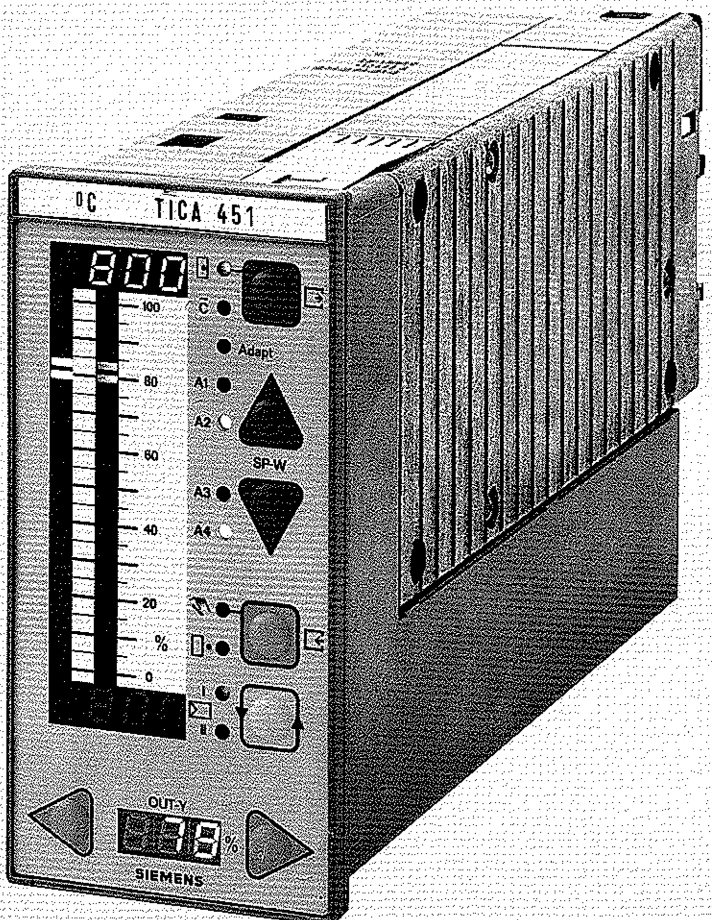
SIEMENS

SIPART DR22 Controller®

6DR 2200

Manual   Order No.: C73000-B7476-C222-10



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Manual

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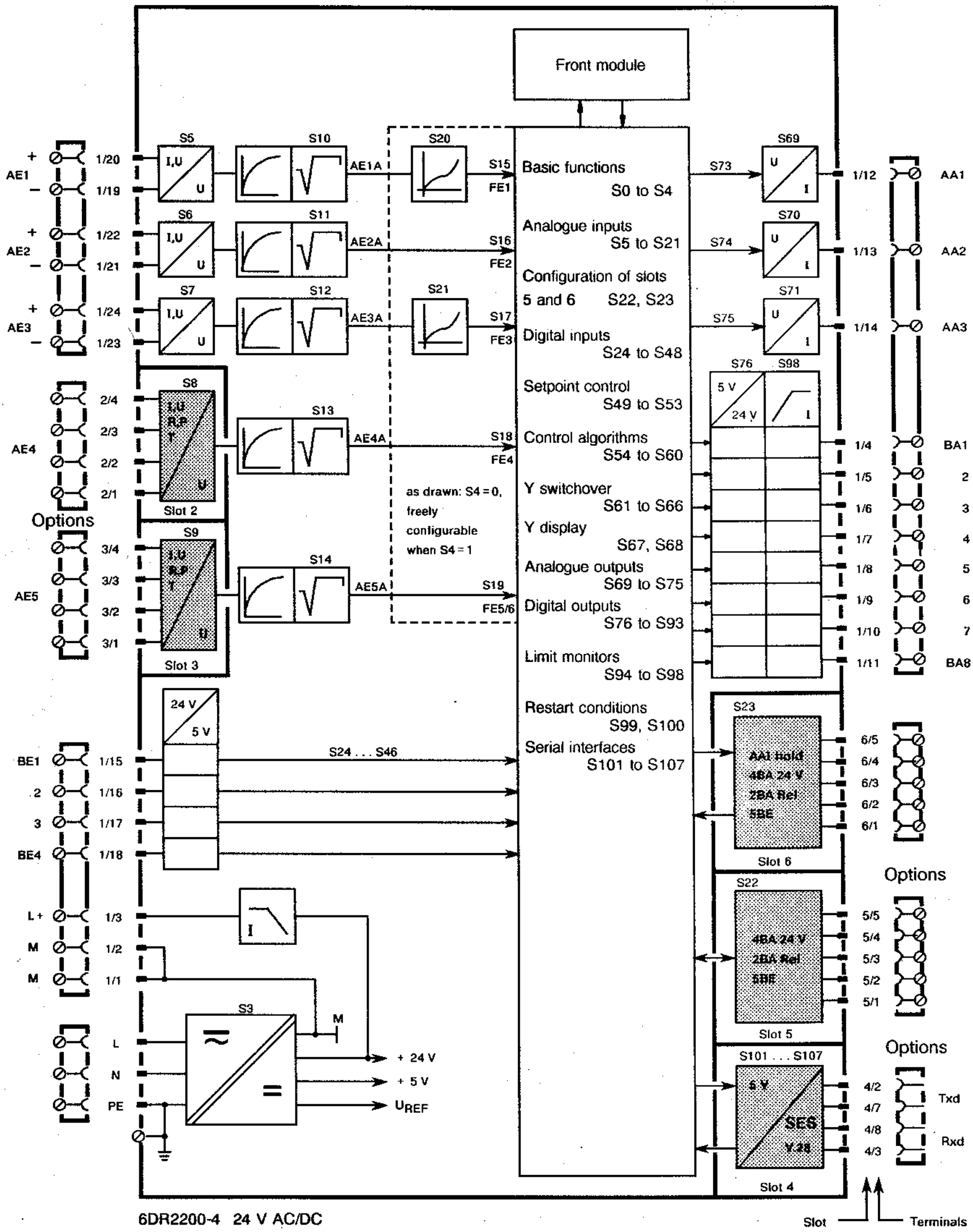


6DR2200-4 24 V AC/DC
6DR2200-5 115/230 V AC switchable

Block Diagram SIPART DR22

Table of Contents

1 Technical Description

WARNING

This instrument is powered by electricity. Certain components within electrical instruments are by necessity subject to very high voltages. Serious physical injury or damage to property/ equipment may ensue if the warnings in this manual are ignored. Only suitably qualified personnel should use this instrument. These personnel should be fully conversant with all warnings and maintenance procedures described in this manual.

The troublefree and safe operation of this instrument depends on a number of factors: proper transport, specialist storage, erection and installation, as well as careful operation and maintenance.

1.1 Range of Application

The SIPART DR22 controller is a high performance, microprocessor based instrument. Its internal program memory contains a large number of standard functions for controlling industrial processes. A user with no programming knowledge can simply call up and execute these functions.
In addition, the controller uses a rugged adaptation procedure that significantly simplifies the commissioning of even the most critical control loops. The controller automatically calculates optimum control parameters on demand, and does not assume that the user has any prior knowledge of how the control loop might respond. The procedure used here is particularly suitable for control loops with recovery times and aperiodic transient responses; even long dead times are taken into account.
In more complex applications, the standard input connections can be reconfigured and connected to additional analogue function blocks provided by the user. These function blocks can be very easily interconnected by menu driven firmware, thus enabling optimum solutions to be found for even the most complex tasks.
This configuring capability guarantees maximum flexibility in the use of the controller, allowing it to be configured quickly and easily to meet the requirements of the application in hand. Consequently, the SIPART DR22 is suitable for a very wide range of industrial control applications, eg. as a:

- fixed setpoint controller for one, two or three component control, optionally using two setpoints
- DDC fixed setpoint controller for one, two or three component control
- slave controller (synchronisation control, SPC controller) with local/remote switchover
- fixed or controlled ratio controller with local/remote switchover
- cascade controller (dual-loop controller)
- cascaded ratio controller (dual-loop controller)
- override controller with min./max. manipulated variable selection (dual-loop controller)

The extensive hardware configuration underlines the universal nature of the controller by providing diverse interfaces to the control loop. The controller may also be connected via a plug-in serial interface to a higher-level system or controlled and monitored by a centralised Personal Computer.
The SIPART DR22 can be used to control electromotive drives as either a continuous controller (K), or as a three position step controller (S), without having to change the hardware configuration. It can also be used as a dual-loop controller where the application requires two loops to be inter-connected, eg. cascade control, cascaded ratio control or override control.

1.2 Design

The SIPART DR22 controller is of modular design and consequently easy to service and simple to reconfigure or retrofit. It consists of an extremely well equipped, fully functional standard unit, to which additional signal converters can be added in order to extend its range of applications. These modules are inserted in slots in the rear of the instrument (Figure 1-3).

The standard unit comprises:

- the front module with controls and displays
- the main circuit board with CPU and terminal strips
- plastic moulded housing with an interface board
- power supply unit

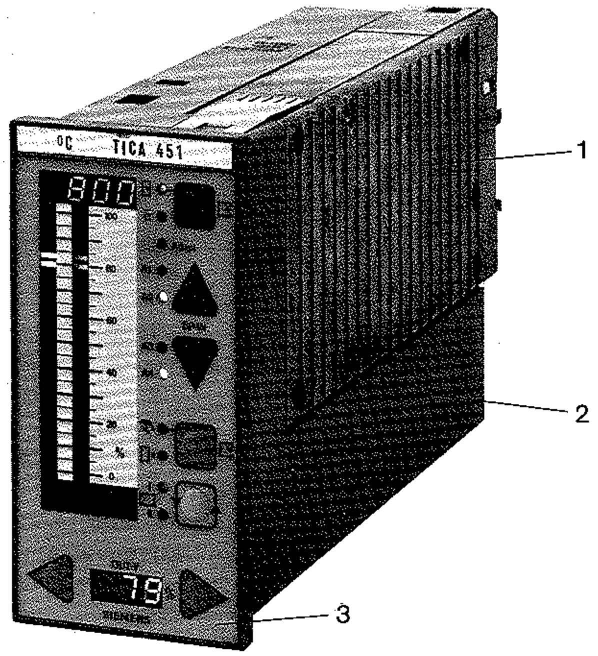
Connections between the various modules are made via the interface board fixed in the housing. The main circuit board is inserted in slot 1 and screwed into place. Attached to it is a 10-way and 14-way terminal block to which all inputs and outputs of the standard controller are connected. Should the number of signals for a particular application exceed the capacity of the standard unit, a further five slots are available for additional option modules.

The standard controller has three fixed, electronically isolated analogue inputs (AE) that can be wired to either nominal voltage (0/0.2 to 1 V, or 0/2 to 10 V) or current (0/4 to 20mA) signals. There are also four digital inputs (BE, 0/24 V) and eight digital outputs (BA, 0/24 V, 30mA) that can be used for a variety of purposes and which operate in either normal or inverted mode.
The controller also has three analogue outputs (AA) of 0/4 to 20mA which can be assigned to any of the controller's internal variables.
Electrical supply for the transmitters is provided by a short-circuit proof L+ output (DC 24 V, 100mA). The power supply unit is situated in a completely enclosed metal housing that is screwed to the plastic body of the controller. The power supply unit comes in two different versions, which means that two types of SIPART DR22 are available:

6DR2200-4	– for	DC	24 V	connection
6DR2200-5	– for	AC	230 V	connection
	switchable to	AC	115 V	connection

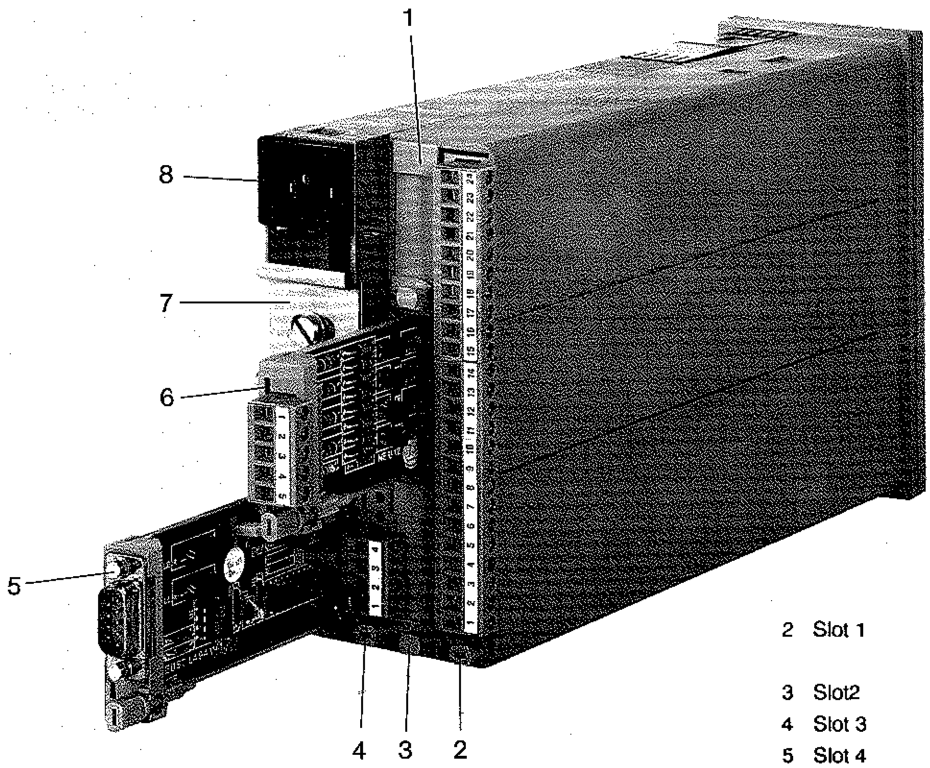
Many applications can be implemented by using just the three analogue inputs integrated in the standard unit. To handle very complex control applications, or to connect other input signals, two additional input modules can be inserted in slots 2 and 3, thus increasing the total number of analogue inputs to five. Apart from the processing of standard voltage and current signals, these input modules can also be used to directly connect Pt100 resistance thermometers, all common types of thermocouple and resistance transmitters/potentiometers.
Slot 4 is used either for an interface module with a V.28 point-to-point output, or the SIPART bus for communication with a higher-level system.
Slots 5 and 6 can be used for different types of signal converter for various functions or may, if required, be fitted with boards providing additional digital I/O. Slot 6 may also be used to accommodate a special analogue "hardhold" output module. This module retains the most recent value of the manipulated variable of the K controller should a power cut occur, or during maintenance work on the controller. For additional security, the power supply for this module can be provided by the controller, as well as from an external source.

- To observe the admissable lead emissions according to EN 55011 the measuring and control leads have to be filtered by the accompanying ferrite tubes. Depending on the quantity of leads either one or both ferrite tubes can be used.
  The leads should be bundled through the ferrite tubes in a distance of about 10 cm. from the terminal.



1 Power supply unit
2 Body
3 Front module

Figure 1-2 Front view



1 Slot 6 4BA 24 V or
2BA relay or
5BE or
y-hold

2 Slot 1 Main circuit board 3AE (I/U),
3AA, 4BE, 8BA, L +
3 Slot2 AE (I/U, R, P, T)
4 Slot 3 AE (I/U, R, P, T)
5 Slot 4 4 SES
6 Slot 5 4BA, 24 V or
2BA relay or
5BE
7 DIN rail
8 Mains plug

Figure 1-3 Rear view

1.3 Mode of operation

1.3.1 Standard unit

As described in section 1.2, the standard unit consists of three main units:

- Power supply unit
- Front module
- Main circuit board

- **Power supply unit**

The SIPART DR22 uses a high efficiency primary switched-mode power supply unit for AC 115/230 V (switchable) or for AC/DC 24 V. The internal +24 V and +5 V supplies and the U_{ref} = +5.5 V reference potential are generated from the power supply. The metal enclosure is located on a protective conductor (safety class 1). The power supply and the internal supplies are isolated from each other by a protective baffle. Should an overvoltage occur, a surge cutoff feature converts internal power supply voltages into extra-low functional voltages. As no other voltages are generated by the controller, these statements apply to all process signals (see section 1.5, Technical data, for a list of relevant standards). The controller has a high power output rating, making a total of 450mA available for the L+, AA and BA outputs.

- **Front module**

The front module contains pushbuttons and displays and the corresponding display drivers.
The displays use LED technology to achieve long life, brilliance and an optimum viewing angle. The various pushbuttons have a tactile feel with a noticeable "click" and high reset force. They are actuated through the protective foil by means of plunger switches that are arranged in such a way so as not to overstress the foil. The processor on the main board interrogates the pushbuttons in parallel, which allows several to be pressed simultaneously. The LEDs are time-division multiplexed by the main board processor via the driver module using I^2C bus technology.
The controller can be configured in a wide variety of ways. The pushbuttons and displays required for a particular function are always active on the front module. Elements not required for a particular task are de-activated.

- **Main board**

The main board contains the standard controller's signal processing, the CPU (Central Processing Unit), and connections (via the interface board) to the various slots.
Process signals are fed via external static/dynamic surge suppressor circuits and then via appropriate circuitry before being matched to the signal level of the CPU. In the case of analogue inputs, analogue outputs and digital outputs, this matching is performed by modern thick-film integrated circuits.
To reduce cycle time, the CPU employs a Master-Slave dual processor system. The Microprocessors contain integrated AD and DA converters, watch-dog circuits for cycle monitoring and UARTs (Universal Asynchronous Receiver/Transmitter) for the serial interfaces. The Slave processor uses an integrated 8k ROM, the Master processor an external 64k EPROM and an 8k RAM. Customised user configurations are stored in a plug-in user program memory containing a serial 0.5k EEPROM. During commissioning it is therefore possible to plug the user program memory into the controller being installed, which then does not need to be reconfigured. An additional serial EEPROM is available in which critical data can be saved in the event of a power cut, etc. The entire CPU employs CMOS technology. The SIPART DR22 program executes within a fixed 70 ms cycle (if S4 = 1, 90 ms cycle).
A process image is created at the start of each routine. Data from analogue and digital inputs is acquired, pushbutton operations detected and process variable inputs read via the serial interface. These input signals are processed and all necessary calculations performed depending on which functions are currently in use. Output data is then sent to the displays, analogue and digital outputs, and calculated values stored prior to transmission down the serial interface. Program execution in S controllers is interrupted every 1.1 ms in order to disable the S outputs so as to ensure high resolution. Data traffic on the interfaces is also handled in interrupt mode.

The SIPART DR22 read only memory (ROM) contains a large number of preprogrammed functions for controlling industrial processes, machines and equipment. The user programs the controller by setting configuring switches corresponding to the functions required. The overall function of the controller is determined by the combined setting of all configuring switches. No programming knowledge is required. All settings are made via the front module of the SIPART DR22 or via the serial interface; no programming device is necessary. Customised programs created in this manner are stored in non-volatile user memory.

There are a total of 108 configuring switches (S0 to S107) with a varying number of positions. Every configuring switch is assigned a function, with at least two alternatives. A specific function can only be selected by a particular configuring switch setting.
As a rule, the decision is very simple; either a function is required, or it is not.

Controllers leaving the factory normally have their configuring switches set to "0". This is the usual setting for the individual functions, so in most cases only a few configuring switches will need to be set during commissioning. It is always wise, however, to check that the individual configuring switch settings are compatible with the current application.

1.3.2 Option modules

- **6DR2800-8J Analogue input module for U or I (I/U)**

To increase the number of analogue inputs in the standard unit

can be fitted in slot 2 as AE4 with configuring switch S8 }
or in slot 3 as AE5 with configuring switch S9 } set start-of-scale value

The circuit logic used on the main board for AE1 to AE3 is also used here. The input amplifier is designed as a differential amplifier with switchable amplification for 0 to 1 V or 0 to 10 V input signals. An input impedance of 49.9 Ω ± 0.1 % is connected between the AE+ and AE- input signals (AE1 to AE3 in the standard unit by jumper setting, AE4 and AE5 on the option modules by wiring). The start-of-scale value 0/4mA or 0/0.2 V (2 V) is set by configuring switches (S5 to S7 for AE1 to AE3 in the standard unit, S8 and S9 for AE4 and AE5 on the option modules).
The differential amplifier is designed to handle common mode voltage of up to +10 V and has a high common mode rejection, ie. currents between the amplifier reference point (reference line M) and the inputs AE+ or AE– are suppressed. It's therefore possible, providing the controllers have a common earth, to connect the current inputs in series, as with electrical isolation. Voltage dips on the reference line can be suppressed by using this circuit logic for voltage inputs and using two core cables for non-floating voltage sources. This is called electronic potential isolation.

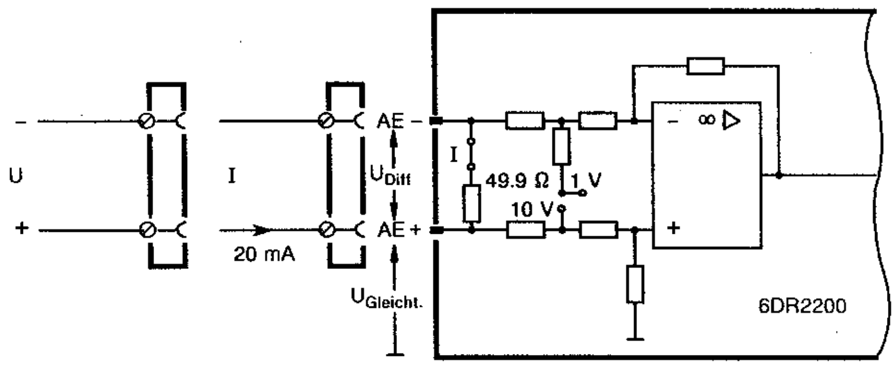
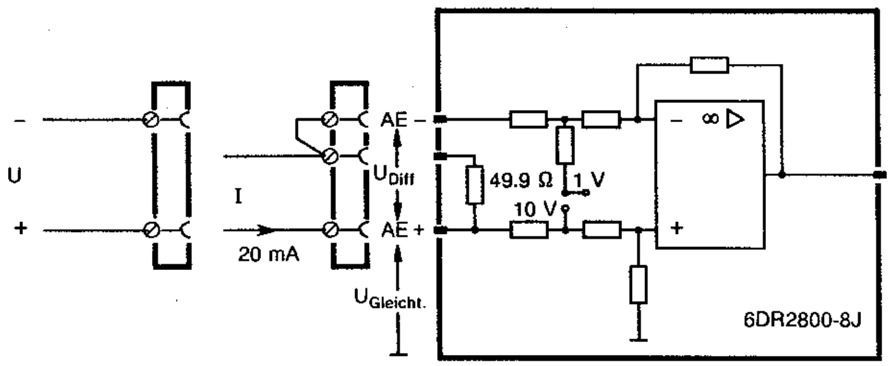


Figure 1-4 Current/Voltage input to standard unit 6DR2000 (AE1 to AE3)



U_{Diff} = voltage difference

$U_{Gleicht.}$ = common mode voltage

Figure 1-5 Current/Voltage input to option module 6DR2800-8J (AE4 and AE5)

- **6DR2800-8R Analogue input module for resistance (R)**

For direct connection of resistance transmitters (potentiometers) and to increase the number of analogue inputs in the standard unit

can be fitted in slot 2 as AE4, with configuring switch S8 = 0 or 1
or in slot 3 as AE5, with configuring switch S9 = 0 or 1

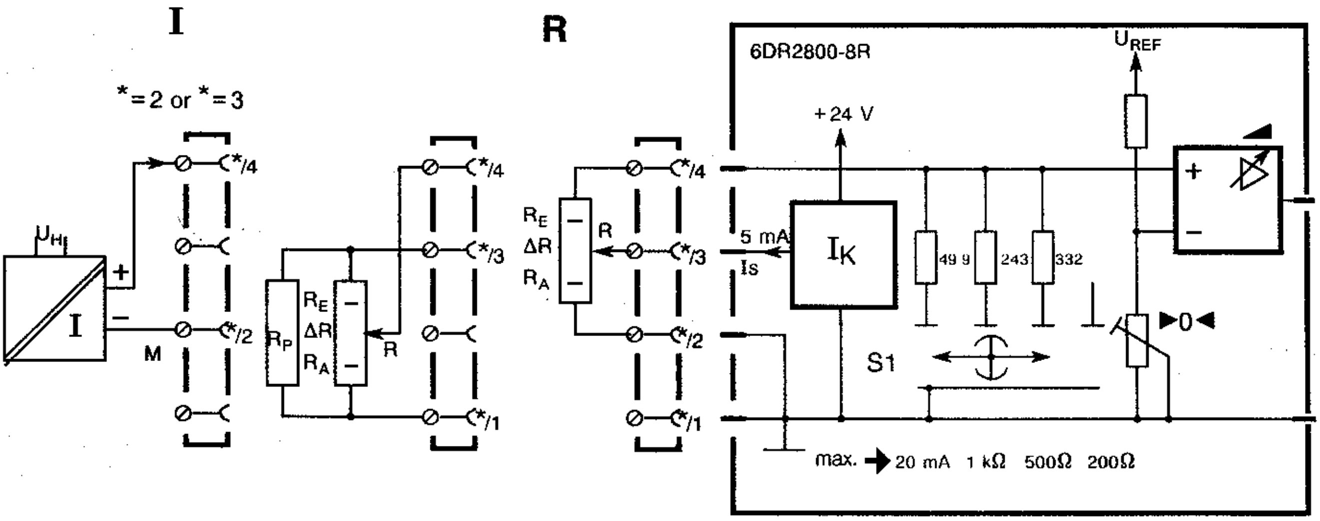


Figure 1-6 Block diagram R module 6DR2800-8R

Potentiometers with a rated value of 800 to 1200 Ω can be used as resistance transmitters. The potentiometer wiper is fed a constant current I_S = 5 mA. This ensures that the contact resistance of the wiper does not become part of the measurement. A sliding switch on the module allows resistors to be connected in parallel to the potentiometer, thus defining an approximate measuring range. Start-of-scale and full-scale values are set using the two calibration potentiometers located on the rear of the module.
Trimming of the measuring range is accomplished either via the displays on the front module (in accordance with any configuring already undertaken), or an analogue output is assigned to the appropriate input. The analogue output should be configured for 4 to 20 mA.

If any resistance transmitters are incapable of handling the 5 mA current on the wiper (eg. some types of plastic film potentiometers) or have a rated resistance > 1 kΩ, then the external wiring must be changed.
The sliding switch will be set to 200 Ω (no internal shunt resistance). The +5 mA constant current is fed to the end of the potentiometer (pin 3) and the potentiometer wiper moved to the amplifier input (pin 4). A coarse calibration is achieved by means of an external shunt resistor (R_P) (which corresponds to the otherwise internal resistors connected in parallel).
This module can also be used as a current input with adjustable start-of-scale and full-scale values. The impedance is 49.9 Ω relative to ground and is not electronically isolated.

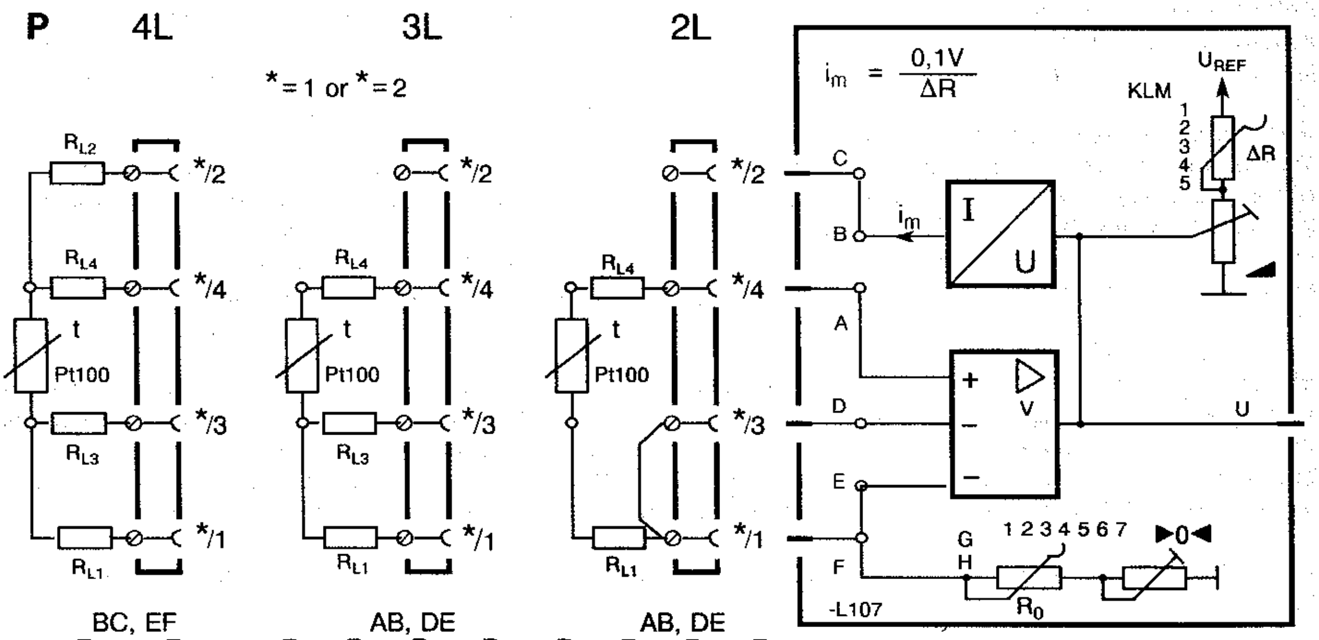
- **6DR2800-8P Analogue input module Pt 100 (P)**
  For the direct connection of Pt100 resistance thermometers and increasing the number of analogue inputs in the basic unit

  can be fitted in slot 2 as AE4, with configuring switch S8 = 0 or 1
  or in slot 3 as AE5, with configuring switch S9 = 0 or 1

Pt100 resistance thermometers can be connected in two, three or four wire circuits. The appropriate selection is made by jumper settings on the module. The following conditions apply:

Two wire circuit	RL1 + RL4 ≤ 10 Ω
Three wire circuit	RL1 = RL3 = RL4 ≤ 50 Ω
Four wire circuit	RL ≤ 80 Ω
Measuring range	–50 to 850 °C
Smallest measuring span	≥ 50 °C
Zero suppression	RtA ≤ 5Δ R

The measuring range R_{tA} to R_{tE} is established by jumper settings on the module. The start-of-scale value Ro (from R_{tA} according to the type of circuit) and measuring span $\Delta R = R_{tE} - R_{tA}$ are selected from Pt100 look-up tables that show the relationship between temperature and resistance. The required jumper settings are shown in Table 2-1. A high precision decade resistance box is required for subsequent fine calibration using the two trimming resistors on the rear of the module. In two wire circuits, line resistance can, if necessary, be calibrated at the same time as the start-of-scale value Ro. The output temperature signal is linearised.
Trimming is accomplished either via the displays on the front module (in accordance with any configuring already undertaken), or an analogue output is assigned to the appropriate input. The analogue input should be configured for 4 to 20 mA.



$R_0 = R_{tA}$ $\quad$ $R_0 = R_{tA} + R_{L4} - R_{L1}$ $\quad$ $R_0 = R_{tA} + R_{L1} + R_{L4}$

4L

$$
\begin{aligned}
U &= U_A - U_D - U_E \\
&= v \cdot i_m (R_{tA} + R_{L1} + R_O - (R_{L1} + R_O) - R_O) \\
&= v \cdot i_m (R_{tA} + R_{L1} + R_O - R_{L1} - R_O - R_O) \\
&= v \cdot i_m (R_{tA} - R_O)
\end{aligned}
$$

3L

$$
\begin{aligned}
U &= U_A - U_D - U_E \\
&= v \cdot i_m (R_{L4} + R_{tA} + R_{L1} + R_O - 2 (R_{L1} + R_O)) \\
&= v \cdot i_m (R_{L4} + R_{tA} + R_{L1} + R_O - 2R_{L1} - 2R_O) \\
&= v \cdot i_m (R_{tA} - R_O + R_{L4} - R_{L1})
\end{aligned}
$$

2L

$$
\begin{aligned}
U &= U_A - U_D - U_E \\
&= v \cdot i_m (R_{L4} + R_{tA} + R_{L1} + R_O - 2(R_O)) \\
&= v \cdot i_m (R_{tA} - R_O + R_{L4} + R_{L1})
\end{aligned}
$$

Figure 1-7 Block diagram Pt100 module 6DR2800-8P

- **6DR2800-8T Analogue input module for thermocouples and mV transmitters (T)**
  For the direct connection of thermocouples and mV transmitters, and to increase the number of analogue inputs in the standard unit

can be fitted in slot 2 as AE4	S8 = 0 or 1
or in slot 3 as AE5	S9 = 0 or 1

The measuring span is ≥ 10 mV, the start-of-scale value ≤ 50 mV. The module is electronically isolated. The user selects the measuring span and start-of-scale value by jumper settings on the module. Trimming takes place during operation at the rear of the module. The signal is linearised using the lineariser in the standard unit (see section 1.4.4, Figures 1-27 and 1-28 to 1-31). A temperature sensor located on the terminal block is used for cold junction compensation. An external cold junction may also be used. The following thermocouples can be connected:

to DIN IEC 584 Part 1:	Cu-CuNi	type T
	Fe-CuNi	type J
	NiCr-Ni	type K
	NiCr-CuNi	type E
	Pt10Rh-Pt	type S
	Pt13Rh-Pt	type R
	Pt30Rh-Pt6Rh	type B (jumper settings on one side to E)
to DIN 43710:	Cu-CuNi	type U
	Fe-CuNi	type L

As the low drift input amplifier possesses a very high common mode rejection, a low-frequency AC or DC voltage of up to ± 10 V may occur between the transmitter and the controller earth. This means that where two SIPART DR22s are fitted with thermocouple inputs, and the controllers are connected to one another via the earth cable, unisolated (surface welded, undefined earth) thermocouples can also be connected. If this is not the case, we recommend that pin 3 be connected to the reference line (terminal 1 on the standard unit) to prevent undefined common mode voltages. Electrical isolation is then provided by the power supply. Trimming with an mV signal is implemented by this type of connection.

If desired, thermocouples can also be connected via thermostats/compensation boxes, or directly, with an internal cold junction, to temperature sensors fitted to the terminal block (terminals 1 and 2). The compensation circuit has a reference point of 0 °C. It generates a negative field voltage of the same size as the thermoelectric e.m.f of the connected thermocouple/its compensation cables on the terminal pair 3 and 4. This compensation is only effective when the jumper setting "NORM" is selected. If trimming is performed with an mV signal, the jumper setting "NORM" on the module must be set to "TEST" for the duration of the calibration.

The selection of thermocouple type for internal compensation is determined by jumper settings on the module, as is the setting of the start-of-scale value Uo and the measuring span ΔU. For thermocouples of type B, thermocouples with an external cold junction, and mV signals not emanating from a thermocouple, the jumper setting for "thermocouple type" should be left open (single pole connection to E). The jumper setting can remain on "TEST" during operation for thermocouples with an external reference junction and pure mV signals.

A further jumper setting on the module determines whether the input signal is forced down-scale or up-scale following a thermocouple breakage.

Selection of the start-of-scale value Uo is performed by a jumper setting on the module. Refer to the appropriate DIN/IEC table. The mV range is then added programatically (the gradations on the module are: 0.5, 1, 2, 4, 8, 16, and 32 mV). A further jumper in this sequence determines whether the voltage at the start-of-scale is positive (= P) or negative (= N).

Jumper settings for the measuring span ΔU are shown in table 2-2.

Calibration of the measuring range (start-of-scale value and span) is performed by an mV transmitter via the trimming resistors on the rear of the module; set the jumper to "TEST". Set the jumper to "NORM" for thermocouples with internal cold junctions. Trimming is accomplished either via the displays on the front module (in accordance with any configuring already undertaken), or an analogue output is assigned to the appropriate input. The analogue input should be configured for 4 to 20 mA.

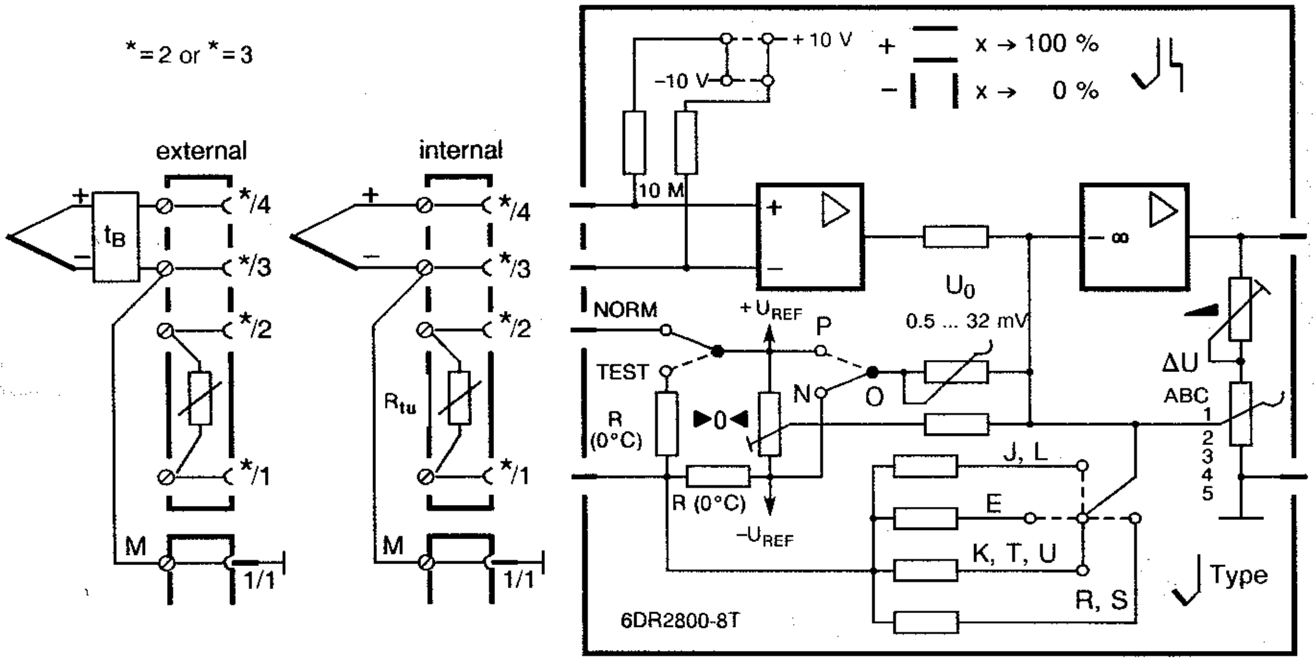


Figure 1-8 Block diagram for thermocouples/mV module 6DR2800-8T

- **6DR2801-8D Digital output module with two 35 V BA relays**
  (supersedes 6DR2801-8A, see Section 2.2.3 Wiring of option modules)

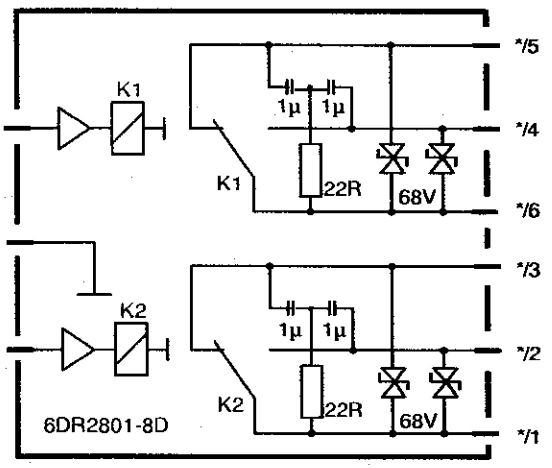
  For the conversion of 2 digital outputs/slot to 35 V relay contacts.

  can be fitted in slot 5 (S22 = 3) as BA9 and BA10
  or in slot 6 (S23 = 3) as BA13 and BA14

This function is configured by switches S76 to S85, mode of operation by switches S86 to S93.

This module is fitted with two relays whose changeover contacts have floating outputs.
The RC combinations of the spark suppressors are each wired parallel to the NC and NO contacts.
AC consumers of a very low rating can be affected by the current flow (eg. holding current on contactors) across open contacts on the spark suppressor capacitors (1µF). In this case, replace the capacitors by ones with lower capacitance values. The 68-V suppressor diodes fitted parallel to the contacts have an additional action and limit the induced voltage.

> ⚠ **Warning**
> The relay contacts are only suitable for switching voltages of up to AC/DC 35 V!



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

* = 5 or * = 6

Figure 1-9 Block diagram for relay module 6DR2801-8D

- **6DR2801-8B Digital output module with 4 BA 24 V, and 1 BE (BLPS)**
  To increase the number of digital outputs in the standard unit

  can be fitted in slot 5 (S22 = 1) as BA9 to BA12
  or in slot 6 (S23 = 1) as BA13 to BA16

The function is configured by switches S76 to S85, mode of operation by switches S86 to S93.

The module has four digital outputs ≥ 19 V ≤ 30 mA. The output signals are referred to the reference line M and are short-circuit proof. They can drive standard relays and 6DR2804-8A/8B contact relays directly.

If the additional digital input on this module is connected to L+ on the standard unit (or any other +24 V voltage), parameterisation and configuring from the front module is inhibited (see sections 3.2 and 1.4.3).

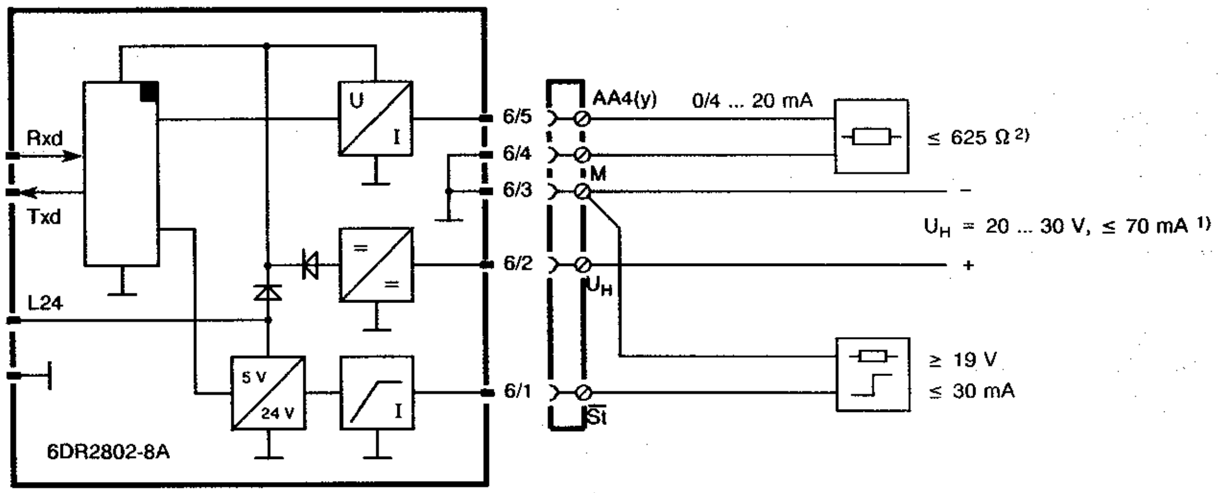
- **6DR2801-8C Digital input module with 5 BE**
  To increase the number of digital inputs in the standard unit

  can be fitted in slot 5 (S22 = 2) as BE5 to BE9
  or in slot 6 (S23 = 2) as BE10 to BE14

The function is configured by switches S24 to S38, mode of operation by switches S39 to S46.

- **6DR2802-8A Analogue output module with y_{hold} -function**
  As a substitute controller during service activities and to increase the number of analogue outputs in the standard unit.

can be fitted in slot 6 (S23 = 4)
allocation fixed to y, use S72 to select start-of-scale value



1) U_H only needs to be connected if the output signal needs to remain stable during a power cut to the controller, or if the module has to be removed for service purposes.
2) Up to 900 Ω, depending on the supply (see 1.5.3)

Figure 1-10 Block diagram y_{hold}-module 6DR2802-8A

The microprocessor on the y_{hold}-module and the slave processor on the main board communicate serially with each other via Rxd/Txd. The processor supplies the U/I converter and the CPU fault alarm $\overline{St}$ via its analogue output. The module can be supplied externally via its auxiliary supply input, which is ORed with the power supply voltage to the controller. The analogue output on the module is always assigned the manipulated variable (y) of the K controller.

– y_{hold}-function

The analogue output retains its current value if communications with the y_{hold}-processor are interrupted. When communications are restored, the slave processor first reads the current value of the manipulated variable, and then causes the controller output to track this value. In this way, the following modes of operation are possible:
The output signal will remain stable when:
- the CPU self-diagnostics facility is activated (see 1.3.3).
- power supply to the controller is interrupted and the y_{hold}-module is on a separate supply.
- all modules apart from the power supply unit (if the y_{hold}-module is not on a separate supply) are removed.
- the y_{hold}-module is removed (caution: module prone to static! Observe precautionary measures!) and it is on a separate supply (error message on the front module OP. *.6 Err, see 1.3.3).

It is therefore possible to perform all service activities, including replacing the controller, while maintaining the controller's manipulated variable. A bumpless restart is achieved by tracking the manipulated variable held in the y_{hold}-module.
See section 5, Maintenance, for directions as to how to replace modules.

- **$\overline{St}$ alarm output**

This digital output is always high when no error is present, and low otherwise. It is activated when:
- the CPU self-diagnostics facility is activated (see 1.3.3)
- power supply to the controller is interrupted
- the Y_{hold}-module is removed
- the main board is removed.

- **6DR2803-8C Serial Interface (SES)**

Can be fitted in slot 4. Configuring switches S105 to S107 are used to establish the communications procedure.

This interface is used to connect the SIPART DR22 to a higher-level system for operation and monitoring and/or configuring purposes. By way of the interface all process variables, the remote and local setpoint, the remote manipulated variable, the local manual manipulated variable and status flags, parameters and configurations can be transmitted and received.

Interface communication may take place via:

RS232	Point-to-point
SIPART bus	With the SIPART bus driver as a serial data bus with a maximum of 32 stations
RS485	As a serial data bus with up to 32 stations, currently not for SIPART DR22

The interface module 6DR2803-8C offers electrical isolation between Rxd/Txd and the controller. Switching between RS232, SIPART BUS and RS485 is performed by a jumper.

Use as an RS485 interface is currently not possible in the SIPART DR22.

A comprehensive technical manual (order no. C73000-B7400-C133) describing the protocol is available for those wishing to write driver software.
The old interface module 6DR2803-8A for SIPART bus and RS232 without electrical isolation can also be used. For a description see the manual, SIPART DR22 C73000-B7400-C222, version < 8.

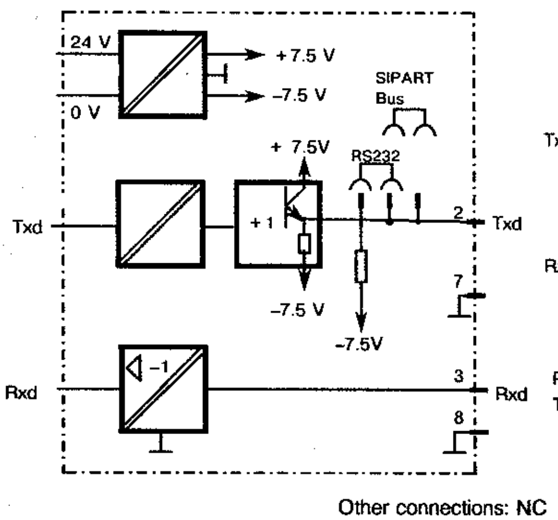


Fig. 1-11a Block diagram serial interface with RS232/SIPART BUS

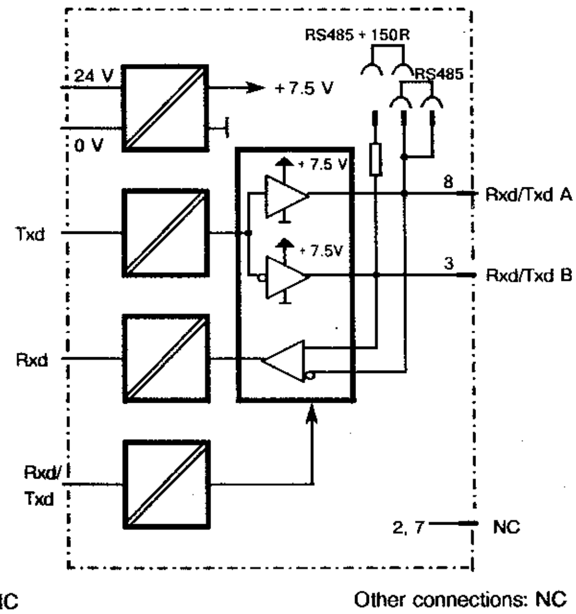


Fig. 1-11b Block diagram serial interface with RS485

- **C73451-A347-B202 SIPART-bus driver**

The bus driver acts as the link between a SIPART bus, with a maximum of 32 stations, and the V.28 or TTY point-to-point communication with the remote system. It is supplied as a separate module ready for fixing to a mounting rail. Up to 32 controllers can be connected to the bus (cable runs should be kept as short as possible).

The SIPART bus can power cables up to a capacitance of 25 nF, which corresponds to a cable run of 500 m using the recommended ribbon cable. The point-to-point link to the remote system can power 2.5 nF (corresponds to 50 m unscreened cable) in V.28 mode, and 75 nF (1500 m unscreened cable) in TTY mode.

The maximum permitted cable capacitance depends on how low the resistance is on Txd. The values specified here only apply to SIPART modules. External resistances etc. must be taken into account when connecting to a remote system.

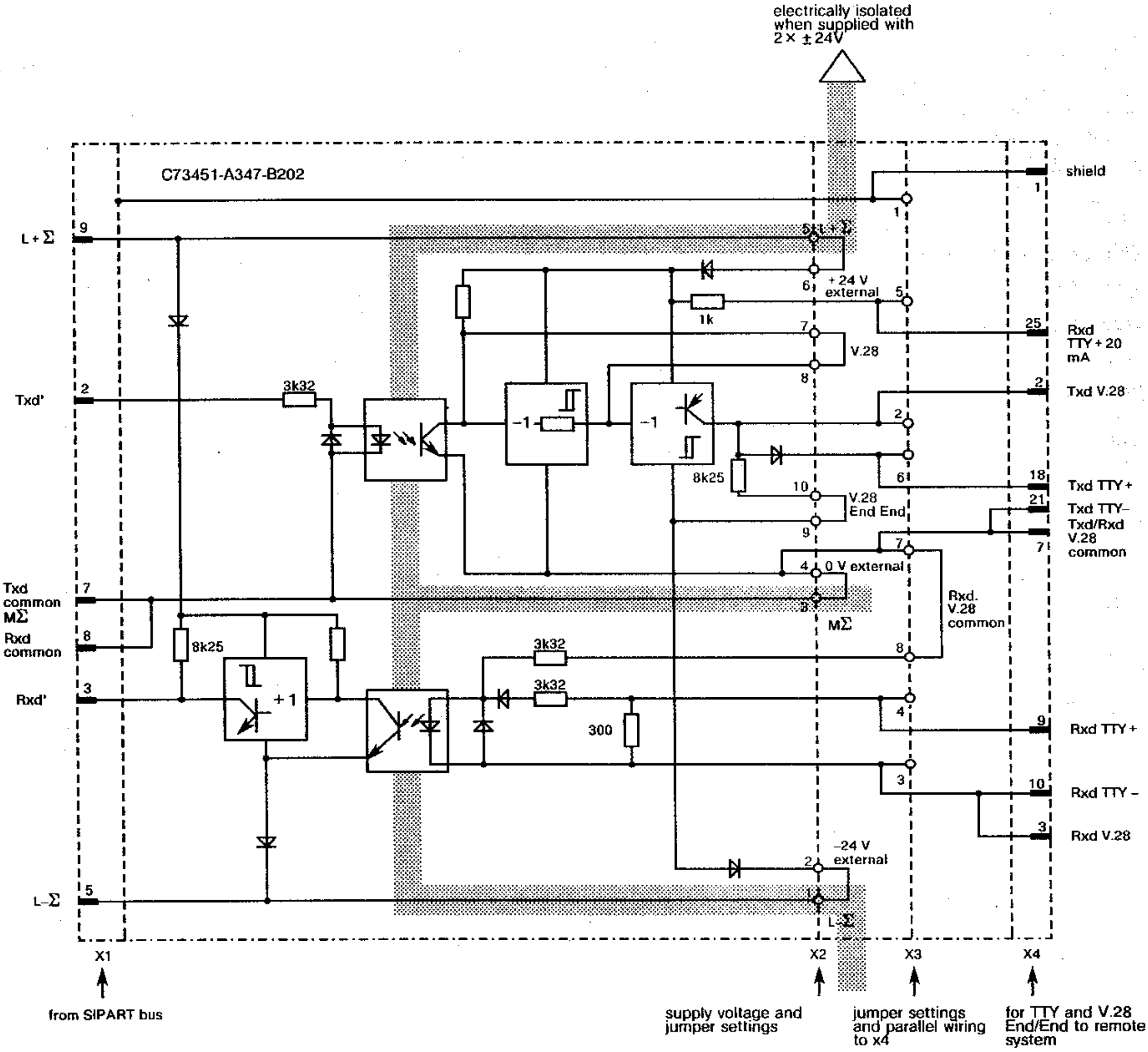


Figure 1-12 Block diagram SIPART bus driver C73451-A347-B202

The bus driver concentrates the parallel connected SES terminations from up to 32 stations on port x1.

On the transmit side of the controller SES (Txd), corresponding to the bus driver's receiver input (Txd'), the inactive state is passive via resistances on the SES modules < 0 V. As only one SES station can transmit on demand, the bus then becomes positive active > +5 V.

On the receive side of the controller SES (Rxd), corresponding to the bus driver's transmit output (Rxd'), the signal is strong enough to supply the inputs of all 32 stations. The inactive state here is passive > 0 V, the transmit state active negative < –5 V.

For communication with a remote system there is a choice of using either V.28 point-to-point or TTY current loop at the remote system side (port x4). Each time you alternate between these two, connections have to be amended (refer also to section 2.2.5), and the mode of operation determined by the jumpers x2/7 – x2/8 (without jumpers: TTY mode, inactive state 20 mA. With jumpers: V.28 mode, inactive state < –5 V).

When operating in V.28 mode, the jumper x2/9 must also be set = x2/10 to ensure a negative signal, and Rxd V.28 common and Txd V.28 common must be connected (x3/7 = x3/8), as the V.28 standard prescribes three-wire communication and Rxd and Txd both lie on a common supply point. As a result of this connection, it is no longer possible to use the optocoupler of the Rxd input for electrical isolation purposes during V.28 point-to-point communications (see Figure 2-38).

The Rxd input is normally implemented by an optocoupler in TTY operation in order to make full use of electrical isolation facilities when two TTY interfaces are connected (see Figure 2-41).

If the remote system TTY transmit is only a switch (eg. an optocoupler), rather than an active signal source, then the necessary current is drawn via a resistance from the bus driver +24 V external (connection Rxd TTY +20 mA). If the remote system Rxd and Txd are both implemented by optocouplers, then electrical isolation is also achieved in this case (see Figure 2-42).

The ± 24 V power supply for the bus driver is supplied from an external power supply unit (a suitable unit for fitting to a mounting rail is 6DR2900-8BA). If the bus driver is supplied with one ± 24 V supply, the required jumper settings x2/1 = x2/2, x2/3 = x2/4 and x2/5 = x2/6 means there will no electrical isolation between the bus side (Rxd', Txd') and the point-to-point side to the remote system (Rxd, Txd).

If two ± 24 V (1 × ± 24 V supplies are available (one for the bus side and one for the point-to-point side), then electrical isolation is achieved without having to set the appropriate jumpers (see Figures 2-39 and 2-40).

Note:

If a Teleperm-D device is on the bus, this supplies the bus side of the driver via the bus cable terminals L+Σ, MΣ and L–Σ. If the aforementioned jumpers are set, it can supply the entire bus driver, though with no electrical isolation. If electrical isolation is required, the point-to-point side (terminals + 24 V external, 0 V external, – 24 V external) must be supplied from an external ± 24 V source.

- **6DR2804–8A Interface relay with 4 contacts 230 V**
  8B Interface relay with 2 contacts 230 V

For the conversion of 2 or 4 digital outputs to 230 V relays

Can be snapped on to mounting rails, eg. on the rear of the controller.
Each module contains one or two relays modules, depending on the version. Each relay module is fitted with two contacts and a suppressor diode connected in parallel to the coil. Each relay has a changeover contact and spark suppressor in both possible circuit configurations. AC consumers of a very low rating can be affected by the current flow (eg. holding current on contactors) across open contacts on the spark suppressor capacitors (33 nF). In this case, replace the capacitors by ones with a lower capacitance. The changeover contact is connected to the plug-in terminal block by a three pole cable, so that it's possible to switch between normally open and normally closed circuits. The relays can be energised by the controller's digital outputs.

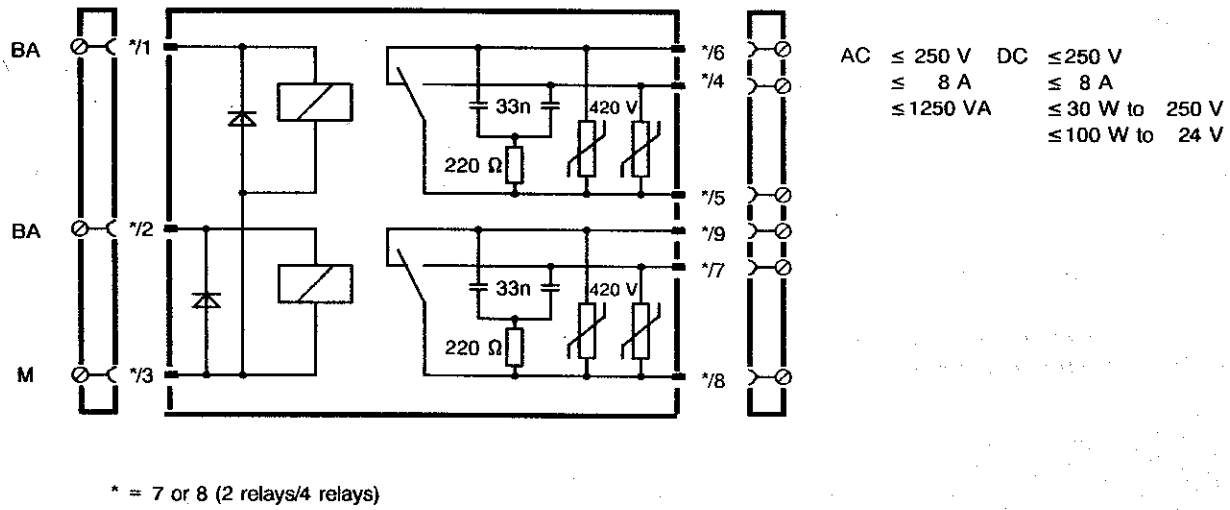


Figure 1-13 Block diagram of interface relay 230 V 6DR2804-8A (4 relays), 6DR2804-8B (2 relays)

⚠ WARNING

The relays used here are designed to carry a maximum switching voltage of 250 V AC/DC in surge class III and pollution degree 2, as specified in DIN/VDE 0109 Dec. 83 (→ IEC 664 and 664A). The same applies to ventilation clearances and the creepage path on the main board. Resonance sharpness of up to double the rated voltage on the open contact assembly can occur when driving phase-shift motors.

Phase-shift motors that generate such high resonance sharpness should only be driven by suitable switching elements, adhering closely to the technical data and the relevant safety regulations.

1.3.3 CPU Self-diagnostics

The CPU executes self-diagnostic routines, either cyclically or following a reset. There are three different types of reset:

- **Power On-Reset**
  always occurs if the 5 V supply drops below 4.45 V, ie. power is interrupted for longer than is specified in the technical data.
  All parameters and configurations are reloaded into RAM from the user program memory. Actual process values and status flags are reloaded from the EEPROM
  If S100 = 1, the digital x-display flashes to indicate that a Power On Reset has occurred. Acknowledge it by pressing the selector pushbutton (12).
  If S100 = 0, flashing is suppressed.

- **Manual Reset**
  The manual reset pushbutton is located on the main board and accessible once the front module has been removed (see 5. Maintenance).
  Loading procedures and indicator functions are identical to those for a Power On Reset.

- **Watch dog-Reset**
  Both processors are equipped with integrated watch-dog timers that independently monitor the cyclic execution of the programs.
  When a Watch-dog Reset occurs, all parameters and configurations are reloaded into RAM from the user program memory. Actual process values and status flags to enable processing to continue are taken from RAM.
  Flashing on the front module does not occur.

CPU-tESt appears in the x and w displays for a maximum of 5 seconds following every reset.
Every identifiable self-diagnostic error causes a flashing error message to be output to the digital x and w displays. Analogue and digital outputs are in a defined state. The alarm output, $\overline{St}$, of the Y_{hold} module will be low. The reactions listed in table 1-1 will of course only take place if the appropriate outputs and/or front module can still be driven correctly following the error, and the outputs themselves still function correctly.

If S4 = 1 (freely configurable input area), additional error messages occur that indicate incorrect configuring (see sections 3.3.6 and 3.3.7).
Further error messages are output during adaptation (see section 3.2.3) and parameter control (see 3.3.3).
All error messages are output to the digital w and x displays and flash.

Error message digital w digital x	Monitoring of	When monitored	Monitored by	Reactions							Probable cause of error-remedy
				Y_{hold}-module			Basic unit		Options 2)		
				$\overline{St}$	AA4 with U_H	AA4 without U_H	AA1 to 3	BA1 to 8	BA9 to 12	BA13 to 16	
CPU Err	EEPROM	Manual Reset Power On Reset Watch dog Reset	master µP	0	last y	last y 0 mA last y	0 mA	0	0	0	Monitored CPU modules defect - replace main board
	external RAM, RAM master µP, external EPROM	Manual Reset Power On Reset	master µP	0	last y	last y 0 mA	0 mA	0	0	0	
	Data traffic, master-slave µP	cyclic	master µP and slave µP	0	last y	last y	0 mA	0	0	0	
CPU. Err	RAM slave µP, ROM slave µP	Manual Reset Power On Reset Watch dog-Reset	slave µP	0	last y	last y 0 mA last y	0 mA	0	0	0	Slave µP defect - replace main board
MEM Err	User program memory	Manual Reset Power On Reset Watch dog Reset	master µP	0	last y	last y 0 mA last y	0 mA	0	0	0	User program memory module not present or defect - insert or replace
		during save			continue processing using current data				continue processing using current data		
OP.5.* 1) Err	Data traffic slave µP-slot 5	cyclic	slave µP and master µP	0	continue processing using current data				latest status or undefined	continue processing using current data	Option module not present, or defect, or S22 does not correspond to option - insert option module, or replace, or correct (S22 3)
OP.*.6. 1) Err	Data traffic slave µP-slot 6	cyclic	slave µP, master µP	0	removed last y defective undefined	removed 0 mA defective undefined	continue processing using current data		continue processing current data	latest status or undefined	Option module not present, or defect, or S23 does not correspond to option - insert option module, or replace, or correct (S23 3)
x, w, y-displays flash	Data traffic slave µP-front module	cyclic	slave µP	0	continue processing using current data						Front module defect - replace front module

1) duplicate error display OP.5.6 possible, * indicates invisible character

2) When an error occurs, the signal of digital inputs BE5 to 9 and BE10 to 14 is set to 0 (following inversion).

3) If a S22/23 2BA relay has been selected by S22/S23, no monitoring occurs

Table 1-1 CPU Error message

1.4 Functional Description of configuring switches

Controllers normally leave the factory with configuring switches set to "0". This is the normal setting for the individual functions, so in most cases only a few selected configuring switches will need to be set during commissioning. It is always wise, however, to check that individual configuring switch settings are compatible with the application in hand.
Configuring switch S0 is used in configuring mode StrS to assign the various user programs a number from 1 to 254. The factory setting is 0, and this is automatically regenerated by the APSt (All Preset) function. Switch S0 automatically flips from 0 to 1 each time the factory setting of a parameter or configuration is amended via the Front module.
Configuring switches S1 and S2 are extremely important. S1 is used to select the controller type, and consequently affects how command, final and secondary controlled variables are processed, and how the control deviation is calculated. S2 is used to define the controller's output configuration, which in turn establishes how the automatic, hand, safety and tracking manipulated variables are processed, as well as determining whether the manipulated variable output is an S or K function.
The functions behind configuring switches S3 to S98 correspond to the logical signal processing sequence. S99 and S100 define restart conditions, and S101 to S107 the communications procedure on the serial interface. The following sections also adhere to this sequenceThe functions behind configuring switches S3 to S98 correspond to the logical signal processing sequence. S99 and S100 define restart conditions, and S101 to S107 the communications procedure on the serial interface.
The following sections also adhere to this sequence.

1.4.1 Standard connections for analogue input signal processing (S3 to S21)

If S4 = 0, the analogue input area connections are standard (see Figure 1-14). If S4 = 1, this standard assignment is disabled, and the whole input area can be freely configured (see section 1.4.2).
Signals to each of the 5 analogue inputs pass through an AD converter that suppresses 50/60 Hz. Interference (S3) by averaging over 20 or 16 2/3 ms respectively. S5 to S9 are then used to normalise each 0/4 – 20 mA signal range to a working range of 0 – 100 %.
S5 to S9 are also used to establish whether measuring range monitoring (to detect transmitter faults) is required. Monitoring is the responsibility of a separate AD converter routine that performs no averaging so that should a transmitter fail, the switchover to manual operation via S63 is bumpless. The monitoring routine reports dips and surges of – 3 % and + 103 %, allowing a hysteresis of 1 %, on the digital x and w displays. Individual alarms are ORed to create a group transmitter fault signal MUF, that can be assigned to a digital output and negated if desired (see section 1.4.8). Only those analogue inputs actually selected for transmitter fault monitoring will be monitored and displayed on the Front module (nothing is indicated on the Front module displays of analogue inputs that are not being monitored). Their alarm signals are input to the OR function. The selector pushbutton (12) is used to acknowledge error messages. The alarm signal generated by the OR function remains on until the offending analogue input signals are within limits again.
Following monitoring of the measuring range, the 5 analogue signals are each passed through a first order filter that can be set by the parameters tF1 to tF5 in parameterisation mode onPA either to oFF, or from 0.1 to 1000 seconds. The factory setting is 1 second.
The square root of each signal can now be calculated, if desired, using S10 to S14. Having calculated the square root, the 5 analogue inputs become available for further processing, and are now known as outputs AE1A to AE5A.
All types of controller (S1) always process the 6 function inputs FE1 to FE6. FE1 to FE3 are assigned different functions, depending on the type of controller (see 1.4.4). A lineariser is connected infront of function inputs FE1 to FE3 so that the actual physical values of non-linear process variables can be correctly represented (see 1.4.2 function block Fu for mode of operation, and 1.4.4 Figure 1-27 and Figures 1-28 to 1-31 to set the 13 vertices).
The function input FE4 is used exclusively for feedforward control, either via the D element or the controller output signal (S55). Function inputs FE5 and FE6 are used to determine the controller's output configuration and are reversed depending on the setting of S2. FE5 is used as the input tracking signal y_N for the manipulated variable on K controllers (S2 = 0), and FE6 for manipulated variable feedback y_R on S controllers with internal feedback (S2 = 1), or for position feedback y_R on S controllers with external feedback (S2 = 2).
Configuring switches S15 to S19 are used to assign outputs AE1A to AE5A to the function inputs FE1 to FE5/6. The outputs AE1A to AE5A and function inputs FE1 to FE6 can be assigned to analogue outputs (S73 to S75), limit signals (S94 to S95) and used for parameter control (S60). They may be read via the SES. The majority of control applications can be implemented using different types of controller and output configurations in conjunction with this input structure.

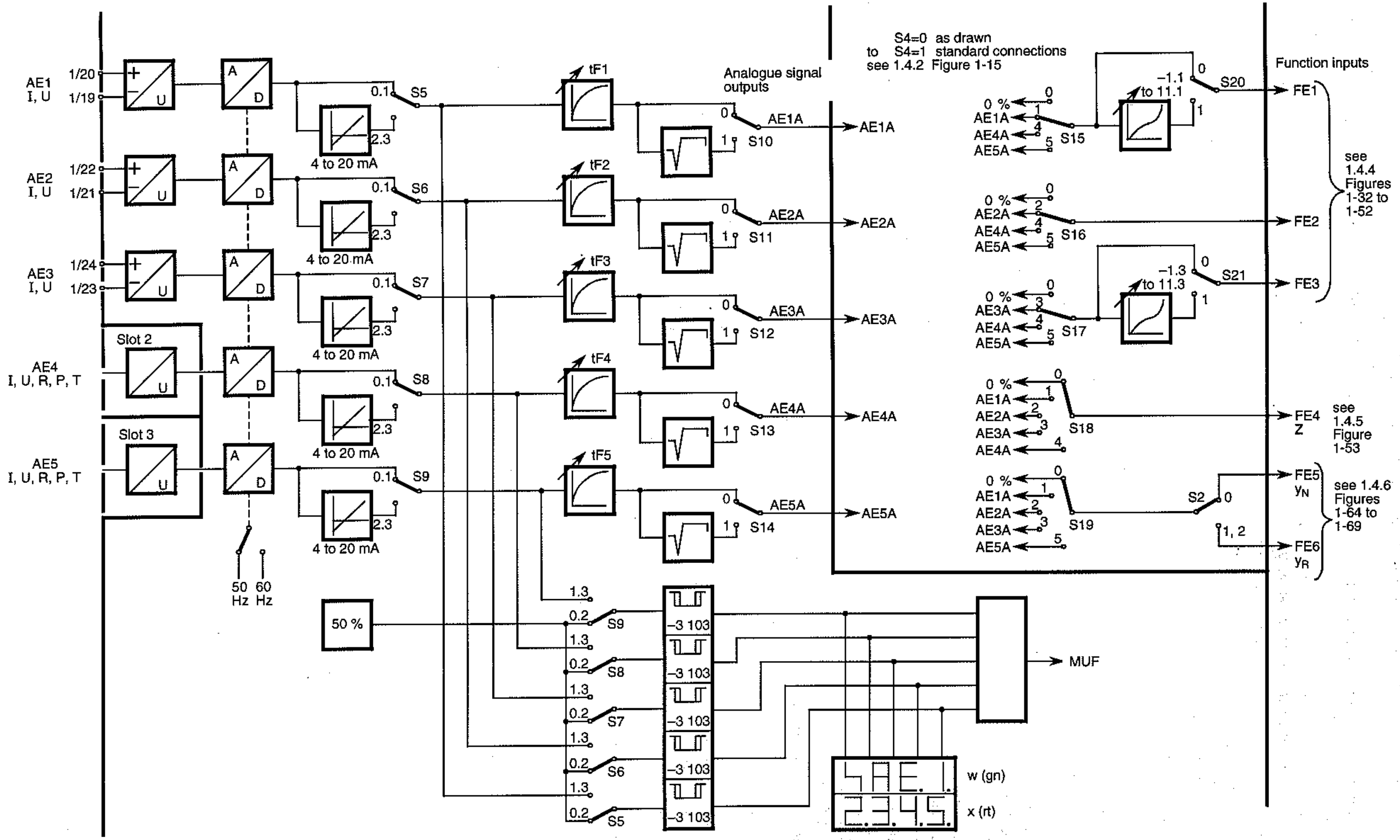


Figure 1-14 Standard connections for analogue input signal processing (S4=0)

1.4.2 Freely configurable analogue input signal processing (S3 to S14)

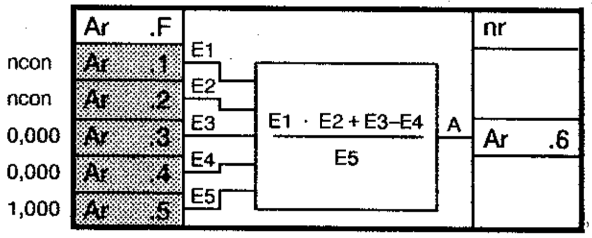
If S4 = 1, the standard connections of the analogue input area (S4 = 0) are disabled and all connections can be freely configured (see Figure 1-16).
In principle, this freely configurable input area represents a very flexible single multifunctional entity.
Signal processing is identical to that described in section 1.4.1 up to and including we come to the outputs AE1A to AE5A. The function inputs FE1 to FE6 also work in the same way, except that FE5 (tracking input) and FE6 (positional feedback input) can be used in parallel (see section 1.4.6, S controller with external positional feedback).
If required, as many as five different types of function block can now be freely configured between the outputs AE1A to AE5A and the function inputs FE1 to FE5. Each block may be used as often as required. The outputs AE1A to AE5A represent data sources, whereas the function inputs FE1 to FE5 are data sinks. 10 connectable linear parameters with a range of –1.999 to 9.999 (corresponding to –199.9% to 999.9%) and a number of standard constants are arranged in parallel to the outputs as data sources.
Depending on its complexity, every function block has a different number of inputs (data sinks), and one output (data source).

Parameters are assigned to function blocks, linearisers and correction computers in configuration mode oFPA. The connectable parameters P1 to P10 are assigned in parameterisation mode onPA.

The required functions are selected and defined by configuring via the front module (configuring mode FdEF), connected (configuring mode FCon), and sequenced in the processing cycle (configuring mode FPoS), see sections 3.3.5 to 3.3.7. There are no restrictions regarding interconnectability, ie. any data source can be connected to any data sink. Data sources and sinks of functions that have not been defined are masked out to save time. In addition, data sinks that are only optionally required for a particular function are assigned constant values that may nevertheless be overwritten. Any inputs that are by default ncon (not connected) are mandatory for the function and must be connected. This extremely flexible configuring potential within the analogue input area enables solutions to be found for even the most complex application problems.

- **Function block descriptions**

– **Arithmetic Ar1 to Ar6**



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

E5 is limited to values ≥ 0.5 %

Figure 1-15 Function block arithmetic Ar1 to Ar6

This function block performs the four basic arithmetic operations by assigning 0 or 1 to the inputs. The default setting E3 = E4 = 0, E5 = 1 gives A = E1 × E2.

Typical industrial applications are dosing or weighting (E1 × E2), measuring range offset (E1 × E2 + E3) or difference generation (E3 - E4).

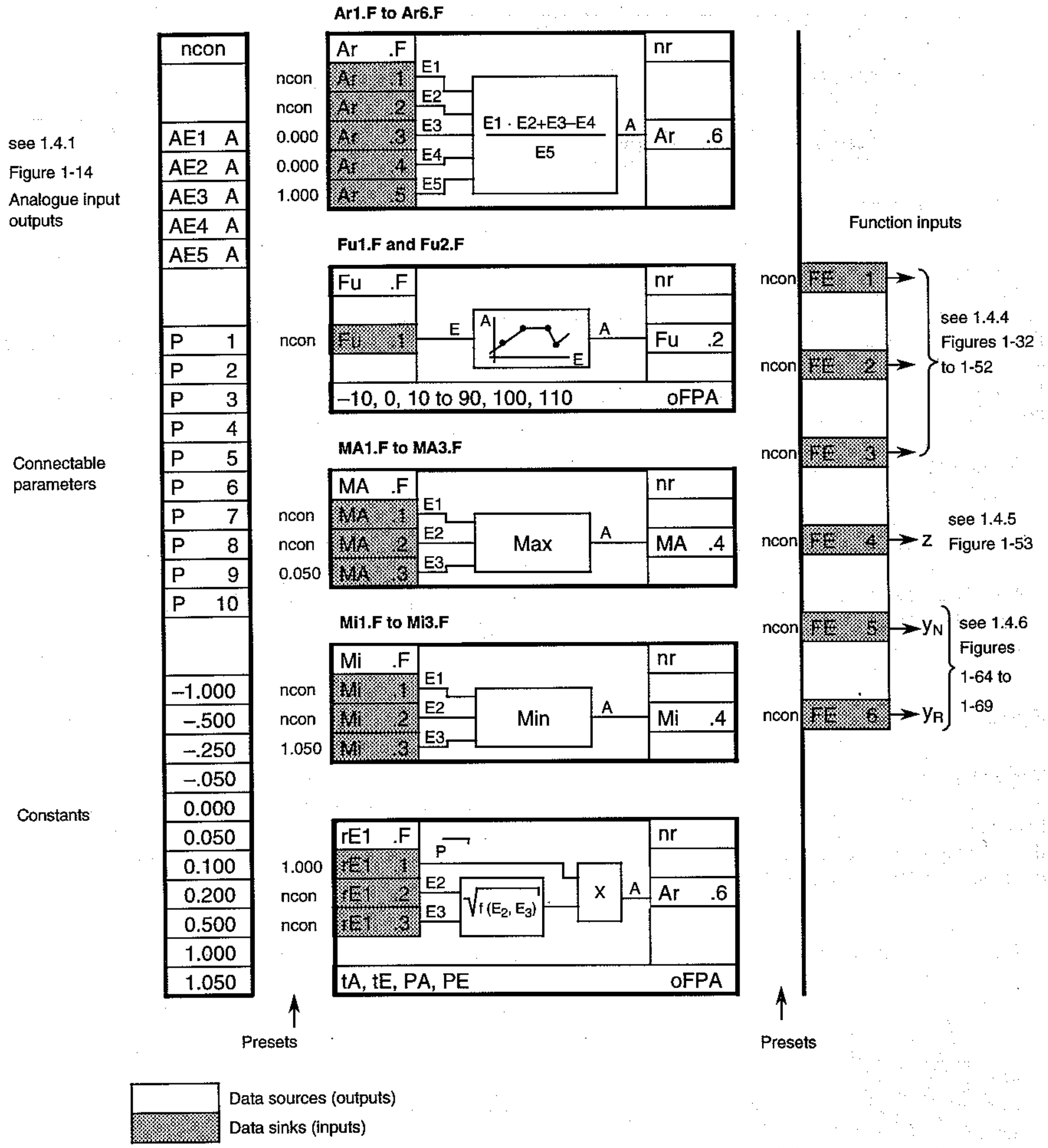


Figure 1-16 Freely configurable analogue input signal processing (S4=1)

- **Linearisers Fu1 and Fu2**

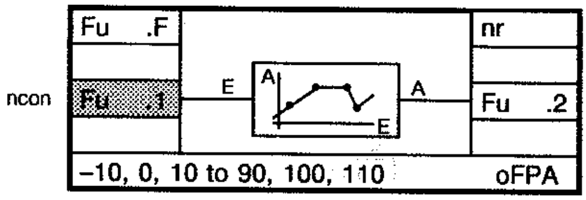
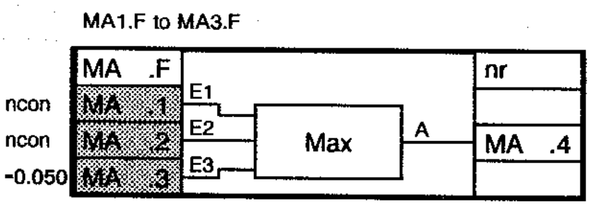


Figure 1-17 Function block linearisers Fu1 and Fu2

For every value of the input variable E in the range –10 % to +110 %, the lineariser assigns a value in the range –199.9 % to +199.9 % to the output variable A: A=f(E). Values of –10 % to +110 % of E are passed to the function in intervals of 10 % with the aid of the parameter "vertices 1....13". Parabolas are drawn between these vertices by the program such that they merge tangenitally to create a continuous function. The vertices at –10 % and +110 % of E are required for the overflow. No further increase is produced if E rises further. When the displays are being linearised, the 13 vertices are applied to the linearisation function so that connecting it in series with the transmitters produces a straight line (see 1.4.4 Figures 1-28 to 1-31).

