Green is the color of the setpoint:
The four-digit green digital display (19) and the green LED bargraph (18) display the setpoint. The green Internal/External key (2) is used to switch between the internal and external setpoint, the internal setpoint is set with the green ±Δw-adjusting keys (6). The green internal LED (1) signals operation with the internal setpoint, the $\overline{C}$-LED (3) also lights green when there is no CB control signal.

Yellow is the color of the manipulated variable:
The yellow H/A key is used to switch between manual and automatic operation. The yellow manual LED (8) signals by lighting steadily or flashing that manual operation has been activated. Lighting up of the yellow y-external LED (10) signals an external intervention in the manipulated variable, i.e. a follow-up (DDC), safety or blocking operation. The manipulated variable generally displayed in the yellow digital display (14) can be adjusted with the yellow ±Δy-keys (13) in manual operation. The yellow ±Δy-LEDs (15) indicate the output of the adjusting increments in all operating modes of the S-controller.

The alarm LEDs (5) and (7) signal exceeding or dropping below of the limit values. The adaptation LED (4) signals the progress of the parameter optimization during the adaptation process by lighting steadily or flashing.

The displays and setpoint keys in the double controllers are switched over by the Shift key (12) with which the displays can also be switched to different signal levels in single controllers. The corresponding controller LEDs (11) signal the switching state.

The measuring point label (20) is exchangeable. To change it, open the plexiglass cover with a pointed tool in the center and take out the label. Behind it a screw is revealed which can be used to separate the front module from the controller (see chapter 5, page 227 ”Maintenance”).



1	Internal LED (green)	ON: Internal setpoint
2	Internal-/External-key	Switch setpoint or Exit-key when configuring
3	C̄-LED (green)	ON: no computer standby or Exit LED when configuring
4	Adaptation LED (yellow)	OFF: Adaptation prepared Flashing: Adaptation in progress ON: Adaptation ended
5.1	A1-LED (red)	Response of limit value A1
5.2	A2-LED (red)	Response of limit value A2
6.1	+Δw-key	Adjusting keys internal setpoint
6.2	−Δw-key	
7.1	A3-LED (red)	Response of limit value A3
7.2	A4-LED (red)	Response of limit value A4
8	Manual-LED (yellow)	ON: Manual operation internal Flashing: Manual operation external
9	H/A-key	Shift Manual-/Automatic-operation or Enter key when configuring
10	y-external LED (yellow)	External y-intervention or Enter-LED in configuring
11.1	Controller I-LED (green)	Operation/Display level controller I
11.2	Controller II-LED (green)	Operation/Display level controller II Flashing: Display and active functions are not identical ON: Display and active functions are identical
12	Shift key	Switch Operation and Display level controllerI /controller II
13.1	+Δy-key	Adjusting keys manual manipulated variable
13.2	- Δy-key	
14	Digital display (yellow)	for the manipulated variable y
15.1	+Δy-LED (yellow)	Display of the +Δy adjusting increments in the S-controller
15.2	−Δy-LED (yellow)	Display of the -Δy adjusting increments in the S-controller
16	Digital display (red)	for the controlled variable x
17	Analog display (red)	for the controlled variable x
18	Analog display (green)	for the setpoint w
19	Digital display (green)	for the setpoint w
20	Exchangeable measuring point label, behind it screw for removing the front module	

Figure 3-1 Control and display elements in the process operation

3.2 Selection level

You enter the selection level for the various configuring menus by pressing the Shift key (12) for longer (approx. 5 s) until ”PS” flashes in the y-display.

Condition:	Digital signal ”Block-Operate”	bLb = 0 and
	”Block-Parameterize, Structure”	bLPS = 0

The controller operates in online mode in the selection level, i.e. its last operating mode is retained, the current process variables can be traced on the analog displays (1), (2).

The configuring menus can be selected with the ±ΔW-keys. If none of these menus is called with the Enter key (9) within about 20 s (≙ enter the configuring level), the controller automatically returns to the process operation level.

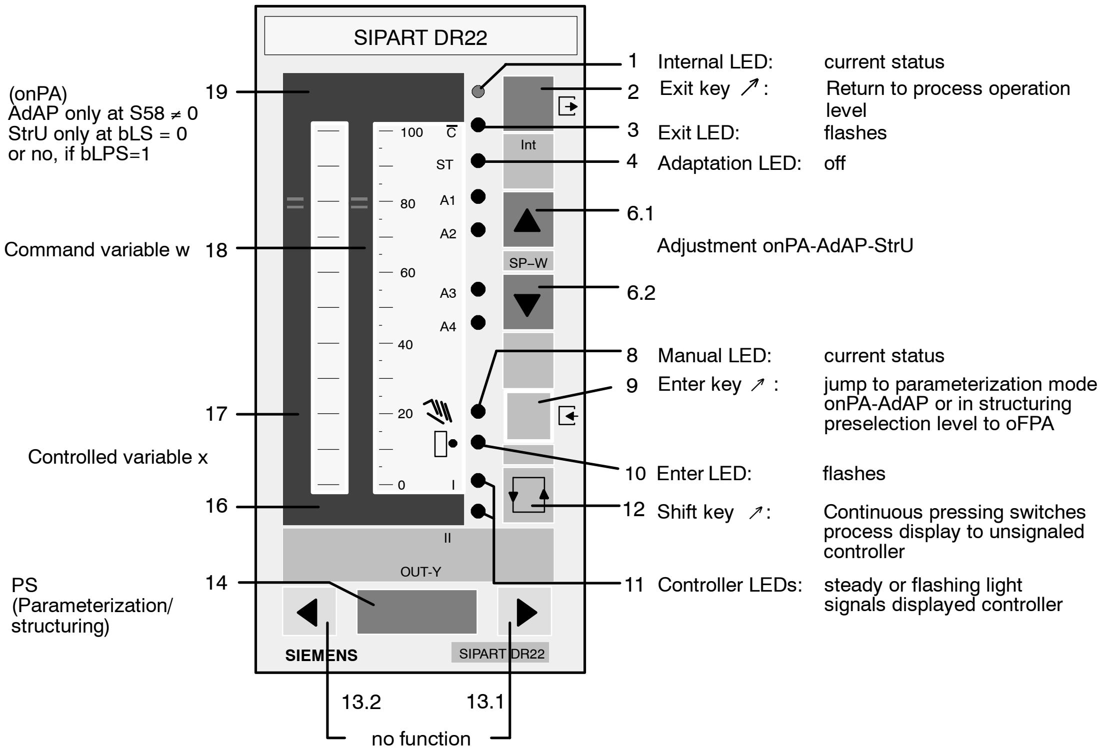


Figure 3-2 Control and display elements in the selection level

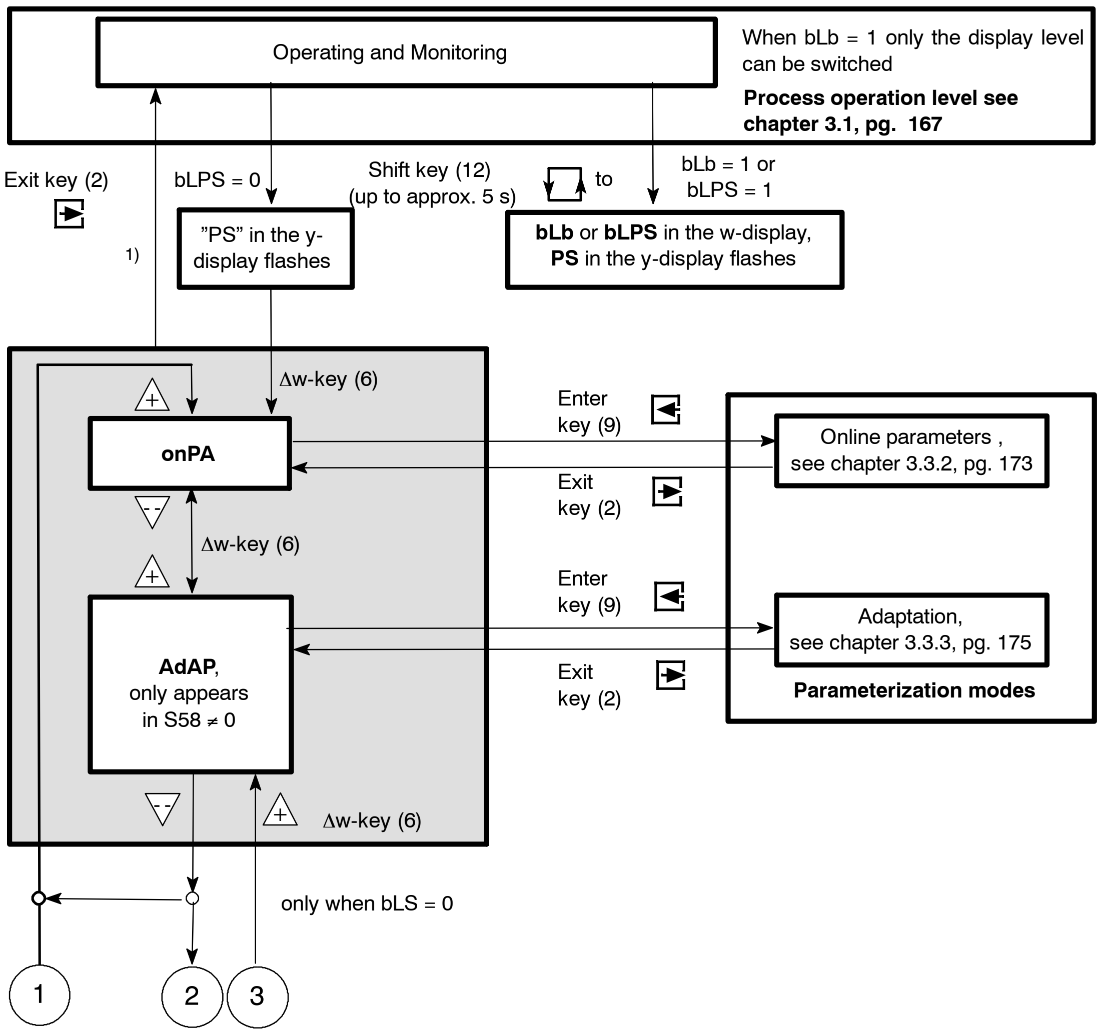


Figure 3-3 Selection level

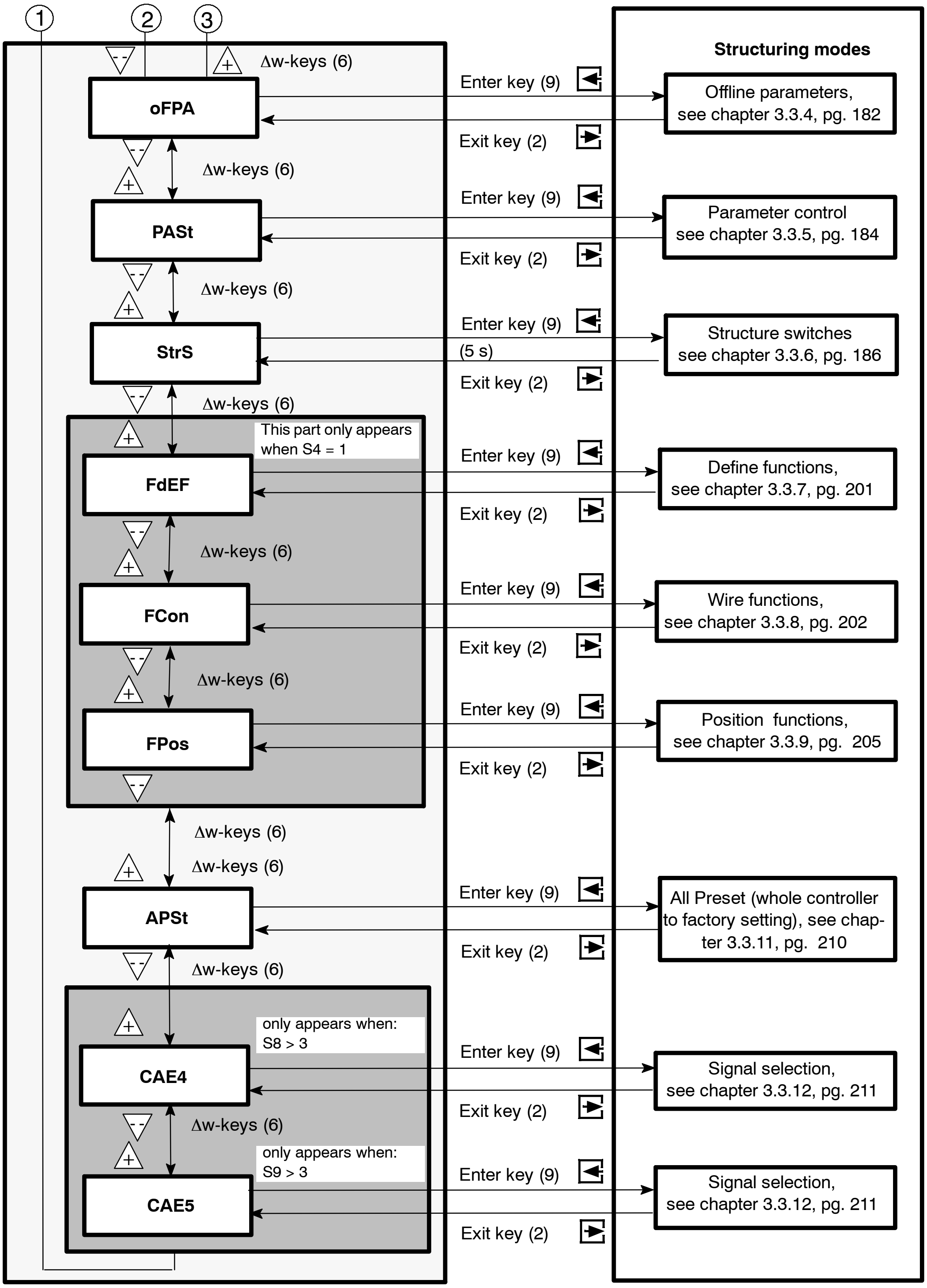


Fig. 3-3 (continued) Selection level

3.3 Configuring level (parameterization and structuring mode)

3.3.1 Paramterization

Parameterization including the selection level takes place online, i.e. the controller continues operating in its last operating mode. The analog x-display (17) and W-display (18) still displays the process image so that the reaction of the controlled system to parameter changes can be read off directly. The Internal LED (1) and Manual LED (8) and the Alarm LEDs A1 to A4 indicate the current operating state. The Internal/External key (2) becomes the Exit key, the corresponding $\overline{C}$-LED (3) indicates ready to exit, i.e. whenever the LED flashes, pressing the Exit key returns from the selected level to the higher level in the hierarchy.

The ±Δw-keys (6) serve to adjust the variables displayed in the digital w-display (mode name or parameter value).

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 causes a jump down to the next level in the hierarchy. The digital x-display still indicates the controlled variable x except in mode AdAP (see chapter 3.3.3, page 175). The ±Δy-keys (13) serve to adjust the parameter name displayed in the y-display.

In double controllers the remaining process displays can still be switched over to the controllers not selected in the process operation level with the Shift key (12) but now only for as long as the Shift key (12) is pressed. The extension of the switch over cycle by A1 to A4 which may have been selected with S98 is suppressed. The discrepancy signaling by the controller I /controller II LEDs (11) is not changed with this switchover. Therefore the controller with the unlit controller LED (steady or flashing light) is always displayed whilst the Shift key is pressed.

The parameters with a large numeric range can be adjusted rapidly in the parameterization modes onPA and AdAP.

First select the adjustment direction with one Δw-key and then switch on the rapid action by simultaneously pressing the other Δw-key.

If the control signal bLPS = 1, parameterization and structuring is blocked, no PS (w and y-indicators) appears when you press the Shift key.

If the control signal bLS = 1, structuring is blocked, oFPA to CAE5 are hidden in the parameterization preselection level.

3.3.2 Parameterization mode onPA (online parameters)

The parameters which have a directly visible effect on the process when they are adjusted are arranged in the parameterization mode onPA. The other parameters are arranged in the structuring mode oFPA.

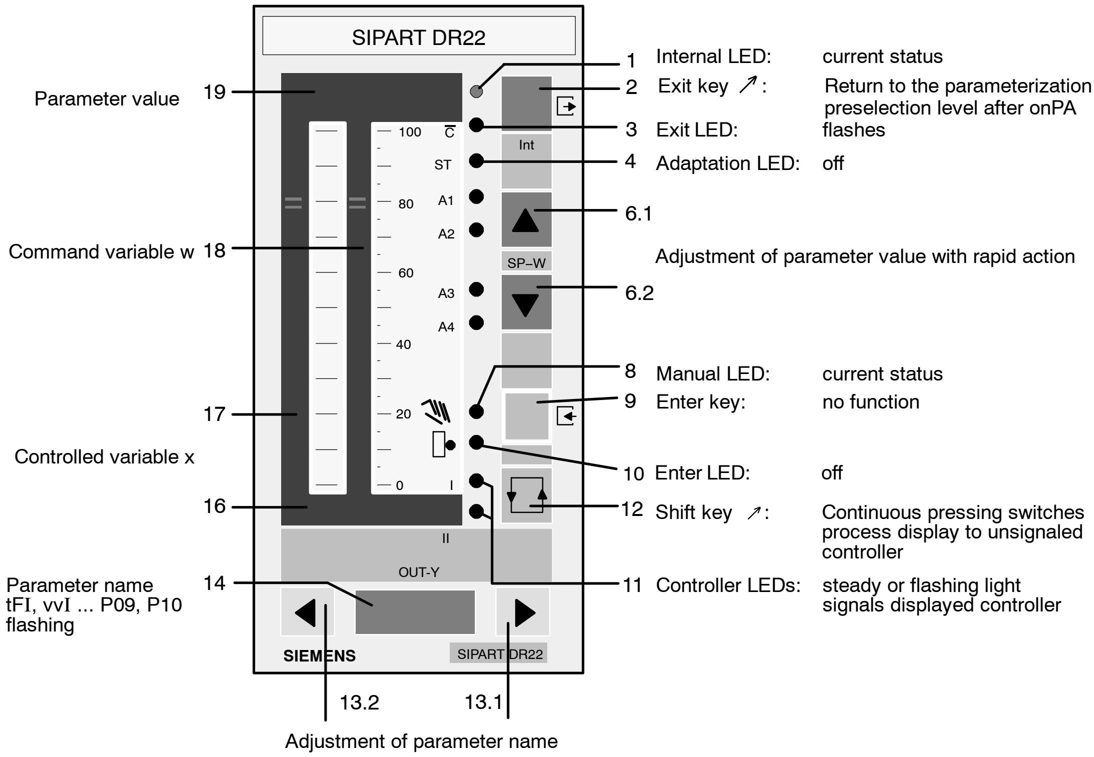


Figure 3-4 Control and display elements in the parameterization mode onPA

Digital display			Factory setting	Resolution	Di-men-sion	Parameter meaning
y	x	w Adjustment/ display area				
tFI		oFF, 1 to 1000	1	128 values/octave	s	Filter time constant xdI
vvI		0.100 to 10,00	5.000	↓	1	Derivative action gain
cPI		0.100 to 100.0	0.100	↓	1	Proportional action factor
tnI		1,000 to 9984	9984	↓	s	Integral action time
tvI		oFF, 1.000 to 2,992	oFF	128 values/octave	s	Derivative action time Parameter set I
AHI		0.0 to 10.0	0.0	0.1	%	Response threshold xdI
Y0I		Auto, 0.0 to 100.0	Auto	0.1	%	Operating point P-controller
YAI[1]		−10.0 to 110.0	- -5.0	0.1	%	Manipulated variable limiting start
YEI[1]		−10.0 to 110.0	105.0	0.1	%	Manipulated variable limiting end
tFII		oFF, 1 to 1,000	1	128 values/octave	s	Filter time constant xdII
vvII		0.100 to 10.00	5.000	↓	1	Derivative action gain
cPII		0.100 to 100.0	0.100	↓	1	Proportional action factor
tnII		1.000 to 9984	9984	↓	s	Integral action time
tvII		oFF, 1.,000 to 2,992	oFF	128 values/octave	s	Derivative action time Parameter set II
AHII		0.0 to 10.0	0.0	0.1	%	Response threshold xdII
Y0II		Auto, 0.0 to 100.0	Auto	0.1	%	Operating point P-controller
YAII[1]		−10.0 to 110.0	−5	0.1	%	Manipulated variable limiting start
YEII[1]		−10.0 to 110.0	105,0,0	0.1	%	Manipulated variable limiting end
dr	Controlled variable x	0.080 to 8.000 [2]	0,80	0.080	s	Display refresh rate
tY		oFF, 1 to 1000	oFF	128 values/octave	s	Floating time
tA		20 to 600	200	20	ms	min. actuating pulse pause
tE		20 to 600	200	20	ms	min. actuating pulse length
tYII		oFF, 1 to 1,000	oFF	128 values/octave	s	Floating time Controller II
tAII		20 to 600	200	20	ms	min. actuating pulse pause when S1 = 12
tEII		20 to 600	200	20	ms	min. actuating pulse length
tF1		oFF, 0.1 to 1000	1	128 values/octave	s	Filter time constant AE1
↓		↓	↓	↓	↓	↓
tFb		oFF, 0.1 to 1000	1	128 values/octave	s	Filter time constant AEb
c1		-1.999 to 19.999	0	0.001	1	Multiplicative constant
c2		-1.999 to 19.999	0	0.001	1	Multiplicative constant
c3		-1.999 to 19.999	0	0.001	100 %	Additive constant
c4		-1.999 to 19.999	1	0.001	1	Multiplicative constant
c5		-1.999 to 19.999	0	0.001	100 %	Additive constant
c6		-19.99 to 19.99	0	0.01	1	Multiplicative constant
c7		-19.99 to 19.99	0	0.01	1	Multiplicative constant
c8		-1.999 to 19.999	0	0.001	100 %	Additive constant
c9		-1.999 to 19.999	0	0.001	1	Multiplicative constant
P01		-1.999 to 19.999	1	0.001	1	connectable parameters
↓		↓	↓	↓	↓	↓ only when S4 = 1
P15		-1.999 to 19.999	1	0.001	1	connectable parameters

1) YE > YA
2) typical cycle times

Table 3-1 Parameter list onPA

3.3.3 Parameterization mode AdAP (Adaptation)

This mode only appears in the parameterization preselection level when S58 ≠ 0 (with adaptation). The Enter function into the parameterization mode AdAP is only possible when the controller is in manual operation (when adapting the master controller in cascades (S1 = 5/6) only in internal and automatic operation of the master controller).

In the parameterization mode AdAP, the controller influences the process online (but in manual operation).

In double controllers (cascade, ratio cascade and override controllers), adaptation is always made to the controller selected by the Shift key (12) in the process operation level.

The remaining process displays can still be switched over to the controllers not selected in the process operation level with the Shift key (12) but only for as long as the Shift key (12) is pressed. Steady or flashing lights in the controller I/controller II LEDs signal the adapted controller. In override controllers (S1 = 7/8) the flashing controller LED signals that the other controller would be active in automatic operation.

The parameterization mode AdAP has 4 different states:

- Pre adaptation
- During adaptation
- Aborted adaptation
- Post adaptation

The digital display and the keys are assigned different functions in the individual states which are integrated smoothly in the operating concept of the controller.

In pre- and post-adaptation the digital displays and the keys are used for the parameter display and -setting as is the case in the parameterization mode and structuring mode onPA or oFPA (see figure 3-6, page 179).

The complete process image as described in chapter 3.1, page 167 is displayed during adaptation (see figure 3-7, page 179).

In the case of aborted adaptation the error message flashes in the digital x- and w-displays. The error messages are acknowledged with the Enter key (9) (see figure 3-7).

- **Pre adaptation**

The adaption LED (4) is off and indicates readiness for adaptation. First the parameters for the presettings (tU, dPv, dY) are displayed. They must be set according to the desired step signal. Then the old parameters **.o with the ID Pi or Pid with their value and the new parameters **.n with the ID Strt AdAP appear on the displays. If there is parameter control (S59 ≠ 0) PAST is displayed as a note in place of the value when **.o. The old and the new parameters are not adjustable.

The adaptation can only be started with the Enter key (9) when the new parameters **.n are selected with the display Strt AdAP (manual operation is a prerequisite).

