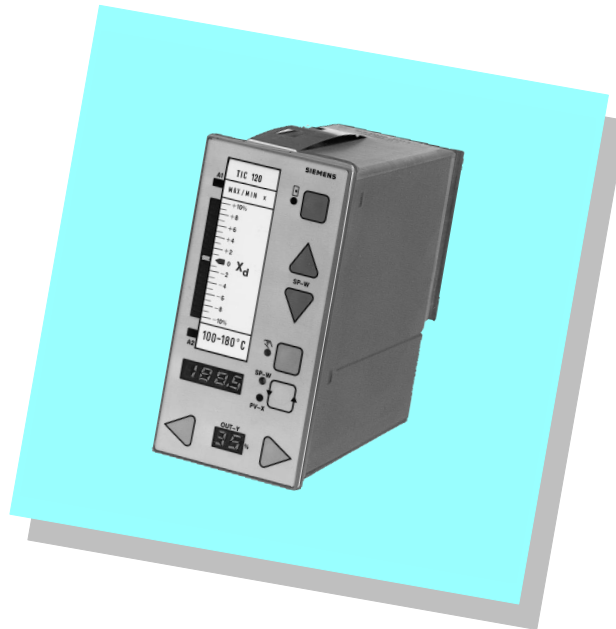


# SIPART DR20 Controllers

# 4



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# SIPART DR20 Controllers

## Description

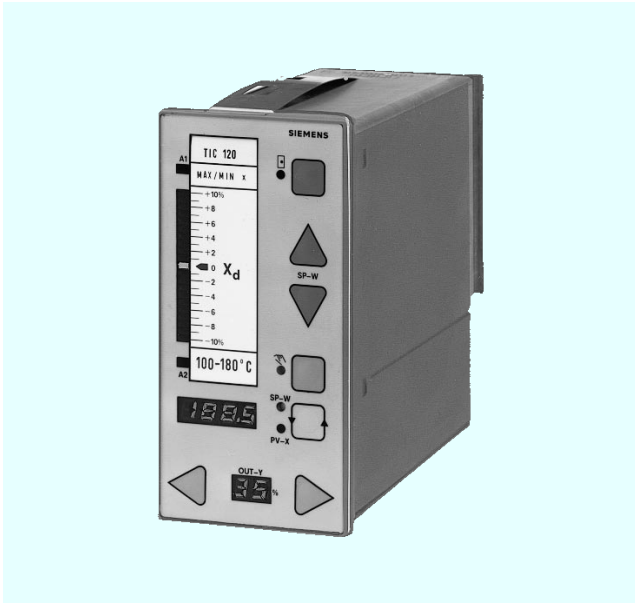
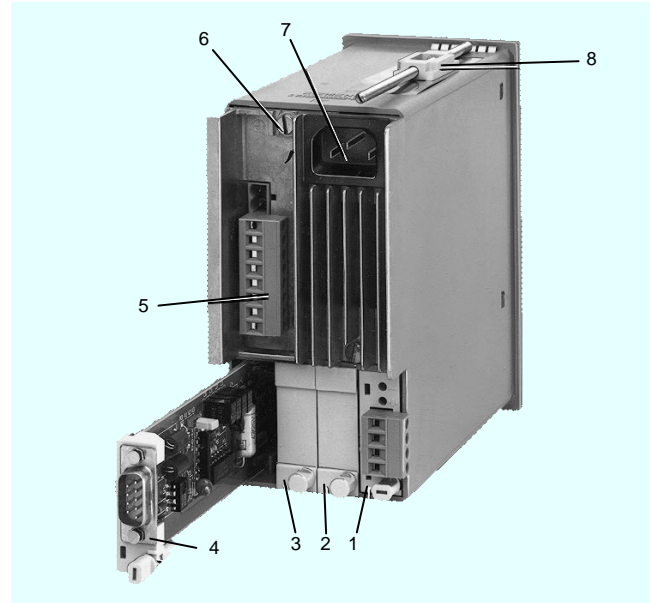


Fig. 4/1 SIPART DR20 controller



1 Slot AE3, fitted with module  
2 Slot AE4, not fitted, with dummy panel  
3 Slot GW, not fitted, with dummy panel  
4 Slot SES, module pulled out  
5 Terminal block of standard device  
6 Earthing screw  
7 Mains plug  
8 Clamp for fixing the device in a panel;  
second clamp underneath device  
Fig. 4/2 SIPART DR20 controller, rear view

## Application

The SIPART DR20 controller is a process controller suitable for a wide range of applications both in process engineering as well as in mechanical and apparatus engineering. It is available as a:

- Continuous controller (K controller) for connection to pneumatic or hydraulic actuators with proportional action
- Controller with stepped output (S controller), programmed either as a three-position step controller for electric actuators or a two-step controller with two outputs for heating and cooling.

As a result of its flexibility, the SIPART DR20 controller is suitable for simple control loops as well as for solving complex control tasks. It can be retrofitted at any time with an interface for connection to higher-level systems (process computers or control systems) or incorporated in a central operation and monitoring system with a personal computer.

The device can also be configured as a ratio station, process indicator or manual/automatic control station.

## Design

The SIPART DR20 process controller is of modular design and therefore easy to service, to convert and to retrofit. It consists of a fully functional standard device into which additional modules can be inserted to increase the number of inputs and outputs. These modules are used in the SIPART DR19, SIPART DR21, SIPART DR22 and SIPART DR24 controllers. They are inserted into slots at the rear of the standard device (Fig. 4/2).

The standard device comprises:

- Control and display unit with main circuit board (CPU)
- Standard circuit board with power pack and switching elements for the built-in input and output circuits
- Plastic housing.

The basic circuit boards is inserted into the housing from the rear and connected to the main circuit board via a contact strip. The standard device has 2 built-in analog inputs (non-floating current inputs 0 (4) to 20 mA) as well as a digital input to which various functions can be assigned and which acts normally or inverted.

The manipulated variable of the SIPART DR20 controller depends on the controller design:

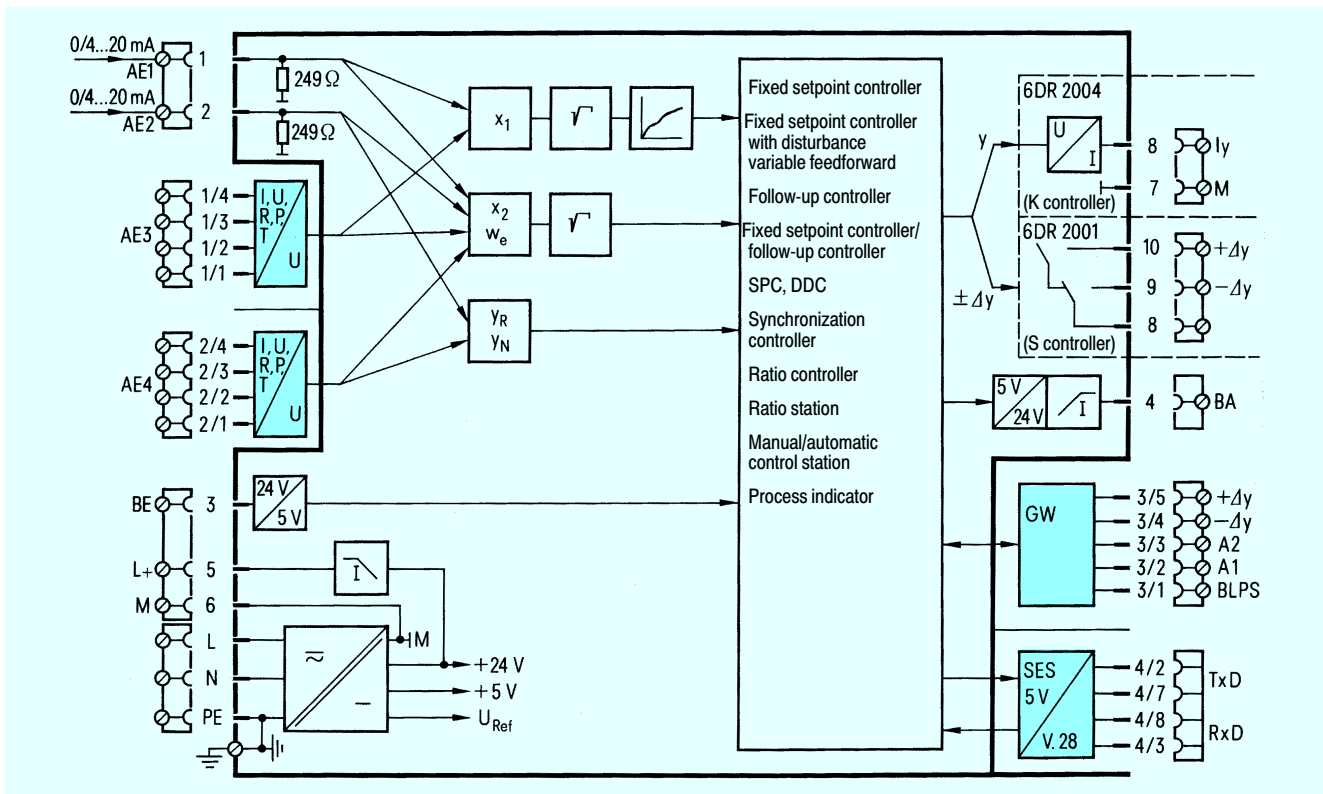
- In the K controller, the output circuit provides a continuous current of 0 to 20 mA or 4 to 20 mA
- The S controller has a stepped output with two relays for 250 V/5 A with spark suppression elements.

The controller also has a digital output to which various functions can be assigned just like the digital input and which acts normally or inverted.

Two slots are provided for additional analog inputs (AE3 and AE4). Input/output modules for I/U/TC/RTD/R can be inserted in these slots.

The controller can handle 3 analog input signals at the same time.

## Description



- Options
- AE Analog input
- BA Digital output
- BE Digital input
- GW Limit monitor
- SES Serial interface

Fig. 4/3 Function diagram of a SIPART DR20 controller

The slot GW is provided for a module to output limit signals. Two different limit signal modules are available.

The fourth slot SES is provided for an interface module for serial communication with a higher-level system.

### Analog inputs

The analog inputs AE1 and AE2 built into the standard device are non-floating and suitable for the input of current signals. The impedance is 249 Ω. The signal range (0 to 20 mA or 4 to 20 mA) is determined using configuring switches.

Configuring switches are also used to allocate the process variables  $x_1$ ,  $y_R/y_N$ ,  $x_2$ ,  $w_E$  to the inputs AE1, AE2 (standard controller) or AE3, AE4 (options).

### Mode of operation

The SIPART DR20 digital controller operates with an LSI micro-controller. The ROM contains a large number of functions for the control of process engineering plants.

The user programs the device according to the task by selecting the desired function on the so-called configuring switches. Programming knowledge is not required. The specific program produced in this manner is stored in the non-volatile part of the data memory and is protected against power failure. A back-up battery is not required.

The SIPART DR20 controller can be configured as a P, PD, PI or PID controller. The device can also be used as a ratio station, process indicator or manual/automatic control station.

Serial data transfer with higher-level systems is also possible when fitted with an interface module. The SIPART DR20 controller can operate in SPC and DDC modes in this case.

### Controller manipulated variables

- S controller with stepped output (6DR2001)

The output circuit has two floating relay contacts.

Via the controller output, a motorized actuator can be driven clockwise or counter-clockwise. It is important not to exceed the permissible switching voltage. Phase-shifting motors must therefore only be connected via intermediate switching devices.

The control algorithm is followed by a position control loop. The feedback of this position controller is simulated either internally by an integrator with adjustable positioning time or externally from the final control element depending on the configuration. The minimum pulse length and pulse pause of the positioner are adjustable.

The function of the output circuit can be configured, so the controller can also be used as a two-step controller.

## Description

### ■ K controller with continuous output (6DR2004)

The manipulated variable is output as a standardized current signal with this controller design. The signal range (0 to 20 mA or 4 to 20 mA) is selected by configuring. The output can be switched off in DDC mode if desired.

The function of the output circuit is configurable, so that if equipped with the input/output module with 4 digital inputs, the controller can also be used as a two-step or an S controller.

### ■ Two-step controller

If the controller is configured as a two-step controller, the manipulated variable  $y$  is output as a pulse duty factor with a variable period. This means the internal  $y$  range (0 to 100 %) can be divided into two with a parameterizable dead band. Each section can have a different period duration.

The pulse duty factor runs from 0 to 100 % in each section.

The main use of this type of controller is as a temperature controller controlling, for example, a heating/cooling circuit or opening and closing an electromagnetic valve.

## Digital input and output signals

### ■ Digital input

The standard device of the SIPART DR20 controller contains a digital input which can act either normally or inverted.

The function of the digital input can be configured as follows:

- BI** Blocking of controller output  
In the case of two-position controllers and K controllers, this signal is used to hold the duty factor or the positioning current at the last value. No positioning signal is output any more with three-position step controllers.
- Si** Safety position of output  
In the case of K controllers, two-step controllers and three-position step controllers with external position feedback, the manipulated variable is forced to the parameterized safety value.  
In the case of the three-position step controllers with an internally simulated positioner, the manipulated variable is forced in a defined manner towards 0 or 100 %.
- N** Tracking of output  
In the case of K controllers and two-step controllers, a manipulated variable is produced corresponding to the input signal  $y_N$ . Tracking is not possible with three-position step controllers.
- CB** Computer status  
In the case of controllers configured for DDC back-up mode, the CB signal sets them to back-up mode if push-button (1) in Fig. 4/17 is in position "Remote". In the case of SPC controllers, SPC mode is started.  
The CB signal can also be used for controlled two-setpoint or three-setpoint mode.  
The effect of a CB signal being present can be made dependent on a manual acknowledgement independent of whether the CB signal is set via the digital input BE or the serial interface.  
The digital input BE is available for other digital functions if the CB signal is set via the serial interface.

### SES Serial interface

A digital signal does not trigger any function in the device. However it is transmitted via the serial interface to the higher-level system.

### BLPS Blocking

The digital signal BLPS blocks the operating modes "Parameterization" and "Configuring" against unintentional adjustments.

Since only one digital input function is effective at a time, the unassigned functions have a defined signal status:

CB = "1", BI = Si = N = SES = BLPS = "0".

### ■ Digital output

In a similar manner to the digital input, a digital output is always present in the standard device of the SIPART DR20 controllers.