- **Maximum value selection MA1 to MA3**

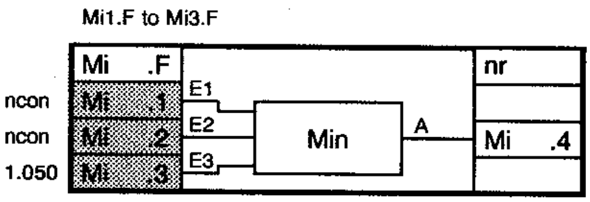


A = max (E1,E2, E3)
The largest of the three input values is passed to the output

Figure 1-18 Function block maximum value selection

The default operation of this function passes the largest of E1 and E2 through to A, at the same time limiting it to the value of E3 (–5 %). Typical applications are in maximum value selection circuits and minimum value limitation.
If only 2 inputs are required, the third input must be assigned a minimum value beyond the range of both inputs, otherwise minimum value limitation will occur.

- **Minimum value selection Mi1 to Mi3**

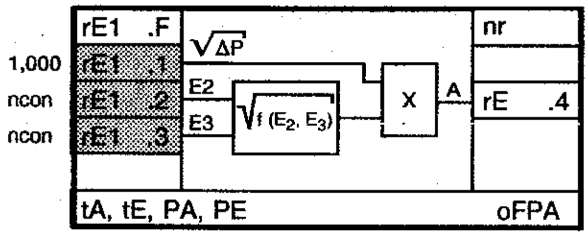


A = min (E1, E2, E3)
The smallest of the three input values is passed to the output

Figure 1-19 Function block minimum value selection

The default operation of this function passes the smallest of E1 and E2 through to A, at the same time limiting it to the value of E3 (105 %). Typical applications are in minimum value selection circuits and maximum value limitation. If only 2 inputs are required, the third input must be assigned a maximum value beyond the range of both inputs, otherwise maximum value limitation will occur.

• **Correction computer rE1 for ideal gases**



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

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

Figure 1-20 Function block correction computer rE1 for ideal gases

The square root of the differential pressure signal must be present on input 1. The measuring range is standardised to the formula using the parameters PA, PE, tA and tE (lower/upper correction quotients for pressure and temperature).

Application

The correction computer is used to calculate the flow rate of gases from the differential pressure Δp, correcting for fluctuations in pressure and temperature. The medium must be in a pure state, ie. condensation of liquid must not take place. This is particularly important where the gas is near saturation level.

Errors caused by changes in the state variables of the medium (pressure, temperature) are corrected by this flow correction computer

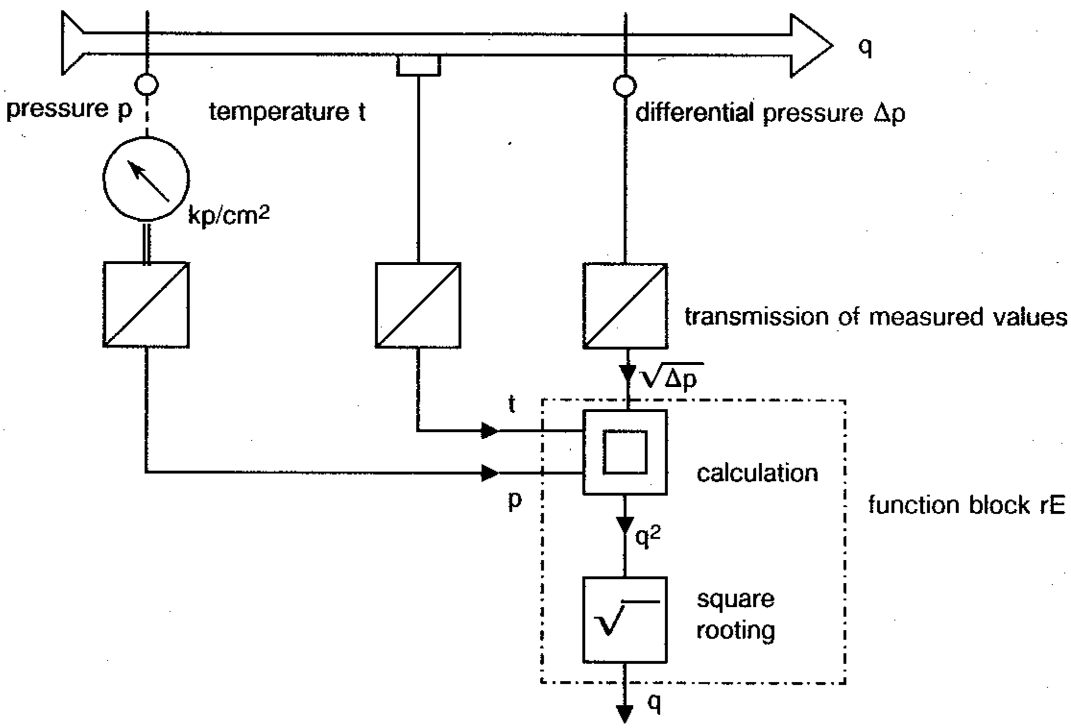


Figure 1-21 Principle of the method of differential pressure measurement

Notes on physical principles

The differential pressure method is based on the laws of continuity and Bernoulli's energy equation.
According to the law of continuity, the rate of flow of a substance in a pipe is equal at all points.
If the cross-section is reduced at a particular point, the rate of flow must increase at that point. Bernoulli's energy equation states that the total energy content of a flowing substance consists of the sum of the kinetic energy (from its velocity) and potential energy (of its pressure).
Consequently, an increase in velocity results in a loss of pressure.
This loss of pressure, the so-called "differential pressure", is used in calculating the rate of flow q.

Thus: $q = c \cdot \sqrt{\Delta p}$

where c is a factor that depends on the dimensions of the piping, the shape of the constriction, the density of the flowing substance, plus a few other factors.
The equation states that the differential pressure caused by the constriction is proportional to the square of the rate of flow.

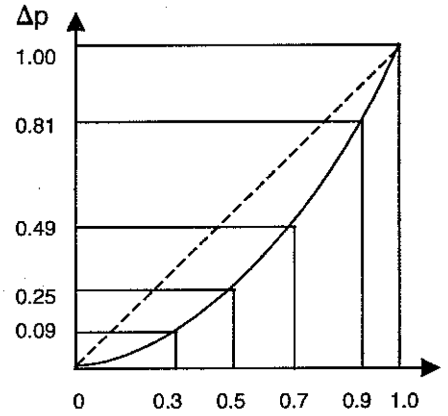


Figure 1-22 Relationship between rate of flow q and differential pressure Δp

The rate of flow at the measuring point is measured by a restrictor in the piping. This restrictor is equipped with two connections for tapping the differential pressure.
If the physical properties of the restrictor and the substance to be measured are known, the above equation can be solved, and the differential pressure can be used to calculate the rate of flow.

Once a particular restrictor has been selected, the theoretical or actual rate of flow can be expressed thus:

$q_B = K \cdot \sqrt{\rho_B} \cdot \sqrt{\Delta p}$ or $q = K \cdot \sqrt{\rho} \cdot \sqrt{\Delta p}$

Measurement errors can occur if the density during operation deviates from that used to derive the technical data for the restrictor, as density is a factor in the above equation. Consequently, during operation, a correction factor F is applied to the density.

$$F = \sqrt{\frac{\rho}{\rho_B}} = \sqrt{\frac{V_B}{V}}$$

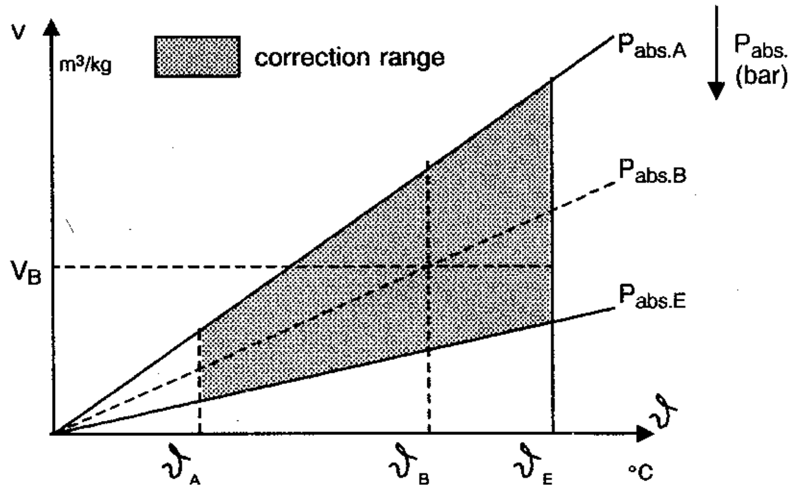
with $V = \frac{1}{\rho}$

as the specific volume.

In order to be able to perform the correction using the factor F, the current specific volume must first be established.
In the case of dry gases, the densities change according to the laws for ideal gases:

$$V = R\frac{T}{p} = \frac{1}{\rho}$$ The correction factor can then be expressed thus: $$F = \sqrt{\frac{T_B \cdot p}{p_B \cdot T}}$$

with p as absolute pressure and T as absolute temperature.



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

q rate of flow
ρ density
Δp differential pressure
p pressure
ϑ temperature (°C)
T temperature (K)
V specific volume
K correction factor for restrictor
R gas constant
F correction factor f (p, T)

Indices:

A lower
E upper
B theoretical
abs absolute value
m mass
v volume

Figure 1-23 Representation of correction range

The resulting corrected rate of flow can be expressed thus:

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

The factor $K \cdot \sqrt{\rho_B}$ in this formula has already been used for measuring the differential pressure, so may be ignored by the computer.

Referring to the correction factor results in:

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

The measuring range is standardised to the formula using the parameters PA, PE, tA and tE (lower/upper correction quotients for pressure and temperature).

Mass flow computer, qm

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

$$PA = \frac{p_{absA}}{p_B}, \qquad PE = \frac{p_{absE}}{p_B},$$

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

Volume flow computer, based on operational state q_v

As volume is proportional to the reciprocal of the density, this computer can be made by replacing inputs E2 and E3 of the mass flow computer.

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

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

$$tA = \frac{p_{absA}}{p_B}, \qquad tE = \frac{p_{absE}}{p_B},$$

Volume flow computer, based on standard state q_{vN}

As the output signal now relates to volume flow in standard state, T_N = 273, 15 K, P_N = 1.01325 bar_{abs}, and no longer to operational state, it must be corrected accordingly.

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

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

$$PA = \frac{PabsA}{PB}, \qquad PE = \frac{PabsE}{PB}$$

The following applies to all computers:

P_{absA} to P_{absE}	range of absolute pressure transmitter (bar)
T_A to T_E	range of absolute temperature transmitter (K) converted to the range of the measuring transmitter ϑ A to ϑ E: T(K) = 273, 15 + ϑ (° C)
p_B, T_B	Theoretical pressure and temperature of the orifice (absolute values)

p_B and T_B must lie within the measuring range of the transmitters; they may not lie more than a factor of 100 away from the limits of the measuring range.

PA, tA = 0.01 to 1
PE, tE = 1 to 99.99

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

If the ranges selected for PA, PE, tA or tE are not adequate, a straight line equation can be connected before the appropriate input to condition the signal (function block Ar).

1.4.3 Digital input signal processing (S24 to S48)

- **Assignment and logic of digital inputs (S24 to S46)**

see Figure 1-24
Configuring switches S24 to S38 are used to assign the control signals CB, He ...+yBL, –yBL, or a Lo status, to the digital inputs BE1 to BE14. CB (S24), P I (S30) and PII (S31) may also be High (S** = –1). Configuring switches S39 to S46 enable the control signals to be inverted if required.

The option module 5BE (6DR2801-8C) can be inserted in slots 5 and 6 to increase the digital inputs BE1 to BE4 in the standard unit by BE5 to BE9 and BE10 to BE14 respectively.

The unassigned digital input BLPS (block parameterisation and configuring) becomes available when the option module 4BA 24 V+1BE (6DR2801-8B) is inserted in slots 5 and/or 6. These digital inputs are ORed with the digital input assigned via S29. Irrespective of how slots 5 and 6 are configured, digital input signals can therefore be used to block parameterisation and configuring.

Configuring switches S22 and S23 must be set accordingly when option modules are present in slots 5 and 6, otherwise errors will occur (see 1.3.3).
All digital inputs can be read via the SES.

- **Connection of digital inputs BE1 to BE14 and control signals via the SES (S47 to S49, S101)**

see Figure 1-25
The control signals CB and N can be present either as static signals or pulses on digital inputs (pushbutton on panel). This selection is made by S47 for CB and S48 for **N**. If a pulse is selected, every rising edge will trigger the flip-flop. In the following paragraphs, the initial flip-flop status is assumed to be CB or N respectively.

When S101 = 2/3 (4, 5)[1], all control signals apart from ±Δw and ±Δy can also be sent via the serial interface and ORed with the existing control signals on the digital inputs. Incremental adjustment of w or y via the serial interface is not meaningful because of the bus delay times. The highest level of operator control when talking to a computer lies with the stand-alone controller. Control signals can therefore be switched off via the SES by ANDing them with $RC=\overline{Int} \wedge CB$ using the controller's local/remote pushbutton (2) or CB_{ES} (with optional watch-dog timer) or CB_{BE} (central computer failure).

Additionally, if S101 = 2 to 5 the internal flip-flop can be activated parallel to the pushbutton via IntES.

If S101 = 2, (4)[1] the CB signal is generated as an OR function from CB_{ES} via the serial interface and CB_{BE} via a binary input so that it is optionally possible to work with one signal.

If S101 = 3, (5)[1], the OR function is replaced by an AND function so that the CB set via the serial interface can be reset via a central computer fail line S101 = 4, 5 from software version -A07 onwards).

At the same time, the sources for the remote setpoint wES or wEA and for the remote manipulated variable yES or yN are switched with S101. The depth of contact is additionally set via the serial interface. In this way it is also possible, for example, to specify the process variables analogue and the accompanying status signals via the SES.

The function $\overline{RC}=Int \wedge CB$ also controls command variable switchover on all types of controller, even during SPC operation, and manipulated variable switchover in DDC mode (see section 1.4.4).
The two controller types S1 = 10/11 operate without command variable switchover. The local pushbutton and the control signal CB are available, with the logic operation $\overline{RC} = Int \vee \overline{CB}$, for blocking operation via the serial interface (e.g. in case of interfacing to control systems).

1) From software version -B05

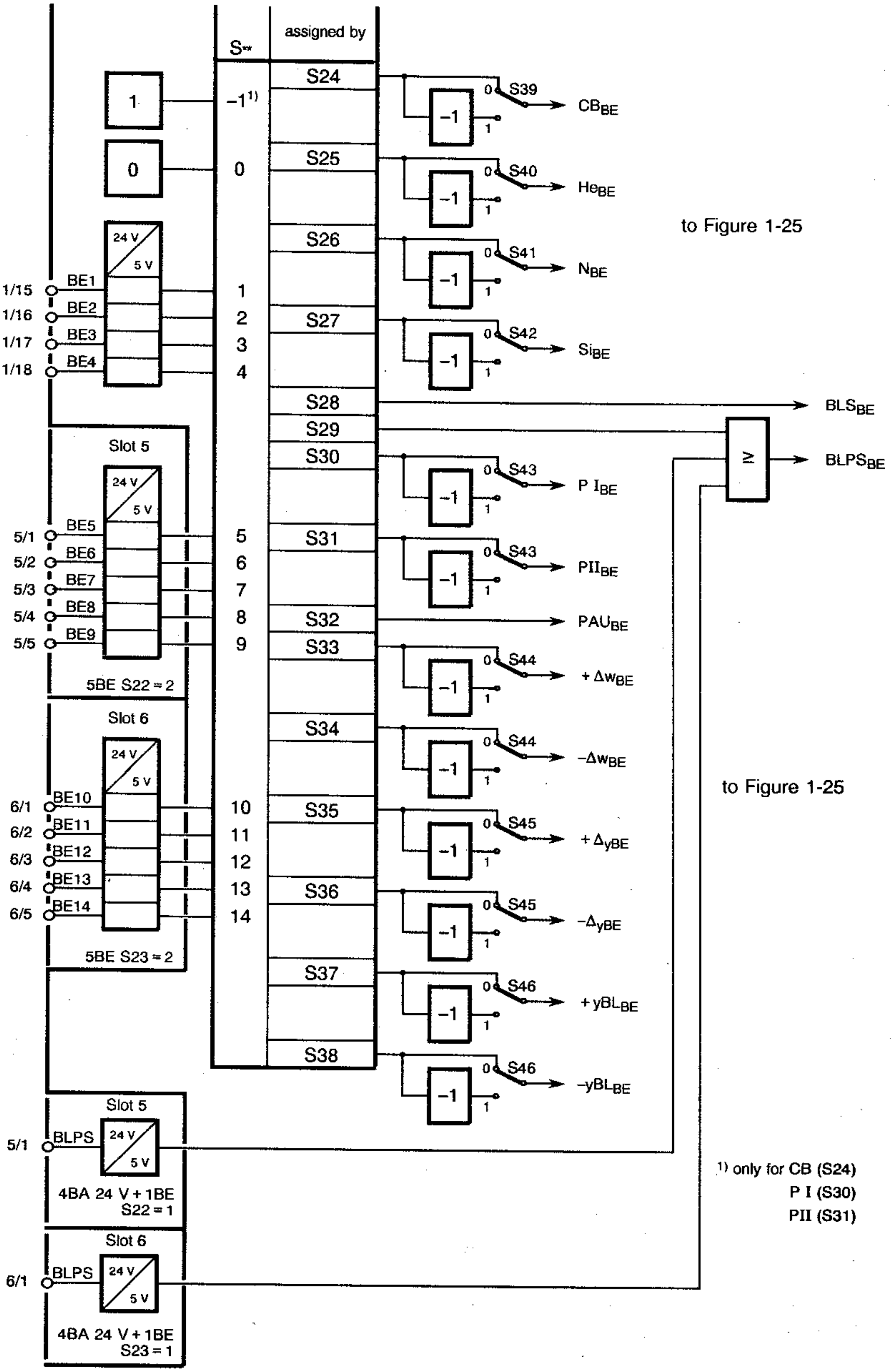
If S47 = 0, the logical function $RC = \overline{Int} \wedge CB$ performs a static switchover. If Int is preset (Local LED (1) off), CB can be used to toggle between controller and computer values (command variable and manipulated variable). Computer readiness CB is displayed inverted on $\overline{C}$-LED (3) ($\overline{C}$ = CB, CB = 1 ≙ $\overline{C}$ LED off). Computer readiness on the part of the controller is shown by an inverted $\overline{RB}$ = Int signal. Computer operation RC is also shown as an inverted $\overline{RC} = \overline{Int \wedge CB}$ signal.

If S47=1, static switchover is performed with acknowledgement. Each time the computer comes on-line again (CB flips from 0 to 1), the internal flip-flop is set to 1 (local LED on, $\overline{C}$ LED off). Computer operation
$RC = Int \wedge \overline{CB}$ then only takes effect once the local pushbutton is pressed (Int=0).
S49 can be used to deactivate the local/remote pushbutton. Local or remote operation must then be selected in advance.

The control signal H is created as an OR function from the manual/automatic pushbutton (9) with subsequent flip-flop (Hi) and the control signal He. He can be input via the SES or digital inputs in the same manner as described above.

Configuring switch S64 is used to prevent manual/automatic switchover, locking the controller in either automatic only (H = 0) or manual only (H = 1). The Manual LED (8) displays the current mode (refer also to section 1.4.6).

If S64 = 0 to 2, He is input statically both via the SES and via the digital inputs. If S64 = 3/4 (software -B05), input is dynamic, that is, every rising edge switches manual-automatic-manual. Additionally, if configuring switch S64 = 4, blocking of HeES with $\overline{RC} = Int \vee \overline{CB}$ is cancelled.



1) only for CB (S24)
P I (S30)
PII (S31)

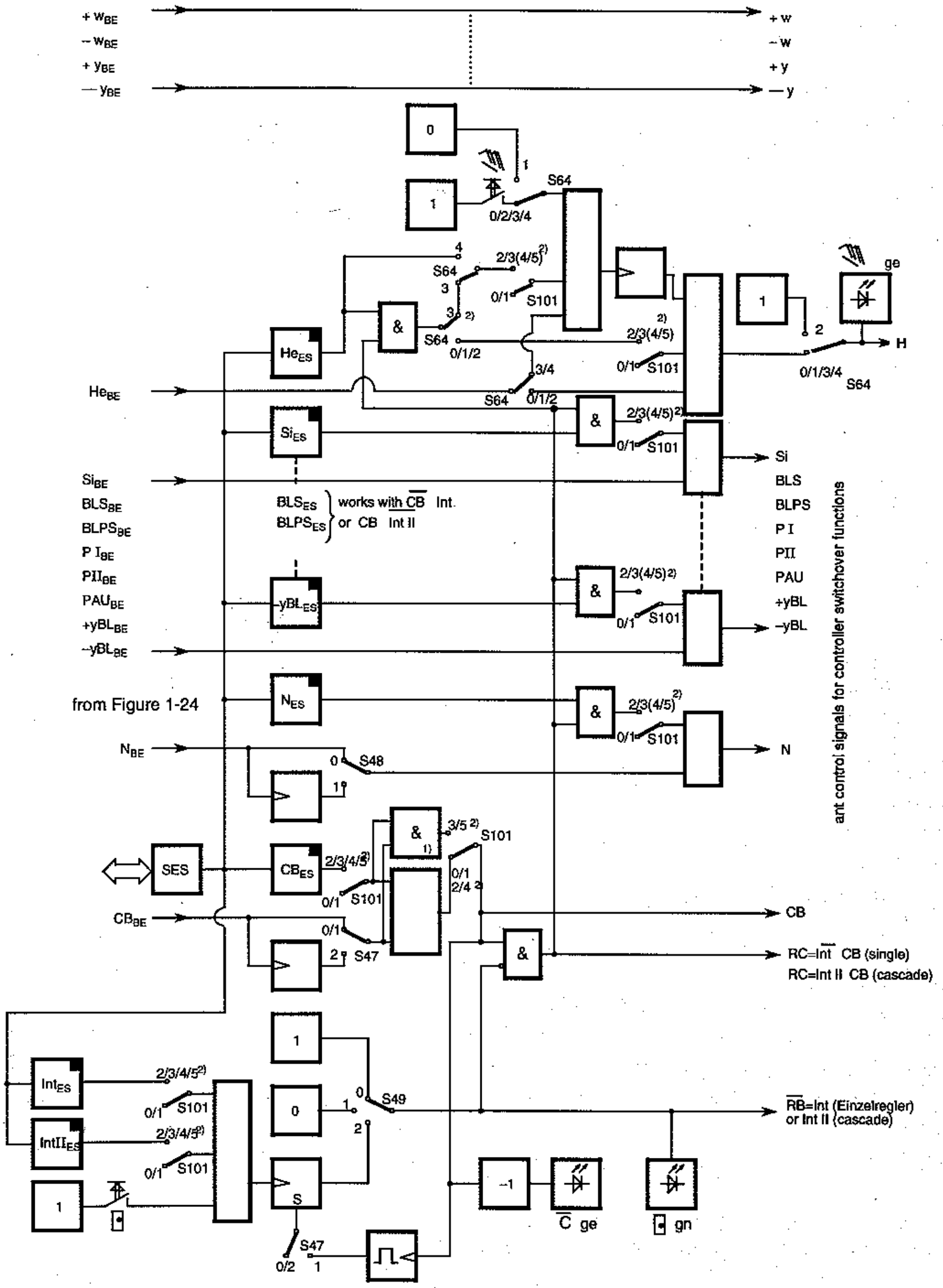


Figure 1-25 Connection of digital inputs BE1 to BE14 and control signals using the SES (S47, S48, S49, S101)

1) from software version -A07
2) from software version -B05

- **Digital control signals - a glossary**

CB *Computer ready*
Depending on the type of controller, this digital signal, in conjunction with the local/remote pushbutton, causes either a setpoint switchover or initiates DDC operation. In SPC and DDC mode central computer failure.

He *Remote Manual*
This signal blocks the controller output and allows the manipulated variable to be adjusted manually from the front module.

N *Tracking*
This signal causes the signals from K controllers and three position step controllers with external position feedback to track to the value of the y_N signal.

Si *Safety mode*
The manipulated variable of K controllers and three position step controllers with external position feedback is assigned the parameterisable safety value. The manipulated variable is forced up-scale or down-scale in three position step controllers with internal simulation of position feedback.

BLS *Block configuring*
Other than process operation, the controller will only allow switchover to online parameterisation when this signal is on. This allows the parameters necessary to match the controller to the process to be chosen, and any necessary adjustments to be made prior to adaptation. Configuring is not possible.

BLPS *Block parameterisation and configuring*
The controller cannot be configured in any way, not even parameterised. The only permissible operation is normal process operation in line with the type of controller in use.

P I *P mode controller* I
This signal causes controller I (parameter set I) to switch into P mode.

PII *P mode controller* II
This signal causes controller II (parameter set II) to switch into P mode.

PAU *Parameter switchover*
The controller family includes both single-loop and dual-loop controllers (interconnected controllers). This signal causes single-loop controllers using parameter set I to switch to parameter set II. Dual-loop controllers use both sets in any case, so changing from one to the other is not possible.

$\pm\Delta w$ *Incremental setpoint adjustment*
Remote setpoint or ratio setpoint incrementally adjusted via digital inputs.

$\pm\Delta y$ *Incremental manipulated variable adjustment*
Remote manipulated variable incrementally adjusted via digital inputs during tracking.

$\pm yBL$ *Direction dependent blocking of manipulated variable*
Direction dependent limiting of the value of the manipulated variable by an external signal, eg. from the actuator's limit switch. This limiting is effective in all modes of operation.

1.4.4 Controller Types (S1, S49 to S53)

- **Common functions**

– Manual setpoint wi or setpoint ratio wvi input via front panel

When the green Local LED (1) is on, the ±Δw pushbuttons (see Figure 3-1) can be used to adjust the value of the local setpoint. The various types of adjustment are indicated by a ↗ in the tables. Any exceptions to this rule are described in the paragraphs relating to the appropriate controllers. Adjustments take place incrementally, initially with a resolution of 1 digit, and then in a rapid progression so that even large adjustments can be made quickly. Each time the adjustment is interrupted by releasing the pushbuttons, the progression restarts with the smallest step.

– Manual setpoint wi or setpoint ratio wvi input via SES

Whenever the local setpoint can be adjusted via the pushbutton (6) on the front panel of the controller, parallel input via the SES is also possible. As setpoints can only be adjusted absolutely and not incrementally via the SES, it is advisable to use the setpoint ramp tS to avoid sudden setpoint fluctuations.

The control signal Int and the automatic/manual switchover can also be preset with the manual manipulated variable adjustment facility via the SES, so that complete parallel process operation is possible via the SES (see also section 1.4.6).

– Source for remote setpoints S53 and S101

The remote setpoint wE for each controller is derived from a maximum of three different sources:

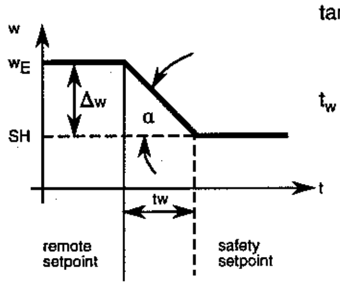
remote setpoint as absolute value via analogue inputs (wEA)
remote setpoint incrementally adjusted via control signals ±Δ w (wEΔ) } select with S53

remote setpoint as absolute value from SES (wES) — select with S101

– Setpoint ramp tS

The tS parameter (oFPA) enables the rate of adjustment of the working setpoint w (or on a ratio controller S1 = 4, the working ratio setpoint) to be set between 0 and 100 % to oFF, or 0.1 to 9984 minutes. tS also specifies the time the control signal ±Δw takes to increment from 0 to 100 %. If tS = oFF, the rate of adjustment increases towards infinity.

A setpoint ramp can be used to prevent sudden setpoint fluctuations when switching over to the untracked variables SH, wi, wEΔ, and wES when S52 = 1, or to wEA from a controller that is not being tracked.



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

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

Figure 1-26 Setpoint switchover using a ramp

– Setpoint thresholds SA, SE

The parameters SA and SE (oFPA) are used to limit the working setpoint w to a minimum (SA) and maximum (SE) value within a range of –10 to 110 %.
Exception: Ratio controller (S1 = 4) and cascaded ratio controller, controlled ratio controller (S1 = 6)

– Tracking an inactive setpoint to the working setpoint (S52)

Normally the inactive setpoint tracks to the working setpoint to ensure a bumpless switchover. The local setpoint wi, the remote setpoint incremented via ± Δw (wEΔ), and a remote setpoint sent via the SES (wES), can all be tracked. The safety setpoint SH cannot be tracked. Any remote setpoint received via analogue inputs (wEA) can only be tracked indirectly in that the output signal from the source controller is tracked. The current value of w is assigned to an analogueoutput and used as the value to be tracked. The tracking control signal is formed by ORing H∨N∨Si, and the result assigned to a digital output.

If S52 = 1, tracking is inhibited. This switch position is often used on slave controllers (S1 = 3) when the local setpoint is being used as a type of safety value, or where multiple setpoints are in use.

– x-tracking (S50)

x-tracking (ratio controller – xv-tracking) is activated by setting configuring switch S50 = 1. This causes the setpoint (ratio setpoint) to track the controlled variable (actual ratio), thereby creating a control difference (xd) of zero. Tracking only takes place when the controller is not in automatic (A) mode, in other words in manual mode (H), tracking mode (N), DDC mode, and whenever the safety manipulated variable (Si) is being used: $\bar{A}$ = H∨N∨Si.
X-tracking is not possible in direction dependent blocking mode, as setting the control difference in the direction of the blocking to zero would cause a P-fluctuation that would immediately cancel out the block.

x-tracking ignores any setpoint ramp that may be present. By tracking the setpoint to the actual value, the control difference becomes zero, so switching back to automatic mode will be bumpless. During manual and DDC mode, it can usually be safely assumed that the actual value will be at the desired level, so the tracked setpoint should also correspond to the actual value.

x-tracking will only be completely effective when the inactive setpoint is also tracked to the working setpoint (S52 = 0). This causes not only the working setpoint w, but also the setpoint source for automatic mode to be tracked prior to switchover into automatic.
Although the control difference may be zero in A mode, a switchover to automatic mode when S52 = 1 (no tracking) will cause the old, untracked setpoint to become the working setpoint. This sudden fluctuation can be dampened by using the setpoint ramp tS.

This combination is particularly appropriate if you cannot be certain that the actual value will reach the required value during A mode (especially safety mode). In full x-tracking, the tracked setpoint will then be incorrect.

– Constants c1 to c6

Some process variables are physically linked with each other: Constants c1 to c3 are used for operations involving controlled variables, c4 and c5 for operations involving command variables.
The constants are parameterised in onPA mode and take values in the range –1.999 to 9.999. The constant c6 is used for feedforward control at the output ya (see 1.4.6 Figure 1-53). It is also parameterised in onPA mode and has a value in the range –9.99 to 9.99.

- **Control signals for setpoint switchover**

Assuming these control signals are available on the type of controller in question, setpoint switchover is determined by an AND function RC = Int ∧ CB. The LEDs $\bar{C}$ (3) and Local (1) indicate the status of the CB control signal and the setting of the Local pushbutton (2).

Use S49 to disable the local/remote pushbutton (2) and lock the controller in either local or remote mode (see section 1.4.3 Figure 1-25). The factory setting for S49 is 0 (local).
S24 can be used to assign Lo or Hi to the CB signal, or to assign it a digital input (see section 1.4.3 Figure 1-24). Factory setting is S24 = –1, CB = 1.

This table shows how the various setpoint switchover parameters can be configured:

Switchover dependent on	Int	S49	CB	S24	Working setpoint w S1 = 3, 4, 5, 6, 7, 8	Working setpoint w S1 = 0/1
Int and CB	0∨1	2	0∨1	1 to 14	wi (SH) or wE	wi1 or wi2
Int only	0∨1	2	1	–1	wi or wE	wi1 or wi2
CB only	0	1	0∨1	1 to 14	wi (SH) or wE	wi1 or wi2
remote only } no switchover	0	1	1	–1	wE	wi1
local only } no switchover	1	0	optional	optional	wi	wi2

Table 1-2 Setpoint switchover options using S24 and S49

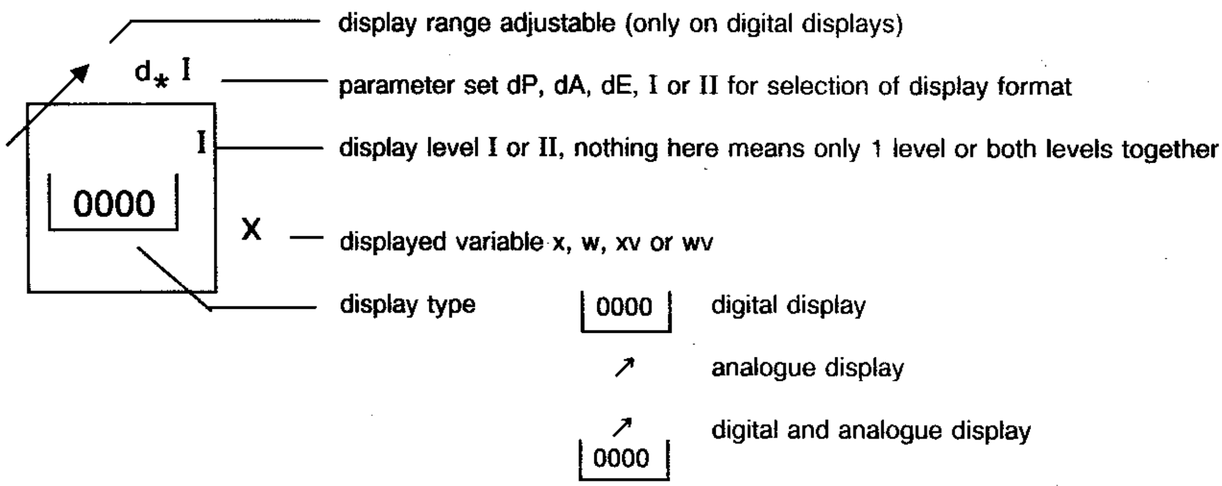
- **Actual and Setpoint value displays**

Analogue displays with a resolution of 1.7 %, and 4-digit digital displays are located on the front module. There are red and green versions of each. The red displays indicate actual values, the green displays setpoints. A 3-digit yellow digital display is used to indicate the manipulated variable y. The adjustment pushbuttons and status LEDs have the same colour as their corresponding displays, and are positioned accordingly.

The two analogue displays always indicate the working setpoint and the actual value. The difference between these two values is the control difference xd or control deviation xw = –xd. The digital actual value display also indicates the actual value, except in the case of ratio controllers, where the actual ratio will be displayed. The digital setpoint display indicates the required setpoint, except in the case of ratio controllers, where the ratio setpoint will be displayed.

The displays, the local/remote pushbutton (2) and the ±Δw adjustment pushbuttons are switched between Controller I/Controller II, depending on the type of controller, by the selector pushbutton (12).

To simplify the following block diagrams, the following symbols have been used:



- **Display range**

The digital displays are 4-digit, 7-segment displays whose display range can be set in configuring mode oFPA using the parameters dP (decimal point), dA (start-of-scale) and dE (full scale). In dual-loop controllers and process variable indicators (S1 > 4), x and w display ranges are parameterised identically, whereas they are parameterised separately for display levels I and II.
Parameters for display level II are identical to level I in single-loop controllers (S1 ≤ 4), and cannot be modified.
The value to be displayed as the start-of-scale (corresponding to 0 % on analogue displays) is determined by dAI and dAII respectively. Similarly, dEI and dEII are used to determine the value corresponding to the full-scale (or 100 % on analogue displays). The position of the decimal point is fixed using dPI or dPII. If the start-of-scale value is smaller than the full-scale value, an increase in the calculated value results in an increase in the display value, and vice versa. The numerical range for the start-of-scale and full-scale values lies between –1999 and 9999. Outside this range –oFL and oFL will be displayed. The factory setting is 0.0 to 100.0 %.

The refresh rate parameter dr (onPA) is used to stabilise digital displays if process variables start to fluctuate. Nonlinear process variables can be physically corrected by a linearisation function. Process variables and setpoints are displayed in the ranges specified by dP, dA and dE, depending on the type of controller:

S1	Display format corresponding to						Selection range adjusted 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 %

Table 1-3 Display format for parameters and setpoints

A corresponding assignment can also be made for the limit monitors A1 to A4, see 1.4.9.

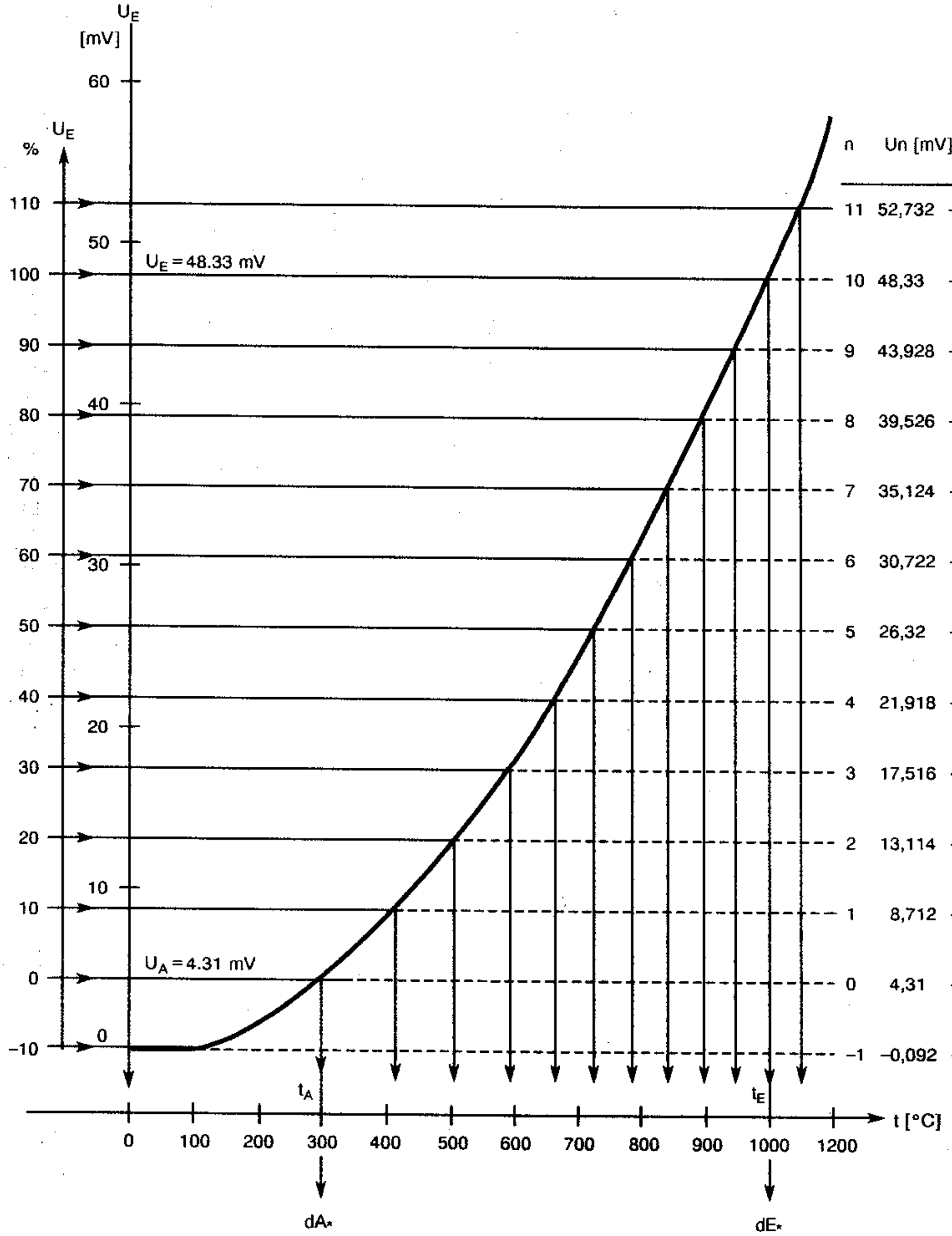
Analogue displays have a fixed display range of 0 to 100 %. Start-of-scale and full-scale violations are indicated by a flashing 0 % or 100 % LED respectively. Displays consist of one, or two, alternatively illuminating LEDs. The centre point of the illuminated LEDs acts as a "pointer". This format enables the display resolution to be doubled. When a digital display is parameterised with a falling characteristic (d*E < *A), the effect on analogue displays is also reversed, except on ratio controllers.

- **Setting the lineariser, S4 = 0**

Select the display start-of-scale (dA*) and full-scale values (dE*), and the decimal point (dP*) in configuring mode oFPA.
Divide the measuring range U_A to U_E ± 10 % into segments of 10 % and derive the voltage values.

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

Derive physical values for Un from either the appropriate function table or graphically from the appropriate curve (interpolate where necessary). Enter the corresponding value (-1* to 11*) in configuring mode oFPA.



n	Un [mV]		Vertex	t [°C]
11	52,732	→	11*	1048
10	48,33	→	10*	1000
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 1-27 Example: Linearisation of thermocouple type B Pt30Rh/Pt6, measuring range 300 – 1000 °C.

– Setting the lineariser, S4 = 1

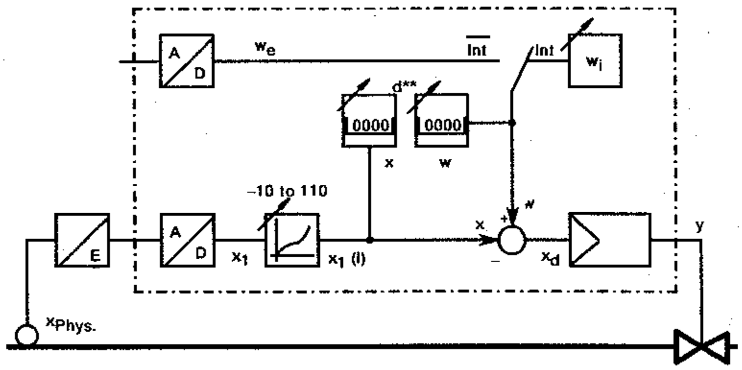


Figure 1-28
Linearisation of non-linear control and display variables

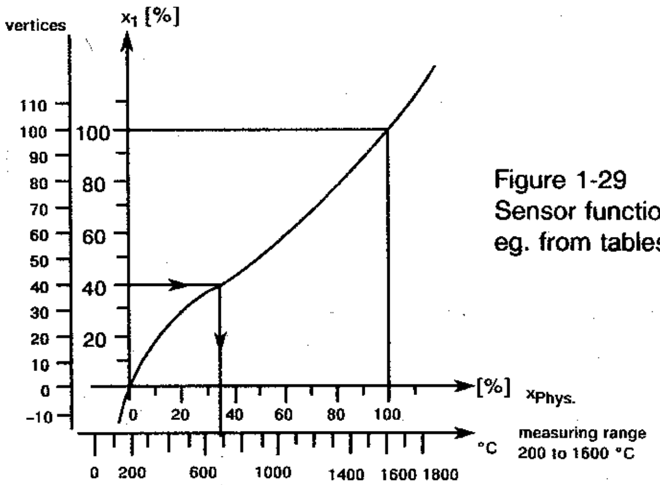


Figure 1-29
Sensor function, eg. from tables

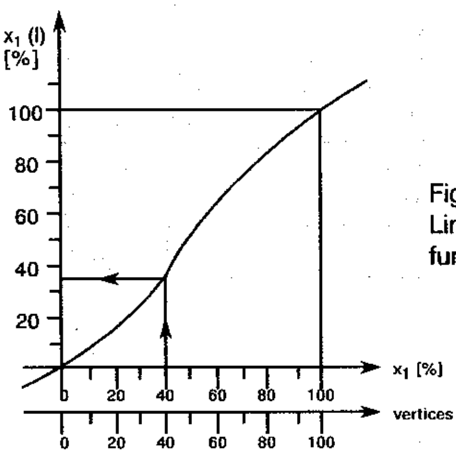


Figure 1-30
Linearisation function

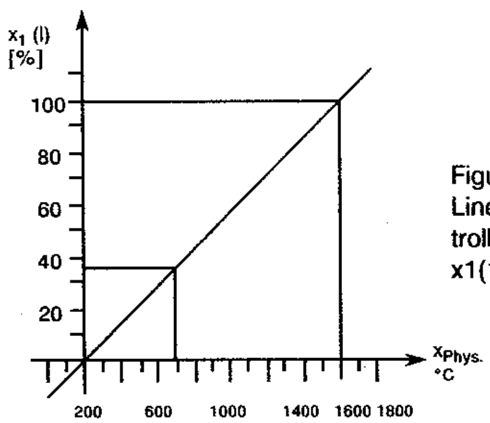


Figure 1-31
Linearised controlled variable x1(1)

The vertices for the lineariser are expressed here in % rather than in physical values as they can be used for many different purposes.
Vertices are set in configuring mode oFPA and must lie between –199.9 and +199.9 %. The vertices at 0 and 100 are set to 0 and 100 % so that x1(1) is again available as a standardised variable, and to ensure that the reference points used to define the digital displays ranges are correct. The parameters dA*, dE* and dP* are used to match the display range to the actual physical range.
Use the sensor function as shown in Figure 1-29 and calculate the vertices by dividing the measuring range into 10 % segments (x_{phys} in %). The vertices from –10 to 110 % can then be read off the x_{phys} axis and entered in configuring mode oFPA.

- **Function inputs FE1 to FE6**

FE4 to FE6 always have the same control functions:

FE4 feedforward control (z) of either the D element or the manipulated variable y (selection via S55)

FE5 tracking input (y_N) for feedforward control on K controllers (S2 = 0) and S controllers with remote feedback (S2 = 2)

FE6 feedback manipulated variable (y_R) for the y display on S controllers with position simulation (S2 = 1), or feedback manipulated variable (y_R) for S controllers with remote feedback (S2 = 2)

Functions implemented by FE1 to FE3 vary depending on the type of controller (S1).

S1	FE1 (linearisable)	FE2	FE3 (linearisable)
0 Fixed setpoint controller with 2 independent setpoints	x1 final control variable	x2 secondary control variable	x3 secondary controlled variable
1 Fixed setpoint controller with 2 dependent setpoints	"	"	"
2 DDC fixed setpoint controller	"	"	"
3 Slave, synchronisation, SPC controller	"	"	wE remote command variable
4 Ratio controller	x1 controlled process variable	x2 command process variable	wvE remote command variable for ratio setpoint
5 Cascade controller	x1II final control variable master controller	x2II secondary control variable master controller	xI controlled variable slave controller
6 Cascaded ratio controller	xII final control variable master controller	x2I command process variable slave controller	x1I controlled process variable slave controller
7/8 Override controller	x1I final control variable main controller	x2I secondary controlled variable main controller	xII controlled variable limiting controller
9 Process variable indicator	xI process variable 1	–	xII process variable 2

Table 1-4 Controller dependent functions of inputs FE1 to FE3

- **S1 = 0: Fixed setpoint controller with 2 independent setpoints**

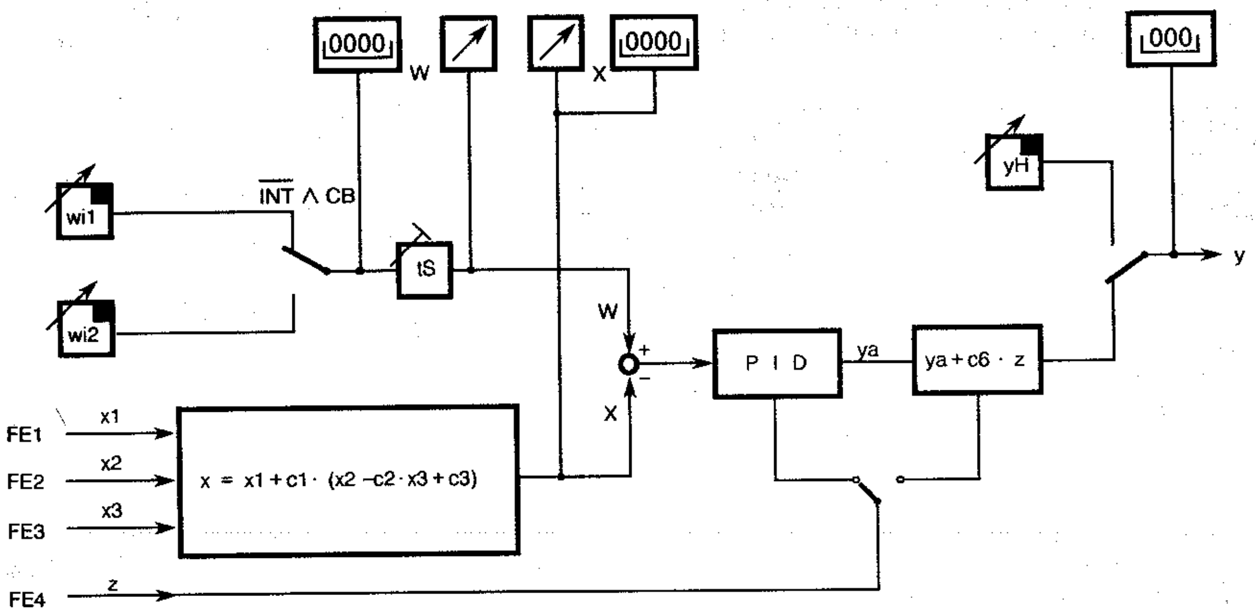


Figure 1-32 Control principle S1 = 0

This type of controller can be configured as a fixed setpoint controller with 2 independent setpoints, or as a fixed setpoint controller with one setpoint by blocking local/remote switchover (factory setting). It can be used as a one, two or three component controller by assigning constants c1, c2 and c3 to the inputs x1, x2 and x3.

The two local setpoints can be individually adjusted on the front module. The control signals Int and CB are used to change from one setpoint to the other, as shown in table 1-5. The working setpoint is indicated by the LEDs Local and $\overline{C}$. The moment an LED comes on, wi2 becomes effective.

Control commands: Digital inputs		Control commands: Front	Signal Front LED			Digital outputs			working w S50 =		Comments
H∨N∨Si	CB	local	local	$\overline{C}$		$\overline{RB}$	$\overline{RC}$		0	1	
0	1	0	0	0		0	0		wi1	wi1 (n)[1]	switchover CB, Int = 0 / switchover with Int, CB = 1
0	0	0	0	1		0	1		wi2	wi2 (n)	
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	switchover CB, Int = 0 / switchover with Int, CB = 1
1	0	0	0	1		0	1		wi2	x	
1	1	1	1	0		1	1	2)	wi2	x	
1	0	1	1	1		1	1		wi2	x	

1) The setpoint is tracked to the controlled variable x if S52 = 0 and S50 = 1; tracking does not apply to the switchover wi1/wi2
If S52 = 1, automatic mode starts with wi = x (xd = 0). If the setpoint ramp tS is active, the working setpoint tracks the previously selected value.

2) Factory setting for a fixed setpoint controller with 1 setpoint (S49 = 0: local only, Int = 1, S24 = −1: CB = 1) $\overline{RB}$ = Int

$\overline{RC} = \overline{Int \wedge CB} = Int \vee \overline{CB}$

Table 1-5 Switchover between wi1 and wi2

The digital w display II can be made to indicate the inactive setpoint and the digital x display the final control variable x1 by pressing the selector pushbutton (12) (display range I must be parameterised, display range II will automatically be parameterised). The working setpoint and the actual x value continue to be displayed on the analogue indicators.

Switchover using selector pushbutton	working w 1)	LED Controller I	LED Controller II	displayed w 2)		displayed x	
				digital	anal.	digital5)	anal.
I	wi1	1	0	wi1 ↗4)	wi1	x	x
II	wi1	0	0.5 3)	wi2 ↗	wi1	x1	x
I	wi2	1	0	wi2 ↗	wi2	x	x
II	wi2	0	0.5 3)	wi1 ↗	wi2	x1	x

1) via CB and Int as table 1-5
2) displayed x digital/analogue
3) 0.5 = flashing frequency 1:1
4) ↗ = adjustable
5) x1 from software version -A05

Table 1-6 Switchover between display levels

The setpoint indicated in the digital w display can also be set using the ±Δw adjustment pushbuttons (see Figure 3.1, item 6). The display level is indicated by the Controller I/Controller II LEDs. A flashing light indicates that the displayed setpoint and the working setpoint are not identical.
A steady light, on the other hand, indicates that they are identical.
If switchover between wi1 and wi2 is blocked by S49 (Int) and S24 (CB), then the digital w display is not switched over to display level II. Instead, only the digital x display is switched over. Display level II is indicated by a steady light.

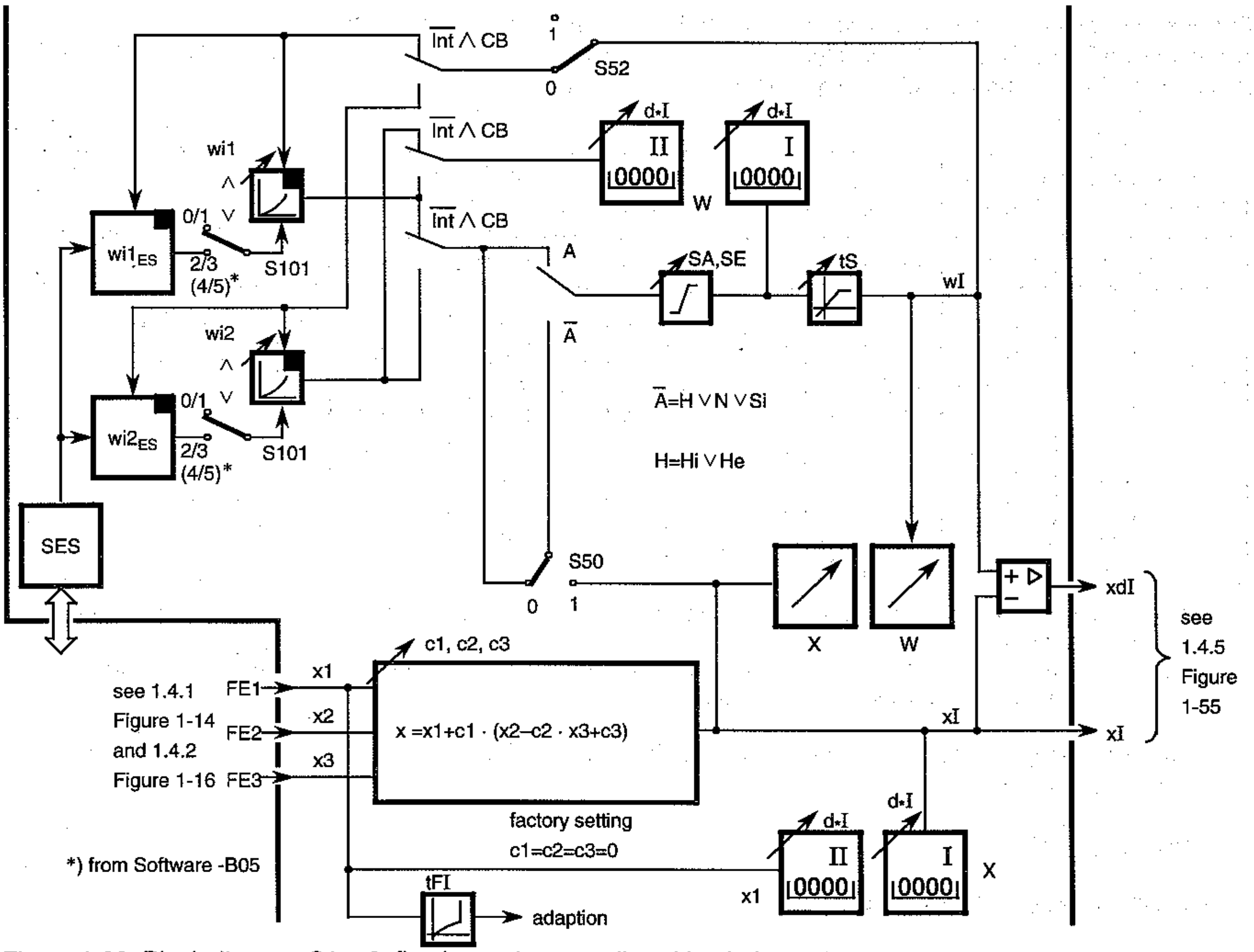


Figure 1-33 Block diagram S1 = 0, fixed setpoint controller with 2 independent setpoints

- **S1 = 1: Fixed setpoint controller with 2 dependent setpoints**

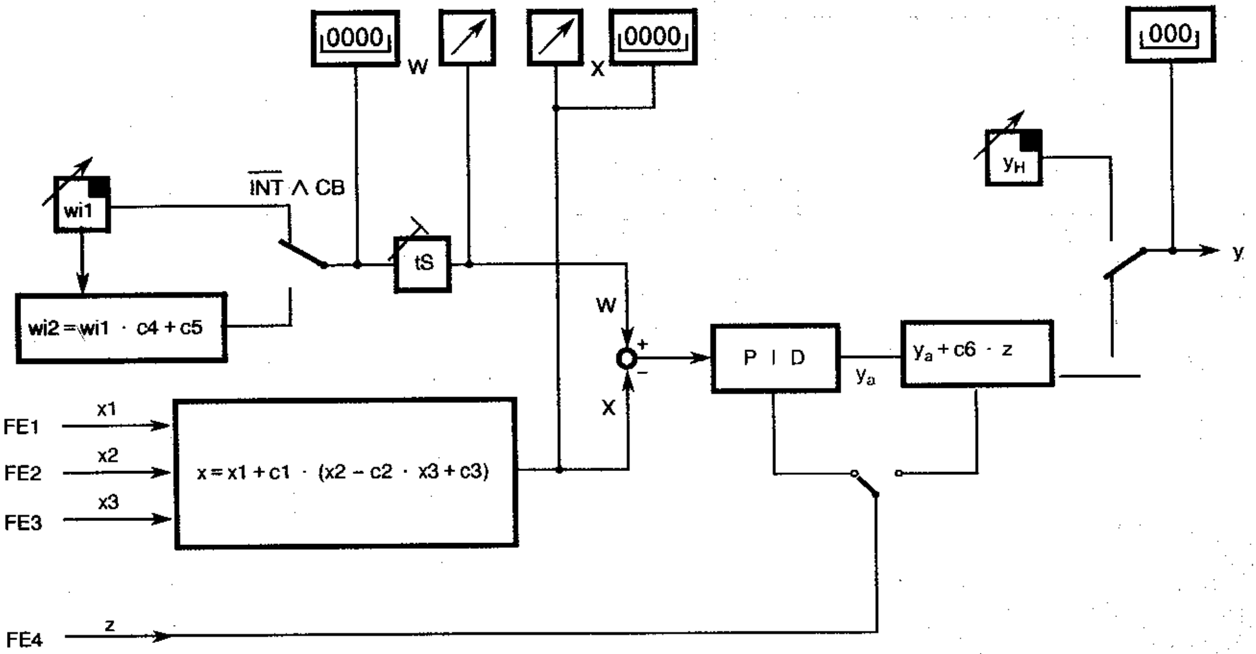


Figure 1-34 Control principle S1 = 1

This type of controller is used in control loops where the second setpoint has to maintain a particular relationship to the first. Constants c4 and c5 are used to define this relationship.

The factory settings for c4 and c5 are 1 and 0 respectively.

Switchover and display functions work in the same way as with S1 = 0. Only the local setpoint (wi1) can be adjusted, assuming it's being displayed.

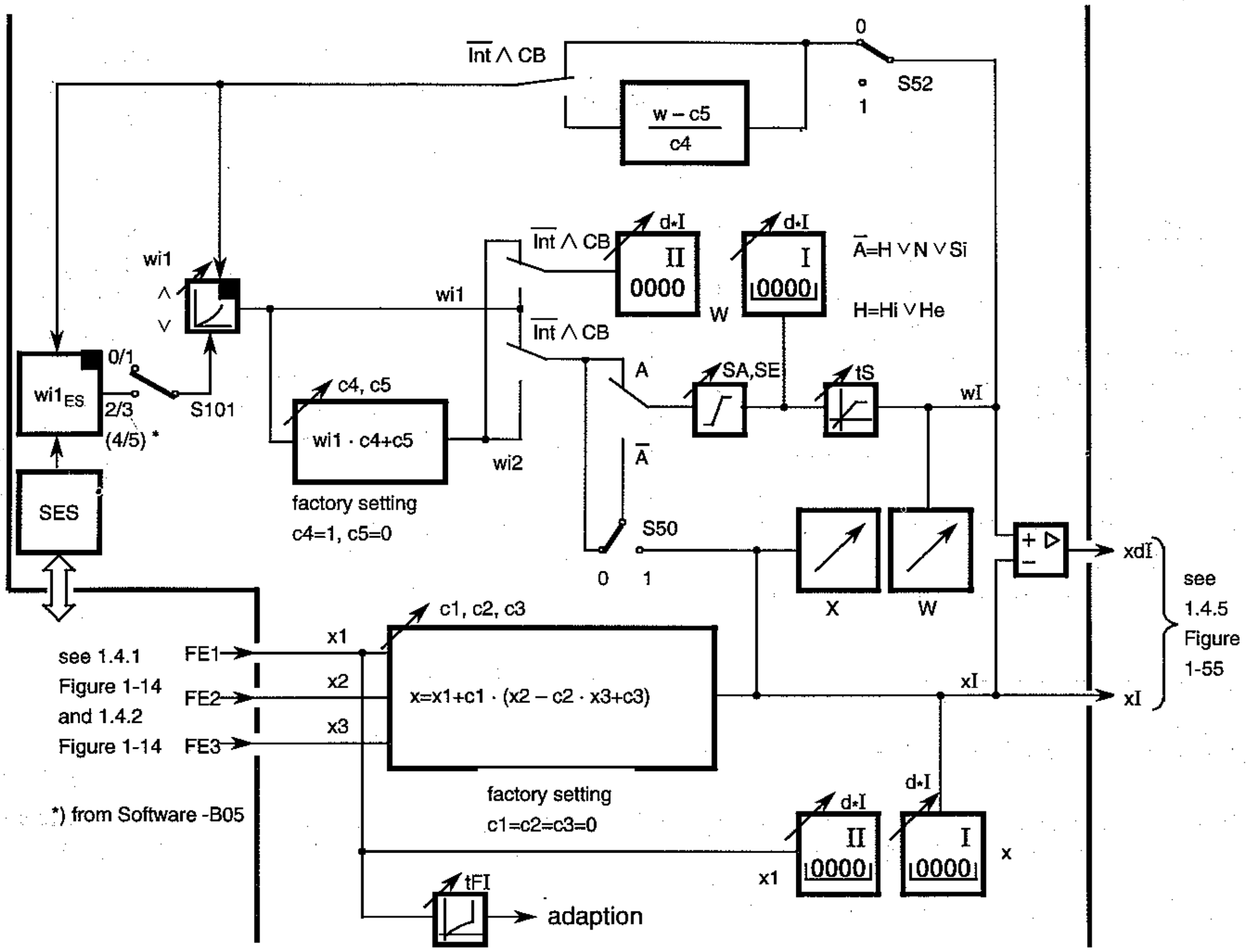


Figure 1-35 Block diagram S1 = 1, fixed setpoint controller with 2 dependent setpoints

- **S1 = 2: DDC Fixed setpoint controller**

The DDC controller is responsible for assuming control of the control loop as smoothly as possible following a computer failure. In DDC mode, the process computer is normally in control. The controller waits in stand-by mode, ie. it tracks the computer's manipulated variable or, where applicable, sets the control difference to 0 to ensure a bumpless switchover.
To achieve full redundancy in continuous control loops, the manipulated variable signal can be output in parallel by the computer. In this case, the manipulated variable signal from the K controller is disabled during computer mode (S66 = 1). If the signal from the controller's manipulated variable is also disabled, the two signals just need to be ORed. In SIPART controllers, an OR diode is already integrated in the output signal.
If the U/I converter of the K controller is also to be used to feed the final control element during computer mode, then the manipulated variable must not be disabled (S66 = 0).

DDC mode corresponds to tracking mode in other controllers, except that switchover to tracking mode is not initiated through the control signal N, but as a function of the control signal CB and the local/remote pushbutton:

DDC mode ≙ RC = $\overline{\text{Int}} \wedge$ CB = 1

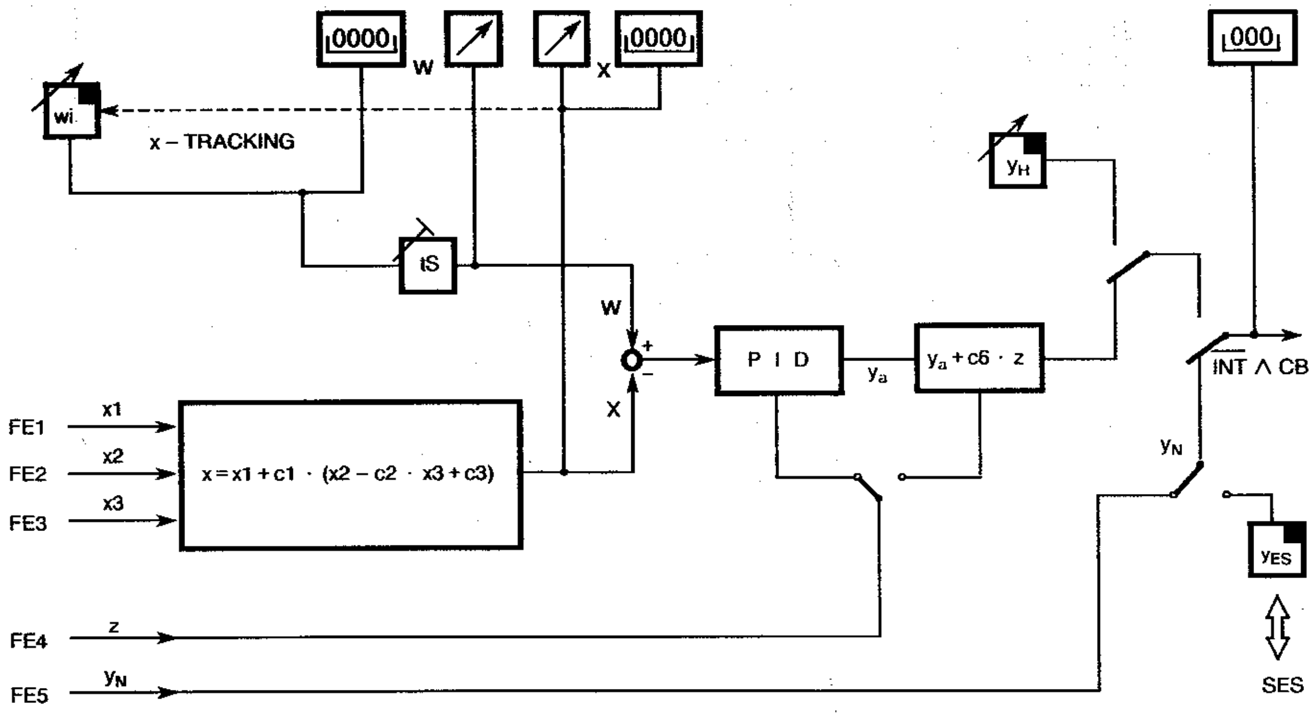


Figure 1-36 Control principle S1 = 2

As is the case in tracking mode on the other types of controller, the y-remote LED is used to indicate DDC mode. The status of the control signal CB and the local/remote pushbutton are indicated by the LEDs $\overline{C}$ and Local. In case a computer failure occurs, the setpoint is tracked during DDC mode. The setpoint that would then become effective is always displayed.

S50 is used to choose between x-tracking and wi. S51 is used to specify the default setpoint.

S61 establishes whether DDC or manual mode has priority. If DDC mode has priority over manual, the manual/automatic pushbutton can be used to select whether automatic or manual mode is to be used following a computer failure. If a manual intervention has to be made during computer mode, then switchover to local mode is required in addition to the switchover to manual; the Local (1) and Manual (8) LEDs are then on, the y-remote LED (10) goes out, and continued computer stand-by is indicated by the fact that LED $\overline{C}$ (3) is off.

If manual mode has priority over DDC, you can switch directly from computer mode to manual mode. The Manual LED (8) comes on and the y-remote LED (10) goes out. The LEDs Local (1) and $\overline{C}$ (3) are both off, indicating computer readiness of the controller and computer stand-by respectively.
If a computer failure should now occur, the controller will always switch to automatic mode.

Control signals digital inputs				front	Signals front LED			digital outputs		working y	working w when				Comments	Computer failure
± yBL	Si	H 1)	CB3)	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	ys	wi (n, ↗)7)	x	wi (n, ↗)7)	x	safety mode, computer ready, controller ready	
0	1	0	0	0	0	1	1	0	1	ys	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	ys	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	ys	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	ys	wi (n, ↗)7)	x	wi (n, ↗)7)	x	safety mode, computer ready, controller ready	
0	1	1	0	0	0	1	1	0	1	ys	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	ys	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	ys	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 mode has priority over manual DDC S61 = 0

Control signals digital inputs				front	Signals front LED			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	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		y_{BL}	as above but without x-tracking				blocking mode, as above	

Table 1-8 DDC Controller, S1 = 2, manual mode has priority over DDC S61 = 1

1) Manual mode can be selected by

Control signals		Signals	
Digital input He	Front Hi	Front manual LED	Digital output H
0	0	0	0
1	0	0.9 6)	1
0	1	1	1
1	1	1	1

Table 1-9 Creation of control signal H = Hi$\vee$He

2) In DDC mode, the manipulated variable signal is disabled if S66 = 1. If S101, y_E is sourced from y_N (FE5) when S62 = 0, or $y_{N\Delta}$ when S62 = 1. If S101 = 2, y_{ES} (SES) takes effect. The remote manipulated variable sourced from $\pm\Delta y$ and the SES (y_{ES}) is tracked. If y is sourced from FE5 (y_N), the source controller must be tracked.

3) The table shows static computer switchover without acknowledgement, S47 = 0.

4) In manual or safety mode, computer stand-by or computer mode cannot be signalled if digital output H is ORed with the control signal Si.

5) 0.5 = flashing frequency 1 : 1

6) 0.9 = flashing frequency 0.1 off, 0.9 on

7) adjustable from sortware version -A05

(↗) = adjustable

(n) = variable tracks the last value effective before switchover, consequently switchover is bumpless.

The tracking signal (N) has no effect on DDC controllers. The table applies to S52 = 0 (tracking of inactive setpoint to working). If S52 = 1 (no tracking) and x-tracking is on, automatic mode starts with wi = x (xd = 0). If the setpoint ramp tS is active, the working setpoint is tracked to the old setpoint wi.

The digital x display can be made to indicate the final control variable x1 by pressing the selector pushbutton (12). The relevant display level is indicated by a steady light on the LED Controller I or Controller II (from software version -A05).

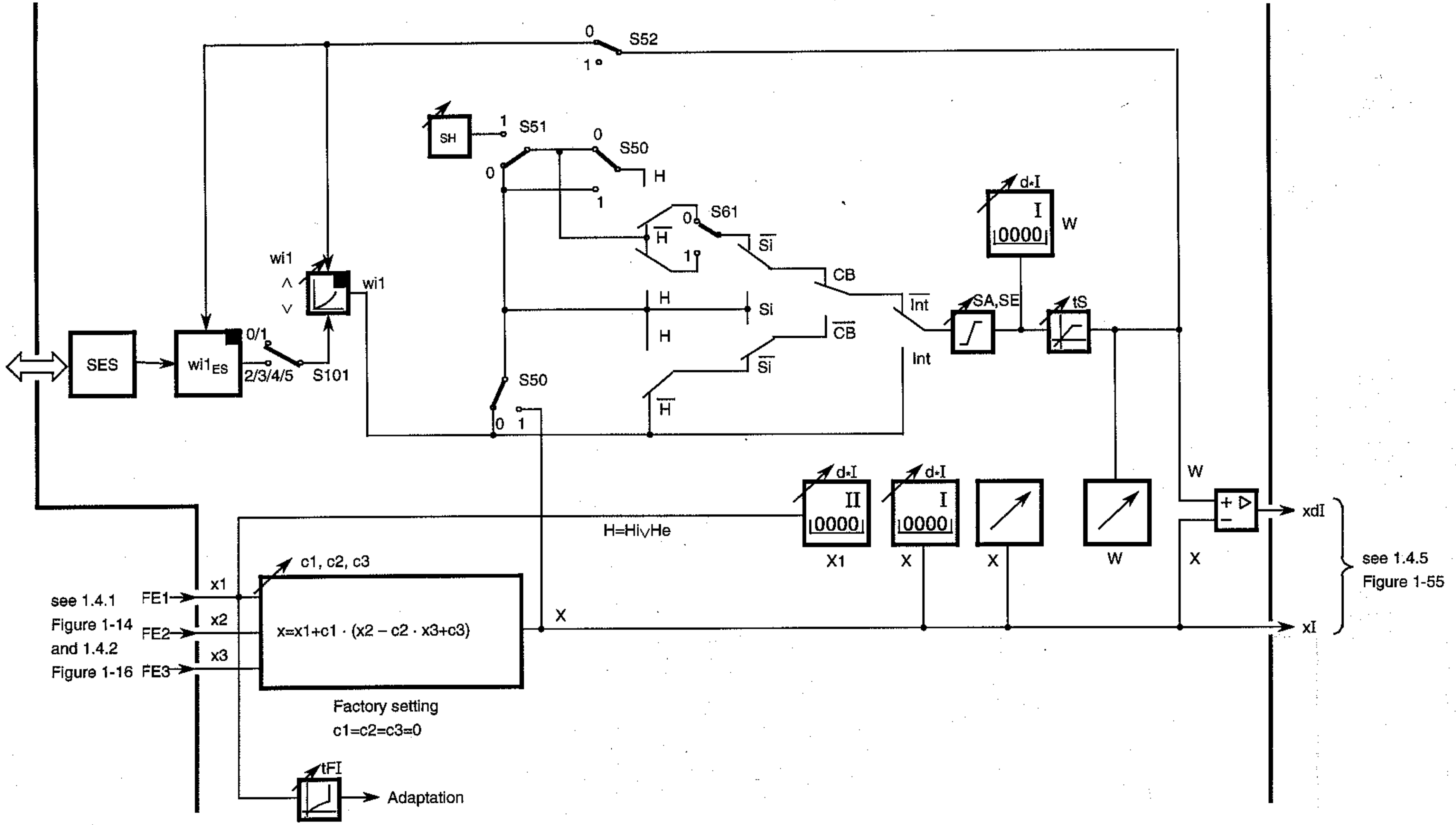


Figure 1-37 Block diagram S1 = 2, DDC fixed setpoint controller

1.4.4

• **S1 = 3: Slave controller, synchronisation controller, SPC controller**

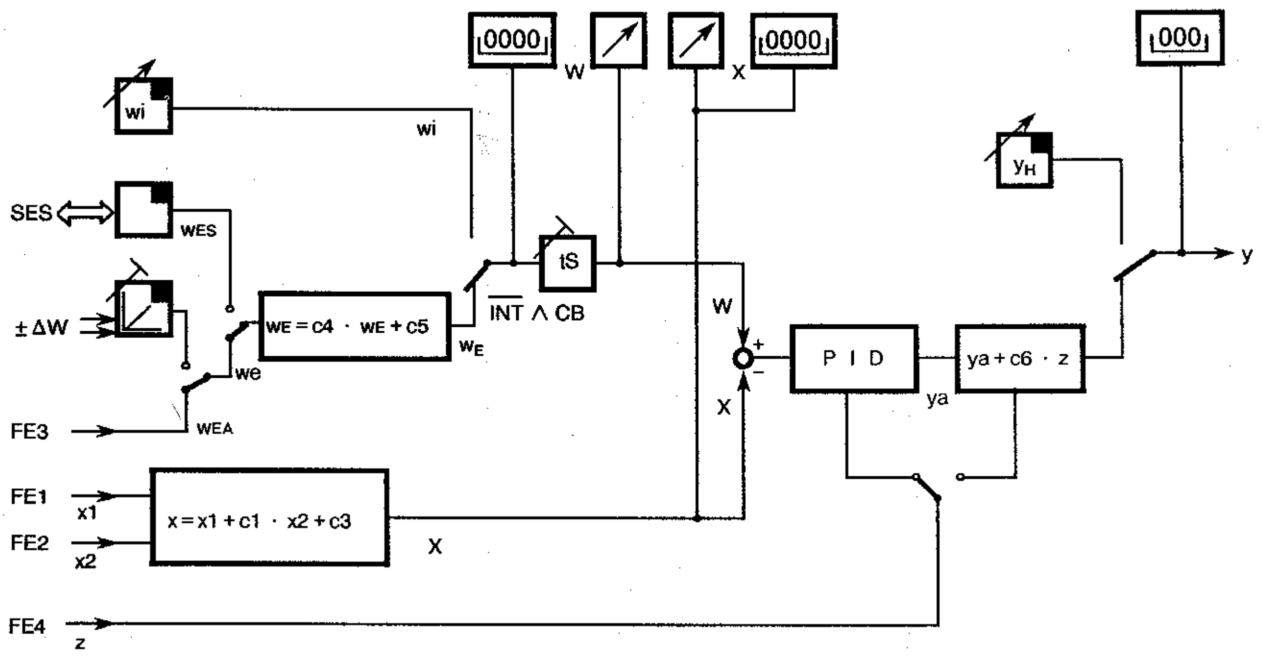


Figure 1-38 Control principle S1 = 3

With this type of controller, the control signal CB and the local/remote pushbutton (2) are used to initiate switchover between local (wi) and remote (wE) setpoints (see tables 1-11 and 1-12).
The remote setpoint can be input either via the analogue input FE3 (wEA), or incrementally (wEΔ) using the digital signal ±Δw (select with S53), or via the SES (wES) (select with S101). By assigning an appropriate analogue output, the working setpoint w can be fed back to the source controller as wEA (for tracking purposes) or wEΔ (for display purposes).
This type of controller is used for cascade control using 2 separate controllers (master controller and slave controller), synchronisation control, fixed setpoint control using remote setpoints (eg. from an operator console via incremental ±Δw inputs), and SPC (setpoint) control. This controller comes into its own when linked to the SIPART operating and monitoring software. Here, the tracking signal (N_{es}) and the y_{ES} input are used to enable the controller to function as a fixed setpoint controller with a remote setpoint source (w_{ES}) and automatic/manual switchover (see section 1.4.6).