- **During adaptation**

The adaption LED (4) flashes indicating that the adaptation is in progress. The process can be monitored over the whole process display.

- **Aborted adaptation**

The adaptation LED (4) is off indicating readiness for adaptation after error acknowledgement. The current adaptation can be aborted manually or automatically by the error monitor.

Manual abortion can be activated in the event of danger by pressing the Exit key (2). The program then jumps to the parameterization preselection level after AdAP. From there you can return to the process operation level by pressing the Exit key (2) again. The controller is in manual operation and the manual manipulated variable can be adjusted.

Automatic aborting is effected by the error monitors. The error messages are displayed on the digital x- and w-displays. The error message is acknowledged by pressing the Enter key (9), the parameterization mode AdAP is retained, tU is displayed, the presettings can be corrected if necessary. The adaptation is aborted by the signals N (DDC), Si and ±ybL. Abortion by the SES control signals N_{ES} (DDC), Si_{ES}, $\pm ybL_{ES}$ can be prevented by Internal operation.

- **Post adaptation**

The adaption LED (4) is on indicating the end of adaptation. The parameters **.o with the ID Pi or Pid and the new parameters **.n with the ID Pi.1 to 8 and Pid.1 to 8 for Pi and Pid controller design are offered. The digits after the Pi or Pid ID indicate the determined line order. If there is parameter control (S59 ≠ 0) the old parameters **.o are displayed with PAST instead of the parameter value.

The old and new parameters are adjustable but the new parameters only if there is no parameter control.

On pressing the Exit key the parameters **.o or **.n just selected are transferred when returning to AdAP in the parameter preselection level. The LED (4) is now off. When transfering **.o, these parameters remain unchanged if they have not been changed manually. When transfering **.n the old parameters are overwritten by the new parameters. The new parameters are deleted, i.e. after jumping back to the parameterization mode AdAP, the **.n parameters are identified by Strt AdAP.

The transfered parameters do not affect the process until the process operation level has switched to Automatic after pressing the Exit key (2).

When the Exit key (2) is pressed with parameter control (**.o PAST) and selection of **.n, the error message no AUto appears (see fig. 3-5, page 178). It indicates that no automatic transfer is possible, the **.n parameters and the controlling variable SG must be noted down (see chapter 1.5.5, page 96 ”Adaptation”).

• Adaptation error messages

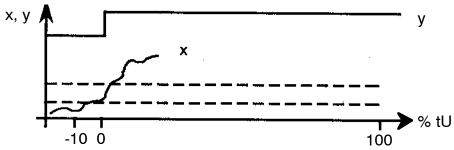
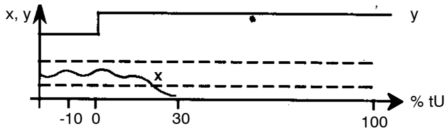
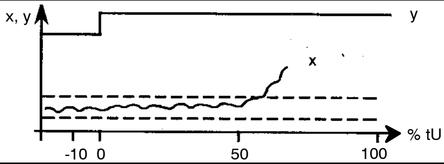
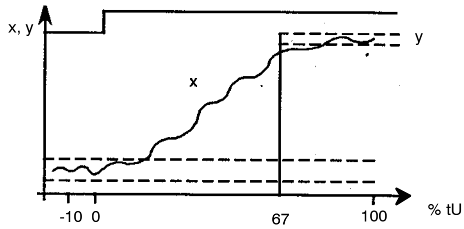
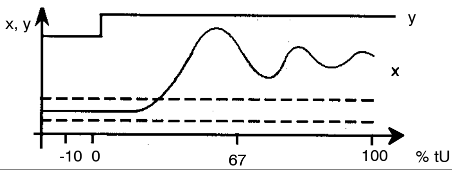
Error message digital x/w display	Explanation	
not StAt	not stable at 10 % tU after start of adaptation ⇒ wait and restart adaptation	
no dY	after expiry of Ty the y step in the S-controller is not executed correctly ⇒	Check position feedback and drive of the final control element
Y oFL	y outside the measuring span of 0 to 100% ⇒	y_{Manual} ±Δy too big or too small
ALL PASS	step response in wrong direction within 30 % tU ⇒ Change active direction of the controller ⇒ control loop undershoot (all pass loop), all-pass loops not defined among loop models	
too SMAL	x after 50 % tU still within starting band ⇒ tU too short ⇒ y step too small	
no scale	at 67 % tU full scale value not reached yet full ⇒ tU too short ⇒ loop cannot reach full scale value, e.g. integrally active line ⇒ transient recovery time t_{95} > 12 h	
Pv oFL	x outside the measuring span 0 to 100 % ⇒	y_{Manual} ±Δy too big or too small
too FASt	because of too small a line time constant no sufficiently accurate adaptation not possible	(transient recovery time t_{95} < 5 s)
ovEr Shot	> 10 % overshoot of the transient function ⇒ sufficiently accurate adaptation not possible	
n.ddc ModE	Follow–up or DCC-mode via the control signals ⇒	cancel mode of operation
Si ModE	safety operation via the control signals ⇒	
YbL ModE	direction-dependent blocking operation via the control signals ⇒	
HE ModE	Manual external operation by the control signals ⇒	

Table 3-2 Adaptation error messages

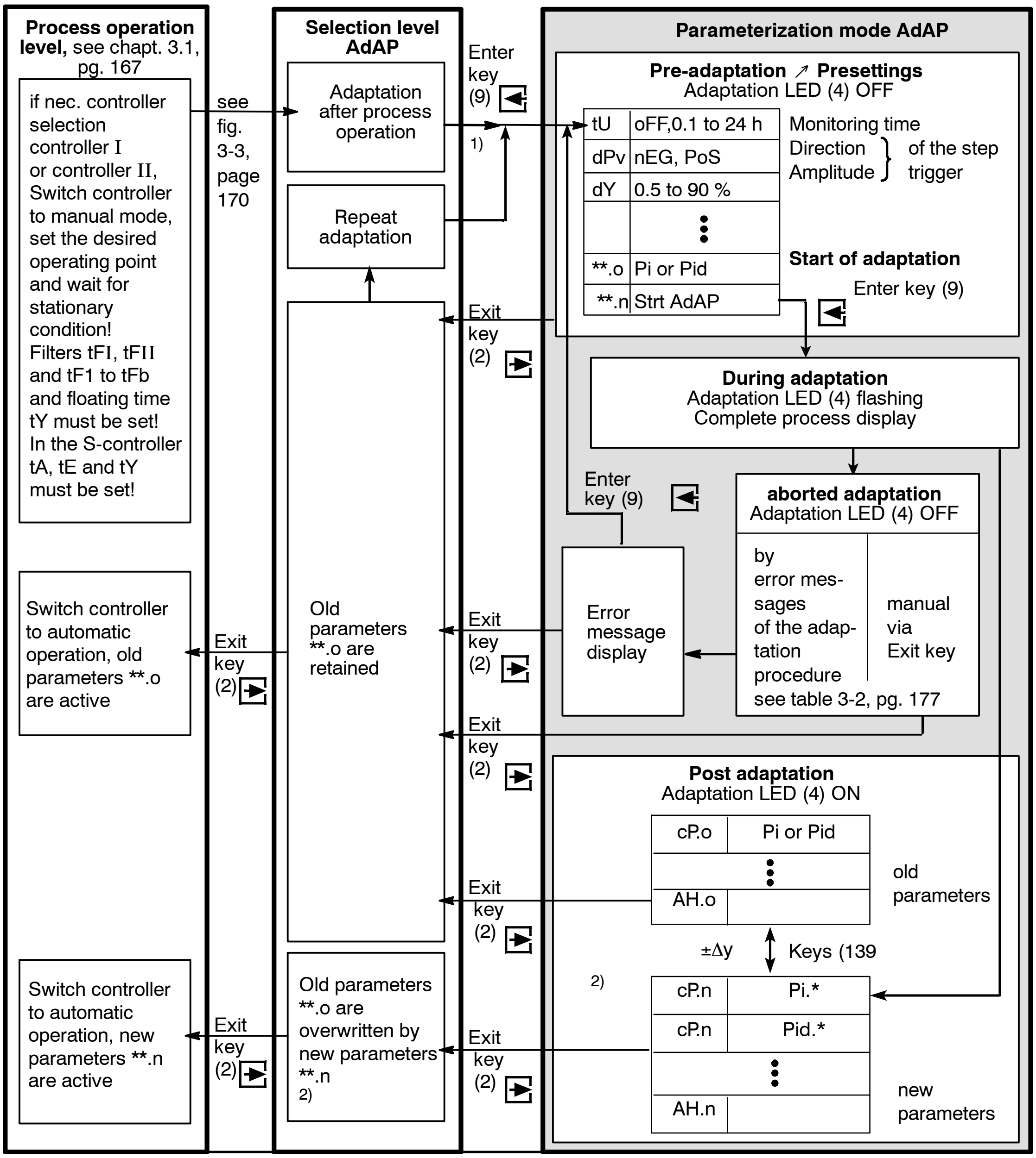


Figure 3-5 Parameterization mode AdAP

* loop order 1 to 8

** parameter name

1) Enter function only active in manual operation (in the case of adaptation of the master controller in cascades (S1 = 5/6) master controller set to Internal and Automatic)

2) Error message no AUto
If new parameters are selected and there is parameter control, the flashing error message no AUto appears after pressing the Exit key (no automatic transfer).
Press the Enter key: Error is acknowledged; return to parameterization mode AdAP; the parameters won by adaptation can be noted.
Pressing the Exit key: Jump to the parameterization preselection mode AdAP; the new parameters **.n are deleted. On jumping to the parameterization mode AdAP, Strt AdAP appears in **.n.

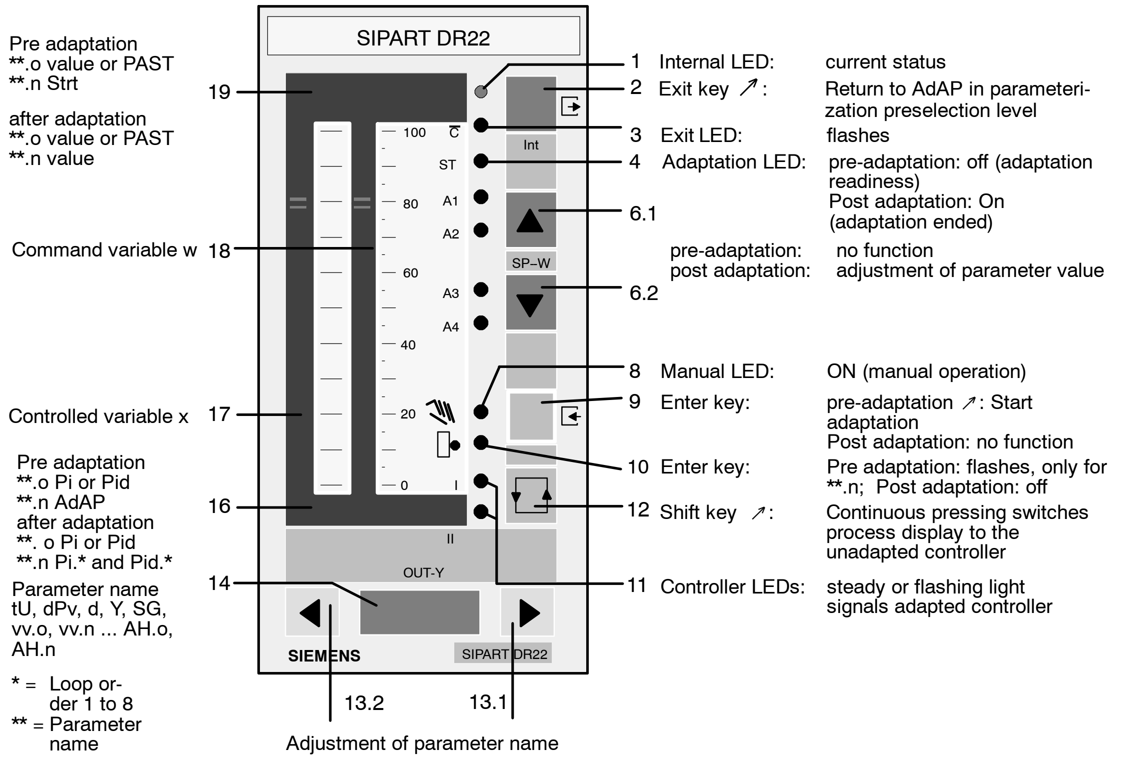


Figure 3-6 Control and display elements in pre- and post adaptation in the parameterization mode AdAP

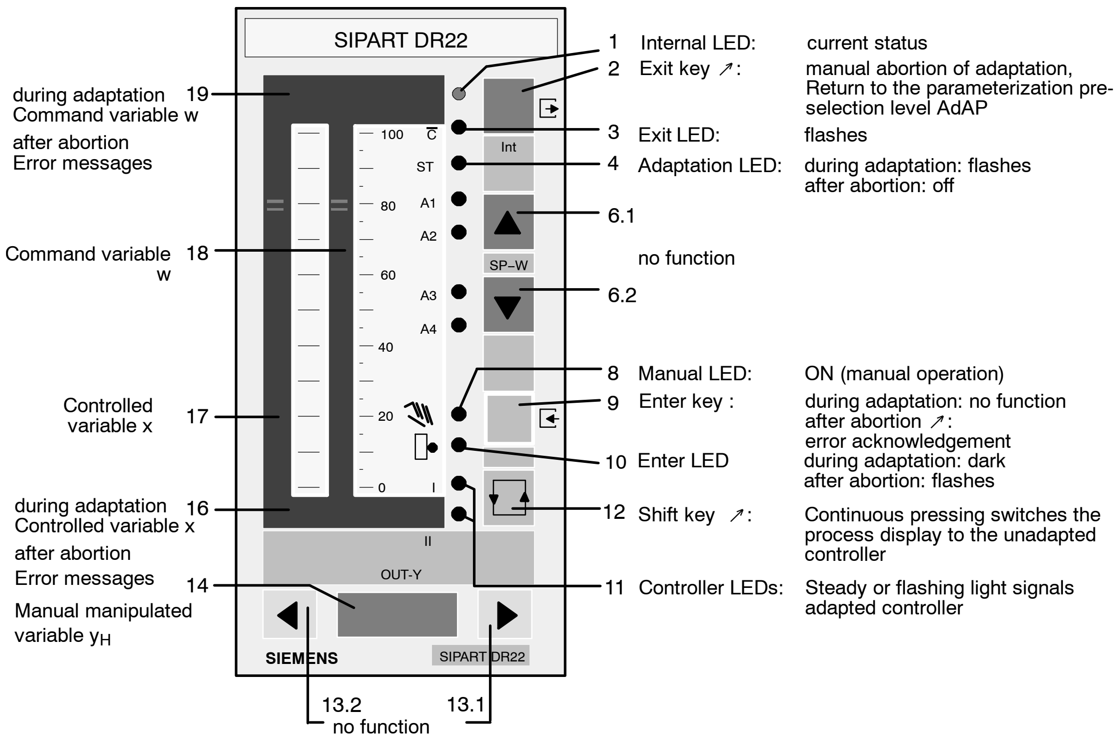


Figure 3-7 Control and display elements during adaptation and at aborted adaptation in the parameterization mode AdAP

Pre adaptation

Digital display			Factory setting	Resolu-tion	Di-men-sion	Parameter meaning
y	x	w Adjustment/ display area				
tU dPv dY	Con-trolled varia-ble x	oFF, 0.1 - 24.0 nEG, PoS 0.5 - 90.00	oFF PoS 0.5	0.1 - 0.1	h - %	Monitoring time Direction of step response Amplitude of step response — Pre-settings for the adaptation
vv.o	Pi or Pid	0.10 - 10.0[1)] or PASt [1)]	5.000	128 values per octave	1	previous derivative action gain at: Tv = oFF Tv ≠ oFF previous derivative action gain parameter-controlled
vv.n	AdAP	Strt [1)]	-	-	-	Start adaptation
cP.o	Pi or Pid	0.100 - 100.0[1)] or PASt [1)]	0.100	128 values per octave	1	previous proportional action factor at: Tv = oFF Tv ≠ oFF previous proportional action factor parameter-controlled
cP.n	AdAP	Strt [1)]	-	-	-	Start adaptation
tn.o	Pi or Pid	1.000 - 9984[1)] or PASt [1)]	9984	128 values per octave	s	previous integral action time at: Tv = oFF Tv ≠ oFF previous integral action time parameter-controlled
tn.n	AdAP	Strt [1)]	-	-	-	Start adaptation
tv.o	Pi or Pid	oFF[1)] 1.0 - 2992 [1)] or PASt [1)]	oFF	128 values per octave	s	previous derivative action time at: Tv = oFF Tv ≠ oFF previous derivative action time parameter -controlled
tv.n	AdAP	Strt [1)]	-	-	-	Start adaptation
AH.o	dark	0.0 - 10.0[1)] or PASt [1)]	0.0	0.1	%	previous response threshold previous response threshold parameter-controlled
AH.n	AdAP	Strt [1)]	-	-	-	Start adaptation

1) not adjustable

Table 3-3 Parameter list AdAP

Post adaptation

Digital display			Factory setting	Resolu-tion	Di-men-sion	Parameter meaning
y	x	w Adjustment/ display area				
SG	dark	–0.5 - 105.0[1]	-	-	%	Controlling variable for parameter control
vv.o	Pi or Pid	0.100 – 10.00 or PASt [1]	5.000	128 values per octave	1	previous derivative action gain at: Tv = oFF Tv ≠ oFF previous derivative action gain parameter-control-led
vv.n	Pid.* Pid.*	5.000	-	128 values per octave	1	new derivative action gain for PID controller
cP.o	Pi or Pid	0.100 - 100.0 or PASt [1]	0.100	128 values per octave	1	previous proportional action factor at: Tv = oFF Tv ≠ oFF previous proportional action factor parameter-con-trolled
cP.n cP.n	Pi.* Pid.*	0.100 - 100.0[2] 0.100 - 100.0[2]	- -	128 values per octave	1 1	new proportional action factorfor PI controller PID controller
tn.o	Pi or Pid	1.000 - 9984 or PASt [1]	9984	128 values per octave	s	previous integral action time at: Tv = oFF Tv ≠ oFF previous integral action time parameter-comtrolled
tn.n tn.n	Pi.* Pid.*	1.000 - 9984[2] 1.000 - 9984[2]	-	128 values per octave	s s	new integral action time for PI controller PID controller
tv.o	Pi or Pid	oFF 1.0 - 2992 or PASt [1]	oFF	128 values per octave	s	previous derivative action time at: Tv = oFF Tv ≠ oFF previous derivative action time parameter-control-led
tv.n	Pid.*	1.000 - 2992[2]	-	128 values per octave	s	new derivative action time for PID controller
AH.o	dark	0.0 - 10.0 or PASt [1]	0.0	0.1	%	previous response threshold previous response threshold parameter-controlled
AH.n	dark	0.0 - 10.0[2]	-	0.1	%	new response threshold

* identification loop order 1 to 8
SG means: controlling variable for the parameter control
1) not adjustable
2) only adjustable if there is no parameter control

Table 3–3 Parameter list AdAP (continued)

3.3.4 Structuring mode oFPA (offline Parameters)

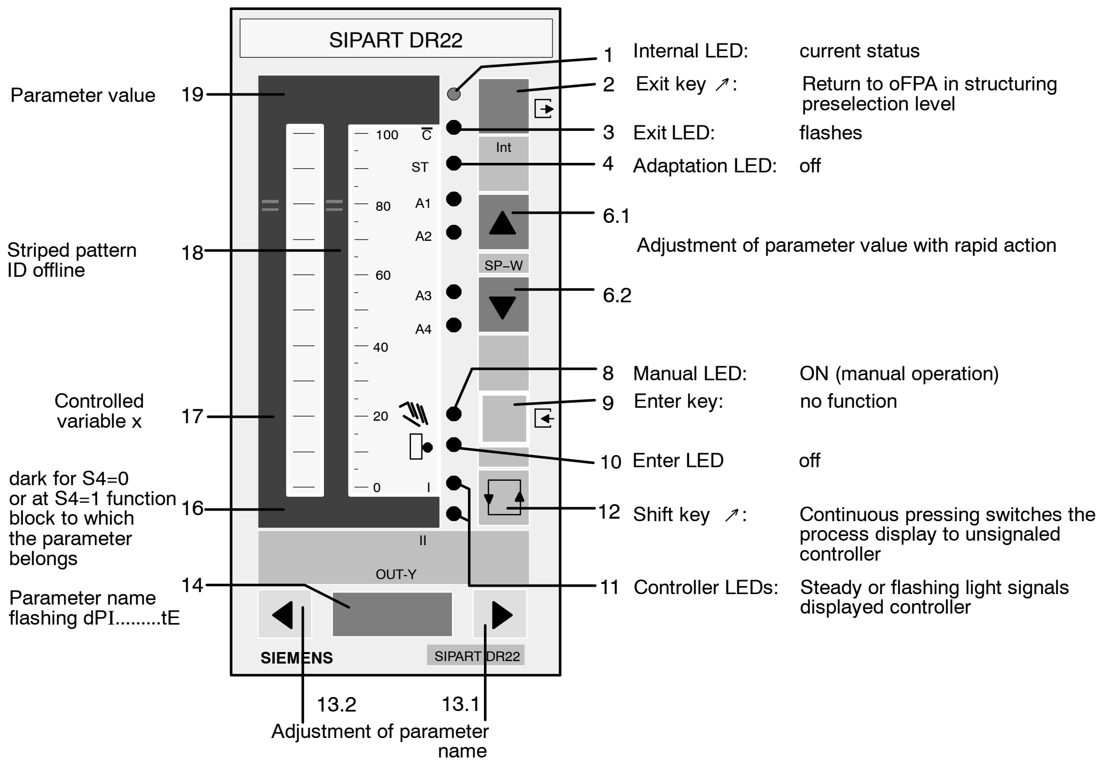


Figure 3-8 Control and display elements in the structuring mode oFPA

S1	S94, S95 S267, S268	assigned to	Display format	Resolution
≠4 ≠6	0 1 2 38	xdI xI wI |xdI|	according to dAI to dEI -1999 to 19999	1 digit
4 and 6	0 1 2 38	xdI xI wI |xdI|	% % %	0,1 %
	3 4	xv wv	according to dAI to dEI -1999 to 19999	1 digit
5 to 9 and 12	5 6 7 39	xdII xII wII |xdII|	according to dAII to dEII -1999 to 19999	1 digit
0 to 12	8 ↓ 37	y ↓ FE12	%	0,1 %