The following functions can be implemented:

- RC** Controller in computer mode. This signal is only output with DDC and SPC controllers.
- H** Controller in manual mode
- RB** Controller ready for computer
- MuSt** The analog input signals are monitored for range violation according to the position of configuring switch S11. A signal is output if a fault is detected.
- SES** The digital signal can be set by a command via the serial interface independent of all controller functions.

### ■ Limit monitor (option, slot GW)

The inputs and outputs of the limit monitor are permanently assigned the following functions:

- 6DR2801-8D (2 relay outputs)  
for outputting alarm signals A1 and A2
- 6DR2801-8E (4 digital outputs, 2 digital inputs)  
for outputting alarm signals A1 and A2, plus the manipulated variable  $y$  in the case of S controllers (the relays in the S controller are disabled automatically).  
One digital input is assigned to the BLPS function. The second digital input cannot be used in the SIPART DR20 controller.

## Power pack

The SIPART DR20 controllers can be connected to various power supplies. The designs for AC 230 V and AC 115 V are fitted with a transformer power pack. This is part of the basic circuit board. The design for AC/DC 24 V has a primary switched-mode power pack which is also fitted on the basic circuit board.

All voltages output by the power pack are stabilized and short-circuit-proof. Short dips in the power supply do not affect the device function. The power pack is designed such that the power, even with the fully configured device, is sufficient for several external loads (e. g. relays or transmitters) with DC 24 V, max. 60 mA.

## Description

### Zero-volt system

The SIPART DR20 controllers have a 0-V conductor  $M$  at the field terminals to which all analog and digital input and output signals are referred.

The controllers need not be connected together in the case of systems without interconnected control loops. In all other cases the 0-V connections of all controllers must be individually connected to one star point which may be connected to one point of the mains protective earth conductor.

### Device functions

The SIPART DR20 controller can easily be configured for various tasks. A large number of functions are already stored in the program memory of the controller. These are called from the memory by configuring, i. e. appropriate setting of the configuring switches, according to the control task or activated by parameterizing using pushbuttons on the front panel. Neither programming/software knowledge nor a special programming unit is required.

The following device types can be configured:

#### Single-component fixed setpoint controller

The controller only processes the main controlled variable  $x_1$  as the analog input signal. The setpoint  $w_1$  is set on the front panel of the controller.

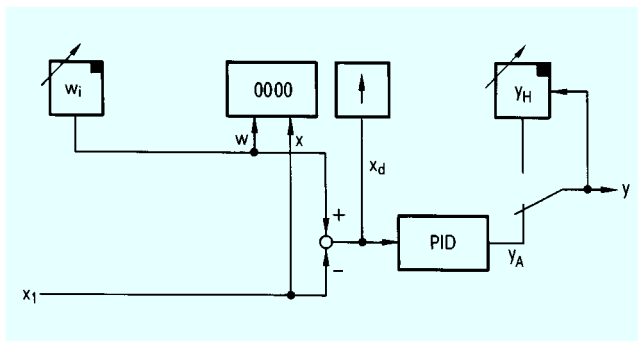


Fig. 4/4 Single-component fixed setpoint control

#### Fixed setpoint controller with disturbance variable feedforward at the input

A disturbance value  $x_2$  weighted by the factor  $c_2$  and a constant  $c_1$  are added to the main controlled variable  $x_1$ . The total is compared as the resulting controlled variable  $x$  with the setpoint  $w_L$  set on the front panel of the controller. The parameters  $c_1$  and  $c_2$  can be adjusted as numbers between -199.9 % and +199.9 %.

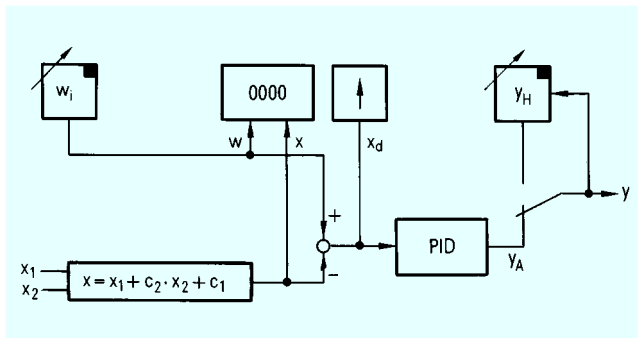


Fig. 4/5 Fixed setpoint control with disturbance variable feedforward at the input

#### Fixed setpoint controller with disturbance variable feedforward at the output

The manipulated variable is calculated from the main controlled variable  $x_1$  and the setpoint set on the front panel of the controller. The disturbance variable  $x_2$  is weighted by the factor  $c_2$  and added to the output signal.

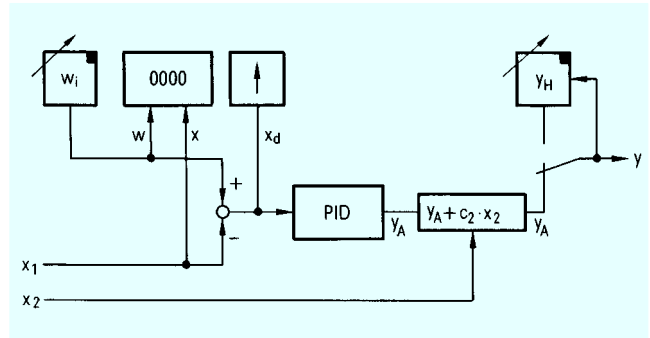


Fig. 4/6 Fixed setpoint control with disturbance variable feedforward at the output

#### DDC back-up fixed setpoint controller

The DDC controller operates together with a higher-level system in parallel mode. The higher-level system takes over control during DDC mode and the controller is in standby mode. The manipulated variable of the controller is made to track that of the higher-level system so that bumpless transfer can be made to the controller when the control system is switched off.

The negative deviation can be made equal to zero by  $x$ -tracking during standby mode.

DDC mode is activated by the digital signal  $CB$  provided the controller is switched to remote mode (switch 1, Fig. 4/17). The controller takes over control in a bumpless manner if the  $CB$  signal is no longer present. The link can be made via the serial interface ( $y_{ES}$ ) or via the hardware input ( $y_N$ ).

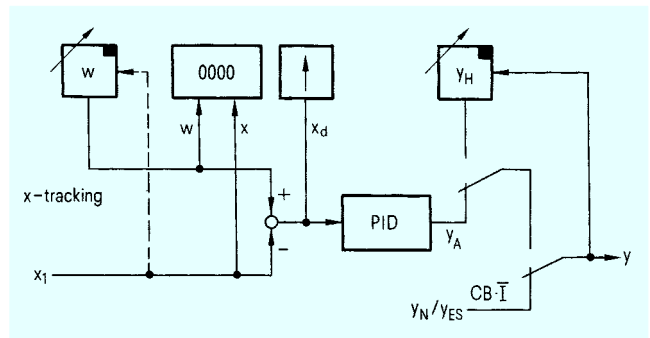


Fig. 4/7 DDC back-up fixed setpoint control with a K controller

## Description

### Slave controller without local/remote switchover via the front of the control unit

The main applications are cascade control and remote setpoint transmitters, but also possible SPC controls.