- **SPC control**

The computer controls the setpoint during computer mode RC = $\overline{\text{Int}}\wedge$CB = 1. If the computer goes down (CB flips from 1 to 0), the controller examines S51 to determine whether to use the most recent setpoint from the computer (tracked wi), or the safety setpoint SH.

- **Cascade control**

The manipulated variable of the master controller, eg. a fixed setpoint controller (containing the final controlled variable), becomes the remote setpoint for a slave controller (containing the secondary controlled variable, disturbance). This in turn controls the final control element. In this way, the final controlled variable can be corrected more rapidly when changes in the value of the secondary controlled variable occur. For example, temperature control in a continuous furnace (furnace temperature = final controlled variable) where the viscosity of the substance being heated (secondary controlled variable) varies.

- **Synchronisation control**

A main controller supplies several synchronisation controllers in parallel. The constants c4 and c5 can be used to define a relationship between the controller's individual setpoints. The corresponding controlled variables can then be corrected (controlled variable synchronisation).

– Local/remote switchover

Setpoint switchover is determined by the logical operation $RC = \overline{Int} \wedge CB$ and its negation (see tables 1-11 and 1-12). Apart from their normal functions as switchover pushbutton and control signal respectively, with possible values 1 and 0, the status of both signals can also be locked (Int with S49 and CB with S24), see 1.4.3 Figure 1-24 and 1-25. The factory setting is Int = 1 (S49 = 0) and CB = 1 (S24 = –1), in other words, **the working setpoint is always the local setpoint wi, and switchover is not possible.**

These options allow local/remote switchover to a slave controller to depend solely on the value of Int (S49 = 2, S24 = –1) or CB (S49 = 1, S24 = 1 to 14). If switchover to a remote setpoint is inhibited (S49 = 1, S24 = –1), the controller functions as a slave controller with no local/remote option (see table 1-2).

– Displaying the remote setpoint w_E

The digital w display II can be made to indicate the remote setpoint wE and the digital x display the final control variable x1 by pressing the selector pushbutton (12) (display range I must be parameterised, display range II will automatically be parameterised). The working setpoint and the actual value continue to be displayed on the analogue indicators.

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

A flashing light indicates that the displayed remote setpoint and the working setpoint are not identical. A steady light, on the other hand, indicates that they are identical.

Select via switchover pushbutton	working w 1)	LED Controller I	LED Controller II	displayed w 3)		displayed x	
				digital	analogue	digital 4)	analogue
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) using CB and Int as shown in tables 1-11 and 1-12
2) 0.5 flashing frequency 1:1
3) only when not x-tracking
4) from software version -A05

Table 1-10 Display level switchover

If switchover between local and remote setpoint is inhibited by S49 and S24, the digital w display cannot be switched to display level II. Only the digital x display is switched. Display level II is indicated by a steady light.

– Operation with 2 or 3 setpoints

If tracking the inactive setpoint to the working setpoint is inhibited by S52 = 1, multiple setpoint operation is possible (switching between wi, w_E and SH, see table 1-12).

– Controlled variable processing

2 component control is implemented (feedforward control). The constants c1 and c3 are used to weight the final and secondary controlled variables respectively.

Control signals digital inputs		front	Signals front		digital outputs		working w when				Comments	computer failure
HVNVSi	CB 1)	local	local 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	WE (n) 2)		WE (n) 2) → SH 3)		automatic mode, SPC mode	↓
0	0	0	0	1	0	1	wi (n, ↗)6)		oder wi (n, ↗)6)		automatic mode, computer switched off, controller in SPC stand-by mode	
0	1	1	1	0	1	1	wi (n, ↗)		wi (n, ↗)		automatic mode, computer on stand-by, controller not in SPC stand-by mode 5)	
0	0	1	1	1	1	1	wi (n, ↗)		wi (n, ↗)		automatic mode, computer switched off, controller not in SPC stand-by mode	
1	1	0	0	0	0	0	WE (n) 2)	x	WE (n) 2) → SH 3)	x	manual, tracking or safety mode 5)	
1	0	0	0	1	0	1	wi (n, ↗)6)	x	oder wi (n, ↗)6)	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		

Table 1-11 Slave/Synchronisation/ SPC controller with local/remote switchover S1 = 3 and tracking of the inactive setpoint to the working setpoint S52 = 0

1) The table shows static computer switchover without acknowledgement. S47 = 0.
2) If S101 < 2, WE is sourced from WEA (FE3) when S53 = 0, or WEΔ (± ΔW) when S53 = 1. If S101 = 2. WES (SES) takes effect. The remote setpoint sourced from ± Δw (WEΔ) and the SES (WES) is tracked. If the remote setpoint is sourced from FE3 (WEΔ), the source controller must be tracked.
3) SH will only attain WE when Int = 0 and CB flips from 1 to 0 (computer goes down). wi remains the working setpoint if CB = 0 and Int is switched from 1 to 0. Since SH is not tracked, a switch to SH can be made using the setpoint ramp tS.
4) In manual, tracking, or safety mode, computer stand-by or computer mode cannot be signalled if digital outputs H and N and the control signal Si are ORed.
5) Factory setting
6) Adjustable from software version -A05

(n) variable is tracked to the actual value prior to switchover, thereby ensuring a bumpless switchover.
↗ adjustable

Control signals			Signals				working w when				Comments
digital inputs		front	front		digital outputs						
H∨N∨Si	CB 1)	local	local 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	WE 2)		WE 2) → SH 3)		automatic mode 5)
0	0	0	0	1	0	1	wi (↗)6)		or wi (↗)6)		
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	WE 2)	x	WE 2) → SH 3)	x	manual, tracking or safety mode 5)
1	0	0	0	1	0	1	wi (↗)6)	x	or wi (↗)6)	x	
1	1	1	1	0	1	1	wi (↗)	x	wi (↗)	x	
1	0	1	1	1	1	1	wi (↗)	x	wi (↗)	x	

Table 1-12 Slave/Synchronisation/ SPC controller with local/remote switchover (SPC controller), S1 = 3 with no tracking of the inactive setpoint to the working setpoint
S52 = 1 2 or 3 setpoints mode

1) The table shows static computer switchover without acknowledgement, S47 = 0.
2) If S101 <2, WE is sourced from WEA (FE3) when S53 = 0, or WEΔ (±Δw), when S53 = 1. If S101 = 2, WES (SES) takes effect. The setpoint ramp tS can be used when switching over between various setpoints.
3) SH will only attain WE when Int = 0 and CB flips from 1 to 0 (computer goes down). wi remains the working setpoint if CB = 0 and Int is switched from 1 to 0. Since SH is not tracked, a switch to SH can be made using the setpoint ramp tS.
4) In manual, tracking, or safety mode, computer stand-by or computer mode cannot be signalled if digital outputs H and N and the control signal Si are ORed.
5) Factory setting
6) Adjustable from software version -A05

↗ adjustable

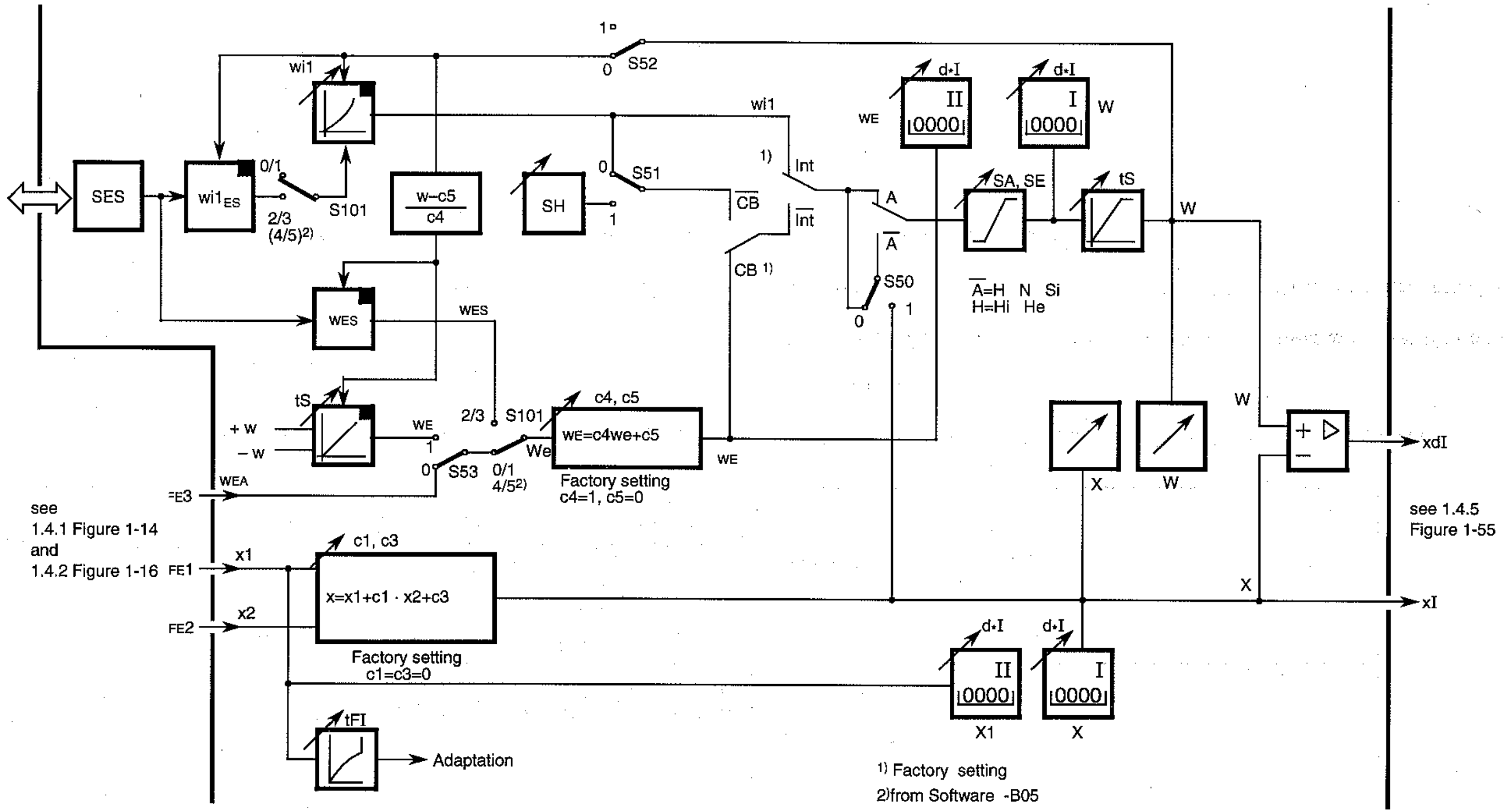


Figure 1-39 Block diagram S1=3, slave controller, synchronisation controller, SPC controller

- **S1 = 4: controlled ratio controller**

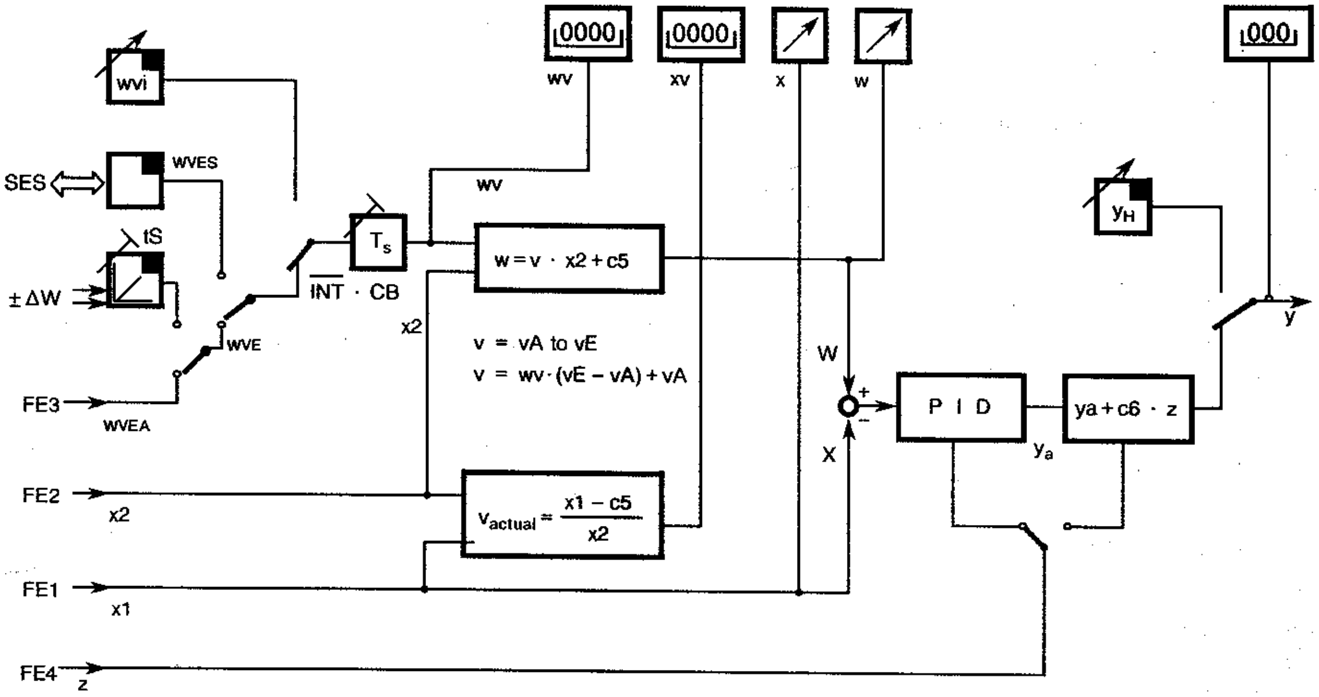


Figure 1-40 Control principle S1 = 4

In ratio control, the command variable x2 is weighted by a variable ratio factor v, and a constant c5 added if necessary, to produce a setpoint w for the subsequent controlled variable x1.

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

Where $xd = w - x1$ resulting in $xd = v \cdot x2 + c5 - x1$

In a stable state (xd = 0), the ratio factor can be expressed as $v = \dfrac{x1 - c5}{x2}$

ie. in a stable state and when c5 = 0, $\dfrac{x1}{x2}$ corresponds to the selected ratio factor v.

A typical application for ratio control is combustion control, where optimum combustion is ensured when a quantity of fuel x1 is mixed with a volume of air x2.
The ratio factor range v = vA to vE is defined in configuring mode oFPA. The span of the range is 0.0 to 9.999 (factory setting vA = 0, vE = 1). In addition, a constant c5 in the range –1.999 to 9.999 (factory setting = 0.0) can be defined.

The standardised ratio setpoint wv (wvi or wvE) of between 0 and 1 is transposed to the ratio factor range.

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

where $w = v \cdot x2 + c5$ resulting in $w = wv\,[(vE - vA) + vA]\,x2 + c5$

The standardised setpoint (wv) and actual ratio (xv) are indicated on the digital w and x displays respectively. The physical value can also be indicated using d*I. The controlled variable x1 and the weighted command process variable w are also indicated, on the analogue w and x displays respectively, so the control difference can be constantly monitored.

The selector pushbutton (12) can be used to indicate the remote ratio setpoint (display level II) in the digital w-display (display level I must be parameterised, display level II will automatically be parameterised). See S1 = 3, slave controller, for more information about display levels. The digital x display indicates the actual ratio xv in both display levels.

The actual ratio is calculated by inverting the ratio formula with the process variables x1 and x2:

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

where $v_{actual} = xv\,(vE - vA) + vA$

resulting in $$xv = \frac{v_{actual} - vA}{vE - vA} \quad or \quad xv = \frac{\frac{x1 - c5}{x2} - vA}{vE - vA}$$

xv is displayed and used for x-tracking. x1 and x2 are limited to +0.5% for the xv display so that the value does not become unstable when x1 and x2 are small, and does not go negative when x2 is negative. The command process variable x2 and slave process variable x1 can be linearised via FE2 and FE1 respectively in the freely configurable input area. This linearisation is reflected in the analogue display and the ratio and consequently indirectly also on the digital setpoint and actual ratio indicators.
The ratio controller does not require a setpoint threshold, as the ratio factor range in effect does this for it. If necessary, the freely configurable input area (S4 = 1) can be used to set a limit on the value of the command process variable x2.
A ratio controller behaves in the same way as a slave controller (S1 = 3) when it comes to changing the ratio setpoint wv. The notes and tables in the section dealing with slave controllers also apply here. Replace the variables wi and wE by wvi and wvE. This type of controller can be used as a ratio controller with a manually selected fixed ratio, or as a ratio controller with a variable ratio factor.
Fixed ratio mode is suitable, for example, in straightforward combustion control applications (see example), where the ratio factor can, if necessary, be reset manually each time the type of fuel being used changes.
A controlled ratio controller is used when the effect of the ratio factor (combustion quality, toxic exhaust emissions) can be measured. In this case, a master controller adjusts the ratio factor, using combustion quality as the controlled variable (ratio cascade).
Another application of cascaded ratio control is concentration control, eg. control of pH concentrations. The pH value becomes the controlled variable for the master controller, the flow of soda and acid the controlled process variables, and also the controlled variables for the ratio controller.

- **Example of ratio control**

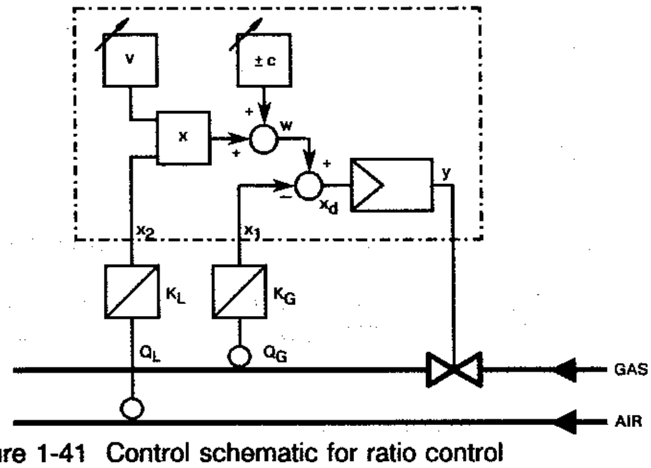


Figure 1-41 Control schematic for ratio control

Air/gas flow rate in combustion control should remain at a constant ratio. The command variable (command process variable) is the rate of air flow Q_L, using a 4 to 20 mA signal to represent a physical range of 0 to 12000 m³/h. The controlled variable (slave process variable) is the rate of gas flow Q_G, which also uses a 4 to 20 mA signal, this time to represent a physical range of 0 to 3000 m³/h. In an ideal combustion the air/gas ratio is:

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

$\frac{Q_L}{Q_G} = L_{\emptyset} \cdot \lambda$ The air factor λ is then 1 and can be modified at the controller within the range 0.75 to 1.25.

The ratio factor v (when xd = 0) is determined by the transfer coefficients K of the transmitters (measuring ranges).

$x_1 = Q_G \cdot K_G$ using the values from the example $K_G = \dfrac{100\,\%}{3000\ m^3/h}$

$$x_2 = Q_L \cdot K_L \qquad K_L = \frac{100\,\%}{12000\ m^3/h}$$

$$v = \frac{x_1}{x_2} = \frac{Q_G}{Q_L} \cdot \frac{K_G}{K_L} \qquad \textit{where} \qquad \frac{Q_G}{Q_L} = \frac{1}{L_{\varnothing} \cdot \lambda}$$

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

Using the values from the example

$$v = \frac{1}{\lambda} \cdot \frac{1}{4} \cdot \frac{100\,\% \cdot h \cdot 12000\ m^3}{3000\ m^3 \cdot 100\,\% \cdot h}$$

results in $v = \dfrac{1}{\lambda}$

i.e. the measuring ranges of the transmitters are defined such that

$$\frac{K_G}{K_L} = \frac{1}{L_{\varnothing}}$$

The required adjustment range of λ results in

$$vA = \frac{1}{\lambda_E} = \frac{1}{1.25} = 0.8$$

$$vE = \frac{1}{\lambda_A} = \frac{1}{0.75} = 1.333$$

vA and vE are defined in configuring mode oFPA

Setting the ratio setpoint wv between 0 and 1 allows the ratio factor v to be set between 0.8 and 1.33, and the air factor λ between 1.25 and 0.75.

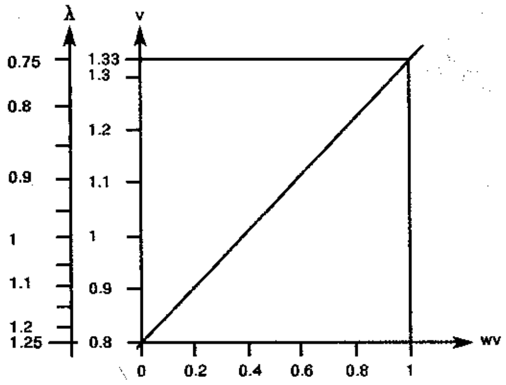
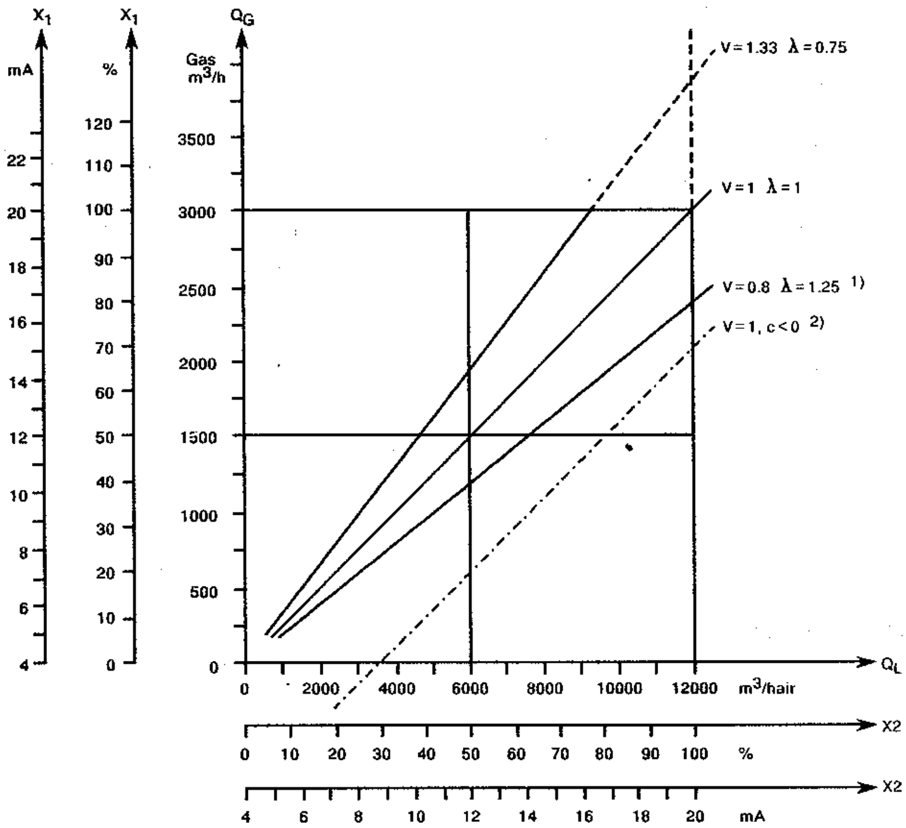


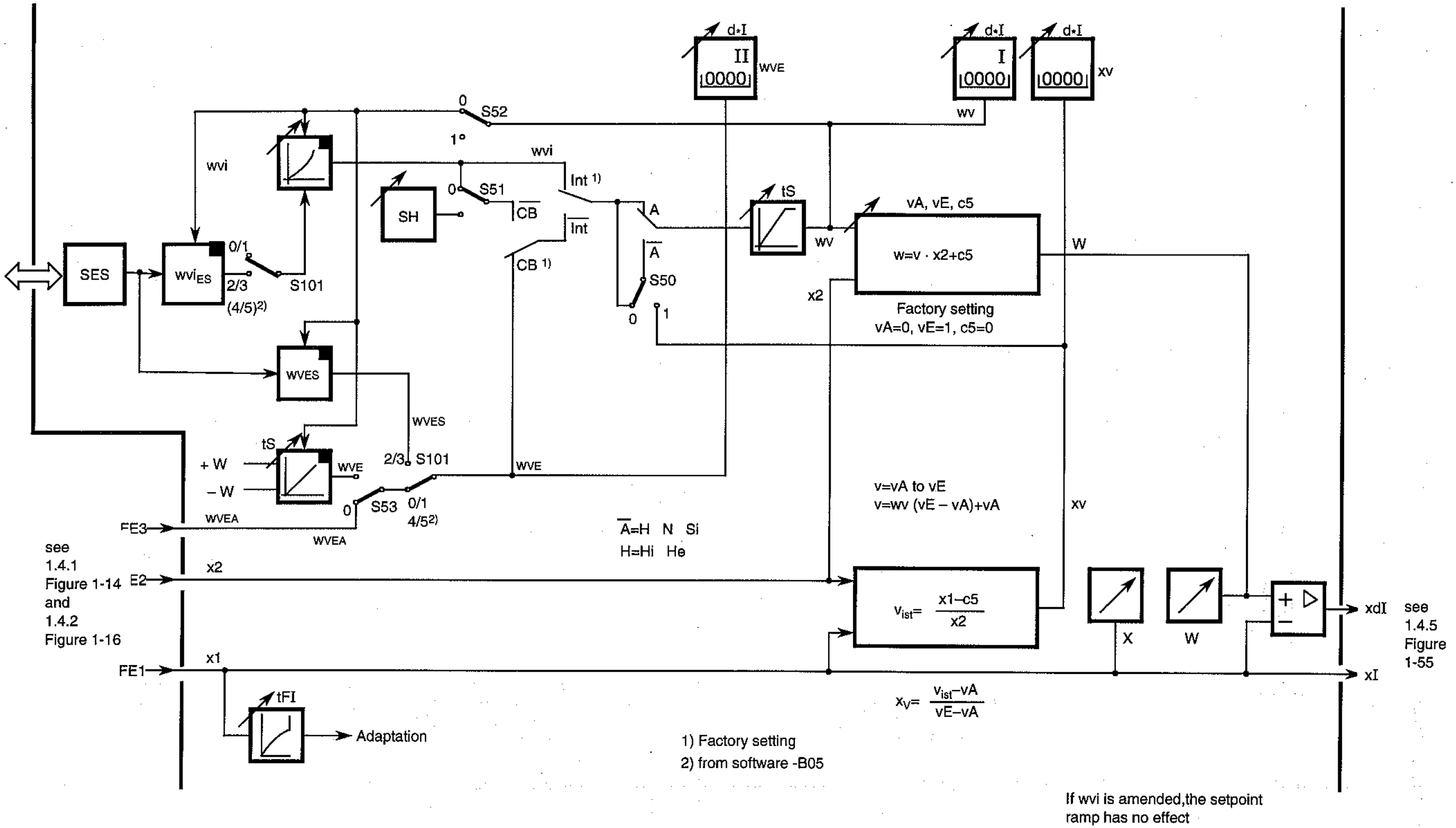
Figure 1-42 Relationship between ratio factor v and air factor λ to standardised ratio setpoint wv.

If combustion is to take place with excess air even at a low flow rate, then the constant c must be negative. The following diagram (Figure 1-43) shows the gas/air ratio in a steady state, with various air factors λ and c = 0, as well as with λ = 1 and c < 0, i.e. with excess air.



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

Figure 1-43 Gas/air ratio in stable state



1) Factory setting
2) from software -B05

Figure 1-44 Block diagram S1=4 controlled ratio controller

- **S1 = 5: Cascade control**

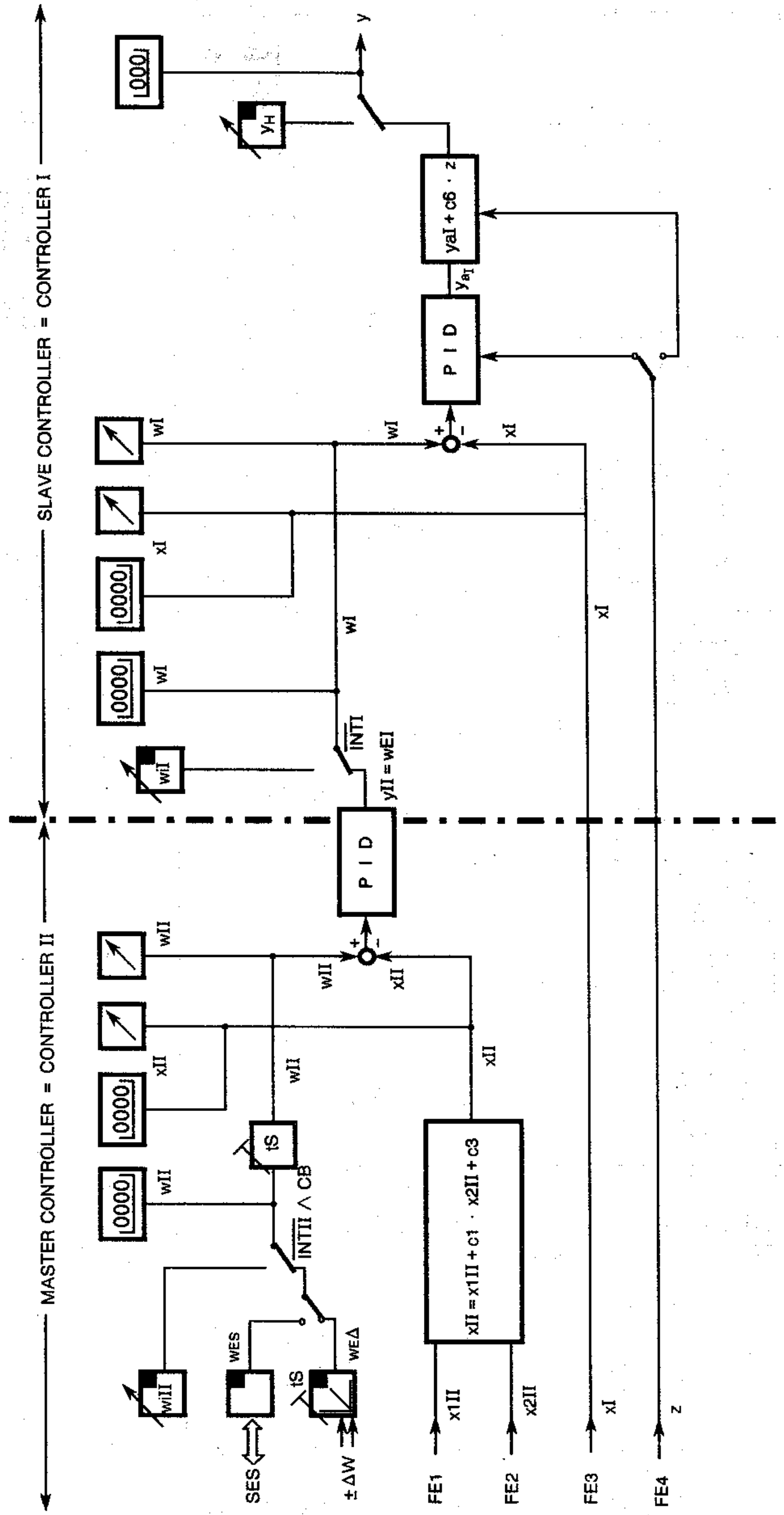


Figure 1-45 Control principle S1 = 5

In this type of controller, a master controller (Controller II) and a slave controller (Controller I) are connected in a cascade within a single device (application, see S1 = 3).

– Master controller (Controller II)

In terms of setpoint switchover, the master controller has the same structure as the slave controller S1 = 3, the only difference being that the remote setpoint wE cannot be input as an absolute value via analogue inputs. The master controller therefore functions as a fixed setpoint controller whose remote setpoint comes either via the SES or is adjusted incrementally using the control signal ±Δw. Use S101 to make your choice. When linked to a computer, a further option (determined by S51) permits processing to continue following a computer crash (CB flips from 1 to 0) using either the computer setpoint (tracked wi), or the safety setpoint SH. The master controller cannot be switched to manual mode, though the slave controller can be instructed to use a local setpoint.

Tracking of the inactive setpoint to the working setpoint can be inhibited by setting S52 = 1.

– Slave controller (Controller I)

The local/remote pushbutton (2) (Int I) is used to switch between local (wiI) and remote (wEI) setpoints in order to disable the cascade during start-up of the slave controller. The remote setpoint wEI is also the manipulated variable of the master controller. Local mode of the slave controller corresponds to manual mode of the master controller.

The y-limiting function of the master controller can be used to implement a setpoint threshold in the slave controller. Tracking of the master controller when the slave controller is in local mode with x-tracking ($\overline{A}$), and tracking of the local setpoint when the slave controller is in remote mode with x-tracking ($\overline{A}$) is performed continuously, so local/remote switchover is always bumpless.

– Switchover of display and control levels

The selector pushbutton (12) is used to switch between digital and analogue x and w displays on the selected controller. It also controls the function of the local/remote pushbutton (2), including the Local LED (1) and the ±Δw adjustment pushbuttons. **The y display (14), manual/automatic pushbutton (9) and the ±Δy adjustment pushbuttons (13) are permanently assigned to the slave controller.**

The LEDs Controller I/Controller II indicate the display and control levels:

Select via selector pushbutton	Controller II master controller	Controller I slave controller	LED $\overline{C}$	LED Local	LED Controller I	LED Controller II	Controller "n" displayed	adjustable wi
Controller II master controller	Int	Int	correspond-	1	0	1	II	wi II ↗[1]
	Ext	Int	ing CB	0	0	0.5	II	–
	Int	Ext		1	0	0.5[2]	II	wi II ↗[1]
	Ext	Ext	$\overline{C}$ = CB	0	0	1	II	–
Controller I slave controller	Int	Int	0	1	1	0	I	wi I ↗[1]
	Ext	Int	0	1	0.5	0	I	wi I ↗[1]
	Int	Ext	0	0	0.5[2]	0	I	
	Ext	Ext	0	0	1	0	I	

1) only when not x-tracking

2) 0.5 flashing frequency 1:1

Table 1-13 Switchover of display levels

A flashing light indicates that the status displayed on the LED Local does not correspond to the status of the other controller.

A steady light indicates that the status displayed on the LED Local and the status of the other controller are identical.

In normal process operation, the display level status will be Controller II (master controller), enabling the master controlled variable x II to be monitored. Display level I is used during start-up. Manual/automatic switchover on the slave controller is possible at both display levels. Depending on which display level is currently selected, either the master controlled variable xII or the secondary controlled variable xI can be monitored. The parameters d*I and d*II, if necessary in conjunction with the linearisation functions, are used to define the ranges of the digital x and w displays for each controller. Both controllers can therefore display corrected physical values.

– x-tracking

If S50 = 1, x-tracking is implemented on both controllers. In $\overline{A}$ mode, the slave controller tracks either the local setpoint or the master controller signal to the secondary controlled variable xI. The master controller implements this function when the slave controller is in $\overline{A}$ or local mode (both Int I and $\overline{A}$ mean the cascade is disabled).

Control signals: digital inputs HVNVSi 6)	CB 1)	front: Int II 7)	front: Int I 7)	Signals: Local LED (front) when Controller II	Local LED (front) when Controller I	5) $\overline{C}$ LED	digital outputs $\overline{RB}$ 4)	$\overline{RC}$ 4)	Int I	master controller working w II when S50 = 0, S51 = 0	S50 = 1, S51 = 0	S50 = 0, S51 = 1	S50 = 1, S51 = 1	slave controller working w I when S50 = 0	S50 = 1	Comments
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

Table 1-14 Cascade control, S1 = 5 with tracking of inactive setpoint to working setpoint S52 = 0

If S52 = 1 (no tracking of inactive setpoint to working setpoint), the note (n) does not apply to w II. When x-tracking is activated (S50 = 1), the master controller starts in automatic mode with w = x (xd = 0), and the working setpoint is tracked to the old value of w over the setpoint ramp time tS.

1) The table shows static computer switchover without acknowledgement, (S47 = 0).
2) If S101 < 2, w_E II is sourced from wEΔ (± Δw). If S101 = 2, wES via the SES.
3) SH will only attain wEΔ when Int II = 0 and CB flips from 1 to 0 (computer goes down). wi II remains effective if CB = 0 and Int is switched from 1 to 0. Since SH is not tracked, a switch to SH can be made over the setpoint ramp time tS.
4) If the cascade is disabled, computer stand-by or computer mode cannot be signalled if ORed with the digital outputs H, N, Int I and the control signal Si.
5) LED $\overline{C}$ = 0 if Controller I is selected.
6) Manual operation or operation using the remote manipulated variable is always possible, regardless of the setting Controller I/Controller II.
7) Switchover only possible from the selected controller. Operating status remains the same.
8) Adjustable from software version -A05

(n) variable tracks the last value effective before switchover, consequently switchover is bumpless.

↗ adjustable

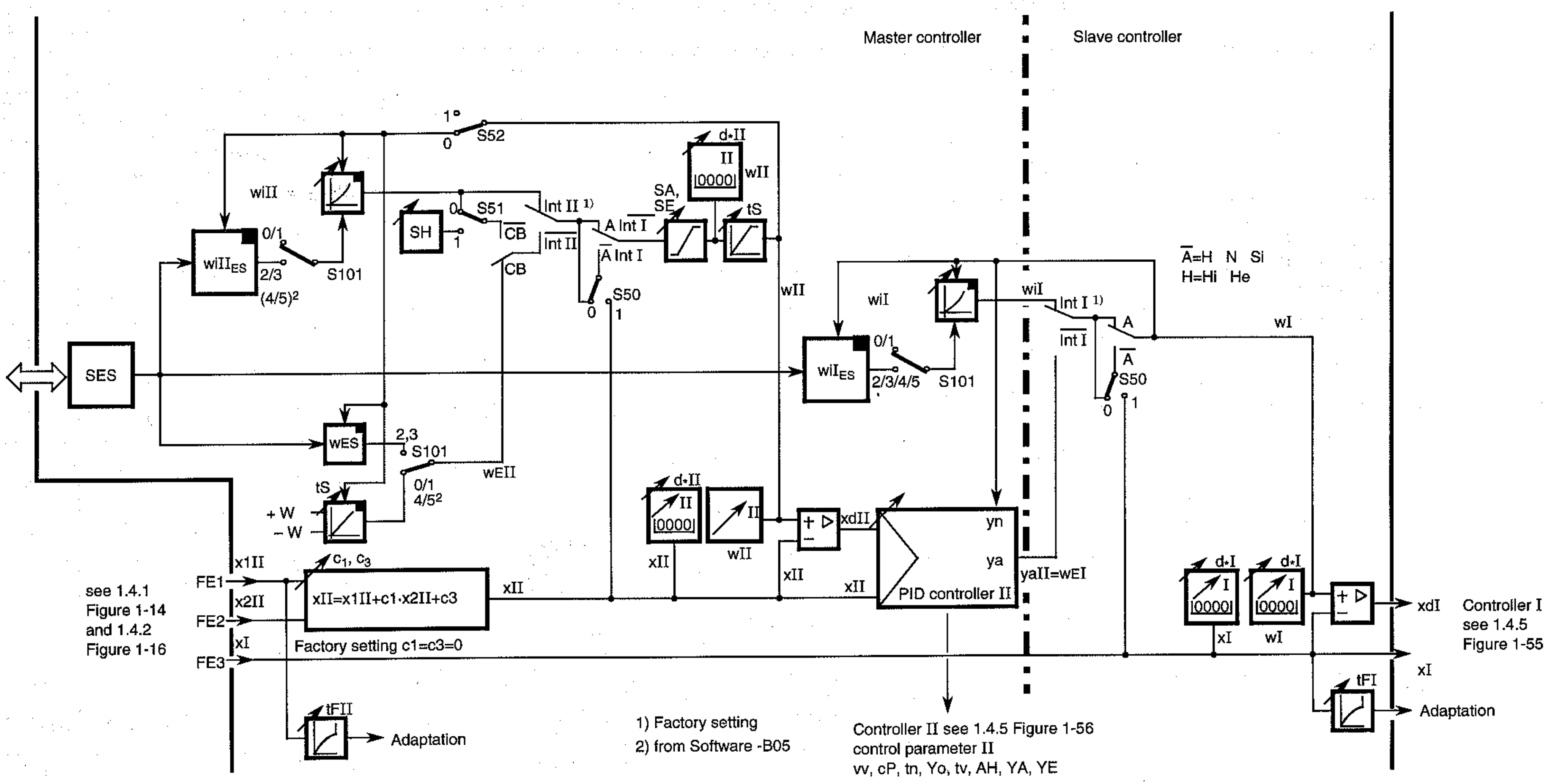


Figure 1-46 Block diagram S1=5 cascade control

- **S1 = 6: Cascaded ratio control**

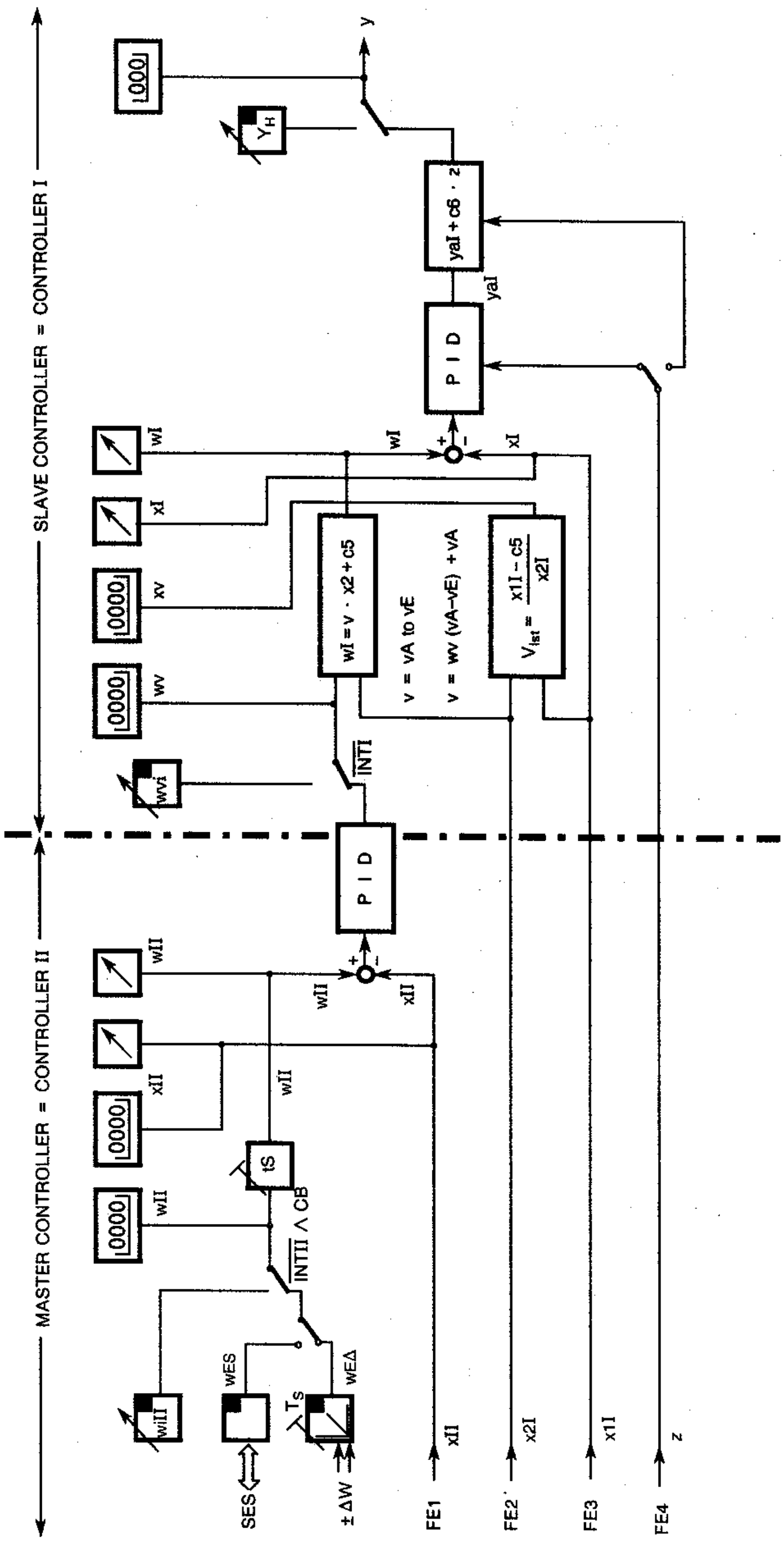


Figure 1-47 Control principle S1 = 6

In this type of controller, a master controller (Controller II) and a slave controller acting as a controlled ratio controller (Controller I) are linked together to form a ratio cascade (application, see S1 = 4).

– Master controller

In terms of setpoint switchover, the master controller has the same structure as the slave controller S1 = 3, the only difference being that the remote setpoint w_E cannot be input as an absolute value via analogue inputs. The master controller therefore functions as a fixed setpoint controller whose remote setpoint comes either via the SES or is adjusted incrementally using the control signal $\pm\Delta w$. Use S101 to make your choice. When linked to a computer, a further option (determined by S51) permits processing to continue following a computer crash (CB flips from 1 to 0) using either the computer setpoint (tracked wi), or the safety setpoint SH. The master controller cannot be switched to manual mode, though the slave controller can be instructed to use a local setpoint. x-tracking in $\overline{A}$ mode is made possible by setting S50 = 1. Tracking of the inactive setpoint to the working setpoint can be inhibited by setting S52 = 1.

– Slave controller

The slave controller operates as a ratio controller as described in S1 = 4. The local/remote pushbutton (2) Int I) is used to switch between local (wvi) and remote (w_{vE}) ratio setpoints in order to disable the cascade. The remote ratio setpoint w_{vE} is also the manipulated variable of the master controller (yaII). Local mode of the slave controller corresponds to manual mode of the master controller.

xv-tracking in $\overline{A}$ mode is made possible by setting S50 = 1. The manipulated variable threshold specified by the master controller and, if necessary, limiting of the command process variable x2I in the freely configurable input area (S4 = 1), can be used to define setpoint limits. Tracking of the master controller when the slave controller is in local mode with xv-tracking ($\overline{A}$), and tracking of the local ratio factor wvi when the slave controller is in remote mode with x-tracking ($\overline{A}$) is performed continuously, so local/remote switchover is always bumpless.

The data in Table 1-14, and the comments therein regarding x-tracking in cascade controllers, also apply here when the variables wi and w_E are replaced by wvi and w_{vE} respectively.

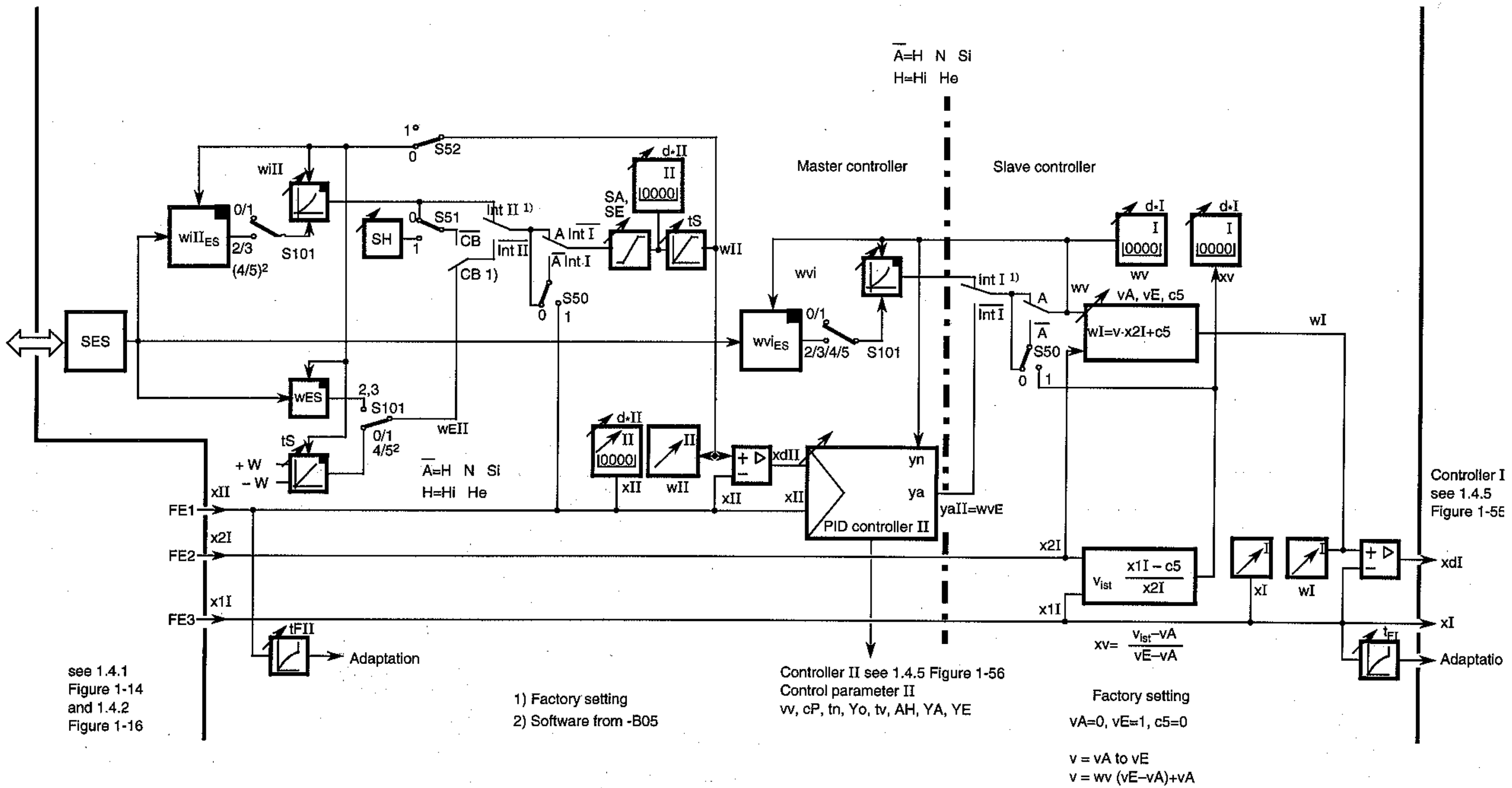


Figure 1-48 Block diagram S1=6 cascade ratio control

• **S1 = 7/8: Override control**

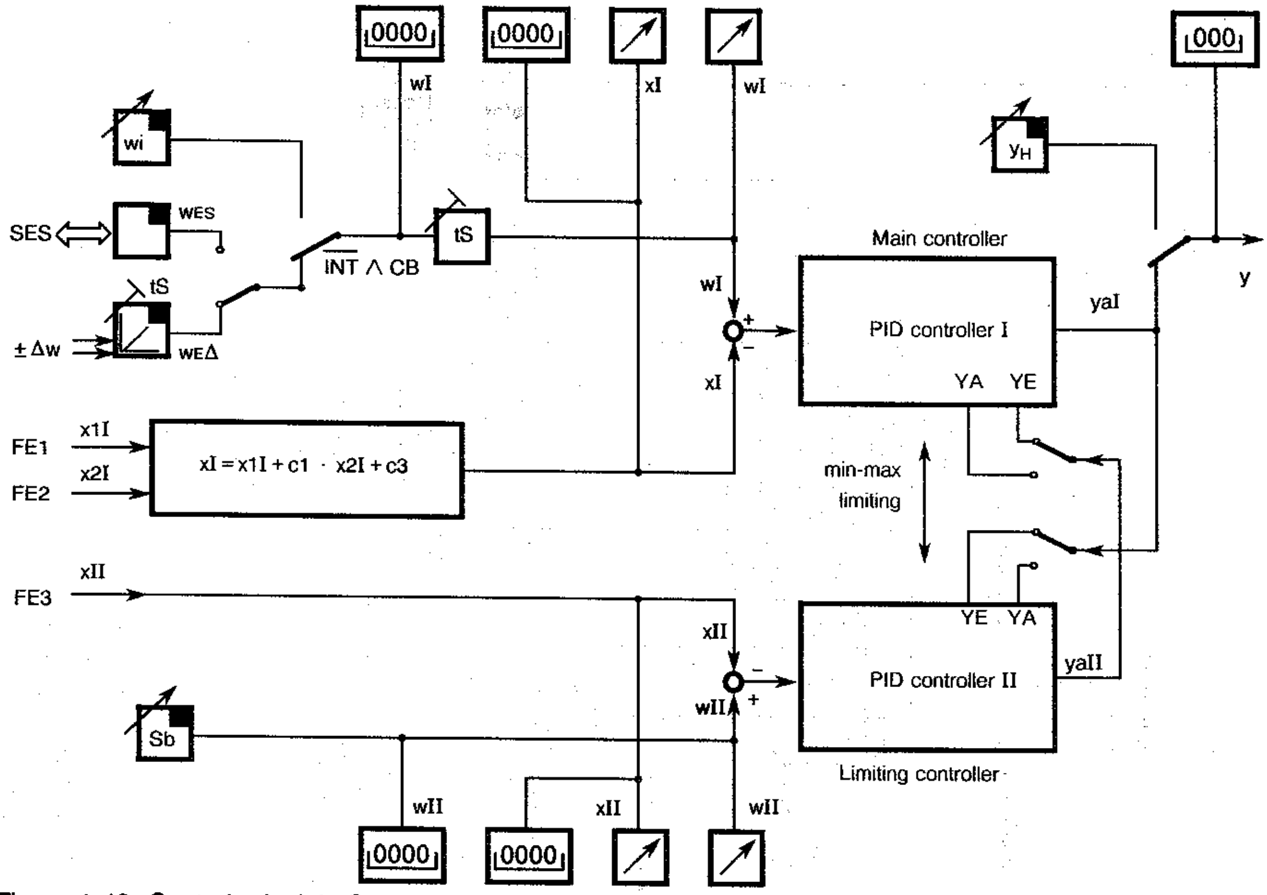


Figure 1-49 Control principle S1 = 7/8

In override control (limiting control, replacement control), two controllers - a main controller (Controller I) and a limiting controller (Controller II) - both controlling the same final control element are positioned in parallel. The manipulated variables of the two controllers are limited by the parameters yA (S1 = 7) or yE (S1 = 8). This results in controlled variable limitation that is related to the setpoints specified by, or being used by, the controllers.
One of the two controllers - preferably the main controller - is always active and actually controls the process. The inactive controller has a control difference that starts to influence the manipulated variable towards one of its limits yA or yE. In this case, any further integration is inhibited in order to prevent integral saturation. Controller II overrides Controller I when the control difference in the inactive controller reverses. Changes in the controlled variable towards the pivot point also lead to override by the P component (also by the D component, where appropriate). This results in very good dynamic behaviour.
In contrast to minimum/maximum limiting, using two controllers allows the control difference to be modified to better match the differing timing properties of the two control loops. Trying to implement minimum/maximum limiting on the manipulated variables can cause integral saturation, leading to dynamic problems with the inactive controller.

– Example: Reactor temperature control with maximum permitted shield temperature

The temperature of a reactor core is to be controlled without allowing the temperature of the shield to exceed a specified maximum value (setpoint threshold Sb). During normal operation, the core temperature is controlled to the predefined setpoint Wcore by the main controller (Controller I). As the temperature of the shield lies below the critical threshold level Sb, the control difference in the limiting controller (Controller II) is positive. The manipulated variable of the main controller, increased by 1%, is fed to the limiting controller and becomes its upper manipulated variable limit. The positive control difference forces the limiting controller towards this maximum.
The limiting controller in turn feeds the main controller the upper limit of its manipulated variable. This, however, has no effect on the main controller's manipulated variable, as it already lies 1 % above the value of the manipulated variable of the main controller. In this situation, the main controller can modify its manipulated variable completely independently of the limiting controller, and correct any fluctuations in the temperature of the reactor core.

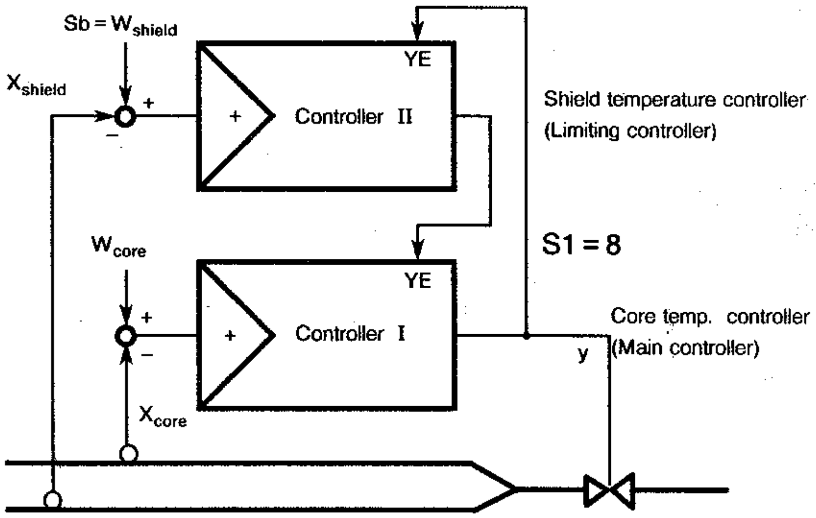


Figure 1-50 Temperature control with maximum shield temperature limit

If the temperature of the shield rises above the setpoint limit Sb, eg. as a result of problems with the water supply, the limiting controller will acquire a negative control difference. As a result, its manipulated variable frees itself from its predefined limit, and heat output is reduced. The limiting controller now imposes this new, lower manipulated variable on the main controller as its new upper manipulated variable limit. The reduced heat output results in a positive control difference in the main controller, which forces the signal from the main controller towards the manipulated variable limit. The limiting controller now maintains the process at a constant shield temperature.

1.4.4

When everything starts to cool, the shield temperature will also sink. To maintain a constant shield temperature, the limiting controller will now increase heat output. As a result, the temperature of the core will also start to rise, causing a negative control difference in the main controller.
The main controller now reduces the value of its manipulated variable and consequently the level of heat output. It imposes a new manipulated variable limit on the limiting controller. The shield temperature falls below the setpoint limit and the signal from the limiting controller is forced towards the new limit as a result of the positive control difference. The process is now controlled at a constant core temperature.
From this it can be seen that override always takes place when the controlled variable of the inactive controller is greater than the working setpoint (xd). The maximum value of the manipulated variable is then reduced, ie. the controlled variables are assigned maximum values. In this example, the setting of a maximum value on the manipulated variables corresponds to the selection of a minimum value for the manipulated variables
The choice between minimum or maximum limiting depends on configuring switch settings (S1 = 7 or 8) and the selected direction of control of the controller (normal: +kp or reversed: -kp):

S1	Manipulated variable limit	Corresponding y selection	Direction of action of controller		Overridden by		Controlled variables limited to	
			Main Controller I	Limiting Controller II	Main Controller I when	Limiting Controller II when	xI	xII
7	y_A	Max	norm +kp	norm +kp	xdI > 0, x I< wI	xdII > 0. xII < Sb	Min	Min
7	y_A	Max	rev -kp	rev -kp	xdI < 0, xI > wI	xdII < 0. xII > Sb	Max	Max
8	y_E	Min	norm +kp	norm +kp	xdI < 0, xI > wI	xdII < 0. xII > Sb	Max	Max
8	y_E	Min	rev -kp	rev -kp	xdI > 0, xI < wI	xdII > 0. xII < Sb	Min	Min
7	y_A	Max	norm +kp	rev -kp	xdI > 0, xI < wI	xdII < 0. xII > Sb	Min	Max
7	y_A	Max	rev -kp	norm +kp	xdI < 0, xI > wI	xdII > 0. xII < Sb	Max	Min
8	y_E	Min	norm +kp	rev -kp	xdI < 0, xI > wI	xdII > 0. xII < Sb	Max	Min
8	y_E	Min	rev -kp	norm +kp	xdI > 0, xI < wI	xdII > 0. xII > Sb	Min	Max

Table 1-15 Directions of controlled variable limits depending on S1 = 7/8 and direction of action of controller

When determining the direction of action of the controller, transmitter logic, the direction of action of the control element and the control loop itself are all taken into account (see section 4.1). As a rule, the limiting and main controller will have the same direction of action, so the second part of the table can be ignored.

- **Main controller I**

In terms of setpoint switchover, the master controller has the same structure as the slave controller S1 = 3, the only difference being that the remote setpoint wE cannot be input as an absolute value via analogue inputs. Main controller I therefore functions as a fixed setpoint controller whose remote setpoint comes either via the SES or is adjusted incrementally using the control signal ±Δw. Use S101 to make your choice. When linked to a computer, a further option (determined by S51) permits processing to continue following a computer crash (CB flips from 1 to 0) using either the computer setpoint (tracked wi), or the safety setpoint SH.
x-tracking in $\bar{A}$ mode is possible when S50 = 1. Tracking of the inactive setpoint to the working setpoint can be inhibited by setting S52 = 1.

- **Limiting controller II**

The limiting controller has the same structure as a fixed setpoint controller, but with no x-tracking or setpoint switchover facilities. The physical setpoint limit Sb is set within a range –10 to 110 % relative to the display range dEII - dAII = 100% in configuring mode oFPA.

- **Switchover of display and control levels**

The selector pushbutton (12) is used to switch display and control levels between Controller I and Controller II. This applies in all modes of operation. The LEDs Controller I/Controller II indicate which controller is being displayed and which currently controls the process.
The digital and analogue x and w displays are switched over. In control level II, the local pushbutton (2) and the ±Δw adjustment pushbuttons have no effect, and the Local LED (1) is off. **The y display, manual/automatic pushbutton (9) and the ±Δy adjustment pushbuttons (13) are permanently assigned to the common controller output and can be used in both display levels.**

Select via switchover pushbutton	Effective controller	LED Controller I	LED Controller II	Controller "n" displayed	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 when not x-tracking
2) 0.5 flashing frequency 1:1
↗ adjustable

Table 1-16 Switchover of display levels

A flashing Controller I/Controller II LED indicates that the displayed controller and the actual controller are not identical.
A steady LED indicates that the displayed controller and the actual controller are identical.
The process can be monitored at any time by switching over manually.
In normal process operation, the display level status will be Controller I (main controller), so the main controlled variable x1I can be monitored. If the Controller I LED is flashing, then the setpoint limit has been reached and the controller is instructing the operator to switch to display level II (limiting controller), and to use the controlled variable of the limiting controller. The parameters d*I and d*II, if necessary in conjunction with the linearisation functions, are used to define the ranges of the digital x and w displays for each controller. Both controllers can therefore display corrected physical values.

- **Automatic/manual switchover**

As both controllers generate a common automatic manipulated variable y_a, automatic/manual switchover is common to both controllers. During manual, tracking, safety and blocking mode, both controllers track to the working y value. As the manipulated variable limits defined by the parameters YAI and YEI are only effective in automatic mode, they represent absolute limits when in automatic mode. Tracking of YA and/or YE can only progress as far as these limits. Once values for YAI and YEI have been defined, terminating parameterisation mode onPA will automatically cause these values to be assigned to YAII and YEII.

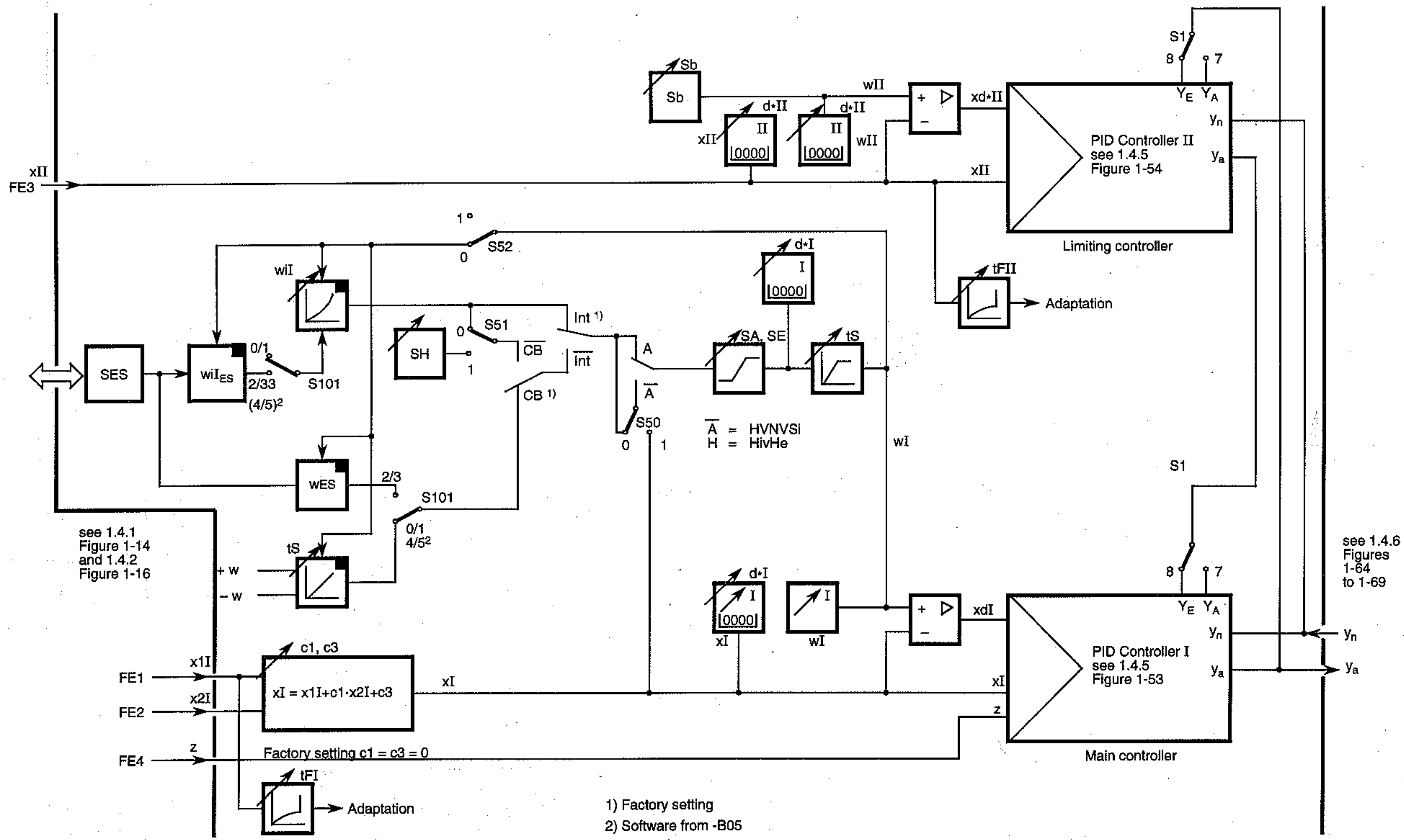


Figure 1-51 Block diagram S1 = 7/8 Override control

• **S1 = 9: Process variable indicator**

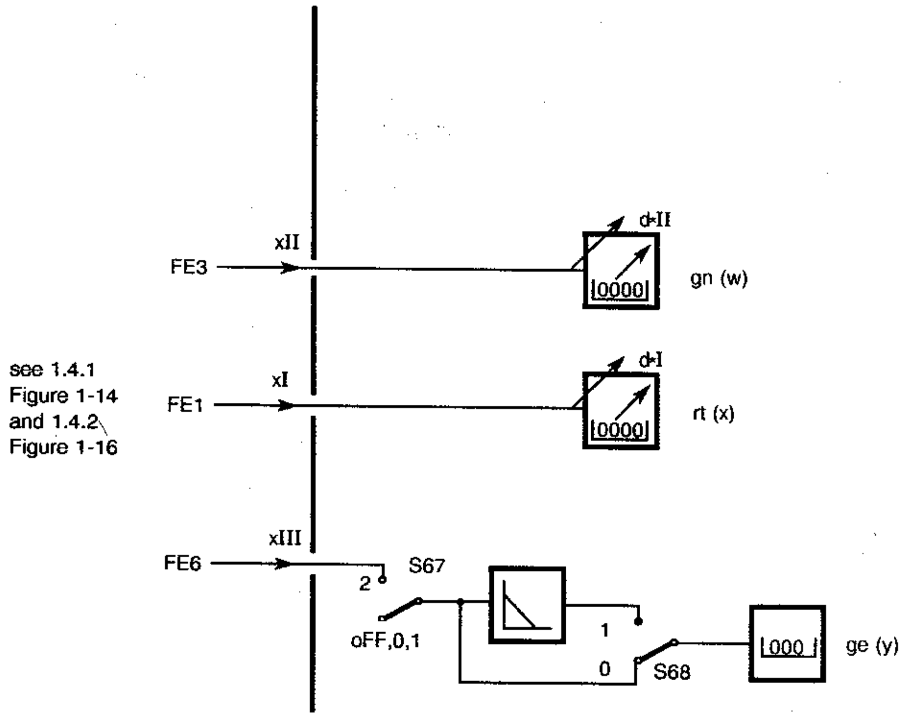


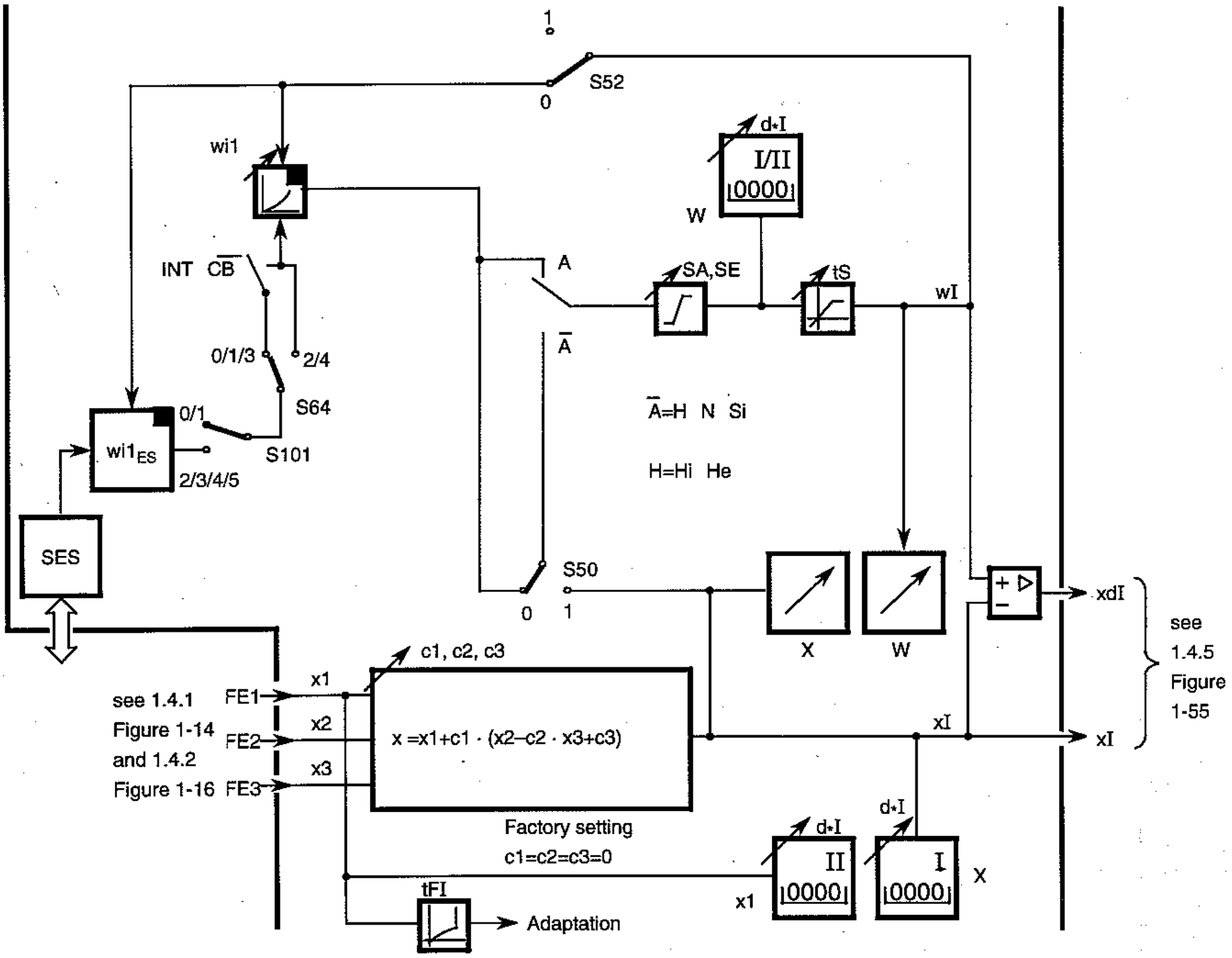
Figure 1-52 Block diagram Process variable indicator

The process variable indicator enables the operator to monitor 3 process variables (xI to xIII).

The process variables xI and xII are displayed on the x and w displays, whereby the digital and analogue displays are connected in parallel. The parameters d*I and d*II, if necessary in conjunction with the linearisation function, can be used to display corrected physical values for both variables. Display level switchover is not possible. The LEDs Controller I/Controller II remain off.

Process variable xIII is displayed in the y display, and if required can be switched off by setting configuring switch S67 to the oFF position. The display range is 0 to 100 %, and depending on the setting of configuring switch S68 will display a rising or falling characteristic. The overflow range is –10 to 110 %. Assigning the limit monitors A1 to A4 to FE1, FE3 or FE6 will allow alarm statuses to be output (see 1.4.9).

• **S1 = 10 Fixed setpoint controller with 1 setpoint (control system interface)**



Note: S64 = 3 is recommended for this controller type

Figure 1-53 Block diagram S1 = 10 Fixed setpoint controller for control system interfacing, from software version -B05 onwards

This fixed setpoint controller is specially designed for interfacing to the control system. The control actions by the signals Int and CB, which are not otherwise usable in this controller type, are available for blocking of control system operation via the SES.