Table 3-4 Parameter range and resolution for the alarms A1 to A4

Digital display y	Digital display x	w Adjustment/ display area	Factory setting	Resolution	Dimension	Parameter meaning
dPI	dark	–.--- to ----	----.-	–	–	Decimal point display I
dAI		– 1,999 to 19,999	000.0	1 digit	–	Start value } Display range
dEI		– 1,999 to 19,999	100.0	1 digit	–	Full scale value } Display I
dPII		–.--- to ----	----.-	–	–	Decimal point display II
dAII		-1,999 to 19,999	000.0	1 digit	–	Start value } Display range
dEII		-1,999 to 19,999	100.0	1 digit	–	Full scale value } Display II
A1		–110 to +110 %	5.0	1 digit	–	Alarm 1
A2		referenced to	–5.0	or	–	Alarm 2
A3		dE – dA	5.0	0.1 %	–	Alarm 3
A4		see table 3-4	–5.0		–	Alarm 4
H1.2		0.1 to 20.0	1	0.1	%	Hysteresis alarms A1 and A2
H3.4		0.1 to 20.0	1	0.1	%	Hysteresis alarms A3 and A4
SA		–10 to +110 %	–5.0	1 digit	–	Setpoint limit start
SE		referenced to	105.0	or	–	Setpoint limit end
SH		dE – dA	0.0	0.1 %	–	Safety setpoint
Sb		see table 3-6	0.0		–	Limit setpoint for override control
tS		oFF, 0.1 to 9984	oFF		min	Setpoint ramp
vA		0.000 to 9.999	0.000	0.001	1	Ratio factor start
vE		0.000 to 9.999	1.000	0.001	1	Ratio factor end
yS		–10.0 to 110.0	0.0	0.1	%	Safety manipulated variable
y1		0.0 to 100.0	50.0	0.1	%	Manipulated variable range y1 } at
y2		0.0 to 100.0	50.0	0.1	%	Manipulated variable range y2 } Split range
–1.1			–10.0		–	Linearized FE1 vertex value at –10 %
0.1			0.0		–	Linearized FE1 vertex value at 0 %
1.1		–10 to 110 %	10.0	1 digit	–	Linearized FE1 vertex value at –10 % only when
↓		referenced to	↓		–	↓ S4= 0
11.1		dE – dA	110.0	or	–	Linearized FE1 vertex value at 110 % and
–1.3		or	–10.0		–	Linearized FE3 vertex value at –10 % S20 or
0.3		–199.9 to 199.9 %	0.0	0.1 %	–	Linearized FE3 vertex value at 0 % S21 ≠ 1
1.3		see table 3–6,	10.0		–	Linearized FE3 vertex value at 10 %
↓		page 184	↓		–	↓
11.3			110.0		–	Linearized FE3 vertex value at 110 %
–10	FU1	–199.9 to 199.9	–10	0.1	%	Function transmitter 1 vertex value at –10 %
0	FU1	–199.9 to 199.9	0	0.1	%	Function transmitter 1 vertex value at 0 %
10	FU1	–199.9 to 199.9	10	0.1	%	Function transmitter 1 vertex value at 10 % only when
↓	↓	↓	↓	↓	↓	↓ S4= 1
110	FU1	–199.9 to 199.9	110	0.1	%	Function transmitter 1 vertex value at 110 % and
–10	FU2	–199.9 to 199.9	–10	0.1	%	Function transmitter 2 vertex value at –10 % FU1 or
0	FU2	–199.9 to 199.9	0	0.1	%	Function transmitter 2 vertex value at 0 % FU2=YES
10	FU2	–199.9 to 199.9	10	0.1	%	Function transmitter 2 vertex value at 10 %
↓	↓	↓	↓	↓	↓	↓
110	FU2	–199.9 to 199.9	110	0.1	%	Function transmitter 2 vertex value at 110 %
PA	rE	0.010 to 1.000	1	0.001	1	Correction quotient pressure start
PE	rE	1.000 to 99.99	1	0.001/0.01	1	Correction quotient pressure end only when
tA	rE	0.010 to 1.000	1	0.001	1	Correction quotient temperature start S4=1
TE	rE	1.000 to 99.99	1	0.001/0.01	1	Correction quotient temperature end
SAII	dark	–10 to 110 %	–5.0	1 digit	–	Setpoint limit start } Controller II
SEII		referenced to	105.0	or	–	Setpoint limit end } when S1 = 12
		dEII – dAII		0.1 %		
tSII		oFF, 0.1 to 9984	oFF		min	Setpoint ramp Controller II when S1=12
YSII		–10.0 to 110.0	0.0	0.1	%	Safety manipulated variable Controller II when S1=12
Pd		–.--- to ----	----.-	–	–	display range
Ad		– 1999 to 19999	000.0	1 digit	–	ratio controller
Ed		– 1999 to 19999	100.0	1 digit	–	
H2		0.1 to 20.0	1	0.1	%	Hysteresis alarms A2 at S267 ≠ 1
H4		0.1 to 20.0	1	0.1	%	Hysteresis alarms A4 at S268 ≠ 1
y3		0.0 to 100.0	50.0	0.1	%	Manipulated variable range y3 } Split range controller II
y4		0.0 to 100.0	50.0	0.1	%	Manipulated variable range y4 } at S1 = 12

Table 3-5 Parameter list oFPA

S1	–1.1 to 11.1	–1.3 to 11.3	SA, SE, SH	Sb	Parameter range reference to dE* – dA* = 100 %	Resolution
0	d*I	d*I	d*I	–	-10 to 110 %	1 digit
1	↓	↓	↓	–	↓	↓
2	↓	↓	↓	–	↓	↓
3	d*I	d*I	↓	–	-10 to 110 %	1 digit
4	%	%	d*I	–	-199.9 to 199.9 %	0.1 %
5	d*II	d*I	d*II	–	-10 to 110 %	1 digit
6	%	%	d*II	–	-199.9 to 199.9 %	0.1 %
7	d*I	d*II	d*I	d*II	-10 to 110 %	1 digit
8	↓	↓	d*I	d*II	↓	↓
9	d*I	d*II	-	–	↓	↓
10	d*I	d*I	d*I	–	↓	↓
11	d*I	d*I	d*I	–	↓	↓
12	d*I	d*II	d*I	–	-10 to 110 %	1 digit

Table 3-6 Parameter range and resolution for the display format dependent parameters

3.3.5 Structuring mode PASt (parameter control)

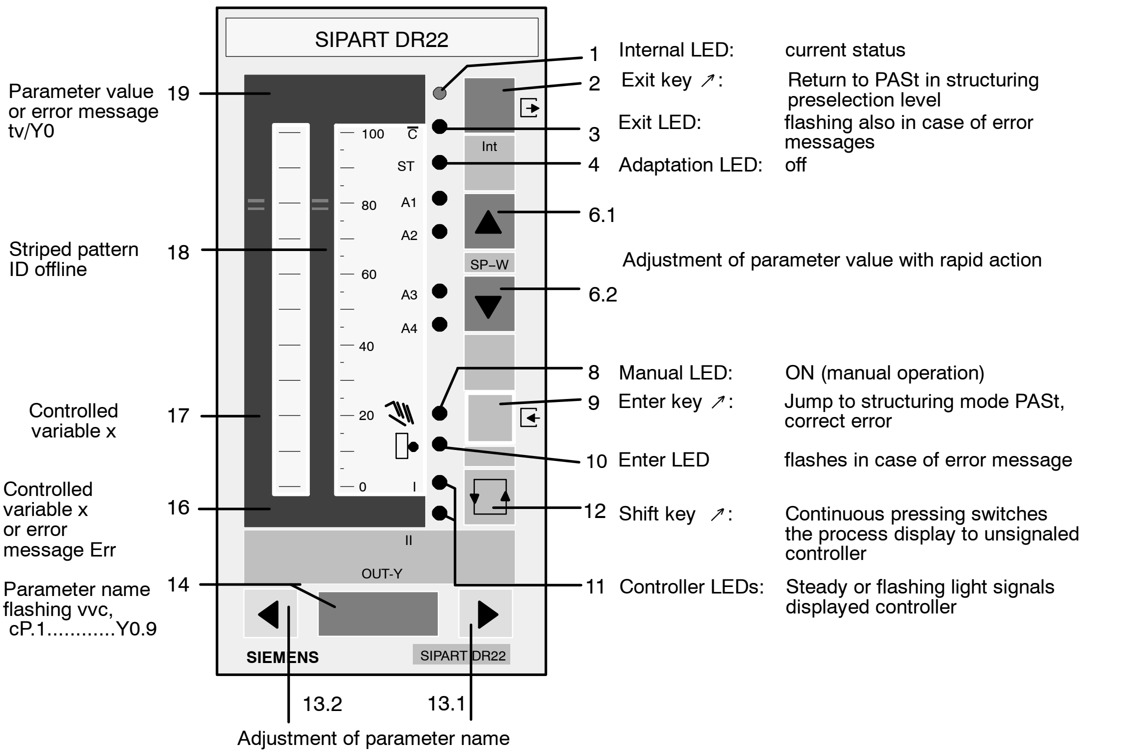


Figure 3-9 Control and display elements in the structuring mode PASt

Digital display y	Digital display x	Digital display w Adjustment/ display area	Factory setting	Resolution	Dimen-sion	Parameter meaning
vvc	Controlled variable x	0.100 – 10.00	5	128 values/ octave	1	Derivative action gain
cP1 cP3 cP5 cP7 cP9		0.1 – 100	0.1 0.1 0.1 0.1 0.1	128 values/ octave	1 1 1 1 1	Proportional action factor at SG = 10 % Proportional action factor at SG = 30 % Proportional action factor at SG = 50 % Proportional action factor at SG = 70 % Proportional action factor at SG = 90 %
tn1 tn3 tn5 tn7 tn9		1 – 9984	9,984 9,984 9,984 9,984 9,984	128 values/ octave	s s s s s	Integral action time at SG = 10 % Integral action time at SG = 30 % Integral action time at SG = 50 % Integral action time at SG = 70 % Integral action time at SG = 90 %
tv1 tv3 tv5 tv7 tv9		oFF, 1 – 2992	oFF oFF oFF oFF oFF	128 values/ octave	s s s s s	Derivative action time at SG = 10 % Derivative action time at SG = 30 % Derivative action time at SG = 50 % Derivative action time at SG = 70 % Derivative action time at SG = 90 %
AH1 AH3 AH5 AH7 AH9		0.0 – 10.0	0.0 0.0 0.0 0.0 0.0	0.1	% % % % %	Response threshold at SG = 10 % Response threshold at SG = 30 % Response threshold at SG = 50 % Response threshold at SG = 70 % Response threshold at SG = 90 %
Y01 Y03 Y05 Y07 Y09		Auto, 0.0 – 100.0	0.0 0.0 0.0 0.0 0.0	0.1	% % % % %	Operating point P-Reg. at SG = 10 % Operating point P-Reg. at SG = 30 % Operating point P-Reg. at SG = 50 % Operating point P-Reg. at SG = 70 % Operating point P-Reg. at SG = 90 %

SG means: controlling variable for the parameter control

Table 3-7 Parameter list PASt

Error messages

- **tv Err:**

  If tv.1 to tv.9 have not been set all = off or have not been set all ≠ off, the error message tv Err appears when returning to the structuring preselection mode after PASt with the Exit key.

  Pressing the Enter key:
  Error correction possibility by jumping to tv.1 in the structuring mode PASt.

  Pressing the Exit key:
  Error message is acknowledged, return to the structuring preselection level after PASt, tv.1 to tv.5 are automatically set to oFF.

- **Y0 Err:**

  If Y0.1 to Y0.9 have not been set all = AUto or have not been set all ≠ AUto, the error message Y0 Err appears on returning to the structuring preselection level after PASt with the Exit key.

  Pressing the Enter key:
  Error correction possibility by jumping to the structuring mode PASt after Y0.1.

  Pressing the Exit key:
  Error message is acknowledged, return to the strucuring preselection level after PASt, Y0.1 to Y0.2 are automatically set to AUto.

3.3.6 Structuring mode StrS (structure switches)

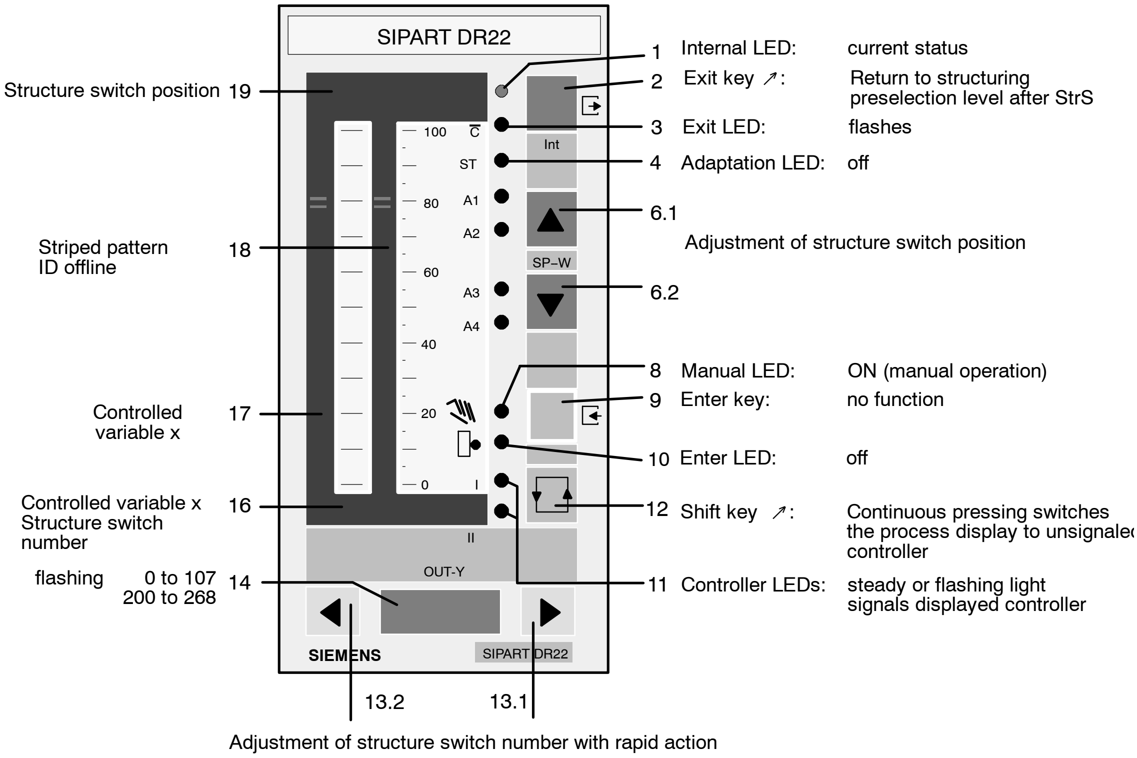


Figure 3-10 Control and display elements in the structuring mode StrS

Structure switches		Switch position	Function
Basic settings	S0	 [0] 1) 1 ↓ 254	**Identification of the user program memorys** Identification for factory setting (APSt) ID number for various user programs
Basic settings	S1	 [0] 1 2 3 4 5 6 7 8 9 10 11 12	**Controller type** Fixed setpoint controller 2 independent setpoints Fixed setpoint controller 2 dependent setpoints DDC fixed setpoint controller Follow-up/Synchronized/SPC controller with Int/Ext switching ratio controller cascade control ratio-cascade control override control max. selection y override control min. selection y Process display Fixed setpoint controller with 1 setpoint (control system coupling) Follow-up controller without Int/Ext switching (control system coupling) Double fixed setpoint/follow-up controller
Analog inputs	S2	 [0] 1 2	**Output structure** K-output S-output internal feedback S-output external feedback
Analog inputs	S3	 [0] 1	**Mains frequency suppression** 50 Hz 60 Hz
Analog inputs	S4	 [0] 1	**Connection of input range** fixed connection free connection
Analog inputs	S5	 [0] 1 2 3	**Input signal AE1** 0 . . . 20 mA without 0 . . . 20 mA with 4 . . . 20 mA without 4 . . . 20 mA with } transmitter monitoring MUF
Analog inputs	S6	 [0] 1 2 3	**Input signal AE2** 0 . . . 20 mA without 0 . . . 20 mA with 4 . . . 20 mA without 4 . . . 20 mA with } transmitter monitoring MUF

[ ] factory setting

1) Position 0 cannot be set manually.
As soon as the factory setting is changed (parameters or structures) S0 is automatically set from 0 to 1, APSt sets S0 to 0, FPSt has no influence.

Table 3-8 Structure switch tables

Structure switches		Switch position	Function
Analog inputs	S7	[0] 1 2 3	**Input signal AE3** 0 . . . 20 mA without 0 . . . 20 mA with 4 . . . 20 mA without 4 . . . 20 mA with } transmitter monitoring MUF
	S8	[0] 1 2 3 4 5 6 7	**Input signal AE4** 0 . . . 20 mA or U, R without MUF 0 . . . 20 mA or U, R with MUF 4 . . . 20 mA without MUF 4 . . . 20 mA with MUF Uni without MUF (0 % in open circuit) Uni without MUF (100 % in open circ.) Uni with MUF (0 % in open circuit) Uni with MUF (100 % in open circuit)
	S9	[0] 1 2 3 4 5 6 7	**Input signal AE5** 0 . . . 20 mA or U, R without MUF 0 . . . 20 mA or U, R with MUF 4 . . . 20 mA without MUF 4 . . . 20 mA with MUF Uni without MUF (0 % in open circuit) Uni without MUF (100 % in open circ.) Uni with MUF (0 % in open circuit) Uni with MUF (100 % in open circuit)
	S10	[0] 1	**Root extraction AE1** no yes
	S11	[0] 1	**Root extraction AE2** no yes
	S12	[0] 1	**Root extraction AE3** no yes
	S13	[0] 1	**Root extraction AE4** no yes
	S14	[0] 1	**Root extraction AE5** no yes
Analog inputs (only active when S4 = 0)	S15	0 [1] 4 5 6 7 8 9 10 11 2 3	**Assignment FE1 to AE1 to AE11** 0 % AE1A AE4A AE5A AE6A AE7A AE8A AE9A AEAA AEbA AE2A AE3A
	S16	0 [2] 4 5 6 7 8 9 10 11 1 3	**Assignment FE2 to AE1 to AE11 (AEb)** 0 % AE2A AE4A AE5A AE6A AE7A AE8A AE9A AEAA AEbA AE1A AE3A
	S17	0 [3] 4 5 6 7 8 9 10 11 1 2	**Assignment FE3 to AE1 to AE11 (AEb)** 0 % AE3A AE4A AE5A AE6A AE7A AE8A AE9A AEAA AEbA AE1A AE2A
	S18	[0] 1 2 3 4 5 6 ↓ 11	**Assignment FE4 to AE1 to AE11 (AEb)** 0 % AE1A AE2A AE3A AE4A AE5A AE6A ↓ AEbA
	S19	[0] 1 2 3 5 6 7 8 9 10 11 4	**Assignment FE5/6 to AE1 to AE11 *) (AEb)** 0 % AE1A AE2A AE3A AE5A AE6A AE7A AE8A AE9A AEAA AEbA AE4A

*) Effect as FE5/FE6 depending on S2 = 0 / S2 = 1, 2 (see fig. 1-5, page 24)

[ ] factory setting

Structure switches		Switch position	Function
Assembly slots 5 and 6	S20	 [0] 1	**Linearization FE1** no yes
	S21	 [0] 1	**Linearization FE3** no yes
	S22	 [0] 1 2 3 4 5 6	**Assembly slot 5** not assembled 4 BA/2 BE (BA9 to BA12/BE5, BE6) 5 BE (BE5 to BE9) 2 relays (BA9, BA10) Y-hold (AA7) 3-AE (AE9 to AE11) 3 AA/3 BE (AA7 to AA9/BE5 to BE7)
	S23	 [0] 1 2 3 4 5 6	**Assembly slot 6** not assembled 4 BA/2 BE (BA13 to BA16 /BE10, BE11) 5 BE (BE10 to BE14) 2 relays (BA13, BA14) Y-hold (AA4) 3-AE (AE6 to AE8) 3 AA/3 BE (AA4 to AA6/ BE10 to BE12)

Binary inputs

Assignment of control signals to the binary inputs

S24 CB	**S25** He	**S26** N	**S27** Si	**S28** bLS bLS	**S29** bLPS bLPS	**S30** P I	**S31** P II	**S32** PAU	**S33** +Δw	**S34** −Δw	**S35** +Δy	**S36** −Δy	**S37** +ybL	**S38** −ybL	Assignment
[−1] 0	– 0	– 0	– 0	– [0]	– [0]	−1 [0]	−1 [0]	– [0]	– [0]	– [0]	– [0]	– [0]	– [0]	– [0]	High Low
1 2 3 4	1 [2] 3 4	1 2 [3] 4	1 2 3 [4]	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	BE1 BE2 Basic BE3 card BE4
5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	BE5 BE6 Slot BE7 BE8 5 BE9
10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	BE10 BE11 Slot BE12 BE13 6 BE14
15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	FE9 FE10 FE11 FE12

[ ] factory setting

Table 3−8 Structure switch tables (continued)

Direction of effect of the digital inputs on assigned control signals

S39 CB/CBII	**S40** He/HeII	**S41** N/NII	**S42** Si/SiII	**S43** PI / PII	**S44** +dw/−dw	**S45** +dy/−dy	**S46** +ybL/−ybL +ybLII/−ybLII	Direction of effect
[0] 1	[0] 1	[0] 1	[0] 1	[0] 1	[0] 1	[0] 1	[0] 1	24 V = High 0 V = High

Direction of effect of the digital inputs BEs on bLS, bLPS and PAU corresponds to the meaning position ”0”.

Structure switches		**Switch position**	**Function**
Digital inputs	S47	[0] 1 2	**Control signal CB** static without acknowledgement static with acknowledgement dynamic as pulse (flip-flop effect)
	S48	[0] 1	**Control signal N (follow-up)** static dynamic as pulse (flip-flop effect)
setpoint switching	S49	[0] 1 2	**Blocking switching Internal/External** internal only external only no blocking
	S50	[0] 1	**x-tracking at H + N (DDC) + Si** no yes
	S51	[0] 1	**setpoint in event of CB failure** last wi (at S52 = 0 last w) safety setpoint SH
	S52	[0] 1	**Follow-up of wi to the active setpoint** yes no
	S53	[0] 1	**Source for the external setpoint** absolute setpoint WEA incremental setpoint WEΔ

Structure switches		**Switch position**	**Function**
Control algorithm	S54	[0] 1	**Direction of effect of controller I referenced to xd I** normal (cP > 0) reversed (cP < 0)
	S55	[0] 1 2 3	**D−element and z lock-on controller I** D-element | z xd I | y x I | y Direction of effect against x | D-element (z(FE4)) Direct. of effect with x | D-element (z(FE4))
	S56	[0] 1	**Direction of effect controller II referenced to xd II** normal (cP > 0) reversed (cP < 0)
	S57	[0] 1 2 3	**D−element lock−on controller II** D-element | z xd II | y x II | y Direction of effect against x | D-element (z(FE7)) Direction of effect with x | D-element (z(FE7))
	S58	[0] 1 2	**Adaptation selection** no adaptation possible control behavior without overshoot control behavior with periodic transient response according to amount optimum
	S59	[0] 1 2	**Parameter control** without Controller I (instead of parameter set I) Controller II (instead of param. set II)

[ ] factory setting

Table 3−8 Structure switch tables (continued)

Structure switches		Switch position	Function	
Control algorithm	S60		**Assignment of the controlling variable SG for the parameter control**	
			SG controlling variable	**Display SG in AdAP [%]**
		[0]	$10\lvert xdI \rvert$ at S59 = 1 or $10\lvert xdII \rvert$ at S59 = 2	- - - -
		1	xI at S59 = 1 or xII at S59 = 2	xI / xII
		2	wI at S59 = 1 or wII at S59 = 2	xI / xII
		3	y	y
		4	xv	xv
		5	wv	xv
		6	AE1A	AE1A
		7	AE2A	AE2A
		8	AE3A	AE3A
		9	AE4A	AE4A
		10	AE5A	AE5A
		11	FE1	FE1
		12	FE2	FE2
		13	FE3	FE3
		14	FE4	FE4
		15	FE5	FE5
		16	FE6	FE6
		17	10 % at Pi(D) and 30 % at P (D)	- - - -
		18		yII
		19	AE6A	AE6A
		20	AE7A	AE7A
		21	AE8A	AE8A
		22	AE9A	AE9A
		23	AEAA	AEAA
		24	AEbA	AEbA
		25	FE7	FE7
		26	FE8	FE8
		27	FE9	FE9
		28	FE10	FE10
		29	FE11	FE11
		30	FE12	FE12

Structure switches		Switch position	Function		
output switching	S61		**Priority N (DDC) or H**		
		[0]	N (DDC)		
		1	H		
	S62		**Source for external manipulated variable**		
		[0]	absolute manipulated variable YN		
		1	incremental manipulated variable YNΔ		
	S63		**Manual operation in event of transmitter fault**		
		[0]	no switching (fault display only)		
		1	manual operation starting with last y		
		2	manual operation starting with ys		
	S64		**switching manual / automatic via**		
			Manual key H	control s. He	interlock He_{ES}
		[0]	yes	yes/static	with
		1	no	yes/static	with
		2	no switching, only manual mode		
		3	yes	yes/dynamic	with
		4	yes	yes/dynamic	without
	S65		**Function split range** (for K-controller only)		
		[0]	Y1 rising / Y2 falling		
		1	Y1 rising / Y2 rising		
	S66		**Iy switch off in N/DDC mode** (for K-controller only)		
		[0]	without		
		1	with		