As long as  $CB = 1$  the controller will accept the remote setpoint in this mode of operation as command variable  $x_2/w_E$  or via the serial interface. If the digital signal  $CB = 0$ , the setpoint push-buttons on the front of the control unit operate without any further intervention.

With cascade control the cascade is to be separated at the master controller by switching to manual mode.

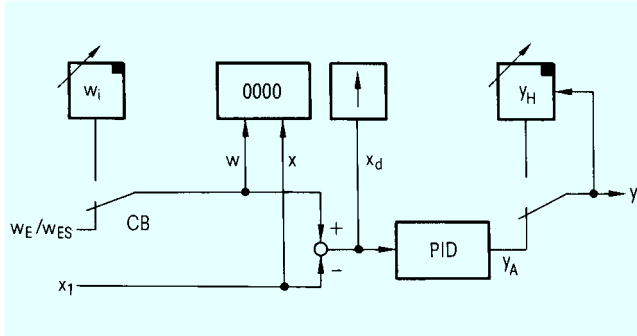


Fig. 4/8 Slave control without local/remote switchover via the front of the control unit

### Slave controller with local/remote switchover

This is provided for SPC mode and for operation with 2 or 3 set-points. The remote setpoint can be applied either via an analog input of the controller as an input variable  $x_2/w_E$  or via the serial interface.

When operating with 2 or 3 fixed setpoints, the controller is configured such that the local setpoint is not made to track the effective setpoint. Selection between the local and remote setpoints is then possible using the selector for local/remote mode providing  $CB = "1"$ .

If  $CB = "0"$  and configuring switch S18 is in position "1", the selector for local/remote mode is used to select between the local setpoint and the safety setpoint. With the switch position remote, CB is used to switch between the remote and local setpoints ( $S18 = 0$ ) or between the remote and safety setpoints. The transition from one setpoint to the other takes place with a jump if  $T_w = 0$  or with a ramp function if  $T_w > 0$ .

In SPC mode the setpoint is controlled by a higher-level system via the serial interface. SPC mode is operational if the device is switched to remote mode and the digital signal CB is present at the same time. If the CD signal is no longer present, the controller continues to operate, depending on the configuration, either with the last setpoint or using the parameterized safety setpoint.

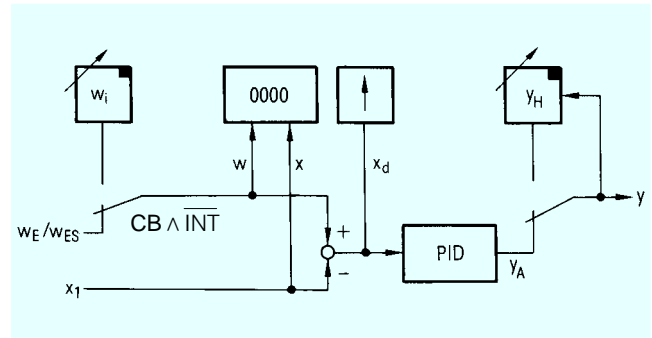


Fig. 4/9 Slave control with local/remote switchover

### Synchronization controller without local/remote switchover

This input configuration is suitable for controlled variable synchronization.

The remote setpoint is weighted by the parameterizable factor  $c_2$  and offset by the constant  $c_1$ .  $x$ -tracking is possible.

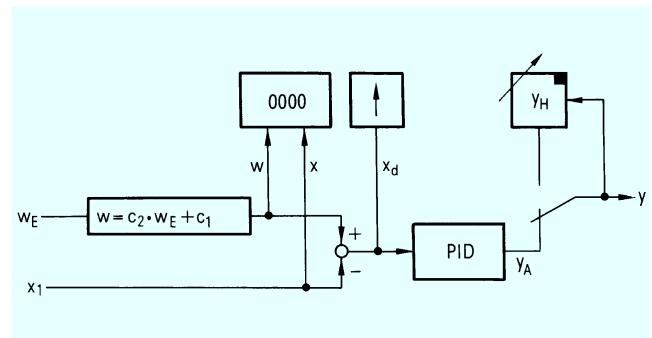


Fig. 4/10 Synchronization control without local/remote switchover

### Ratio controller

The command process variable  $x_2$  is weighted by the ratio  $w_v$  and forms the setpoint for the controlled process variable  $x_1$ .

The range of adjustment for the ratio  $w_v$  is defined by parameterization between 0.0 and 9.999 (parameters  $w_{va}$  and  $w_{ve}$ ). A value  $c_1$  can be applied in addition.

The setpoint ratio  $w_v$  entered using the setpoint pushbuttons is indicated as the setpoint on the digital display, the current ratio  $x_v$  as the actual value. The latter value is also available for  $x$ -tracking. The negative deviation indicates  $x_d = w - x$ .

The setpoint ramp is effective for  $w_v$ .

**Description**

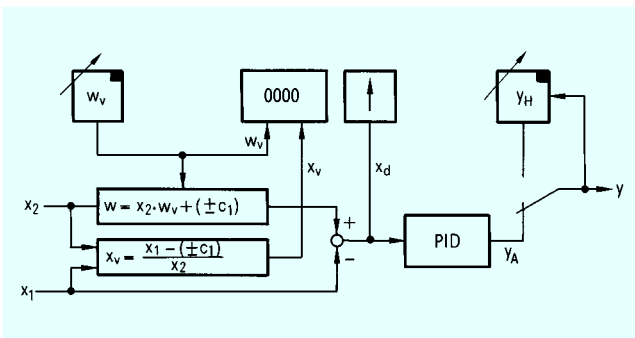


Fig. 4/11 Ratio controller

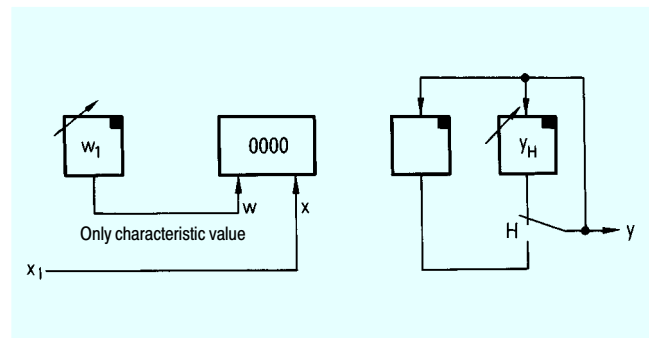


Fig. 4/13 Manual/automatic control station

Ratio station

Configuring as a ratio station is only possible with K controllers. The setpoint for a subsequent slave controller is calculated in the ratio station from the command process variable  $x_2$  by multiplication with the adjustable ratio  $w_v$  and, if applicable, addition of constant  $c_1$  and then directly output as the signal  $y_A$ . The range of adjustment for  $w_v$  is defined between 0.0 and 9.999 by parameterization (parameters  $w_{va}$  and  $w_{ve}$ ).