With Int $\vee$ $\overline{CB}$ the setpoint signal wiES is disconnected and manual intervention via HeES where S64 = 3 is prevented.

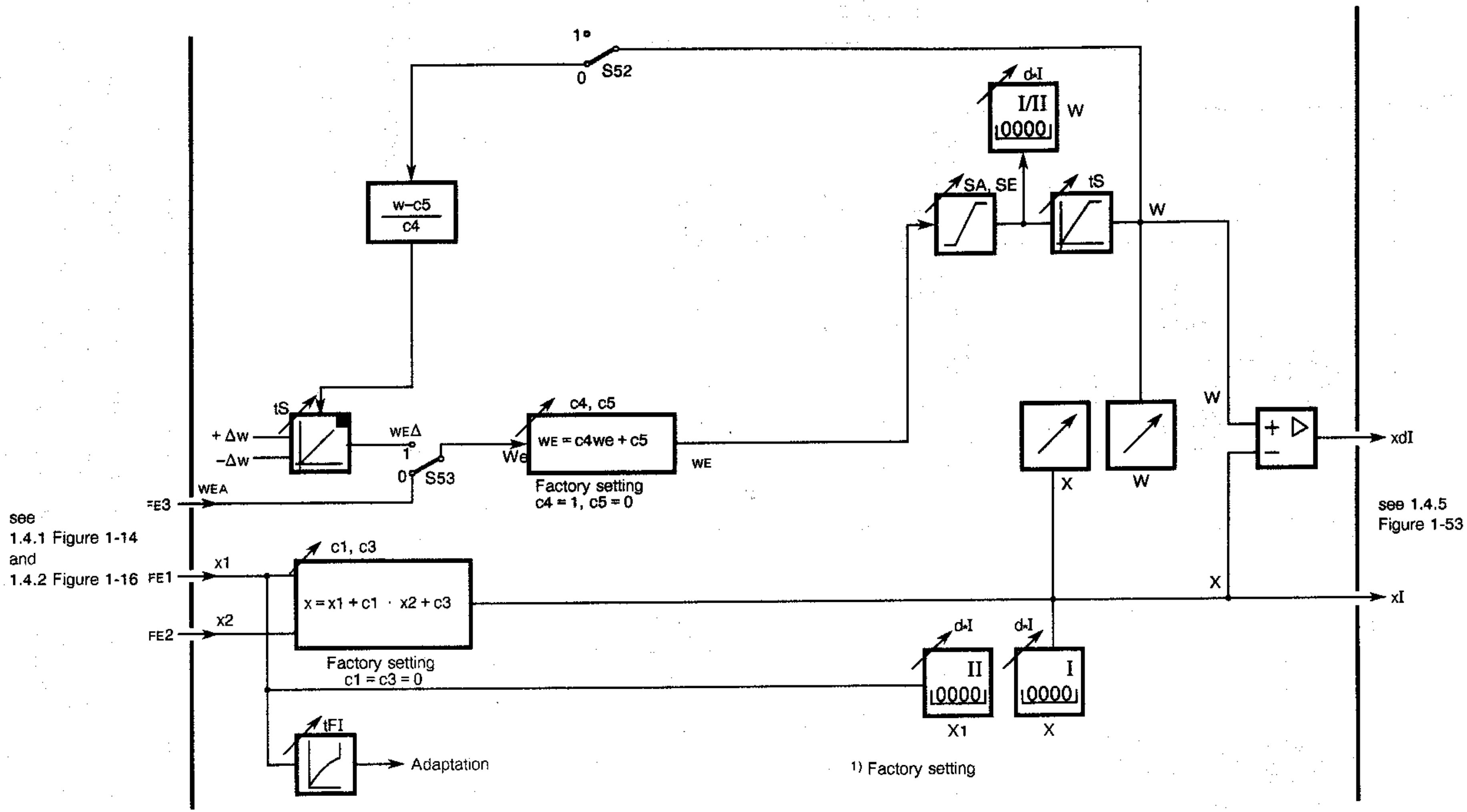
S64 = 3 is expressly recommended for this wiring configuration.
The remaining wiring configuration of the input function is almost identical to configuration S1 = 0.

• **S1 = 11 Slave controller without Int/Ext switchover (control system interface)**

This slave controller is specially designed for control system interfacing. It differs from configuration S1 = 3 in that setpoint switchover to wi via Int and CB is removed, and so those control signals are available for blocking of control system operation via the SES. With Int $\vee$CB manual intervention via HeES where S64 = 3 is prevented. S64 = 3 is expressly recommended for this wiring configuration.

A cascaded control is cancelled by manual setting on the master controller.

The remaining functions are the same as configuration S1 = 3.



Note: S64 = 3 is recommended for this controller type

Figure 1-54 Block diagram S1 = 11 Slave controller for control system interfacing, from software version -B05 onwards

1.4.5 Control algorithms, parameter control, adaption (S54 to S60)

- Control algorithms
  The PID control algorithm for controllers I and II is implemented as a non-interactive parallel structure. It corresponds closely to the ideal control equations, though ignores filter constants and cycle time.

- **P controller**

$$ya = \pm kp \cdot xd = yo \quad \text{or} \quad \frac{YA}{XD} = \pm KP$$

- **PI controller**

$$YA = \pm KP\,(XD + \frac{1}{Tn}\int_0^t xd\,dt) + yo\,(t) \quad or \quad \frac{ya}{xd} = \pm kp\,(1 + \frac{1}{jw\,Tn})$$

- **D component (zD component)**

The D component may be added if required

$$\frac{ya}{E} = \pm\, kp \frac{jw\,Tv}{1 + jw\frac{Tv}{vv}}$$

Depending on the setting of S55 or S57, the input variable E for the D element will be xd, x, –z, or +z. Feedforward of z is only possible in controller I.

- **zy component (controller I only)**

The zy component may be added to the ya output signal.

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

1.4.5 to 1.4.11

Structure controller I

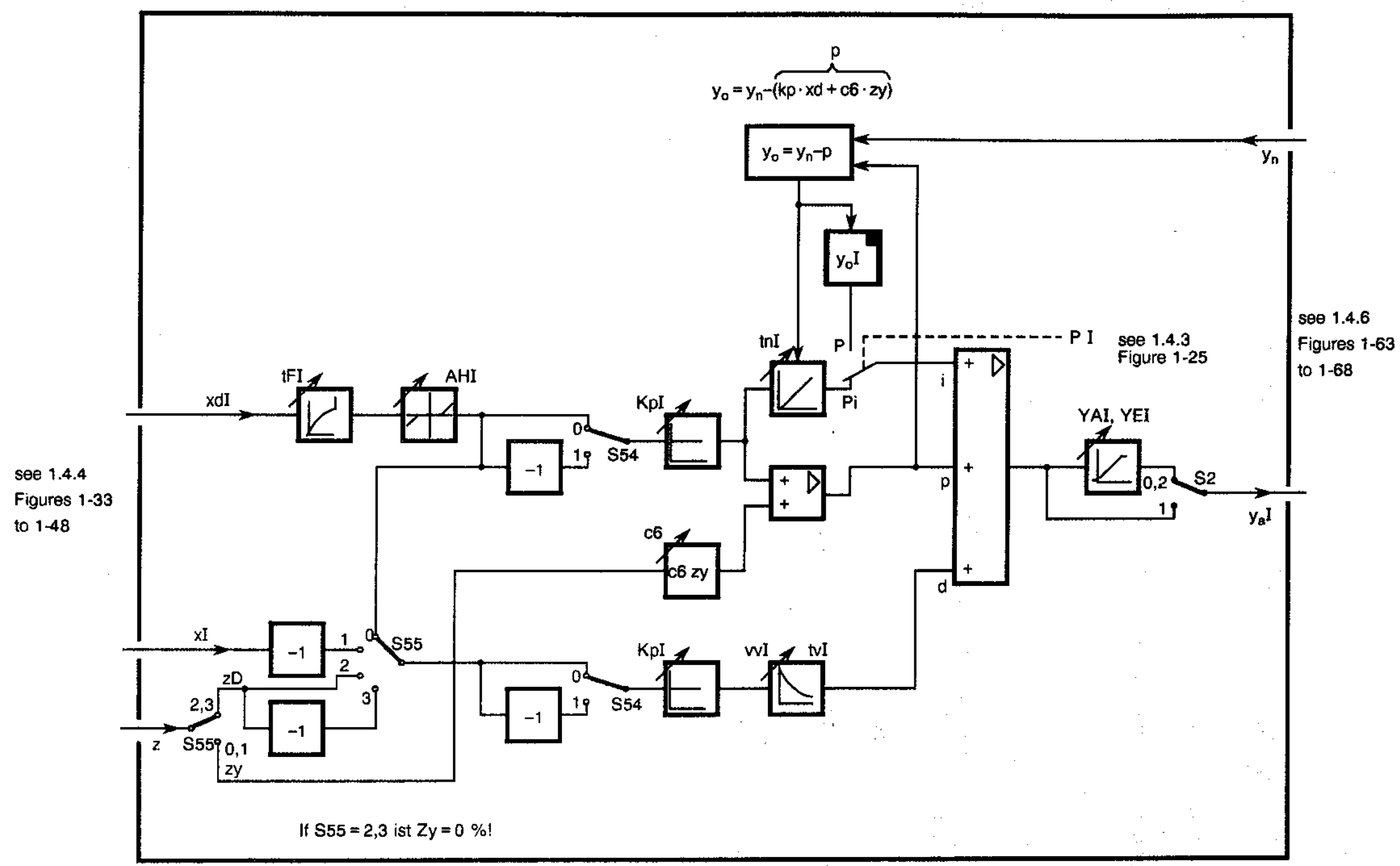


Figure 1-55 Block diagram showing structure of controller I (main controller, slave controller)

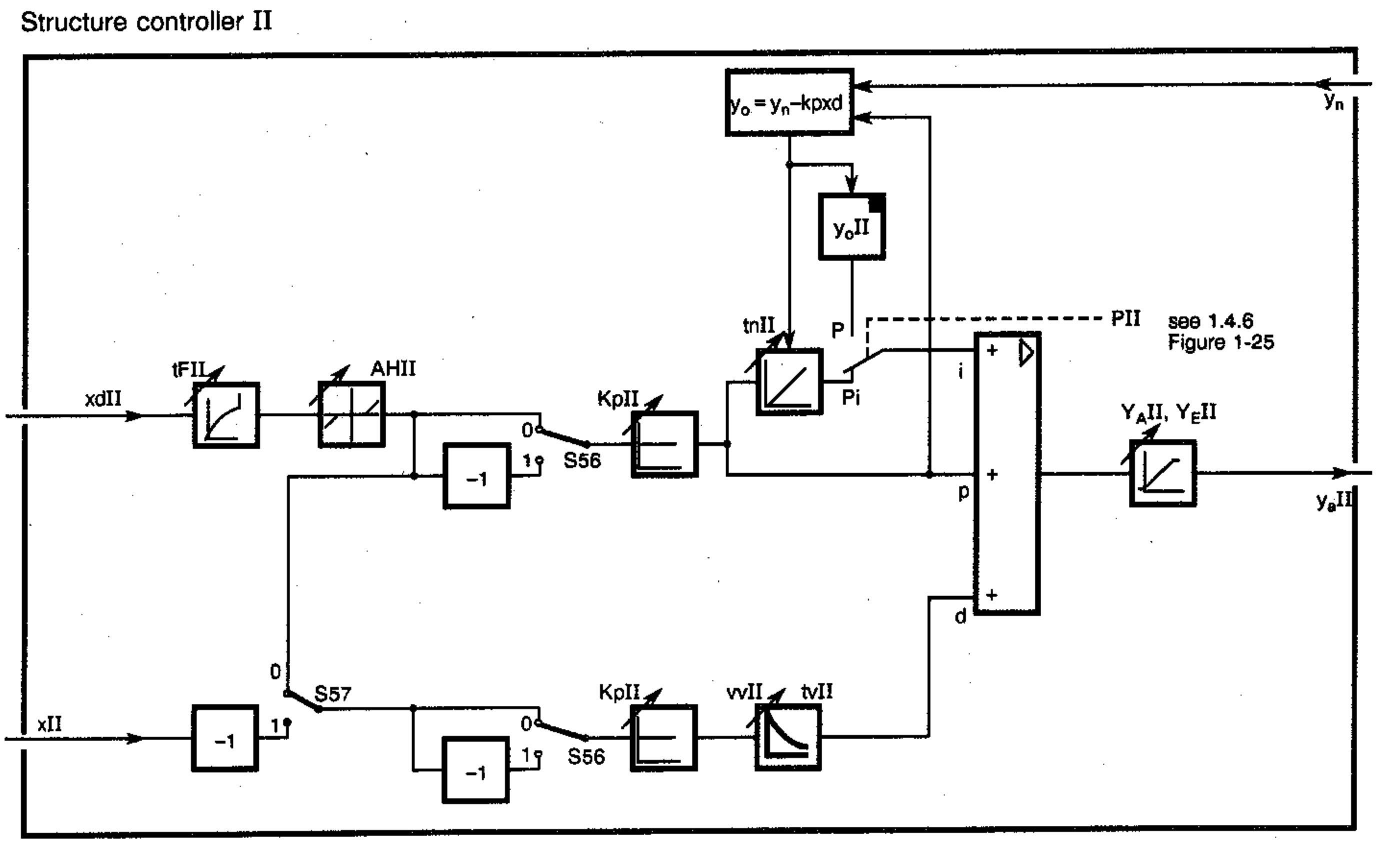


Figure 1-56 Block diagram showing structure of controller II (master or limiting controller) see Figures 1-46, 1-48, 1-51

- **Direction of control**

Direction of control is set by S54 (controller I) or S56 (controller II). The direction of control must always be the opposite (negative feedback) of the control loop (including control element and transmitter).
S54/56 = 0, normal action controller ($+k_p$, increase in x causes y to fall) for standard control loops (increase in y causes x to rise).
S54/56 = 1, reverse action controller ($-k_p$, increase in x causes y to rise) for control loops operating in reverse (increase in y causes x to fall).

- **Working point yo in P controllers**

The working point yo of a P controller can either be set automatically, or defined as a parameter (onPA).

- **Automatic working point (yo = auto)**
The working point yo is always tracked whenever the controller is not in automatic mode (manual, tracking, safety or blocking mode). This ensures that switchover to automatic is always bumpless.
As a result, the working point yo is in effect set automatically when in manual mode:

$yo = y_H \pm K_p (w - x_H)$ for controller II or

$yo = y_H \pm K_p (w - x_H) \pm c6 \cdot z_y$ for controller I

If, in manual mode, the manipulated variable (y_H) forces the controlled variable (x_H) to reach the setpoint (w), then the working point (yo) and manipulated variable (y_H) will be identical.

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

- **Fixed working point (yo = 0 to 100 %)**
The controller uses a fixed working point that has been defined as a parameter, regardless of the mode of operation.

- **Manipulated variable limits yA, yE**

The manipulated variable limits set by the parameters YA and YE only function in automatic mode. These limits lie at -10 and +110 % respectively. Note, however, that the controller can neither output negative manipulated variable signals, nor can it handle negative position feedback signals.

Should the manipulated variable ya reach one of the limits YA or YE when in automatic mode, further integration will be inhibited in order to avoid integral saturation. This ensures that the manipulated variable can be amended immediately once the polarity of the control difference is reversed.

In manual, tracking (DDC) and safety modes, the value of the manipulated variable y may exceed these limits. A bumpless transition to the most recent manipulated variable follows on switching into automatic mode, though the only amendments to the manipulated variable which will then be effective are those which move its value back towards the range YA to YE.
For controller I, manipulated variable limits can only be defined for K controllers and three position step controllers with external position feedback (S2 = 0 and S2 = 3).

- **Bumpless switchover to automatic mode**

To ensure bumpless switchover to automatic mode, the I component/working point yo (only when Yo = auto) is always tracked whenever the controller is not in automatic mode (manual, tracking, safety or blocking modes). If the D component is still active, it is set to 0.

- **P-Pi switchover**

If the control signal P*=1, the controller switches from Pi to P operation. If Yo=auto, switchover is bumpless.

- **Adaptive filter**

The control difference xd is fed through an adaptive filter. The filter is activated by changing tFI, or tFII, from oFF to 1 second (onPA). Increasing tF* further allows the filter to be used at a lower frequency disturbance level (time constant in the range seconds to hours). Repeated fluctuations within a band are treated by the filter as noise, and filtered out using the preset time constant tF*; fluctuations in a direction that lead out of the filter band are passed unfiltered to the Pi(D) algorithm, allowing corrections to be performed immediately. As time passes, the filter automatically adapts itself to the new noise levels.

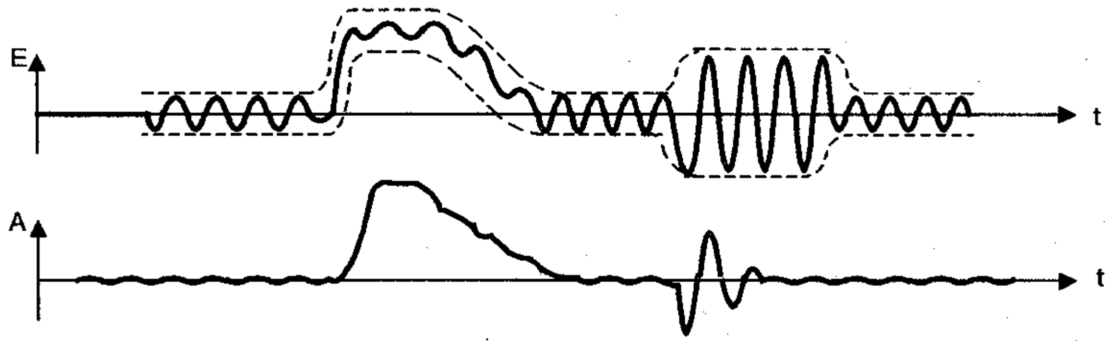


Figure 1-57 Effect of the adaptive non-linear filter

1.4.5 to 1.4.1

The factory setting for tFI and tFII is 1 second. On controllers with a D element, these filter values should be as high as possible to offset the increased input noise level caused by vv.kp. This also applies to the adaptation process (see 4.4).

- **Response threshold AH**

The control difference outside the response threshold AH (dead zone element) is fed to an adaptive filter.

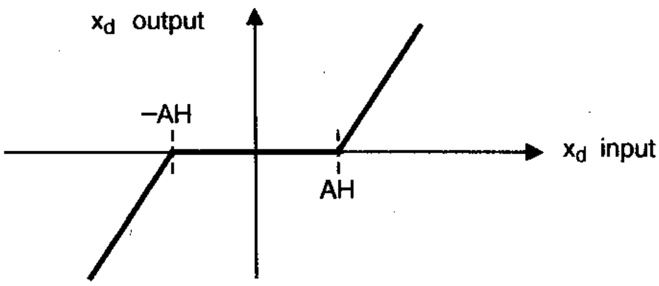


Figure 1-58 Effect of the dead zone element

The presence of a dead zone element gives the controller a progressive response. The gain is small, or even 0, in the case of minor control differences; by contrast, the value of kp will be reached with large differences. Remember that the remaining control difference could equal the value of the response threshold AH. The response threshold can be set as high as 10 % in parameterisation mode onPA. The factory setting is 0 %.

A minimum value for AH can be calculated by $\Delta x = ks \cdot \Delta y$ for S controllers (see section 4.3). This may then be increased to stabilise the control loop further. To stabilise the control loop on K controllers, and also to reduce wear and tear on the control element, a lower response threshold is recommended.

- **Parameter switchover**

Single-loop controllers, ie. fixed setpoint controllers with two independent setpoints, fixed setpoint controllers with two dependent setpoints, DDC fixed setpoint controllers, slave controllers (synchronisation controllers, SPC controllers) and ratio controllers, use parameter set I and can be switched to parameter set II by the control signal PAU = 1. Both parameter sets can be defined separately in parameterisation mode onPA. Each parameter set contains the parameters vv, cP, tn, tv, AH, Yo, YA and YE, each flagged I or II. The switchover option is primarily designed for 2 setpoint operation and should normally only be executed when in manual mode, as bumpless switchover in automatic mode is not possible.
Dual-loop controllers (cascade control, cascaded ratio control and override control) operate with separate parameter sets I and II for controllers I and II respectively. Parameter switchover using the PAU control signal is not possible.

- **Parameter control**

Configuring switch S59 can be used to replace parameter sets I and II, with the exception of the parameters YA and YE, by a scheduled parameter set. With dual-loop controllers, one of the two controllers may operate with the scheduled parameter set. On single-loop controllers, the control signal PAU not only enables the scheduled parameter set to be used, but also allows switchover to one of the fixed parameter sets. The parameters cP (kp), tn, tv, AH and Yo are scheduled via a line with vertices at 10 %, 30 %, 50 %, 70 % and 90 % of the controlling variable. The controlling variable is chosen using S60. Any relevant variable known to the controller may be used.

S59	PAU	Working parameter set
0	0	Parameter set I
0	1	Parameter set II
1	0	Scheduled parameter set
1	1	Parameter set II
2	0	Parameter set I
2	1	Scheduled parameter set

Table 1-17 Parameter set selection using S59 and control signal PAU

The parameters at each vertex (indicated by the suffix 1, 3, 5, 7, 9 for 10 %, 30 % , 50 %, 70 %, 90 % of the controlling variable) are entered manually in configuring mode PAST. Values that lie outside the threshold vertices at 10 % and 90 % remain constant.

Vertices of parameters that are not to be controlled are all assigned the same value. The derivative action gain parameter vvc cannot be controlled, but may still be assigned a value in the range 0.1 to 10.

In the case of the parameter tv, an additional condition must be adhered to: tv.1 to tv.9 must either be all = oFF (PI or P controller) or all ≠ oFF (PID or PD controller), otherwise the error tv Err (see 3.3.3) will occur when quitting configuring mode PAST using the Exit pushbutton.

Yo can lie between 0 and 100 %, in which case it functions as a "fixed" working point. Yo can also be set = Auto, in which case parameter control does not occur and the working point is selected automatically when not in automatic mode (see working point with P controllers).

Yo.1 to Yo.9 must either be all = Auto or all ≠ Auto, otherwise the error Yo Err (see section 3.3.3) will occur when quitting configuring mode PAST using the Exit pushbutton.

Typical controlling variables are the control difference xd (this has the effect 10|xd|) for progressive control and x or y for working point dependent control (non-linear processes). If S60 = 17, a simulated controlled variable of 10 % is used for PI operation and 30 % for P operation. This enables a large kp (cP.3) value to be used, eg. during start-up in P mode (control signal P = 1), so the working point is reached quickly. After switching to PI mode (P = 0), a smaller kp value (cP.1) permits stable control.
The values of parameters and controlling variables can be acquired through adaptation (see paragraph entitled "adaptation").

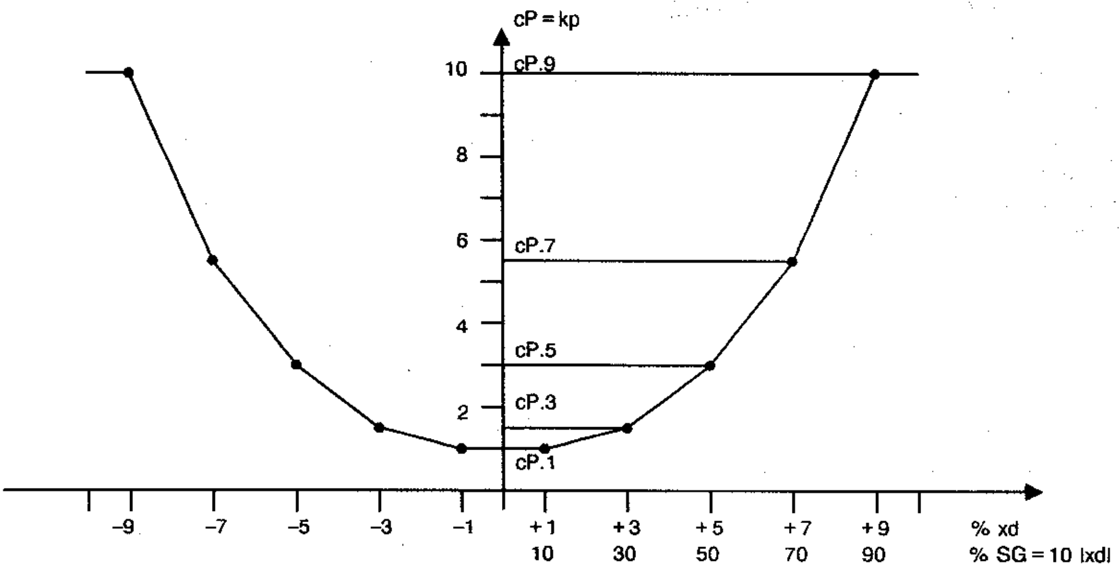


Figure 1-59 Example of kp control using 10|xd| as control variable for progressive control

- **Adaption (S58)**[1]
Adaptation is a reliable and simple aid to commissioning. The adaptation process is far superior to manual optimisation, particularly with slow control loops and where PID control is being used. It is initiated by the operator and can be aborted at any time. If required, parameters output by adaptation can be altered or adopted by the user. In conjunction with parameter control, adaptation may also be applied to non-linear control loops.
The adaptation process requires the following parameters. These are assigned in parameterisation mode AdAP, which can only be entered when S58 ≠ 0:
tU Monitoring period
dPV Direction of step change
dY Amplitude of step change
The configuring switch S58 is used to select the type of control response (with or without overshoot).
The adaptation process can be divided into identification of the control loop and drafting of the controller.

– **Identification of the control loop**
The controller is driven in manual mode to the desired working point. By pressing the Enter pushbutton, the manual manipulated variable will be modified by a specified amplitude (dY) in a specified direction (dPv). This y step is output directly in the case of K controllers, but because of the different positioning time Ty (set against actual) with S controllers, a position feedback is required and the y step must be measured. The y step is output after 10 % of the monitoring period tU has elapsed, assuming that during this time the controlled variable has reached a stable state. Otherwise an error message is output and identification is aborted (see section 3.2.3, Table 3-2).
The step response of the control loop is now measured by up to 84 pairs of time and amplitude values. The main controlled variable for each particular type of controller (see Figures 1-33 to 1-51) is used, suitably filtered, for controlled variable measurement. Measured values are sampled during every cycle. The adaptive filter is used to suppress the noise level. Data is stored on a cyclic basis, emptying a buffer and then refilling it, thereby also allowing slow control loops to be monitored.

1) This description applies to software version -A05 and higher

Once initial identification is complete (the controlled variable x must leave the initial identification band before 50 % of the monitoring period tU has elapsed), 95 % of the full-scale value must be reached before $^2/_3$ of the monitoring period elapses. The monitoring period tU must therefore be $\geq$ 2 T95 of the control loop. The remaining time is required for identification of the full-scale value. Identification of the full-scale value can take place immediately after the start-of-scale value, but it always requires at least $^1/_3$ of the measurements for this purpose. Once the full-scale value has been identified, no further measured value pairs are recorded.

A comparison with the recorded transient function is now made using stored Ptn models, where n = 1 to 8, and identical time constants T, by varying the values for n and T. The calculated control loop gain ks is transferred to the model of the control loop. The comparison is made using the minimum error area F (n, T).

In addition, actual dead times are measured, which shift the control loop in question to a higher order.

Self-regulating control loops with periodic transient responses of the 1st to 8th order, and a recovery time T95 of between 5 seconds and 12 hours, can be identified. Dead time components are permitted.

The recovery time T95 on S controllers should be twice as long as the positioning time Ty.

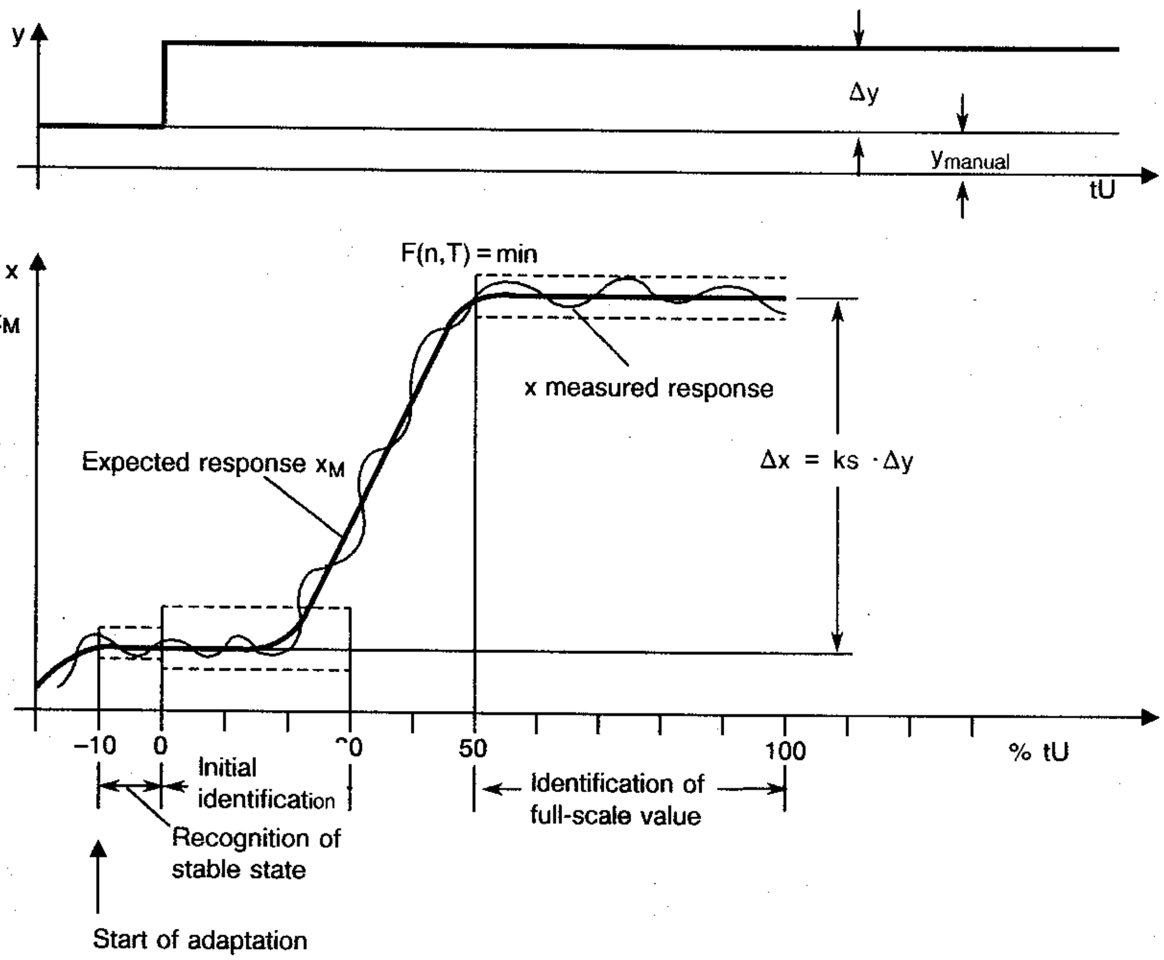


Figure 1-60 Adaptation response with no errors where tU = 2 x T95

Error checks take place during control loop identification so the whole procedure can be prematurely aborted if necessary. There are a total of 13 test points. If an error is detected, it is indicated by flashing digital x and w displays. As soon as an error message is output, identification of the control loop is aborted and can only be restarted once the necessary parameters have been corrected in parameterisation mode AdAP. Refer to section 3.2.3 for acknowledgements to error messages, and Table 3-2 for a list of error messages.

- **Controller drafting**

Controller drafting is performed using absolute value optimisation (S58 = 2). This procedure is very robust and also permits variations in control loop gain. However, it does generate an overshoot of approximately 5 % if the command variable is changed. This can be prevented, if required, by setting S58 = 1 (controller drafting with no overshoot), in which case kp is reduced to 80 %.

The controller is drafted for PI and PID response, ie. kp, tn, and, in the case of PID control, tv, are calculated with the derivative action gain set to 5. This can only be achieved if the D element is connected to xd or x, as appropriate (S55 = 0 or 1).

In the case of S controllers, the response threshold AH is calculated in addition to kp, tv and tn. The parameters tA, tE and tY must first be assigned values according to the type of actuator being used (see 4.3). If the settling time T95 is close to 2 tY (positioning time), then overshoots may occur in controllers with a D element, even when S58 = 1.

Controllers on 1st order control loops should be configured as PI or PID controllers, and on 2nd order control loops as PID controllers, since kp tends towards infinity in these cases, making absolute value optimisation unsuitable. The controller is drafted such that the ratio system time constant to control loop constant is 3 (S58 = 1) or 10 (S58 = 2).

Once adaptation is complete, both the old (identified by .o) and the new (identified by .n) parameters can be read in parameterisation mode AdAP. New parameters for PI and PID controllers are displayed.

In addition, the identified control loop order (1 to 8) is appended to the PI/PID.
The selected **.0, **.n PI.* or **.n PID.* parameters (** = parameter name, * = control loop order 1 to 8) can be edited and used if required.

How to use adaptation is described in section 3.2.3. Commissioning is explained in section 4.5.

1.4.6 Controller output structures (S2, S61 bis S68)

Depending on the setting of configuring switch S2, controller I can have three different types of output structure:

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

- **S2 = 0: continuous (K) controller** (figures 1-61 and 1-62)
  Primarily for controlling pneumatic proportionally acting positioning devices, or as a master controller in cascades.

  In K controllers, the automatic manipulated variable (ya) of controller I is processed directly via the switchover function, with no further conversion. Where two final control elements are being used, two split range signals y1 and y2 are allocated to the manipulated variable y. These two independent manipulated variables can be parameterised in configuring mode oFPA by Y1 and Y2. S65 allows the split range functions to be defined as either rising-falling (y1 heating element - y2 cooling element) or rising-rising (y1 control element span I - y2 control element span II).

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

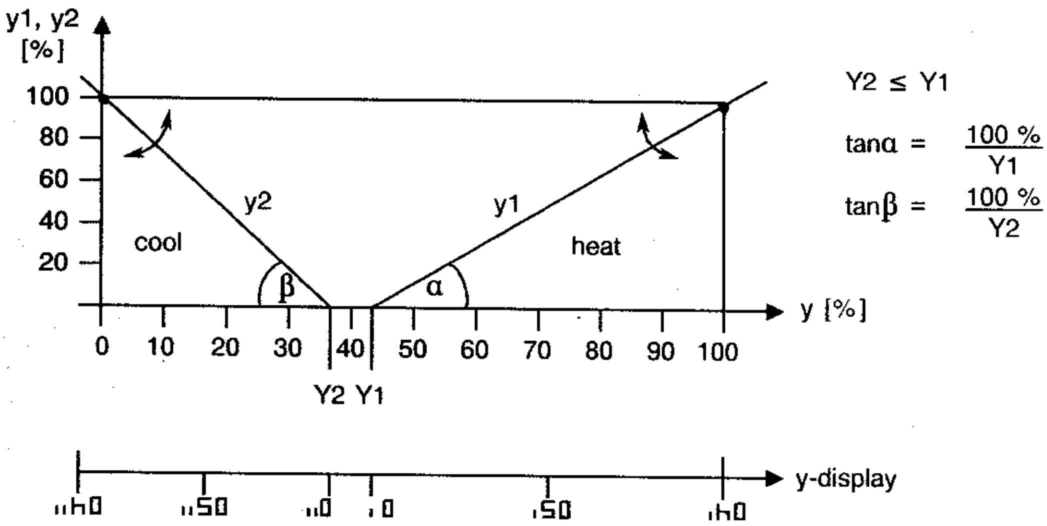
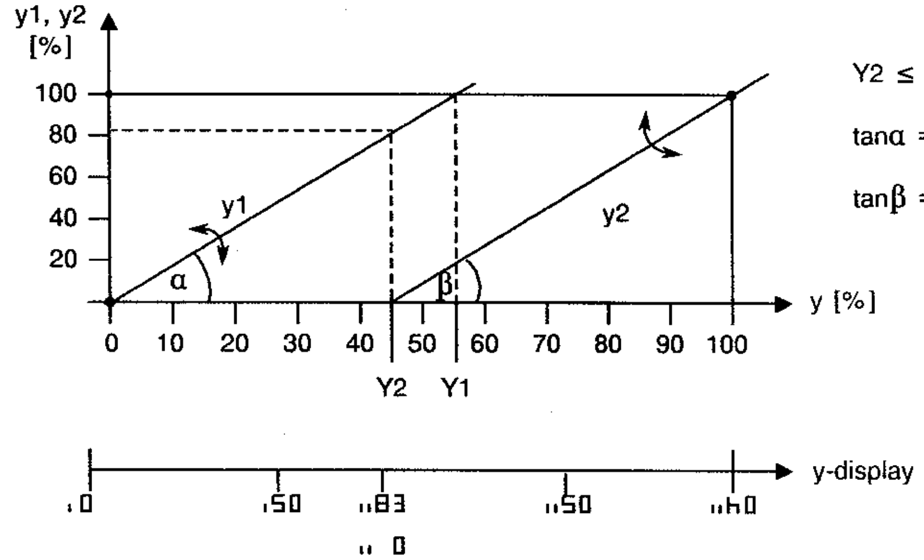


Figure 1-61 Split range function rising - falling

Parameters Y1 and Y2 are used to determine where the y1 and y2 straight line functions intersect the 0 % axis. Overlapping is impossible, as Y1 cannot be smaller than Y2, therefore simultaneous heating and cooling is prevented. To save energy, an interval of 6 to 10 % is normally allowed between 'terminate cooling' and 'start heating'. Depending on the design of the cooling and heating elements, in relation to the span of the controlled variable, satisfactory control results in both areas can be achieved by varying the degree of steepness to compensate for control loop gains. As a rule, cost considerations will result in the cooling element being somewhat under dimensioned, so Y2 will have to be steeper than Y1.

When S67 = 1, the manipulated variable currently being applied to the signals y1 and y2 is indicated by a I or II in the display. Consequently, only two segments will be available for displaying the value of the manipulated variable itself. Any values greater than or equal to 100 % are therefore indicated by "h". The display changes from y1 to y2 in the middle of the dead zone.

- **Split range function rising - rising (S65 = 1)**



$Y2 \leq Y1$

$\tan\alpha = \frac{100\ \%}{Y1}$

$\tan\beta = \frac{100\ \%}{100\ \% - Y2}$

Figure 1-62 Split rangefunction rising - rising

Parameter Y1 determines where y1 and 100 % intersect, and parameter Y2 where manipulated variable y2 and 0 % intersect. As Y1 cannot be smaller than Y2, no gap can exist therefore there is no uncontrollable area when using two setpoints on one line. Depending on the design of the positioning device, in relation to the span of the controlled variable, satisfactory control results can be achieved across the entire range by varying the degree of steepness to compensate for control loop gains.

When S67 = 1, the manipulated variable currently being applied to the signals y1 and y2 is indicated by a I or II in the display. Consequently, only two segments will be available for displaying the value of the manipulated variable itself. Any values greater than or equal to 100 % are therefore indicated by "h". The y1 signal remains displayed until y2 attains a value ≥ 0.

- **Positioning time tY** 1)

With S62 = 0 (absolute-value input of YN), the positioning speed of the automatic manipulated variable can be set with tY. No limitation is carried out in the position oFF, the minimum positioning time for 0 to 100 % manipulated variable is defined in the positions 1 to 1000 s. The rate of rise of the P, I and D components as well as the manipulated variable Z is limited. This limiting of the rate of rise is always used if the subsequent control element has positioning times > 1 s in order to prevent integral saturation or if the process cannot cope with the surges of the P, D or Z component. It must be taken into account in this case that the settling time becomes longer.

With S62 = 1 (incremental input of YN), tY is used to set the positioning speed of the integrator. The positioning time is defined for changes from 0 to 100 %. When in the position oFF, the integrator output changes with a jump.

1) From software version -A07 onwards

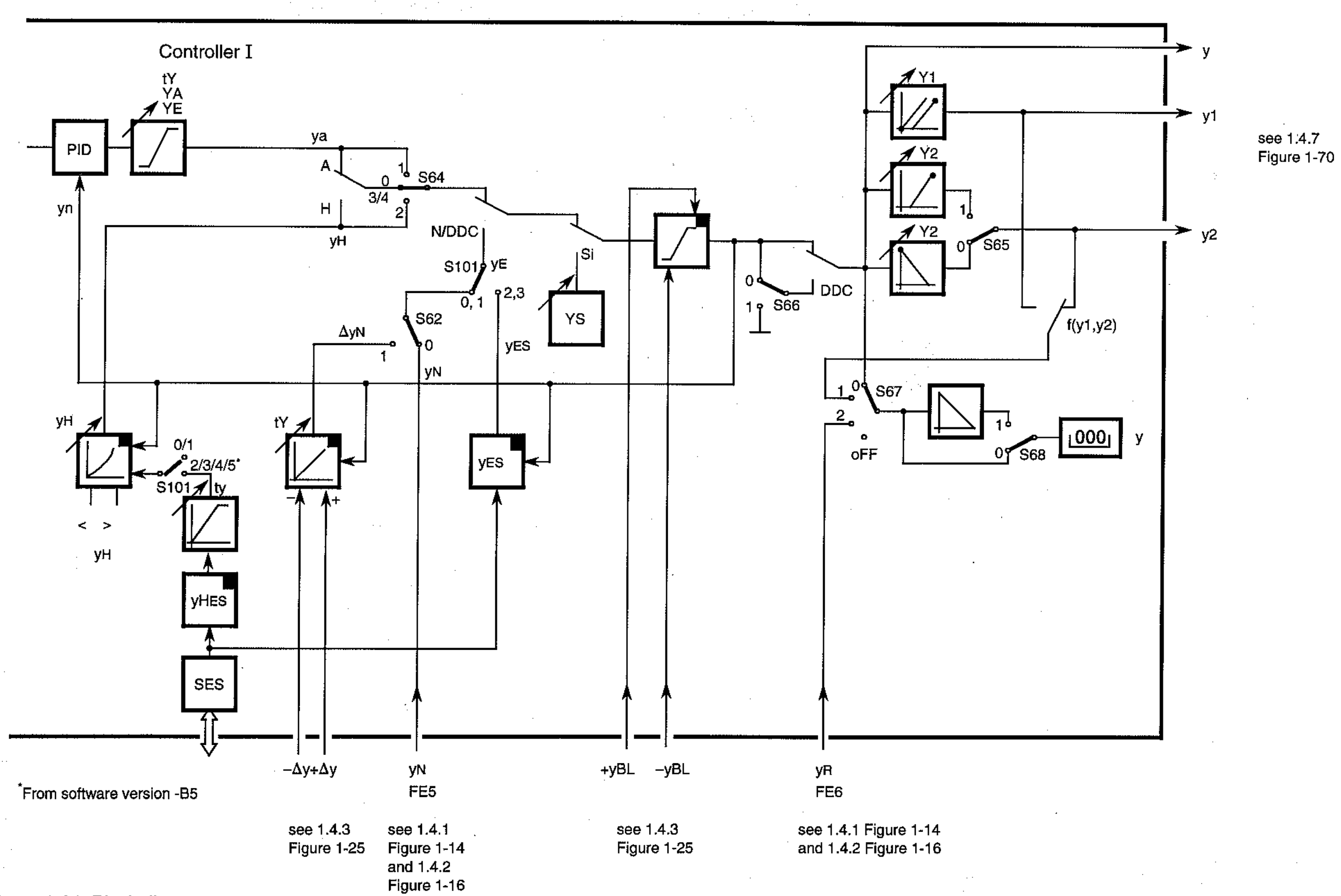
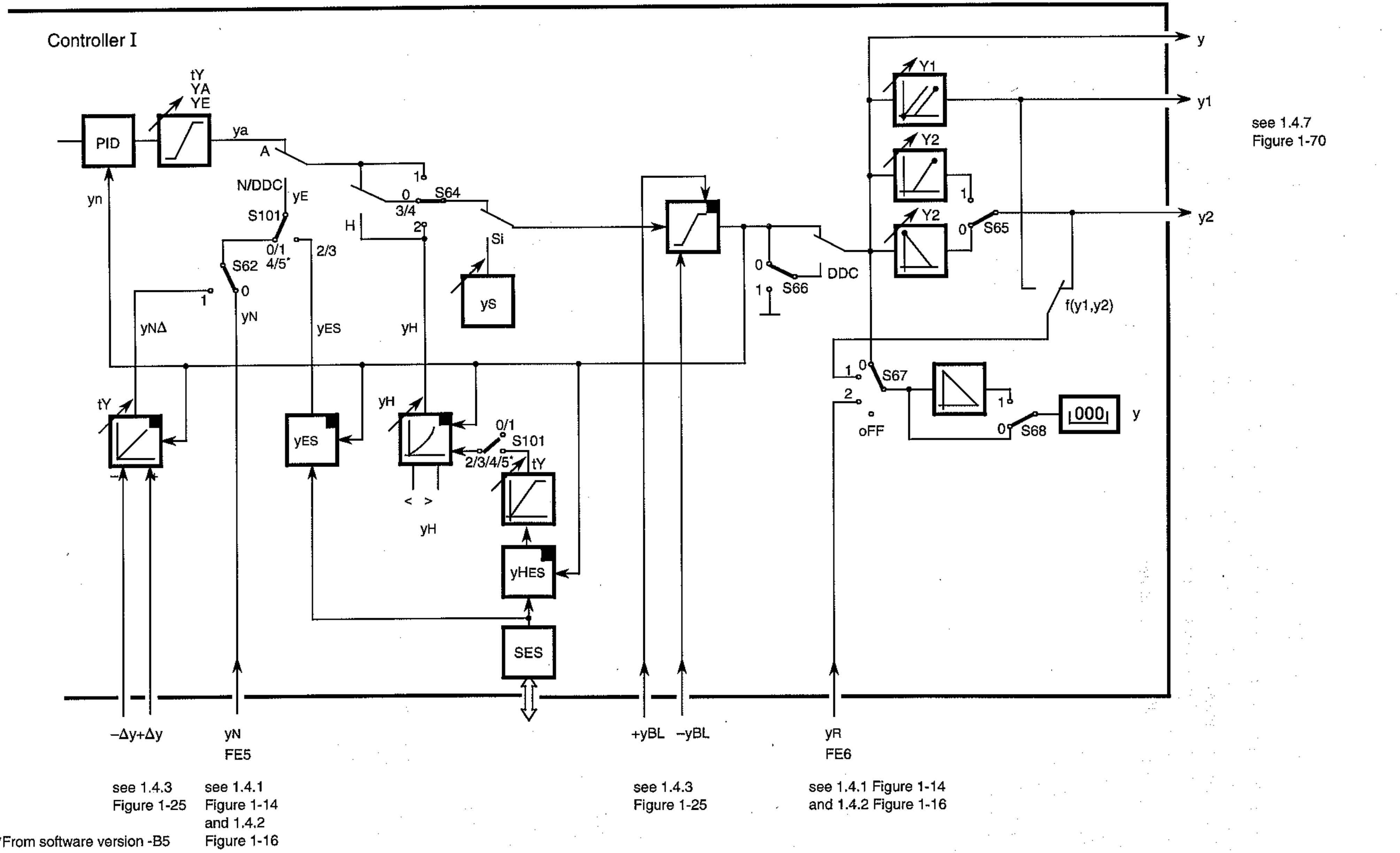


Figure 1-64 Block diagram
controller S2 = 0
Tracking (DDC) has priority over manual mode S61 = 0



*From software version -B5

Figure 1-65 Block diagram
K controller S2 = 0
Manual mode has priority over tracking (DDC) S61 = 1

- **S2 = 1: Three position step controller (S) with internal position feedback** (Figure 1-66 and 1-67)

  For controlling integral action motor driven positioning devices.
  In the case of S controllers, a positioning controller is connected internally to the K controller. The positioning loop consists of a comparator with a three position switch and hysteresis, plus an integrator in the feedback loop. The integrator uses a variable positioning time tY (parameterisation mode onPA), that replaces the position feedback, to simulate the I response of the final control element. The internal integrator and the signal from the K controller are both reset (synchronised) cyclically by the same amount to prevent them diverging or becoming saturated as time passes. As the y signal is only a relative manipulated variable (y'), it is not possible to apply a threshold to the manipulated variable ya, nor is it possible to enter absolute values for yE and yS. The safety manipulated variable ys is defined as a direction dependent permanent contact. If YS 50 % (oFPA) -Δy switches to a permanent contact, when YS + 50 %, +Δy switches to a permanent contact so that the position of the final control element corresponds to the safety position. The positioning controller has a variable minimum pulse length (tE) and pause (tA), through which the response threshold of the positioning controller can be indirectly specified:

- Pulse on $A_{ee} = 2\frac{100\,\%\cdot tE}{tY}$

- Pulse 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 positioning time (defined in parameterisation mode onPA)

Aee must at least be generated as a deviation following a pulse pause until a positioning pulse of length tE is output. Aea may remain constant as the remaining deviation of the positioning control loop.

Aa may be generated as a deviation following a positioning pulse until another pulse in the same, or opposite, direction is output. Once tA has expired, the positioning controller again reacts according to tE.

See section 4.3 regarding setting criteria for tA and tE.

The position feedback yR via FE6 is only used by S controllers with internal position feedback to display the manipulated variable. If it is not connected, S67 is set to 0 and nothing appears in the y display (14).

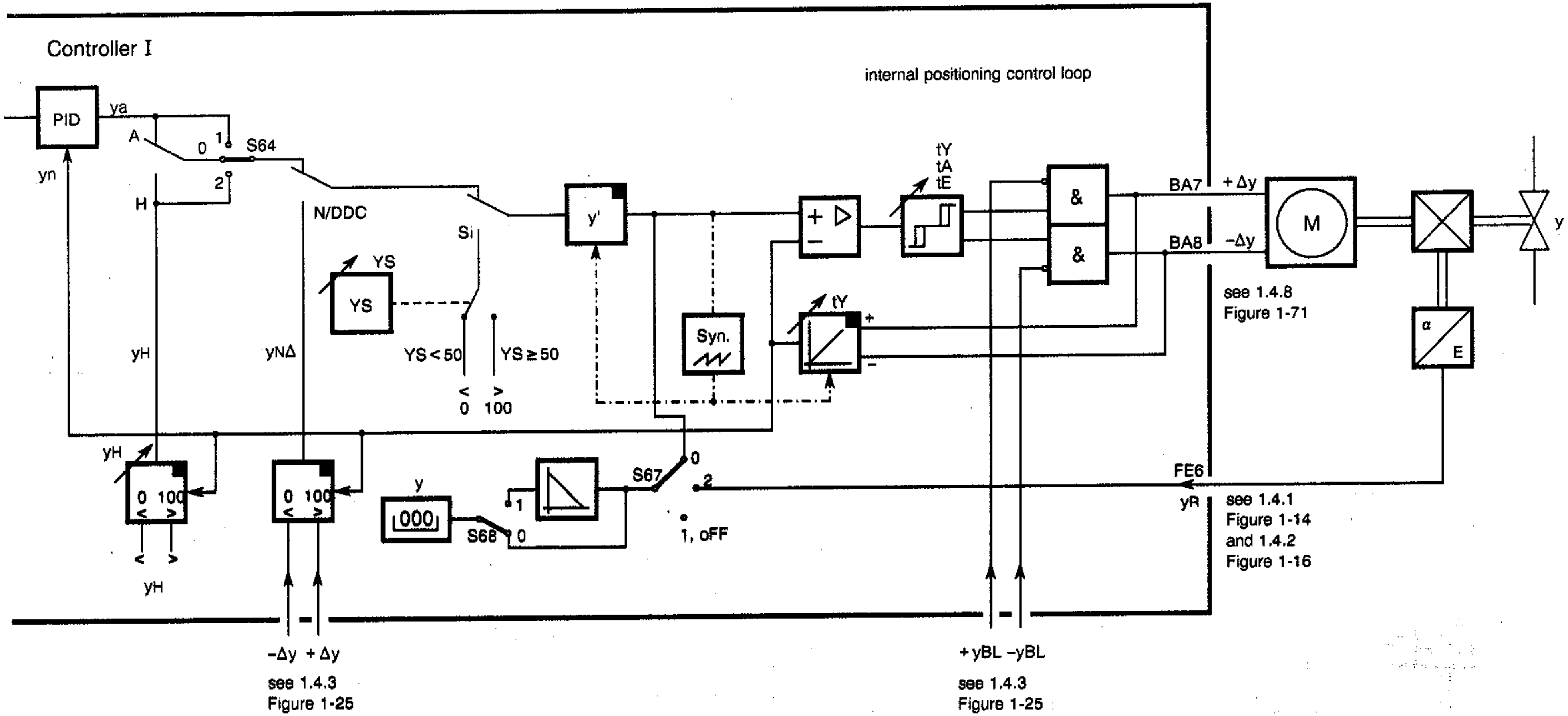


Figure 1-66 Block diagram
S controller with internal position feedback S2 = 1
Tracking (DDC) has priority over manual mode S61 = 0

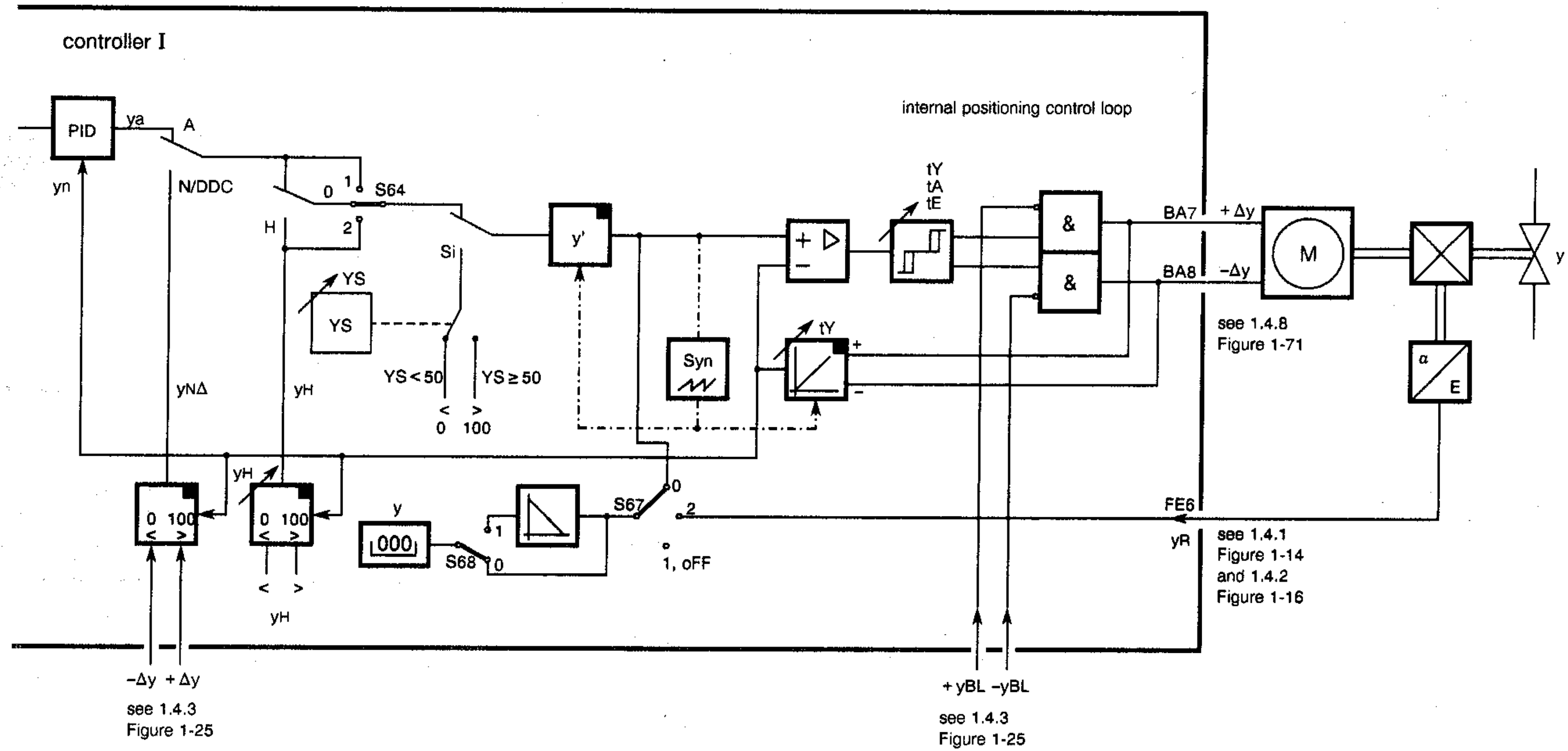


Figure 1-67 Block diagram
S controller with internal position feedback S2 = 1
Tracking (DDC) has priority over manual mode S61 = 1

- **S2 = 2: Three position step controller (S) with external position feedback** (Figures 1-65 and 1-66)

  For controlling integral action motor driven positioning devices.
  In the case of S controllers with external position feedback, the "internal positioning control loop" is replaced by an actual position controller (with the y signal of the K controller as the setpoint, and the position feedback y_R from FE6 as the actual value). As a result, limits can be declared for the manipulated variable ya, and absolute values entered for y_E and ys.
  As well as entering an absolute value for y_E, the manual manipulated variable can also be entered as an absolute value via the SES (y_{ES}) in tracking mode. If y_E is entered via the tracking signal y_N (FE5), the freely configurable input area (S4=1) must be used, as FE5 is not available to the standard input area when S2=2 (see Figure 1-14).
  The parameters tE (minimum pulse length) and tA (minimum pulse pause), in conjunction with tY (positioning time), are also used here to define the response threshold of the positioning controller. Values are assigned to all these parameters in parameterisation mode onPA.

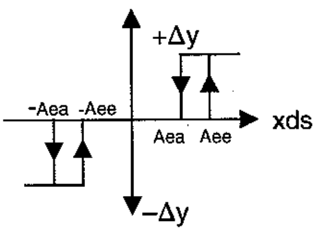
– Pulse on $A_{ee} = 4 \; \frac{100\,\% \cdot tE}{ty}$

– Pulse off $A_{ea} = 3 \; \frac{100\,\% \cdot tE}{ty}$

– Hysteresis $A_{ee} - A_{ea} = \frac{100\,\% \cdot tE}{ty}$

– Pause $A_a = \frac{100\,\% \cdot tA}{ty}$

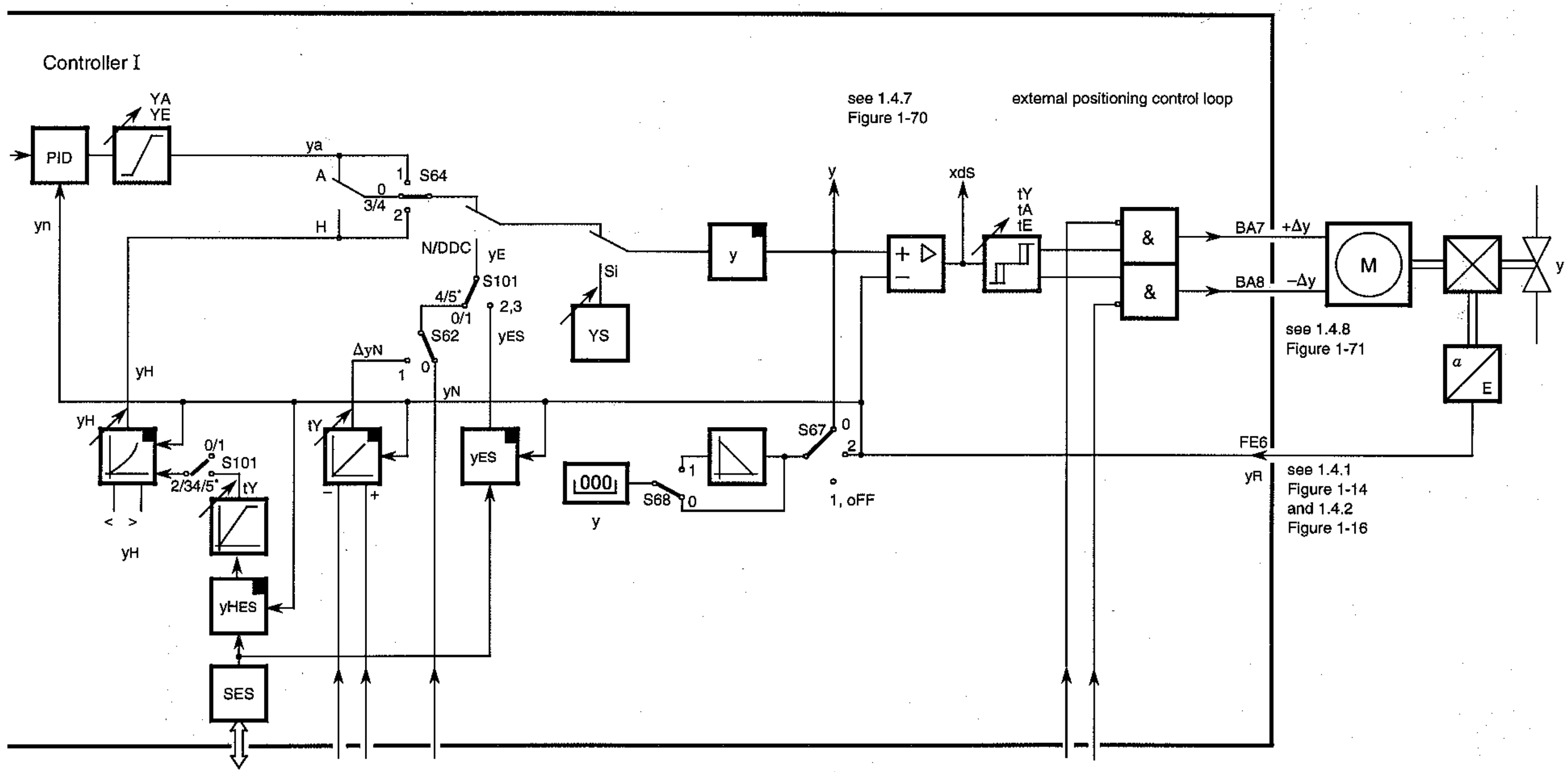
If the control deviation xds Aee, the three position switch switches to a direction dependent permanent contact. The negative feedback from the positioning control loop causes xds to reduce until it is less than Aea. The permanent contact is then turned off. After a pause of tA, pulses of length tE followed by further pauses tA are sent until xds Aee.



Individual pulses are also sent when xds, rising from zero, fails to reach Aee. These pulses, which are no longer transformed completely into changes of direction, stabilise the control loop even more, ie. theoretically (no tracking), the individual pulses should cease at 0.25 or 0.5 Aee. Control in the opposite direction will only then start once tA has elapsed.
The control difference of the positioning control loop can be measured by assigning xds to an analogue output.

Manual adjustment in the form of incremental adjustments can also be implemented here by overriding the three position switch. Manual adjustment will then still be possible, even if position feedback is interrupted.

To simplify commissioning of the positioning control loop, the manual manipulated variable is entered as an absolute value when S67=0. In this switch position, optimisation is achieved by using the manual manipulated variable to alter the control loop setpoint (see 4.3). Note, however, that the value of the manual manipulated variable, which is displayed, will change more rapidly than the actual manipulated variable of the final control element, so tracking will occur. The transient recovery status can be monitored on the Δy LEDs (15) in the y display. Once optimisation is complete, the actual manipulated variable can be displayed via the position feedback signal y_R (FE6) by setting S67=2.



* DR22: from software version -B5

Figure 1-68 Block diagram
S controller with external position feedback S2 = 2
Manual mode has priority over tracking (DDC) S61 = 0

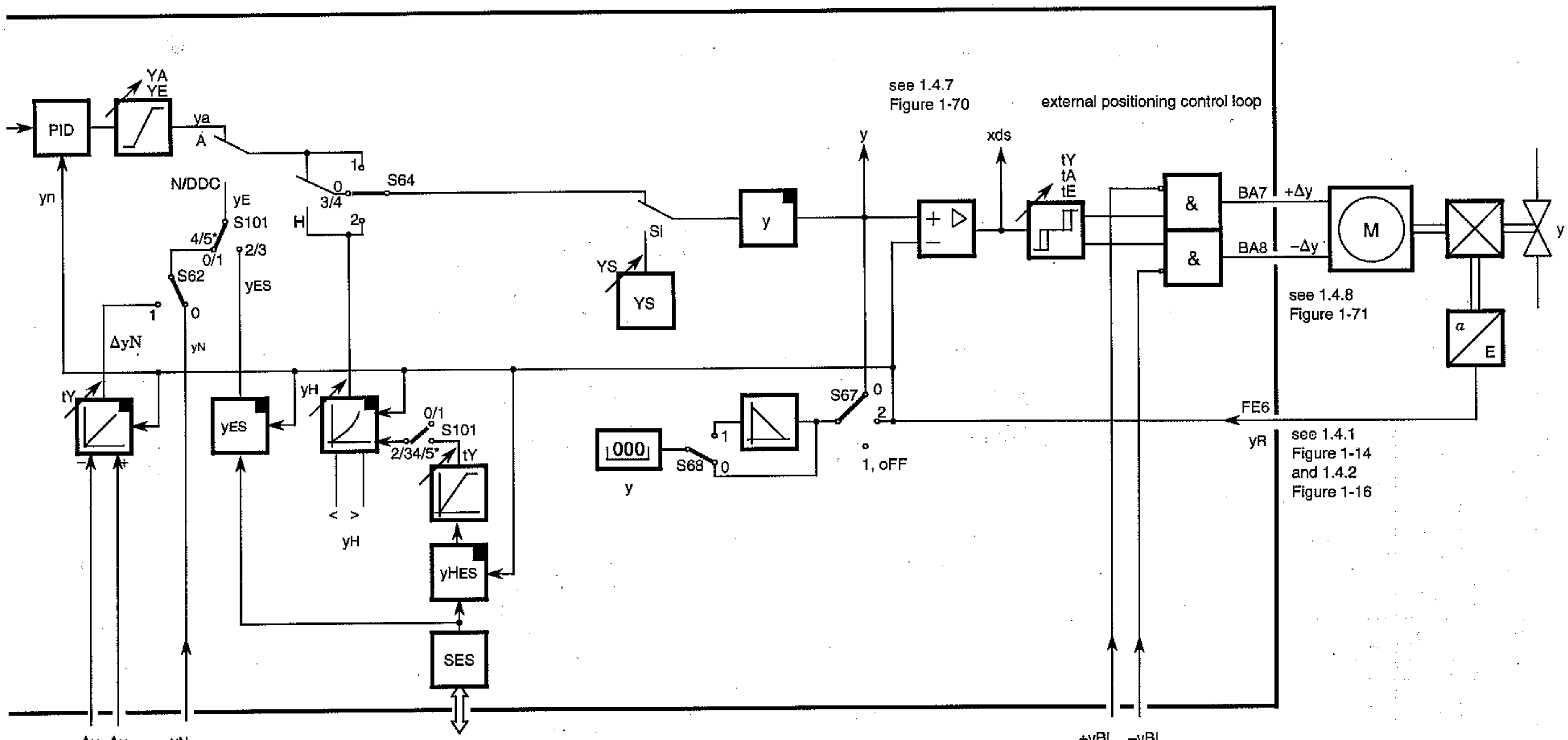


Figure 1-69 Block diagram
S controller with external position feedback S2 = 2
Manual mode has priority over tracking (DDC) S61 = 1

1.4.5 to 1.4.11

Control signals					Signals				Actual y	Comments
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)	tracking mode
0	0	1	1	0	0.9[5]	1	1	1	y_E (n)	tracking mode
0	0	1	0	1	1	1	1	1	y_E (n)	tracking mode
0	0	1	1	1	1	1	1	1	y_E (n)	tracking mode
1	0	as above				1	as above		$\pm y_{BL}$ 3)	± blocking mode
1	1					1			$\pm y_{BL}$ 3)	± blocking mode
0	1					1			y_S 4)	safety mode

Table 1-17 Signal switchover for all types of controller except DDC fixed setpoint controllers (S1 = 2)
Tracking mode has priority over manual mode (S61 = 0)

Control signals					Signals				Actual y	Comments
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)	tracking mode
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					1			$\pm y_{BL}$ 3)	± blocking mode
0	1					1			y_S 4)	safety mode

Table 1-18 Signal switchover for all types of controller except DDC fixed setpoint controllers (S1 = 2)
Manual mode has priority over tracking mode (S61 = 1)

1) The table shows static N switchover without acknowledgement, S48 = 0.
2) If S101 < 2, y_E is sourced from y_N (FE5) when S62 = 0, or $y_{N\Delta}$ via $\pm\Delta y$ when S62 = 1. If S101 = 2, y_{ES} comes via the SES. Remote manipulated variables sourced from $\pm\Delta y$ ($y_{N\Delta}$) and the SES (y_{ES}) are tracked. When sourced via FE5 (y_N), the source controller must be tracked.
3) Blocking is direction dependent, changes in the opposite direction are possible.
4) On S controllers with internal position feedback (S2 = 1), moves up scale or down scale, on all other types of controller to the safety manipulated variable
5) 0.9 = flashing frequency 0.1 off, 0.9 on
6) 0.5 = flashing frequency 1:1
(n) variable is tracked to the actual value prior to switchover, thereby ensuring a bumpless switchover.
(↗) adjustable

- **Automatic mode ($y = y_a$)**
  Automatic mode is initiated by pressing the automatic/manual pushbutton (the yellow Manual LED (8) goes out). All other control signals He, N (DDC), Si and ±yBL must be 0. The automatic manipulated variable is switched through to the controller output.

- **Manual mode ($y = y_H$)**
Manual mode is initiated either by pressing the automatic/manual pushbutton (the yellow Manual LED (8) comes on), or as an OR function of the He control signal. The control signals Si and ±yBL must be 0. If tracking mode has priority over manual mode (S61 = 0), the control signal N (DDC) must also be 0. The manual manipulated variable is switched through to the controller output. On K controllers the manual manipulated variable is entered as an absolute value, on S controllers as a positional increment.

- **Tracking (DDC) - Mode ($y = y_E$)**
Tracking mode is initiated by the control signal N (in DDC mode by the control signal CB and the local/remote pushbutton, see section 1.4.4). The control signals Si and ±yBL must be 0. If manual mode has priority over tracking (S61 = 1), then the control signal H = Hi v He must also = 0.
The remote manipulated variable y_E is switched through to the controller output. If S101 = 0 or 1, y_E is sourced either as an absolute value (y_N) from the functional input FE5 (S62 = 0), or as a remote manipulated variable with incremental adjustment from the control signal ±Δy ($y_{N\Delta}$) (S62 = 1). The adjustment is in increments of 100 %/tY. If S101 = 2, the remote manipulated variable is an absolute value sourced via the SES (y_{ES}).
On S controllers with internal position feedback (S2 = 1), the manipulated variable cannot be entered as an absolute value. In this case, a remote manipulated variable with incremental adjustment ($y_{N\Delta}$) must be used.

1.4.5 to 1.4.11

- **Safety mode ($y = y_S$)**
Safety mode is initiated by the control signal Si. The control signal ±yBL must be 0. The safety manipulated variable ys, which can be parameterised in the range −10 to 110 % in configuring mode oFPA, is switched through to the controller output. On S controllers with internal position feedback (S2 = 1), the manipulated variable cannot be entered as an absolute value. If safety mode is initiated, a ±y signal is output when ys 2 %, and a +Δy signal output when ys ≥ 50 %. This causes the final control element to be positioned either down scale or up scale.

- **Direction dependent blocking mode**
Blocking mode is controlled by the ±yBL control signals. All other control signals have no effect. If a control signal is present, the manipulated variable signal is blocked in a particular direction, ie. only changes in the other direction are permitted. If both control signals are present at the same time, the signal is blocked totally. Direction dependent blocking is required primarily for S controllers with internal position feedback and positioning devices with limit switches in order to avoid integral saturation, otherwise the controller will not be able to react immediately following reversal of the control difference.

As described above, ±yBL control signals have priority over Si and H or N. Priority over H or N can be selected with S61. All these modes of operation have priority over automatic. Switchover statuses are indicated by the LEDs Manual (8) and y-remote (10). The Manual LED comes on when the current mode of operation is manual and manual mode was preselected (assuming modes of operation are currently subject to priority control). If Hi = 0 (automatic mode selected by manual/automatic switchover), a flashing frequency of 0.9 indicates that He = 1 (set by control signal). Switching the control signal He from 1 to 0 will then establish automatic mode.
Tracking (DDC), safety and blocking mode are indicated by the LED y-remote. When manual mode has priority over tracking, a flashing frequency of 0.5 indicates that manual mode is selected. However, tracking mode is on stand-by, and will become effective if switchover to automatic mode occurs.

- **Blocking of manual/automatic switchover (S64)**
The mode of operation can be locked into either automatic only or manual only using S64. Other modes of operation are still possible, however tracking mode is only possible if it has priority over manual mode (see section 1.4.3, Figure 1-29).

- **Manual mode following transmitter failure S63**
If a transmitter alarm occurs (see section 1.4.1), S63 controls switchover into manual mode. If S63 = 1, manual mode starts with the latest value of y, if S63 = 2, with the value of the YS parameter. In either case, the ±Δy pushbuttons can be used following the switchover to modify the value of the manual manipulated variable.

- **Source and direction of the y-displays S67, S68**
  S67 enables different variables to be displayed on the y-display. The y-display may even be turned off completely. On K controllers, the absolute value of the manipulated variable y, or the values of the split range manipulated variables y1 and y2, can be displayed. On S controllers, the position feedback signal y_R via FE6 can be displayed.
  The display direction, rising or falling, can be selected using S68 (see 4.1).

- **Control system interfacing via the serial interface**
  As from software version -B05, in addition to the DDC (S1 = 2) and SPC (S1 = 3) controllers complete parallel process operation is possible via the serial interface. If S101 2, the control signals Int and Hi (via HeES where S64 = 3/4, see section 1.4.3) and the process variables wi and yH can be written via the serial interface, so that switchover from local to remote setpoint and automatic/manual switchover is possible in all controller types. When the local setpoint wi or the manual manipulated variable yH are active, they can also be modified via the SES or the adjuster pushbuttons on the front panel. As setpoints can only be adjusted absolutely and not incrementally via the SES, it is advisable to use the setpoint ramp (tS) or the dynamic manipulated variable limiter with ty to avoid sudden setpoint fluctuations.
  This parallel "front panel operation" via the serial interface can be blocked by way of $\overline{RC}$ = Int $\overline{CB}$ where S64 = 3 (see 1.4.3). This option of blocking controller operation via the SES on the front panel is only realistic for fixed setpoint controllers with one setpoint (S1 = 10) and slave controllers without local/remote switchover (S1 = 11), as in all other controller types both the local pushbutton and the control signal CB have other additional functions.

  In configuration S64 = 4, the blocking option does not apply and operation is always parallel to the front panel pushbuttons.
  To avoid simultaneous activation via the front panel and the SES, the last switchover action can be read both from the process control system and from the controller. For this, a status bit is set when writing IntES and HeES which is not reset until one of the front panel pushbuttons Int or Hi is pressed. If the last operation was via the front panel pushbuttons, the process control system can deliver a warning by interrogating the status bits.
  If the last operation was via the SES, the SES warning in the x/w display flashes for 3 s when the local or manual pushbutton is pressed. This initial pressing of the pushbutton does not yet initiate a switch. The required switchover function is only activated when the pushbutton is pressed again.

1.4.7 Analogue output signal processing (S69 to S75))

The configuring switches S73 to S74 are used to assign the analogue outputs AA1 to AA3 to internal controller variables. The analogue output AA4 (y_{hold} 6DR2802-8A) in slot 6 is permanently assigned to the manipulated variable y. If the y_{hold} module is present, then S23 must be set to 4, otherwise error messages will occur (see section 1.3.3).
Switches S69 to S72 enable each output to be configured to output signals in the range 0/4 to 20 mA.
The bipolar process variables xdI, xdII and xdS are output with an offset of 50 % (10/12 mA respectively), and can, if desired, be reversed.