Structure switches		Switch position	Function	
y display	S67		**Manipulated variable display**	
		[0]	controller output y	
		1	split range output y1, y2	
		2	position feedback y_R	
		oFF	no display	
	S68		**Direction of effect of the manipulated variable display**	
		[0]	normal: yAn = y	
		1	inverted: yAn = 100 % − y	
analog outputs	S69		**Output signal AA1**	Basic controller
		[0]	0 to 20 mA	
		1	4 to 20 mA	
	S70		**Output signal AA2**	Basic controller
		[0]	0 to 20 mA	
		1	4 to 20 mA	
	S71		**Output signal AA3**	Basic controller
		[0]	0 to 20 mA	
		1	4 to 20 mA	
	S72		**Output signal AA4**	
		[0]	0 to 20 mA	Slot 6
		1	4 to 20 mA	

[ ] factory setting

Table 3–8 Structure switch tables (continued)

Assignment of analog outputs to controller signals

S73 AA1	**S74** AA2	**S75** AA3	assigned to
0	[0]	[0]	0 %
[1]	1	1	y
2	2	2	y1
3	3	3	y2
4	4	4	AE1A
5	5	5	AE2A
6	6	6	AE3A
7	7	7	AE4A
8	8	8	AE5A
9	9	9	FE1
10	10	10	FE2
11	11	11	FE3
12	12	12	FE4
13	13	13	FE5
14	14	14	FE6
15	15	15	50 % + xd I
16	16	16	50 % − xd I
17	17	17	x I
18	18	18	w I
19	19	19	xv
20	20	20	wv
21	21	21	50 % + xd II
22	22	22	50 % − xd II
23	23	23	x II
24	24	24	w II
25	25	25	50 % + xdS
26	26	26	50 % − xdS
27	27	27	y II
28	28	28	y3
29	29	29	y4
30	30	30	AE6A
31	31	31	AE7A
32	32	32	AE8A
33	33	33	AE9A
34	34	34	AEAA
35	35	35	AEbA
36	36	36	FE7
37	37	37	FE8
38	38	38	FE9
39	39	39	FE10
40	40	40	FE11
41	41	41	FE12

[ ] factory setting

Table 3−8 Structure switch tables (continued)

Digital outputs

Assignment of digital signals to digital outputs

S76	**S77**	**S78**	**S79**	**S80**	**S81**	**S82**	**S83**	**S84**	**S85**	
$\overline{RB}$	$\overline{RC}$	H	N	A1	A2	A3	A4	MUF	Int I	assignment to
0	0	0	0	0	0	[0]	[0]	[0]	[0]	none
[1]	1	1	1	1	1	1	1	1	1	BA1 Basic
2	[2]	2	2	2	2	2	2	2	2	BA2 card
3	3	[3]	3	3	3	3	3	3	3	BA3
4	4	4	[4]	4	4	4	4	4	4	BA4
5	5	5	5	[5]	5	5	5	5	5	BA5
6	6	6	6	6	[6]	6	6	6	6	BA6
7	7	7	7	7	7	7	7	7	7	BA7
8	8	8	8	8	8	8	8	8	8	BA8
9	9	9	9	9	9	9	9	9	9	BA9 Slot
10	10	10	10	10	10	10	10	10	10	BA10
11	11	11	11	11	11	11	11	11	11	BA11 5
12	12	12	12	12	12	12	12	12	12	BA12
13	13	13	13	13	13	13	13	13	13	BA13 Slot
14	14	14	14	14	14	14	14	14	14	BA14
15	15	15	15	15	15	15	15	15	15	BA15 6
16	16	16	16	16	16	16	16	16	16	BA16

Note: Same assignment initiates ”or” function
Unassigned digital outputs BAs can be set by SES
In structured S-controllers (S2 ≠ 0, or S231 ≠ 0 bei S1 = 12) the outputs +dy / −dy are fixed to BA7 / BA8, or BA5 / BA6

Direction of effect of the digital outputs

S86	**S87**	**S88**	**S89**	**S90**	**S91**	**S92**	**S93**	
$\overline{RB}/\overline{RBII}$	$\overline{RC}/\overline{RCII}$	H/HII	N/NII	A1/A2	A3/A4	MUF	Int I/Int II	Direction of effect
[0]	[0]	[0]	[0]	[0]	[0]	[0]	[0]	24 V = High
1	1	1	1	1	1	1	1	0V = High

Remark: S-controller outputs +dy / −dy are always High active

[ ] factory setting

Table 3−8 Structure switch tables (continued)

Assignment of limit value alarm inputs A1, A3 to the controller signals

S94 A1 (A2)	**S95** A3 (A4)	Input
[0]	[0]	xdI
1	1	xI
2	2	wI
3	3	xv
4	4	wv
5	5	xdII
6	6	xII
7	7	wII
8	8	y
9	9	y1
10	10	y2
11	11	AE1A
12	12	AE2A
13	13	AE3A
14	14	AE4A
15	15	AE5A
16	16	FE1
17	17	FE2
18	18	FE3
19	19	FE4
20	20	FE5
21	21	FE6
22	22	xdS
23	23	yII
24	24	y3
25	25	y4
26	26	AE6A
27	27	AE7A
28	28	AE8A
29	29	AE9A
30	30	AEAA
21	21	AEbA
32	32	FE7
33	33	FE8
34	34	FE9
35	35	FE10
36	36	FE11
37	37	FE12
38	38	|xdI|
39	39	|xdII|

[ ] factory setting

NOTE:

S94: Assignment also for A2, if S267= −1
S95: Assignment also for A4, if S268= −1

Table 3−8 Structure switch tables (continued)

Structure switches		Switch position	Function
Limit value alarms	S96		**Funct. of the limit value alarms A1, A2**
		[0]	A1 max / A2 min
		1	A1 min/ A2 min
		2	A1 max / A2 max
		3	A1 min/ A2 max
	S97		**Funct. of the limit value alarms A3, A4**
		[0]	A3 max / A4 min
		1	A3 min/ A4 min
		2	A3 max / A4 max
		3	A3 min/ A4 max
	S98		**Setting and display of the limit values A1 to A4** Display in the process operation level / Setting in the process operation level
		[0]	no / no
		1	yes / no
		2	yes / yes
Restart conditions	S99		**Restart conditions after mains recovery and manual reset**
		[0]	last operating mode, last w, last y
		1	manual and internal operation, last w,
	S100		**Optical signaling after mains recovery or reset**
		[0]	without } flashing of the digital x display
		1	with } flashing of the digital x display

Structure switches		Switch position	Function			
Serial interface	S101		**Data transfer**			
			Reception by DR22	Control signal CB_{BE}/CB_{ES}	Source for w_E	y_N
		0	nothing	only	w_{EA}	y_N
		[1]	configure	CB_{BE}	bzw. $w_{E\Delta}$	bzw. $y_{N\Delta}$
		2	configure process variables status registers	$CB_{BE} \vee CB_{ES}$	w_{ES}	y_{ES}
		3		$CB_{BE} \wedge CB_{ES}$		
		4		$CB_{BE} \vee CB_{ES}$	w_{EA} or $w_{E\Delta}$	y_N or $y_{N\Delta}$
		5		$CB_{BE} \wedge CB_{ES}$		
	S102		**Data transfer rate**			
		[0]	9,600 baud			
		1	4,800 baud			
		2	2,400 baud			
		3	1,200 baud			
		4	600 baud			
		5	300 baud			
	S103		**Cross parity**			
		[0]	even			
		1	odd			
	S104		**Longitudinal parity position**			
		[0]	without			
		1	after ETX			
		2	before ETX			
	S105		**Longitudinal parity**			
		[0]	normal			
		1	inverted			
	S106		**Station no.**			
		[0]	0			
		1	1			
		.	.			
		.	.			
		125	125			
	S107		**Time monitor CBES**			
		[0]	without			
		1	1 s			
		2	2 s			
		.	.			
		.	.			
		25	25 s			

The serial interface in the SIPART DR22 must be set as follows for operation on the Profibus DP:

Structure switch	Setting
S101	2 (recommendation)
S102	0
S103	0
S104	0
S105	0
S106	0 – 125
S107	< 10

[ ] factory setting

Table 3−8 Structure switch tables (continued)

Structure switches	Switch posi-tion	Function
S200		**Input signal AE6**
	[0]	0 ... 20 mA without MUF
	1	0 ... 20 mA with MUF
	2	4 ... 20 mA without MUF
	3	4 ... 20 mA with MUF
S201		**Input signal AE7**
	[0]	0 ... 20 mA without MUF
	1	0 ... 20 mA with MUF
	2	4 ... 20 mA without MUF
	3	4 ... 20 mA with MUF
S202		**Input signal AE8**
	[0]	0 ... 20 mA without MUF
	1	0 ... 20 mA with MUF
	2	4 ... 20 mA without MUF
	3	4 ... 20 mA with MUF
S203		**Input signal AE9**
	[0]	0 ... 20 mA without MUF
	1	0 ... 20 mA with MUF
	2	4 ... 20 mA without MUF
	3	4 ... 20 mA with MUF
S204		**Input signal AE10**
	[0]	0 ... 20 mA without MUF
	1	0 ... 20 mA with MUF
	2	4 ... 20 mA without MUF
	3	4 ... 20 mA with MUF
S205		**Input signal AE11**
	[0]	0 ... 20 mA without MUF
	1	0 ... 20 mA with MUF
	2	4 ... 20 mA without MUF
	3	4 ... 20 mA with MUF
S206		**Root extraction AE6**
	[0]	no
	1	yes
S207		**Root extraction AE7**
	[0]	no
	1	yes
S208		**Root extraction AE8**
	[0]	no
	1	yes
S209		**Root extraction AE9**
	[0]	no
	1	yes
S210		**Root extraction AE10**
	[0]	no
	1	yes
S211		**Root extraction AE11**
	[0]	no
	1	yes

Assignment FE7 – FE12 to AE1A – AEbA

S212 FE7	**S213** FE8	**S214** FE9	**S215** FE10	**S216** FE11	**S217** FE12	assignment to
[0]	[0]	[0]	[0]	[0]	[0]	0 %
1	1	1	1	1	1	AE1A
2	2	2	2	2	2	AE2A
3	3	3	3	3	3	AE3A
4	4	4	4	4	4	AE4A
5	5	5	5	5	5	AE5A
6	6	6	6	6	6	AE6A
7	7	7	7	7	7	AE7A
8	8	8	8	8	8	AE8A
9	9	9	9	9	9	AE9A
10	10	10	10	10	10	AEAA
11	11	11	11	11	11	AEbA

[ ] factory setting

Table 3–8 Structure switch tables (continued)

Assignment of control signals to the binary inputs

S218 bLb	**S219** CBII	**S220** HeII	**S221** NII	**S222** SiII	**S223** /tSI	**S224** /tSII	**S225** wSLI	**S226** wSLII	**S227** +ybLII	**S228** −ybLII	**S269*)** tsHI	**S270*)** tsHII	Assignment
– [0]	[−1] 0	– [0]	– [0]	– [0]	– [0]	– [0]	−1 [0]	−1 [0]	– [0]	– [0]	−1 [0]	−1 [0]	High Low
1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	BE1 BE2 Basic BE3 card BE4
5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	5 6 7 8 9	BE5 BE6 Slot BE7 BE8 5 BE9
10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	10 11 12 13 14	BE10 BE11 Slot BE12 BE13 6 BE14
15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	15 16 17 18	FE9 FE10 FE11 FE12

*) As of software version −C09

Direction of effect of the digital inputs on assigned control signals

S229 /tSI and /tSII	**S230** /wSLI and /wSLII	Direction of effect
[0] 1	[0] 1	24 V = High 0 V = High

[ ] factory setting

Table 3−8 Structure switch tables (continued)

Structure switches		Switch position	Function
	S231	 [0] 1 2	**Output structure controller 2** K-output S-output internal feedback S-output external feedback
	S232	 [0] 1 2	**Blocking switching Internal/External controller 2 at S1 = 12** internal only external only no blocking
	S233	 [0] 1	**x-tracking controller 2 at H+N(DDC)+Si** no yes
	S234	 [0] 1	**Setpoint at CB II failure** wi we or last wes
	S235	 [0] 1	**Follow-up wi II to active setpoint** yes no
	S236	 [0] 1 2	**Display switching at ratio controller/cascade** xv, wv / xv, wve xv, wv / x, w (standardized to Ad, Ed) xv, wv / x, wve / x, w (standardized to Ad, Ed)
	S237		**unused**

Structure switches		Switch position	Function
output switching	S238	 [0] 1	**priority NII (DDC) or HII** NII + (DDC) HII
	S239	 [0] 1 2	**Manual operation controller II in case of transmitter fault** no switching manual operation starting with last yII manual operation starting with ySII
	S240	 [0] 1 2 3 4	**Switching manual/automatic controller II via** Manual key Hi | control s. He | interlock He_{ES} yes | yes/static | with no | yes/static | with no switching manual operation yes | yes/dynamic | with yes | yes/dynamic | without
	S241	 [0] 1	**Function split range controller 2** (only K controller) y3 rising / y4 falling y1 rising / y4 rising
	S242	 [0] 1	**Iy switch off in N II/DDC II mode** (only K controller) without with
	S243	 [0] 1 2 oFF	**Manipulated variable display controller 2** controller output yII split range outputs y3/y4 position feedback y_RII no display
	S244	 [0] 1	**Direction of effect manipulated variable display controller 2** normal: yAn = yII inverted: yAn = 100 % − yII
	S245	 [0] 1	**Manipulated variable limit YA/YE** only active in automatic operation active in all operating modes
	S246	 [0] 1	**Manipulated variable limit YAII/YEII** only active in automatic operation active in all operating modes
analog outputs	S247	 [0] 1	**Output signal AA5** 0 to 20 mA 4 to 20 mA
	S248	 [0] 1	**Output signal AA6** 0 to 20 mA 4 to 20 mA
	S249	 [0] 1	**Output signal AA7** 0 to 20 mA 4 to 20 mA
	S250	 [0] 1	**Output signal AA8** 0 to 20 mA 4 to 20 mA
	S251	 [0] 1	**Output signal AA9** 0 to 20 mA 4 to 20 mA

[ ] factory setting

Table 3−8 Structure switch tables (continued)

Assignment of analog outputs to controller signals

S252 AA4	**S253** AA5	**S254** AA6	**S255** AA7	**S256** AA8	**S257** AA9	assignment to
0	[0]	[0]	[0]	[0]	[0]	0 %
[1]	1	1	1	1	1	y I
2	2	2	2	2	2	y1
3	3	3	3	3	3	y2
4	4	4	4	4	4	AE1A
5	5	5	5	5	5	AE2A
6	6	6	6	6	6	AE3A
7	7	7	7	7	7	AE4A
8	8	8	8	8	8	AE5A
9	9	9	9	9	9	FE1
10	10	10	10	10	10	FE2
11	11	11	11	11	11	FE3
12	12	12	12	12	12	FE4
13	13	13	13	13	13	FE5
14	14	14	14	14	14	FE6
15	15	15	15	15	15	50 % + xd I
16	16	16	16	16	16	50 % − xd I
17	17	17	17	17	17	x I
18	18	18	18	18	18	w I
19	19	19	19	19	19	xv
20	20	20	20	20	20	wv
21	21	21	21	21	21	50 % + xd II
22	22	22	22	22	22	50 % − xd II
23	23	23	23	23	23	x II
24	24	24	24	24	24	w II
25	25	25	25	25	25	50 % + xdS I
26	26	26	26	26	26	50 % − xdS I
27	27	27	27	27	27	y II
28	28	28	28	28	28	y3
29	29	29	29	29	29	y4
30	30	30	30	30	30	AE6A
31	31	31	31	31	31	AE7A
32	32	32	32	32	32	AE8A
33	33	33	33	33	33	AE9A
34	34	34	34	34	34	AEAA
35	35	35	35	35	35	AEbA
36	36	36	36	36	36	FE7
37	37	37	37	37	37	FE8
38	38	38	38	38	38	FE9
39	39	39	39	39	39	FE10
40	40	40	40	40	40	FE11
41	41	41	41	41	41	FE12

Assignment of digital signals to digital outputs

S258 /RB II	**S259** /RC II	**S260** H II	**S261** N II	**S262** Int II	**S263** FE9	**S264** FE10	**S265** FE11	**S266** FE12	assignment to
[0]	[0]	[0]	[0]	[0]	[0]	[0]	[0]	[0]	none
1	1	1	1	1	1	1	1	1	BA1
2	2	2	2	2	2	2	2	2	BA2
3	3	3	3	3	3	3	3	3	BA3
4	4	4	4	4	4	4	4	4	BA4
5	5	5	5	5	5	5	5	5	BA5
6	6	6	6	6	6	6	6	6	BA6
7	7	7	7	7	7	7	7	7	BA7
8	8	8	8	8	8	8	8	8	BA8
9	9	9	9	9	9	9	9	9	BA9
10	10	10	10	10	10	10	10	10	BA10
11	11	11	11	11	11	11	11	11	BA11
12	12	12	12	12	12	12	12	12	BA12
13	13	13	13	13	13	13	13	13	BA13
14	14	14	14	14	14	14	14	14	BA14
15	15	15	15	15	15	15	15	15	BA15
16	16	16	16	16	16	16	16	16	BA16

[ ] factory setting

Table 3−8 Structure switch tables (continued)

Assignment of limit value alarm inputs to the controller signals

S267: input limit value alarm A2

S267: input limit value alarm A4

S267 A2	**S268** A4	Input
[−1]	[−1]	like A1 or. A3
0	0	xdI
1	1	xI
2	2	wI
3	3	xv
4	4	wv
5	5	xdII
6	6	xII
7	7	wII
8	8	y
9	9	y1
10	10	y2
11	11	AE1A
12	12	AE2A
13	13	AE3A
14	14	AE4A
15	15	AE5A
16	16	FE1
17	17	FE2
18	18	FE3
19	19	FE4
20	20	FE5
21	21	FE6
22	22	xdS
23	23	yII
24	24	y3
25	25	y4
26	26	AE6A
27	27	AE7A
28	28	AE8A
29	29	AE9A
30	30	AEAA
31	31	AEbA
32	32	FE7
33	33	FE8
34	34	FE9
35	35	FE10
36	36	FE11
37	37	FE12
38	38	|xdI|
39	39	|xdII|
S269	−1 [0] . . . 18	tsH1 see S228 *)

		Function
S270	−1 [0] . . . 18	tsH2 see S228 *)
S271	 [0] 1 **) 2 **)	Locking of status signals via the serial interface SES with locking by RC with locking by RB without locking

[ ] factory setting

*) As of software version −C09
**) As of software version −D06

Table 3−8 Structure switch tables (continued)

3.3.7 Structuring mode FdEF (define functions)

In the FdEF mode (only appears when S4 = 1) the functions for the freely connectable input range are determined (defined) which are to be used for the user program.

The functions are defined with YES or suppressed with no (factory setting: all functions no). Only the functions marked YES appear in the structuring modes FCon (connect functions) and FPos (position functions)

The functions are stored in alphabetical order and are called one after another as questions, the answer is set with YES or no.

Digital display	
x (question)	w (answer)
Ar1	
Ar2	
Ar3	
Ar4	
Ar5	
Ar6	
Fu1	
Fu2	YES or no
MA1	
MA2	
MA3	
Mi1	
Mi2	
Mi3	
Digital display (continued)	
x (question)	w (answer)
rE1	
AS1	
AS2	
AS3	
AS4	
AS5	
Co1	YES or no
Co2	
nA1	
nA2	
no1	
no2	

Table 3-9 Question/answer cycle structuring mode FdEF

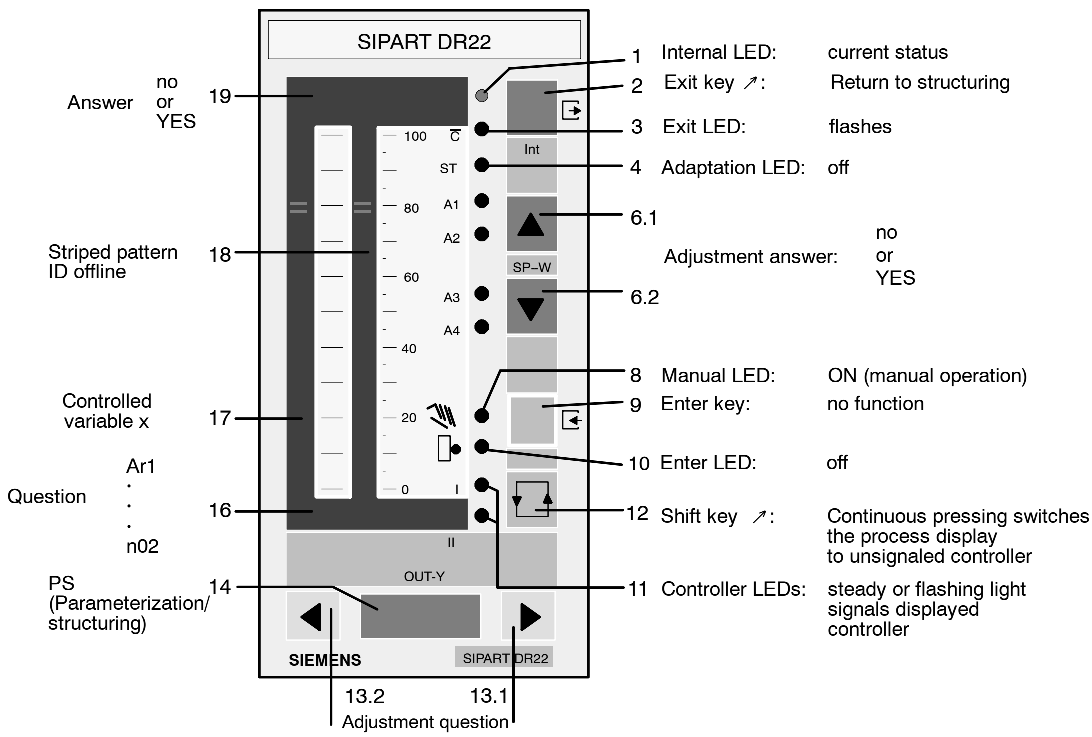


Figure 3-11 Control and display elements in the structuring mode FdEF

3.3.8 Structuring mode FCon (connect functions, connection)

In the FCon mode (only appears when S4 = 1) the functions defined with YES in the FdEF mode are connected (software „connected") with each other and with the selectable inputs and outputs (FE1 to FE12) of the freely connectable range. A connection is made by setting a data source/data sink pair on the digital x and y display. The data sink (question) is always set first followed by the data source (answer). The connection is established when switching to the next data sink or returning to the structuring preselection mode FCon.

The data sinks (inputs of the functions and the outputs of the freely connectable range) and the data sources (outputs of the functions and inputs of the freely connectable range) are stored in the listed order. The data sources and sinks of the functions defined by no are hidden.

Every data sink can only be assigned exactly one data source whereas every source can be connected with as many sinks as you like. The parallel loop of inputs (sinks) is therefore achieved by connection of the respective inputs with the same output (source). The presettings of the inputs (ncon or numeric values) specified in the description of the various functions is transferred to the FCon mode and can be changed (overwritten) there if necessary.

Changes in the FdEF, if FCon has already been carried out

If functions defined by YES are overwritten by no after connection in the FdEF mode, the existing connection to the inputs and outputs of the functions overwritten by no is removed. The inputs (data sinks) fed by the output of the deleted function are identified by ncon (not connected).

Error message ncon Err

It is not permissible to end the connection with data sinks defined by ncon because the desired functions cannot run with undefined inputs.

If the structuring preselection level is to be left with the Exit key and some data sinks (inputs) are still defined by ncon, the flashing error message ncon Err appears and the structuring preselection level is not exited, the error can be corrected (Enter key) or ignored (Exit key).

The error message is acknowledged by pressing the Enter key. It returns to the configuring mode FCon to the first data sink marked ncon, the error can be corrected.