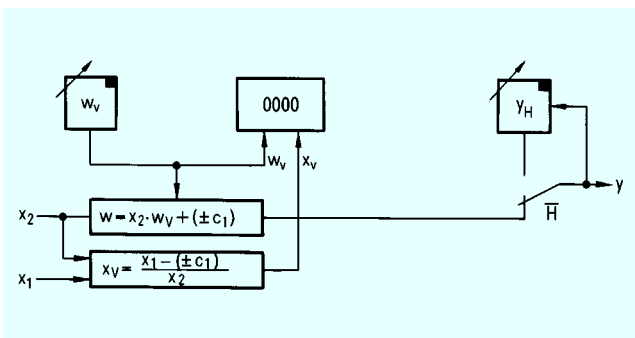


Fig. 4/12 Ratio station

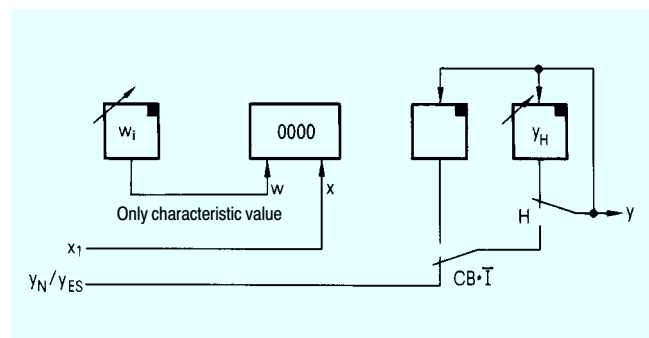


Fig. 4/14 DDC manual control station K

Manual/automatic control station, DDC manual control station

The device outputs a signal which can be adjusted using the manipulated variable pushbuttons and indicated in % on the two-digit y-indicator. Values between -9 and +109 % are displayed.

Any process variable  $x_1$  applied to the device via an analog input can be indicated on the four-digit display. The setpoint display can be used together with the setpoint adjustment keys to output any characteristic setpoint.

When configuring the digital input for the CB function, the SIPART DR20 controller can also be used in this mode as a DDC manual control station.

Process variable indicator

One of 2 external variables  $x_1$  and  $x_2$  can be displayed in engineering units on the four-digit digital indicator. The display range is set in the factory to 0.0 to 100.0 %. The user can set the range to anywhere between -1999 and +9999 (parameters LA and LE).

The display range is the same for both external variables  $x_1$  and  $x_2$ .

When connected to a higher-level system, the value  $w_{ES}$  applied via the serial interface can be displayed instead of  $x_2$ . The limit monitors (A1 and A2) can be configured to these input variables.

A further process variable can be indicated in % on the two-digit y-display. The associated input signal is  $y_R/y_N$ .

The device also enables the following possibilities in this mode:

- If the standard device is a K controller, a current of 0 (4) to 20 mA is output via the analog output. This signal can be set as the variable  $w_1$  using the setpoint pushbuttons when switching to local mode and read on the four-digit display.
- If the standard device is an S controller, the signals of a 2nd limit monitor can be output via outputs  $+\Delta y$  and  $-\Delta y$ . The switching thresholds of this limit monitor are set by parameters  $y_a$  and  $y_e$  with a hysteresis of 1 %. The associated input signal is  $y_R/y_N$ .



## Description

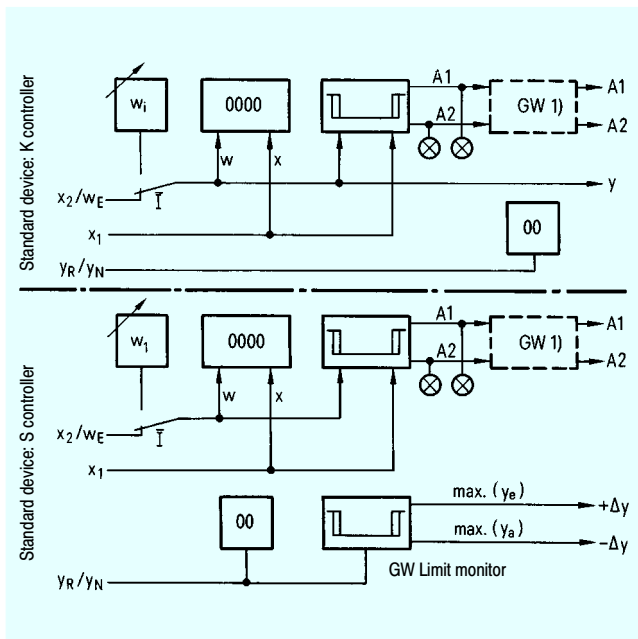


Fig. 4/15 Process indicators

The following functions can be implemented in the various SIPART DR20 controllers:

### ■ Processing of the analog input signals

The controller can process 3 input variables ( $x_1$ ,  $x_2/w_E$  and  $y_R/y_N$ ). The square-roots of the variables  $x_1$  and  $x_2/w_E$  can be extracted if desired, the main controlled variable  $x_1$  can also be linearised.

### ■ Display in engineering units and linearisation of the main controlled variable

The process variables (controlled variable  $x$ , command variable  $w$  and limits  $A1$  and  $A2$ ) which can be indicated on the four-digit display can be displayed as percentages or in engineering units providing the same measuring range applies to these variables. The start-of-scale value  $LA$  and the full-scale value  $LE$  are entered as parameters. The decimal point is set using a configuring switch. The refresh rate of the digital display can also be selected.

In order to display a non-linear controlled variable  $x_1$  in digital form, this must first be linearised within its measuring range. Linearisation is carried out using a progression consisting of 8 straight lines within the range. These are entered via 7 vertices as the parameters  $L1$  to  $L7$ .

The lineariser can also be parameterized for a falling characteristic.

### ■ Transmitter monitoring

All or only some of the process variables  $x_1$ ,  $x_2/w_E$ ,  $y_R/y_N$  are monitored for range violation as selected using a configuring switch. In the case of a violation, the four-digit display indicates the disturbed input.

In addition, an automatic switch over to manual mode can be configured.

The fault indication can be acknowledged. The signal  $MuSt$  and the configured manual mode are not overridden and are retained.

1) Option.

### ■ Setpoint ramp, setpoint limiting and x-tracking

To prevent the setpoint or the setpoint ratio from changing impermissibly fast, the desired rate of change can be set. The parameter  $T_w$  is used for the time in which the setpoint changes by 100 %. The setpoint ramp is always effective except with x-tracking.

The setpoint range can be limited by the parameters  $w_a$  and  $w_e$ . The ramp function and the setpoint limiting are independent of whether the setpoint is applied remotely or locally.

x-tracking can also be configured. In this case the setpoint  $w$  is made to track the controlled variable  $x$  without a delay in manual, tracking or DDC mode as well as with the safety manipulated variable or with manipulated variable blocking so that switching back to automatic mode is bumpless. In the case of controllers operated in mode "Local setpoint", the actual value of the controlled variable is then accepted as the setpoint. In the case of mode "Remote setpoint", the actual value is also initially accepted as the setpoint when switching back to automatic mode. However, this is then adjusted by the parameterized ramp  $T_w$  to the value of the remote command variable. Setpoint limits are effective with x-tracking.

### ■ Filter and response threshold of negative deviation

A 1st order filter with the time constant  $t_F$  acts on the negative deviation  $x_d$ .

The filter is switched on with a jump in the display of parameter  $t_F$  from OFF to 1 s and can be adjusted within wide limits.

The time  $t_F$  should only be adjusted to a value so that  $x_d$  does not oscillate ( $t_F < \text{recovery time } T_g$ ).

A dead-zone element (response threshold  $A$ ) can be parameterized if the controller output is to be dampened in addition to the effect of the filter. In this manner small control oscillations resulting from a finite resolution (S controller) can be overcome and gear box backlash can be prevented.