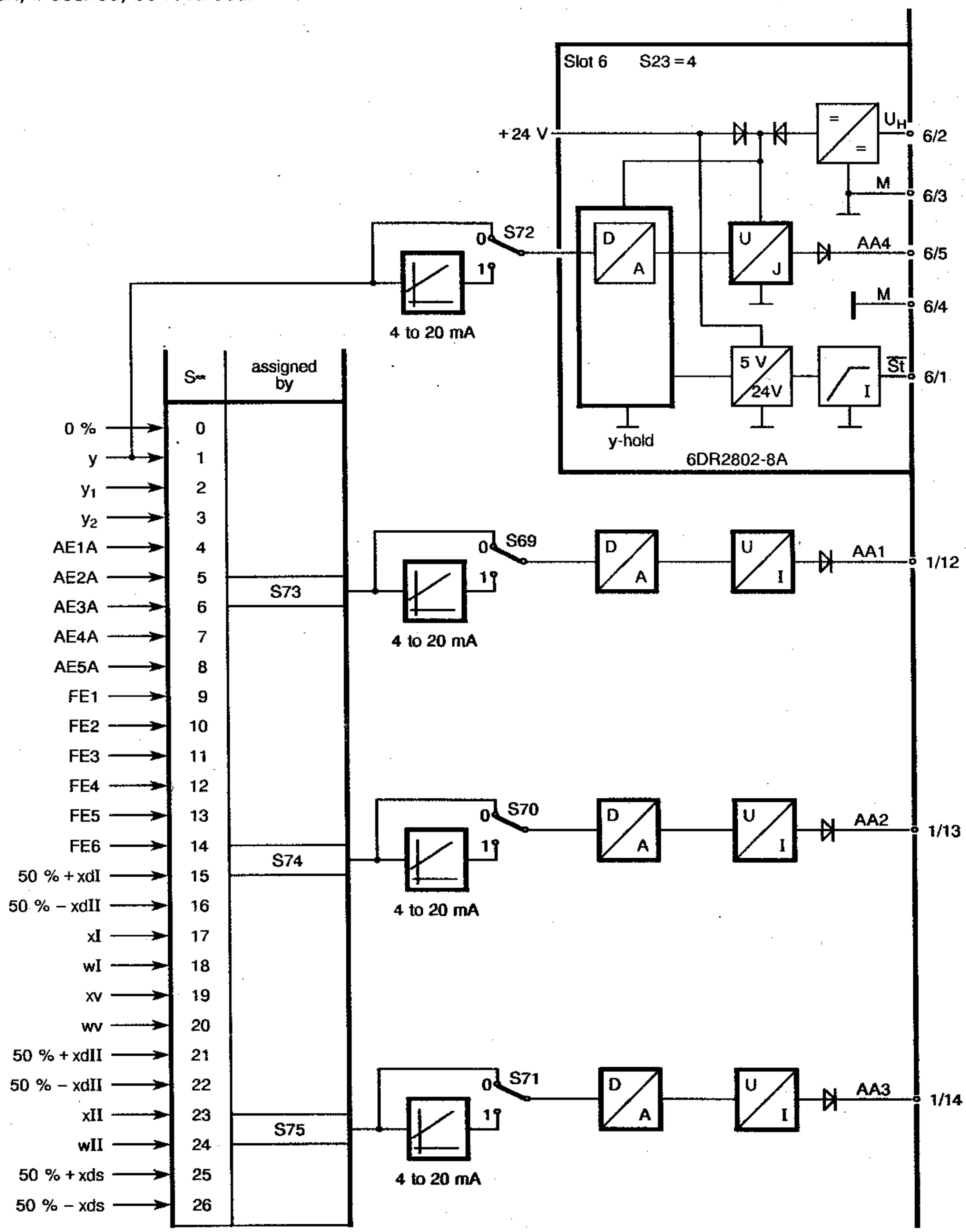


Figure 1-70 Analogue output assignments S69 to S75

1.4.8 Digital output signal processing (S76 toS93)

see Figure 1-71

Signal logic for $\overline{RB}$, $\overline{RC}$ ... MUF, Int I can, if desired, be reversed using configuring switches S86 to S96. Configuring switches S76 to S85 are used to assign these signals to the digital outputs BA1 to BA16.

The eight digital outputs in the standard controller, BA1 to BA8, can be increased to a maximum of 16 by inserting the option modules 4BA 24 V+1BE (6DR2801-8B) or 2BA 35 V Relays (6DR2801-8A) in slots 5 and 6. BA9 to BA12 are added by inserting the 4BA 24 V+1BE module in slot 5, and BA13 to BA16 by inserting it in slot 6. BA9 and BA10 are added when the 2BA 35 V Relay module is inserted in slot 5, and BA13 and BA14 by inserting it in slot 6.

If option modules are inserted in slots 5 and 6, the corresponding configuring switches S22 and S23 must be set correctly, otherwise errors will occur (see section 1.3.3).

The control signals $\pm\Delta y$ (position increments on S controllers) cannot be assigned and cannot be reversed. They are assigned to BA7 and BA8 by default when configuring S controllers (S2 = 1 or 2), ie. BA7 and BA8 can only be freely assigned on K controllers (S2 = 0).

If different control signals are assigned to the same digital output, the signals are ORed.

Unassigned digital outputs (switch position 0) are low, and can be set via the SES when S101 = 2. All digital outputs are connected via OR diodes.

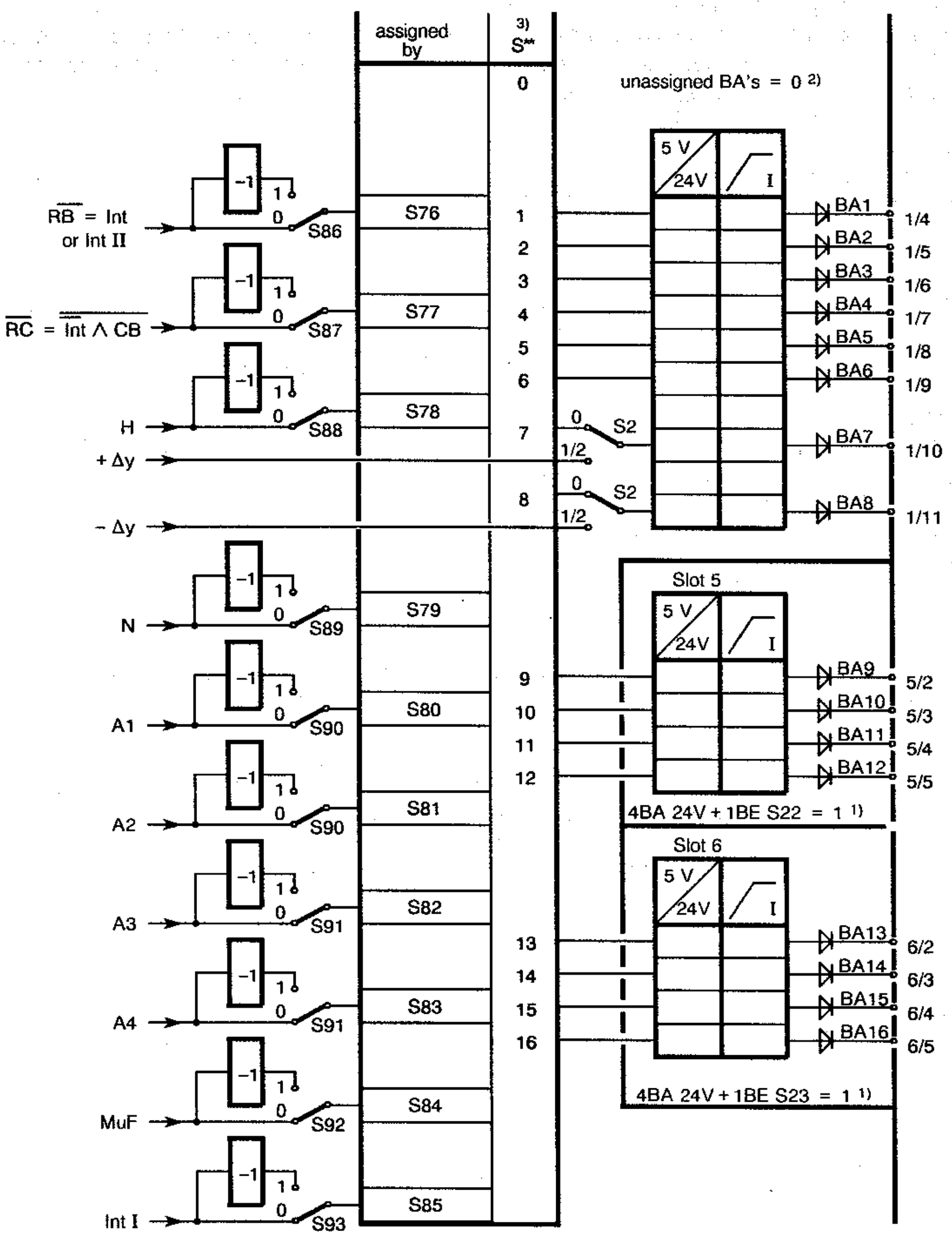


Figure 1-71 Digital output assignments (S76 to S93)

1) Only BA9 to BA10 and BA13 to BA14 are added when using the 2BA 35 V Relay, 6DR2801-8A module (S22 = 3, S23 = 3 respectively).
2) Unassigned when S** = 0. Digital outputs are = 0, but can be set via the SES when S101 = 2.
3) Assigning several control signals to one digital output will result in the signals being ORed.

1.4.5 to 1.4.11

- **Digital output signals - a glossary**

$\overline{RB}$ Controller not on computer stand-by
This signal indicates that the controller is operating in local mode, in other words, it is not ready to take over from the computer should the latter go down. This signal refers to the master controller in cascade control (dual-loop control) and the main controller in override control.

$\overline{RC}$ Computer not operating
This signal indicates a negative computer mode $\overline{RC} = \overline{Int \wedge CB}$ and controls setpoint switchover/DDC mode. This signal refers to the master controller in cascade control and the main controller in override control.

H Manual mode
The controller is in manual mode. This would have been caused either by automatic/manual switchover from the front of the device (Hi), or, assuming the control signals Si, ±yBL and N (where tracking mode has priority over manual mode) are all low, by the digital input signal He.

N Tracking mode
Assuming the control signals Si, ±yBL and H (where manual mode has priority over tracking mode) are all low, then the controller is in tracking mode.

A1/A2 A1/A2 Alarm 1 and 2, set by the limit monitors A1 and A2.

A3/A4 A3/A4 Alarm 3 and 4, set by the limit monitors A3 and A4.

MUF Transmitter fault
The device's analogue input signals can be monitored for range violation. If a range violation occurs, this signal signifies a group alarm.

Int I Slave controller in local mode
In the case of cascade controllers (dual-loop controllers), this signal indicates that the slave controller has been switched into local mode, thereby disabling the cascade.

$\pm\Delta y$ Positional increment for the Δy adjustment on S controllers.

1.4.9 Limit Monitors (S94 to S100)

The pairs of limit monitors A1, A2 and A3, A4 are assigned to the internal controller variables xdI, xI ... FE6, xd_S by the configuring switches S94 and S95. The configuring switches S96 (for A1, A2) and S97 (A3, A4) determine which monitoring function (max/min, min/min or max/max) each pair of limit monitors is to perform.

The limits A1 to A4 and hystereses H1.2 and H3.4 can be set in configuring mode oFPA. Configuring switch S98 is used to indicate whether A1 to A4 are only to be displayed at the process level, or whether they can also be adjusted.

In this case, the cycle of the selector pushbutton (12) displayed on the y display (14) is extended by the limits A1 to A4:

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

Depending on how they have been parameterised, the limits are expressed either as physical values according to the digital x and w display formats (see 1.4.4), or as %.

S1	S94, S95	Assigned to	Display format	Range
≠4 ≠6	0 1 2	xdI xI wI	corresponding to dAI to dEI −1999 to 9999	at most −110 % to +110 % in relation to dEI–dAI = 100 %
4 and 6	0 1 2	xdI xI wI	% % %	−110 % to +110 %
	3 4	xv wv	corresponding to dAI to dEI −1999 to 9999	at most −110 % to +110 % in relation to dEI–dAI = 100 %
5 to 9	5 6 7	xdII xII wII	corresponding to dAII to dEII −1999 to 9999	at most −110 % to +110 % in relation to dEII–dAII = 100 %
0 to 9	8 ↓ 22	y ↓ xds	%	−110 % to +110 %

Table 1-19 Display format of limit values A1 to A4

A2 may not be greater than A1, neither may A4 be greater than A3.

The hystereses H1.2 and H3.4 can be adjusted between 0.1 and 10 %.

The limit function (min or max) is referred to the display, ie. if the display is configured with dE*<dA*, the logic is reversed. In terms of the process signal, a selected 'min' function becomes a 'max' function.

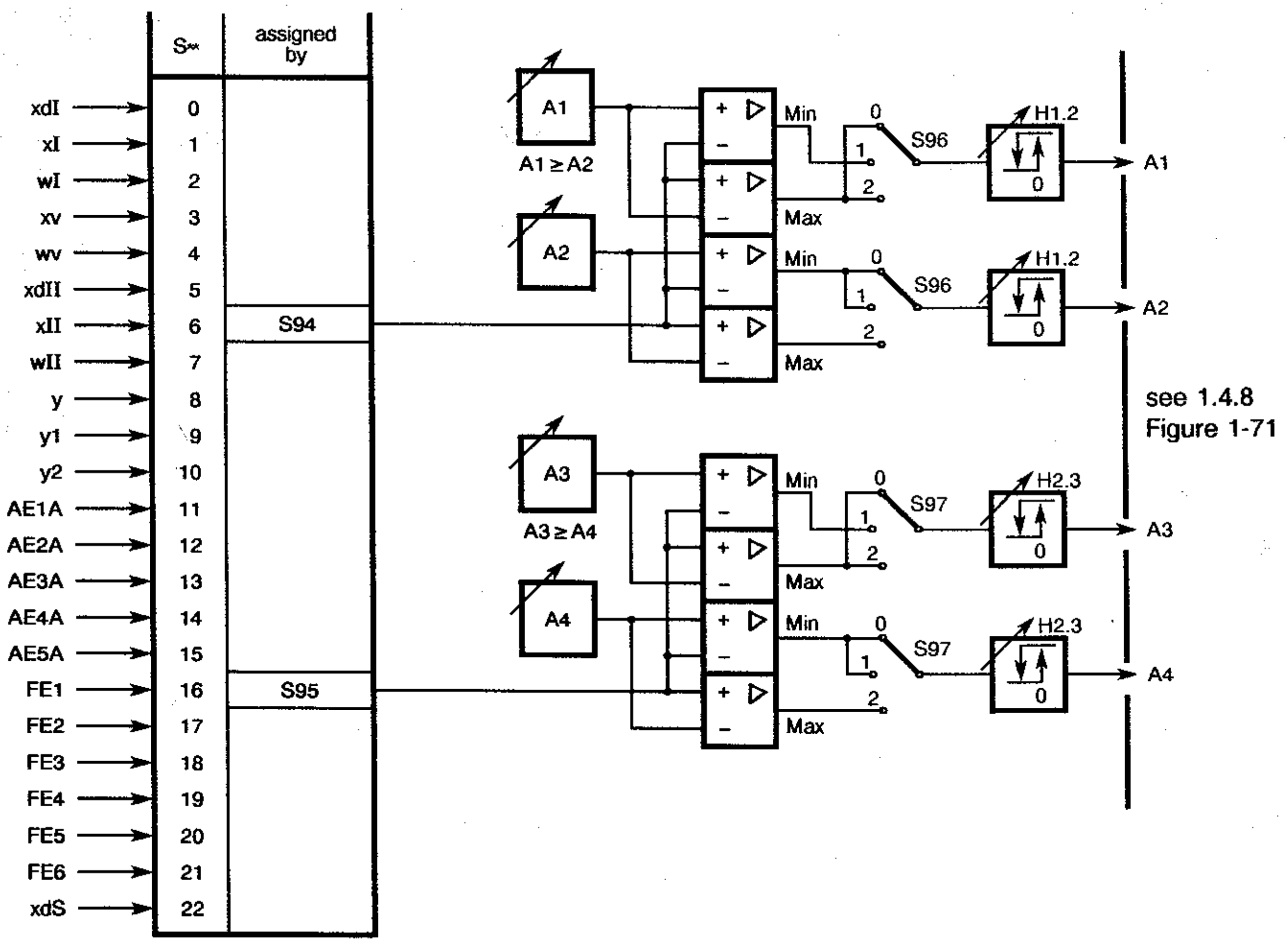


Figure 1-72 Assignment and function of limit monitors (S94 to S97)

1.4.10 Restart conditions (S99, S100)

S99 determines restart conditions following a power failure or a manual reset. In position 0, the controller continues in the same mode of operation and with the same value of y that was present before the power failure or watch-dog reset occurred. This variant should be used if short power dips are to be expected in a slow control loop.

In position 1, restart following a power failure takes place in manual and local mode (also with Int I in cascades), using ys with K controllers, and the last value of y with S controllers. If S49 or S64 = 1, indicating remote and automatic mode only respectively, then restart takes place in the appropriate mode.

S100 is used to output an visual signal indicating that power has been restored. This signal causes the digital x display to flash. Flashing is acknowledged by pressing the selector pushbutton (12) or by alarm interrogation via the SES.

1.4.11 Serial Interface (S101 to S107)

S101 is used to specify to what extent the SES can be used. In general, all available data can be read. In position 0, no data can be sent to the controller. In position 1, only parameters and configurations can be transmitted. In addition to parameters and configurations, the variables wES (remote setpoint via the SES) and yES (remote manipulated variable via the SES) plus all control signals can be sent via the SES when S101 = 2. In this switch position, all other potential sources of the remote setpoint and manipulated variable are disabled.

Configuring switches S102 to S107 determine the communications procedure on the serial interface. See the technical description C73000-B7400-C133 for more details.

1.5 Technical Data

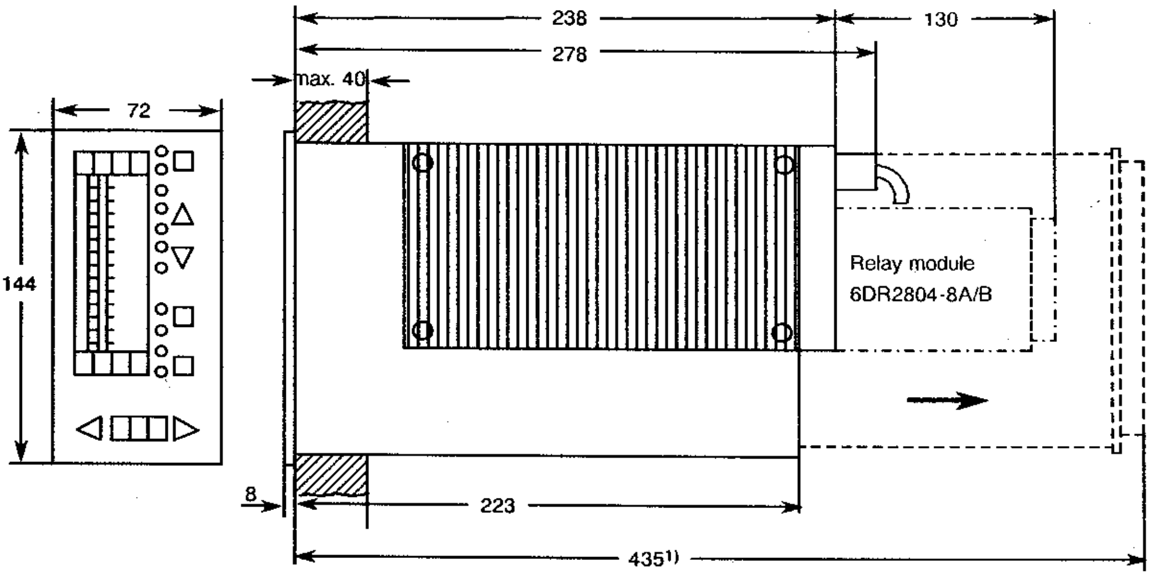
1.5.1 General

Mounting position	any
Climatic class	
in storage 1k2 to DIN IEC 721 Part 3-1	–25 to +75 °C
in transit 2k2 to DIN IEC 721 Part 3-2	–25 to +75 °C
in operation 3k3 to DIN IEC 721 Part 3-3	0 to +50 °C
Degree of protection to EN 60529	
Fascia	IP64
Housing	IP30
Connections	IP20

Controller design

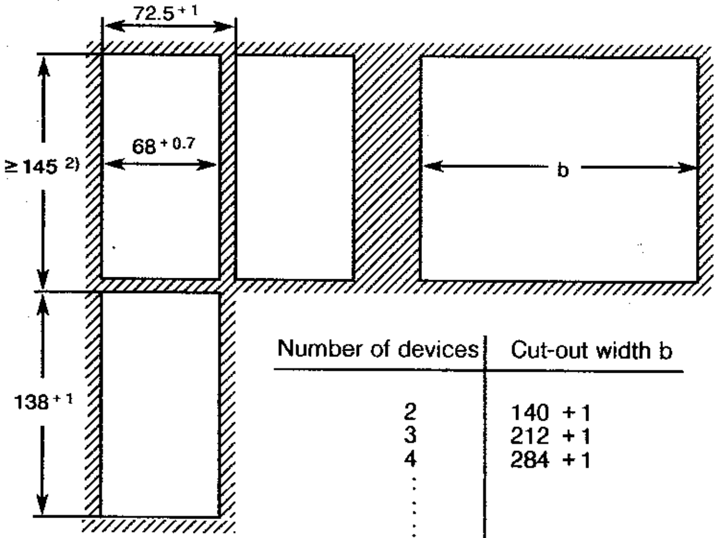
- To DIN EN 61 010 Part 1 (IEC 1010 - 1 + A1)
- Protection class I to IEC 536
- Outputs are functional extra-low voltages with protective separation from the mains to DIN VDE 0100 Part 410, November 1983
- Ventilation and creepage paths for surge class III and pollution level 2 to DIN VDE 0110 Part 1, January 1989, unless stated otherwise.

Weight, max.configuration	approx. 1.2 kg
Colour	
Fascia frame	RAL 7037
Fascia surface	RAL 7035
Material	
Housing, fascia frame	Polycarbonate, reinforced with fibre glass
Front foil	Polyester
Rear panels, modules	Polybutylene-terephthalate
Connections	
Power supply 115/230 V AC	3-pin earthed plug IEC320/V DIN 49457A
24 V AC/DC	special 2-pin plug
Process signals	Plug-in terminal blocks 1.5□ AWG 14
Mounting rail on rear of power supply	NS 35/7.5 DIN/EN 50 022
Dimensions and panel cut-outs	see Figures 1-73 and 1-74



1) to allow for different sizes of main board

Figure 1-73 SIPART DR22 dimensions, in mm.



Number of devices	Cut-out width b
2	140 +1
3	212 +1
4	284 +1
:	
10	716 +1

2) Stacking with no intermediate spacing is permitted if the ambient temperature range is not exceeded.

Figure 1-74 Panel cut-outs, dimensions in mm.

1.5.2 Standard controller

- **Power supply**

Rated voltage	230 V AC | 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			
Peak voltages (1.2 µ/50 to IEC 801-5 symm. unsymm.	1 kV 2 kV	1 kV 2 kV	0.5 kV 1 kV	
Power consumption Standard controller, no 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
Permitted voltage dips 3) Standard controller, no options without I_{Ext} Standard controller with options, without I_{Ext} Standard controller with options, with I_{Ext}	≤90 ms ≤80 ms ≤50 ms	≤70 ms ≤60 ms ≤35 ms	≤55 ms ≤50 ms ≤35 ms	≤30 ms ≤25 ms ≤20 ms
Test voltage (1 min.) primary-secondary primary-protective conductor secondary-protective conductor	1.5 kV AC 1.5 kV AC 700 V DC		500 V AC 500 V AC 700 V DC	

1) Includes harmonic content
2) Current derived from L+, BA, AA passed to remote consumers
3) The loading current is thereby reduced to 13 V on AA, 15 V on L+ and 14 V on BA.

Table 1-20

1.5 to 1.5.3

- ***Analogue inputs AE1 to AE3***

– **Voltages**

Rated signal range (0 to 100 %)	0/199.6 to 998 mV or 0/2 to 10 V (switchable)
Control range	≤ –5 to 105 %
Input impedance	
Differential	200 kΩ
Common-mode	> 500 kΩ
Common-mode voltage	0 to +10 V
Filter time constant	50 ms
Zero error	0.1 % + A/D conversion error
Gain error	0.2 % + A/D conversion error
Linearity error	see A/D converter
Common-mode error	0.07 %/V
Effect of temperature	
Zero	0.05 %/10k
Gain	0.1 %/10k
Static destruction limit	± 35 V

– **Currents**

Rated signal range	0/4 to 20 mA
Control range	–1 to 21 mA
Input impedance	
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 A/D converter
Gain error	see A/D converter
Linearity error	see A/D converter
Common-mode error	0.07 %/V
Effect of temperature	
Zero	0.05 %/10k
Gain	0.1 %/10k

- ***Analogue outputs AA1 to AA3***

Rated signal range (0 to 100 %)	0 to 20 mA or 4 to 20 mA
Control range	0 to 22 mA or 3,6[1] to 21,6 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	≤ 0.1 %
Load dependence	≤ 0.1 %
Zero error	≤ 0.3 %
Gain error	≤ 0.3 %
Linearity error	≤ 0.05 %
Effect of temperature	
Zero	≤ 0.1 %/10 k
Gain	≤ 0.1 %/10 k
Static destruction limit	–1 to 35 V

1) From software version -B1 onwards

- ***Transmitter supply L+***

Rated voltage	+20 to 26 V
On-load current	≤ 100 mA, short-circuit proof
Short-circuit current	≤ 200 mA pulsed
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 impedance	≥ 27 kΩ
Static destruction limit	± 35 V

- ***Digital outputs BA1 to BA8 (connected via OR diodes)***

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

- ***CPU data***

Cycle time	70 ms ± 0.7 % when S4 = 0 90 ms ± 0.7 % when S4 = 1
Smallest integration rate	$\frac{dy}{dt} = \frac{kp \cdot xd}{tn} = \frac{0.1 \cdot 0.1\ \%}{10^4\ s}$

- ***A/D conversion***

Method		Successive approximation with >120 measurements per input and averaging within 20 or 16.67 ms
Input range		–5 to 105 %
Resolution		11 bit ≙ 0,06 %
Zero error		≤ 0.2 %
Gain error		≤ 0.2 %
Linearity deviation		≤ 0.2 %
Temperature influence		
	On zero	≤ 0.05 %/10 k
	On gain	≤ 0.1 %/10 k

- ***Adjustment of setpoint and manipulated variable***

Method		2 pushbuttons (more-less)
Rate		progressive
Resolution	wi	1 digit
	y	0.1 %

- **Parameters**

Method	2 pushbuttons (more-less)
Rate	progressive
Resolution	
Linear parameters, %	≤ 0.1 %
Linear parameters, physical	1 digit
Logarithmic parameters	128 values/octave
Precision	
Time parameters	± 2 %
all others	absolute, corresponding to resolution

- **Display technology**

– **Digital x and w displays** — 4-digit, 7-segment LEDs

Colour	x	red
	w	green
Digit height		7 mm
Display range		adjustable start-full scale
Numeric range		–1999 to 9999
Overflow		< –1999: -oFL > 9999: oFL
Decimal point		adjustable (fixed-point) __.--- to ----
Refresh rate		adjustable 0.08 to 8.000 secs. [1]
Resolution		1 digit, but not better than A/D converter
Display error		corresponding to A/D converter and analogue inputs

– **Analogue x and w displays** — vertical row of 30 LEDs

Colour	x	red
	w	green
Display range		0 to 100 %
Overflow		flashing of first or last LED
Resolution		1.7 % by alternate lighting of 1 or 2 LEDs, the centre point of the illuminated LEDs acting as a pointer.
Refresh rate		cyclic

– **Digital y display** — 3-digit, 7-segment LED

Colour	yellow
Digit height	7 mm
Display range	0 to 100 %
Overflow	–10 to 110 %
Refresh rate	adjustable 0.08 to 8.000 secs. [1]
Resolution	1 %

---

1) averaged from cycle times

1.5.3 Option Modules

- **6DR2800-8J/R/P/T AE4 (slot 2), AE5 (slot 3)**

Signal converter for order number	Current 6DR2800-8J	Voltage 6DR2800-8J	Potentiometer 6DR2800-8R	Resistance thermometer 6DR2800-8P	Thermocouple, mV 6DR2800-8T
Measuring range start of scale	0 or 4 mA 1)	0 V or 2 V 1) or 199.6 mV 1)	0 Ω	R_{IA} ≥ 80.25 Ω tA ≥ –50 °C	–5 ΔU... 0 ... +5ΔU
Min. span (100 %)			ΔR ≥ 0.8 R	ΔR_t = 19 Ω	ΔU = 10 mV
Max. zero suppression			RA ≤ 0.2 R	R_{IA} ≤ 5 ΔRt R_{tE} ≤ 390.26 Ω	IUI ≤ 5 ΔU
Full scale	20 mA	10 V , 998 mV	R = 80 to 1200 Ω	tE ≤ 850 °C	≤ 60 mV
Input range	–5 to 105 %	–5 to 105 %	–5 to 105 %	–5 to 105 %	–5 to 105 %
Input impedance					2 MΩ
Difference	49.9 Ω ± 0.1 %	200 kΩ			1 MΩ
Common-mode	500 kΩ	≥ 200 kΩ			
Permissible common-Mode voltage	0 to +10 V	0 to +10 V			–10 to +10 V
Input current			5 mA ± 5%	100 mV/ΔR	
Line resistance					
Two-wire system			–	$R_{L1}+R_{L2}$ ≤ 10 Ω	$R_{L1}+R_{L2}$ ≤ 300 Ω
Three-wire system			< 10 Ω each	$R_{L1} = R_{L2} = R_{L3}$ ≤ 50Ω	–
Four-wire system			–	R_L ≤ 80 Ω	–
Filter time constant ± 20 %	50 ms	50 ms	50 ms	50 ms	20 ms
Errors 3)					
Zero	≤ 0.3 %	≤ 0.2 %	≤ 0.2 %	≤ 0.1 % 2)	≤ 0.1 % 2)
Gain	≤ 0.5 %	≤ 0.2 %	≤ 0.2 %	≤ 0.1 % 2)	≤ 0.1 % 2)
Linearity	≤ 0.05 %	≤ 0.05 %	≤ 0.2 %	≤ 0.3 %	≤ 0.1 %
Common-mode	≤ 0.07 %/V	≤ 0.02 %/V	–	–	≤ 0.1 %/V
Cold junction Compensation					≤ 2 °C
Influencing effects of temperature 3)					
Zero	≤ 0.05 %/10 K	≤ 0.02 %/10 K	≤ 0.1 %/10 K	≤ 0.2 %/10 K	≤ 0.3 %/10 K
Gain	≤ 0.1 %/10 K	≤ 0.1 %/10 K	≤ 0.3 %/10 K	≤ 0.3 %/10 K	≤ 0.3 %/10 K
Cold junction Compensation					≤ 0.5 °C/10 K
Static destruction limit					
Across inputs	± 40 mA	± 35 V	± 35V	± 35 V	± 35 V
Relative to reference Line	± 35V	± 35 V	± 35 V	± 35 V	± 35 V
Dynamic destruction limit 1.2/50 µs, 13 Ω	± 500 V	± 500 V	± 500 V	± 500 V	± 500 V

1) Start of scale set during configuring
2) Measuring range can be adjusted by jumpers or trimmed by user
3) Not including A/D converter errors
4) Terminal 1 : ±10 V
5) With R = RA + ΔR + RE adjustable in 3 ranges
R = 200 Ω
R = 500 Ω
R = 1000 Ω

Table 1-21

1.5 to 1.5.3

- **6DR2801-8D (2BA 35 V Relays)**

  BA9 and BA10 (slot 5) or BA13 and BA14 (slot 6)

- **Contact material** Ag/Ni

- **Contact loading capacity**

Switching voltage	AC ≤ 35 V	DC ≤ 35 V
Switching current	≤ 5 A	≤ 5 A
Switching power	≤ 150 VA	≤ 100 W at 24 V
		≤ 80 W at 35 V

- **Life expectancy**

mechanical		2 × 10^7 switching operations
electrical	24V/4A ohmic	2 × 10^6 switching operations
	24 V/1A inductive	2 × 10^5 switching operations

- **Spark suppressor** connected in series 1 µF/22 Ω with varistor 75 V_{rms} in parallel

- **6DR2801-8B (4BA 24 V + 1 BE (BLPS))**

  BA5 to BA9 (slot 5) or BA10 to BA14 (slot 6)

- **Digital outputs**

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

- **Digital input BLPS**

Signal status 0	≤ 4.5 V or open
Signal status 1	≥ 13 V
Input impedance	≥ 2.4 kΩ
Static destruction limit	± 35 V

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

– **Analogue output AA4 (Iy)**

Rated signal range (0 to 100 %)		0 to 20 mA or 4 to 20 mA
Input range		0 to 22 mA or 3,6[2] to 21.6 mA
Load voltage		
supplied	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 %
Gain error		≤ 0.1 %
Linearity error		≤ 0.05 %
Effect of temperature		
	Zero	≤ 0.1 %/10 k
	Gain	≤ 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
On-load current	≤ 30 mA, short-circuit proof
Short-circuit current	≤ 50 mA
Static destruction limit	–1 to +35 V

– **Auxiliary power supply U_h**

Voltage range		+20 V ... +30 V (including harmonic content)
Power consumption		
	when supplied from controller	≤ 6 mA
	when supplied by U_H	≤ 70 mA
Static destruction limit		± 35 V

1) From software version -B1 onwards

1.5 to 1.5.3

- **6DR2803-8C (Serial interface)**

Transferable data	Operational status, process variables, parameters and configuring switches
Communications procedure	To DIN 66258 A or B
Character format	0 bits (start bit, 7-bit ASCII character, parity bit, stop bit)
Signal interval h	2 or 4
Transmission speed	300 to 9600 bit/s
Transmission	Asynchronous, half-duplex
Addressable stations	32
Data traffic watchdog	1 to 25 s, or none

Electrical isolation between Rxd/Txd and the controller

Max. common-mode voltage	50 V UC
Test voltage	500 V AC

	RS232	SIPART BUS	RS485[5]
Receive input Rxd			
Signal level 0	0 to +12 V[4]	0 to +12 V[4]	$U_A > U_B$, +0.2 to +12 V
1 [1]	-3 to -12 V[4]	-3 to -12 V[4]	$U_A < U_B$, -0.2 to -12 V
Input resistance	13 k	13 k	12 k
Transmit output Txd			
Signal level 0	+5 to +10 V	+5 to +10 V	$U_A > U_B$, +3.5 to +6 V
1 [1]	-5 to -10 V	0 V	$U_A < U_B$, -3.5 to -6 V
Load impedance, on-load current	1.67 mA	20 mA	54

Cable capacitance and lengths
at 9600 bit/s[2]

	Cable capacitance	Recommended lengths	
		Unscreened ribbon cable	Screened round cable
RS232 point-to-point[3]	≤2.5 nF	50 m	25 m
SIPART Bus	≤25 nF	500 m	250 m
RS485 Bus[5]	≤200 nF	4000 m	2000 m

1) Check technical specification of partner system

1) Signal state 1 indicates active state.
2) Linear increase using lower Baud rates.
3) Check technical specification of partner system !
4) Input protected with 14 V Z-diode, higher voltages possible with current limitation to 50 mA.
5) RS485 currently not applicable in SIPART DR22 !

- **C73451-A347-B202 (SIPART bus driver)**

Auxiliary power

Supply voltage			Power consumption	
			with only $\pm L_\Sigma$	with $\pm L_\Sigma$ and $\pm 24\ V_{ext}$
$L_+\Sigma$	+20 to	+30 V	60(90)[1] mA	30 mA
$L_-\Sigma$	–20 to	–30 V	60 mA	30 mA
$+24\ V_{ext}$	+20 to	+30 V	-	30(60)[1] mA
$-24\ V_{ext}$	–20 to	–30 V	-	30 mA

Table 1-23 1) when using Rxd TTY 20 mA output

– **Electrical isolation between**

Txd' - Txd with $\pm L_\Sigma$ and $\pm 24\ V_{ext}$
Rxd' - Rxd with $\pm L_\Sigma$ and $\pm 24\ V_{ext}$

Rxd TTY - Txd TTY, Rxd' and Txd' Test voltage 500V AC
Screen, plug - complete electronics Test voltage 500V AC

Transmission speed ≤ 9600 bit/sec.

1.5 to 1.5.3

– **SIPART bus interface (x1)**

Receive input Txd'
Relative to M_Σ

Signal level 0 U_E = +3 to +35 V

Input current $I_E = \dfrac{U_E - 1.5\ V}{3.3\ k\Omega}$

Signal level 1 [1] U_E = 0 V to -35 V

Input current $I_E = \dfrac{U_E + 0.7\ V}{3.3\ k\Omega}$

Transmit output Rxd'
Relative to M_Σ

Signal level 0 with 1 V.28 load	+5 to +15 V
On-load current	≤ 1.67 mA
Signal level 0 with 32 V.28 loads	≥ 0 V
Signal level 1	–5 to –15 V
On-load current	≥ –18 mA

– **V.28 Point-to-point interface to remote system (x4)**

Receive input Rxd
Relative to 0 V external by connection Rxd common to Txd common

Signal level 0 U_E = 0 to +35 V

Input current $I_E = \dfrac{U_E - 0.7\ V}{3.3\ k\Omega}$

1) Signal level 1 is the idle state

Signal level 1 1) U_E = –3 to –35 V

Input current $I_E = \frac{U_E + 1.5\,V}{3.3\,k\Omega}$

Transmit output Txd

Relative to 0 Vexternal

Signal level 0	+5 to +15 V 2)
On-load current	≤ 12 mA, short-circuit proof
Signal level 11) with jumper x2/9 = 10 5)	–5 to 15 V
On-load current with jumper x2/9 = 10 5)	≥ 1.67 mA
Signal level 11) without jumper x2/9 = 10	≤ 0 V 2)

- **TTY Point-to-point interface to remote system (x4)**

Receive input Rxd

Electrically isolated

Signal level 0	≤ +2 mA
Signal level 1 1)	+14 to +40 mA
Impedance	300 Ω

Current output for passive transmit Rxd +20 mA

Resistance at +24 V external 1 kΩ ± 5 %, 1 W

Transmit output Txd

Relative to 0 $V_{external}$

Signal level 0	0 mA
Signal level 1 1)	+15 to +25 mA
Impedance	≤ 400 Ω
No-load voltage	≤ +15 V

Cable capacitance and lengths at 9600 bit/sec 4)

	Cable capacitance	Recommended run lengths	
		Unscreened ribbon cable	Screened round cable
V.28 point-to-point3)	≤2.5 nF	50 m	10 m
SIPART bus	≤25 nF	500 m	100 m
TTY point-to-point3)	≤75 nF	1500 m	300 m

Table 1-24

Degree of protection

Housing	IP50 to DIN 40050
Connections (plugged in)	IP30 to DIN 40050
Housing 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 1-75

1) Signal level 1 indicates inactive state
2) Can be used with SIPART bus
3) Check technical specification of partner system
4) Linear increase using lower Baud rates
5) With V.28 Point-to-point connection

- **6DR2804-8A/B (230 V interface relay)**

1 Relay module	6DR2804-8B
2 Relay modules	6DR2804-8A
Per relay module	2 changeover contacts and spark suppressors
– **Contact material**	Silver-cadmium oxide
– **Contact loading capacity**	

Switching voltage	AC	≤ 250 V	DC	≤ 250 V
Switching current		≤ 8 A		≤ 8 A
Switching power		≤ 1250 VA		≤ 30 W at 250 V
				≤ 100 W at 24 V

– **Life expectancy**	
Mechanical	2×10^7 switching operations
Electrical 24V/4A ohmic	$2 \times 10^6/I(A)$ switching operations
– **Spark suppressor**	Connected in series 22 nF/220 Ω with varistor 420 V_{eff} in parallel
– **Excitation coil**	
Voltage	+19 to +30 V
Resistance	1.2 kΩ ± 180 Ω
– **Electrical isolation**	
Excitation coil-contacts between relay modules (6DR2804-8A)	With additional isolation, ventilation and creepage paths for surge class III [2]) and pollution level 2 [2])
Contact-contact of a relay module	with additional isolation, ventilation and creepage paths for surge class II [2]) and pollution level 2 [2])
– **Degree of protection**	
Housing	IP50 to DIN 40050
Connections (plugged in)	IP20 to DIN 40050
– **Housing material**	Polyamide 66
– **Mounting rail assembly** on	NS35/7.5 DIN EN 5002 NS35/15 DIN EN 50035 NS32 DIN EN 50035
– **Dimensioned diagram**	see Figure 1-76

1.5 to 1.5.3

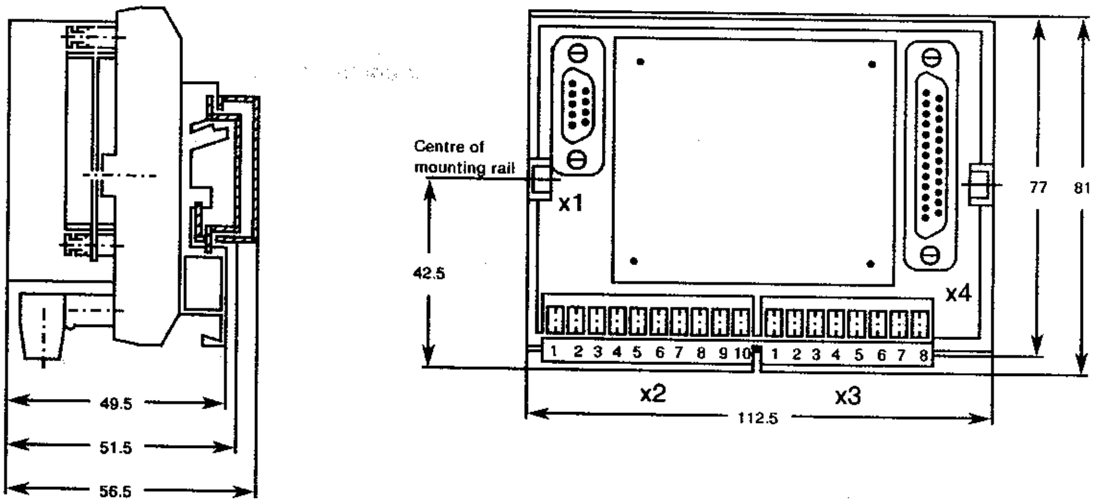


Figure 1-75 SIPART bus driver, dimension in mm

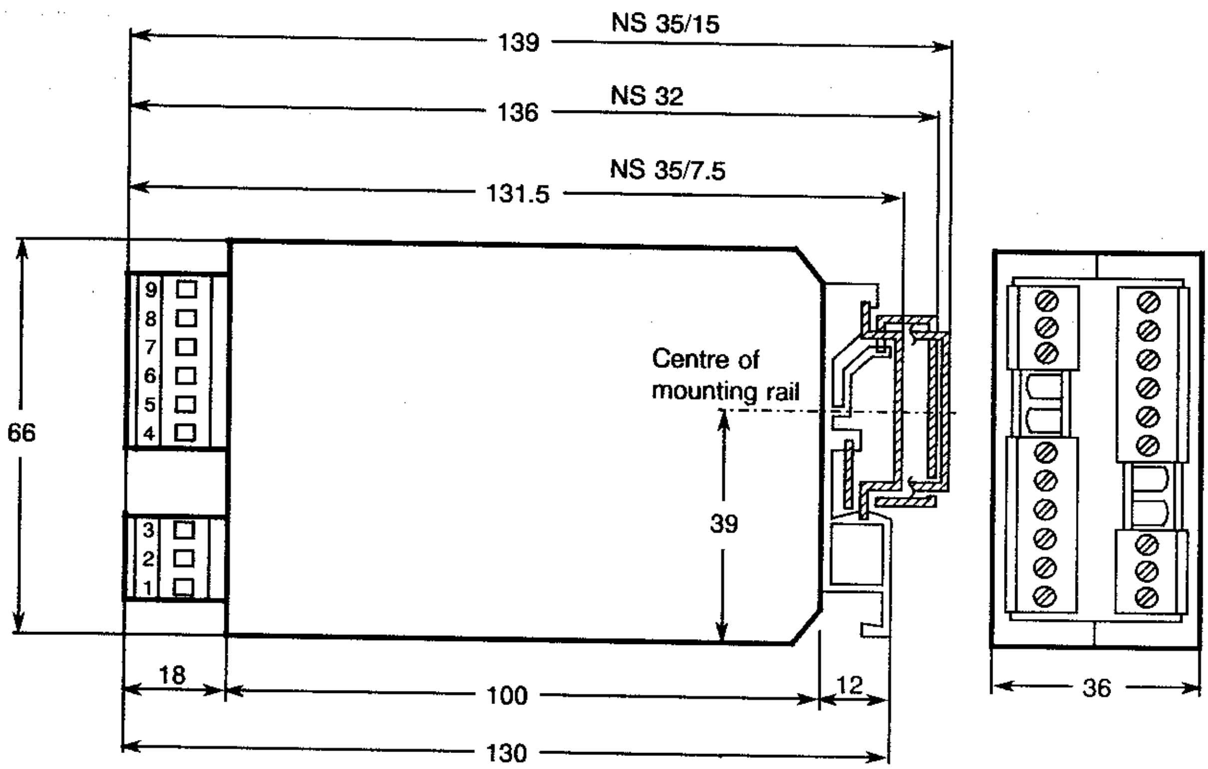


Figure 1-76 Interface relay, dimensions in mm

2 Installation

2.1 Mounting

- **Selecting a suitable location**

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

- **Panel mounting**

  SIPART DR22 controllers can be mounted either in individual panel cut-outs or in open tiers (see 1.5.1, Figures 1-73 and 1-74).

  - In order to ensure adequate interference suppression, even at high frequencies, the upper edge of the panel cut-out must be left unpainted. This allows the contact springs located on top of the controller to make a good HF earth connection.

  - If necessary: push self-adhesive gasket for the seal between the front frame and the front panel over the body and stick to the rear of the collar of the body (see 5.2, item 2.6).

  - Insert the controller into the panel cut-out or the open tier from the front, and attach the two clamps provided so that they latch into the cut-outs in the back of the controller housing.

  - Align the controller and lightly screw the clamps in place. The clamps can be adjusted over a range of 0 to 40 mm.

2.2 Electrical connection

Figure 2.1 shows the layout of the various connection components.

> ⚠ **WARNING**
>
> Observe the "Regulations for the installation of power systems with rated voltages under 1000 V" (VDE 0100).

- **Connection of protective earth conductor**

  Connect the protective earth conductor to the earth screw on the rear of the controller (see Figure 2-1). Where power is being taken from a 115 or 230 V AC mains supply, the protective earth can also be connected via the three-pin plug. The controller reference line and the protective earth may be connected (earthed extra-low voltage).

> ⚠ **WARNING**
>
> Disconnecting the protective earth while the controller is powered up can make the controller potentially dangerous. Do not disconnect the protective earth.

- **Power supply connection**
  Power to the controller is supplied via a three-pin plug (IEC 320/V DIN 49457 A) on 115 and 230 V AC systems, or by a special two-pole plug (polarity irrelevant) on 24 V AC/DC systems. Power plugs are supplied with the controller.

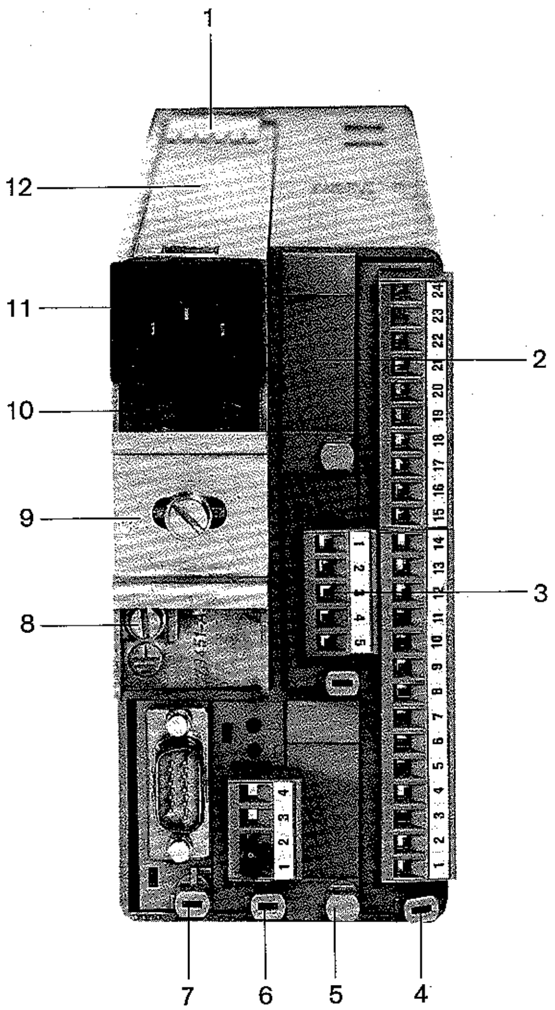
> ⚠ **WARNING**
>
> Disconnect the power supply and set the voltage selection switch (see Figure 2-1) accordingly.
> Observe the mains supply data shown on either the nameplate or voltage selection switch (115/230 V AC), or the voltage plate (24 V AC/DC).
> Feed power cables into the vicinity of the controller via a miniature circuit breaker (fire protection 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 supply not exceeding 150 VA under any circumstances, or circuits with a 150 VA fuse). No circuit breaker is required if the 24 V AC/DC power supply unit is fitted with a 4 A fuse (35 V DC) (T must be at least 3.15 A).

- **Connection of measuring and signal lines**

  Process signals are connected by means of plug-in terminal blocks that can accommodate cables of up to 1.5 mm² (AWG 14) cross-section.

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

Slots 1-8 must be marked on circuit diagrams and terminal blocks.
Measuring lines should be laid separately from power cables because of the danger of interference. If this is not possible, or if correct functioning of the instruments cannot be guaranteed because of interferences on the measuring lines resulting from the plant design, the cables must be screened.
The screen must be earthed separately at either the protective earth of the controller, or on one of the reference line terminals, depending from which reference line the interference comes. If connected to the protective earth, the screen should only be connected at one end to the controller to prevent creation of an earth loop.
The SIPART DR22 is designed with a large EMC to ensure interference free operation. To maintain a high degree of reliability, we recommend that all inductances (eg. relays, motors, contactors) in the vicinity of, or that are connected to the controller, be connected to suitable suppressors (eg. RC combinations).



1 Protective earth contact

2 Slot 6

4BA 24 V	BA13 to BA16
2BA relay	BA13, BA14
5BE	BE10 to BE14
y-hold	AA4

3 Slot 5

4BA 24 V	BA9 to BA12
2BA relay	BA9, BA 10
5BE	BE5 to BE9

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

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

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

7 Slot 4
SES

8 Earth screw

9 DIN rail

10 Voltage selection switch

11 Mains plug

12 Power supply unit

Figure 2-1 Rear view of controller

- **Connection of serial interface and bus driver**

The bus side of the driver is connected to the controller by a ribbon cable attached to a 9-way subminiature D-plug (x1). Parallel interfaces can therefore be implemented cheaply.
V.28 point-to-point connections are established by a 9-way round cable socket connector.
A round cable attached to a 25-way subminiature D-plug provides a screw-in connection for the point-to-point side of the bus driver to the remote system. D-plugs are not supplied with the modules.
Power for the bus driver is supplied via a 10-way terminal block (x2). Jumpers on the 10-way block (and also on an additional 8-way block (x3) allow the supply to be configured as required. The 8-way block x3 is connected in parallel to the 25-way jack x4, which allows the remote system to be connected to x3 if necessary.
The 10-way and 8-way terminal blocks are supplied with the driver.

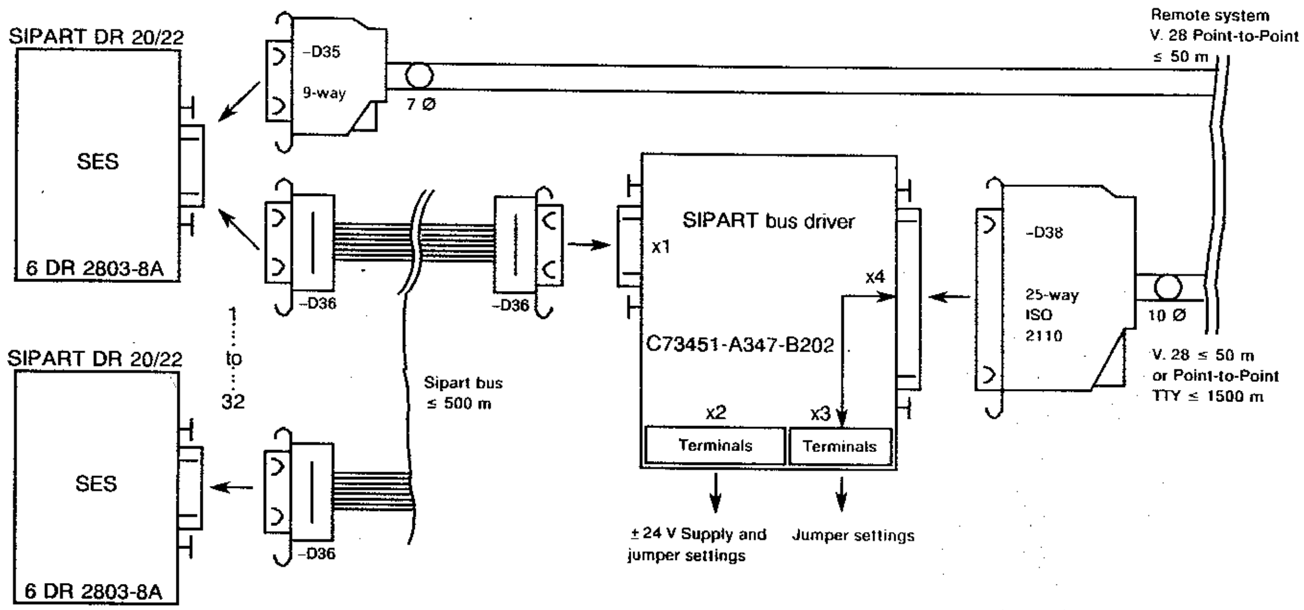


Figure 2-2 SES and bus driver interfaces

9-way D-plug for round cable (soldered)	C73451-A347-D39
9-way D-plug for ribbon cable (ipcd)	C73451-A347-D36
25-way D-plug for round cable (soldered)	C73451-A347-D38
Recommended cables	
10 core ribbon cable AWG 26	Fli-y10x1x0,14
core unscreened round cable	JE-LiYY 4x1x0.5 BdSi

- **Zero-volt system**

On the process side, the SIPART DR22 controller has just one 0 V conductor (reference line, M). This is connected to the standard unit at terminals 1/1 and 1/2. If necessary, additional proprietary terminals can be snapped onto the DIN rail on the power pack. The controller uses a continuous reference for both inputs and outputs. All process signals relate to this point.
This reference line is also connected to vacant terminal modules. These should only be used when practically no input current passes across ground (eg. see Figure 2-12, I4L).

The power supply and process signals are electrically isolated from each other. SIPART DR22 controllers do not need to be interconnected when controlling individual control loops. Where control loops are interconnected, all the controllers' reference lines must be connected either to a common termination or to a continuous ground bar with a large cross-section. One, and only one, reference line at the common termination may be connected to the plant protective earth conductor.

Analogue signals between controllers use only a 0/4 to 20 mA signal. These are interpreted as 4-way signals (differential amplifier with potential isolation), so voltage dips on ground are not interpreted as errors (see Figures 2-23 to 2-29).

The signal-to-noise ratio on digital signals is so large that voltage dips on the ground bar can be ignored.

2.2.1 Block diagram

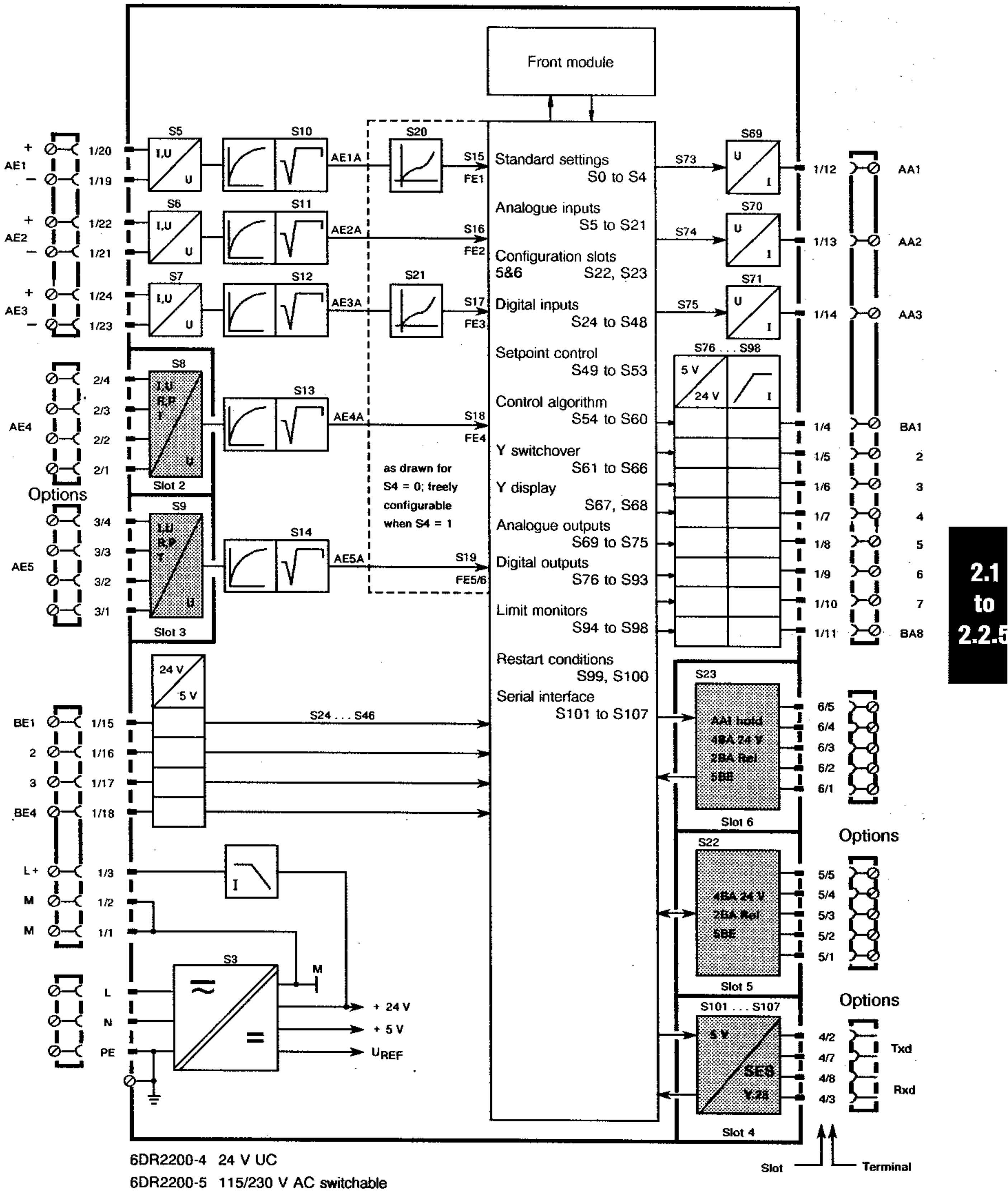


Figure 2-3 SIPART DR22 Block diagram

2.2.2 Standard controller wiring diagrams

- **Power supply**

Note:
Disconnect the power supply and set the voltage selection switch (see Figure 2-1) to the voltage required.

– - 6DR2200-5 (115/230 V AC, switchable)

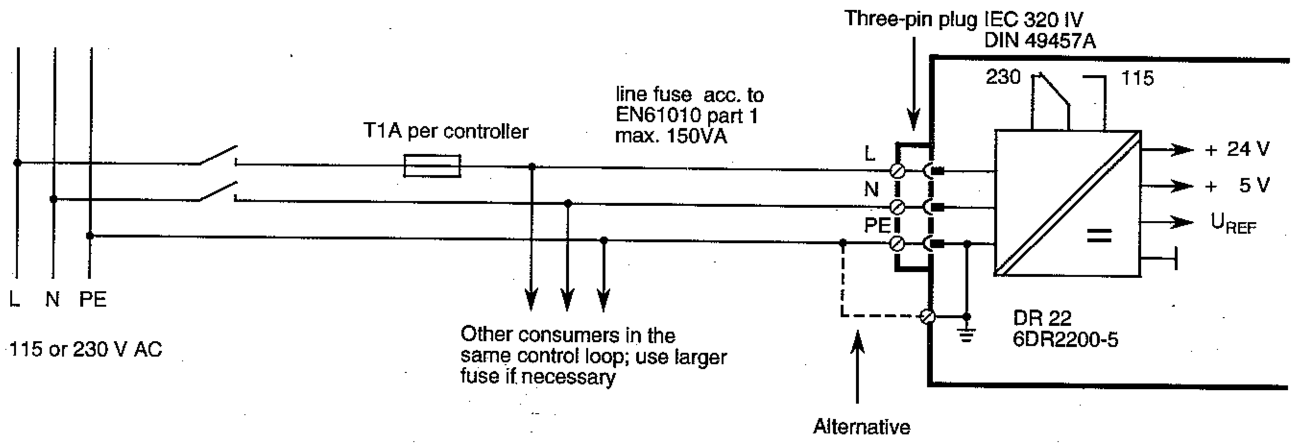


Figure 2-4 115/230 V AC power supply wiring diagram

– - 6DR2200-4 (24V AC/DC)

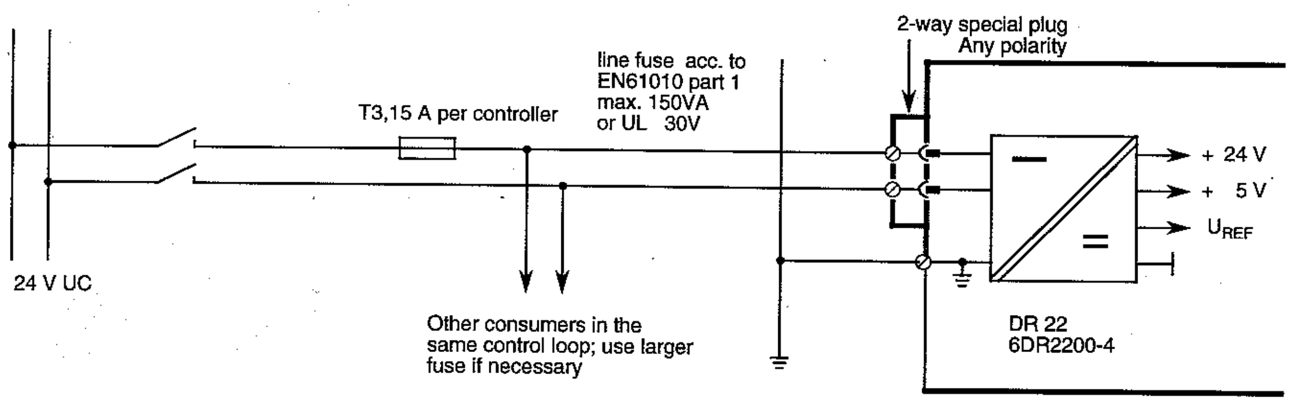
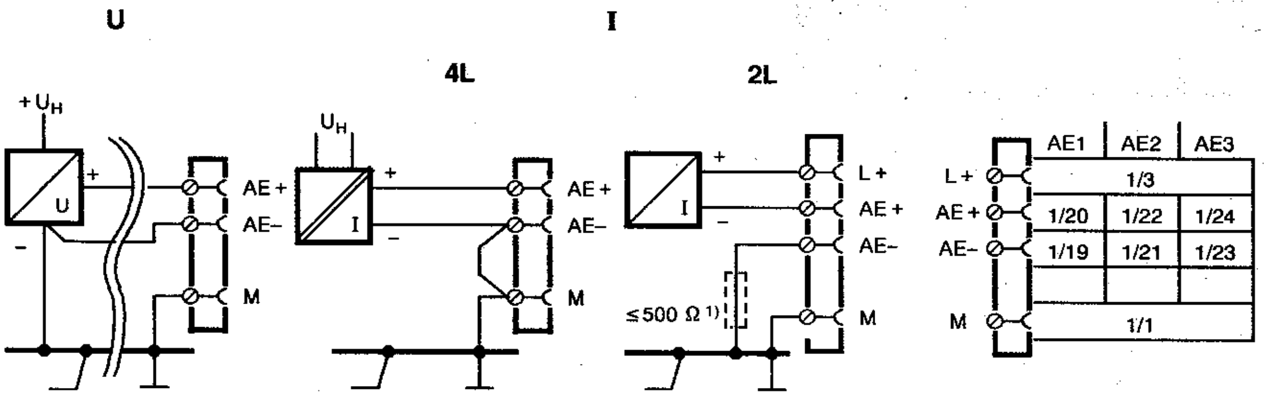


Figure 2-5 24 V AC/DC power supply wiring diagram

- **AE1 to AE3**

– **Wiring diagram**



See 2.2.4 for more details

Set 0/4 to 20 mA with S5 to S7

1) Potential load impedance from additional controllers

Figure 2-6 AE1 to AE3 U or I wiring diagram

– **Jumper settings**

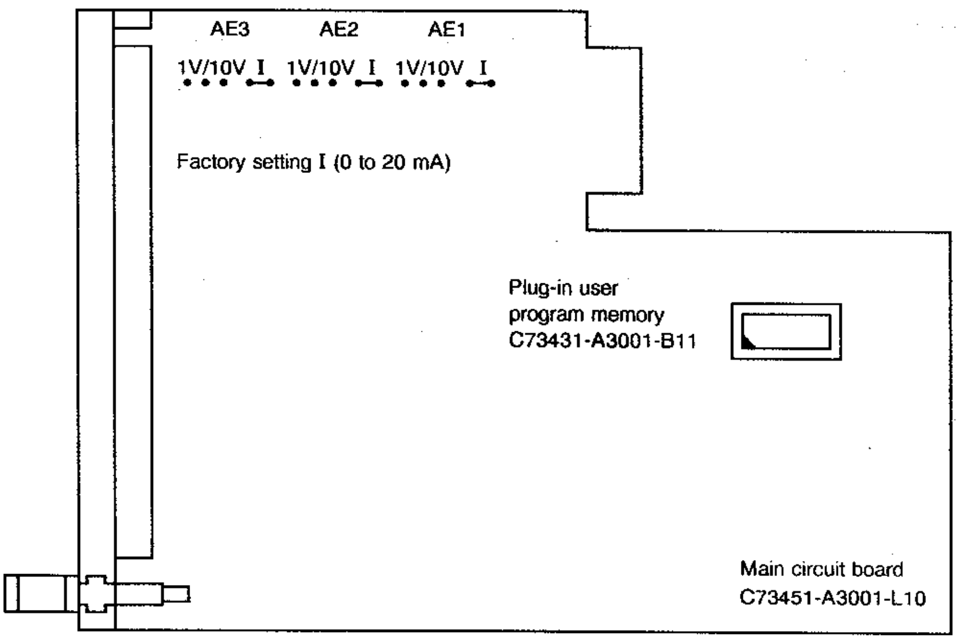


Figure 2-7 AE1 to AE3 jumper settings

2.1 to 2.2.5

- **BE1 to BE4**

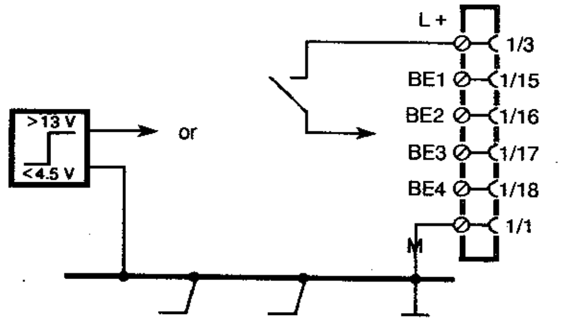


Figure 2-8 BE1 to BE4 wiring diagram

Select function with S24 to S38
Select logic with S39 to S46

- **AA1 to AA3**

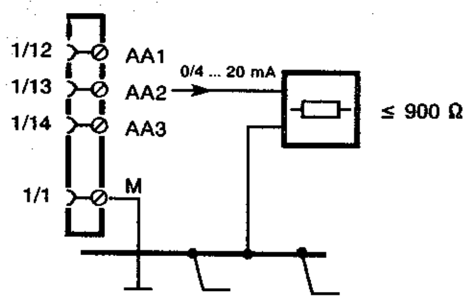


Figure 2-9 AA1 to AA3 wiring diagram

Select function with S73 to S75
Select 0/4 to 20mA with S69 to S71

- **BA1 to BA8**

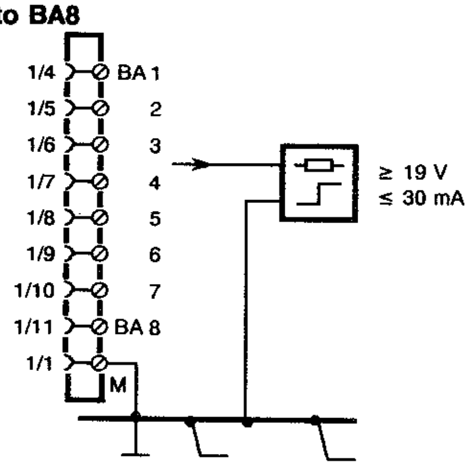


Figure 2-10 BA1 to BA4 wiring diagram

Select function with S76 to S85
Select logic with S86 to S93

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

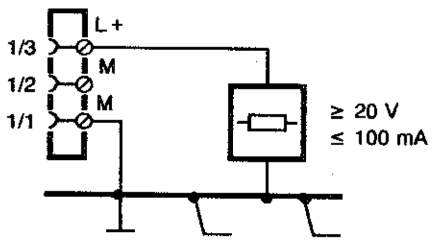
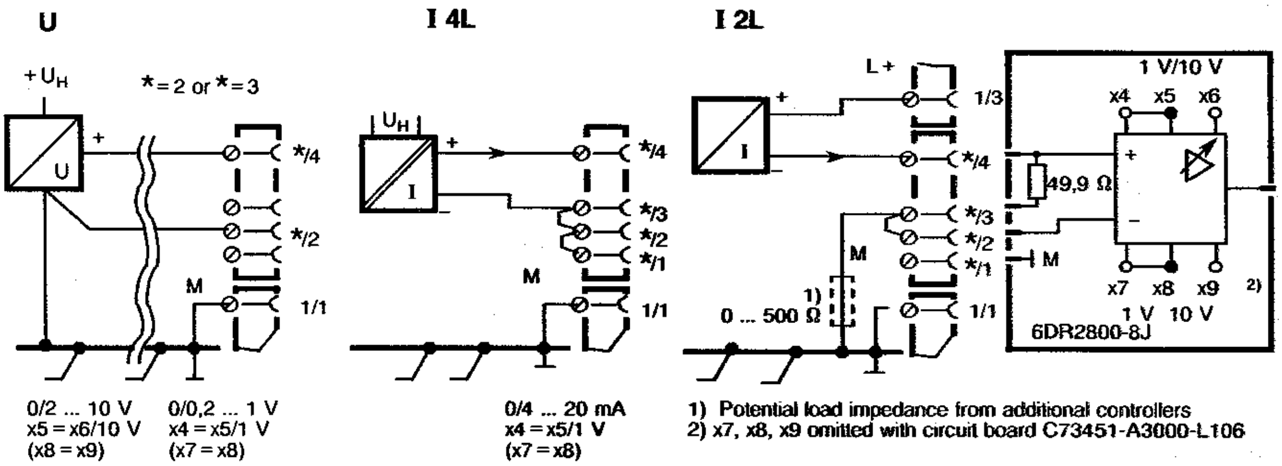


Figure 2-11 L + connection

2.2.3 Wiring of option modules

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

For AE4 in slot 2 with S8 and
For AE5 in slot 3 with S9 } Select measuring range 0 to 1 V/10 V/20 mA or 0.2 V/2 V/4 mA to 1 V/10 V/20 mA



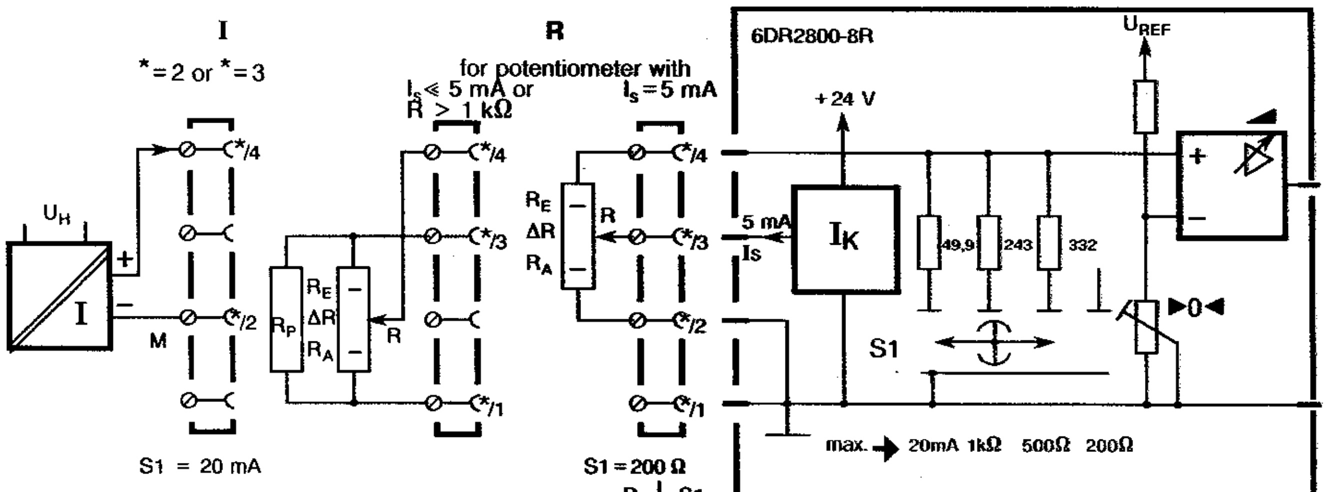
Factory setting 1 V x4 = x5 (und x7 = x8)

Figure 2-12 Wiring of U/I module 6DR2800-8J

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

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

- **Wiring**



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

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

Factory setting S1 = 200 Ω

Figure 2-13 Wiring of R module 6DR2800-8R

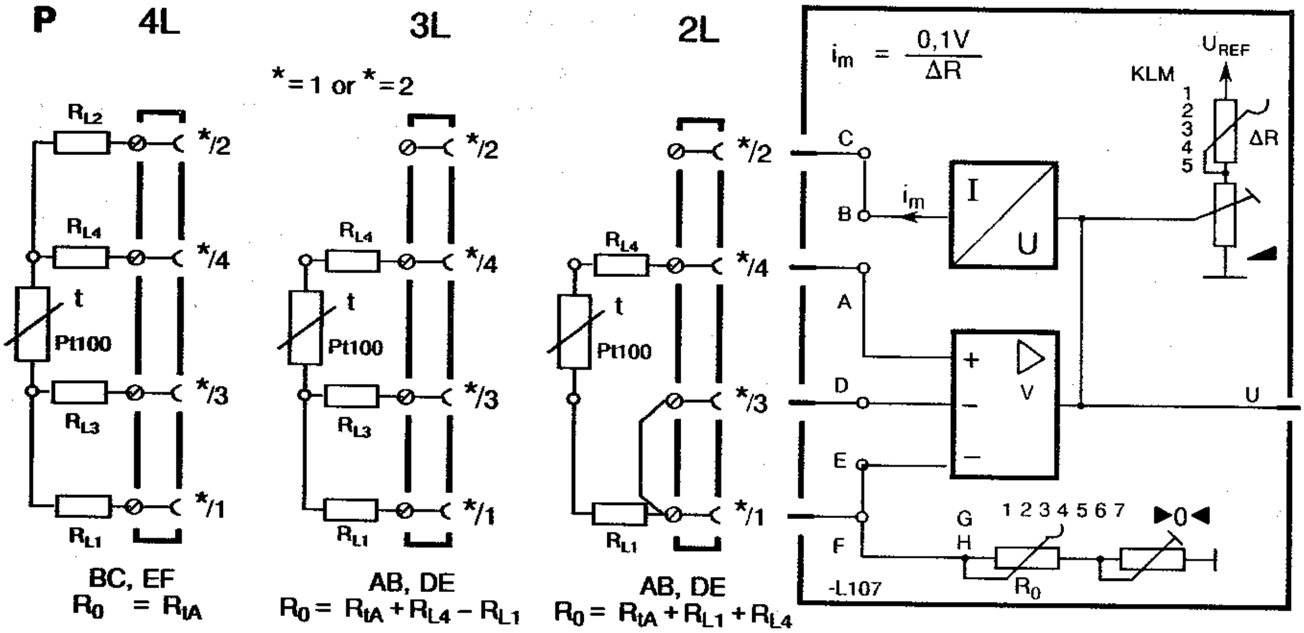
- **Calibration**

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

- **6DR2800-8P** **Pt100 Input**

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

– **Wiring**



4L

$$U = U_A - U_D - U_E$$
$$= v \cdot i_m (R_{tA} + R_{L1} + R_O - (R_{L1} + R_O) - R_O)$$
$$= v \cdot i_m (R_{tA} + R_{L1} + R_O - R_{L1} - R_O - R_O)$$
$$= v \cdot i_m (R_{tA} - R_O)$$

2L

$$U = U_A - U_D - U_E$$
$$= v \cdot i_m (R_{L4} + R_{tA} + R_{L1} + R_O - 2(R_O))$$
$$= v \cdot i_m (R_{tA} - R_O + R_{L4} + R_{L1})$$

3L

$$U = U_A - U_D - U_E$$
$$= v \cdot i_m (R_{L4} + R_{tA} + R_{L1} + R_O - 2\,(R_{L1} + R_O))$$
$$= v \cdot i_m (R_{L4} + R_{tA} + R_{L1} + R_O - 2R_{L1} - 2R_O)$$
$$= v \cdot i_m (R_{tA} - R_O + R_{L4} - R_{L1})$$

Figure 2-14 Wiring of Pt100 module 6DR2800-8P

– **Jumper settings**

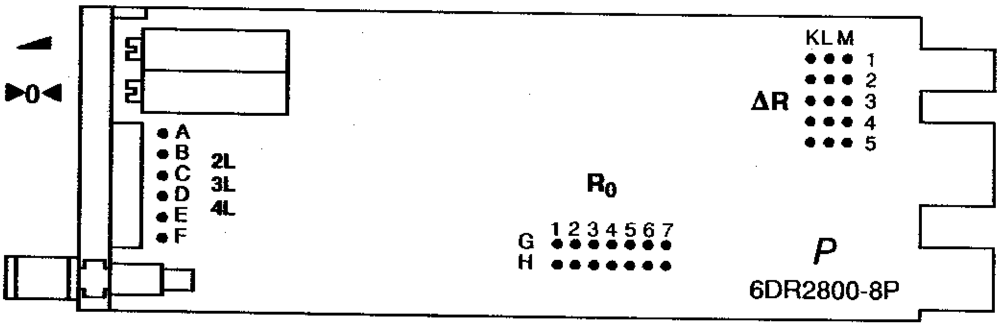


Figure 2-15 Jumper settings for Pt100 module 6DR2800-8P

1. Set Pt100 switching mode to 2L, 3L or 4L
2. Get R_{tA} and R_{tE} from Pt100 table (DIN/IEC 751 Oct. 85)
3. Calculate R_0 according to wiring configuration (see above)
4. Set R_0 jumpers according to Table 2-1
5. Calculate $\Delta R = R_{tE} - R_{tA}$
6. Set jumpers for ΔR according to Table 2-1

Factory setting:

4L	BC, EF							
R_0	1 GH	2 GH	3 GH	4 GH	5 GH	6 GH	7 GH	R_0 = 80,31 Ω RtA = -50 °C
ΔR	1 KL	2 LM	3 LM	4 LM	5 LM			ΔR = 309,95 Ω RtE = 850 °C

– **Calibration**

1. Simulate R_{tA} (with resistances in the case of 2L) using ▶0◀ display, or set analogue output (depending on the configuration) to start-of-scale value or 4 mA.
2. Simulate R_{tE} using ◢ display, or set analogue output to full-scale value or 20 mA.