Digital display	
x (question)	w (answer)
Ar1.1	ncon
↓	AE1A
Ar1.5	↓
↓	AEbA
Ar6.1	Ar1.6
↓	↓
Ar6.5	Ar6.6
FE1	Fu1.2
↓	Fu2.2
FE12	MA1.4
Fu1.1	MA2.4
Fu2.1	MA3.4
MA1.1	Mi1.4
MA1.2	Mi2.4
MA1.3	Mi3.4
↓	P01
MA3.1	↓
MA3.2	P15
MA3.3	rE1.4
Mi1.1	−1.000
Mi1.2	−.500
Mi1.3	−.250
↓	−.050
Mi3.1	0.000
Mi3.2	0.050
Mi3.3	0.100
rE1.1	0.200
rE1.2	0.500
rE1.3	1.000
AS1.1	1.050
AS1.2	AS1.4
↓	↓
AS5.2	AS5.4
AS5.3	Co1.4
Co1.1	Co2.4
Co1.2	nA1.4
↓	nA2.4
Co2.2	no1.4
Co2.3	no2.4
nA1.1	bE01
nA1.2	↓
↓	bE09
nA2.2	AE1ϟ
nA2.3	↓
no1.1	AE5ϟ
no1.2	AEϟ
↓	A1
no2.2	A2
no2.3	A3
	A4
	Int I
	Int II
	SPiI
	SPiII
	SPI
	SPII
	yI
	yII
	SAA1
	↓
	SAA4

Table 3-10 Question/answer cycle of the structuring mode FCon

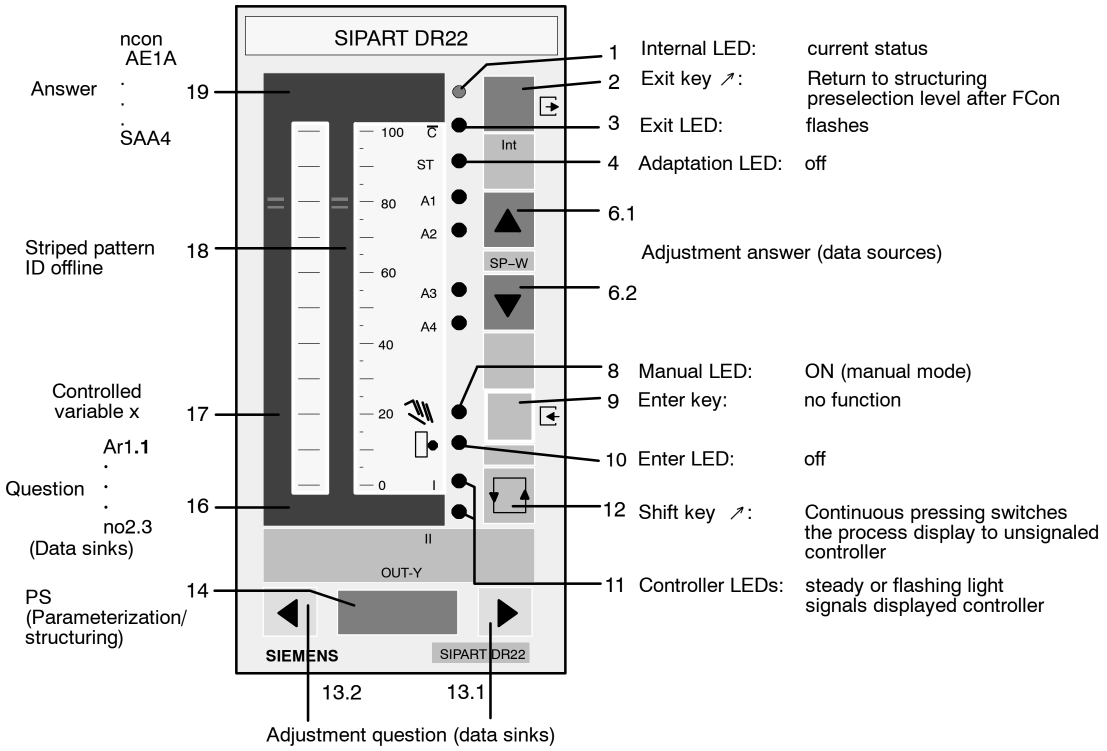


Figure 3-12 Control and display elements in the structuring mode FCon

3.3.9 Structuring mode FPoS (position functions)

In the FPos mode (only appears when S4 = 1) the chronological order for processing the functions defined by YES in FdEF is determined. This chronolgical processing of the freely connectable range is inserted in the processing cycle of the controller at the right time.

The position numbers 1 to 31 are called as questions and the positioning is established by assigning to a function (answer).

Only defined functions appear in the answer cycle, already positioned functions are automatically deleted from the answer cycle.

For positioning, the guideline applies that the input variables of a function have already been calculated before they have been processed. Since this requirement cannot be met, it must be taken into account that values from the previous cycle are used for operation in the case of feedbacks.

If a positioned function is defined by no in FdEF, this function is deleted from the positioning list. The order for processing the other functions remains unchanged. The gap is closed automatically by shiting them together.

Existing positioning sequences can be corrected with inSt, dElt and nPos (in the answer cycle).

- **Function inSt (insert)**

To insert a not yet positioned function in an existing positioning sequence.

Set the position with ±Δy-keys (13) in place of which the not yet positioned function block is to be inserted. Set inSt with ±Δw-keys (6) inSt, the Enter-LED flashes and indicates the effectiveness of the Enter key.

On pressing the Enter key (9), the set position number no** is defined by nPoS and the Enter LED goes out.

The previous positioning series from no** is shifted up one position, the nr** can now be overwritten with the still free function. If the end of the positioning sequence is reached by the inSt function (position number >31), the function cannot be executed (Enter LED does not go out).

- **Function dELt (delete)**

To close nPoS- gaps within a positioning sequence. Set the position number which is to be deleted with ±Δy-keys (13). Set dELt with the±Δw-keys (6), the Enter LED flashes and indicates the effectiveness of the Enter key (9). On pressing the Enter key the set position number nr** is defined by the function of the following position numbers. The previous positioning sequence is moved down one position number from no**.

- **Function nPoS (not positioned)**

To exchange function blocks within a positioning sequence. Select the position numbers to be changed with the±Δy-keys and mark respectively with nPoS. Then the functions overwritten with nPoS are available again in the answer cycle. They can be assigned to the position numbers occupied with nPoS.

Error messages

- **–PoS Err**
  Ending positioning with unpositioned (but defined) functions is not allowed. If the structuring preselection level is to be exited with the Exit key, the flashing error message –Pos Err appears for non-positioned functions. The structuring preselection level is not exited, the error can be corrected (Enter key) or ignored (Exit key).

  The error message is acknowledged by pressing the Enter key. It then jumps back to the first positioning number marked by nPos in the structuring mode FPos, the error can be corrected.

- **nPoS Err**

  Ending positioning with a positioning sequence which contains nPos gaps is not allowed.

  If the configuring mode is to be exited with the Exit key and nPos gaps still exist, the flashing error message nPos Err exists. The structuring preselection level is not exited, the error can be corrected (Enter key) or ignored (Exit key). The error message is acknowledged by pressing the Enter key. It then jumps back to the first positioning number marked by nPos in the structuring mode FPos, the error can be corrected.

Digital display	
x (question) position number no.	w (answer) function
1	nPoS
|	Ar1
|	↓
|	Ar6
|	dELt [1)]
|	↓
|	Fu1
|	Fu2
|	inSt [1)]
|	MA1
|	MA2
|	MA3
|	Mi1
|	Mi2
|	Mi3
|	rE1
|	AS1
|	↓
|	AS5
|	Co1
|	Co2
|	nA1
|	nA2
↓	no1
31	no2

1) with Enter function

Table 3-11 Question and answer cycle, structuring mode FPos

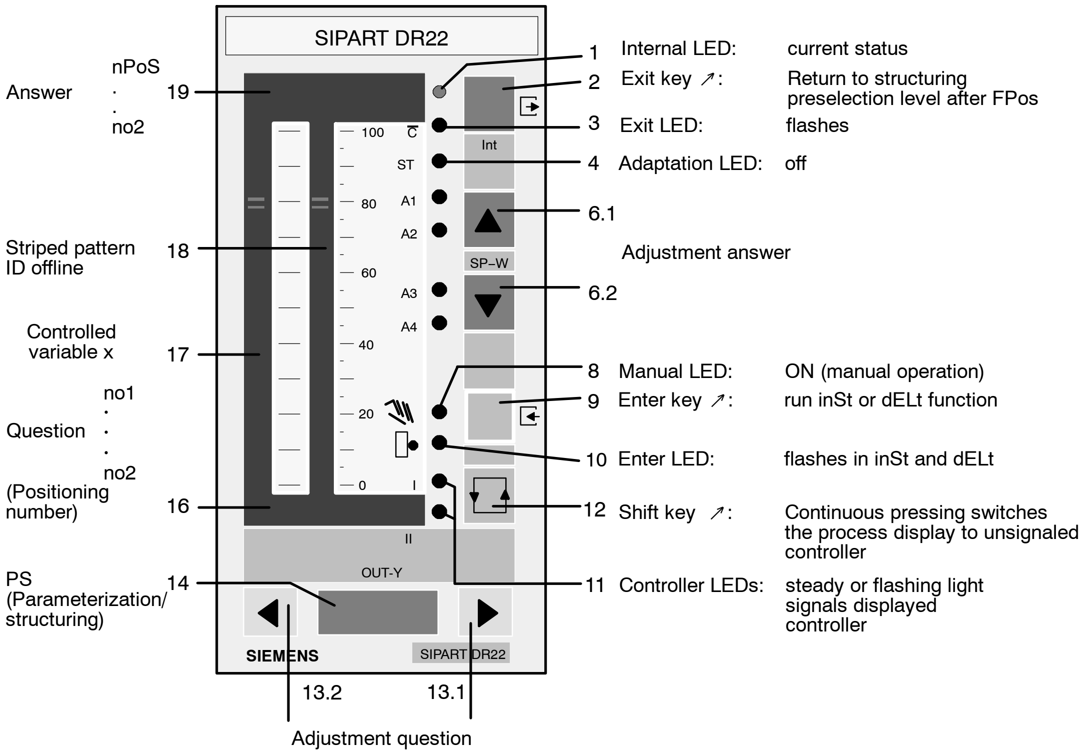
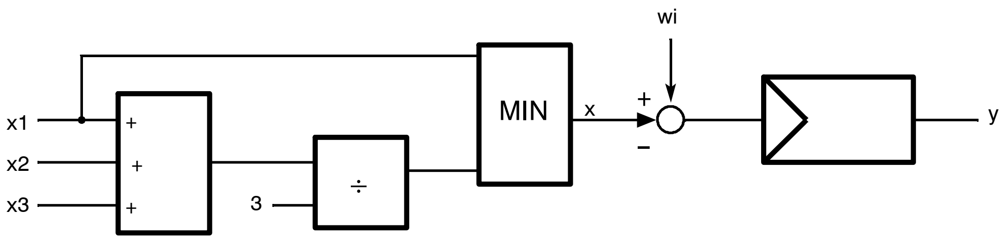


Figure 3-13 Control and display elements in the structuring mode FPoS

Application example for the freely connectable input range

- **Problem**
  Fixed value controller K with averaging of three controlled variables x1 to x3 and limiting of the maximum value to the main controlled variable x1, i.e. if the average value exceeds the main controlled variable this becomes effective.

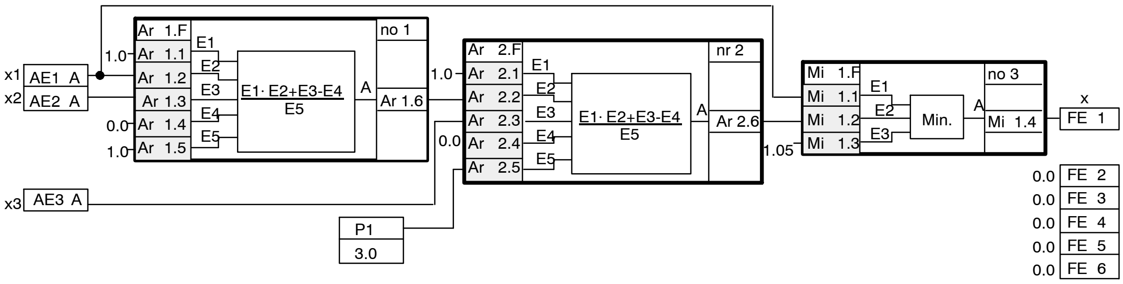


$$x = \frac{x1 + x2 + x3}{3} \quad \text{and } x \leq x1$$

- **Interfaces to the process**
  x1 to x3 as 4 to 20 mA signal via AE1 to AE3
  y as 4 to 20 mA signal via AA4 (y_{hold})
  Power supply 230 V

- **Controller version**
  6DR 2210-5
  and 6DR2802-8A in slot 6

- **Connection diagram**



- **Structurings**
  StrS
  S1 = 11
  S4 = 1
  S5 = 3
  S6 = 3
  S7 = 3
  S23 = 4
  S72 = 1

  rest of structure switches factory setting

FdEF

Question	Answer
Ar1.F	YES
Ar2.F	YES
Mi1.F	YES
Rest	no

FCon

Question	Answer
Ar1.1	1,000
1.2	AE1A
1.3	AE2A
1.4	0,000
1.5	1,000
Ar2.1	1,000
2.2	Ar1.6
2.3	AE3A
2.4	0,000
2.5	P1
FE1	Mi1.4
2	0,000
3	0,000
4	0,000
5	0,000
6	0,000
Mi1.1	AE1.A
1.2	Ar2.6
1.3	1,050

FPos

Question	Answer
no 1	Ar1.F
no 2	Ar2.F
no 3	Mi1.F

oFPA
PAST } depending on task set

- **Parameterizations**
  (onPA)
  P1 = 3,000
  rest of parameters after task set

3.3.10 Structuring mode FPSt (Functions Preset, factory setting)

The structuring mode FPSt only appears when S4 = 1 and serves to reset the freely connectable range to the factory setting. We recommend that you run the Preset function first in the case of extensive changes in the structuring modes FdEF, FCon and FPos.

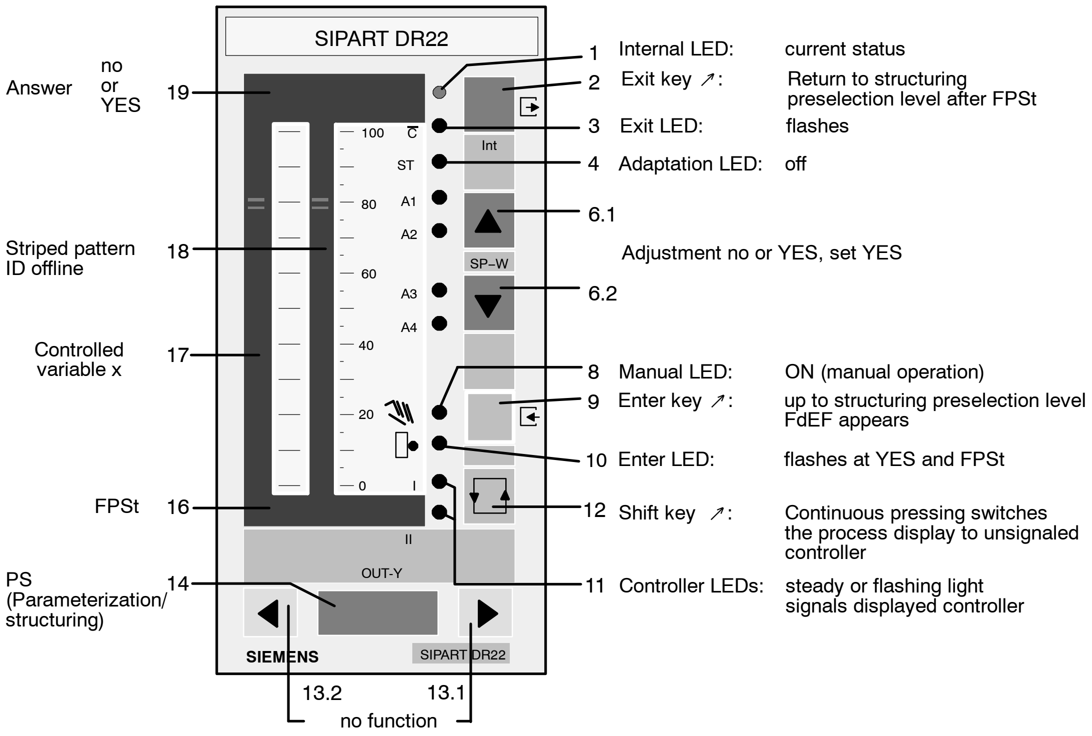


Figure 3-14 Control and display elements in the structuring mode FPSt

After jumping to the structure mode FPSt with the Enter key no FPSt appears. Set YES with +Δw key (6.1) and press the Enter key (9) until the structuring preselection level appears with FdEF. The Preset function is run. Select structuring mode FdEF by pressing the Enter key and make new definitions.

3.3.11 Structuring mode APSt (All Preset, factory setting)

The structuring mode 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.

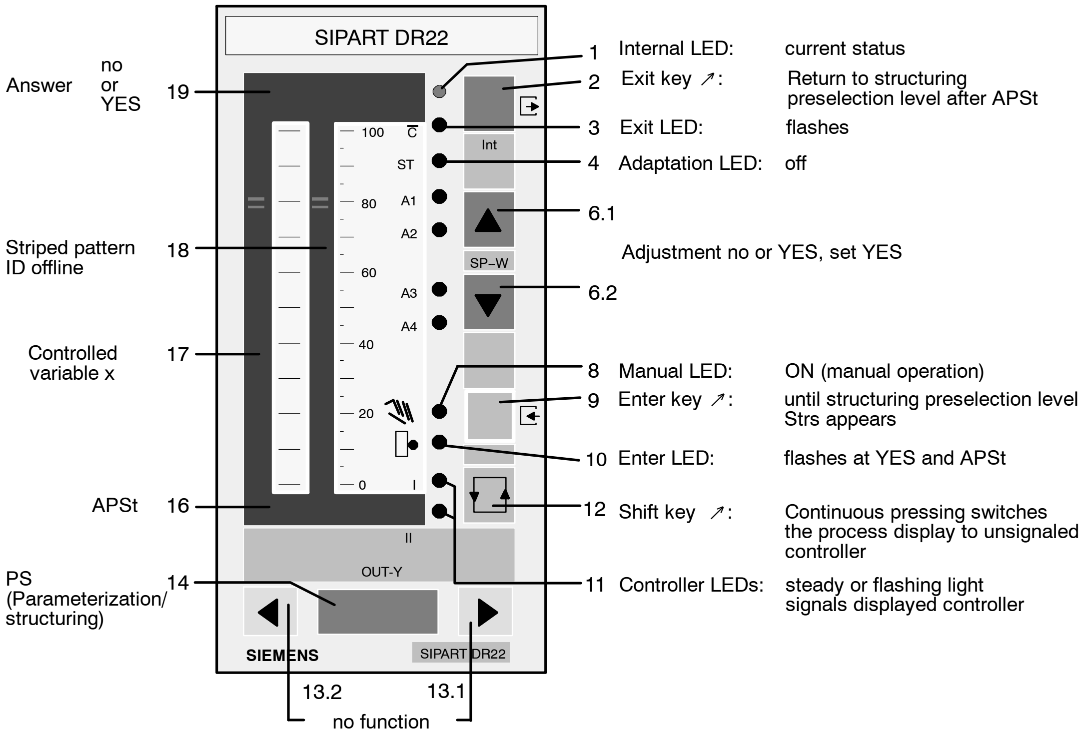


Figure 3-15 Control and display functions in the structuring mode APSt

No APSt appears after jumping to the structuring mode APSt with the Enter key. Set YES with +Δw key (6.1) and press the Enter key (9) until the structuring preselection level appears with StrS. The Preset function is run. Select structuring mode Strs by pressing the Enter key and re-structure the controller.

3.3.12 Set structuring mode CAE4/CAE5 – UNI module(s)

The measuring ranges for the various selectable signal transmitters for slot 2 (AE4) or slot 3 (AE5) can be defined in these menus and fine adjustment performed if necessary.

The CAE4 menu is only offered in the selection level if S8 is set ≥ 4.

The CAE5 module is only offered in the selection level if S9 is set ≥ 4.

When S8 (S9) = 4, 6 the appropriate measuring signal is set to 0 in the event of a broken sensor, when S8 (S9) = 5, 7 it is set to 1.

The following parameters are available in the CAE4/CAE5 menus for setting the measuring range and adjustment:

Display x parameters	Parameter Meaning	Display w Parameter range	Meaning Setting	Factory setting	Display unit	Display/ function only when:
SEnS	Sensor type	Mv. tc.in tc.EH Pt.4L Pt.3L Pt.2L r.– r.‾	Mv signal Thermocouple internal reference point Thermocouple external reference point PT100 4-wire PT100 3-wire PT100 2-wire Resistor < 600 Ω Resistor < 2,8 kΩ	Mv.		
unit	Temperature unit	°C °F °AbS	Degrees Celsius Degrees Fahrenheit Degrees Kelvin	°C		
tc	Thermocouple type	L,J,H,S,b,r,E n,t,U Lin	Type L,J,K,S,B,R,E,N,T,U any type (without linearization)	L		SEnS=tc.in, tc/EH
tb 1)	Temperature reference point	0.0...400.0		50.0	°C, °F, °AbS	SEnS=tc.EH
Mr	Line resistance	0.00...100.00		10.00	ohms	SEnS=Pt.2L
Cr	Calibration line resistance	Difference to Mr			ohms	SEnS=Pt.2L
MP	Decimal point measuring range	_.--- to ----		___.-		
MA 2)	Range start	−1999...19999		0.0	Mv, °C, °F, °AbS	
ME 2)	Range full scale	−1999...19999		100.0	depending on setting SEnS	
CA 3)	Calibration range start	curr. measured value +/− ΔA				
CE 3)	Calibration range full scale	curr. measured value +/− ΔE				
PC 4)	Preset calibration	no,YES,no C				SEnSE!=r._, r.‾

1) If no specified type of thermocouple is selected with tc=Lin, parameter tb in inactive.
2) The set measuring range standardizes the measured value to 0 to 1 for transfer to the connectable range. If the physical operating display of the measuring value is to be made, the assigned display dp,dA,dE must be set accordingly.
3) For SEnS=r._ / r̄. the unit of the CA/CE display is in %.
4) Effect PC for SEnS = Mv., tc.in, tc.EH, Pt.2L, Pt.3L, Pt.4L.
PC=no C is displayed with A=E=0. It is not possible to switch to ”YES” with tA2.
PC=no is displayed by adjusting CA/CE (fine calibration). It is possible to switch to ”YES”.
Fine calibration is reset by pressing the Enter key (3s). (ΔA=ΔE=0, PC=no C).

The corresponding settings of the CAE4(5) menus for the different signal transmitters are described below.

The range and thus the current measured value can be corrected with the parameters CA/CE to compensate tolerances of the transmitters or adjustments with other display instruments.

3.3.12.1 Measuring range for mV (SEnS=Mv.)

- **MA/ME measuring range**

  Call parameters MA, ME, set range start and full scale:
  –175 mV ≤ MA ≤ ME +175 °C

- **CA/CE fine adjustment**

  Call parameter CA:
  Set signal at the low end of the range, correct the display with CA if necessary.

  Call parameter CE:
  Set signal at the top end of the range, correct the display with CE if necessary.

3.3.12.2 Measuring range for U, I (SEnS=Mv.)

- **MA/ME measuring range**

  The setting is made in mV (–175 mV to +175 mV);
  The input signal types U and I are set to range 0/20 to 100 mV in the measuring range plug (6DR2805–8J);

Example:	0 to 10 V or 0 to 20 mA:	MA = 0,	ME = 100;
	2 to 10 V or 4 to 20 mA:	MA = 20,	ME = 100

  Call parameters MA, ME, set range start and full scale.

- **CA/CE fine adjustment**

  Call parameter CA:
  Set signal at the low end of the range, correct the display with CA if necessary.

  Call parameter CE:
  Set signal at the top end of the range, correct the display with CE if necessary.

3.3.12.3 Measuring range for thermocouple with internal reference point (SEnS=tc.in)

- **Set tc thermocouple type**
- **MA/ME measuring range**

  Call parameters MA, ME, set range start and full scale according to the temperature unit (unit).

- **CA/CE fine adjustment**

  Call parameter CA:
  Set signal at the low end of the range, correct the display with CA if necessary.

  Call parameter CE:
  Set signal at the top end of the range, correct the display with CE if necessary.

3.3.12.4 Measuring range for thermocouple with external reference point (SEnS=tc.EH)

- **Set tc thermocouple type**
- **tb-external reference point temperature**

  Set the external reference point temperature with tb. Specify temperature unit with unit.

  Attention: tb has no effect at tc=Lin

- **MA/ME measuring range**

  Call parameters MA, ME, set range start and full scale according to temperature unit (tc).