### ■ Matching the direction of action

The basic setting of the controller applies to controlled systems with a normal action. In the case of reversed controlled systems, the sign of the proportional gain  $K_P$  must be inverted using a configuring switch. This applies to the P and I components as well as to the D element to which a disturbance variable  $x_2$  may also be applied.

The manipulated variable display can be configured from a rising output to a falling output.

### ■ Control algorithm

P(D) and PI(D) control algorithms are implemented as parallel interaction-free structures and are the same independent of the output structure S or K of the device.

P or PI control can be selected by configuring.

The negative deviation  $x_d = w - x$  is multiplied by the proportional gain  $K_P$  for the P component. This value is positive for a normal-acting controlled system and negative for a reversed loop.  $K_P$  can be adjusted in a range from 0.1 to 100.0 by parameterization.

The I component has a range of adjustment for  $T_n$  from 1 to 9984 s. The internal processing ensures that even very small negative control deviations can be integrated without faults even with large reset times.



## Description

Switch S27 can be configured to select which of the variables  $x_1$ ,  $x$  or  $x_2/w_e$  is to be applied to the D element. The D element amplifies this input signal by a factor  $V_v$  (1 to 10) and applies it to a reducing timer with the time constant  $T_v/V_v$ . The D component is added to the P or PI component without feedback.

The derivative action time  $T_v$  can be adjusted in the range from 1 to 1000 s. The D element can be switched off by setting  $T_v < 1$  s (OFF).

Three-position step controllers can only be operated as P controllers with external feedback. To enable bumpless transfer from automatic to manual mode without manual adjustment, the manual manipulated variable signal is made to track the controller output signal during automatic mode.

If automatic mode is not selected, the I component or the working point  $y_0$  is tracked such that bumpless switchover to automatic mode is possible. Any remaining D component is set to zero in the process. This structure results in automatic adjustment of the working point  $y_0$  with the P controller. The working point  $y_0$  can also be set manually.

### ■ Limitation of controller manipulated variable

The parameters  $y_a$  and  $y_e$  can be used to limit the manipulated variable in K controllers and three-position step controllers with position feedback. Limitation of the manipulated variable is only effective in automatic mode.

Limits of parameters  $y_a$  and  $y_e$ : -10 % and +110 %.

However, the controller cannot output negative manipulated variable currents or receive negative position feedbacks.

If the manipulated variable  $y_A$  reaches one of the limits  $y_a$  or  $y_e$  in automatic mode, further integration is inhibited. This prevents integral saturation. In this manner a change in the manipulated variable is immediately possible when the polarity of the negative deviation is reversed.

If the manipulated variable has been driven out of the range  $y_a$  to  $y_e$  during manual, tracking, safety or DDC mode, the last manipulated variable is accepted in a bumpless manner when switching to automatic mode, but only changes in the direction of range  $y_a$  to  $y_e$  are subsequently carried out.

Manipulated variable limitation is not possible with three-position step controllers with internal position feedback.

With two-step controllers, the parameters  $y_a$  and  $y_e$  are used to set the dead band between the channels 1 and 2 (heating and cooling).

### ■ Limit monitors

The configuring switch S22 can be used to select which of the variables  $x_d$ ,  $x$  or  $w$  (with ratio control  $x_v$  or  $w_v$ ) is to be monitored for limit violations and displayed on the LEDs A1 and A2.

The alarm type is defined using configuring switch S23. In addition to the normally used type min. - max., limit monitoring min. - min. or max. - max. is also possible. It is then possible to output a preliminary alarm and a main alarm for each monitored variable in the case of upward violations or downward violations.

The limit monitors are normally set in parameter mode. Configuring switch S24 can be used to define that the limit monitors can also be set in the process operation mode.

Limit violations are signalled by two LEDs. The set limits are displayed in the same engineering unit as the actual value and setpoint. The hysteresis is 1 % of the measuring range.

### ■ Blocking of the parameterization and configuring modes

As an alternative to blocking the parameterization and configuring modes via the digital input BE in the basic controller, switchover to the parameterization and configuring mode can also be blocked via the digital input BE of the signal converter.

### ■ Restart conditions

Short dips in the operating voltage are bridged by the storage effect of the power pack depending on the respective loading of the device. In the event of a longer power failure, the set parameters and configurations are stored in a non-volatile memory.

The last effective setpoint  $w$  is also loaded into this memory if it has not been changed for at least 5 min.

Following interruptions in the power or when switching the device on again, processing takes place automatically with the operating modes, setpoints and manipulated variables defined by configuring switch S41. The four-digit display (11, Fig. 4/17) flashes in the process. The signal is acknowledged by pressing the selector (7).

### ■ Signalling of device faults

A memory monitoring circuit and a watchdog circuit in the SIPART DR20 controller cyclically monitor the device for correct functioning. A reset automatically takes place if a fault is detected and the device starts with the restart conditions.

### Input/output modules (option modules)

The hardware configuration of the standard unit can be extended to cater for special requirements. A range of modules which can be ordered as accessories, are provided for this purpose.

These modules are inserted in slots in the rear of the controller. The slots are coded to prevent modules being inserted incorrectly.

Some settings on the modules may need to be modified before they are inserted in the controller.

Configuring switches are used to make the necessary connections to the inputs and outputs.

## Description

### ■ Communication with higher-level systems

The SIPART DR20 controller can transmit and receive status flags, process variables, parameters and configuring switch settings via an interface module (option).

The following interface modules are available:

#### PROFIBUS DP module

- Transmission rate up to 1.5 Mbits/s
- Address range up to 31 (number of possible stations on the PROFIBUS is additionally determined by the master interface module, the data range of the interface module, and the number of parametrized process data)

#### SES module RS 232

- Transmission rate 9.6 kbits/s
- RS 232 as point-to-point connection or SIPART bus up to 32 stations

The RS 485 bus of the interface module cannot be used in conjunction with the SIPART DR20 controller.

The advantages of the independent SIPART DR20 single-loop controller are also used to full effect together with higher-level systems:

- Problem-free adaptation of each device to the application
- Operational safety; if the higher-level system is switched off or if a part of it fails, the SIPART DR20 controller continues to operate as an autonomous device with the previously-defined conditions
- Flexibility; modifications to or extensions of individual control loops are also possible at any time during operation of the complete system
- Both SPC and DDC modes possible
- The higher-level system is freed to a certain extent by transferring the controller functions to the single-loop controller
- Can also be used as a DDC manual control station
- Distributed design of system results in easier maintenance and operational understanding.

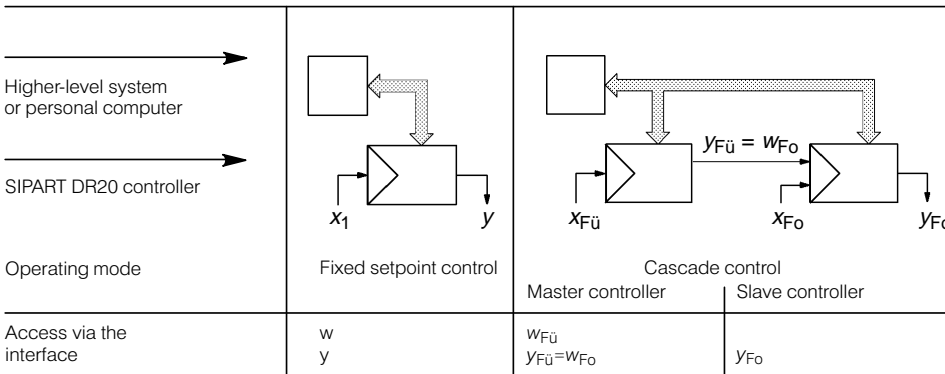


Fig. 4/16 Possible operating modes of the SIPART DR20 controllers when operating via the serial interface

### Control and display functions

Operation of the SIPART DR20 controller is in 3 modes:

- Process operation
- Parameterization
- Configuring.