R_0 (Ω)	1	2	3	4	5	6	7
79.3 –82.4	GH	GH	GH	GH	GH	GH	GH
81.3 –84.4	GH	GH	GH	GH	GH	GH	G
83.3 –86.4	GH	GH	GH	GH	GH	G	GH
85.3 –88.4	GH	GH	GH	GH	GH	G	G
87.3 –90.5	GH	GH	GH	GH	G	GH	GH
89.3 –92.5	GH	GH	GH	GH	G	GH	G
91.3 –94.5	GH	GH	GH	GH	G	G	GH
93.3 –96.5	GH	GH	GH	GH	G	G	G
94.3 –97.4	GH	GH	GH	G	GH	GH	GH
96.3 –99.4	GH	GH	GH	G	GH	GH	G
98.3 –101.4	GH	GH	GH	G	GH	G	GH
100.3 –103.4	GH	GH	GH	G	GH	G	G
102.3 –105.5	GH	GH	GH	G	G	GH	GH
104.3 –107.5	GH	GH	GH	G	G	GH	G
106.3 –109.5	GH	GH	GH	G	G	G	GH
108.3 –111.5	GH	GH	GH	G	G	G	G
109.4 –112.5	GH	GH	G	GH	GH	GH	GH
111.4 –114.5	GH	GH	G	GH	GH	GH	G
113.4 –116.5	GH	GH	G	GH	GH	G	GH
115.4 –118.5	GH	GH	G	GH	GH	G	G
117.4 –120.6	GH	GH	G	GH	G	GH	GH
119.4 –122.6	GH	GH	G	GH	G	GH	G
121.4 –124.6	GH	GH	G	GH	G	G	GH
123.4 –126.6	GH	GH	G	GH	G	G	G
124.4 –127.5	GH	GH	G	G	GH	GH	GH
126.4 –129.5	GH	GH	G	G	GH	GH	G
128.4 –131.5	GH	GH	G	G	GH	G	GH
130.4 –133.5	GH	GH	G	G	GH	G	G
132.4 –135.6	GH	GH	G	G	G	GH	GH
134.4 –137.6	GH	GH	G	G	G	GH	G
136.4 –139.6	GH	GH	G	G	G	G	GH
138.4 –141.6	GH	GH	G	G	G	G	G
140.3 –143.4	GH	G	GH	GH	GH	GH	G
142.3 –145.4	GH	G	GH	GH	GH	G	GH
144.3 –147.4	GH	G	GH	GH	GH	G	G
146.3 –149.5	GH	G	GH	GH	G	GH	GH
148.3 –151.5	GH	G	GH	GH	G	GH	G
150.3 –153.5	GH	G	GH	GH	G	G	GH
152.3 –155.5	GH	G	GH	GH	G	G	G
153.3 –156.4	GH	G	GH	G	GH	GH	GH
155.3 –158.4	GH	G	GH	G	GH	GH	G
157.3 –160.4	GH	G	GH	G	GH	G	GH
159.3 –162.4	GH	G	GH	G	GH	G	G
161.3 –164.5	GH	G	GH	G	G	GH	GH
163.3 –166.5	GH	G	GH	G	G	GH	G
165.3 –168.5	GH	G	GH	G	G	G	GH
167.3 –170.5	GH	G	GH	G	G	G	G
168.4 –171.5	GH	G	G	GH	GH	GH	GH
170.4 –173.5	GH	G	G	GH	GH	GH	G
172.4 –175.5	GH	G	G	GH	GH	G	GH
174.4 –177.5	GH	G	G	GH	GH	G	G
176.4 –179.6	GH	G	G	GH	G	GH	GH
178.4 –181.6	GH	G	G	GH	G	GH	G
180.4 –183.6	GH	G	G	GH	G	G	GH
182.4 –185.6	GH	G	G	GH	G	G	G
183.4 –186.5	GH	G	G	G	GH	GH	GH
185.4 –188.5	GH	G	G	G	GH	GH	G
187.4 –190.5	GH	G	G	G	GH	G	GH
189.4 –192.5	GH	G	G	G	GH	G	G
191.4 –194.6	GH	G	G	G	G	GH	GH
193.4 –196.6	GH	G	G	G	G	GH	G
195.4 –198.6	GH	G	G	G	G	G	GH
197.4 –200.6	GH	G	G	G	G	G	G

R_0 (Ω)	1	2	3	4	5	6	7
199.3 –202.4	G	GH	GH	GH	GH	GH	G
201.3 –204.4	G	GH	GH	GH	GH	G	GH
203.3 –206.4	G	GH	GH	GH	GH	G	G
205.3 –208.5	G	GH	GH	GH	G	GH	GH
207.3 –210.5	G	GH	GH	GH	G	GH	G
209.3 –212.5	G	GH	GH	GH	G	G	GH
211.3 –214.5	G	GH	GH	GH	G	G	G
212.3 –215.4	G	GH	GH	G	GH	GH	GH
214.3 –217.4	G	GH	GH	G	GH	GH	G
216.3 –219.4	G	GH	GH	G	GH	G	GH
218.3 –221.4	G	GH	GH	G	GH	G	G
220.3 –223.5	G	GH	GH	G	G	GH	GH
222.3 –225.5	G	GH	GH	G	G	GH	G
224.3 –227.5	G	GH	GH	G	G	G	GH
226.3 –229.5	G	GH	GH	G	G	G	G
227.4 –230.5	G	GH	G	GH	GH	GH	GH
229.4 –232.5	G	GH	G	GH	GH	GH	G
231.4 –234.5	G	GH	G	GH	GH	G	GH
233.4 –236.5	G	GH	G	GH	GH	G	G
235.4 –238.6	G	GH	G	GH	G	GH	GH
237.4 –240.6	G	GH	G	GH	G	GH	G
239.4 –242.6	G	GH	G	GH	G	G	GH
241.4 –244.6	G	GH	G	GH	G	G	G
242.4 –245.5	G	GH	G	G	GH	GH	GH
244.4 –247.5	G	GH	G	G	GH	GH	G
246.4 –249.5	G	GH	G	G	GH	G	GH
248.4 –251.5	G	GH	G	G	GH	G	G
250.4 –253.6	G	GH	G	G	G	GH	GH
252.4 –255.6	G	GH	G	G	G	GH	G
254.4 –257.6	G	GH	G	G	G	G	GH
256.4 –259.6	G	GH	G	G	G	G	G
258.3 –261.4	G	G	GH	GH	GH	GH	G
260.3 –263.4	G	G	GH	GH	GH	G	GH
262.3 –265.4	G	G	GH	GH	GH	G	G
264.3 –267.5	G	G	GH	GH	G	GH	GH
266.3 –269.5	G	G	GH	GH	G	GH	G
268.3 –271.5	G	G	GH	GH	G	G	GH
270.3 –273.5	G	G	GH	GH	G	G	G
271.3 –274.4	G	G	GH	G	GH	GH	GH
273.3 –276.4	G	G	GH	G	GH	GH	G
275.3 –278.4	G	G	GH	G	GH	G	GH
277.3 –280.4	G	G	GH	G	GH	G	G
279.3 –282.5	G	G	GH	G	G	GH	GH
281.3 –284.5	G	G	GH	G	G	GH	G
283.3 –286.5	G	G	GH	G	G	G	GH
285.3 –288.5	G	G	GH	G	G	G	G
286.4 –289.5	G	G	G	GH	GH	GH	GH
288.4 –291.5	G	G	G	GH	GH	GH	G
290.4 –293.5	G	G	G	GH	GH	G	GH
292.4 –295.5	G	G	G	GH	GH	G	G
294.4 –297.6	G	G	G	GH	G	GH	GH
296.4 –299.6	G	G	G	GH	G	GH	G
298.4 –301.6	G	G	G	GH	G	G	GH
300.4 –303.6	G	G	G	GH	G	G	G
301.4 –304.5	G	G	G	G	GH	GH	GH
303.4 –306.5	G	G	G	G	GH	GH	G
305.4 –308.5	G	G	G	G	GH	G	GH
307.4 –310.5	G	G	G	G	GH	G	G
309.4 –312.6	G	G	G	G	G	GH	GH
311.4 –314.6	G	G	G	G	G	GH	G
313.4 –316.6	G	G	G	G	G	G	GH
315.4 –318.6	G	G	G	G	G	G	G

ΔR (Ω)	1	2	3	4	5
18.4 –19.6	K	K	K	KL	KL
19.5 –20.8	K	LM	K	KL	KL
20.6 –22.0	LM	K	KL	K	KL
21.9 –23.4	LM	LM	KL	K	KL
23.0 –24.5	K	KL	LM	K	KL
24.3 –25.9	LM	LM	K	K	KL
25.7 –27.4	LM	K	LM	K	KL
27.0 –28.8	KL	KL	LM	LM	KL
28.5 –30.4	LM	KL	K	KL	K
30.2 –32.2	KL	LM	K	KL	K
31.3 –33.4	K	KL	LM	KL	K
33.2 –35.4	LM	KL	LM	KL	K
35.2 –37.5	KL	LM	LM	KL	K
36.2 –38.5	LM	LM	K	KL	K
38.3 –40.8	KL	K	KL	K	K
40.5 –43.2	K	K	KL	KL	LM
42.7 –45.5	K	LM	KL	KL	LM
45.0 –47.9	KL	KL	LM	KL	LM
47.3 –50.4	LM	KL	K	KL	LM
48.5 –51.7	K	K	KL	K	K
51.2 –54.6	K	KL	KL	LM	K
54.3 –57.8	LM	KL	KL	LM	K
56.6 –60.3	LM	K	K	KL	LM
59.6 –63.5	LM	LM	KL	K	K
62.4 –66.5	LM	K	LM	KL	LM
65.6 –69.9	LM	LM	LM	KL	LM
69.4 –73.9	LM	KL	KL	K	LM
71.9 –76.5	KL	K	KL	K	LM
75.0 –79.9	KL	KL	K	LM	K
78.2 –83.3	K	LM	KL	LM	K
82.8 –88.2	LM	LM	KL	LM	K
87.0 –92.7	KL	KL	LM	LM	K
88.2 –94.0	KL	K	KL	LM	LM
92.7 –98.7	KL	LM	KL	LM	LM
94.8 –101.0	K	K	KL	K	LM
99.3 –105.8	LM	K	KL	K	LM
105.4 –112.3	LM	LM	KL	K	LM
110.7 –117.9	KL	KL	LM	K	LM
115.3 –122.8	KL	LM	K	K	K
121.5 –129.5	LM	K	KL	LM	LM
126.4 –134.7	LM	KL	K	LM	K
133.8 –142.6	KL	KL	LM	LM	LM
138.3 –147.3	K	KL	LM	LM	K
146.1 –155.6	LM	KL	LM	LM	K
154.5 –164.6	KL	K	K	LM	K
157.8 –168.1	K	KL	K	K	LM
165.5 –176.3	LM	KL	K	K	LM
168.9 –179.9	KL	LM	K	LM	K
176.8 –188.4	K	KL	LM	K	LM
184.4 –196.4	LM	KL	LM	K	LM
194.5 –207.2	KL	LM	LM	LM	K
203.0 –216.2	LM	KL	K	LM	LM
213.9 –227.8	K	KL	LM	LM	LM
219.5 –233.9	KL	LM	K	K	LM
230.6 –245.6	KL	K	KM	K	LM
243.8 –259.7	KL	LM	LM	K	LM
254.7 –271.3	KL	K	K	LM	LM
267.5 –285.0	KL	LM	K	LM	LM
278.0 –296.1	KL	K	LM	LM	LM
290.4 –310.4	KL	LM	LM	LM	LM

A single character means that only one jumper pole should be attached.

Table 2-1 Jumper settings for start-of-scale value (Ro) and measuring range ΔR of Pt100 module

2.1 to 2.2.5

- **6DR2800-8T Thermocouple input and mV transmitter)**

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

- **Wiring**

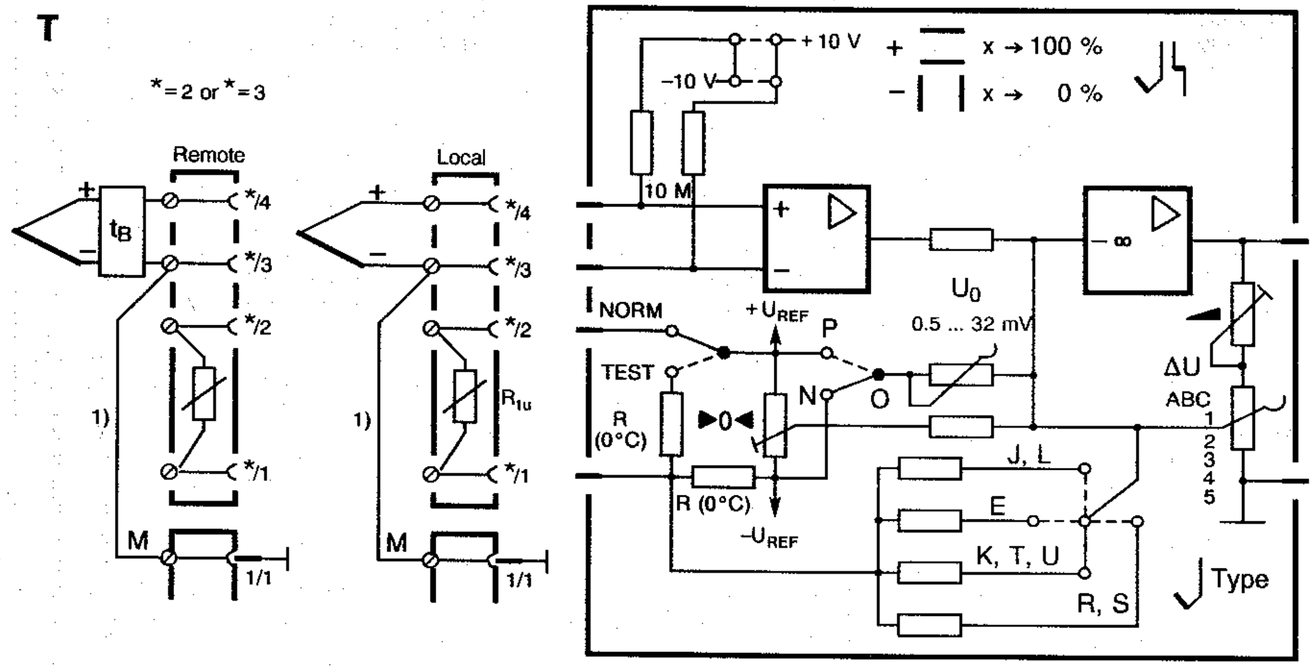
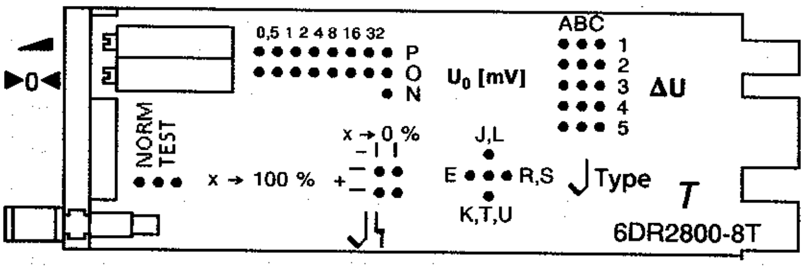


Figure 2-16 Wiring of thermocouple module 6DR2800-8T

All common types of thermocouple and mV sources can be connected to this module. As the low drift input amplifier possesses a very high common mode rejection, a low-frequency AC or DC voltage of up to ± 10 V may occur between the transmitter and controller reference line. This means that where two SIPART DR22 are fitted with thermocouple inputs, and the controllers are connected to one another via the reference line, unisolated (surface welded, undefined earth) thermocouples can also be connected. If this is not the case, we recommend that in order to prevent undefined common mode voltages, pin 3 be connected to reference line M (terminal 1/1 on the standard controller). Electrical isolation is then achieved via the power supply. Trimming with an mV transmitter can also be performed using this circuit.

- **Jumper settings**



Factory setting

Type	K, T, U
	− ‖ x → 0 %
U_0 value	0.5 + 1 + 2 + 4 + 8 + 16 + 32 mV
	U_0 = −63.5 mV
U_0 polarity	N = 0 Uo < 0
ΔU	1 2 3 4 5 ΔU = 34 mV
	A AB BC BC BC
	NORM

Figure 2-17 Jumper settings for thermocouple module 6DR2800-8T

1. Set jumpers for internal cold junction according to type of thermocouple J (DIN 43710/IEC 584). With types B and E, mV transmitters and an external cold junction: attach one jumper pole to E.
2. Determine response in event of thermocouple breakage J↯ : − I I indicates that $x \rightarrow 0$ %, +⊥ $x \rightarrow 100$ %
3. Refer to thermocouple table (DIN 43710 or DIN IEC 584) for values of U_{tA} and U_{tE}.
4. Calculate U_O according to location of cold junction: internal 0 °C: $U_O = U_{tA}$
   external tB: $U_O = U_{tA} - U_{tB}$
   mV transmitter: $U_O = U_A$
5. Set appropriate jumpers to value of U_O, 0.5 + 1 + 2 + 4 + 8 + 16 + 32mV. If a voltage is not required, only attach one jumper pole.
   Set jumpers for U_O polarity: $U_O \geq 0$, jumper 0 = P; $U_O < 0$, jumper 0 = N
6. Calculate $\Delta U = U_{tE} - U_{tA}$
7. Set jumpers for ΔU according to Table 2-2.
8. If actual physical values are to be displayed, parameterise the thermocouple lineariser (see 1.4.4, Figures 1-27 to 1-41).

– Calibration

1. Set jumper to TEST position.
2. Supply U_O from mV transmitter using ▶0◀ display, or set analogue output (depending on the configuration) to start-of-scale value or 4 mA.
3. Supply U_O and ΔU from mV transmitter using ◢ display, or set analogue output to full-scale value or 20 mA.

– Operation

Set jumper to NORM position for thermocouples using an internal cold junction.

Leave jumper on TEST for thermocouples using external compensation and mV transmitters.

ΔU (mV)	1	2	3	4	5
9.7 –10.3	AB	AB	A	BC	AB
10.1 –10.7	AB	A	AB	BC	AB
10.6 –11.2	A	AB	AB	BC	AB
11.0 –11.7	AB	AB	BC	AB	AB
11.5 –12.0	AB	A	A	A	BC
11.8 –12.4	A	AB	AB	BC	A
12.2 –13.0	AB	AB	BC	A	AB
12.7 –13.3	A	AB	A	BC	AB
13.2 –13.9	AB	A	BC	AB	AB
13.8 –14.6	A	AB	BC	AB	AB
14.4 –15.0	A	AB	A	BC	A
14.9 –15.7	AB	A	BC	A	AB
15.5 –16.4	AB	AB	AB	BC	BC
16.1 –17.1	AB	BC	A	AB	AB
16.7 –17.3	A	A	A	BC	AB
17.1 –18.1	AB	BC	AB	A	A
18.0 –19.2	AB	AB	BC	AB	BC
18.9 –20.0	BC	AB	AB	AB	A
19.6 –20.6	A	BC	AB	AB	A
20.3 –21.3	AB	BC	A	A	A
21.2 –22.5	AB	AB	BC	BC	A
22.0 –23.2	BC	AB	A	AB	A
23.0 –24.2	BC	A	AB	AB	A
23.9 –24.9	A	BC	A	AB	A
24.5 –26.0	AB	BC	AB	BC	A
25.8 –27.5	BC	AB	AB	BC	AB
27.3 –29.0	AB	BC	BC	AB	A
28.4 –30.2	BC	AB	BC	AB	AB
30.1 –31.6	A	BC	AB	A	BC
31.4 –33.4	BC	BC	AB	AB	AB
33.2 –35.0	A	AB	BC	BC	BC
34.8 –36.9	BC	BC	AB	A	AB
36.8 –39.2	BC	AB	BC	BC	AB
38.4 –40.8	BC	BC	AB	AB	BC
40.5 –43.1	AB	BC	BC	BC	BC
42.6 –45.2	BC	BC	AB	A	BC
44.1 –46.6	BC	BC	A	AB	BC
46.2 –49.0	BC	BC	BC	AB	A
48.8 –51.4	BC	A	BC	BC	A
50.9 –54.1	BC	BC	BC	BC	AB
53.8 –56.9	BC	BC	A	BC	BC
55.4 –58.8	BC	BC	BC	BC	A
57.9 –61.6	BC	BC	BC	BC	BC

Table 2-2 Jumper settings for measuring span ΔU of thermocouple modules. A single character means that only one jumper pole should be attached.

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

BE5 to 9 in slot 5 (S22 = 2) } Select function with S24 to S38
BE10 to 14 in slot 6 (S23 = 2) } Select logic with S39 to S46

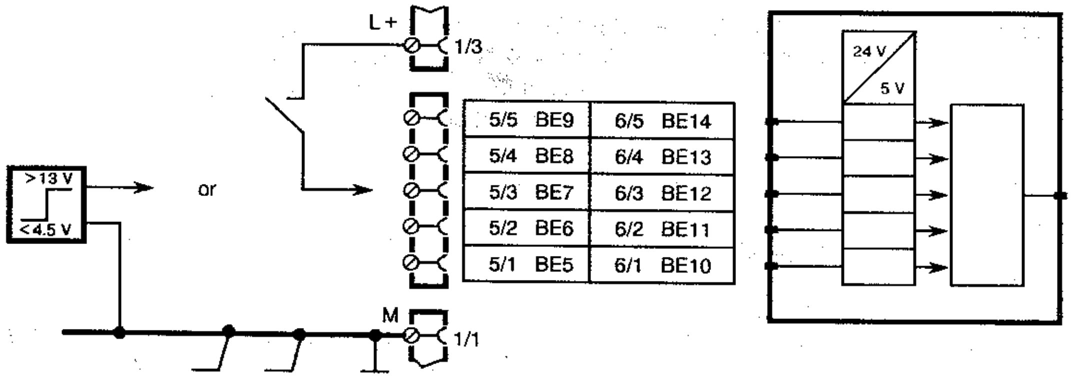


Figure 2-18 Wiring of 5BE module 6DR2801-8C

- **6DR2801-8B 4BA (24 V + 1 BE (BLPS))**

BA9 to BA12 in slot 5 (S22 = 1) } Select function with S76 to S85
BA13 to BA16 in slot 6 (S23 = 1) } Select logic with S86 to S93

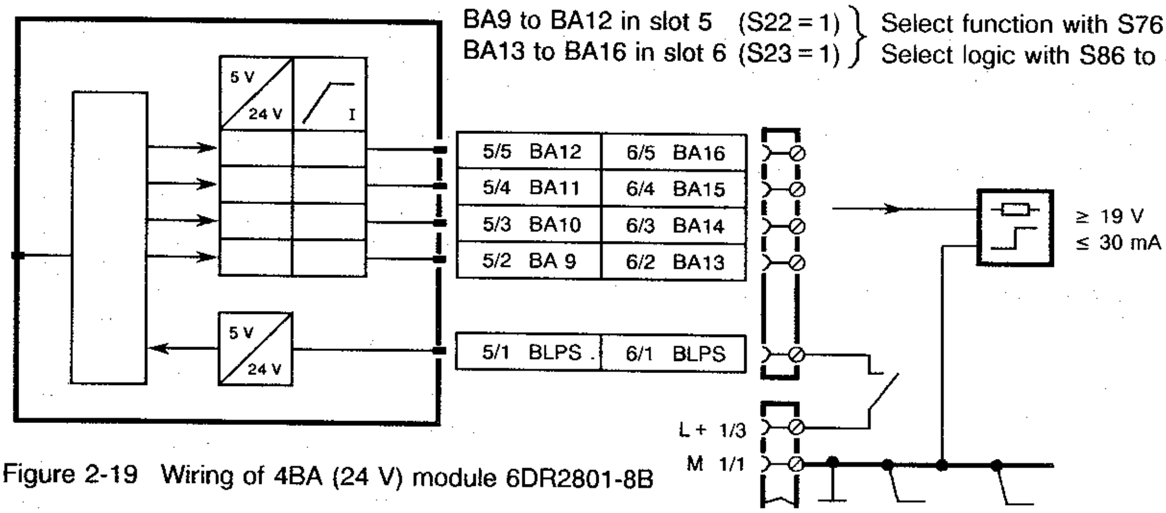
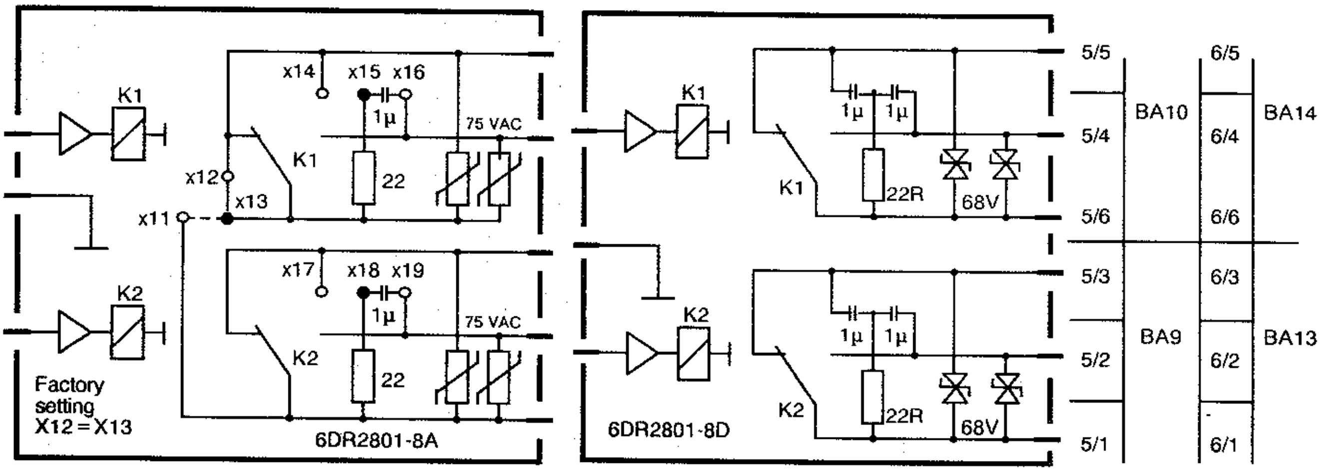


Figure 2-19 Wiring of 4BA (24 V) module 6DR2801-8B

- **6DR2801-8D (2BA 35 V Relay)**

BA9 and BA10 in slot 5 (S22 = 3) } Select function with S76 to S85
BA13 and BA14 in slot 6 (S23 = 3) } Select logic with S86 to S93



6DR2801-8A superseded by 6DR2801-8D

AC ≤ 35 V
≤ 5 A
≤ 150 VA

DC ≤ 35 V
≤ 5 A
≤ 80 W at 35 V
≤ 100 W at 24 V

Figure 2-20 Wiring of 2BA (Relay) module 6DR2801-8A and -8D

•• 6DR2802-8A (y_{hold})

AA4 in Slot 6 only (S23 = 4) standard assignment to y
Use S72 select 0/4 to 20 mA

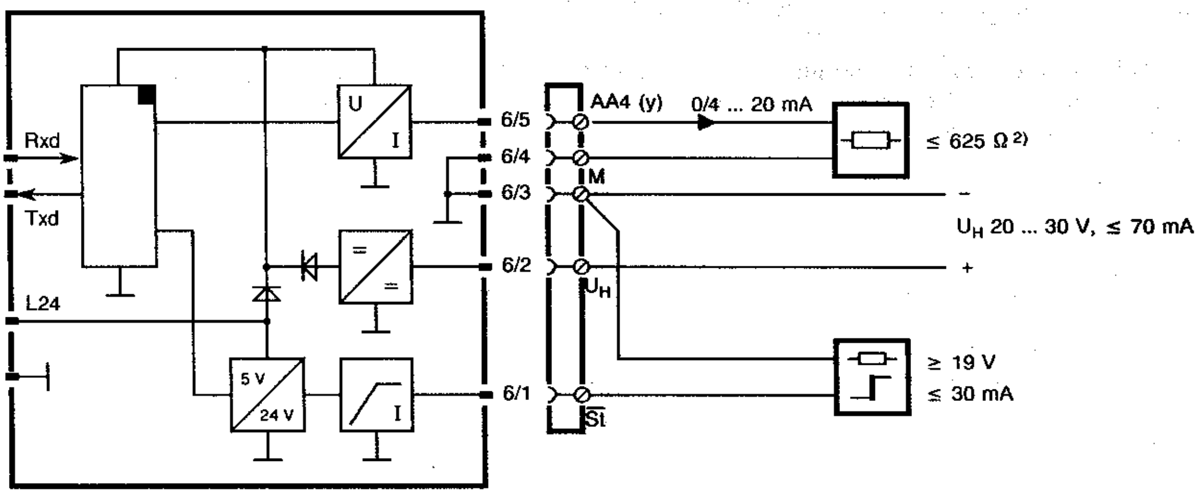


Figure 2-21 Wiring of Y_{hold} module 6DR2802-8A

1) UH only needs to be connected if the output signal has to be maintained should the controller's power supply fail, or if the module is removed for any reason.

2) Up to 900 Ω, depending on the supply voltage (see 1.5.3, Technical data).

6DR2804-8A (Interface relay 230 V, 4 changeover contacts)
6DR2804-8B (Interface relay 230 V, 2 changeover contacts)

Example: Wiring of S controller ± Δy outputs using 230 V 2 interface relays, 6DR2804-8B.

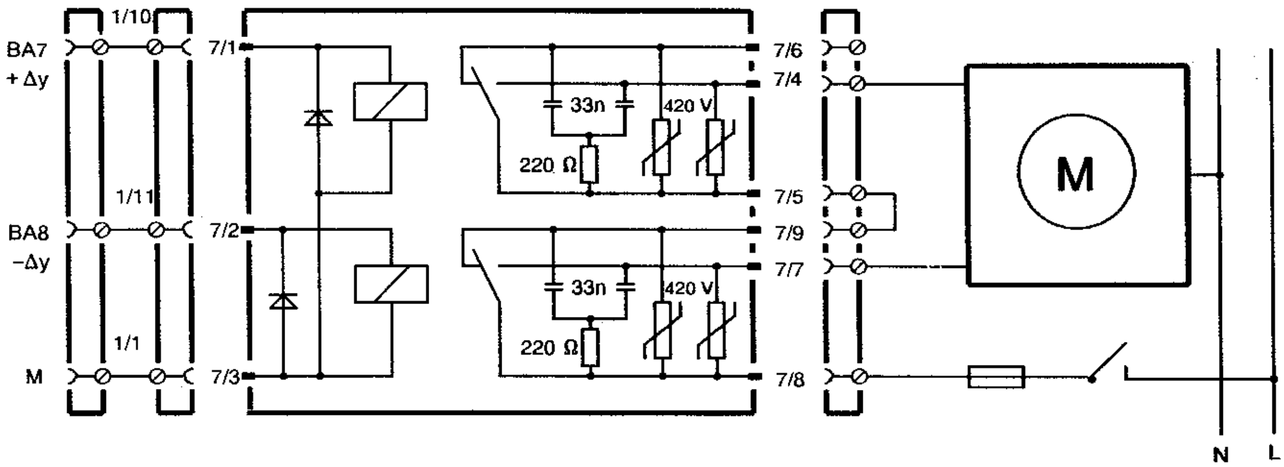


Figure 2-22 Wiring of 230 V interface relay 6DR2804-8

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

Note: Observe maximum switching voltage (refer to 1.3.2 if resonance sharpness occurs with phase shift motors).

AC	250 V	DC	250 V	
	8 A		8 A	
	1250 VA		30 W at	250 V
			100 W at	24 V

2.2.4 Additional I and U input wiring

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

The 49.9 Ω input impedance is connected across the input signals AE + and AE- (by jumper settings in the standard controller in the case of AE1 to AE3, and by external wiring on the option module for AE4 and AE5).

If the signal is still required when the terminal block is disconnected, the 49.9 Ω ± 0,1 % input impedance (order no. C73451-A347-B79, remove interface plug) must be connected to the terminals between AE + and AE-. The internal 49.9 Ω resistance must then be disabled by appropriate jumper settings, or by rewiring.

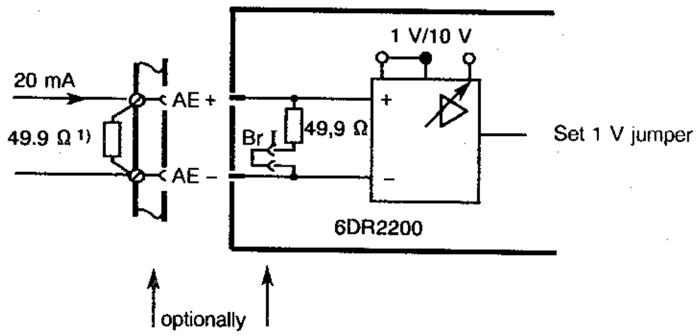
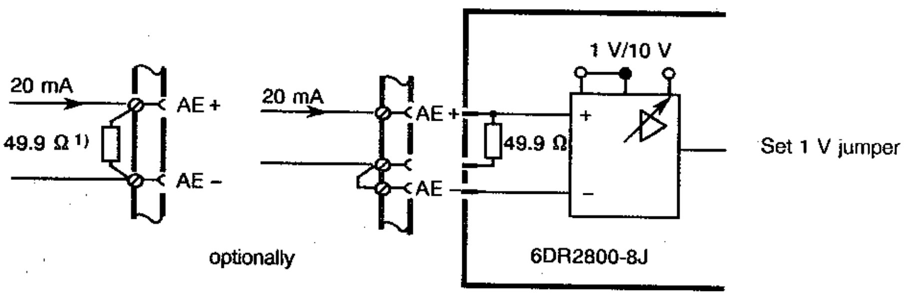


Figure 2-23 Standard controller AE1 to AE3 inputs showing internal/external 49.9 Ω resistance



1) C73451-A347-B79

Figure 2-24 AE4, AE5 inputs on option module 6DR2800-8J showing internal/external 49.9 Ω resistance

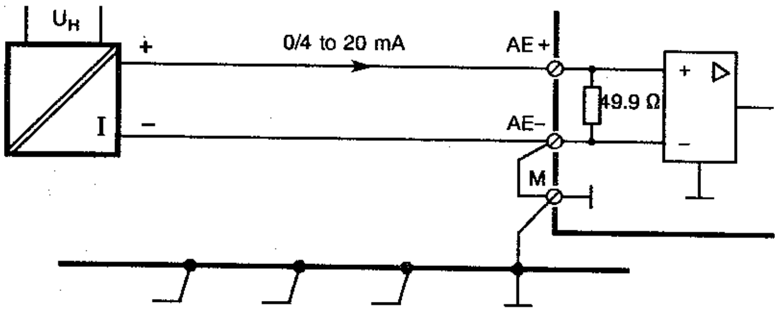


Figure 2-25 0/4 to 20 mA 4-wire transmitter with potential isolation

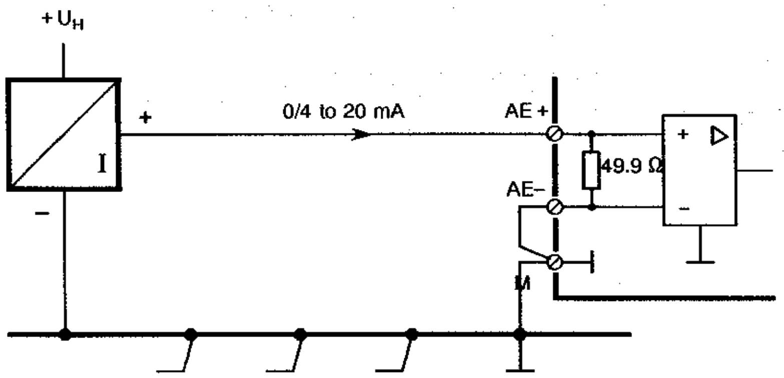


Figure 2-26 0/4 to 20 mA 3-wire transmitter with negative polarity to ground

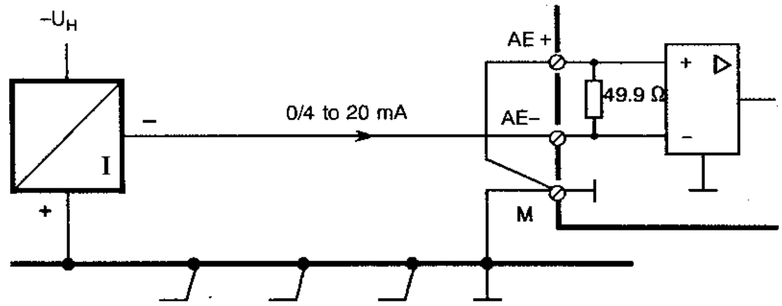


Figure 2-27 0/4 to 20 mA 3-wire transmitter with positive polarity to ground

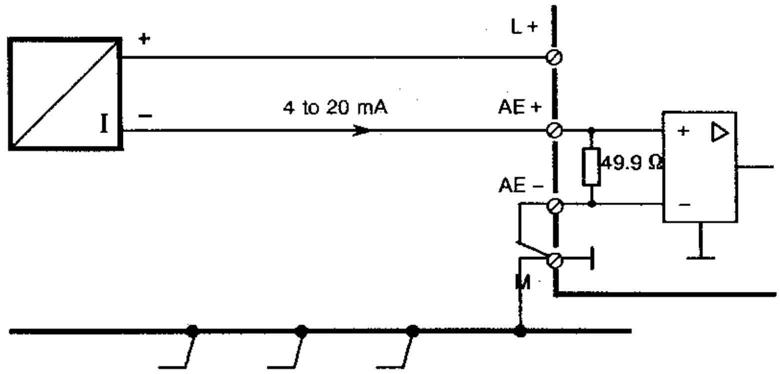
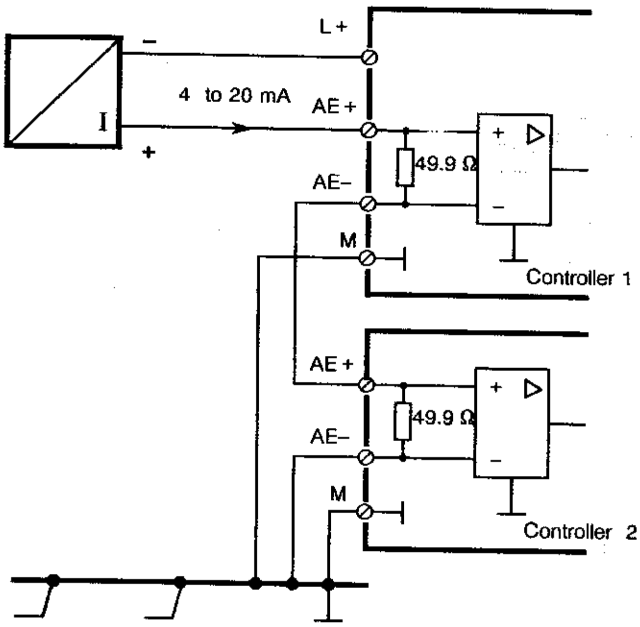


Figure 2-28 4 to 20 mA 2-wire transmitter supplied from controller's L +

2.1 to 2.2.5



Each input amplifier is supplied a differential voltage of 0.2 to 1 V. Controller 1 also has a 0.2 to 1 V common-mode voltage that is suppressed in this case. Several controllers with a total common-mode voltage of up to 10 V can be connected in series. As the last controller's input is connected to earth, its input impedance is referred to earth (eg. AE1 or AE2 of the SIPART DR20).

As there will be an increased impedance in this case (maximum permitted common-mode voltage 10 V), take care not to exceed the maximum impedance voltage of the transmitter, or, where relevant, the on-load voltage.

Figure 2-29 4 to 20 mA 2-wire transmitter connected to two controllers in series and supplied by L+ from one of the controllers

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

Figure 2-30 Wiring of a floating voltage supply

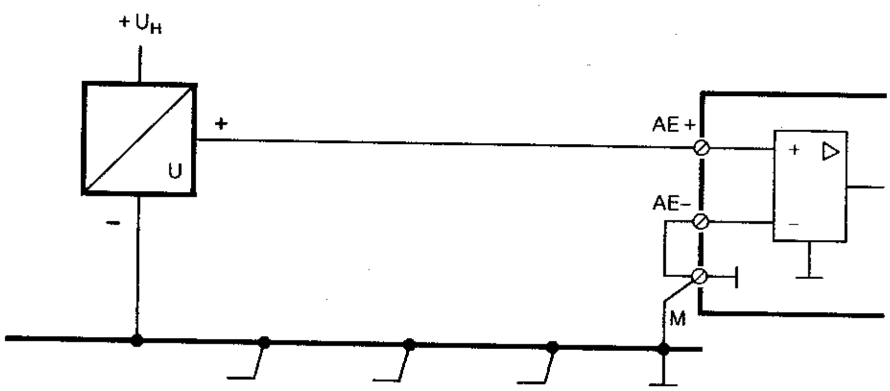


Figure 2-31 Single-pole wiring of a non-floating voltage supply, with negative referred to ground

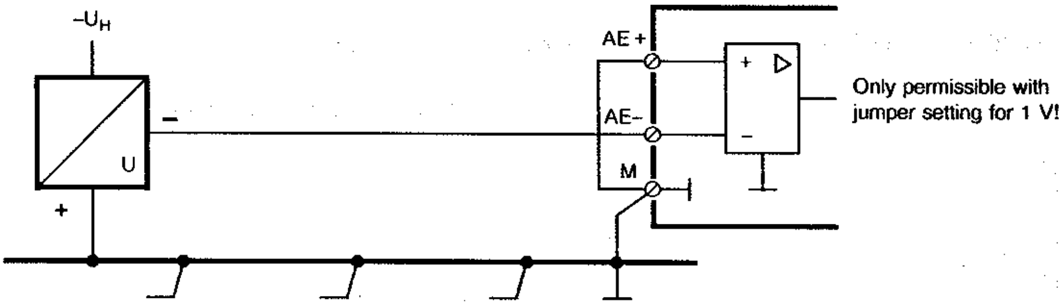


Figure 2-32 Single-pole wiring of a non-floating voltage supply, with positive referred to ground

Note the following with regard to Figures 2-31 and 2-32:
The voltage dip on the ground bar between voltage source and input amplifier appears as a measuring error. Only use this wiring when ground cables are short, otherwise use the configuration shown in Figure 2-33.

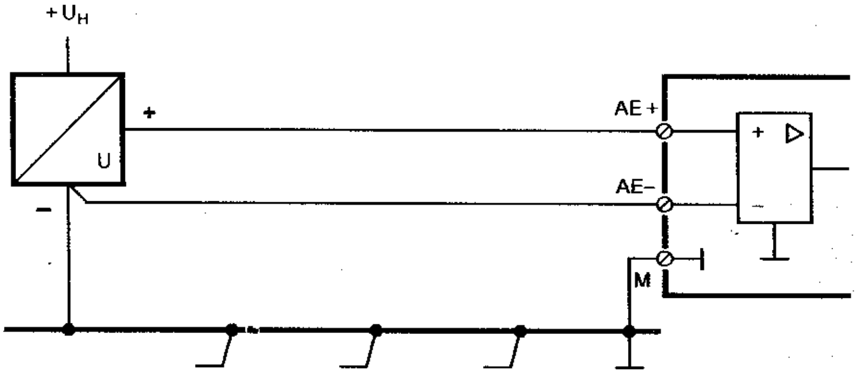


Figure 2-33 Double-pole wiring of a voltage source with positive referred to ground

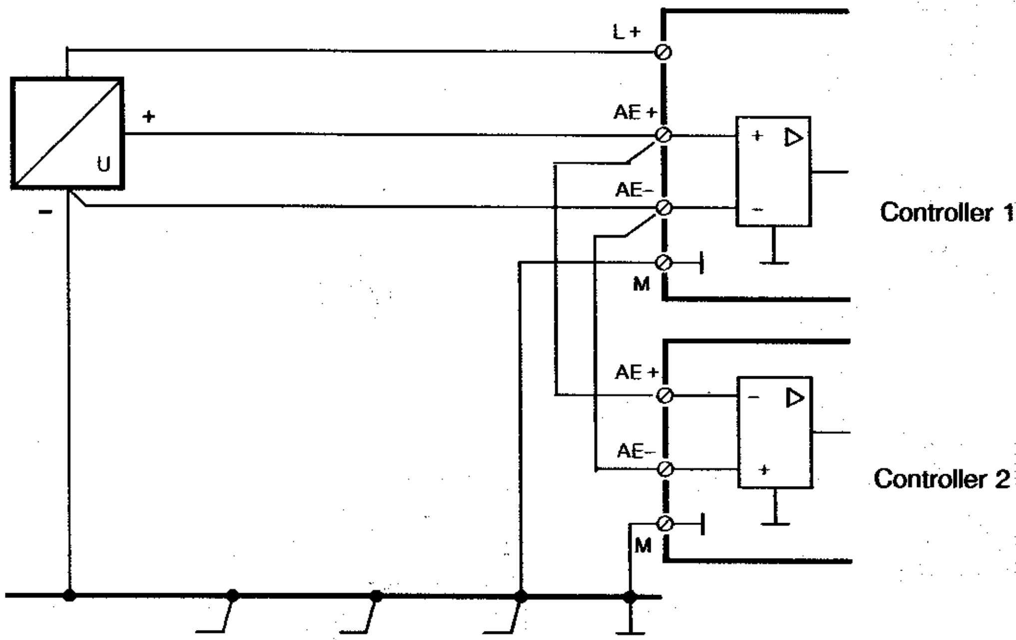


Figure 2-34 Wiring of a non-floating voltage source to two controllers connected in parallel. The voltage source is supplied by L + from one of the controllers, with negative referred to ground.

Note the following with regard to Figures 2-33 and 2-34:
The voltage dip on the ground bar between voltage source and input amplifier appears as a common-mode voltage and is suppressed.

2.2.5 Wiring the serial interface and the SIPART bus driver

- **6DR2803-8C (V.28 point-to-point serial interface)**

Insert in slot 4. Use configuring switches S101 to S107 to establish communications procedure.

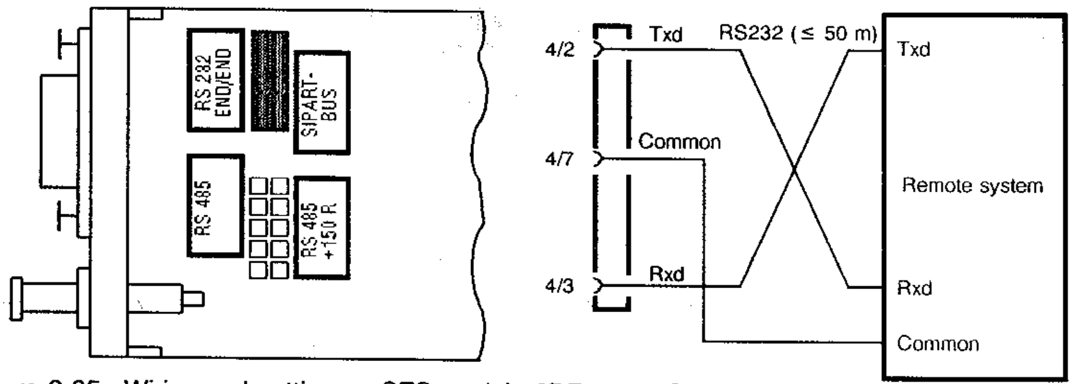


Figure 2-35 Wiring and setting on SES module 6DR2803-8C with RS232 point-to-point

- **SIPART bus**

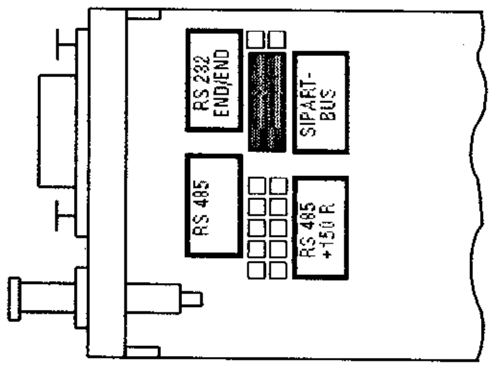


Figure 2-36 Setting on SES module 6DR2803-8C with connection to SIPART bus

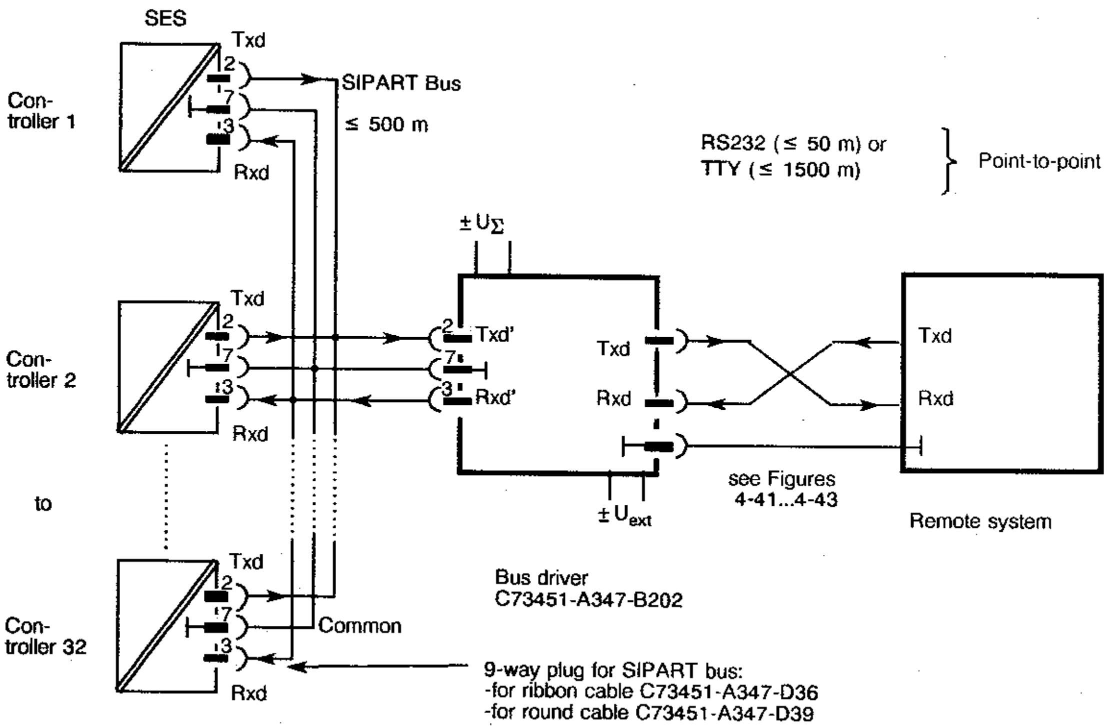


Figure 2-37 SIPART bus/SES(6DR2803-8C)/bus driver (C73451-A347-B202)/remote system wiring diagram

Bus driver C73451-A347-B202 wiring principles and interface to remote system

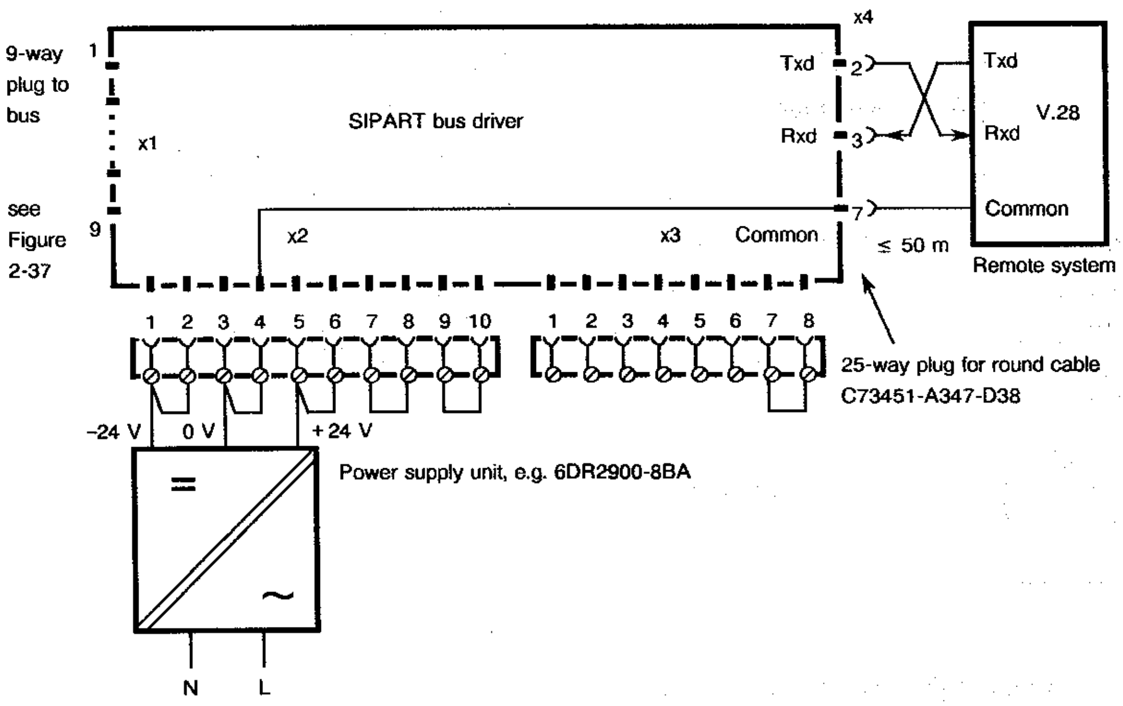


Bild 2-38 RS232 point-to-point via SES 6DR2803-8C to remote system with isolation between SIPART bus and remote system

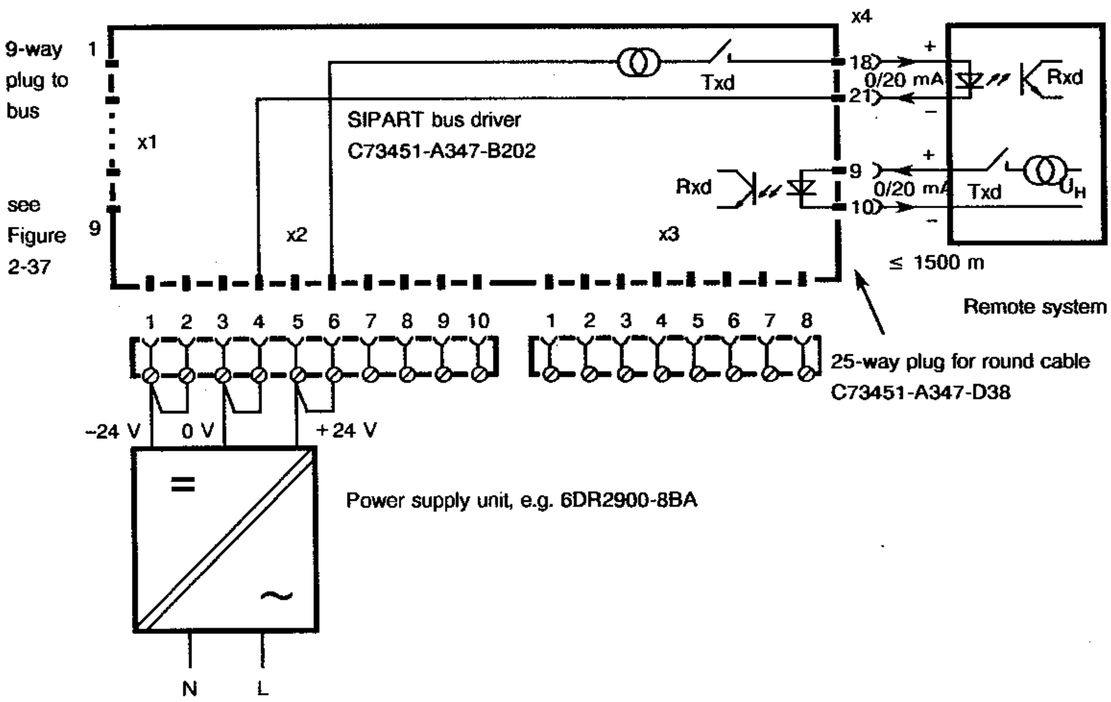


Figure 2-39 TTY to remote system with isolation between SIPART bus and remote system via SES 6DR2803-8C. Txd of remote system is an active current source.

2.1 to 2.2.5

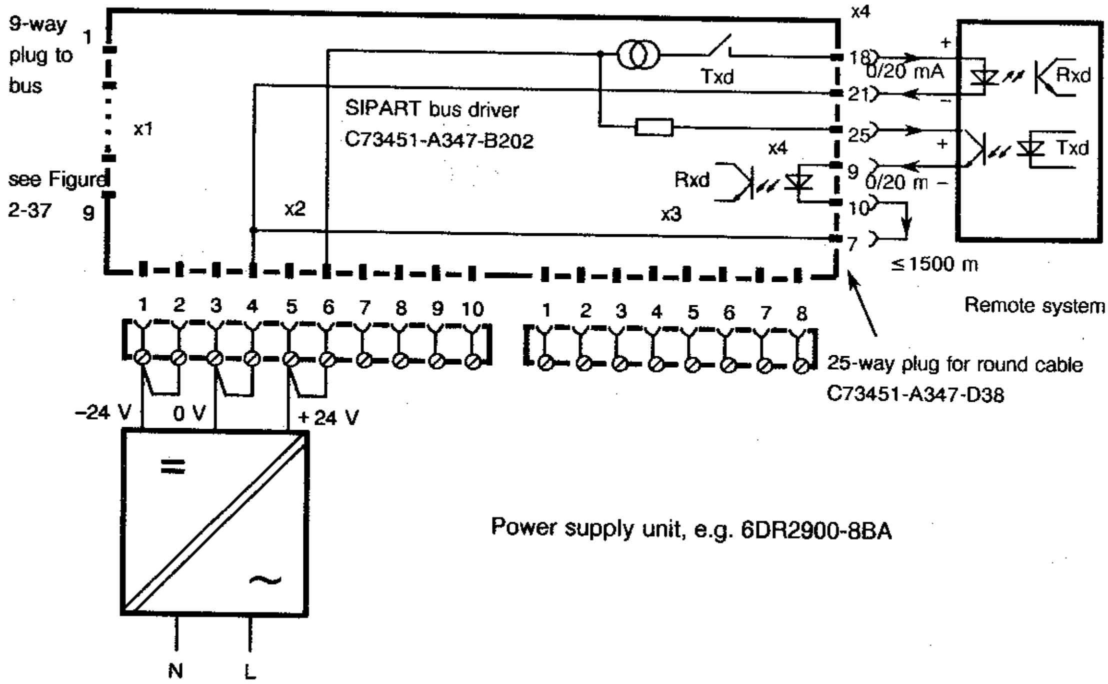


Figure 2-40 TTY to remote system with isolation between SIPART bus and remote system via SES 6DR2803-8C. Txd of remote system is a passive switch.

3 Operation

The SIPART DR22 controller has three principal modes of operation:

- Process operation
- Parameterisation
- Configuring

The controls and displays on the front fascia are assigned different functions during parameterisation and configuring compared with the process operation mode.

Figure 3-1 see fold-out page at end of manual for an overview of controls and displays.

3.1 Process operation

The layout and colour of controls, displays and the front fascia itself should make operation of the SIPART DR22 in this mode clear and simple:

Red is the colour of the controlled variable:
The red 4-digit digital display (16) and the vertical LED bargraph (17) indicate the current value of the controlled variable.

Green is the colour of the setpoint:
The green 4-digit digital display (19) and LED bargraph (18) indicate the setpoint. The green local/remote pushbutton (2) is used to switch between local and remote setpoints. The local setpoint can be adjusted by the green $\pm\Delta w$ pushbuttons (6). The green Local LED (1) indicates operation with the local setpoint. The $\overline{C}$ LED (3) also lights up green if the CB control signal is missing.

Yellow is the colour of the manipulated variable:
The yellow H/A pushbutton is used to alternate between manual and automatic mode. During manual mode, the yellow Manual LED (8) either flashes or remains steady. The yellow y-remote LED (10) indicates remote access to the manipulated variable, ie. tracking, safety or blocking mode. The yellow $\pm\Delta y$ pushbuttons (13) allow the manipulated variable, which is normally displayed in the yellow digital display (14), to be modified during manual operation. The yellow $\pm\Delta y$ LED (15) displays the incremental direction for S controllers, irrespective of the current mode of operation.

Limit violations are indicated by the Alarm LEDs (5) and (7). The Adaptation LED (4) indicates how far parameter optimisation has progressed during the adaptation process. Again, this may be indicated by either a flashing or a steady light.

The selector pushbutton (12) is used to toggle the display and setpoint pushbuttons on dual-loop controllers. This pushbutton can also be used on single-loop controllers to switch displays to indicate other setpoints and alarm values. The associated Controller LED (11) indicates the current status.

The label (20) can be removed. Use a pointed tool to open the plexiglass cover and remove the label. Behind it you will see a screw which fixes the front module to the controller. This can be removed to allow access during maintenance (see chapter 5).

3.2 Parameterisation

Parameterisation, including the parameter preselection process (see Figure 3-2) onPA-AdAP-StrU (on-line parameterisation-adaptation-configuring presets), takes place on-line; in other words, the controller continues in its most recent mode of operation. The analogue x (17) and w (18) displays continue to reflect what is actually happening in the process, so the reaction of the control loop to changes to various parameters can still be observed. The Local and Manual LEDs (1) and (8), and the Alarm LEDs A1 to A4, indicate the actual state of the process. The local/remote pushbutton (2) becomes an "Exit" pushbutton, and the associated $\overline{C}$-LED (3) indicates Exit stand-by; whenever the LED flashes, pressing the Exit pushbutton causes the controller to exit the current mode and return to the next higher one.

The $\pm\Delta w$ pushbuttons (6) are used to modify the variable shown in the digital w display (mode name or parameter value).

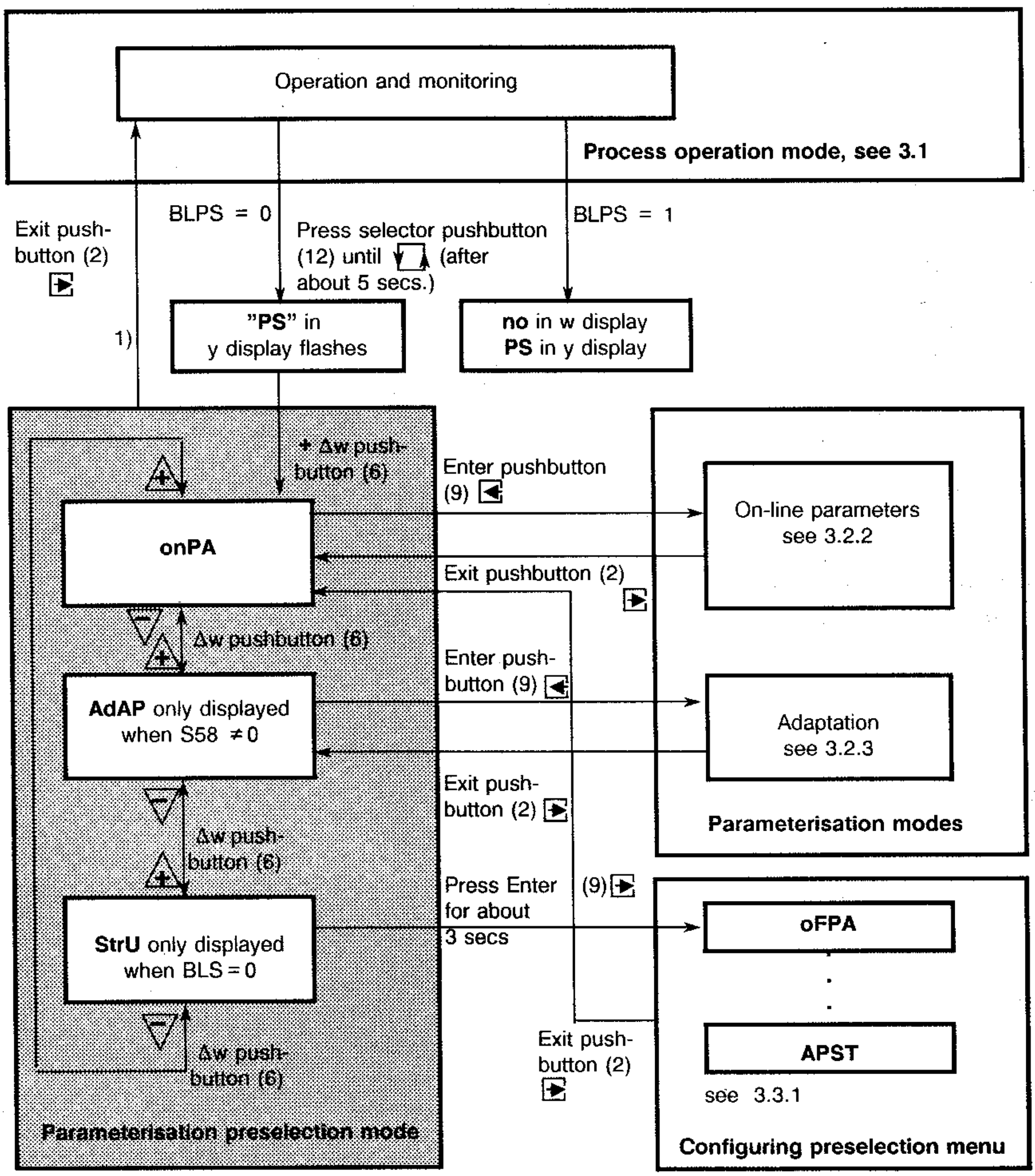
The automatic/manual pushbutton (9) becomes an "Enter" pushbutton, and the associated y-remote LED (10) indicates Enter stand-by; whenever the LED flashes, pressing the Enter pushbutton causes the controller to pass from the current mode to the next lower one. With the exception of AdAP mode (see section 3.3), the digital x display continues to show the value of the controlled variable x. The $\pm\Delta y$ pushbuttons are used to select the name of the parameter shown in the y display.

Pressing and holding the selector pushbutton (12) in dual-loop control causes any remaining process variable displays to be switched over to the inactive controller. Any extension to the switchover cycle (S98) is suppressed. This switchover does not effect discrepancy signalling on the LEDs Controller I/Controller II. Values and statuses from the inactive controller (the controller whose LED is not on or flashing) are displayed while the selector pushbutton is held down.
Parameters with a wide range of values can be adjusted quickly in onPA and AdAP parameterisation modes. First select the direction with one of the Δw pushbuttons, and then start scanning by pressing the other Δw pushbutton as well.

If the BLPS control signal is on, parameterisation and configuring are inhibited. noPS appears in the w and y displays when the selector pushbutton is pressed.

If the control signal BLS is on, configuring is inhibited. In this case StrU is masked out during parameter preselection mode.

3.2.1 Parameterisation preselection mode



1) Automatic return if no enter function executed in parameterisation or configuring mode within 20 secs.

Figure 3-2 Parameterisation preselection mode

3.1 to 3.2.3

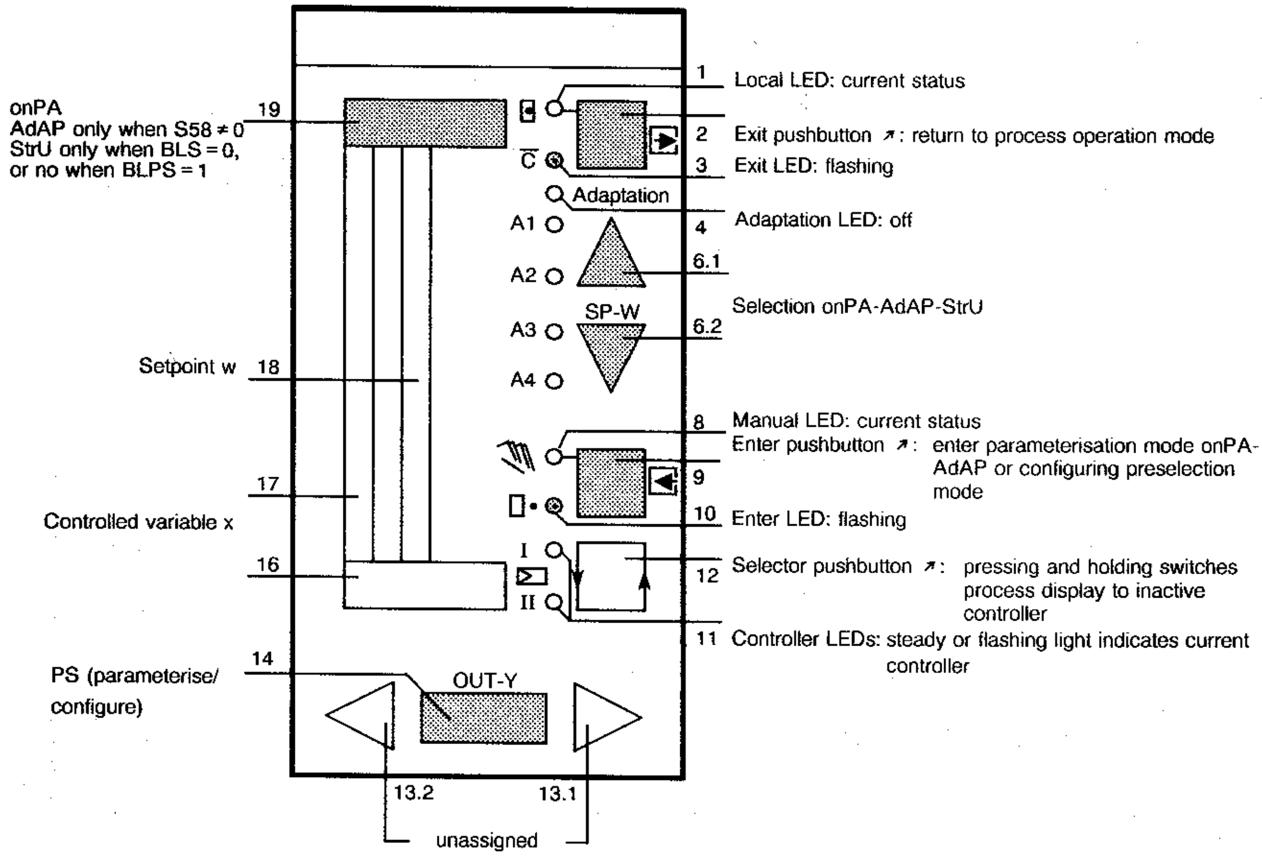


Figure 3-3 Parameterisation preselection mode controls and displays

3.2.2 Parameterisation mode onPA (on-line parameters)

In parameterisation mode onPA, only those parameters whose effect on the process has to be closely observed are defined. Remaining parameters are defined in configuring mode oFPA.

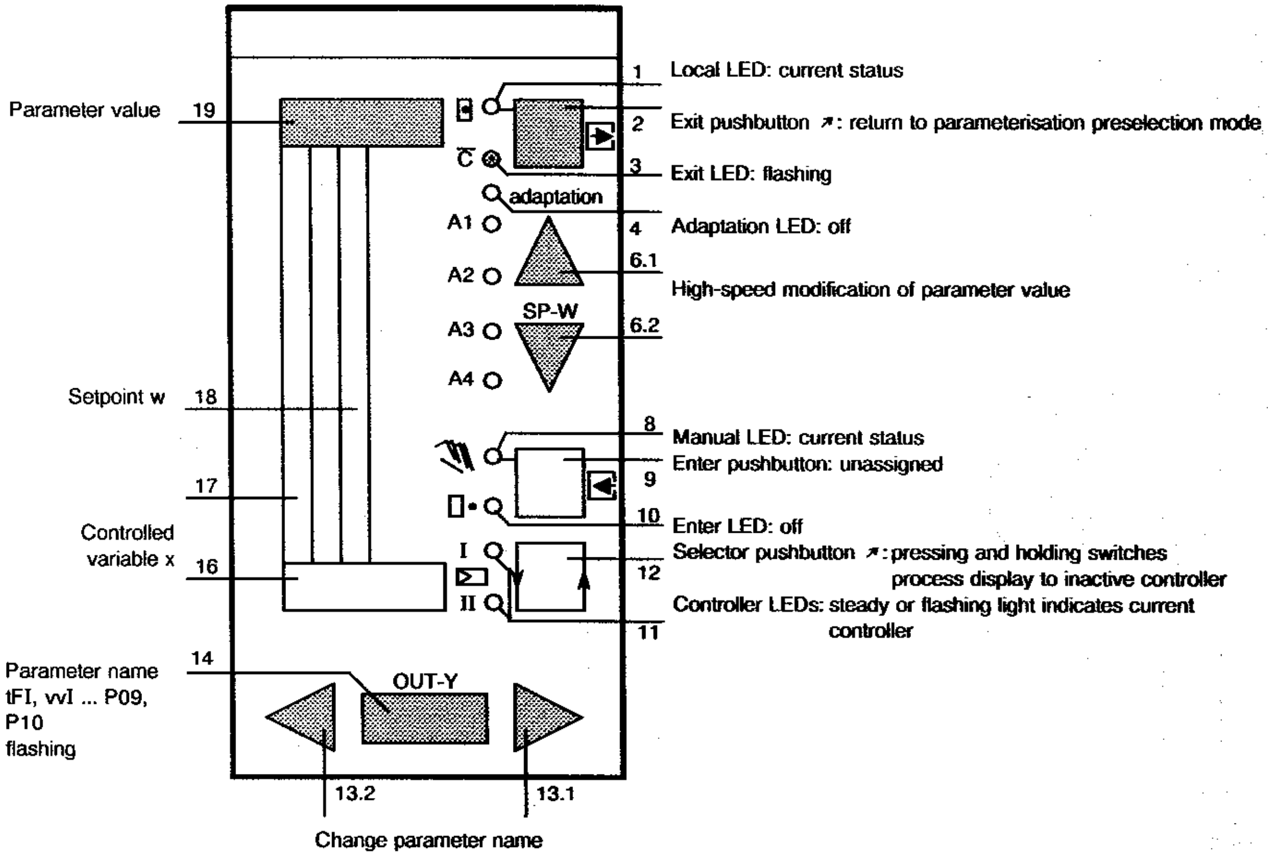


Figure 3-4 Parameterisation mode onPA controls and displays

3.1 to 3.2.3

Digital display y	x	w Range	Factory setting	Resolution	Dimension	Meaning of parameter
tFI	Controlled variable x	oFF, 1 to 1000	1	128 values per 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 gain
tnI		1.000 to 9984	9984	↓	s	Reset time
tvI		oFF, 1.000 to 2992	oFF	128 values per octave	s	Derivative action time Parameter set I
AHI		0.0 to 10.0	0.0	0.1	%	Response threshold xdI
YoI		Auto, 0.0 to 100.0	Auto	0.1	%	Working point P controller
YAI[1]		- 10.0 to 110.0	- 5.0	0.1	%	Lower limit of manipulated variable
YEI[1]		- 10.0 to 110.0	105.0	0.1	%	Upper limit of manipulated variable
tFII		oFF, 1 to 1000	1	128 values per 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 gain
tnII		1.000 to 9984	9984	↓	s	Reset time
tvII		oFF, 1.000 to 2992	oFF	128 values per octave	s	Derivative action time Parameter set II
AHII		0.0 to 10.0	0.0	0.1	%	Response threshold xdII
YoII		Auto, 0.0 to 100.0	Auto	0.1	%	Working point P controller
YAII[1]		- 10.0 to 110.0	- 5.0	0.1	%	Lower limit of manipulated variable
YEII[1]		- 10.0 to 110.0	105.0	0.1	%	Upper limit of manipulated variable
dr		0.080 to 8.000 [2]	0.80	0.080	s	Display refresh rate
tY		oFF, 1 to 1000 [4]	oFF [4]	128 values per octave	s	Positioning time
tA		20 to 600	180	20	ms	Min. positional pulse interval
tE		20 to 600	180	20	ms	Min. positional pulse length
tF1		oFF, 0.1 to 1000	1	128 values per octave	s	Filter time constants AE1
↓		↓	↓	↓	↓	↓
tF5		oFF, 0.1 to 1000	1	128 values per octave	s	Filter time constant AE5
c1		- 1.999 to 9.999	0	0.001	1	Multiplication constant
c2		- 1.999 to 9.999	0	0.001	1	Multiplication constant
c3		- 1.999 to 9.999	0	0.001	100 %	Addition constant
c4		- 1.999 to 9.999	1	0.001	1	Multiplication constant
c5		- 1.999 to 9.999	0	0.001	100 %	Addition constant
c6		- 9.99 to 9.99	0	0.01	1	Multiplication constant
P01		- 1.999 to 9.999	1	0.001	1	Switchable parameters
↓		↓	↓	↓	↓	↓ only when S4=1
P10		- 1.999 to 9.999	1	0.001	1	Switchable parameters

1) YE > YA
2) Average of cycle times

Table 3-1 onPA parameter list

3.2.3 Parameterisation mode AdAP (adaptation) [3]

This mode only appears in parameter preselection mode when S58 0 (with adaptation). The Enter function can only be used in this mode when the controller is in manual (and only when the slave controller is in local and automatic mode if adaptation is being performed on a cascade master controller (S1 = 5/6).
During adaptation, the controller is on-line to the process, albeit manually.