- **CA/CE fine adjustment**

  Call parameter CA:
  Set signal at the low end of the range, correct the display with CA if necessary.

  Call parameter CE:
  Set signal at the top end of the range, correct the display with CE if necessary.

3.3.12.5 Measuring range for PT100-4-wire and PT100-3-wire connection (SEnS=Pt.3L/PT.4L)

- **MA/ME measuring range**

  Call parameters MA, ME, set range start and full scale:
  -200 °C ≤ MA ≤ ME +850 °C
  Specify temperature unit with Unit.

- **CA/CE fine adjustment**

  Call parameter CA:
  Set signal at the low end of the range, correct the display with CA if necessary.

  Call parameter CE:
  Set signal at the top end of the range, correct the display with CE if necessary.

3.3.12.6 Measuring range for PT100-2-wire connection (SEnS=Pt.2L)

- **MR/CR adjustment of the feed line resistance**

Path 1: The feed line resistance is known.
- Enter the known resistance with parameter MR.
- CR is ignored.

Path 2: The feed line resistance is unknown.
- Short circuit PT100 sensor at the measuring point.
- Call parameter CR and press Enter key until 0.00 Ω is displayed.
- MR displays the measured resistance value.

- **MA/ME measuring range**

Call parameters MA, ME, set range start and end:
-200 °C ≤ MA ≤ ME +850 °C
Specify temperature unit with Unit.

- **CA/CE fine adjustment**

Call parameter CA:
Set signal at the low end of the range, correct the display with CA if necessary.

Call parameter CE:
Set signal at the top end of the range, correct the display with CE if necessary.

3.3.12.7 Measuring range for resistance potentiometer (SEnS=r._ for R < 600 Ω, SEnS=r.¯ for R< 2.8 kΩ)

Path 1: The start and end values of the R-potentiometer are known.
- Call parameters **MA, ME**, set range start and full scale:
  0 Ω ≤ MA ≤ ME 600 Ω/2.8 kΩ
- Parameters **CA/CE** display at R=MA 0 %, at R=ME 100 %.

Path 2: The start and full range value of the R-potentiometer are unknown.
- Call parameter **CA** :
  Move final control element to position 0%, press Enter until 0.0 % is displayed.
- Call parameter **CE** :
  Move final control element to position 100 %, press Enter until 100.0 % is displayed.
- Parameters **MA/ME** show the appropriate resistance values.
- **MP** must be set so that there is no 'exceeding of the range' (display: oFL)

4 Commissioning

4.1 Adapting the controller direction of effect to the controlled system

- **Definitions**

Normal effect system

Increasing y causes increasing x; e.g. increasing energy supply or increasing mass flow causes increasing temperature.

Normal effect final control element (valve):

Increasing current or actuating command +Δy cause actuator to open (increasing y); e.g. a greater energy supply or greater mass flow. y_{An} is the displayed manipulated variable.

In cascade controls the folow–up controller for observing the direction of effect of the master controller is considered part of the controlled system.

The direction of effect of the controller is referenced to the main controlled variables FE1 and FE3. The following statements apply for normal effect transmitters (increasing physical variable causes increasing transmitter current), increasing process display (dE* > dA*) and no reservation in the freely connectable range or no falling characteristic in linearization in the fixed connected range.

- **Direction of effect of system and actuator known**

K controller

The following is prescribed:			Select the desired effect here:				This gives settings of S54 or S56 and S68 and function 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 currently	valve	actual value/ controlled variable	S54 or S56	Kp (cP)	S68	y_{An} =
normal	normal	normal	100 %	rises	opens	rises	0	pos.	0	y
	reversing	reversing	0 %	falls	opens	rises	1	neg.	1	100 % - y
reversing	normal	reversing	0 %	falls	closes	rises	1	neg.	1	100 % - y
			100 %	rises	opens	falls	1	neg.	0	y
	reversing	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 4-1 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 settings of S54 or S56 and S68 and function 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	S54 or S56	Kp (cP)	S68	y_{An} =
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 4-2 Controller direction of effect and y-display direction of effect of system and actuator direction of effect in S-controllers

- **Direction of effect of system and actuator unknown**

  Put controller in manual mode, leave structure switches S54, S56 and S68 in factory setting (0).

  – **Determine direction of effect of the actuator**

  Press the right manipulated variable adjusting key if possible with the process switched off or near 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 monitored as follows:

  – normal effect system: rising x means normal effect actuator
  – reversing member: falling x means normal effect 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**

  Actuate the right manipulated variable 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 4-1, page 215 and table 4-2.

– **Note for cascade control**

In cascade controllers first the direction of effect of the follow–up controller is determined and set as described above if necessary. Then the direction of effect of the master controller is adapted to the system. This is done as described above. It must be noted that the follow–up controller has been switched to internal operation because manual adjustment of the master controller is performed by adjusting the setpoint of the follow–up controller. The display should be switched to the master controller with the Shift key (12) to observe the main manipulated variable.

4.2 Setting the split range outputs and the actuating time in K-controllers (S2 = 0)

- **Split range outputs Y1, Y2**

In split range operation the two partial manipulated variables must be adapted to the control range of the individual final control elements with the slope setting so that as constant a system amplification Ks as possible is achieved over the whole setting range.

Determine the system line amplifications in the partial setting ranges in manual operation.

$$Ks1 = \frac{\Delta x}{\Delta y1} \quad \text{and} \quad Ks2 = \frac{\Delta x}{\Delta y2}$$

Then set *Y1* and *Y2* so that

at S65 = 0 rising – falling

$$\frac{100\,\% - Y1}{Y2} = \frac{Ks1}{Ks2}$$

at S65 = 1 rising – rising

$$\frac{Y1}{100\,\% - Y2} = \frac{Ks1}{Ks2}$$

- **Floating time tY**

At S62 = 0: set tY to the floating time of the following actuating drive. If the control circuit is to be calmed additionally, e.g. to avoid hard impact on the actuating drive, tY can be further increased in Automatic operation.

At S62 = 1: set tY to the desired floating time for the incremental follow-up variable.

4.3 Adaptation of the S-controller to the actuating drive

- **S-controller with internal feedback (S2 = 1)**

The floating time of the actuating drive is set with the online parameter tY (1 to 1000 s); **Attention:**the factory setting is oFF !

The online parameter tE should be selected at least great enough that the actuating drive starts moving reliably under consideration of the power switches connected before it. The greater the value of tE, the more resistant to wear and more gentle 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 is 200 ms for tE. This corresponds to a y resolution in a 60 s actuating drive of:

$$\Delta y = \frac{100\ \% \cdot tE}{tY} = \frac{100\ \% \cdot 200\ ms}{60\ s} = 0.33\ \%$$

The minimum possible resolution is transposed with the system line amplification Ks to the controlled variable:

$$\Delta x = K_s \cdot \Delta y$$

The parameter tA (minimum turn-off time) should be chosen at least great enough that the actuating drive is safely disconnected under consideration of the power switches connected before it before a new pulse appears (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.

According to the set tE and the resulting Δy or Δx, the response threshold AH I must be set or for the controller II AH II. The following condition must be satisfied:

$$AH\ I \text{ or } AH\ II > \frac{\Delta x}{2} \quad \text{or} AH\ I \text{ or } AH\ II > \frac{Ks \cdot tE \cdot 100\ \%}{2 \cdot ty}$$

Otherwise the controller outputs positioning increments although the control deviation has reached the smallest possible value due to the finite resolution. For setting of AHI or AHII see chapter 4.4, page 219.

- **S-controller with external feedback (S2 = 2)**

The position control circuit is optimized with the online parameter tY. 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 tY and the resulting response thresholds smaller than in the S-controller with internal position feedback for the above mentioned reasons.

The position control circuit is optimized in manual mode. To do this, S67 is set to 0 for the optimizing phase so that the manual manipulated variable is preset as an absolute value. It must be noted that the active manipulated variable trails the manipulated variable display due to the floating time of the actuator.

In the case of non-linearity in the position control circuit, the optimization must take place in the range of greatest slope.

- Set S67 to 0
- Set tA and tE so that the actuating drive can **just** process the actuating increments (see S-controller with internal feedback).
- Set 1st order filter of the y_R-input (tF1, 2, 3, 4 or 5) to 0.01 Ty (real floating time of the drive).
- Increase tY until the position control circuit overshoots due to small manual changes in the manipulated variable (observe opposite pulse on the Δy-LEDs (15) in the y-display).
- Reduce tY slightly again until the position control circuit is calm.
- Reset S67 to 2.

4.4 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 (tF1 to tFb) for the input filters are set in the onPA parameterization mode and to the greatest possible value permitted by the control circuit without affecting the controlability (tF1 to tFb $<$ 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 sets itself automatically and its size is therefore unknown, the time tFI or tFII (onPA) can only be selected so great that the control circuit cannot oscillate in the case of a large dead zone (tFI or tFII 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.

  When using the adaptation method the filters **must** be set.

- **Optimization of the response threshold AH**

  If the controller output is to be calmed or the load on the actuator reduced additionally, the response threshold AHI can be increased for controller I or AHII for controller II. The response threshold AH is given in S-controllers by the setting of tE (see chapter 4.3, page 218) and must be greater than zero. A response threshold of approx. 0.5 % is recommendable for K-controllers.

  It must be taken into account that the remaining control error can assume the value of the set response threshold.

4.5 Automatic setting of control parameters by the adaptation method

The adaptation method should always be preferred to manual settings because the control results with the parameters gained from adaptation are better especially in slow controlled systems and this saves optimization time.

- **Presetting**

  - **S58 selecting the control behavior (structuring mode Strs)**

    No adaptation is possible when S58 = 0. In position 1 a control behavior without overshoot is offered. In position 2 changes in the command variables can be expected with a maximum 5 % overshoot.

  - **tU: Monitoring time (parameterization mode AdAP)**

    tU is necessary for error messages only and has no influence on the identification quality. tU must be set at least double the transient recovery time T_{95} of the controlled system. If you have little knowledge of the controlled system, use tU = oFF (factory setting) for adapting. After successful adaptation tU is automatically set to $2T_{95}$.
    At tU $<$ 0.1 h (6 min) tU = oFF is displayed.

  - **dPv: Direction of the step command (parameterization mode AdAP)**

    The direction of the controlled variable change from the set operating point is selected with this configuring switch: $x_{manual} \pm \Delta x = \pm ks$ ($y_{manual} \pm \Delta y$). In controlled systems with batches it is recommendable to perform one adaptation with rising x and one with falling x. The averaged or dynamically more uncritical parameters can then be used for the control.

  - **dy: Amplitude of the step command (parameterization mode AdAP)**

    The step command must be selected so great that the controlled variable changes by at least 4 % and the controlled variable change must be 5 times the average noise level. The greater the controlled variable change, the better the identification quality. Controlled variable changes of approx. 10 % are recommended.

- **Notes on certain types of control for pre-adaptation**

  - **Cascade control**

    Double controllers are always adapted to the controller selected by the Shift key (12). In cascade controls the sequence controller is adapted first in manual operation by selecting the controller I with the Shift key (12). We recommend you to use the controller version without overshoot (S58=1) so that the command behavior is uncritical. Then the master controller is adapted in internal and automatic mode of the follow-up controller. To do this, switch the folow-up controller to Internal on selecting the controller I (corresponds to manual operation of the master controller) and switch over to automatic operation, set the desired operating point by changing the setpoint if necessary. Then switch over to controller II (master controller) with the Shift key and start adaptation. The setpoint step of the follow-up controller is invisible for system identification.

– **Ratio-cascade control**

When adapting the master controller in ratio cascades, the master process variable should not fluctuate too greatly otherwise additional changes in this controlled variable may occur at a constant ratio factor (v±Δv) due to the control dynamic of the ratio controller (follow-up controller) and non-linearities between the ratio factor and the controlled variable of the master controller. These additional changes in the controlled variable would falsify the adaptation result because only changes by the ratio factor are to be measured.

– **Override controls**

When selecting the operating point in override controls (including the Δy-step for the adaptation) it must be ensured that the limiting setpoint is not exceeded in adaptation of the limiting controller and the main controller.
If the desired operating point cannot be attained due to the operating state of the system, the adaptation must be made at a level which comes closest to the later operating state.

In the example explained in chapter 1.5.4.9, page 77, (core temperature control with casing temperature limiting) the maximum permissible casing temperature cannot be reached in adaptation of the limiting controller if the cooling water flow is not interrupted. Therefore adaptation must take place at a low level without exceeding the maximum permissible core temperature. In the other case, if the cooling water is switched off or fails, the maximum permissible casing temperature is exceeded, when adapted to the normal core temperature. In this case adaptation must take place at a low core temperature.

– **Non-linear controlled systems**

In non-linear controlled systems several adaptations should be made at different load states. The adaptation results and the (previously selected with S60) controlling variable SG must be noted. The controlling variable is also read off in the parameterization mode AdAP in the range from 0 to 100 %. The parameter sets determined in this way, related to the controlling variable SG, are then entered in the structuring mode PASt (if necessary with interpolation). In this way ideal controller results can be achieved even on non-linear controlled systems.

- **Notes on the adaptation results**

– **D-part**

In S-controllers and K-controllers on controlled systems of 1st order the D part brings no noticeable advantages due to the finite actuating time ty or for reasons founded in the control theory. The disadvantages in the form of wear on the positioning side dominate.

– **Range limits**

If one of the determined parameters reaches its range limits, the other parameter should be adjusted slightly in the opposite direction of action.
If systems of the 8th order are identified the determined Kp must be reduced for safety reasons and if the control circuit is too slow (uncritical), then re-increased in manual optimization.

– **kp variation**

In the special cases, controlled system of the 1st order in connection with Pi and PiD controllers and controlled systems of 2nd order in connection with PiD controllers, the kp can be varied freely. In controller design according to the amount optimum, Kp can be increased up to 30 % as a rule without the control behavior becoming critical.

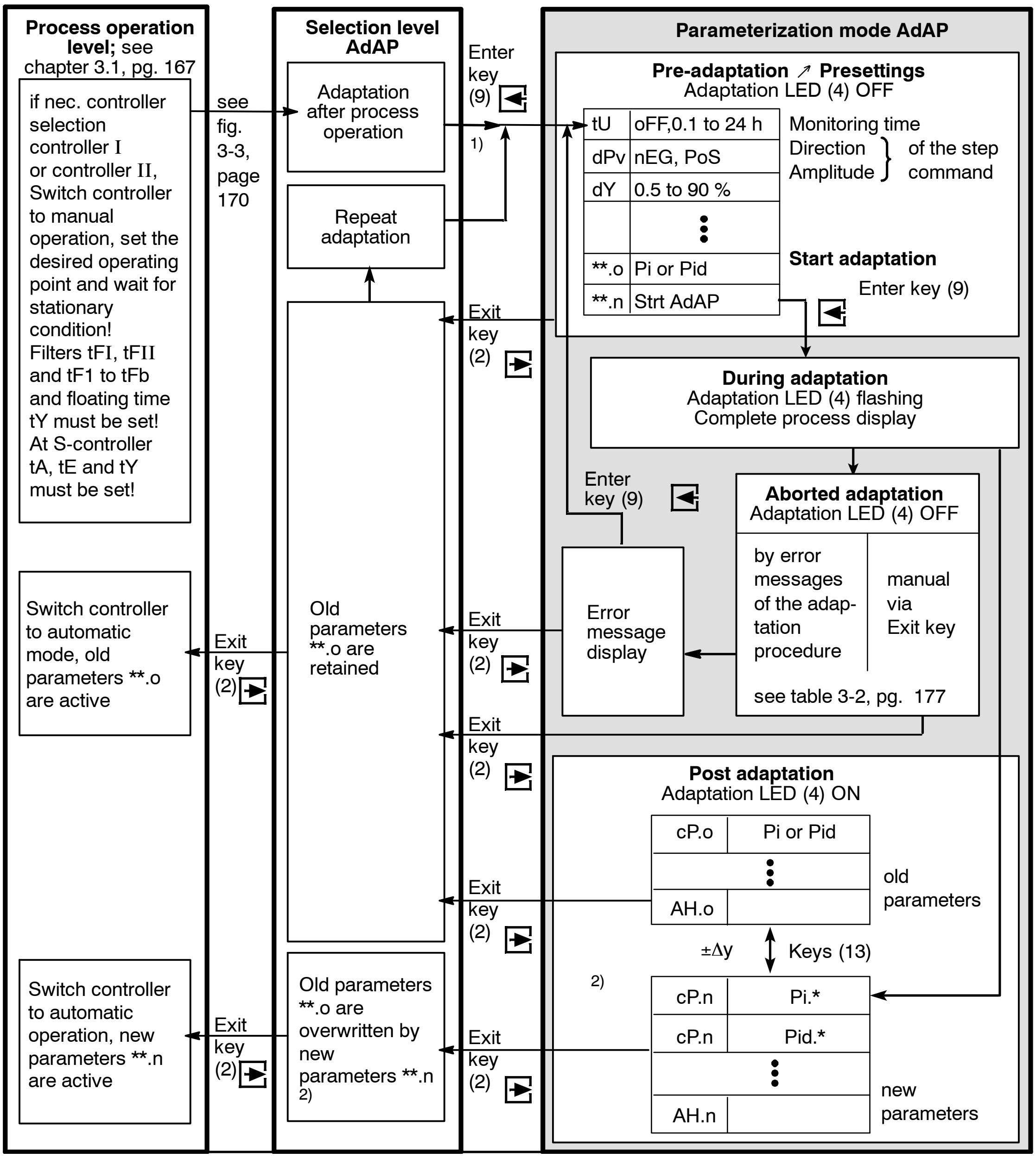


Figure 4-1 Parameterization mode AdAP

* loop order 1 to 8
** Parameter name
1) Enter function only active in manual operation (in the case of adaptation of the master controller in cascades (S1 = 5/6) master controller set to Internal and Automatic)
2) Error message no AUto
If new parameters are selected and there is parameter control, the flashing error message no AUto appears after pressing the Exit key (no automatic transfer).

Press the Enter key:	Error is acknowledged; return to parameterization mode AdAP; the parameters gained from the adaptation can be noted.
Pressing the Exit key:	Jump to the parameterization preselection mode AdAP; the new parameters **.n are deleted. On jumping to the parameterization mode AdAP, Strt AdAP appears in **.n.

4.6 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 loop stable in any case, the following factory settings must be made (the values apply for both parameter sets):

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 working point can also be entered manually by setting the online parameter Yo 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 entered manually by setting the online parameter Yo 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.

4.7 Manual setting of the control parameters after the transient 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 mode" position of the controller by a sudden change in the manipulated variable and the course of the controlled variable registered with a recorder. This will roughly give a transient function corresponding to 4-2.
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 $Kp \approx 0.8 \cdot \frac{Tg}{Tu \cdot Ks}$

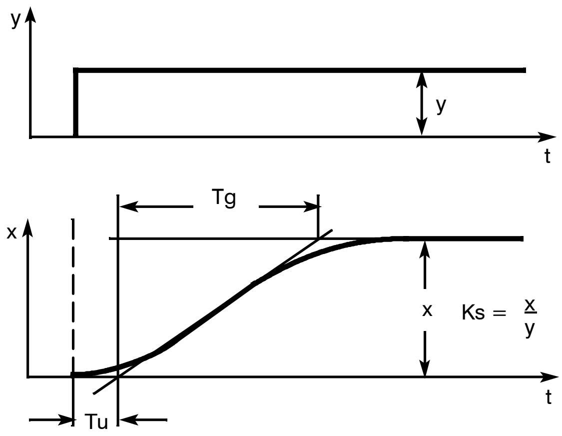
Integral action time $Tn \approx 3 \cdot Tu$

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	Command variable
x	Controlled variable
t	Time
Tu	Delay time
Tg	Compensation time
Ks	Transmission factor of the controlled system

Figure 4-2 Transient function of a controlled system with compensation

5 Maintenance

5.1 General information and handling

The controller is maintenance-free. White spirit or industrial alcohol is recommended for cleaning the front foil and the plastic casing if necessary.

In the event of an error the modules

- Front module
- Main board
- Option modules

may be changed freely without readjustment with power supplied.

ATTENTION

All modules contain components which are vulnerable to static. Observe the usual safety precautions!

To maintain the current for the controller manipulated variable of the K-controller, use the y_{hold}-module (see chapter 1.4.2, page 13). Final control elements on S-controllers remain in their last position.

WARNING

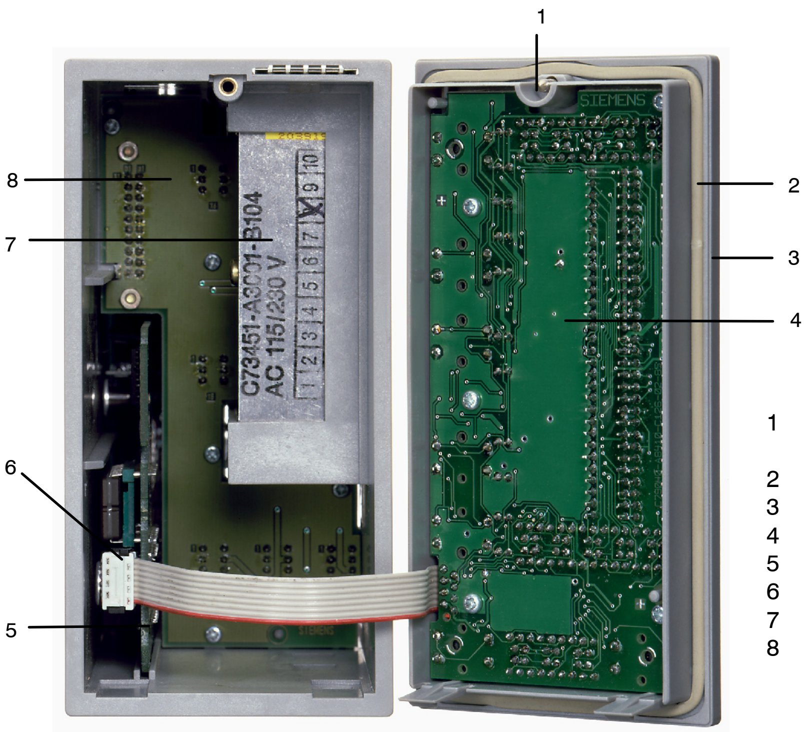
The power supply unit and the interface relay may only be changed when the power supply has been safely disconnected!

WARNING

Modules may only be repaired in an authorized workshop. This applies in particular for the power supply unit and the interface relay due to the safety functions (isolation and functional extra-low voltages).

1 Fixing screw for the front module

Figure 5-1 Front module with rating plate and cover removed



1 Fixing screw (shaft screw)
2 Sealing ring
3 Front panel
4 Front board
5 Main board
6 Plug Ribbon cable
7 Power supply unit
8 Connection plate

Figure 5-2 Controller with front module open

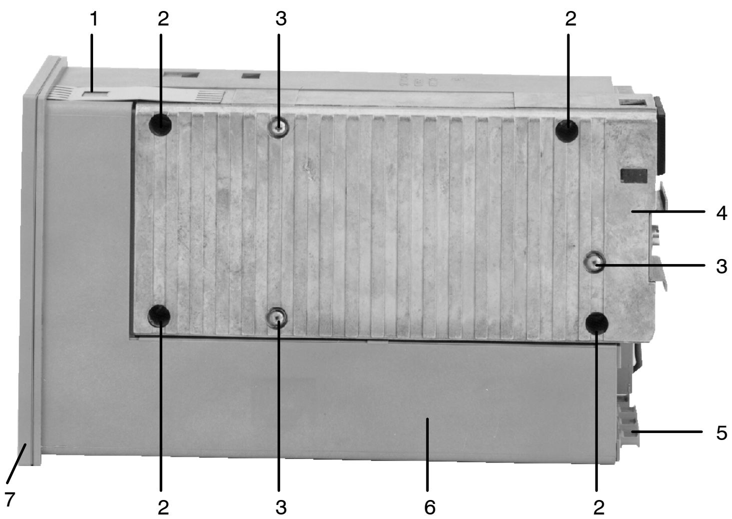
- **Replacing the front module**
  - Carefully lever out the label cover with a screwdriver at the cutout at the top and snap the cover out of the bottom hinge points by bending slightly.
  - Loosen screw (captive) (see (1) Figure 5-1).
  - Tip the front module at the screw head and pull out to the front angled slightly until the plug of the ribbon cable is accessible.
  - Pull off the plug from the ribbon cable (see (6) Figure 5-2).
  - Install in reverse order. Make sure the seal is positioned perfectly!