The pushbuttons and displays on the front of the device are sometimes assigned different functions in these 3 operating levels.

#### Process operation (Fig. 4/17)

Operation of the SIPART DR20 controller in process mode is self-explanatory as a result of the layout and colors of the front panel, control elements and inscriptions.

The display (13) can be configured for display of the negative deviation  $x_d (w - x)$  or the deviation  $x_w (x - w)$ . It consists of 21 LEDs of which the center one is green and the others red in groups of 10 or display of a positive or negative deviation. The display resolution can be selected in several steps from  $\pm 2.5\%$  to  $\pm 40\%$ .

The label (14) is replaceable. Condition on delivery: labelled for scale range  $\pm 10\%$ .

The rear is plain and can be labelled for individual inscriptions, e. g. loop tag No., measuring range, dimension of variable.

The LEDs (12) indicate downward or upward violation of limits A1 or A2. The visual function is always present independent of whether the controller is equipped with a limit module for remote signalling or not.

The four-digit display (11) indicates either the actual value  $x$ , the setpoint  $w$ , the limits A1 and A2 and - with configuring switch S18 in position "1" - also the safety setpoint SH. The display is switched over using the pushbutton (7). The LEDs (6) and the digital display (10) signal which of the variables is currently indicated.

The manipulated variable  $y$  is adjusted in manual mode using the pushbuttons (8). In the K controllers, the rate of adjustment increases the longer the button is pressed. In the S controllers, the associated output relay is activated and the mark (9.1 or 9.2) next to the respective pushbutton lights up in the display (10).

## Description

The two-digit display (10) indicates the manipulated variable output or feedback. The display range is -9 to +109 %. The numbers 100 to 109 are displayed as h0 to h9. The marks (9.1 and 9.2) indicate the output of manipulated variable signals with S controllers.

The selector (5) is used to switch the controller from automatic mode to manual mode and vice versa. The yellow LED (4) lights up in manual mode. It flashes in the case of tracking mode of the controller, activation of the safety manipulated variable or with manipulated variable blocking.

The pushbuttons (3) are used to adjust the internal setpoint of the SIPART DR20 controller. The rate of adjustment increases with the time of pressing. Setpoint adjustments are only possible if the green LEDs (2 and 6.1) signal that the four-digit display indicates the setpoint and that local mode is present.

The pushbuttons (3, Fig. 4/17) can also be used to adjust the safety setpoint SH if this variable is indicated on the display (11) and if configuring switch S24 ist at "1".

The selector (1) is used to switch between local and remote modes. The LED (2) lights up with local mode.

Remote mode means with

- fixed setpoint controllers: that the setpoint is protected against readjustment
- ratio controllers and ratio stations: that the setpoint ratio is protected against readjustment
- Slave/ SPC controllers: that the setpoint is passed on to the controller via the analog input  $w_E$  or the serial interface (SES)
- DDC back-up controller and DDC manual control station: that back-up mode is present.

The selector (1) has no function in slave controllers without local/remote switchover and in synchronization controllers and manual/automatic control stations.

The LED (2) then remains dark. In remote mode with the computer switched on (CB = "1"), the LED flashes with a duty cycle of approx. 0.9. The duty factor changes to approx. 0.5 if the CB signal fails in remote mode.

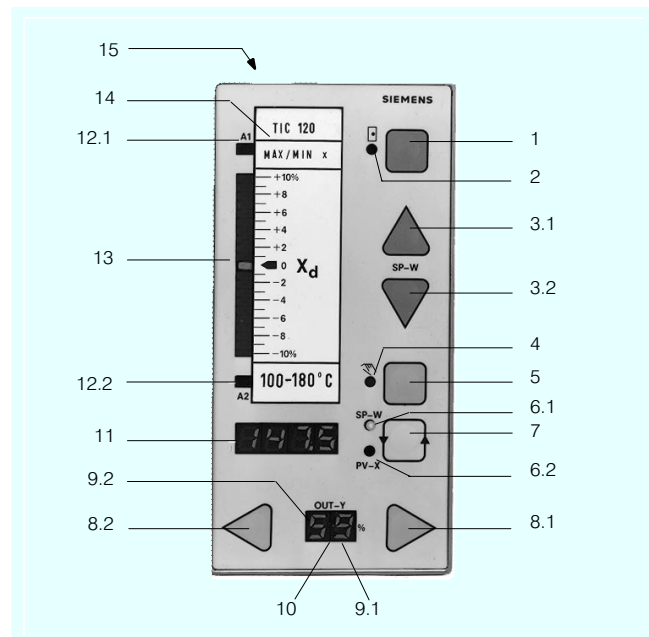
### Parameterization

In order to prevent maloperations of the SIPART DR20 controller, several operations, which must be made within 20 s, are required to switch to parameterization and configuring otherwise an automatic return is made to process operation.

Proceed as follows:

1. Press the selector (7) until the two-digit display (10) flashes "PS". Release pushbutton. The display "PS" now becomes steady.
 

The two digital displays (10 and 11) now no longer indicate process variables. However the controller remains fully functional, and indicates the negative deviation  $x_d$  (display 13).
2. Press pushbutton (3.1) several times until the digital display (11) signals "PAR". The controller can now be parameterized.



- 1 Selector for local/remote mode
- 2 LED (green)  
Steady light: local setpoint  
Flashing light: specific SPC or DDC states
- 3.1 Pushbutton to increase the setpoint
- 3.2 Pushbutton to decrease the setpoint
- 4 LED (yellow)  
Steady light: manual mode  
Flashing light: remote intervention (N, Si, Bi)
- 5 Selector for manual/automatic mode
- 6.1 LED (green), lights up if display (11) indicates w
- 6.2 LED (red), lights up if display (11) indicates x
- 7 Selector for four-digit display (11) and to activate the parameterization and configuring levels
- 8.1 Pushbutton to adjust manipulated variable in direction of 100 % display
- 8.2 Pushbutton to adjust manipulated var. in direction of 0 % display
- 9.1 Mark lights up with S controllers when +  $\Delta y$  is output
- 9.2 Mark lights up with S controllers when -  $\Delta y$  is output
- 10 Two-digit display for manipulated variable y and for selected parameter and configuring switch
- 11 Four-digit display for actual value x, setpoint w, limits A1 and A2, safety setpoint SH if applicable as well as parameters and configuring switch values
- 12.1 LED (red), indicates upward or downward violation of limit A1
- 12.2 LED (red), indicates upward or downward violation of limit A2
- 13 Display for negative deviation and for deviation
- 14 Replaceable label
- 15 Cover for scale replacement

Fig. 4/17 SIPART DR20 controller, controls and displays

3. Scroll through the parameter list forwards or backwards using pushbuttons (8.1 and 8.2). The display (10) indicates the selected parameter. The first parameter to appear is always the last one which was selected in a previous parameterization mode.
4. Set the called parameter using the pushbuttons (3.1 and 3.2). Its value is indicated on the four-digit display (11).
5. Return to process operation by pressing the selector (7).