Adaptation of dual-loop controllers (cascade, ratio and override controllers) is always performed on the controller selected by the selector pushbutton (12) during process operation.

In dual-loop control, the remaining process displays can be switched to the inactive controller during process operation by pressing and holding the selector pushbutton (12). A steady or flashing controller I/II LED indicates which controller is currently being adapted. With override control (S1 = 7/8), a flashing controller LED indicates that the other controller would take over in automatic mode (see section 1.4.4, Table 1-16).

There are 4 different statuses in AdAP mode:

- Pre adaptation,
- During adaptation,
- Aborted adaptation,
- Post adaptation.

3) Description valid from software version -A05

4) Extension to oFF and 1 s from software version -A07 onwards

The digital displays and controls have different functions in these various states, though they all still adhere to the control and operation philosophy of the controller.

Before and after adaptation, the digital displays and controls are used to select and display parameters, in exactly the same way as the parameterisation and configuring modes onPA and oFPA (see Figure 3-6).

During adaptation, the complete process image as described in section 3.1 is displayed (see Figure 3-7).

If adaptation is aborted, an error message is flashed onto the x and w digital displays. Error messages are acknowledged by the Enter pushbutton (see Figure 3-7).

- **Pre adaptation**

The adaptation LED (4) is off, indicating that adaptation can begin. The preset parameter values (tU, dPv, dY) are displayed first. They must be adjusted according to the required step response. The old parameter values xx.o, with an indicator PI or PID, and the new parameter values xx.n, with the indicator Strt AdAP, are displayed alternately. Parameter control is active (S59 ≠ 0) if PAST is displayed instead of **.o values. Old and new parameters cannot be adjusted.

Adaptation is started by pressing the Enter button (9). This is only possible when the new parameters **.n are selected and Strt AdAP is displayed.

- **During adaptation**

The adaptation LED (4) flashes to indicate that adaptation is in progress. The process can be monitored using the displays.

- **Aborted adaptation**

The adaptation LED (4) is off, indicating that following acknowledgement of the error message, adaptation may begin. Adaptation can be aborted manually or automatically by the error monitoring subroutine.

To abort adaptation manually, press the Exit button (2). This can be done at any time, and causes the controller to revert to parameterisation preselection mode. Pressing the Exit button (2) again now switches the controller into process operation mode. The controller is in manual mode and the manual manipulated variable can be adjusted.

Automatic abortion is instigated by the error monitoring subroutine (see Table 3-2). Error messages are displayed on the digital x and w displays. Error messages are acknowledged by pressing the Enter button (9). The controller remains in parameterisation mode AdAP, tU is displayed, and the presets can be corrected if necessary. The adaptation is aborted by the signals N (DDC), Si and ±yBL. Abortion by the serial interface control signals N_{ES} (DDC), Si_{ES}, $\pm yBL_{ES}$ can be prevented by operating in local mode.

- **Post adaptation**

The adaptation LED (4) is on, indicating that adaptation is complete. The **.o (for PI or PID configurations) and the new **.n parameters (for PI.1 to 8 and PID.1 to 8 for PI and PID configurations) can now be used. The figures following PI and PID indicate which order control loop was identified. When parameter control is active (S59 ≠ 0), the old parameters **.o are displayed with PAST instead of their values.

The old and new parameters can be adjusted, though the new parameters only when parameter control is not active.

Pressing the Exit button results in transfer of the most recently selected **.o or **.n parameter s to AdAP when reverting to the parameter preselect ion mode. LED (4) is now off. These parameters remain unchanged when transferring **.o unless they have been changed manually. In the case of **.n, the old parameters are overwritten by the new. The new parameters are then deleted, ie. on re-entering AdAP mode the **.n parameters are replaced by Strt AdAP.

These transferred parameters can first be used on the process once the controller is in automatic mode. This switchover to process operation mode takes place when the Exit button (2) is pressed.

If the Exit pushbutton (2) is pressed when parameter control (**.o PAST) is active and **.n is selected, the error message no AUto is displayed (see Figure 3-5). This indicates that an automatic transfer is not possible. The **.n parameters and the control variable SG must be saved (see section 1.4.5 Adaptation).

- **Adaptation error messages**

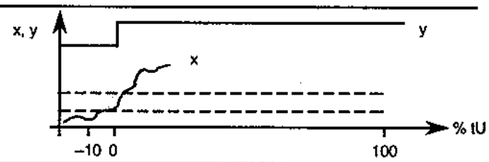
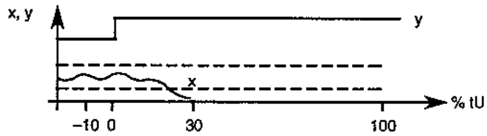
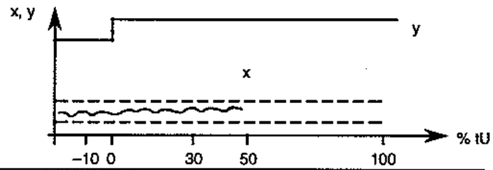
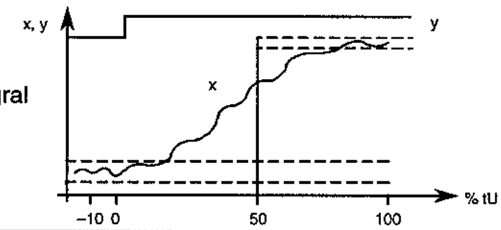
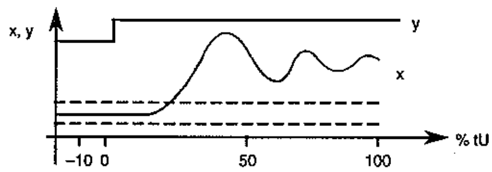
Error message digital x/w display	Explanation	
not StAt	not stable at 10 % tU from start of adaptation ⇒ wait and restart adaptation	
no dY	The y step for an S controller has still not been performed, after being initiated	⇒ Check position feedback and drive of final control element
y oFL	y outside measuring span 0 to 100 %	⇒ y_{manual} ±Δy too large or too small
ALL PASS	Step response in wrong direction within 30 % tU ⇒ Change control direction (S2) ⇒ Control loop undershoots (all-pass loop), all-pass loops not defined amongst loop models	
too SMAL	After 30 % tU, x still within starting band ⇒ tU too short ⇒ y step too small	
no End	Full-scale value still not reached at 50 % tU ⇒ tU too short ⇒ Loop cannot reach full-scale value, eg. integral action control loop ⇒ Transient recovery time t_{95} > 12 h	
PV oFL	x outside measuring span 0 to 100 %	⇒ y_{manual} ±Δy too large or too small
too FASt	system time constant too small; accurate adaptation not possible	(transient recovery time t_{95} < 5 s)
ovEr Shot	> 10 % overshoot of the transient function ⇒ Accurate adaptation not possible	
n.ddc ModE	Tracking or DDC mode using control signals	⇒
Si ModE	Safety mode using control signals	⇒ Cancel mode of operation
YbL ModE	Direction dependent blocking using control signals	⇒
HE ModE	Remote manual mode using control signals	⇒

Table 3-2 Adaptation error messages

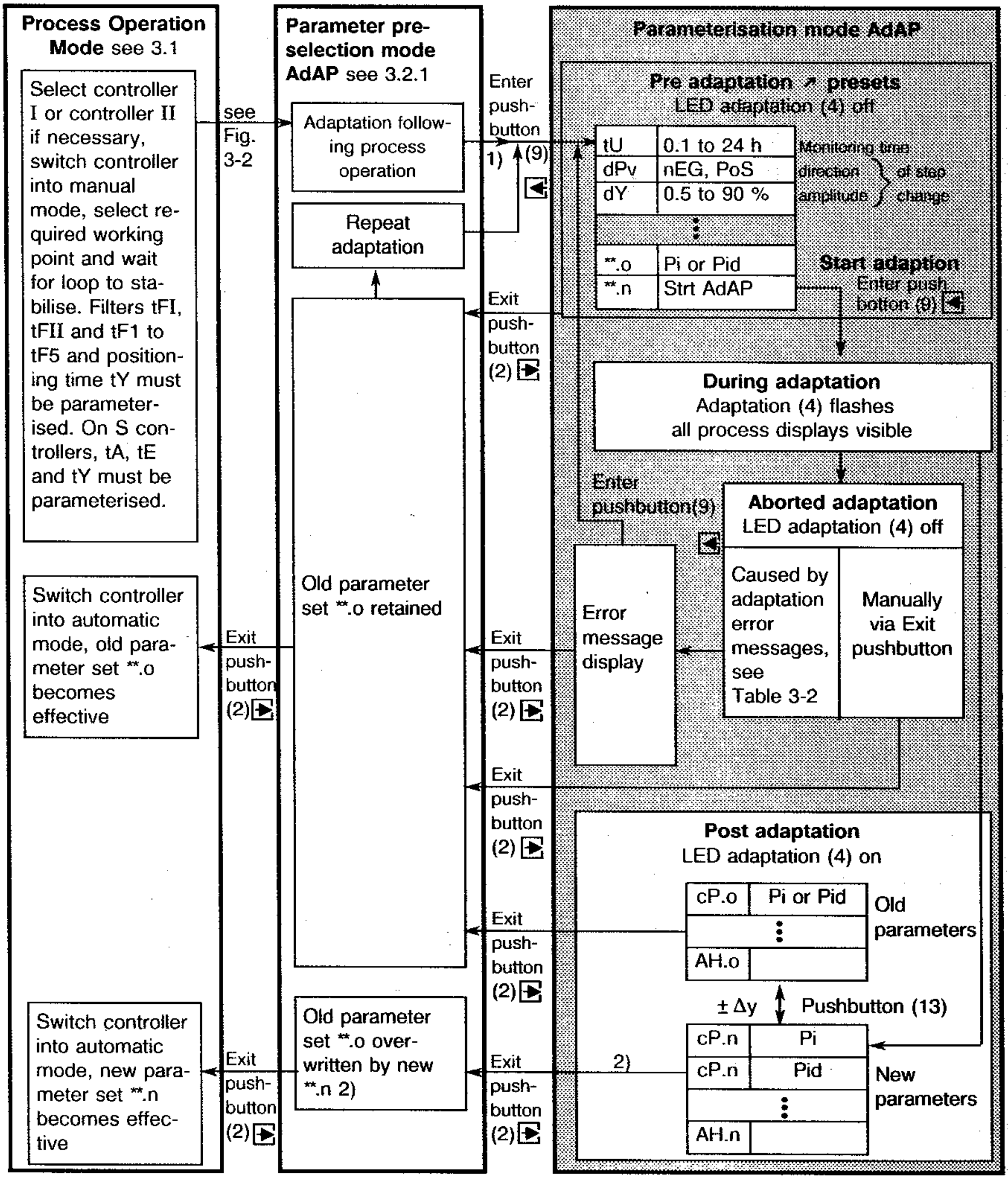


Figure 3-5 Parameterisation mode AdAP

1) Enter function only effective in manual mode (during adaptation of cascaded master controller (S1 = 5/6), slave controller in local and manual).

2) Error message no AUto
If the new parameter set is selected and parameter control is active, the flashing error message "no AUto" (no automatic transfer) will appear when the Exit pushbutton is pressed.
Press Enter: the error message is acknowledged; return to parameterisation mode AdAP; parameters derived from the adaptation can be retained.
Press Exit: enter parameter preselection mode AdAP; new parameter set **.n deleted. When using **.n, returning to parameterisation mode AdAP causes the message "Strt AdAP" to be output.

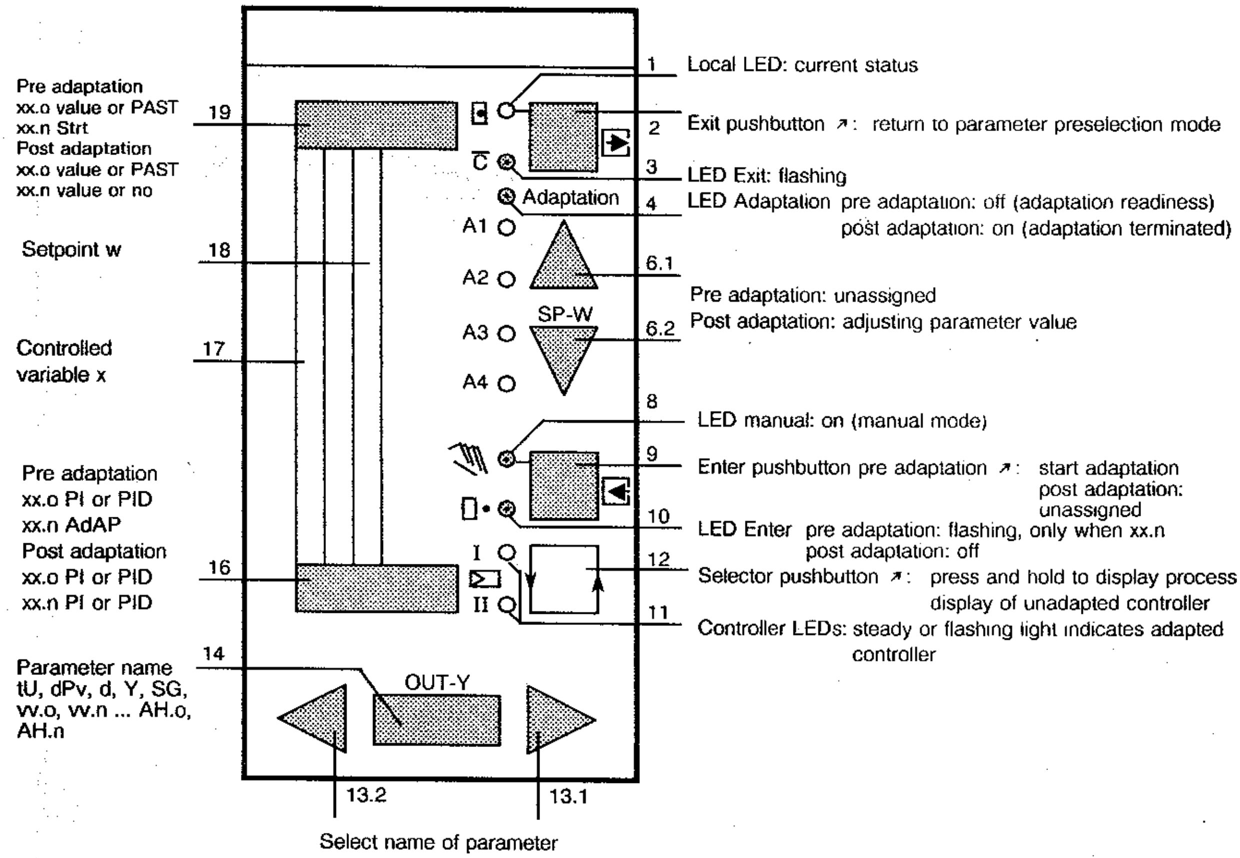


Figure 3-6 Controls and displays before and after adaptation in parameterisation mode AdAP

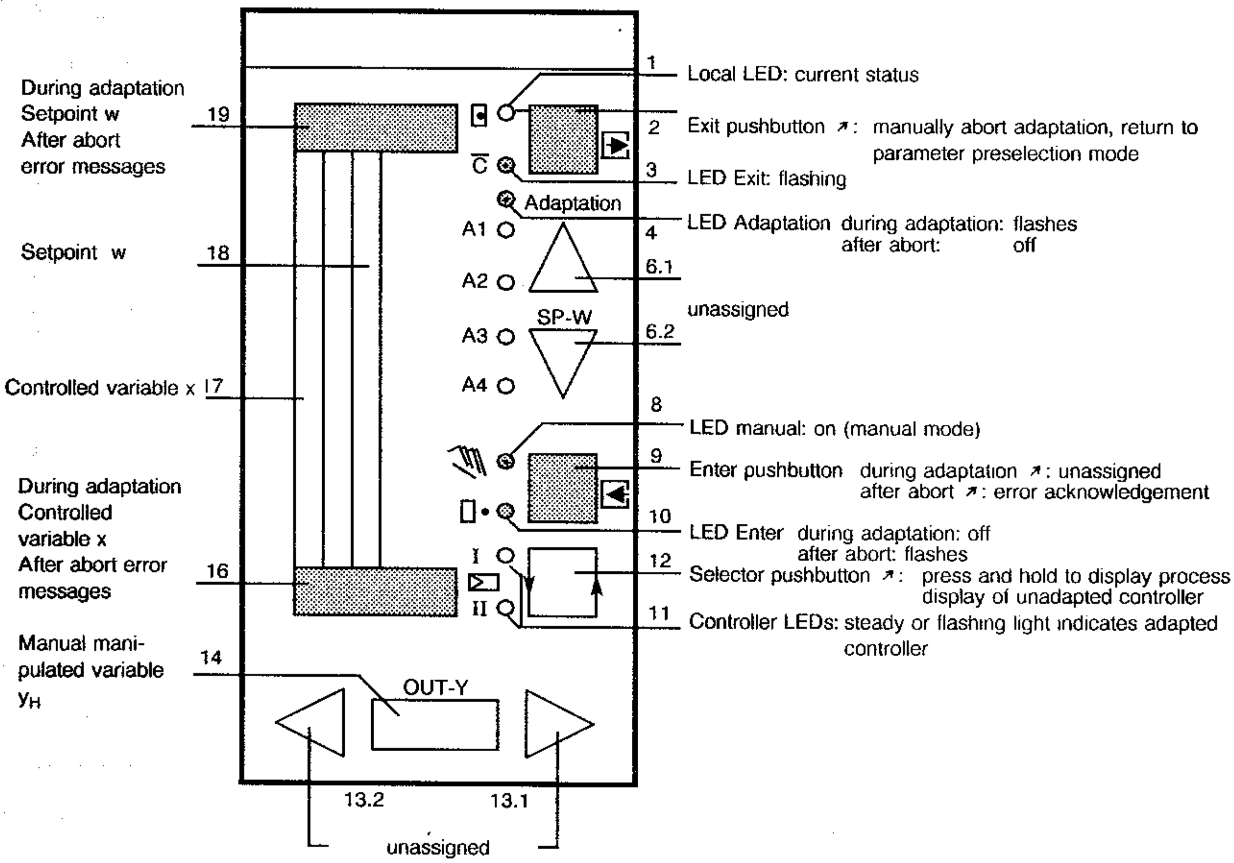


Figure 3-7 Controls and displays during adaptation and following abort in parameterisation mode AdAP

Pre adaptation

Digital display			Factory setting	Resolution	Dimen-sion	Explanation/Comments
y	W Parameterisation/ display range	X				
tU dPv dY	0.1 - 24.0 nEG, PoS 0.5 - 90.0	Controlled variable x	0.1 PoS 0.5	0.1 – 0.1	h – %	Monitoring period Direction of step — Adaptation presets Amplitude of step
vv.o	0.100 - 10.00 1) or PASt 1)	Pi or Pid	5.000	128 values per octave	1	Previous derivative action gain when: Tv = oFF Tv ≠ oFF Previous derivative action gain parameterisable
vv.n	Strt 1)	AdAP	–	–	–	Start adaptation
cP.o	0.100 - 100.0 1) or PASt 1)	Pi or Pid	0.100	128 values per octave	1	Previous proportional gain when: Tv = oFF Tv ≠ oFF Previous proportional gain parameterisable
cP.n	Strt 1)	AdAP	–	–	–	Start adaptation
tn.o	1.000 - 9984 1) or PASt 1)	Pi or Pid	9984	128 values per octave	s	Previous integral reset time when: Tv = oFF Tv ≠ oFF Previous integral reset time parameterisable
tn.n	Strt 1)	AdAP	–	–	–	Start adaptation
tv.o	oFF 1) 1.000 - 2992 1) or PASt 1)	Pi or Pid	oFF	128 values per octave	s	Previous derivative action time when: Tv = oFF Tv ≠ oFF Previous derivative action time parameterisable
tv.n	Strt 1)	AdAP	–	–	–	Start adaptation
AH.o	0.0 - 10.0 1) or PASt 1)	no indication	0.0	0.1	%	Previous response threshold Previous response threshold parameterisable
AH.n	Strt 1)	AdAP	–	–	–	Start adaptation

1) Cannot be adjusted
2) From software version -A05

Table 3-3 AdAP parameter list

Post adaptation

Digital display			Factory setting	Resolution	Dimen-sion	Parameter meaning/Comments
y	w Parameterisation/ display range	x				
SG	-0.5 - 105.0 1)	no indication	–	–	%	Variable for parameter control
vv.o	0.100 - 10.00 or PASt 1)	Pi or Pid	5.000 – –	128 values per octave	1	Previous derivative action gain when: Tv = oFF Tv ≠ oFF Previous derivative action gain parameterisable
vv.n	5.000 or no 1)	Pid Pid	–	128 values per octave	1	New derivative action gain for PID controller No PID facility
cP.o	0.100 - 100.0 or PASt 1)	Pi or Pid	0.100	128 values per octave	1	Previous proportional gain when: Tv = oFF Tv ≠ oFF Previous proportional gain parameterisable
cP.n cP.n	0.100 - 100.0 2) 0.100 - 100.0 2) or no	Pi Pid Pid	– –	128 values per octave	1 1	New proportional gain for PI controller PID controller No PID facility
tn.o	1.000 - 9984 or PASt 1)	Pi or Pid	9984	128 values per octave	s	Previous integral reset time when: Tv = oFF Tv ≠ oFF Previous integral reset time parameterisable
tn.n tn.n	1.000 - 9984 2) 1.000 - 9984 2) or no 1)	Pi Pid Pid	– –	128 values per octave	s	New integral reset time for PI controller PID controller No PID facility
tv.o	oFF 1.000 - 2992 or PASt 1)	Pi or Pid	oFF	128 values per octave	s	Previous derivative action time when: Tv = oFF Tv ≠ oFF Previous derivative action time parameterisable
tv.n tv.n	1.000 - 2992 2) or no 1)	Pid Pid	– –	128 values per octave	s	New derivative action time for PID controller No PID facility
AH.o	0.0 - 10.0 or PASt 1)	no indication	0.0	0.1	%	Previous response threshold Previous response threshold parameterisable
AH.n	0.0 - 10.0 2)	no indication	–	0.1	%	New response threshold

1) Cannot be adjusted
2) Can only be adjusted when parameter control not active

Table 3-3 (cont.) AdAP Parameter list

3.3 Configuring

Configuring preselection mode is entered by pressing the Enter pushbutton until oFPA is displayed (see Figure 3-8). The controller is then in off-line manual mode, ie. the last manipulated variable from on-line operation is retained (with K controllers, with S controllers no increment signals are output). The ±Δy pushbuttons (13) have no effect on the manipulated variable, and the control signals N(DDC), Si and ±yBL are all disabled. All analogue and digital outputs, and the Alarm LEDs A1 to A4, retain their latest values/status. The Manual LED (8) comes on, and the analogue w display contains a zebra pattern. These both indicate that the controller is now off-line. When the Exit pushbutton (2) is pressed, and the controller reverts to the parameter preselection or process operation mode, the controller will remains off-line. For reasons of safety, it can only be reactivated by switching to automatic mode in process operation mode.
During off-line operation, the analogue x display (17) continues to display the controlled variable x. The Local LED (2) indicates the current status.

The Local/Remote pushbutton (2) becomes the Exit pushbutton, and the associated $\overline{C}$ LED (3) means "Ready to Exit". When the LED flashes, pressing the Exit pushbutton causes the controller to revert to the next higher mode.

The ±Δw pushbuttons (6) are used to change the variable shown in the digital w display (see configuring modes 3.3.1 to 3.3.9).

The Automatic/Manual pushbutton (9) becomes the Enter pushbutton, and the associated y-remote LED (10) means "Ready to Enter". When the LED flashes, pressing the Enter pushbutton causes the controller to pass to the next lower mode.

The ±Δy pushbuttons are used to select the variables that are to be displayed in the digital x and y displays (see configuring modes 3.3.1 to 3.3.9).

Pressing and holding the selector pushbutton (12) in dual-loop control causes any remaining process variable displays to be switched over to the inactive controller. Any extension to the switchover cycle (S98) is suppressed. This switchover does not affect discrepancy signalling on the LEDs Controller I/Controller II. Values and statuses from the inactive controller (the controller whose LED is not on or flashing) are displayed while the selector pushbutton is held down.

Parameters with a wide range of values can be adjusted quickly in oFPA and PAST modes. Similarly, configuring switch numbers can also be changed quickly when the controller is in StrS mode:
First select the direction with one of the adjustment pushbuttons, and then start scanning by simultaneously pressing the other adjustment pushbutton.

If the control signal BLS is on, configuring is inhibited. In this case StrU is masked out during parameter preselection mode.

3.3.1 Configuring preselection mode

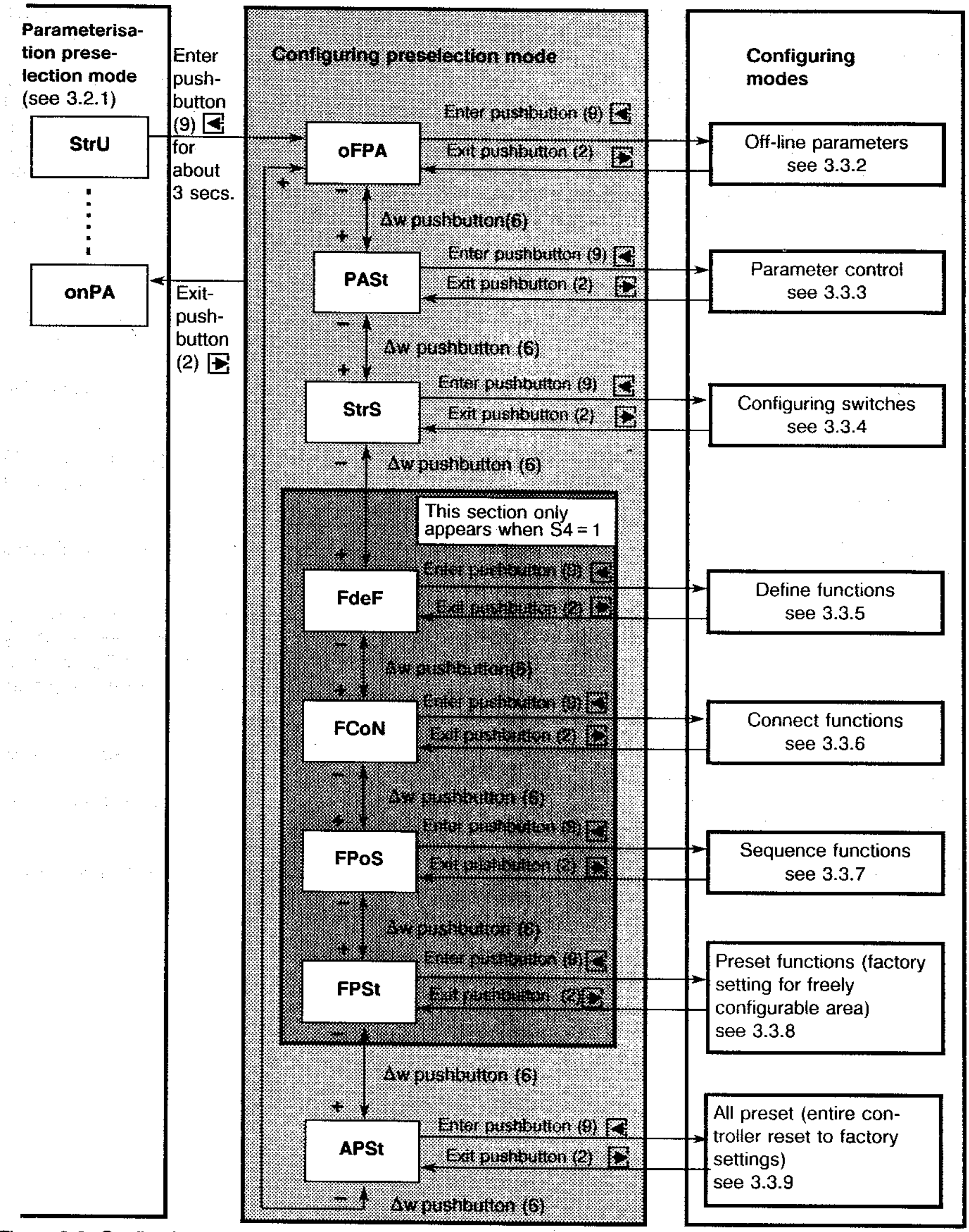


Figure 3-8 Configuring preselection mode

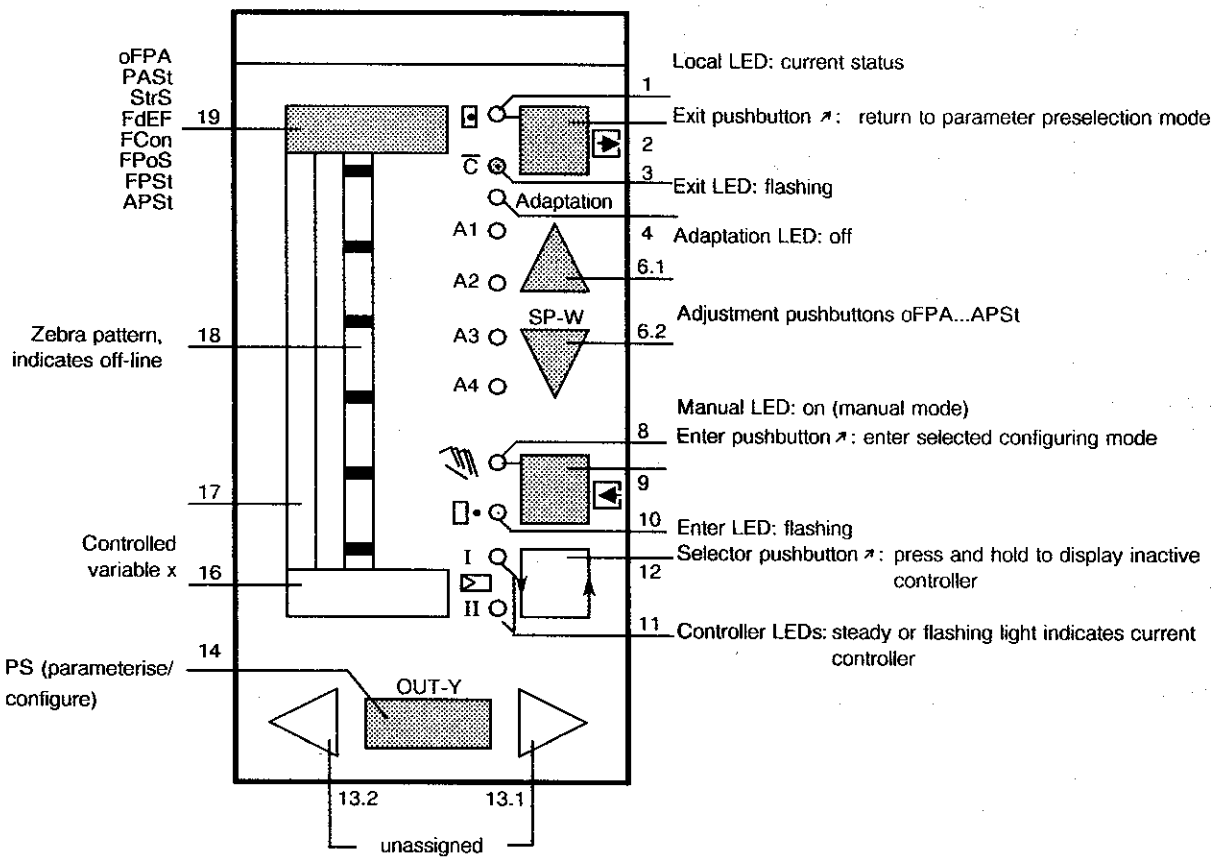


Figure 3-9 Controls and displays in configuring preselection mode

3.3 to 3.3.9

3.3.2 Configuring mode oFPA (off-line parameters)

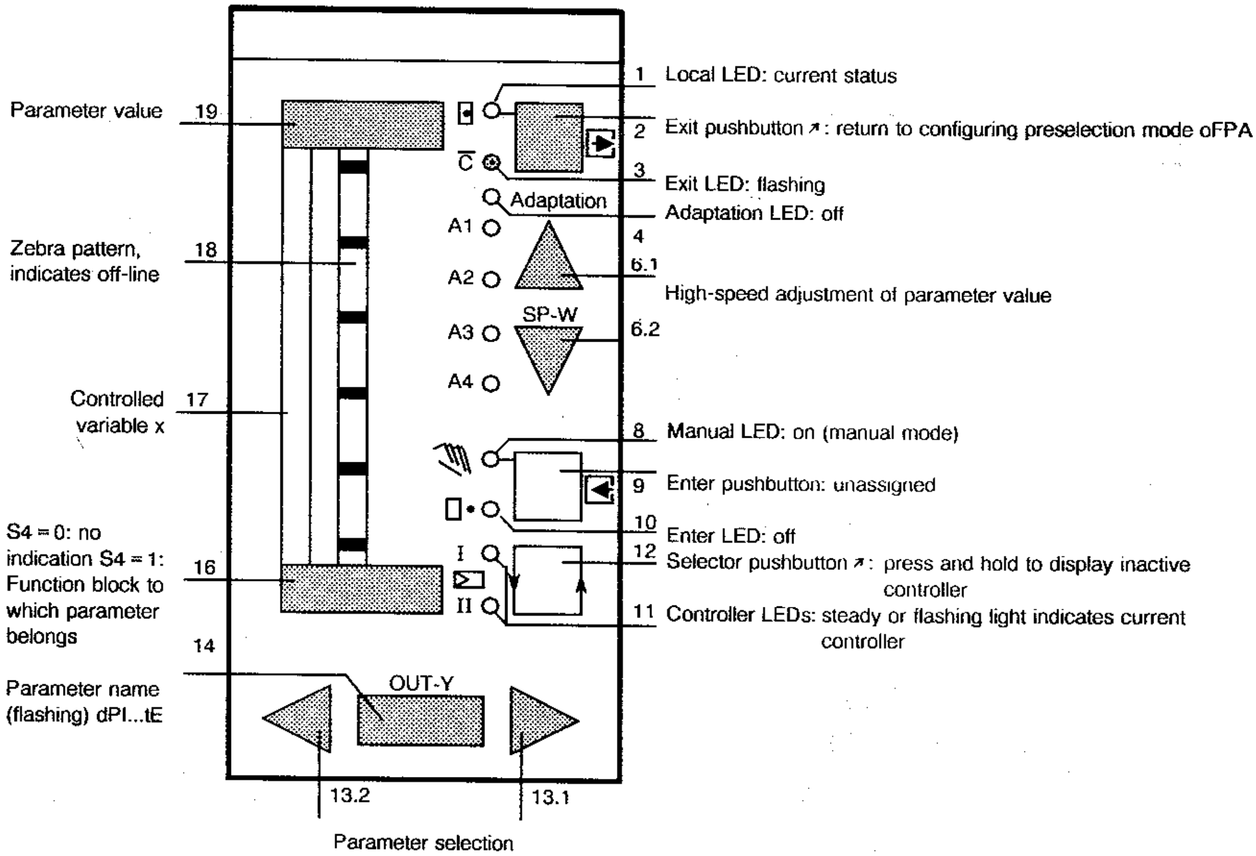


Figure 3-10 Controls and displays in configuring mode oFPA

S1	S94, S95	Assigned to	A1 to A4	Parameter range relative to dE* – dA* = 100 %	Resolution
≠4 ≠6	0 1 2	xdI xI wI	d*I d*I d*I	maximum –110 % to +110 %	1 digit
4 and 6	0 1 2	xdI xI wI	% % %	–110 % to +110 %	0.1 %
	3 4	xv wv	d*I d*I	maximum –110 % to +110 %	1 digit
5 to 9	5 6 7	xdII xII wII	d*II d*II d*II	maximum –110 % to 110 %	1 digit
0 to 9	8 ↓ 22	y ↓ xds	%	–110 % to +110 %	0.1 %

Table 3-4 Parameter range and resolution of alarm signals A1 to A4

Digital display y	x	w Parameter range	Factory setting	Resolution	Dimension	Parameter meaning
dPI	No indication	-.--- to ----	---.-	-	-	Decimal point display I
dAI		- 1999 to 9999	0000	1 digit	-	Start-of-scale } Display range display I
dEI		- 1999 to 9999	1000	1 digit	-	Full-scale } Display range display I
dPII		-.--- to ----	---.-	-	-	Decimal point display II
dAII		- 1999 to 9999	0000	1 digit	-	Start-of-scale } Display range display II
dEII		- 1999 to 9999	1000	1 digit	-	Full-scale } Display range display II
A1		- 110 to +110 %	5.0	1 digit/0.1%	-	Alarm 1
A2 1)		relative to	- 5.0		-	Alarm 2
A3		dE*-dA*	5.0		-	Alarm 3
A4 2)		see Table 3-4	- 5.0		-	Alarm 4
H1.2		0.1 to 10.0	1	0.1	%	Hysteresis alarms A1 and A2
H3.4		0.1 to 10.0	1	0.1	%	Hysteresis alarms A3 and A4
SA		- 10 to +110 %	- 5.0	1 digit/0.1%	-	Lower setpoint limit
SE 3)		relative to	105.0		-	Upper setpoint limit
SH		dE*-dA*	0.0		-	Safety setpoint
Sb		see Table 3-6	0.0		-	Limiting 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	Lower ratio factor
vE 4)		0.000 to 9.999	1.000	0.001	1	Upper ratio factor
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 } in split range
Y2 5)		0.0 to 100.0	50.0	0.1	%	Range y1/y2 } in split range
-1.1			- 10.0		-	Lineariser FE1 vertex at - 10 %
0.1			0.0		-	Lineariser FE1 vertex at 0 %
1.1		- 10 to 110 %	10.0	1 digit	-	Lineariser FE1 vertex at 10 %
↓		relative to	↓			↓
11.1		dE*-dA*	110.0	or	-	Lineariser FE1 vertex at 110 % (only if
-1.3		or	- 10.0		-	Lineariser FE3 vertex at - 10 % S4=0)
0.3		-199.9 to 199.9 %	0.0	0.1 %	-	Lineariser FE3 vertex at 0 %
1.3		see Table 3-6	10.0		-	Lineariser FE3 vertex at 10 %
↓			↓			↓
11.3			110.0		-	Lineariser FE3 vertex at 110 %
-10	FU1	- 199.9 to 199.9	- 10	0.1	%	Lineariser 1 vertex at - 10 %
0	FU1	- 199.9 to 199.9	0	0.1	%	Lineariser 1 vertex at 0 %
10	FU1	- 199.9 to 199.9	10	0.1	%	Lineariser 1 vertex at 10 %
↓	↓	↓	↓	↓	↓	↓
110	FU1	- 199.9 to 199.9	110	0.1	%	Lineariser 1 vertex at 110 %
-10	FU2	- 199.9 to 199.9	- 10	0.1	%	Lineariser 2 vertex at - 10 %
0	FU2	- 199.9 to 199.9	0	0.1	%	Lineariser 2 vertex at 0 % (only if
10	FU2	- 199.9 to 199.9	10	0.1	%	Lineariser 2 vertex at 10 % S4=1)
↓	↓	↓	↓	↓	↓	↓
110	FU2	- 199.9 to 199.9	110	0.1	%	Lineariser 2 vertex at 110 %
						Correction computer
PA	rE	0.010 to 1.000	1	0.001	1	Lower pressure correction quotient
PE	rE	1.000 to 99.99	1	0.001/0.01	1	Upper pressure correction quotient
tA	rE	0.010 to 1.000	1	0.001	1	Lower temperature correction quotient
tE	rE	1.000 to 99.99	1	0.001/0.01	1	Upper temperature correction quotient

1) A1 ≥ A2 2) A3 ≥ A4 3) SE ≥ SA 4) vE ≥ vA 5) Y1 ≥ Y2

Table 3-5 oFPA Parameter List

S1	–1.1 to 11.1	–1.3 to 11.3	SA, SE, SH	Sb	Parameter range relative 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 to 110 %	1 digit

Table 3-6 Range and resolution of display format parameters

3.3.3 Configuring mode PASt (parameter control)

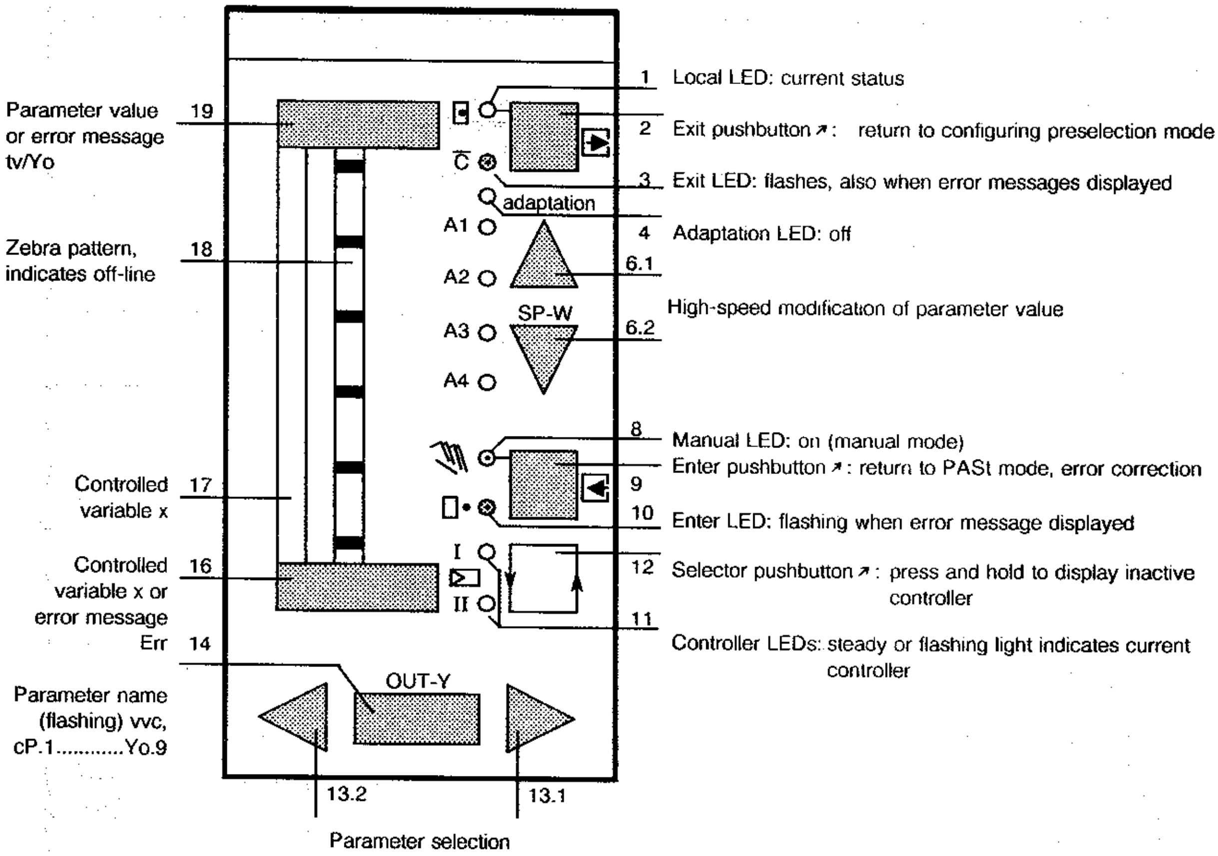


Figure 3-11 Controls and displays in configuring mode PASt

Digital display y	Digital display x	Digital display w Parameter range	Factory setting	Resolution	Dimension	Parameter meaning
vvc	Controlled variable x	0.100 - 10.00	5	128 value per oktave	1	Derivative action gain
cP1		0.1 - 100	0.1	128 value per oktave	1	Proportional gain when SG = 10 %
cP3			0.1		1	Proportional gain when SG = 30 %
cP5			0.1		1	Proportional gain when SG = 50 %
cP7			0.1		1	Proportional gain when SG = 70 %
cP9			0.1		1	Proportional gain when SG = 90 %
tn1		1 - 9984	9984	128 value per oktave	s	Integral reset time when SG = 10 %
tn3			9984		s	Integral reset time when SG = 30 %
tn5			9984		s	Integral reset time when SG = 50 %
tn7			9984		s	Integral reset time when SG = 70 %
tn9			9984		s	Integral reset time when SG = 90 %
tv1		oFF,1 - 2992	oFF	128 value per oktave	s	Derivative action time when SG = 10 %
tv3			oFF		s	Derivative action time when SG = 30 %
tv5			oFF		s	Derivative action time when SG = 50 %
tv7			oFF		s	Derivative action time when SG = 70 %
tv9			oFF		s	Derivative action time when SG = 90 %
AH1		0.0 - 10.0	0.0	0.1	%R	Response threshold when SG = 10 %
AH3			0.0		%	Response threshold when SG = 30 %
AH5			0.0		%	Response threshold when SG = 50 %
AH7			0.0		%	Response threshold when SG = 70 %
AH9			0.0		%	Response threshold when SG = 90 %
Y01		Auto, 0.0 - 100.0	0.0	0.1	%	Working point P-reg. when SG = 10 %
Y03			0.0		%	Working point P-reg. when SG = 30 %
Y05			0.0		%	Working point P-reg. when SG = 50 %
Y07			0.0		%	Working point P-reg. when SG = 70 %
Y09			0.0		%	Working point P-reg. when SG = 90 %

SG: Variable for parameter control

Table 3-7 PASt Parameter Table

- **Error messages:**

– tv Err:

The parameters tv.1 to tv.9 must be either all = off or all off, otherwise the error message tv Err will be displayed when the controller attempts to revert to configuring preselection mode after the Exit pushbutton is pressed.

Press the Enter pushbutton:

The controller reverts to PASt mode and displays parameter tv.1. The error can now be corrected.

Press the Exit pushbutton:

The error message is acknowledged. The controller reverts to configuring preselection mode and parameters tv.1 to tv.5 are automatically set to oFF.

– Yo Err:

The parameters Yo.1 to Yo.9 must be either all = AUto or all AUto, otherwise the error message Yo Err will be displayed when the controller attempts to revert to configuring preselection mode after the Exit pushbutton is pressed.

Press the Exit pushbutton:

The controller reverts to PASt mode and displays parameter yo.1. The error can now be corrected.

Press the Exit pushbutton:

The error message is acknowledged. The controller reverts to configuring preselection modeand parameters Yo.1 to Yo.2 are automatically set to AUto.

3.3.4 Configuring mode StrS (configuring switches)

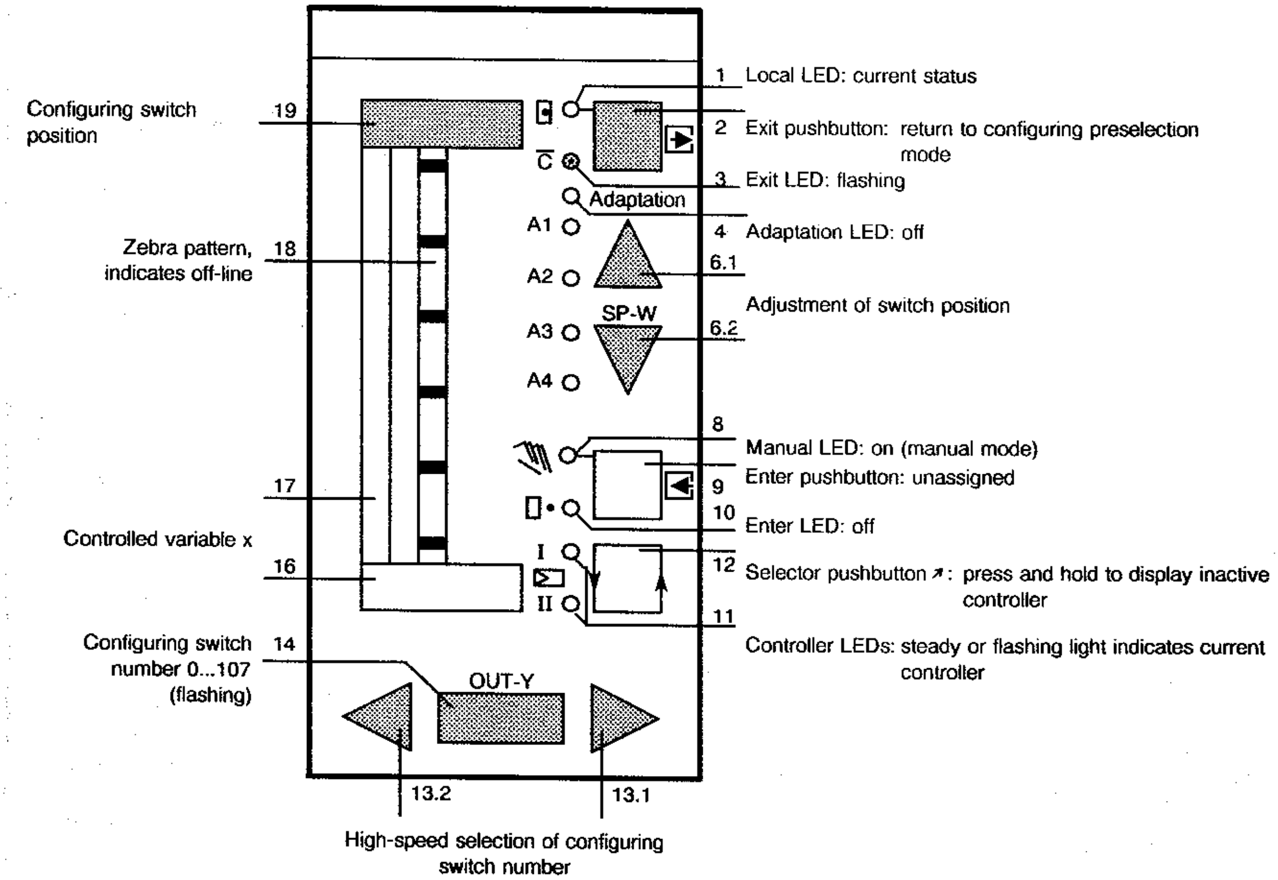


Figure 3-12 Controls and displays in configuring mode StrS

	Configuring switch	Switch position	Function
Basic settings	S0	0 1) (shaded) 1 254	**User program memory** Indicates factory setting (APSt) Number of different user program ″
	S1	0 (shaded) 1 2 3 4 5 6 7 8 9 10 2) 11 2)	**Controller type** Fixed setpoint controller 2 independent setpoints Fixed setpoint controller 2 dependent setpoints DDC fixed setpoint controller Slave, synchronisation, SPC controller with Int/Ext switchover Ratio controller Cascade control Cascaded ratio control Override control max. limit y Override control min. limit y Process variable indicator Fixed setpoint controller with 1 setpoint (control system interface) Slave controller without Int/Ext switchover (control system interface)
	S2	0 (shaded) 1 2	**Output configuration** K output S output internal position feedback S output external position feedback
	S3	0 (shaded) 1	**Mains frequency suppression** 50 Hz 60 Hz
	S4	0 (shaded) 1	**Connection of input area** Standard Freely configurable
Analogue inputs	S5	0 (shaded) 1 2 3	**Input signal AE1** 0 . . . 20 mA no 0 . . . 20 mA with 4 . . . 20 mA no 4 . . . 20 mA with } Transmitter monitoring MUF
	S6	0 (shaded) 1 2 3	**Input signal AE2** 0 . . . 20 mA no 0 . . . 20 mA with 4 . . . 20 mA no 4 . . . 20 mA with } Transmitter monitoring MUF
	S7	0 (shaded) 1 2 3	**Input signal AE3** 0 . . . 20 mA no 0 . . . 20 mA with 4 . . . 20 mA no 4 . . . 20 mA with } Transmitter monitoring MUF
	S8	0 (shaded) 1 2 3	**Input signal AE4** 0 . . . 20 mA or U,R,P,T no MUF 0 . . . 20 mA or U,R,P,T with MUF 4 . . . 20 mA no MUF 4 . . . 20 mA with MUF
	S9	0 (shaded) 1 2 3	**Input signal AE5** 0 . . . 20 mA or U,R,P,T no MUF 0 . . . 20 mA or U,R,P,T with MUF 4 . . . 20 mA no MUF 4 . . . 20 mA with MUF
	S10	0 (shaded) 1	**Extract square root of AE1** No Yes
	S11	0 (shaded) 1	**Extract square root of AE2** No Yes

Table 3-8 Configuring switches

	Configuring switch	Switch position	Function
Analogue inputs	S12	0 (shaded) 1	**Extract square root of AE3** No Yes
	S13	0 (shaded) 1	**Extract square root of AE4** No Yes
	S14	0 (shaded) 1	**Extract square root of AE5** No Yes
Analogue input (only when S4 = 0)	S15	0 1 (shaded) 4 5	**Assignment FE1 to AE1 to AE5** 0 % AE1A AE4A AE5A
	S16	0 2 (shaded) 4 5	**Assignment FE2 to AE2 to AE5** 0 % AE2A AE4A AE5A
	S17	0 3 (shaded) 4 5	**Assignment FE3 to AE3 to AE5** 0 % AE3A AE4A AE5A
	S18	0 (shaded) 1 2 3 4	**Assignment FE4 to AE1 to AE5** 0 % AE1A AE2A AE3A AE4A
	S19	0 (shaded) 1 2 3 5	**Assignment FE5/6 to AE1 to AE5** 0 % AE1A AE2A AE3A AE5A
	S20	0 (shaded) 1	**Linearisation FE1** No Yes
	S21	0 (shaded) 1	**Linearisation FE3** No Yes
Configuration of slots 5 and 6	S22	0 (shaded) 1 2 3	**Slot 5 configuration** Nothing inserted 4 BA / 1 BE (BA9 to BA12) 5 BE (BE5 to BE9) 2 Relay (BA9, BA10)
	S23	0 (shaded) 1 2 3 4	**Slot 6 configuration** Nothing inserted 4 BA / 1 BE (BA13 to BA16) 5 BE (BE10 to BE14) 2 Relay (BA13, BA14) y-hold (AA4)

Position 0 cannot be selected manually

1) Whenever a factory setting is changed (parameter or configuring switch), S0 automatically flips from 0 to 1. APSt resets S0 to 0, FPSt has no effect.

(shaded) Factory setting

2) From software version -B05

3.3 to 3.3.9

Digital Inputs

Assignment of control signals to digital inputs

S24 CB	S25 He	S26 N	S27 Si	S28 BLS	S29 BLPS	S30 P I	S31 P II	S32 PAU	S33 +dw	S34 -dw	S35 +dy	S36 -dy	S37 +yBl	S38 -yBL	Assignment	
-1	-	-	-	-	-	-1	-1	-	-	-	-	-	-	-	High	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Low	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	BE1	
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	BE2	Main
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	BE3	board
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	BE4	
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	BE5	
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	BE6	
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	BE7	Slot 5
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	BE8	
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	BE9	
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	BE10	
11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	BE11	
12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	BE12	Slot 6
13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	BE13	
14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	BE14	

Digital input logic for each control signal

S39 CB	S40 He	S41 N	S42 Si	S43 P I / P II	S44 +dw/-dw	S45 +dy/-dy	S46 +yBl/-yBL	Logic
0	0	0	0	0	0	0	0	24 V = High
1	1	1	1	1	1	1	1	0 V = High

BE logic for BLS, BLPS and PAU corresponds to that indicated by position "0".

Configuring switch		Switch position	Function
Digital inputs	S47		**Control signal CB**
		0	Static no acknowledgement
		1	Static with acknowledgement
		2	Flip-flop
	S48		**Control signal N (track)**
		0	Static
		1	Flip-flop

Factory settings

Table 3-8 Configuring switches (continuation)

Configuring switch		Switch position	Function
Setpoint control	S49		**Block local/remote switchover**
		0	Local only
		1	Remote only
		2	Not blocked
	S50		**x-tracking with H+N(DDC)+Si**
		0	No
		1	Yes
	S51		**Setpoint following loss of CB**
		0	Last wi (last w if S52=0)
		1	Setpoint SH
	S52		**Track wi to working setpoint**
		0	Yes
		1	No
	S53		**Source of remote setpoint**
		0	Absolute value WEA
		1	Incremental setpoint WEΔ

Configuring switch		Switch position	Function	
Control algorithm	S54		**Direction of action controller I relative to xdI**	
		0	Normal (cP > 0)	
		1	Reversed (cP < 0)	
	S55		**Feedforward control of z and D element controller I**	
			D element	z
		0	xdI	y
		1	xI	y
		2	z direction against x	D element
		3	z direction with x	D element
	S56		**Direction of action controller II relative to xdII**	
		0	Normal (cP > 0)	
		1	Reversed (cP < 0)	
	S57		**Feedforward control of D element controller II**	
		0	xdII	
		1	xII	
	S58		**Type of adaptation**	
		0	Adaptation not possible	
		1	Controlled variable with no overshoot	
		2	Controlled variable with periodic overshoot after an otimum value	
	S59		**Parameter control**	
		0	None	
		1	Controller I (instead of parameter set I)	
		2	Controller II (instead of parameter set	

Configuring switch		Switch position	Function	
Control algorithm	S60		**Assignment of parameter control variable SG/SG control variable**	**SG display in AdAP [%]**
		0	10|xdI| if S59=1 or 10|xdII| if S59=2	----
		1	xI if S59=1 xII if S59=2	xI / xII
		2	wI if S59=1 wII if 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 % for Pi(D) and 30 % for P (D)	----

(shaded) Factory settings

Table 3-8 Configuring switches (continuation)

3.3 to 3.3.9

Configuring switch		Switch position	Function
Output switchover	S61		**Priority N(DDC) or H**
		0	N (DDC)
		1	H
	S62		**Source of remote manipulated variable**
		0	Value YN
		1	Incremental variable YNΔ
	S63		**Manual mode following transmitter failure**
		0	No switchover (only error message)
		1	Manual mode using last y
		2	Manual mode using ys
	S64		**Manual/automatic switchover via** Man.buttonHi / Control sig. He / Block He_{FS}
		0	yes / yes/static / with
		1	no / yes/static / with
		2	No switchover to manual
		3[1]	yes / yes/dynamic / with
		4[1]	yes / yes/dynamic / without
	S65		**Split range function (K controllers only)**
		0	Y1 rising, Y2 falling
		1	Y1 rising, Y2 rising
	S66		**Disable Iy in DDC mode** (K controllers only)
		0	no
		1	yes

[1] From software version -B05

Configuring switch		Switch position	Function	
Y-display	S67		**Manipulated variable display**	
		0	Controller signal y	
		1	Split range signal y1, y2	
		2	Position feedback y_R	
		oFF	No indication	
	S68		**Manipulated variable display logic**	
		0	Normal: yAn=y	
		1	Reversed: yAn=100 % - y	
Analogue outputs	S69		**Output signal AA1**	Standard unit
		0	0 to 20 mA	
		1	4 to 20 mA	
	S70		**Output signal AA2**	
		0	0 to 20 mA	
		1	4 to 20 mA	
	S71		**Output signal AA3**	
		0	0 to 20 mA	
		1	4 to 20 mA	
	S72		**Output signal AA4** (permanently assigned to y)	Slot 6
		0	0 to 20 mA	
		1	4 to 20 mA	

Assignment of analogue 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 % + xdI
16	16	16	50 % - xdI
17	17	17	xI
18	18	18	wI
19	19	19	xv
20	20	20	wv
21	21	21	50 % + xdII
22	22	22	50 % - xdII
23	23	23	xII
24	24	24	wII
25	25	25	50 % + xdS
26	26	26	50 % - xdS

Tabelle 3-8 Strukturschaltertabellen (Fortsetzung)

Digital Outputs

Assignment of digital signals to digital outputs

S76 RB	S77 RC	S78 H	S79 N	S80 A1	S81 A2	S82 A3	S83 A4	S84 MUF	S85 Int I	Assigned to
0	0	0	0	0	0	0	0	0	0	None
1	1	1	1	1	1	1	1	1	1	BA1 Main board
2	2	2	2	2	2	2	2	2	2	BA2
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(K controllers only)
8	8	8	8	8	8	8	8	8	8	BA8(K controllers only)
9	9	9	9	9	9	9	9	9	9	BA9 Slot 5
10	10	10	10	10	10	10	10	10	10	BA10
11	11	11	11	11	11	11	11	11	11	BA11
12	12	12	12	12	12	12	12	12	12	BA12
13	13	13	13	13	13	13	13	13	13	BA13 Slot 6
14	14	14	14	14	14	14	14	14	14	BA14
15	15	15	15	15	15	15	15	15	15	BA15
16	16	16	16	16	16	16	16	16	16	BA16

Note: Duplicate assignments create an "OR" function.
Unassigned BAs can be activated via the SES.
Outputs +dy and -dy are permanently assigned to BA7/BA8 in configured S controllers.

Digital Output Logic

S86 RB	S87 RC	S88 H	S89 N	S90 A1 / A2	S91 A3 / A4	S92 MUF	S93 Int I	logic
0	0	0	0	0	0	0	0	24 V = High
1	1	1	1	1	1	1	1	0 V = High

Note: S controller outputs +dy and -dy are always high when active.

Factory setting (shaded)

Table 3-8 Configuring switches (continuation)

3.3 to 3.3.9

Assignment of limit monitor inputs to controller signals

S94 limit monitors A1, A2
S95 limit monitors A3, A4

S94	S95	Limit monitor 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

Configuring switch		Switch position	Function	
Limit monitor	S96		**Function of limit monitors A1, A2**	
		0	A1 max / A2 min	
		1	A1 min / A2 min	
		2	A1 max / A2 max	
	S97		**Function of limit monitors A3, A4**	
		0	A3 max / A4 min	
		1	A3 min / A4 min	
		2	A3 max / A4 max	
	S98		**Parameterisation and display of limit values A1 to A4**	
			Display in process operation mode	Parameterise in process operation mode
		0	No	No
		1	Yes	No
		2	Yes	Yes
Restart conditions	S99		**Restart conditions following power failure and manual reset**	
		0	Previous mode, last w, last y	
		1	Manual and local mode, last w, Ys for K Controllers, last y for S controllers	
	S100		**Visual signal following power restoration or reset**	
		0	No } digital x display flashes	
		1	Yes } digital x display flashes	

Configuring switch		Switch position	Function
Serial Interface	S101		**Data transmission** (see below)
	S102		**Data transmission rate**
		0	9600 Baud
		1	4800 Baud
		2	2400 Baud
		3	1200 Baud
		4	600 Baud
		5	300 Baud
	S103		**Vertical parity**
		0	Even
		1	Odd
	S104		**Longitudinal parity**
		0	None
		1	After ETX
		2	Before ETX
	S105		**Longitudinal parity**
		0	normal
		1	Inverted
	S106		**Station number**
		0	0
		1	1
		.	.
		.	.
		31	31
	S107		**Watch-dog CBES**
		0	none
		1	1 s
		2	2 s
		.	.
		.	.
		25	25 s

S101 – Data transmission:

Switch position	Received by DR21	Control signal CB_{BE}/CB_{ES}	source for w_E	source for y_N
0	Nothing	Only CB_{BE}	w_{EA} or $w_{E\Delta}$	y_N or $y_{N\Delta}$
1	Configuring			
2	Configuring	$CB_{BE} \vee CB_{ES}$	w_{ES}	y_{ES}
3	Proc. variables	$CB_{BE} \wedge CB_{ES}$		
4[1]	Status register	$CB_{BE} \vee CB_{ES}$	w_{EA} or $w_{E\Delta}$	y_N or $y_{N\Delta}$
5[1]		$CB_{BE} \wedge CB_{ES}$		

[1] From software version B05

Factory setting

Table 3-8 Configuring switches (continuation)

3.3.5 Configuring mode FdEF (define functions)

FdEF mode is only accessible when S4 = 1. It is used to define the functions in the freely configurable input area that are to be used by the application program.

Functions are defined or suppressed by responding YES and no respectively. The factory setting for every function is no. Only functions that have been defined will subsequently appear in FCon (connect) and FPos (sequence) modes.

The functions are listed in alphabetical order and displayed sequentially as prompts. Reply YES or no to each prompt.

Digital display	
x (Prompt)	w (Response)
Ar1.F Ar2.F Ar3.F Ar4.F Ar5.F Ar6.F Fu1.F Fu2.F MA1.F MA2.F MA3.F Mi1.F Mi2.F Mi3.F rE1.F	YES or no

Table 3-9 Prompt/Response cycle in configuring mode FdEF

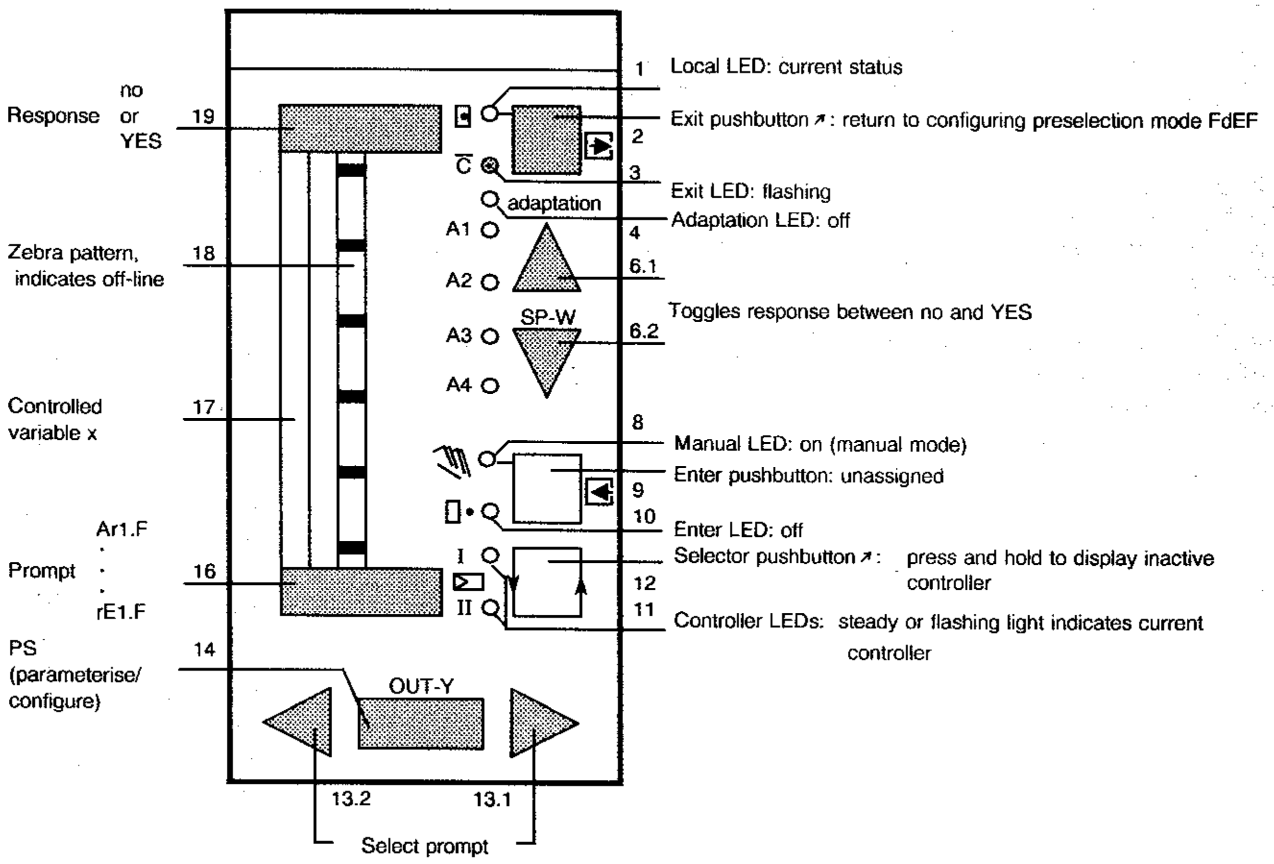


Figure 3-13 Controls and displays in configuring mode FdEF

3.3 to 3.3.9

3.3.6 Configuring mode FCon (connect functions)

FCon mode also only appears when S4 = 1. The functions previously defined in FdEF mode are connected ("softwired") with each other and the inputs (AE1A to AE5A) and outputs (FE1 to FE6) in the freely configurable input area. Connections are made by using the digital x and w displays to establish pairings between data sources and sinks. The data sink is displayed first, as a prompt, and the associated data source entered in response. The connection is established once the next data sink is displayed or when the controller reverts to configuring preselection mode.

Data sinks can be inputs to functions and outputs from the freely configurable input area. Sources are outputs from functions and inputs to the freely configurable area. Both are stored in alphabetical order, undefined (no) functions being masked out. Each data sink can only be connected to one source, whereas a source can be connected to many different sinks. Sinks can be connected in parallel by assigning them to their own sources. The default input values for the various functions (ncon or value) are also adopted by FCon, but may be overwritten if required.

Digital display	
x (Prompt) Data sink	w (Response) Data source
Ar1.1	ncon
↓	AE1A
Ar1.5	↓
↓	AE5A
Ar6.1	Ar1.6
↓	↓
Ar6.5	Ar6.6
FE 1	Fu1.2
↓	Fu2.2
FE 6	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	P10
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
	1.050

Table 3-10
Prompt/Response cycle in configuring mode FCon

- **FdEF amendments following FCon**

It may happen that functions originally selected with YES in FdEF mode, and then connected in FCon, are later amended in FdEF to no. Should this happen, the connections specified in FCon are deleted. Inputs (data sinks) that were connected to outputs of the deleted function are flagged ncon (not connected).

- **Error message ncon Err**

It will not be possible to terminate the connection procedure if any data sinks are still flagged ncon, as functions will not execute if any of their inputs remain undefined.

If, in this case, an attempt is made to quit configuring preselection mode by pressing the Exit pushbutton, the flashing error message ncon Err is displayed. The controller remains in configuring preselection mode. The error must be corrected.

Press the Enter pushbutton to acknowledge the error. The controller then reverts to FCon mode and displays the first data sink still flagged ncon. The error can now be corrected.

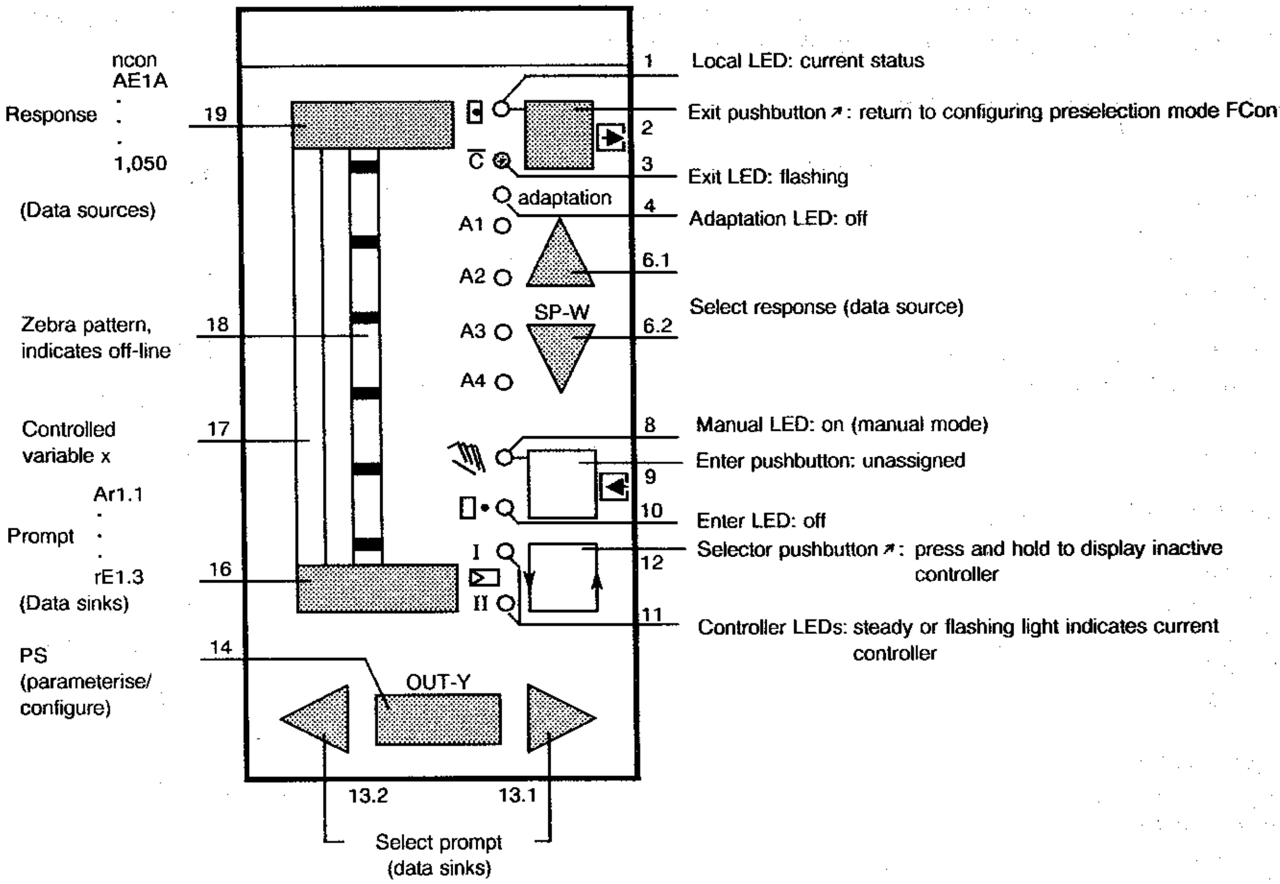


Figure 3-14 Controls and displays in configuring mode FCon

3.3 to 3.3.9

3.3.7 Configuring mode FPoS (sequence functions)

FPoS mode only appears when S4 = 1. Functions previously flagged in FdEF mode with YES are now positioned (in the correct chronological sequence) in the controller's processing cycle.

Position numbers (1 to 20) are displayed, as prompts, and a function assigned to each in response.

Only the names of unsequenced functions appear in the response cycle. Functions that are already sequenced are masked out.

The input parameters for a function will already have been calculated before the function is executed. As this is not possible in feedback situations, values from the previous cycle will be used.

Should an already sequenced function subsequently not be required (no in FdEF), it is removed from the processing sequence. The sequence of all other functions remains unchanged. Gaps are closed automatically.

The functions inST, dELt and nPos (in the response cycle) enable existing processing sequences to be amended.

- **Function inSt (insert)**

Inserts an unsequenced function in an existing sequence.
Use the $\pm\Delta y$ pushbutton (13) to select the position number where the function is to be inserted. Press the $\pm\Delta w$ pushbutton (6) until inSt appears in the display. The Enter LED flashes to indicate that the Enter pushbutton is now "live".
When the Enter button (9) is pressed the selected position number no** is defined nPoS, and the Enter LED goes out.
All position numbers from no** are now incremented by one, allowing no** to be assigned to the new function. If the end of the sequence is reached during this operation (position number > 20), inST cannot be executed and the Enter LED stays on.

- **Function dELt (delete)**

Removes nPoS gaps from a sequence. Use the $\pm\Delta y$ pushbuttons (13) to select the position number to be deleted. Press the $\pm\Delta w$ pushbutton (6) until dELt appears in the display. The Enter LED flashes to indicate that the Enter pushbutton (9) is now "live". When the Enter button is pressed, the selected position number no** is assigned the function currently assigned to the next position number. All position numbers from no** are decremented by one.