- **Replacing the customer foil**

  The customer foil should be pulled out from underneath the front panel with tweezers. It is labelled with the most important display and control symbols and the scale 0 to 100 %.

- **Replacing the main board and option module**
  - Pull off the plug terminal.
  - Release the lock and pull out the module.
    Attention:
    Remove the front module from the main board first (connection cable!)
  - Push in the new module as far as it will go and lock it (the modules are slot-coded but make sure the right modules are plugged into the slots provided for different options).
  - Plug in the terminal (pay attention to slot labeling!),

- **Replacing the power supply unit**
  - Pull out the mains plug!
  - Loosen the clamps and remove the controller from the panel.
  - Loosen the four fixing screws of the power supply unit (see (2) Figure 5-3) (**not** the 3 plated Phillips screws (3) Figure 5-3) and pull out the power supply unit in screw direction.
  - Bend the PE conductor contact spring slightly upwards and place the new power supply unit carefully on the plug terminals in screw direction and make sure the guide lugs snap in by moving slightly from side to side (it can no longer be moved from side to side when it has snapped in).
  - Tighten the four fixing screws diagonally.



1 PE conductor contact spring
2 fixing screws for the power supply unit (shaft screw)
3 Plated Phillips screws for fixing the power supply circuit board in the casing
4 Power supply unit
5 Blanking plate
6 Plastic housing
7 Front module

Figure 5-3 Fixing the power supply unit

- **LED test and software state**

If the Shift key (12) 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 turn on, the digital displays indicate ”18.8.8.8” or ”•88.8.” and a light bar covering three LEDs runs from 0 to 100 % (on reaching 100 %, the light bar starts again at 0 %).

If the Internal/External key (2) is pressed permanently in addition during the lamp test, ”dr22” appears on the digital w-display ”dr22”, the software state of the device appears on the digital x-display and the current cycle time in ms appears on the y-display.

During the LED test and display of the software state the controller continues to operate online in its last operating mode.

5.2 Spare parts list

Item	Figure	Description	Comments	Order number
1		**Front module**		
1.1	(7) Figure 5-3	Front module complete	without rating plate label	C73451-A3001-D41
1.2	—	Front panel with foil		C73451-A3001-B40
1.3	—	Front circuit board		-D31
1.4	(4) Figure 5-2	Screw SN 62217-B2,6×6-St-A3G	Order 5 pieces	H62217-B2506-Z1
1.5	(2) Figure 5-2	Seal		C73451-A3000-C31
1.6	(1) Figure 5-2	Shaft screw M3 SHR 3×10 5.8 A3G		D7964-L9010-S3
1.7	—	Rating plate cover		C73451-A3001 -C5
1.8	—	Rating plate labels		-C16
1.9	—	Customer foil		-C43
2		**Enclosure**		
2.1	(6) Figure 5-3	Plastic housing		C73451-A3001-C3
2.2	(5) Figure 5-3	Blanking plates for unused slots		-A3000-C11
2.3	(1) Figure 5-3	PE conductor contact spring		-A3001-C8
2.4	—	Connection platen		-A3001-C25
2.5	—	Clamps	Order 2 pieces	-A3000-B20
2.6		Self-adhesive sealing rings (front frame/panel) for SIPART DR20/21/22/24	Order 10 pieces	C73451-A3000-C41
3		**Power supply unit**		
3.1	(4) Figure 5-3	Power supply unit 24 V UC	without mains plug and fixing screws	C73451-A3001-B105
3.2	(4) Figure 5-3	Power supply unit 115/230 V AC		-B104
3.3	—	Mains plug 3-pin plug for 115/230 V AC		C73334-Z343-C3
3.4	—	IEC-320/V, DIN 49457A Special 2-pin plug for 24 V UC		C73334-Z343-C6
3.5	(2) Figure 5–3	Shaft screw M4 SHR 4×16 KC-SP	Order 4 pieces	D7964-P8016-R
4		**Main board**		
4.1	(5) Figure 5-2	Main board complete		C73451-A3001-D43
4.2	—	14-pin plug		W73078-B1001-A714
4.3	—	10-pin plug		W73078-B1001-A710
5	—	**Options**	see chapter 6, Ordering Data	
5.1	—	4-pin terminal for 6DR2800-8I/8R/8P		W73078-B1001-A904
5.2	—	5-pin terminal for 6DR2801-8A/8B/8C and 6DR2802-8A		W73078-B1001-A705
5.3	—	6-pin terminal for 6DR2801-8D and 6DR2800-8A		W73078-B1001-A906
5.4	—	3-pin terminal for 6DR2804-8A/8B 6-pin terminal for 6DR2804-8A/8B		W73078-B1001-A703 -A706
5.6	—	Jumpering plug for 6DR2800-8J/8R and main board C73451-A3001-D43		W73077-B2604-U2

- **Ordering information**

  The order must contain:

  - Quantity
  - Order number
  - Description

  For safety reasons, we recommend that you also specify the instrument type in your order.

- **Ordering example**

  2 units W73078-B1001-A714
  Plug 14pin main board DR22

6 Ordering data

SIPART DR22, standard controller with

3 analog inputs 0/4 to 20 mA or 0/0.2 to 1 V or 0/2 to 10 V
3 analog outputs 0/4 to 20 mA
4 digital outputs 24 V
8 digital outputs 24 V

for power supply UC 24 V . . . . 6DR2210−4
for switchable power supply AC 115/230 V . . . . 6DR2210−5
Analog input module with 3AE for 0/4...20 mA or 0/0.2...1 V or 0/2...10 V 6DR2800-8A
Analog input module with 1AE for 0/4...20 mA or 0/0.2...1 V or 0/2...10 V 6DR2800-8J
Analog input module with 1 AE for resistance potentiometer . . . . 6DR2800−8R
UNI module 6DR2800-8V
Digital input module with 5 BE 24 V 6DR2801-8C
Digital output module with 2 BA relays (UC 35 V) 6DR2801-8D
Digital output module with 4 BA 24 V and 2 BI 6DR2801-8E
Analog output module with 1 AA (y_{HOLD}) 6DR2802-8A
Analog output module with 3 AA and 3 BE 6DR2802-8B
Interface relay module with 2 relays (AC 250 V) 6DR2804-8B
Interface relay module with 4 relays (AC 250 V) 6DR2804-8A
Interface module for V.28 end-to-end (RS 232/RS 485) 6DR2803-8C
Interface module PROFIBUS DP 6DR2803-8P

Plug for the serial interface and bus driver
9-pin D-plug for round cable (screw terminal) C73451-A347-D39
Bus plug for Profibus DP . . . . see catalog IK PI
User’s guide SIPART DR22 English C79000-G7476-C154
User’s guide SIPART DR22 German C79000-G7400-C154

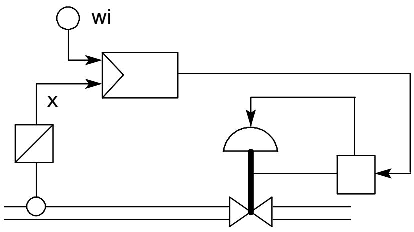
7 Application examples for configuring the controller

Example 1

Fixed setpoint controller with K-output
controlled variable via four–wire transmitter

Block diagram control circuit

The controlled variable x from a four–wire transmitter goes to the analog input AE1, signal range 4 to 20 mA.
The manipulated variable y with 4 to 20 mA goes through AA1 to a position controller SIPART PS.

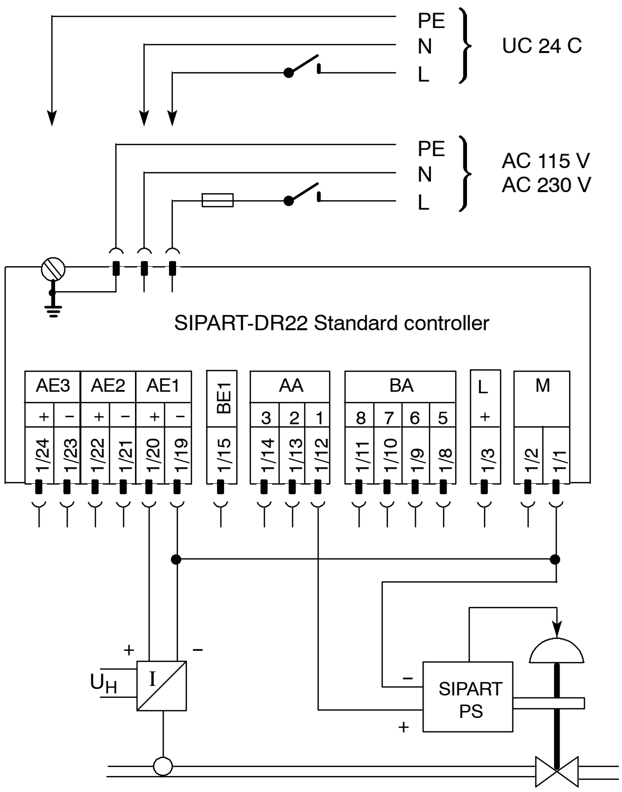


Structure switch Strs		
Switch	Value	Meaning
S 5	2	AE1: 4 to 20 mA
S 69	1	AA1: 4 to 20 mA

Parameter oFPA		
Para-meters	Value	Meaning
dP1	*)	Decimal point
dA1	*)	Display start value
dE1	*)	Display full scale value

Parameter onPA		
Para-meter	Value	Meaning
cP1	*)	Proportional action factor
tn1	*)	Integral action time

*) Setting as required



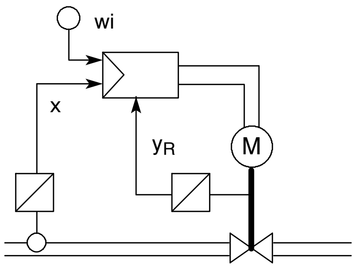
Attention:

- All settings starting from the factory setting (APSt) of the controller
- The above settings/adaptations are absolutely essential.
  Other parameters (e.g. A1 / A2 / ...) as required.

Example 2

Fixed setpoint controller with S-output, internal feedback.
controlled variable via four-wire transmitter
position feedback y_R via two-wire transmitter

Block diagram control circuit



The controlled variable x from a four–wire transmitter goes to the analog input AE1, signal range 4 to 20 mA.
The manipulated variable is switched from the digital outputs via external coupling relays to the actuating drive.
4 to 20 mA are available ar AE2 as a position feedback (only for display on the controller)(position feedback potentiometer with two-wire connection).
The actuating drive has a runtime of 60 s (for 0 to 100 % deviation).

Alarms: A1: xd ±5 %, Max. Output to BA1
A2: x 70 %, Max. Output to BA2

Note: The outputs of the S–controller are permanently assigned to the digital outputs BA7 (+Δy)/BA8 (–Δy)

Structure switch Strs		
Switch	Value	Meaning
S 2	1	S-controller internal
S 5	2	AE1: 4 to 20 mA
S 6	2	AE2: 4 to 20 mA
S 19	2	y_R (FE6) to AE2
S 67	2	Display y_R

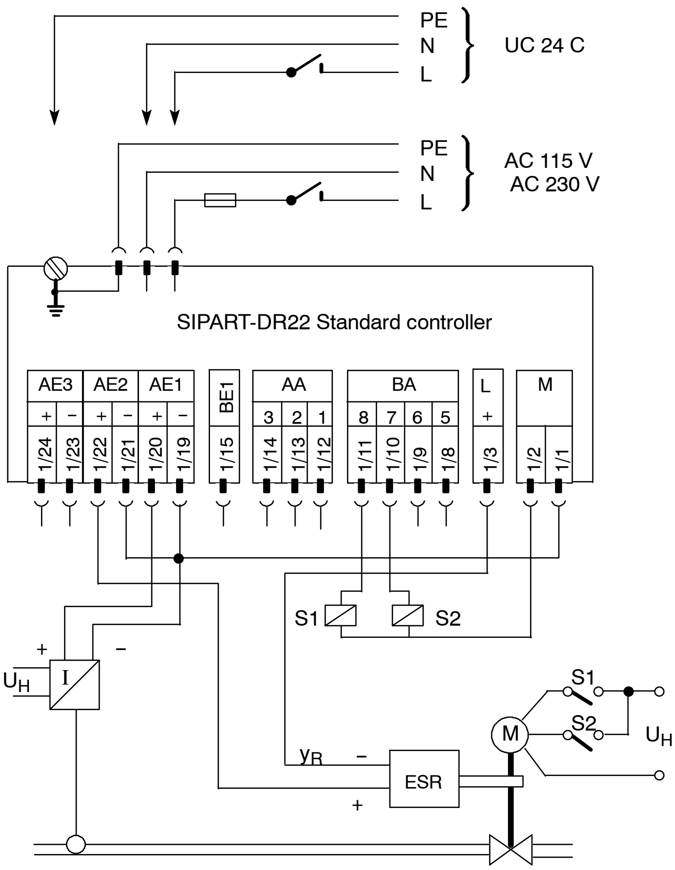
Structure switch for the alarm settings:

S 76	0	Release for BA1
S 77	0	Release for BA2
S 80	1	A1 to BA1
S 81	2	A2 to BA2
S 94	38	A1 to |xd|
S 96	2	A1 max / A2 max
S 267	1	A2 to x

Parameter oFPA		
Para-meters	Value	Meaning
dP1	*)	Decimal point
dA1	*)	Display start value
dE1	*)	Display full scale value
A1	5	Display full scale value
A2	70	Limit value |xd|

Parameter onPA		
para-meters	Value	Meaning
Cp1	*)	Proport. action factor 1
tn1	*)	Integral action time 1
AH1	**0.5**	**Response threshold**
tY1	**60 s**	**Runtime Drive**
tA1	200	Factory setting
tA1	200	Factory setting

*) Setting as required



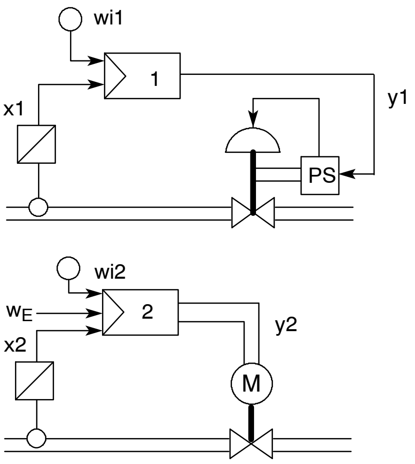
Attention:

– All settings starting from the factory setting (APSt) of the controller
– The above settings/adaptations are absolutely essential. Other parameters as required.

Example 3

SIPART DR22 with two independent control circuits
Control circuit 1: Fixed setpoint controller with K-output
Control circuit 2: Fixed setpoint controller with S-output, internal feedback

Block diagram control circuit



Controller 1: Control circuit x1 via the analog input AE1 (4 to 20 mA) from a two–wire transmitter. Manipulated variable y1 via AA1 (4 to 20 mA) to a position controller SIPART PS.

Controller 2: Controlled variable XII via the analog input AE3 (4 to 20 mA) from a two-wire transmitter. Setpoint wII via AE2 from an external sensor (4 to 20mA). Follow-up of wiII to w_EII. With switching "internal/ external" via the opeating level. Manipulated variable yII via BA to an actuating drive.

Alarms:

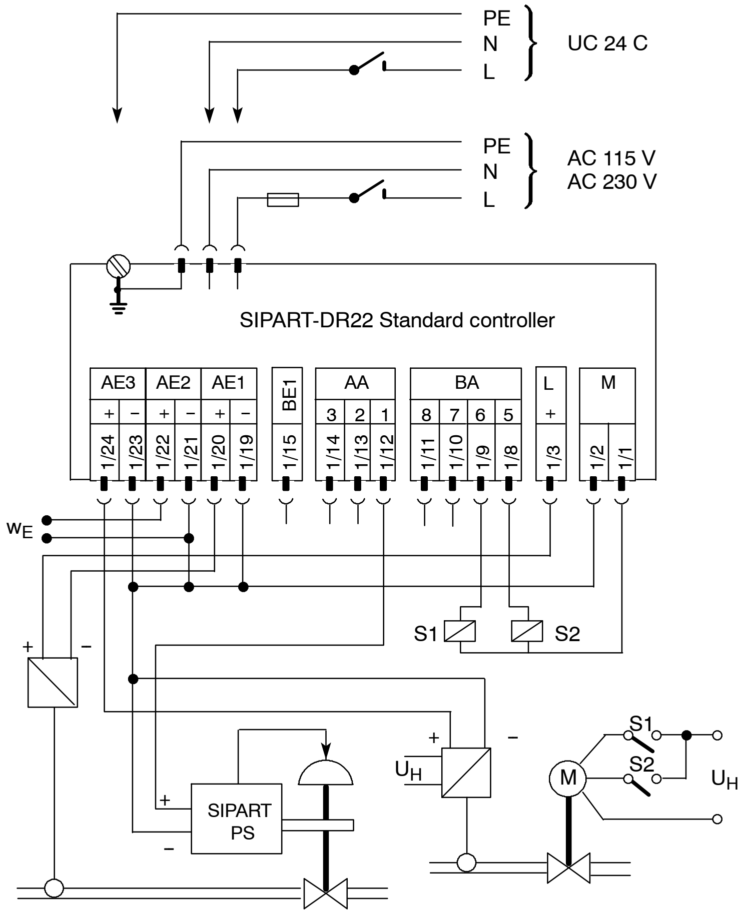
A1:	xd1	± 5 %,	Max.	Output to BA1
A2:	x1	80 %,	Max.	Output to BA2
A3:	xd2	± 5 %,	Max.	Output to BA3
A4:	x2	70 %,	Max.	Output to BA4

Note: The outputs of the S-controller are permanently assigned to the digital outputs BA5 (+Δy)/BA6 (–Δy). (structure switch S231)

Structure switch Strs		
Switch	Value	Meaning
S 1	12	Double controller
S 5	2	AE1: 4 to 20 mA
S 6	2	AE2: 4 to 20 mA
S 7	3	AE3: 4 to 20 mA
S 17	3	x2 to AE3A
S 69	1	AA1: 4 to 20 mA
S 213	2	w_EII to AE2A
S 226	–1	w_{SL}II=high
S 231	1	S-controller internal
S 232	2	Switching setpoint 2
S 243	off	none y_R-display

Structure switch for the alarm settings:

S 76	0	Release for BA1
S 77	0	Release for BA2
S 78	0	Release for BA3
S 79	0	Release for BA4
S 80	1	A1 to BA1
S 81	2	A2 to BA2
S 82	3	A3 to BA3
S 83	4	A4 to BA4
S 94	38	A1 to |xd1|
S 95	39	A4 to |xd2|
S 96	2	A1 max / A2 max
S 97	2	A3 max / A4 max
S 267	1	A2 to x1
S 268	6	A4 to x2



Parameter oFPA		
Para-meters	Value	Meaning
dP1	*)	Decimal point 1
dA1	*)	Display start value 1
dE1	*)	Display full scale value 1
dP2	*)	Decimal point 2
dA2	*)	Display start value 2
dE2	*)	Display full scale value 2
A1	5	Limit value |xd1|
A2	70	Limit value to x1
A3	5	Limit value |xd2|
A4	60	Limit value to x2

Parameter onPA		
Para-meters	Value	Meaning
cP1	*)	Proportional action factor 1
tn1	*)	Integral action time 1
cP2	*)	Proportional action factor 2
tn2	*)	Integral action time 2
AHII	0.5	Response threshold 2
tYII	60 s	Runtime Drive
tAII	200	Factory setting
tAII	200	Factory setting

*) Setting as required

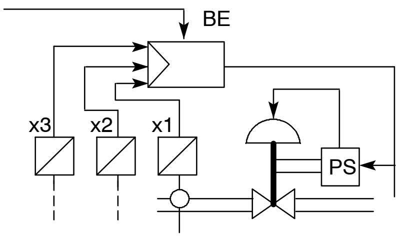
Attention:

- All settings starting from the factory setting (APSt) of the controller
- The above settings/adaptations are absolutely essential. Other parameters as required.

Example 4
Input range freely connected

Fixed setpointe controller with K-output
The active controlled variable x is selected from three inputs:
- switching between x1 and x2 via digital outputs
- max-selection between X1/x2 and x3

Block diagram control circuit



The controlled variable x1 / x2 / x3 of four-wire transmitters (4 to 20 mA) go to the analog inputs AE1 / AE2 / AE3. Switching between between AE1 (x1) and AE2 (x2) via digital input 1. The manipulated variable y (4 to 20 mA) goes via analog output 1 to a position controller SIPART PS.

Structure switch Strs		
Switch	Value	Meaning
S 4	1	Input freely connectable
S 5	2	AE1: 4 to 20 mA
S 6	2	AE2: 4 to 20 mA
S 7	2	AE3: 4 to 20 mA
S 69	1	AA1: 4 to 20 mA

Parameter oFPA		
Parameters	Value	Meaning
dP1	*)	Decimal point
dA1	*)	Display start value
dE1	*)	Display full scale value

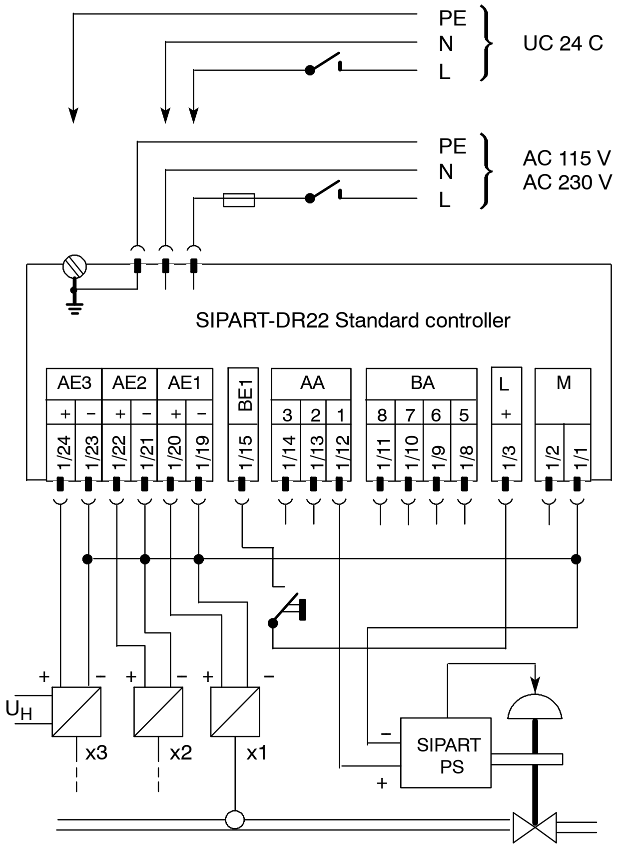
Parameter onPA		
Parameters	Value	Meaning
cP1	*)	Proportional action factor
tn1	*)	Integral action time

*) Setting as required

Freely connectable input range FdEF		
Function block	YES/ NO	Meaning
MA1	YES	Max-selection
AS1	YES	Switch analog signal

Freely connectable input range Fcon		
Sink	Source	Meaning
FE1	MA1.4	x1 to max-selection
MA1.1	AS1.4	Input MAX from switch
MA1.2	AE3A	Input MAX from AE3A
MA1.3	0.050	Factory setting
AS1.1	AE1A	Input switch from AE1
AS1.2	AE2A	Input switch from AE2
AS1.3	bE01	Input switch from BE1

Freely connectable input range FPos		
Block no.	Position	Meaning
01	AS1	
02	MA1	



Attention:
- All settings starting from the factory setting (APSt) of the controller
- The above settings/adaptations are absolutely essential. Other parameters (e.g. A1 / A2 / ...) as required.