- **Function nPoS (not sequenced)**

Replaces function blocks within a sequence. Use the $\pm\Delta y$ pushbuttons (13) to select the position numbers to be replaced and assign nPoS to each one. The associated functions now become available again to the response cycle, and can be assigned to the position numbers that are now flagged nPoS.

- **Error messages**

– – PoS Err

Positioning mode cannot be terminated until all defined functions have been positioned. If an attempt is made to quit configuring preselection mode by pressing the Exit pushbutton, and some functions have still not been positioned, the flashing error message –PoS Err is displayed. The controller remains in configuring preselection mode. The error must be corrected.
Press the Enter pushbutton to acknowledge the error. The controller then reverts to FPoS mode, and displays the number of the first position still flagged nPoS. The error can now be corrected.

– nPoS Err

Positioning mode cannot be terminated if the sequence still contains unpositioned (nPoS) numbers. If an attempt is made to quit configuring preselection mode by pressing the Exit pushbutton, and some nPoS numbers are still present, the flashing error message nPoS Err is displayed. Control remains in configuring preselection mode. The error must be corrected.

Press the Enter pushbutton to acknowledge the error. Control then returns to FPoS mode, and displays the number of the first position still flagged nPoS. The error can then be corrected.

Digital display	
x (Prompt) Position number	w (Response) Function
1	nPoS
¦	Ar1.F
¦	↓
¦	Ar6.F
¦	dELt 1)
¦	↓
¦	Fu1.F
¦	Fu2.F
¦	inSt 1)
¦	MA1.F
¦	MA2.F
¦	MA3.F
¦	Mi1.F
¦	Mi2.F
↓	Mi3.F
20	rE1.F

1) with Enter function

Table 3-11 Prompt/Response cycle in configuring mode FPoS

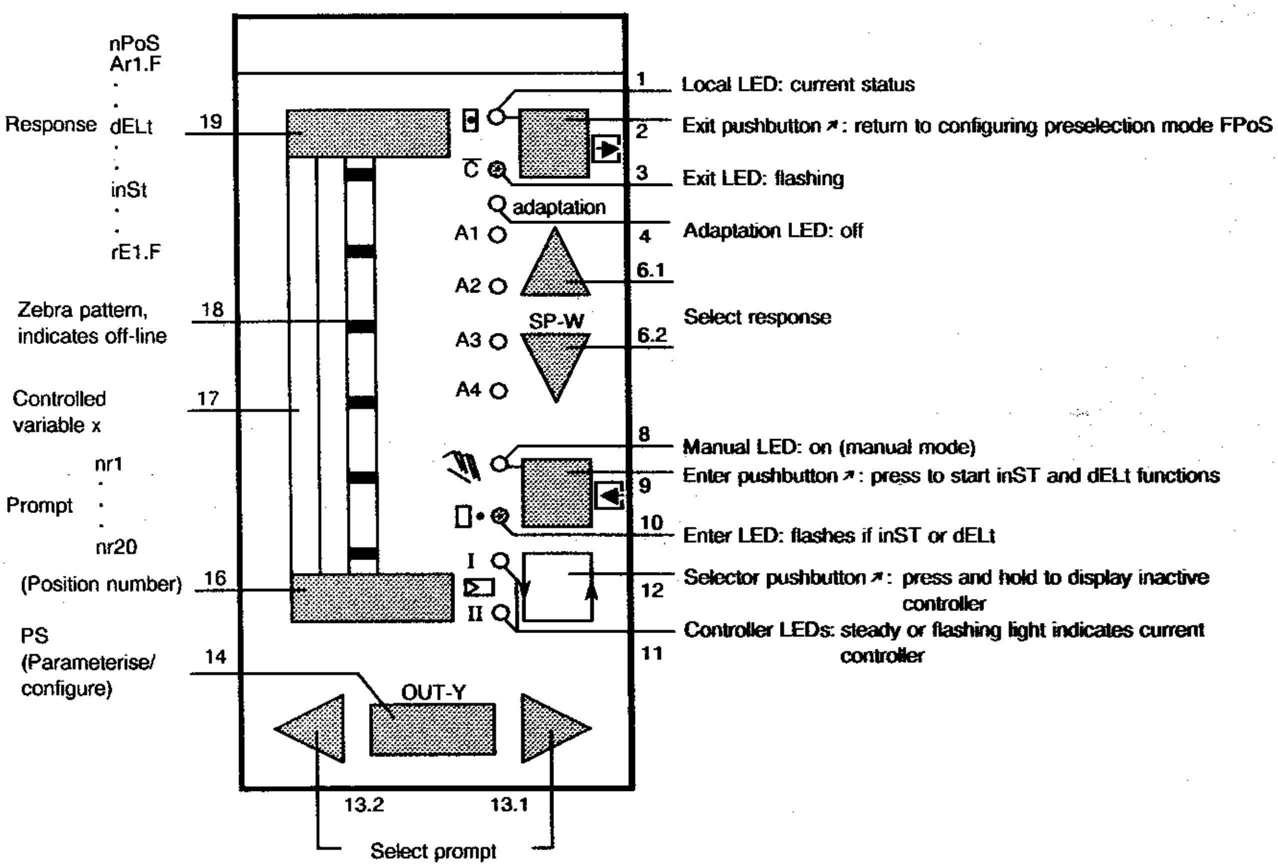
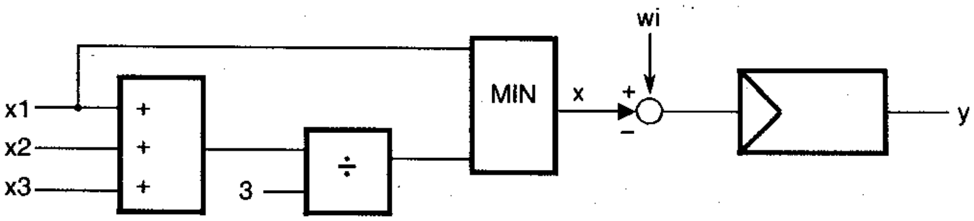


Figure 3-15 Controls and displays in configuring mode FPoS

- **Example of freely selectable input area application**

– **Task**

Fixed setpoint controller K with averaging of three control variables x1 to x3 and maximum value control of final control variable x1, i.e. if the average value exceed this variable, the value this variable's value is used.



$$x = \frac{x1 + x2 + x3}{3} \quad \text{and } x \le x1$$

– **Process interfaces**

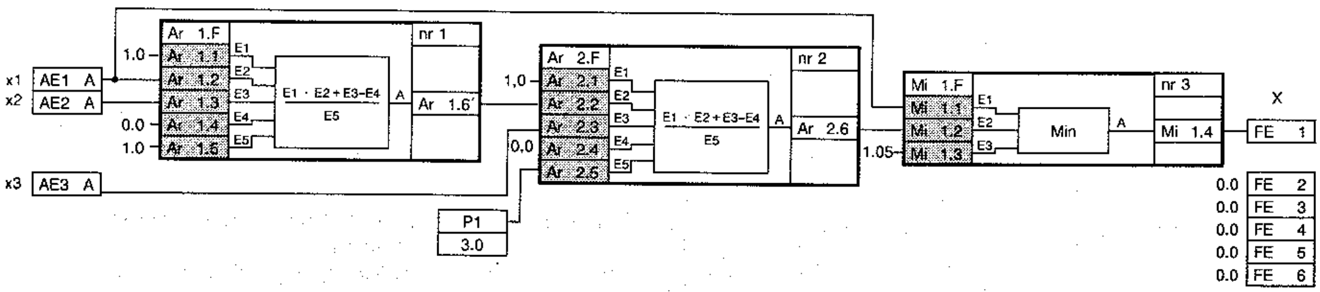
x1 to x3 als 4 ...20 mA signal via AE1 to AE3
y as 4 to ...20 mA signal via AA4 (y_{hold})
Auxiliary power supply 220 V

– **Controller type**

6DR 2200-5
and 6DR2802-8A in slot 6

– **Wiring plan**

Wiring plan



- **Configuration**

StrS

S0 = 11
S4 = 1
S5 = 3
S6 = 3
S7 = 3
S23 = 4
S72 = 1

Remaining configuring switches at factory settings

FdEF

Prompt	Response
Ar1.F	YES
Ar2.F	YES
Mi1.F	YES
Rest	no

FCon

Prompt	Response
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

Prompt	Response
nr 1	Ar1.F
nr 2	Ar2.F
nr 3	Mi1.F

oFPA
PAST } depends on application

- **Paramterisation**

onPA
P1 3.000
Remaining parameters depend on application

3.3 to 3.3.9

3.3.8 Configuring mode FPSt(Preset, factory setting)

Configuring mode FPSt is only accessible when S4 = 1 and is used to reset the freely configurable input area to the factory setting. If a large number of changes are to be made in FdEF, FCon and FPoS modes, we recommend that this Preset function be executed first.

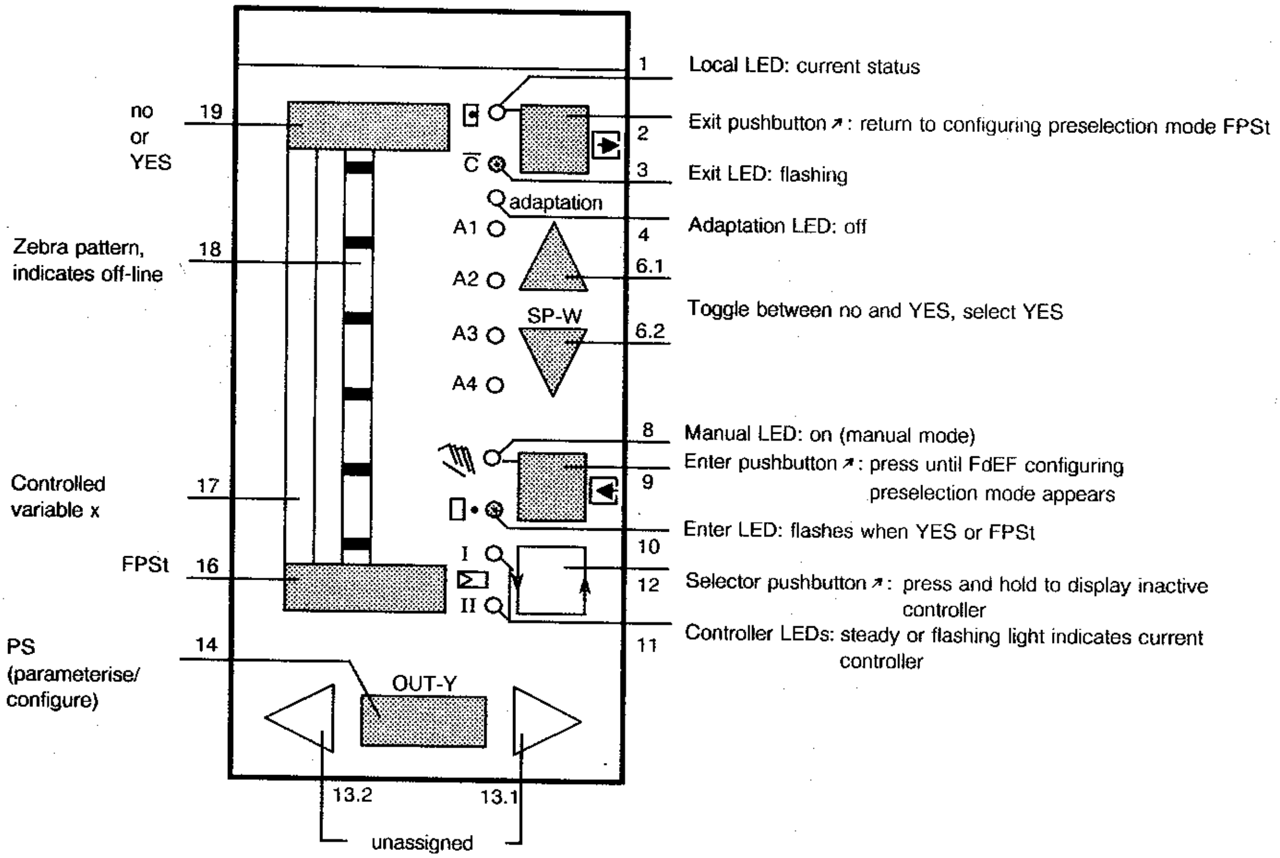


Figure 3-16 Controls and displays in configuring mode FPSt

When FPSt mode is first entered by pressing the Enter pushbutton, no FPSt is displayed. Use the $+\Delta w$ push button (6.1) to select YES, and press the Enter pushbutton (9) until FdEF appears in configuring preselection mode. The Preset function is then executed. Select FdEF by pressing the Enter button and continue with the new definitions.

3.3.9 Configuring mode APSt(All Preset, factory setting)

Configuring mode APSt is used to reset all controller functions (parameters and configurations) to the factory setting. If a large number of changes are to be made, we recommend that this All Preset function be executed first.

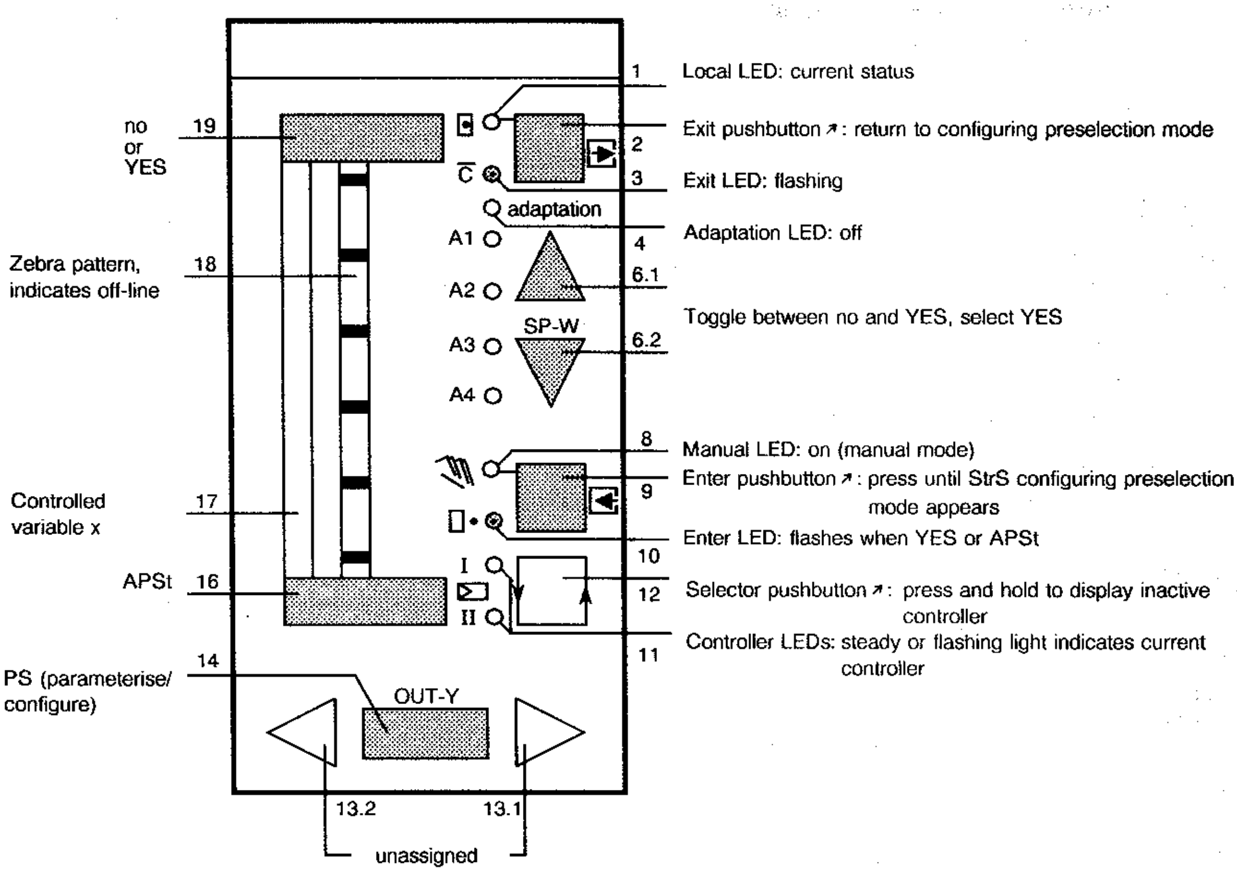


Figure 3-17 Controls and displays in configuring mode APSt

When APSt mode is first entered by pressing the Enter pushbutton, no APSt is displayed. Use the $+\Delta w$ pushbutton (6.1) to select YES, and press the Enter pushbutton (9) until StrS appears in configuring preselection mode. The Preset function is then executed. Select StrS by pressing the Enter button and reconfigure the controller.

4 Commissioning

4.1 Matching the direction of action

- **Definitions**

Normal control loop:
An increase in y causes an increase in x; eg. an increase in power or rate of flow causes temperature to rise.
Normal final control element (valve):
An increased current or $+\Delta y$ signal causes the valve to open; eg. more power or higher rate of flow. The y_{An} signal represents the final control element.
As far as matching the direction of action of the master controller is concerned, the slave controller in cascade control is considered to be part of the control loop.
The direction of action of the controller depends on the control variables FE1 and FE3. The following paragraphs apply to normal action transmitters (increase in physical value causes transmitter signal to increase), a rising process variable scale (dE*>dA*), and no inversion in the freely configurable input area, or no falling linearisation function in the standard area, as the case may be.

- **Direction of action of control loop and final control element known**

K controller

Given:			Select required effect				Required positions for S54/S56 and S68 and controller mode of operation			
Direction of action of control loop	Direction of action of final control element	Direction of action control loop and final control element	20 mA at	Pressing the right hand push-button in manual mode causes: Positioning signal Iy	Valve	Controlled variable	S54/S56	Kp (cP)	S68	y_{An} =
normal	normal	normal	100 %	rises	opens	rises	0	pos.	0	y
	reversed	reversed	0 %	falls	opens	rises	1	neg.	1	100 % −y
reversed	normal	reversed	0 %	falls	closes	rises	1	neg.	1	100 % −y
			100 %	rises	opens	falls	1	neg.	0	y
	reversed	normal	100 %	rises	closes	rises	0	pos.	0	y
			0 %	falls	opens	falls	0	pos.	1	100 % −y

This table can be extended by two lines which, however, have little significance in practice: normal action control loop where the value of the controlled variable falls as the manipulated variable increases.

Table 4-1 Direction of action of K controller and y display depending on direction of action of control loop and final control element

S controller

Given:			Select required effect			Required positions for S54/S56 and S68 and controller mode of operation			
Direction of action of control loop	Direction of action of final control element	Direction of action control loop and final control element	Pressing the right hand push-button in manual mode causes: Active positioning signal	Valve	Controlled variable	S54/S56	Kp (cP)	S68	y_{An} =
normal	$+\Delta y$ opens	normal	$+\Delta y$	opens	rises	0	pos.	0	y_R
reversed	$+\Delta y$ opens	reversed	$-\Delta y$	closes	rises	1	neg.	1	100 %-y_R
			$+\Delta y$	opens	falls	1	neg.	0	y_R

If, in exceptional cases, the connection of the final control element is reversed ($+\Delta y$ closes), the position feedback and the direction of action of the controller (Kp) must also be reversed.

Table 4-2 Direction of action of S controller and y display depending on direction of action of control loop and final control element

- **Direction of action of control loop and final control element unknown**

Put controller into manual mode, leave configuring switches S54, S56 and S68 = 0 (factory setting).

- **Establish direction of action of final control element**

Turn the control loop off, or bring the control element as close as possible to its safety position. Press the right hand manipulated variable adjustment pushbutton and observe whether the control element opens or closes. Opening signifies normal action. If it closes on S controllers, reverse connections $+\Delta y$ and $-\Delta y$.
The final control element can be observed as follows:

– Normal action control loop:	rising x indicates normal action final control element
– Reverse action control loop:	falling x indicates normal action final control element
– On S controllers and correctly connected position feedback:	rising y display indicates normal action final control element

- In addition, the control element can be observed at the place installation

- **Switch to automatic mode:**

Gradually increase Kpht hand manipulated variable adjustment pushbutton and observe whether the controlled variable rises or falls.If the final control element has a normal action, a rising controlled variable indicates a normal action control loop. With a reverse action final control element, it indicates a reverse action control loop. A falling controlled variable signifies a reverse action control loop where the final control element has a normal action, and a normal action control loop with reverse action final control element.

- **Note for cascade control:**

The direction of action of the slave controller is first established and if necessary parameterised as described above. The direction of action of the master controller is thenmatched to the control loop. As manual adjustment to the master controller is made in conjunction with the setpoint from the slave controller, the latter should be switched to local mode. Use the selector pushbutton (12) to observe the value of the main controlled variable on the master controller.

4.2 Parameterisation of split range signals and positioning times on K controllers

- **Split range signals Y1, Y2**

In split range mode, the steepness of the two manipulated variables must be matched to the control range of the individual final control elements to ensure a constant gain Ks across the entire operating range.

Calculate control loop gain in manual mode for each area:

$$Ks1 = \frac{\Delta x}{\Delta y1} \quad and \quad Ks2 = \frac{\Delta x}{\Delta y2}$$

Then parameterise Y1 and Y2 such that

when S65 = 0 rising-falling

$$\frac{100\,\% - Y1}{Y2} = \frac{Ks1}{Ks2}$$

when S65 = 1 rising-rising

$$\frac{Y1}{100\,\% - Y2} = \frac{Ks1}{Ks2}$$

- **Positioning time tY**[1]

With S62 = 0: set tY to the positioning time of the connected actuator. If the control loop is to be dampened in addition, e.g. to prevent hard surges on the actuator, tY can be increased further in automatic mode.
With S62 = 1: set tY to the desired position time for the incremental tracking variable.

4.3 Matching the S controller to the electric actuator

- **S controller with internal position feedback (S2 = 1)**

Use parameter tY to specify the positioning time for the actuator (1 to 1000 secs.). The factory setting is 60 seconds. **Note:** the factory setting is oFF! [1]

tE must be large enough to activate the actuator. The larger the value of tE, the smoother the operation of drives and contacts connected to the controller. Large values of tE require a larger dead zone AH as the resolution of the controlled variable diminishes the longer the pulse length. Within the dead zone the controller cannot control the loop properly.
Factory setting for tE is 180 ms. With a 60 second positioning time, this corresponds to a y resolution of:

$$\Delta y = \frac{100\,\% \cdot tE}{tY} = \frac{100\,\% \cdot 180\ ms}{60\ ms} = 0.3\,\%$$

The controlled variable is calculated by weighting the control loop gain Ks by the smallest possible resolution factor Δy.

$\Delta x = K_s \cdot \Delta y$

The pulse pause tA must be large enough to ensure that the actuator is switched off before a new pulse (particularly one in the opposite direction) is received. The larger the value of tE, the smoother the operation of drives and contacts connected to the controller. However, the controller's dead zone will also be larger. The values of tA and tE are normally the same.
With a positioning time of 60 seconds, we recommend that tA = tE = 120 to 240 ms. The less stable the control loop, the greater should be the values of tA and tE, so long as this can be justified by the control result. The response thresholds AH for the respective controllers must now be determined from the values of tE and the resulting Δy/Δx. The conditions

$$AH\,\mathrm{I}\ /AH\mathrm{II} > \frac{\Delta x}{2} \quad or \quad AH\,\mathrm{I}\ /AH\mathrm{II} > \frac{Ks \cdot tE \cdot 100\,\%}{2 \cdot tY}$$

1) From software version -A07 onwards

must be met, otherwise the controller will output increment signals even though finite resolution would have reduced the control difference to an absolute minimum. See section 4.4 regarding optimisation of AH I and AH II.

- **S Controller with external position feedback (S2 = 2)**

The positioning control loop is optimised using the tY parameter. The same principles as for internal position feedback also apply here, though in this case, dynamic properties of the positioning control loop (non-linearity, override) are also taken into account. As a consequence, tY and the resulting response threshold will generally be smaller than for S controllers with internal position feedback.
Optimisation takes place in manual mode. During optimisation, S67 is set = 0 to allow the manual manipulated variable to be entered as an absolute value. Note that because of the time taken to position the final control element, the displayed manipulated variable and the actual value will not be the same.

Optimisation of non-linear control loops must take place where the non-linearity is steepest.

- Set S67 = 0
- Assign values to tA and tE such that the actuator **just** responds to positioning increments (see S controller with internal feedback).
- Set the first order filter on the yR input (tF1,2,3,4 or 5) to 0.01 tY (actual positioning time of the actuator).
- Increase tY until minor adjustments to the manual manipulated variable cause the positioning control loop to overshoot (watch out for a contrary pulse in the Δy-LEDs (15) of the y display).
- Reduce tY slightly until the control loop stabilises.
- Set S67 = 2.

4.4 First filter and response threshold parameterisation

Suppress mains frequency interference by setting configuring switch S3 to the appropriate frequency (50 or 60 Hz). The factory setting is for 50 Hz.

- **First order filter for analogue inputs**

Values are assigned to the input filters' time constants (tF1 to tF5) in parameterisation mode onPA. The values should be as large as possible without affecting the controller's ability to control the loop (tF1 to tF5 < Tg). The appropriate input filters **must** be optimised if adaptation is to be performed.

- **Adaptive non-linear filter of the control difference**

As the dead zone is generated automatically, its extent is unknown. The filter time constants tFI/tFII (onPA) should therefore be just large enough to prevent the control loop oscillating during large dead zones (tFI/tFII Tg). This filter is strongly recommended if the D component (PD, PID) is being used, as it suppresses the increased level of noise generated by Kp·vv.

The filters **must** be used if adaptation is to be performed.

- **Optimisation of the response threshold AH**

The response thresholds AH I and AH II of controllers I and II can be increased if the controller signal requires further stabilisation, or when the loading on the final control element needs to be reduced. The response threshold for S controllers is derived from tE (see 4.3) and must be greater than zero. A response threshold of about 0.5 % is recommended for K controllers.
Remember that the remaining control difference can have the same value as the current response threshold.

4.5 Using adaptation to generate control parameters automatically 1)

Whenever possible, adaptation should be used. Parameters derived from adaptation, compared with manual efforts, give better control results, particularly in slow control loops, and time spent on optimisation is saved.

- **Presets**

– **S58 Select control response (configuring mode StrS)**

Adaptation cannot be performed if S58 = 0. In position 1, the control response will not allow overshoot, and in position 2, setpoints may have an overshoot of up to 5 %.

– **tU: monitoring period (parameterisation mode AdAP)**

tU is used exclusively with error messages and has no effect on the quality of the identification of the control loop. It should be at least twice as large as the settling time of the control loop, T_{95}. If not enough is known about the response of the control loop, perform adaptation with tU = oFF (factory setting). Once adaptation has been successfully completed, tU is autimatically set to $2T_{95}$. With tU < 0.1 h (6 min), tU = oFF is displayed.

– **dPv: direction of step change (parameterisation mode AdAP)**

This configuring switch is used to select in which direction the controlled variable moves from the selected working point: $x_{manual} \pm \Delta x = \pm$ ks ($y_{manual} \pm \Delta y$). In control loops with backlash, it is advisable to perform adaptation with rising and falling x. The derived parameters, even non-critical dynamic ones, may then be used for control purposes.

– **dy: amplitude of step change (parameterisation mode AdAP)**

The amplitude of the step change must be large enough to modify the controlled variable by at least 4 %, and the modification must be five times the average level of noise. The larger the change in the controlled variable, the better the quality of the identification. Changes of about 10 % are recommended.

- **Notes for certain types of control before adaptation**

– **Cascade control**

In dual-loop controllers, adaptation is always performed on the controller selected by the selector pushbutton (12). In cascade control, controller I is selected and adaptation first performed in manual mode on the slave controller. To prevent the control response becoming significant, we recommend that controllers be configured without overshoot (S58 = 1). The slave controller is then switched to local and automatic mode, and adaptation performed on the master controller. To do this, select controller I, switch the slave controller to local (corresponds to manual mode of the master controller) and then into automatic, or, where appropriate, set the required working point by amending the setpoint. Now press the selector pushbutton (12) to switch to controller II (the master controller) and start adaptation. The step in the slave controller's setpoint for identification of the control loop cannot be seen.

– **Cascade ratio control**

When adaptation is being performed on master controllers in ratio cascades, the controlling process variable should not oscillate too much. If it does, the control dynamics of the ratio controller (slave) and non-linearity between the ratio factor and the controlled variable on the master controller may cause it to oscillate even more, even if the ratio factor remains constant ($v \pm \Delta v$). As only changes caused by the ratio factor should be detected, this additional change to the controlled variable will falsify the results of the adaptation procedure.

1) Description valid from software version -A05

- **Override control**

  When selecting a working point for override control (including the Δy step in adaptation), bear in mind that the setpoint limit may not be exceeded when adapting either the main or limiting controller.
  If the state of the plant prevents the working point from being reached, then adaptation must take place at a more appropriate level.
  In the example quoted in 1.4.4 (temperature control of a chemical in a glass lined vessel), care must be taken to ensure that the temperature difference between the chemical and the jacket does not exceed the value set by Sb. In other words, the step change in the output signal must not cause the process variables to exceed this value.

- **Non-linear control loops**

  For non-linear control loops, a number of adaptations should be performed under varying load conditions. Note the results of the adaptation and the value of the controlling variable SG (previously selected with S60). The controlling variable can also be read in parameterisation mode AdAP as a value between 0 and 100 %. The parameter sets identified in this way, relative to the controlling variable SG, can then be input in configuring mode PASt (with interpolation if necessary). This procedure enables ideal control results to be derived even for non-linear control loops.

- **Notes about the results of adaptation**

- **D element**

  The D element brings no noticeable benefit to S and K controllers in 1st order control loops because of the infinite positioning time Ty, as well as for other reasons that have to do with control theory. Disadvantages in the form of delays to the positioning time predominate.

- **Range limits**

  When one of the identified parameters reaches its limit value, the other parameter should be slightly adjusted in the opposite direction. If an 8th order control loop has been identified, the derived Kp should be reduced slightly for safety reasons.
  If the control loop is too slow (non-critical), then it can be increased, just as with manual optimisation.

- **kp variation**

  kP can be modified at will in the special cases of 1st order control loops with PI and PID controllers as well as 2nd order control loops with PID controllers. Where controllers have been drafted according to absolute value optimisation, the Kp can, as a rule, be increased by about 30 % without the control response becoming critical.

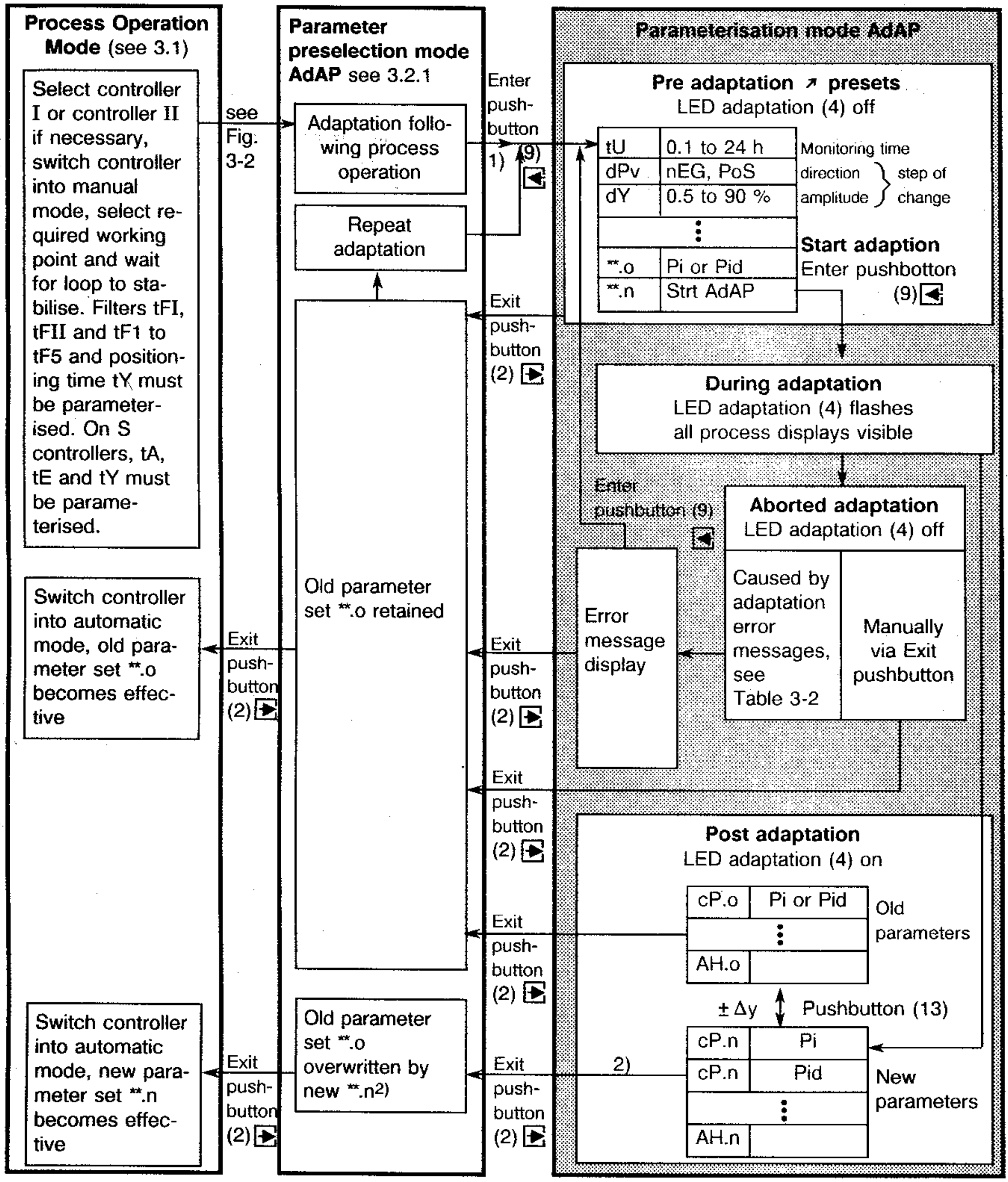


Figure 4-1 Adaptation * 1st to 8th order control loop ** Parameter name

1) Enter function only effective in manual mode (during adaptation of cascaded master controller (S1 = 5/6), slave controller in local and manual).

2) Error message no AUto
If the new parameter set is selected and parameter control is active, the flashing error message "no AUto" (no automatic transfer) will appear when the Exit pushbutton is pressed.

Press Enter: The error message is acknowledged; return to parameterisation mode AdAP; parameters derived from the adaptation can be retained.

Press Exit: Enter parameter preselection mode AdAP; new parameter set **.n deleted. When using **.n, returning to parameterisation mode AdAP causes the message "Strt AdAP" to be output.

4.6 Manual parameterisation of control parameters with no knowledge of control loop response

In this case, optimum parameters for the control loop are not yet known. In order to ensure the control loop remains stable, the following factory settings have been used (these values apply to both parameter sets):

Proportional gain	Kp	=	0.1
Integral reset time	Tn	=	9984 s
Derivative action time	Tv	=	oFF

- **P controllers (control signal P* = high)**

  - Select required setpoint and set control difference to zero in manual mode
  - The working point necessary to achieve a control deviation of zero is set automatically when Yo=AUto (factory setting). The working point can also be entered manually by assigning the desired value to the on-line parameter Yo.
  - Switch to automatic mode.
  - Gradually increase K_p until small changes to the setpoint cause the control loop to oscillate.
  - Reduce K_p slightly until the oscillations cease.

- **PD controllers (control signal P* = high)**

  - Select required setpoint and set control difference to zero in manual mode
  - The working point necessary to achieve a control deviation of zero is set automatically when Yo = AUto (factory setting). The working point can also be entered manually by assigning the desired value to the on-line parameter Yo.
  - Switch to automatic mode.
  - Gradually increase K_p until small changes to the setpoint cause the control loop to oscillate.
  - Switch T_v from oFF to 1 second.
  - Increase T_v until the oscillations cease.
  - Gradually increase K_p until the oscillations start again.
  - Repeat the previous two steps until it becomes impossible to eliminate the oscillations.
  - Reduce T_v and K_p slightly until the oscillations cease.

- **PI controllers (control signal P* = low)**

  - Select required setpoint and set control difference to zero in manual mode.
  - Switch to automatic mode.
  - Gradually increase K_p until small changes to the setpoint cause the control loop to oscillate.
  - Reduce K_p slightly until the oscillations cease.
  - Reduce T_n until the oscillations start again.
  - Increase T_n slightly until the oscillations cease.

- **PID controllers (control signal P* = low)**

  - Select required setpoint and set control difference to zero in manual mode.
  - Switch to automatic mode.
  - Gradually increase K_p until small changes to the setpoint cause the control loop to oscillate.
  - Switch T_v from oFF to 1 second.
  - Increase T_v until the oscillations cease.
  - Gradually increase K_p until the oscillations start again.
  - Repeat the previous two steps until it becomes impossible to eliminate the oscillations.
  - Reduce T_v and K_p slightly until the oscillations cease.
  - Reduce T_n until the oscillations start again.
  - Increase T_n slightly until the oscillations cease.

4.7 Manual parameterisation of control parameters using the transient function

If the transient function of the control loop is known, or can be determined, control parameters can be defined following the guidelines specified in the documentation. The transient function can be observed by causing a step change to the manipulated variable in manual mode, and plotting the response of the controlled variable on a recorder. The transient function will correspond roughly to the one in Figure 4-2.
The following rough formulae are derived from averaged parameterisation results from several sources:

P-controllers:

Proportional gain $Kp \approx \frac{Tg}{Tu \cdot Ks}$

PI-controllers:

Proportional gain $Kp \approx 0.8 \cdot \frac{Tg}{Tu \cdot Ks}$

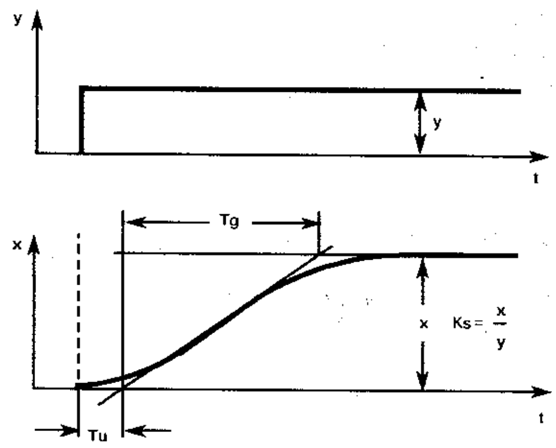
Integral reset time $Tn \approx 3 \cdot Tu$

PID-controllers:

Proportional gain $Kp \approx 1.2 \cdot \frac{Tg}{Tu \cdot Ks}$

Integral reset time $Tn \approx Tu$

Derivative action time $Tv \approx 0{,}4 \cdot Tu$



y Manipulated variable
w Setpoint
x Controlled variable
t Time
Tu Delay time
Tg Recovery time
Ks Transfer coefficient of control loop

Figure 4-2 Transient function of a control loop with recovery

5 Maintenance

5.1 General Notes

The SIPART DR22 controller requires no maintenance. We recommend that white spirit or industrial alcohol be used to clean the front fascia and housing.

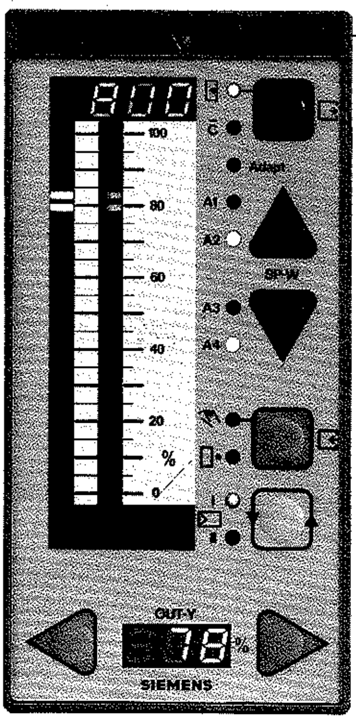
Should the front module, main board, or an individual option module fail, they can simply be replaced without having to disconnect the power supply.

> **Caution !**
> All modules contain components that are vulnerable to static. Observe the usual precautions!

Use the y_{Hold} module to maintain the manipulated variable signal on K controllers (see 1.3.2). Final control elements on S controllers remain in their last position.

> **Warning**
> Make sure that power is disconnected before replacing the power supply unit or interface relay.

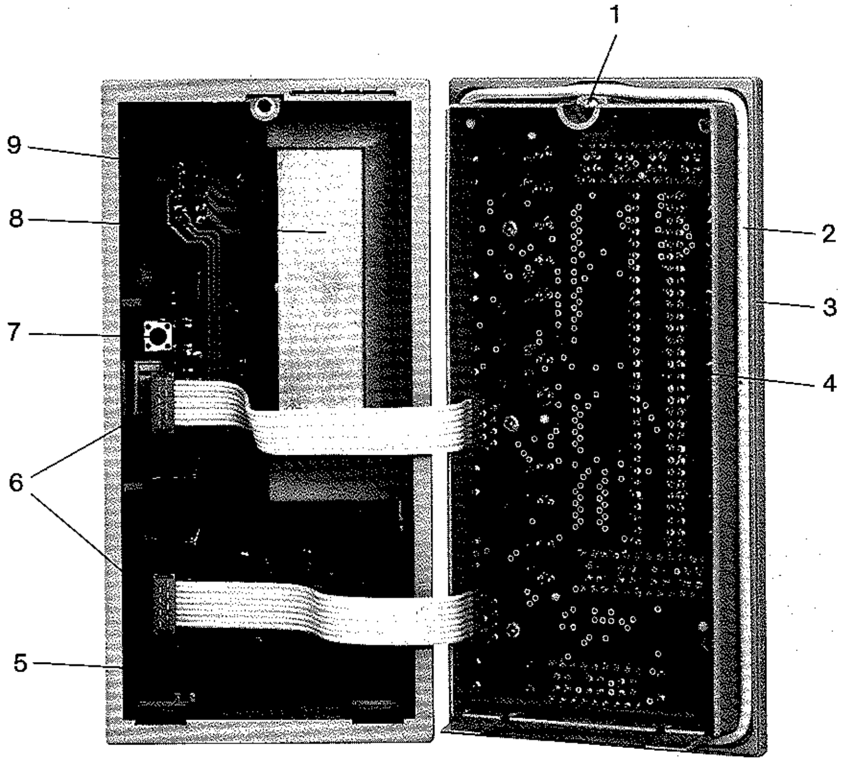
> **Warning**
> Repair of modules may only be performed in authorised workshops. For reasons of safety (isolation and functional extra-low voltages), this applies particularly to the power supply unit and the interface relay.



1

1 Fixing screw that holds the front module in place

Figure 5-1 Front module with tagging label and cover removed



1 Fixing screw
2 Seal
3 Frontpanel
4 Frontboard
5 Main board
6 Ribbon cable terminators
7 Manual reset pushbutton
8 Power supply
9 Connection plate

Figure 5-2 Controller with front module open

- **Replacing the front module**

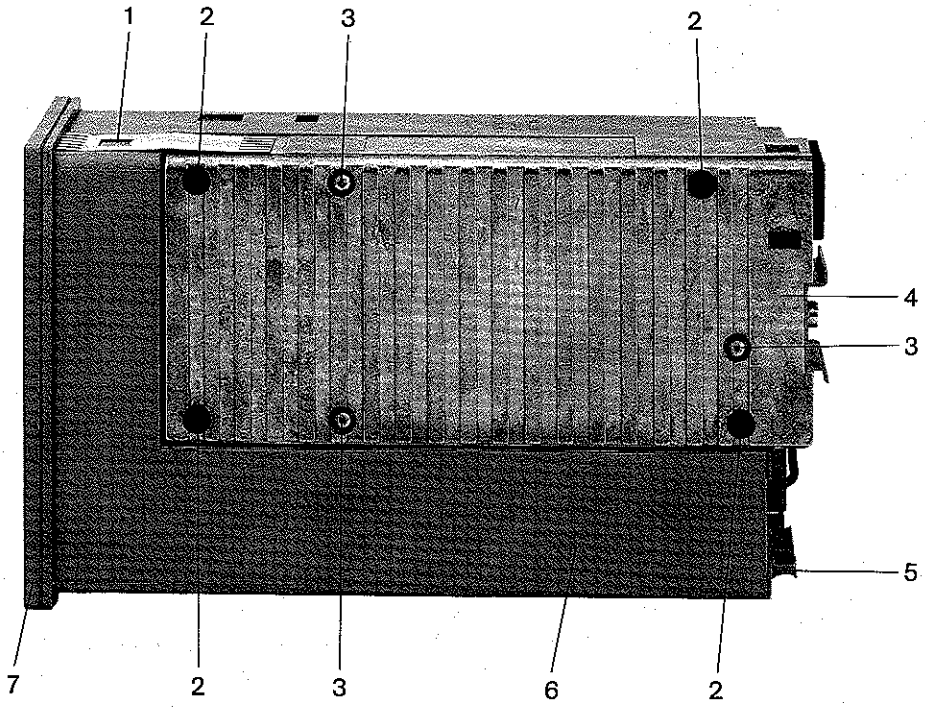
- Open the label cover by inserting a screwdriver into the recess, and carefully prising it up. Remove the label and gently bend the cover to snap it off its lower hinges.
- Undo the captive fixing screw (see (1) Figure 5-1).
- Tilt the module upwards, and pull it out towards you at a slight angle until the ribbon cable plugs are accessible.
- Unplug the ribbon cables (see (6) Figure 5-2).
- Insert the new module in the reverse sequence. Make sure that the seal is located correctly! Insert the ribbon cables so that the cables are to the right of the plugs without crossing them over.

- **Replacing the main board and option modules**

- Remove plug-in terminal blocks.
- Unlock and remove the module.
  Caution: remove the front module before removing the main board (connecting cable!).
- Insert and lock the new module in place (although modules are slot coded, check that you have the correct module when inserting into a multipurpose slot).
- Attach terminal block (make sure it matches slot number).

- **Replacing the power supply unit**

- Disconnect power supply.
- Lacken off latches and remove controller from panel.
- Loosen the four screws (see (2) Figure 5-3) holding the power supply unit in place (**not the three painted** Philips screws, see (3) Figure 5-3). Detach the unit.
- Bend the protective conductor contacts gently upwards and carefully place the new power unit on the positioning tabs, moving it lightly from side to side until it snaps into place.
- Tighten the fixing screws (in diagonal sequence).



1 Protective conductor contacts
2 Power supply unit fixing screws
3 Painted Philips screws for fixing the power supply unit to the inclosure
4 Power supply unit
5 Dummy cover
6 Plastic enclosure
7 Front module

Figure 5-3 Fitting the power supply unit

- **Replacing user program memory on the main board**

- Remove main board
- Carefully remove memory module (without bending pins)
- Insert the new memory module paying careful attention to polarity (◣ to ◣), as forcing the module will bend the coding pin.

- **LED test and software version**

LEDs can be tested by pressing the selector pushbutton (12) for approximately 10 seconds (a flashing "PS" appears in the manipulated variable display after 5 seconds). All the LEDs come on, "8.8.8.8" or "•88.8." appears in each display, and on the two bargraphs, a light spot encompassing 3 LEDs travels from 0 to 100 %, starting again at 0 % when it reaches 100 %.

If the Local/Manual pushbutton (2) is pressed and held during this test, "dr22" appears in the digital w display and the current software version is displayed in the digital x display.

During this procedure, the controller remains on-line and continues operating in its current mode.

- **Manual Reset**

If the controller's processing cycle is interrupted by an error of some sort, a restart can be attempted by a manual reset.
- Remove the front module as described above, but do not unplug the ribbon cables.
- Press the reset button (see Figure 5-2).
- Check on the front module that everything seems OK.
- Replace the front module as described above.

A manual reset has the same effect as a power-on reset (see 1.3).

5.2 Spare parts list

Pos.	Figure	Denomination	Notes	Order-number
1		**Front module**		
1.1	(7) Fig. 5-3	Front module complete 1)	without tagging label cover	C73451-A3001-B100
1.2	—	Front panel with protective foil		C73451-A3001-B3
1.3	(3) Fig. 5-2	Front panel		-A3001-C116
1.4	—	Front board 1)		-A3001-L1
1.5	(4) Fig. 5-2	Screw SN 62217-B2,6 × 6-St-A3G	Order 5 pcs.	H62217-B2506-S3
1.6	(2) Fig. 5-2	Seal		C73451-A3001-C31
1.7	(1) Fig. 5-2	Fixing screw SHR 3 × 10 5.8 A3G		H60110-L100-S3
1.8	—	Tagging label cover		C73451-A3001-C5
1.9	—	10 tagging labels		-C16
2		**Housing**		
2.1	(6) Fig. 5-3	Plastic moulded housing		C73451-A3001-C3
2.2	(5) Fig. 5-3	Dummy cover for unassigned slots		-A3001-C11
2.3	(1) Fig. 5-3	Protective contactor contacts		-A3001-C8
2.4	—	Fixing elements	Order 2 pcs.	-A3000-B20
2.5	(9) Fig. 5-2	Connection plate	5 screws as in 1.5	-A3001-L2
2.6	—	Self-adhesive gasket between front frame and front panel		C73451-A3000-C41
3		**Power supply unit**		
3.1	(4) Fig. 5-3	Power supply unit 24 V UC complete	without power plug	C73451-A3001-B105
3.2	(4) Fig. 5-3	Power supply unit 115/230 V AC compl.		-B104
		Power plug		
3.3		3-pole rubber connector for 115/230 V AC, IEC-320/V, DIN 49457A		C73334-Z343-C3
3.4	—	2-pole special plug for 24 V UC		C73334-Z343-C6
4		**Main board**		
4.1	(5) Fig. 5-2	Main board complete 1)		C73451-A3001-L10
4.2	—	Connection plug 14-pole		W73078-B1001-A714
4.3	—	10-pole		W73078-B1001-A710
4.4	—	User program memory	See also 6. Ordering data	
5	—	**Options**	See also 6. Ordering data	
5.1	—	Terminal 4-pole for 6DR2800-8I/8R/8P		W73078-B1001-A904
5.2	—	Terminal 4-pole with thermal compensation for 6DR2800-8T		C73451-A3000-B17
5.3	—	Terminal 5-pole for 6DR2801-8A/8B/8C und 6DR2802-8A		W73078-B1001-A705
5.4	—	Terminal 6-pole for 6DR2801-8D		W73078-B1001-A906
5.5	—	Terminal 3-pole for 6DR2804-8A/8B		W73078-B1001-A703
		Terminal 6-pole for 6DR2804-8A/8B		-A706
5.6	—	Allocation plug for 6DR2800-8J/8R/8P/8T and main board C73451-A3001-L10		W73077-B2604-U2

1) From front module type no. 2 (label at the long side of front panel), and from type no. 5 of the main board (yellow label at the front edge) onward, the plug-in connection of the front ribbon cables has been modified. The new plug-in connection is not compatible with the former one. If any spare parts of the main board or the front module (circuit board) are requested, please send the corresponding mating component for modification.

- Remarks for orders

Any order must comprise the following:
- Number of pieces desired
- Order-number
- Denomination

We recommend to indicate as well the kind of instrument the spare part belongs to.

- Ordering example

2 pcs.	W73078-B1001-A714 Terminal plug 14-pole	Main board DR22

6 Ordering Data

Standard SIPART DR22 controller with

3 analogue inputs	0/4 to 20 mA or 0/2 to 10 V
3 analogue outputs	0/4 to 20 mA
4 digital inputs	24 V
8 digital outputs	24 V
and user program memory	

for 24 V AC/DC power supply	6DR2200-4
for switchable 115/230 V AC supply	6DR2200-5
Input module for current or voltage	6DR2800-8J
Input module for resistance transmitter	6DR2800-8R
Input module for Pt100 resistance thermometer	6DR2800-8P
Input module for mV signals or thermocouples	6DR2800-8T
Digital input module with 5 24 V inputs	6DR2801-8C
Digital output module with 4 24 V outputs and one input (BLPS)	6DR2801-8B
Digital output module with 2 output relays (35 V AC/DC)	6DR2801-8A
Analogue output module with y_{HOLD} function	6DR2802-8A
Interface relay module with 2 c/o contacts (250 V AC)	6DR2804-8B
Interface relay module with 4 c/o contacts (250 V AC)	6DR2804-8A
SIPART DR22 User program memory	C73451-A3001-B11
Interface module for V.28 point-to-point or SIPART bus	6DR2803-8A
SIPART bus driver	C73451-A347-B202
110/220 V AC power supply unit for bus driver	6DR2900-8BA
Serial interface and bus driver plugs	
9-way D-plug for round cable (soldered)	C73451-A347-D35
9-way D-plug for ribbon cable (ipcd)	C73451-A347-D36
25-way D-plug for round cable (soldered)	C73451-A347-D38
SIPART DR22 Operating Instructions (German)	C73000-B7400-C222
SIPART DR22 Operating Instructions (English)	C73000-B7476-C222
SIPART DR22 Operating Instructions (French)	C73000-B7477-C222
SIPART DR22 Operating Instructions (Spanish)	C73000-B7478-C222
SIPART DR22 Operating Instructions (Italian)	C73000-B7472-C222
Technical description of serial interface and communications procedures	
German	C73000-B7400-C133
English	C73000-B7476-C133

7 Abbreviations & Symbols

A	Control signal: not automatic mode
A*	Alarms parameter (limit values)
AdAP	Adaptation mode
AE*	Analogue inputs
AE*A	Outputs of analogue inputs
AH*	Response threshold (dead zone)
ALL PASS	Error message: All Pass control loops
APSt	Configuring mode: All (controllers) Preset
AUto	Automatic
Ar*	Arithmetic function block
BA**	Digital outputs
BE**	Digital inputs
BLPS	Control signal: Block parameterisation / configuring
$BLPS_{BE}$	Control signal: Block parameterisation / configuring using digital input
$BLPS_{ES}$	Control signal: Block parameterisation / configuring using serial interface
BLS	Control signal: Block configuring
BLS_{BE}	Control signal: Block configuring via digital input
BLS_{ES}	Control signal: Block configuring via serial interface
c*	Parameter: constants
C	LED: computer not ready
CB	Control signal: computer mode
CB_{BE}	Control signal: computer mode via digital inputs
CB_{ES}	Control signal: computer mode via serial interface
cP*	(K_p) proportional gain
CPU	Central Processing Unit
dA*	Parameter: display range start-of-scale
DDC	Direct digital control
dE*	Parameter: display range full-scale
dELt	Delete
dP	Parameter: display decimal point
dPv	Parameter: direction of step change
dr	Parameter: refresh rate of display
dY	Parameter: amplitude of step change
Err	Error
End	Error message: End
ESES	Remote serial interface
FASt	Error message: Fast
FCon	Configuring mode: connect functions
FdEF	Configuring mode: define functions
FE*	Function input
FPoS	Configuring mode: position function
FPSt	Configuring mode: preset functions
Fu*	Function block: lineariser
Fu1, −10 to 110	Parameter: vertices for lineariser 1
Fu2, −10 to 110	Parameter: vertices for lineariser 2

5 to 8

H**	Parameter: alarm hysteresis
H	Control signal: manual mode
Hi	Control signal: manual local
He$_{BE}$ ...	Control signal: manual remote via digital input
He$_{ES}$ ...	Control signal: manual remote via serial interface
HE	Error message: manual remote
inSt	Insert
Int*	Control signal: local
Kp	Proportional gain
LED	Light Emitting Diode
MA**	Function block: find maximum
MEM ...	Memory
Mi**	Function block: find minimum
ModE ...	Mode of operation
ncon	Not connected
n.ddc ...	Error message: tracking or DDC
ndEF ...	Not defined
no	No
not	None
nPoS ...	Not positioned
N	Control signal: tracking
N$_{BE}$	Control signal: tracking via digital input
N$_{ES}$	Control signal: tracking via serial interface
oFL	Overflow
-oFL	–overflow (underflow)
onPA ...	Parameterisation mode: on-line parameterisation
oFPA ...	Configuring mode: off-line parameterisation
OP**	Error message: Option (slot)
OUT	Output: manipulated variable y
ovEr Shot	Error message: overshoot
P*	Control signal: P mode
P*$_{BE-}$	Control signal: P mode via digital input
P*$_{ES}$	Control signal: P mode via serial interface
P**	Connectable linear parameter
PAU	Control signal: parameter switchover
PAU$_{BE}$ ..	Control signal: parameter switchover via digital input
PAU$_{ES}$ ..	Control signal: parameter switchover via serial interface
PV	Controlled variable
$\overline{RB}$	Control signal: computer not ready
rE1	Function Block: correction computer
rE1, PA .	Correction computer parameter: correction factor for pressure start-of-scale
rE1, PE .	Correction computer parameter: correction factor for pressure full-scale
rE1, tA ..	Correction computer parameter: correction factor for temperature start-of-scale
rE1, tE ..	Correction computer parameter: correction factor for temperature full-scale
RC	Control signal: no computer mode

S ...... Configuring switch
SA .... Parameter: lower setpoint limit
Sb ..... Parameter: setpoint limit
SE .... Parameter: upper setpoint limit
SES ... Serial interface
SG .... Parameter: control variable
SH .... Parameter: safety setpoint
Si ..... Control signal: safety mode, error message: safety mode
Si_{BE} ... Control signal: safety mode via digital input
Si_{ES} ... Control signal: safety mode via serial interface
SMAL .. Error message: Small
SP .... Setpoint
SPC ... Setpoint control
StAt .... Error message: stationary, static
StrS ... Configuring mode: configuring switch
StrU ... Parameter preselection mode: select configuring

tA ..... Parameter: minimum length of stop pulse
tE ..... Parameter: minimum length of start pulse
tESt .... Self-test
tF* ..... Parameter: filter time constant
tn* ..... Parameter: integral reset time
tS ..... Parameter: setpoint ramp
too ....
tU ..... Monitoring period
tv* ..... Parameter: derivative action time
tY ..... Parameter: positioning time

v ...... Ratio setpoint factor
v_{ist} ..... Ratio factor
vA ..... Parameter: ratio factor start-of-scale
vE ..... Parameter: ratio factor full-scale
vv* ..... Derivative action gain
vvc .... Derivative action gain (fixed in parameter control)

w ..... Setpoint w
w_E ..... Remote setpoint
w_{EA} .... Remote setpoint via analogue input
w_{ES} .... Remote setpoint via serial interface
$w_{E\Delta}$ .... Remote incremental setpoint
wi ..... Local setpoint
wv ..... Normalised ratio setpoint factor

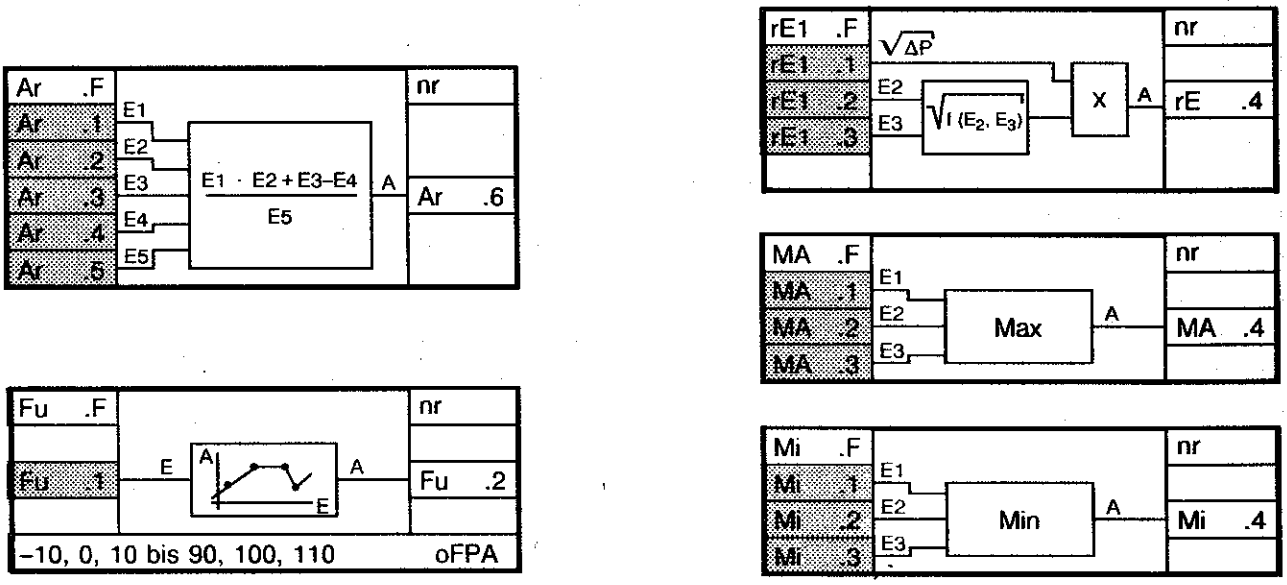
x ...... Controlled variable (measured value)
x* ..... Secondary control variables
xd* .... Control difference
xds .... Control difference, position controller
xv ..... Normalised ratio factor

y ...... Manipulated variable
y1 ..... Split range manipulated variable
y2 ..... Split range manipulated variable
Y1 ..... Split range parameter: range of manipulated variable 1
Y2 ..... Split range parameter: range of manipulated variable 2
YA ..... Parameter: Lower limit of manipulated variable
YE ..... Parameter: Upper limit of manipulated variable
y_E ..... Remote manipulated variable

y_{ES}	Remote manipulated variable via serial interface
$y_{E\Delta}$	Remote incremental manipulated variable
y_H	Manual manipulated variable
y_N	Remote manipulated variable (tracking manipulated variable)
y_S	Safety manipulated variable
YS	Parameter: safety manipulated variable
Yo*	Parameter: working point
YBL	Error message: Blocking mode
$\pm yBL$	Control signal: direction dependent blocking of y
$\pm yBL_{BE}$	Control signal: direction dependent blocking of y via digital inputs
$\pm yBL_{ES}$	Control signal: direction dependent blocking of y via serial interface
$\pm \Delta w$	Control signal: incremental adjustment to w
$\pm \Delta w_{BE}$	Control signal: incremental adjustment to w via digital inputs
$\pm \Delta w_{ES}$	Control signal: incremental adjustment to w via serial interface
$\pm \Delta y$	Control signal: incremental adjustment to y
$\pm \Delta y_{BE}$	Control signal: incremental adjustment to y via digital inputs
$\pm \Delta y_{ES}$	Control signal: incremental adjustment to y via serial interface
–1.1 to 11.1	Parameter: vertices for FE1 lineariser
–1.3 to 11.3	Parameter: vertices for FE3 lineariser
	Controller
	Local
	Remote
	Exit
	Enter
	Fault
AE**	Error message: Fault on analogue inputs
– – – •‾	Decimal point
↗	Adjustable
**.I	Parameter set I
**.II	Parameter set II
**.o	Old parameters
**.n	New parameters
*	Indicates a counter number or parameter name

8 Configuring aids

- Define problem
- Define controller configuration
- – Define positions of jumpers and switches on main board and signal converter
- Draw wiring diagram
- – Draw special wiring, e.g. of freely-programmable area
- Define front panel description
- Record tabular values (configuration, parameterisation)



Freely configurable analogue input signal processing (S4 = 1)

SIPART DR22 settings, Controller number / Measuring point . . . .

Parameters **onPA**

Meaning of parameter	Digital display 14 (y)	16 (x)	19 (w) for default				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 gain	cPI						0,100	1
Reset time	tnI						9984	s
Derivative action time	tvI						oFF	s
Response threshold xdI	AHI						0,0	%
Working point P controller	YoI						Auto	%
Lower limit of manipulated variable	YAI						–5,0	%
Upper limit of manipulated variable	YEI						105,0	%
Parameter set II								
Filter time constant xdII	tFII						1	s
Derivative action gain	vvII						5,000	1
Proportional gain	cPII						0,100	1
Reset time	tnII						9984	s
Derivative action time	tvII						oFF	s
Response threshold xdII	AHII						0,0	%
Working point P controller	YoII						Auto	%
Lower limit of manipulated variable	YAII						–5,0	%
Upper limit of manipulated variable	YEII						105,0	%
Display refresh rate	dr						0,80	s
Positioning time	tY						oFF	s
Min. positional pulse interval	tA						180	ms
Min. positional pulse length	tE						180	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
Multiplication constant	c1						0	1
Multiplication constant	c2						0	1
Addition constant	c3						0	100 %
Multiplication constant	c4						1	1
Addition constant	c5						0	100 %
Multiplication constant	c6						0	1
only when S4=1								
Switchable parameters	P01						1	1
Switchable parameters	P02						1	1
Switchable parameters	P03						1	1
Switchable parameters	P04						1	1
Switchable parameters	P05						1	1
Switchable parameters	P06						1	1
Switchable parameters	P07						1	1
Switchable parameters	P08						1	1
Switchable parameters	P09						1	1
Switchable parameters	P10						1	1
when adaptation								
Monitoring period	tU						oFF	h
Direction of step change	dPv						PoS	-
Amplitude of step change	dY						0,5	%

SIPART DR22 settings, Control number/ Measuring point. . . . .
Parameters <u>**oFPA**</u>

Meaning of parameter		Digital Display 14 (y)	16 (x)	19 (w) for default				Factory setting	Dimen-sion
Decimal point display I		dPI	No indication					---.-	-
Start-of-scale Display range display I		dAI						0000	-
Full-scale Display range display I		dEI						1000	-
Decimal point display II		dPII						---.-	-
Start-of-scale Display range display II		dAII						0000	-
Full-scale Display range display II		dEII						1000	-
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	%
Hysteresis alarms A3 and A4		H3.4						1	%
Lower setpoint limit		SA						–5.0	-
Upper setpoint limit		SE						105.0	-
Safety setpoint		SH						0.0	-
Limiting setpoint for override control		Sb						0.0	-
Setpoint ramp		tS						oFF	min
Lower ratio factor		vA						0.000	1
Upper ratio factor		vE						1.000	1
Safety manipulated variable		YS						0.0	%
Manipulated variable range y1 in split-range		Y1						50.0	%
Manipulated variable range y2 in split-range		Y2						50.0	%
Vertex at –10 %	when S4 = 0 lineariser for FE1 / when S4 = 1 lineariser for Fu1	-1.1 / -10	/ FU1					–10	- / %
Vertex at 0 %		0.1 / 0	/ FU1					0	- / %
Vertex at 10 %		1.1 / 10	/ FU1					10	- / %
Vertex at 20 %		2.1 / 20	/ FU1					20	- / %
Vertex at 30 %		3.1 / 30	/ FU1					30	- / %
Vertex at 40 %		4.1 / 40	/ FU1					40	- / %
Vertex at 50 %		5.1 / 50	/ FU1					50	- / %
Vertex at 60 %		6.1 / 60	/ FU1					60	- / %
Vertex at 70 %		7.1 / 70	/ FU1					70	- / %
Vertex at 80 %		8.1 / 80	/ FU1					80	- / %
Vertex at 90 %		9.1 / 90	/ FU1					90	- / %
Vertex at 100 %		10.1 / 100	/ FU1					100	- / %
Vertex at 110 %		11.1 / 110	/ FU1					110	- / %
Vertex at –10 %	when S4 = 0 lineariser for FE3 / when S4 = 1 lineariser for Fu2	-1.3 / -10	/ FU2					–10	- / %
Vertex at 0 %		0.3 / 0	/ FU2					0	- / %
Vertex at 10 %		1.3 / 10	/ FU2					10	- / %
Vertex at 20 %		2.3 / 20	/ FU2					20	- / %
Vertex at 30 %		3.3 / 30	/ FU2					30	- / %
Vertex at 40 %		4.3 / 40	/ FU2					40	- / %
Vertex at 50 %		5.3 / 50	/ FU2					50	- / %
Vertex at 60 %		6.3 / 60	/ FU2					60	- / %
Vertex at 70 %		7.3 / 70	/ FU2					70	- / %
Vertex at 80 %		8.3 / 80	/ FU2					80	- / %
Vertex at 90 %		9.3 / 90	/ FU2					90	- / %
Vertex at 100 %		10.3 / 100	/ FU2					100	- / %
Vertex at 110 %		11.3 / 110	/ FU2					110	- / %
Lower pressure correction quotient		PA	rE					1	1
Upperpressure correction quotient		PE	rE					1	1
Lower temperature correction quotient		tA	rE					1	1
Upper temperature correction quotient		tE	rE					1	1

5 to 8

SIPART DR22 settings, Controller number / Measuring point ....

Parameters **PASt**

Meaning of parameter	Digital Display						Factory setting	Dimen-sion
	14 (y)	16 (x)	19 (w) for default					
Derivative action gain	vvc	Controlled variable x					5	1
Proportional gain when SG=10 %	cP1						0,1	1
Proportional gain when SG=30 %	cP3						0,1	1
Proportional gain when SG=50 %	cP5						0,1	1
Proportional gain when SG=70 %	cP7						0,1	1
Proportional gain when SG=90 %	cP9						0,1	1
Integral reset time when SG=10 %	tn1						9984	s
Integral reset time when SG=30 %	tn3						9984	s
Integral reset time when SG=50 %	tn5						9984	s
Integral reset time when SG=70 %	tn7						9984	s
Integral reset time when SG=90 %	tn9						9984	s
Derivative action time when SG=10 %	tv1						oFF	s
Derivative action time when SG=30 %	tv3						oFF	s
Derivative action time when SG=50 %	tv5						oFF	s
Derivative action time when SG=70 %	tv7						oFF	s
Derivative action time when SG=90 %	tv9						oFF	s
Response threshold when SG=10 %	AH1						0,0	%
Response threshold when SG=30 %	AH3						0,0	%
Response threshold when SG=50 %	AH5						0,0	%
Response threshold when SG=70 %	AH7						0,0	%
Response threshold when SG=90 %	AH9						0,0	%
Working point P-cont. when SG=10 %	Y01						0,0	%
Working point P-cont. when SG=30 %	Y03						0,0	%
Working point P-cont. when SG=50 %	Y05						0,0	%
Working point P-cont. when SG=70 %	Y07						0,0	%
Working point P-cont. when SG=90 %	Y09						0,0	%

SIPART DR22 settings, Controller number / Measuring point . . . .

<u>Configurations</u>

Switch number	Default				Factory setting	Switch number	Default				Factory setting
0					0	54					0
1					0	55					0
2					0	56					0
3					0	57					0
4					0	58					0
5					0	59					0
6					0	60					0
7					0	61					0
8					0	62					0
9					0	63					0
10					0	64					0
11					0	65					0
12					0	66					0
13					0	67					0
14					0	68					0
15					1	69					0
16					2	70					0
17					3	71					0
18					0	72					0
19					0	73					1
20					0	74					0
21					0	75					0
22					0	76					1
23					0	77					2
24					–1	78					3
25					2	79					4
26					3	80					5
27					4	81					6
28					0	82					0
29					0	83					0
30					0	84					0
31					0	85					0
32					0	86					0
33					0	87					0
34					0	88					0
35					0	89					0
36					0	90					0
37					0	91					0
38					0	92					0
39					0	93					0
40					0	94					0
41					0	95					0
42					0	96					0
43					0	97					0
44					0	98					0
45					0	99					0
46					0	100					0
47					0	101					0
48					0	102					0
49					0	103					0
50					0	104					0
51					0	105					0
52					0	106					0
53					0	107					0

SIPART DR22 settings, Controller number / Measuring point . . . .

FdEF **Define functions**

Prompt: Display 16 (x)	Response: Display 19 (w) Default							
	YES	no	YES	no	YES	no	YES	no
Ar1.F								
Ar2.F								
Ar3.F								
Ar4.F								
Ar5.F								
Ar6.F								
Fu1.F								
Fu2.F								
MA1.F								
MA2.F								
MA3.F								
Mi1.F								
Mi2.F								
Mi3.F								
rE1.F								

Selected definition: response YES or no

FPoS **Sequence functions**

Prompt: Display 16 (x)	Response: Display 19 (w) Default			
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

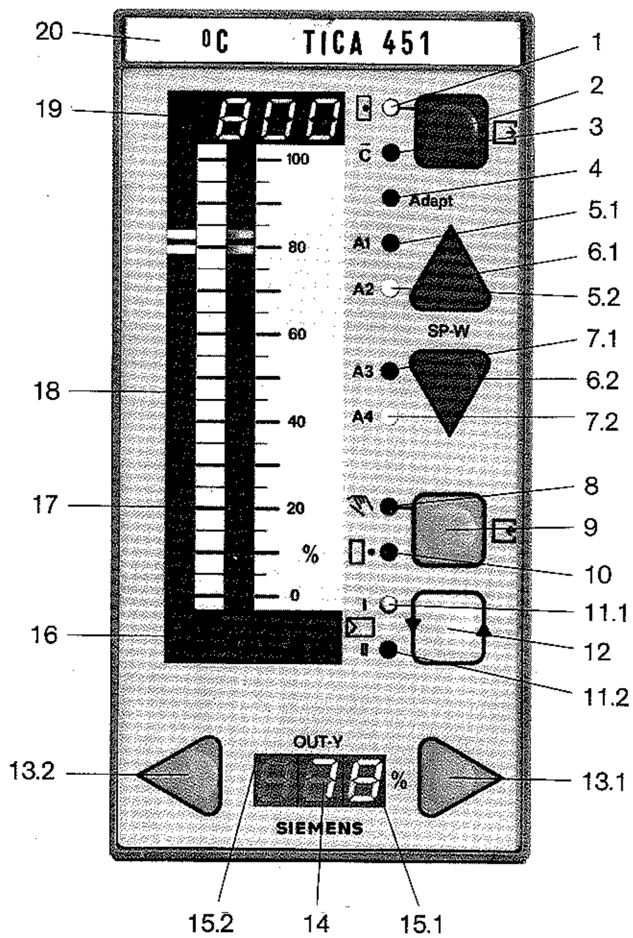
FdEF-, FPoS-lists freely configurable range

SIPART DR22 settings,
Controller number / Meas. point . . . .

FCon Connect functions

Prompt: Display 16 (x)	Response: Display 19 (w) Default			
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				
FU1.1				
FU1.2				
MA1.1				
MA1.2				
MA1.3				
MA2.1				
MA2.2				
MA2.3				
MA3.1				
MA3.2				
MA3.3				
Mi1.1				
Mi1.2				
Mi1.3				
Mi2.1				
Mi2.2				
Mi2.3				
Mi3.1				
Mi3.2				
Mi3.3				
rE1.1				
rE1.2				
rE1.3				

FCon-lists freely configurable range



1	Local LED (green)	On: local setpoint
2	Local/remote pushbutton	Setpoint switchover, or Exit pushbutton during configuring
3	C̄ LED (green)	On: computer not ready, or Exit LED during configuring
4	Adaptation LED (yellow)	Off: adaptation ready Flashing: adaptation in progress On: adaptation terminated
5.1	A1 LED (red)	Limit A1 violated
5.2	A2 LED (red)	Limit A2 violated
6.1	+ Δw pushbutton	Adjust local setpoint
6.2	– Δw pushbutton	Adjust local setpoint
7.1	A3 LED (red)	Limit A3 violated
7.2	A4 LED (red)	Limit A4 violated
8	Manual LED (yellow)	On: local manual mode Flashing: adaptation in progress
9	M/A pushbutton	Manual/automatic switchover, or Enter pushbutton during configuring
10	y-remote LED (yellow)	remote y, or Enter LED during configuring
11.1	Controller I LED (green)	Controller I display/control level
11.2	Controller II LED (green)	Controller II display/control level
	Flashing: display and working function not identical On: display and working function identical	
12	Selector pushbutton	Select Controller I/II display and control level
13.1	+ Δy pushbutton	Adjust manual manipulated variable for manipulated variable y
13.2	– Δy pushbutton	Adjust manual manipulated variable for manipulated variable y
14	Digital display (yellow)	
15.1	+ Δy LED (yellow)	Displays + Δy increment on S controllers
15.2	– Δy LED (yellow)	Displays –Δy increment on S controllers
16	Digital display (red)	For controlled variable x
17	Analogue display (red)	For controlled variable x
18	Analogue display (green)	For setpoint w
19	Digital display (green)	For setpoint w
20	Removable label. Screw to remove front module situated underneath.	

Figure 3-1 Controls and Displays

Siemens Companies and Representatives

America

Argentina
Siemens S.A.
Administración Central
Avenida Pte.
Julio A. Roca 516
Casilla Correo Central 1232
RA-1067 Buenos Aires
☎ (01) 3 31-14 34
Tx 21 812 siebaar

Brazil
Siemens S.A.
Sede Central
Avenida Mutinga, 3650
Caixa Postal 1375, CEP 01051
BR-05110 São Paulo
☎ (0 11) 8 33 22 11
Tx 11-34 090, 11-23 641,
11-36 727,
11-23 713 siembr

Canada
Siemens Electric Limited
Montreal Office
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Highway
Pointe Claire, Que.,
H9R 4R6
P.O.B. 73 00
☎ (5 14) 6 95-73 00
Tx 058-22 778 siemensmtl

Columbia
Siemens S.A.
Carrera 65, No. 11-83
Apartado Aéreo 8 01 50
Bogotá 6
☎ (9) 2 62 88 11, 2 61 14 00
Tx 44 750 siemco

Costa Rica
Siemens S.A.
La Uruca
Apartado 1 00 22
San José 1000
☎ 21 50 50
Tx 2 127 siemenscr

Ecuador
Siemens S.A.
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