8 Configuring tool

- Describing the problem
- Determining the assembly of the controller
  Determining the position of bridges and switches on the main board and signal transformer
- Drawing the wiring diagram
  Recording special connections e.g. of the freely programmable range
- Determining front labelling
- Note table values
  (structuring, parameterizing)

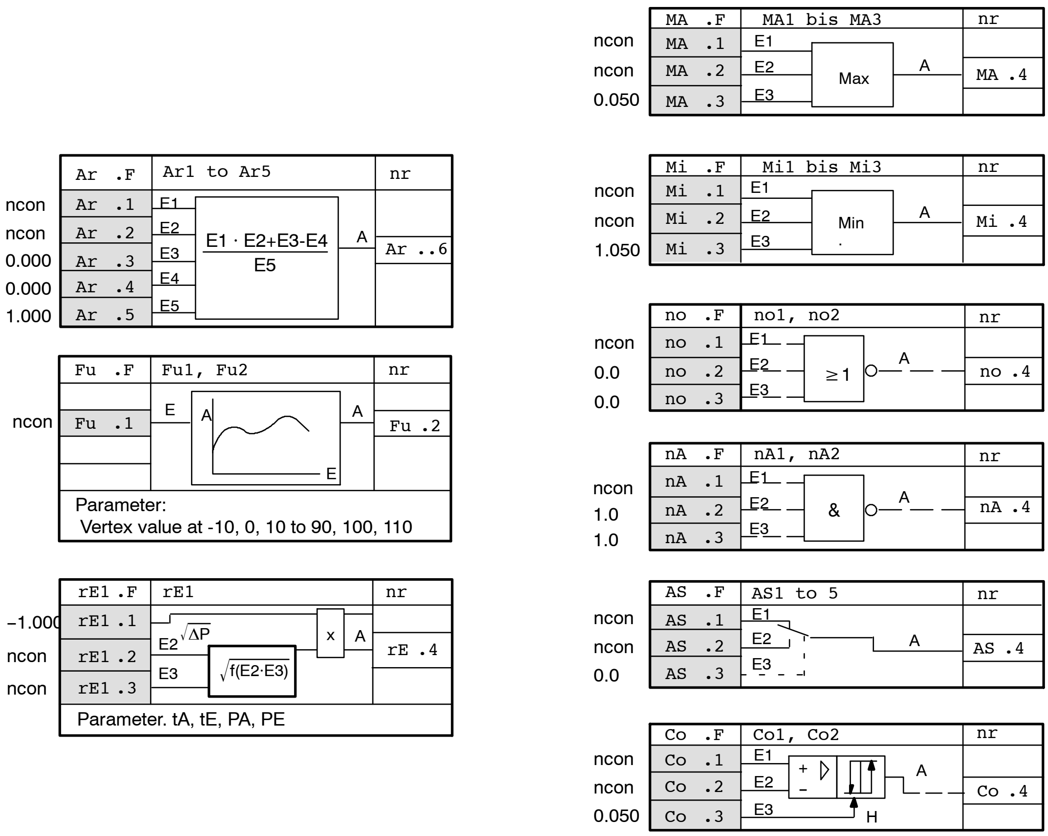


Figure 8-1 Analog input signal processing freely connectable (S4 = 1)

Settings SIPART DR22, controller number / measuring point . . . .

Parameter onPA

Parameter meaning	Digital indication on display 14 (y)	16 (x)	19 (w) for preset				Factory setting	Dimen-sion
Parameter set I								
Filter time constant xdI	tFI	Controlled variable x					1	s
Derivative action gain	vvI						5.000	1
Proportional action factor	cPI						0.100	1
Integral action time	tnI						9984	s
Derivative action time	tvI						oFF	s
Response threshold xdI	AHI						0.0	%
Operating point P-controller	YoI						Auto	%
Manipulated variable limiting start	YAI						–5.0	%
Manipulated variable limiting end	YEI						105.0	%
Parameter set II								
Filter time constant xdII	tFII						1	s
Derivative action gain	vvII						5.000	1
Proportional action factor	cPII						0.100	1
Integral action time	tnII						9984	s
Derivative action time	tvII						oFF	s
Response threshold xdII	AHII						0.0	%
Operating point P-controller	YoII						Auto	%
Manipulated variable limiting start	YAII						–5.0	%
Manipulated variable limiting end	YEII						105.0	%
Display refresh rate	dr						0.8	s
Floating time	tY						oFF	s
min. actuating pulse pause	tA						200	ms
min. actuating pulse length	tE						200	ms
Filter time constant AE1	tF1						1	s
Filter time constant AE2	tF2						1	s
Filter time constant AE3	tF3						1	s
Filter time constant AE4	tF4						1	s
Filter time constant AE5	tF5						1	s
Filter time constant AE6	tF6						1	s
Filter time constant AE7	tF7						1	s
Filter time constant AE8	tF8						1	s
Filter time constant AE9	tF9						1	s
Filter time constant AE10	tFA						1	s
Filter time constant AE11	tFb						1	s
Floating time Controller II	tYII						oFF	s
min. actuating pulse pause when S1 = 12	tAII						200	ms
min. actuating pulse length	tEII						200	ms

Settings SIPART DR22, controller number / measuring point . . . .

Parameter **onPA** (continued)

Parameter meaning	Digital indication on display 14 (y)	16 (x)	19 (w) for preset				Factory setting	Dimen-sion
Multiplicative constant	c1	Controlled variable x					0	1
Multiplicative constant	c2						0	1
Additive constant	c3						0	100 %
Multiplicative constant	c4						1	1
Additive constant	c5						0	100 %
Multiplicative constant	c6						0	1
Multiplicative constant	c7						0	1
Multiplicative constant	c8						0	1
Additive constant	c9						0	100 %
only when S4 = 1								
connectable parameters	P01						1	1
connectable parameters	P02						1	1
connectable parameters	P03						1	1
connectable parameters	P04						1	1
connectable parameters	P05						1	1
connectable parameters	P06						1	1
connectable parameters	P07						1	1
connectable parameters	P08						1	1
connectable parameters	P09						1	1
connectable parameters	P10						1	1
connectable parameters	P11						1	1
connectable parameters	P12						1	1
connectable parameters	P13						1	1
connectable parameters	P14						1	1
connectable parameters	P15						1	1
in adaptation								
Monitoring time	tU						oFF	h
Direction of the step command	dPv						PoS	–
Amplitude of the step command	dY						0.5	%

Settings SIPART DR22, controller number / measuring point . . . .

Parameter **PASt**

	Digital indication on display						Factory setting	Dimen-sion
			19 (w) for preset					
Parameter meaning	14 (y)	16 (x)						
Derivative action gain	vvc	Controlled variable x					5	1
Proportional action factor at SG = 10 %	cP1						0.1	1
Proportional action factor at SG = 30 %	cP3						0.1	1
Proportional action factor at SG = 50 %	cP5						0.1	1
Proportional action factor at SG = 70 %	cP7						0.1	1
Proportional action factor at SG = 90 %	cP9						0.1	1
Integral action time at SG = 10 %	tn1						9984	s
Integral action time at SG = 30 %	tn3						9984	s
Integral action time at SG = 50 %	tn5						9984	s
Integral action time at SG = 70 %	tn7						9984	s
Integral action time at SG = 90 %	tn9						9984	s
Derivative action time at SG = 10 %	tv1						oFF	s
Derivative action time at SG = 30 %	tv3						oFF	s
Derivative action time at SG = 50 %	tv5						oFF	s
Derivative action time at SG = 70 %	tv7						oFF	s
Derivative action time at SG = 90 %	tv9						oFF	s
Response threshold at SG = 10 %	AH1						0.0	%
Response threshold at SG = 30 %	AH3						0.0	%
Response threshold at SG = 50 %	AH5						0.0	%
Response threshold at SG = 70 %	AH7						0.0	%
Response threshold at SG = 90 %	AH9						0.0	%
Operating point P-Reg. at SG = 10 %	Y01						0.0	%
Operating point P-Reg. at SG = 30 %	Y03						0.0	%
Operating point P-Reg. at SG = 50 %	Y05						0.0	%
Operating point P-Reg. at SG = 70 %	Y07						0.0	%
Operating point P-Reg. at SG = 90 %	Y09						0.0	%

Settings SIPART DR22, controller number / measuring point . . . .

Parameter oFPA

Parameter meaning		14 (y)	16 (x)	19 (w) for preset				Factory setting	Dimen-sion
Decimal point display I		dPI	dark					----.-	–
Start value (Display range Display I)		dAI						0.0	–
Full scale value (Display range Display I)		dEI						100.0	–
Decimal point display II		dPII						----.-	–
Start value (Display range Display II)		dAII						0.0	–
Full scale value (Display range Display II)		dEII						100.0	–
Alarm 1		A1						5.0	–
Alarm 2		A2						–5.0	–
Alarm 3		A3						5.0	–
Alarm 4		A4						–5.0	–
Hysteresis alarms A1 and A2		H1.2						1.0	%
Hysteresis alarms A3 and A4		H3.4						1.0	%
Setpoint limit Start		SA						–5.0	–
Setpoint limit end		SE						105.0	–
Safety setpoint		SH						0.0	–
Limit setpoint at override control		Sb						0.0	–
Setpoint ramp		tS						oFF	min
Ratio factor start		vA						0.000	1
Ratio factor end		vE						1.000	1
Safety manipulated variable		YS						0.0	%
Manipulated variable range y1 (at Split range)		Y1						50.0	%
Manipulated variable range y2 (at Split range)		Y2						50.0	%

Parameter meaning	at S4 = 0 Linearizer for FE1 / at S4 = 1 Function transmitter for Fu1	14 (y) at S4 = 0	14 (y) at S4 = 1	16 (x) at S4 = 0	16 (x) at S4 = 1	19 (w) for preset				Factory setting	Dimension at S4 = 0	Dimension at S4 = 1
Vertex value at –10 %		–1.1	–10	dark	FU1					–10	–	%
Vertex value at 0 %		0.1	0		FU1					0	–	%
Vertex value at 10 %		1.1	10		FU1					10	–	%
Vertex value at 20 %		2.1	20		FU1					20	–	%
Vertex value at 30 %		3.1	30		FU1					30	–	%
Vertex value at 40 %		4.1	40		FU1					40	–	%
Vertex value at 50 %		5.1	50		FU1					50	–	%
Vertex value at 60 %		6.1	60		FU1					60	–	%
Vertex value at 70 %		7.1	70		FU1					70	–	%
Vertex value at 80 %		8.1	80		FU1					80	–	%
Vertex value at 90 %		9.1	90		FU1					90	–	%
Vertex value at 100 %		10.1	100		FU1					100	–	%
Vertex value at 110 %		11.1	110		FU1					110	–	%

Settings SIPART DR22, controller number / measuring point . . . .

Parameter **oFPA** (continued)

Parameter meaning		14 (y)	16 (x)	19 (w) for preset				Factory setting	Dimension
Vertex value at −10 %	at S4 = 0 Linearizer for FE3 / at S4 = 1 Function transmitter for Fu2	−1.3 / −10	dark / FU2					−10	– / %
Vertex value at 0 %		0.3 / 0	dark / FU2					0	– / %
Vertex value at 10 %		1.3 / 10	dark / FU2					10	– / %
Vertex value at 20 %		2.3 / 20	dark / FU2					20	– / %
Vertex value at 30 %		3.3 / 30	dark / FU2					30	– / %
Vertex value at 40 %		4.3 / 40	dark / FU2					40	– / %
Vertex value at 50 %		5.3 / 50	dark / FU2					50	– / %
Vertex value at 60 %		6.3 / 60	dark / FU2					60	– / %
Vertex value at 70 %		7.3 / 70	dark / FU2					70	– / %
Vertex value at 80 %		8.3 / 80	dark / FU2					80	– / %
Vertex value at 90 %		9.3 / 90	dark / FU2					90	– / %
Vertex value at 100 %		10.3 / 100	dark / FU2					100	– / %
Vertex value at 110 %		11.3 / 110	dark / FU2					110	– / %
Correction quotient pressure start		PA	rE					1	1
Correction quotient pressure end		PE	rE					1	1
Correction quotient temperature start		tA	rE					1	1
Correction quotient temperature end		TE	rE					1	1
Setpoint limit Start	Controller II at S1 = 12	SAII	dark					−5.0	–
Setpoint limit End	Controller II at S1 = 12	SEII	dark					105.0	–
Setpoint ramp		tSII	dark					oFF	min
Safety manipulated variable		YSII	dark					0.0	%
Decimal point	Ratio controller	Pd	dark					___.–	–
Start of scale	Ratio controller	Ad	dark					0.0	–
Full scale	Ratio controller	Ed	dark					100.0	–
Hysteresis Alarm A2		H2	dark					1.0	%
Hysteresis Alarm A4		H4	dark					1.0	%
Manipulated variable range y3	Controller II in split range	Y3	dark					50.0	%
Manipulated variable range y4	Controller II in split range	Y4	dark					50.0	%

Settings SIPART DR22, controller number / measuring point . . . .

Configuring

Switch number	Preset				Factory setting
0					0
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					0
24					–1
25					2
26					3
27					4
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

Switch number	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					0
64					0
65					0
66					0
67					0
68					0
69					0
70					0
71					0
72					0
73					1
74					0
75					0
76					1
77					2
78					3
79					4
80					5
81					6
82					0
83					0
84					0
85					0
86					0
87					0
88					0
89					0
90					0
91					0
92					0
93					0
94					0
95					0
96					0
97					0
98					0
99					0
100					0
101					1
102					0
103					0

Settings SIPART DR22, controller number / measuring point . . . .

Structuring (continued)

Switch number	Preset				Factory setting
104					0
105					0
106					0
107					0
200					0
201					0
202					0
203					0
204					0
205					0
206					0
207					0
208					0
209					0
210					0
211					0
212					0
213					0
214					0
215					0
216					0
217					0
218					0
219					–1
220					0
221					0
222					0
223					0
224					0
225					0
226					0
227					0
228					0
229					0
230					0
231					0
232					0
233					0
234					0

Switch number	Preset				Factory setting
235					0
236					0
237					0
238					0
239					0
240					0
241					0
242					0
243					0
244					0
245					0
246					0
247					0
248					0
249					0
250					0
251					0
252					1
253					0
254					0
255					0
256					0
257					0
258					0
259					0
260					0
261					0
262					0
263					0
264					0
265					0
266					0
267					–1
268					–1
269					0
270					0
271					0

Settings SIPART DR22, controller number / measuring point . . . .

FdEF **Define function** **FPoS** **Position function**

Question: display 16 (x)	Answer: display 19 (w) Preset							
	YES	no	YES	no	YES	no	YES	no
Ar1								
Ar2								
Ar3								
Ar4								
Ar5								
Ar6								
Fu1								
Fu2								
MA1								
MA2								
MA3								
Mi1								
Mi2								
Mi3								
rE1								
AS1								
AS2								
AS3								
AS4								
AS5								
co1								
co2								
nA1								
nA2								
no1								
no2								

Question: display 16 (x)	Answer: display 19 (w) Preset			
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				

FPos lists freely connectable range

Settings SIPART DR22,
Controller number/measuring point . . . .

FCon **Wire function**

Question: display 16 (x)	Answer: display 19 (w) Preset			
Ar1.1				
Ar1.2				
Ar1.3				
Ar1.4				
Ar1.5				
Ar2.1				
Ar2.2				
Ar2.3				
Ar2.4				
Ar2.5				
Ar3.1				
Ar3.2				
Ar3.3				
Ar3.4				
Ar3.5				
Ar4.1				
Ar4.2				
Ar4.3				
Ar4.4				
Ar4.5				
Ar5.1				
Ar5.2				
Ar5.3				
Ar5.4				
Ar5.5				
Ar6.1				
Ar6.2				
Ar6.3				
Ar6.4				
Ar6.5				
FE1				
FE2				
FE3				
FE4				
FE5				
FE6				
FE7				
FE8				
FE9				
FE10				
FE11				
FE12				
FU1.1				
FU1.2				
MA1.1				
MA1.2				
MA1.3				
MA2.1				
MA2.2				
MA2.3				
MA3.1				
MA3.2				
MA3.3				

FCon lists freely connectable range

Settings SIPART DR22, Controller number / measuring point . . . . . .

FCon **Connect function** (continued)

Question: display 16 (x)	Answer: display 19 (w) Preset			
Mi1.1				
Mi1.2				
Mi1.3				
Mi2.1				
Mi2.2				
Mi2.3				
Mi3.1				
Mi3.2				
Mi3.3				
rE1.1				
rE1.2				
rE1.3				
AS1.1				
AS1.2				
AS1.3				
AS1.4				
AS1.5				
AS2.1				
AS2.2				
AS2.3				
AS2.4				
AS2.5				
AS3.1				
AS3.2				
AS3.3				
AS3.4				
AS3.5				
AS4.1				
AS4.2				
AS4.3				
AS4.4				
AS4.5				
AS5.1				
AS5.2				
AS5.3				
AS5.4				
AS5.5				
co1.1				
co1.2				
co1.3				
co2.1				
co2.2				
co2.3				
nA1.1				
nA1.2				
nA1.3				
nA2.1				
nA2.2				
nA2.3				
no1.1				
no1.2				
no1.3				
no2.1				
no2.2				
no2.3				

FCon lists freely connectable range

Settings SIPART DR22, controller number / measuring point . . . .

Parameter CAE4

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 CAE5

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				

9 Explanation of abbreviations

$\overline{A}$ . . . . Control signal no automatic mode
A* . . . . Parameter Alarms (limit values)
AA . . . . Analog output
AdAP . . . . Parameterization mode Adaptation
AE* . . . . Analog inputs
AE*A . . . . Outputs of the analog inputs
AH* . . . . Response threshold (dead zone)
ALL PASS . . . . Error message all-pass lines
APSt . . . . Structuring mode All Preset (whole controller to factory setting)
AUto . . . . Automatic
Ar* . . . . Function block, Arithmetic

BA** . . . . Digital outputs
BE** . . . . Digital inputs
BLPS . . . . Control signal, Blocking, Parameterization/Structuring
$BLPS_{BE}$ . . . . Control signal, Blocking, Parameterization/Structuring via digital input
$BLPS_{ES}$ . . . . Control signal, Blocking, Parameterization/Structuring via SES
BLS . . . . Control signal, Blocking, Structuring
BLS_{BE} . . . . Control signal, Blocking, Structuring via digital input
BLS_{ES} . . . . Control signal, Blocking, Structuring via SES

c* . . . . Parameter, Constants
$\overline{C}$ . . . . LED, no computer standby
CB . . . . Control signal, Computer operation
CB_{BE} . . . . Control signal, Computer operation via digital inputs
CB_{ES} . . . . Control signal, Computer operation via SES
cP* . . . . (K_p) Proportional action factor
CPU . . . . Central processing unit

dA* . . . . Parameter, display range, start
DDC . . . . Direct digital control
dE* . . . . Parameter, display range, end
dELt . . . . Delete
dP . . . . Parameter, display decimal point
dPv . . . . Parameter direction of step command
dr . . . . Parameter, display refresh rate
dY . . . . Parameter amplitude of the step command

Err . . . . Error
End . . . . Error message end

FASt . . . . Error message for adaptation, system too fast
FCon . . . . Structuring mode, connect functions (connection)
FdEF . . . . Structuring mode, define functions
FE* . . . . Function input
FPoS . . . . Structuring mode, position function
FPSt . . . . Structuring mode, Functions Preset
Fu* . . . . Function block, function transmitter
Fu1, -10 bis 110 . . . Parameter function transmitter 1, vertex points
Fu1, -10 bis 110 . . . Parameter function transmitter 2, vertex points

H** . . . . Parameter, hysteresis alarms
H . . . . Control signal manual mode
Hi . . . . Control signal manual internal
He_{BE} . . . . Control signal manual external via digital input
He_{ES} . . . . Control signal manual external via SES
HE . . . . Error message manual external

inSt . . . . Insert
Int* . . . . Control signal internal

Kp . . . . Proportional action factor

LED . . . . Light emitting diode

MA** . . . . Function block, maximum selection
MEM . . . . Memory
Mi** . . . . Function block, Minimum selection
ModE . . . . Operating mode
MUF . . . . Transmitter fault

ncon . . . . Not connected
n.ddc . . . . Error message follow-up or DDC
ndEF . . . . Not defined
no . . . . No
not . . . . None
nPoS . . . . Not positioned
N . . . . Control signal follow-up
N_{BE} . . . . Control signal follow-up via digital input
N_{ES} . . . . Control signal follow-up via SES

oFL . . . . Overflow, positive overflow
-oFL . . . . Overflow, negative overflow
onPA . . . . Parameterization mode, on-line parameterization
oFPA . . . . Structuring mode, off-line parameterization
OP** . . . . Error message option (slot)
OUT . . . . Output, manipulated variable y

ovEr Shot . . . . Error message overshoot

P* . . . . Control signal P-operation
$P*_{BE-}$ . . . . Control signal P-operation via digital input
$P*_{ES}$ . . . . Control signal P-operation via SES
P** . . . . Connectable, linear parameters
PAU . . . . Control signal parameter switching
PAU_{BE} . . . . Control signal parameter switching via digital input
PAU_{ES} . . . . Control signal parameter switching via SES
PV . . . . Process variable, controlled variable

$\overline{RB}$ . . . . Control signal, computer not ready
rE1 . . . . Function block correction computer
rE1, PA . . . . Parameter correction computer correction quotient pressure start
rE1, PE . . . . Parameter correction computer correction quotient pressure end
rE1, tA . . . . Parameter correction computer correction quotient temperature start
rE1, tE . . . . Parameter correction computer correction quotient temperature end
$\overline{RC}$ . . . . 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_{BE} . . . . Control signal safety operation via digital input
Si_{ES} . . . . Control signal safety operation via SES
SMAL . . . . Error message small
SP . . . . Setpoint
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

tA . . . . Parameter minimum turn-off duration
tE . . . . Parameter minimum turn-on duration
tESt . . . . Self-test
tF* . . . . Parameter filter time constant
tn* . . . . Parameter integral action time
tS . . . . Parameter setpoint ramp
tSH . . . . Control signal setpoint ramp HALT
to . . . . to
tU . . . . Monitoring time
tv* . . . . Parameter derivative action value

tY . . . . Parameter floating time

v . . . . Setpoint ratio factor
v_{ist} . . . . 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)
w_{SL} . . . . Preselection “external setpoint”
wv . . . . Standardized nominal ratio factor

x . . . . Controlled variable x (actual value)
x* . . . . Auxiliary controlled variables, partial controlled variables
xd* . . . . Control difference
xd* . . . . Control difference
xv . . . . Standardized actual ratio factor

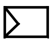
y . . . . Manipulated variable
y1 . . . . Partial manipulated variables in split range
y2 . . . . Partial manipulated variables in split range
Y1 . . . . Parameter manipulated variable range 1 in split range
Y2 . . . . Parameter manipulated variable range 2 in split range
YA . . . . Parameter manipulated variable limit start
YE . . . . Parameter manipulated variable limit end
y_E . . . . External manipulated variable
y_{ES} . . . . External manipulated variable via SES
$y_{E\Delta}$ . . . . External manipulated variable incremental
y_H . . . . Manual manipulated variable
y_N . . . . External manipulated variable (follow-up manipulated variable)
y_S . . . . Safety manipulated variable
YS . . . . Parameter safety manipulated variable
Yo* . . . . Parameter operating point
YBL . . . . Error message blocking mode

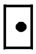
± yBL . . . . Control signal direction-dependent y-blocking
± yBL_{BE} . . . . Control signal direction-dependent y-blocking via digital inputs
± yBL_{ES} . . . . Control signal direction-dependent y-blocking via SES

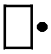
± Δw . . . . Control signal incremental w-adjustment
± Δw_{BE} . . . . Control signal incremental w-adjustment via digital inputs

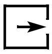
$\pm\Delta w_{ES}$ .... Control signal incremental w-adjustment via SES
$\pm\Delta y$ .... Control signal incremental y-adjustment
$\pm\Delta y_{BE}$ .... Control signal incremental y-adjustment via digital inputs
$\pm\Delta y_{ES}$ .... Control signal incremental y-adjustment via digital inputs

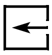
-1.1 to 11.1 .... Parameter vertext points linearizer FE1
-1.3 to 11.3 .... Parameter vertex points linearizer FE3

 .... Controller

 .... Internal

 .... External

 .... Exit

 .... Enter

 .... Fault

 AE** .... Error message fault analog inputs

– – – •‾ .... Identification decimal point

↗ .... adjustable

**.I .... Parameter set I
**.II .... Parameter set II
**.o .... old parameters
**.n .... new parameters

* .... stands for counter number or parameter name

Index

D

P

Q

R

S

T

U

V

W

X

Y

Z