## Description

### Configuring (cf. page 4/13 and Fig. 4/17)

The configuring switches are selected and set in a similar manner to parameterization.

1. Press the selector (7) until the two-digit display (10) flashes "PS". Release pushbutton. The display "PS" now becomes steady.
2. Now press pushbutton (3.1) several times until the four-digit display (11) first indicates "PAr" and then "Str". The controller can now be configured.  
The device now blocks its output. The display (13) indicates a zebra pattern.
3. Scroll forwards or backwards through the configuring switch list using pushbuttons (8.1 and 8.2). The display (10) indicates the selected configuring switch. The first configuring switch is always the last one which was selected in the previous configuring mode.
4. Adjust the selected configuring switch using pushbuttons (3.1 and 3.2). The selected setting is output on the four-digit display (11).
5. A return to parameter mode is made by pressing pushbutton (7), and then to process operation by pressing the pushbutton again.
6. The controller is now in manual mode.

### Lamp test

If pushbutton (7) is pressed for longer than 5 s, all LEDs on the front panel of the controller are triggered until the pushbutton is released independent of the respective display.

The original display setting is set again at the end of the lamp test.

### Display of software release version

The software for the SIPART DR20 controller is being continuously improved as a result of newly gained knowledge. The respective release version of the software is stored in the PROM and can be called as follows:

- Press pushbutton (7) until the lamp test starts.
- During the lamp test, press key (1). The code for the software release version of the device can now be read on the four-digit display (11).

**Description**

**Configuring switches**

Configuring switch	Function
S1	Type of controller
0	Fixed setpoint controller
1	Fixed setpoint controller with disturbance variable feedforward at input
2	Fixed setpoint controller with disturbance variable feedforward at output
3	DDC back-up fixed setpoint controller
4	Slave controller without local/remote switchover via front of control unit
5	Slave controller with local/remote switchover and SPC mode via the serial interface
6	Synchronization controller
7	Ratio controller
8	Ratio station (only K controllers)
9	Manual/automatic control station, DDC manual control station
10	Process indicator
S2	Output structure
0	K controller
1	Two-step controller for heating/cooling
2	S controller with local position feedback
3	S controller with remote position feedback
S3	Mains frequency suppression
0	50 Hz
1	60 Hz
S4 and S5	Signal range of AE1 and AE2 inputs
S6 and S7	Signal range and option module for AE3 and AE4
S8	Assignment of analog input AE1 or AE3 to main controlled variable $x_1$
S9	Assignment of analog input AE2 or AE4 to position feedback $y_R$ or position tracking $y_N$
S10	Assignment of analog inputs AE1, AE2, AE3 and AE4 to disturbance variable $x_2$ / command variable $x_2$ or to remote setpoint $w_e$ (configuring switch S1)
S11	Transmitter monitoring
S12	Square-root extraction of main controlled variable $x_1$
S13	Square-root extracting of $x_2$
S14	Linearization of main controlled variable $x_1$
S15	Assignment of control signals BI, Si, N, CB, BLPS to digital input BE
S16	Direction of action of digital input BE
S17	x-tracking
S18	Setpoint with CB failure
S19	Tracking of local setpoint
S20 and S21	Setting of digital display
S22 to S24	Limit monitor settings
S25	Display range of analog display
S26	Direction of action of controller
S27	D element input
S28	Control algorithm
S29	Priority N/BI or manual mode
S30	Manual mode with transmitter fault
S31	Blocking of manual mode/automatic mode switchover
S32 and S33	Manipulated variable display: Selection of displayed variable and direction of action
S34	Assignment of alarm signals RC, H, RB, MuSt to digital output BA
S35	Direction of action of digital output
S36	Configuration with limit value monitor (option)
S37 and S38	K controller: current output/manipulated variable
S39 and S40	S controller: Matching pulse length/pulse interval
S41	Restart conditions following power failure
S42 to S48	Settings of serial interface: station No., data transmission rate, parity

**Parameters**

Vv	Derivative action gain	SA	Start value for setpoint limitation $w_a/w_{va}$
$K_P$	Proportional gain	SE	End value for setpoint limitation $w_e/w_{ve}$
$T_n$	Reset time	SH	Safety setpoint $w_s$
$Y_0$	Working point of P(D) controller	A2	Alarm, minimum value
$T_v$	Derivative action time	A1	Alarm, maximum value
TF	Filter time constant for $x_d$	A	Response threshold
$T_w$	Setpoint ramp	YA	Manipulated variable limitation (start)
$T_y/T_+$	Valve positioning time/heating period cooling period	YE	Manipulated variable limitation (end)
$T_-$		YS	Safety manipulate variable
LA	Start-of-scale, digital display	c1	Constant $c_1$ (zero)
L1 to L7	Vertices for linearization of final control variable/digital display (interim values)	c2	Constant $c_2$ (factor)
LE	Full-scale value of digital display		

## Technical Data

Technical data											
<p><b>Standard controller</b></p> <p>Analog inputs AE1, AE2            Input signal range <sup>1)</sup>            Input resistance            Filter time constant</p> <p>Digital input BE            Signal status "0" <sup>1)</sup>            "1" <sup>1)</sup>            Input resistance</p> <p>Manipulated variable <math>I_y</math> (K controller)            Output signal range <sup>1)</sup>            Max. permissible load            Influencing effect of load            Max. permissible inductive load</p> <p>Digital output BA            Signal status "0" <sup>1)</sup>            "1" <sup>1)</sup>            Max. load current</p> <p>Manipulated variable <math>\pm \Delta y</math> (S controller)            Contact material            Contact loading capacity            - Max. switching voltage            - Max. switching current            - Max. switching power</p> <p>Max. service life            - Mechanical            - Resistive</p> <p>Built-in spark suppression element (capacitors can be fitted on solder tags)</p> <p>Transmitter supply            Rated supply voltage <math>U_N</math> <sup>1)</sup>            Max. permissible load current            Short-circuit current            Internal resistance</p>	<p>0 to 20 mA or 4 to 20 mA  <math>249 \Omega \pm 0.1 \%</math>            Approx. 25 ms</p> <p><math>\leq 4.5</math> V open-circuit  <math>+13</math> to <math>+35</math> V  <math>\geq 27</math> k<math>\Omega</math></p> <p>0 to 20 mA or 4 to 20 mA  <math>-1</math> to <math>+18</math> V  <math>\leq 0.1 \%</math>            0.1 H</p> <p><math>\leq 1.5</math> V            19 to 26 V            30 mA, short-circuit-proof</p> <table border="1"> <thead> <tr> <th colspan="2">Ag-Ni</th> </tr> <tr> <th>Alternating current</th> <th>Direct current</th> </tr> </thead> <tbody> <tr> <td>250 V</td> <td>250 V</td> </tr> <tr> <td>5 A</td> <td>5 A</td> </tr> <tr> <td>1250 VA</td> <td>100 W at 24 V 50 W at 250 V</td> </tr> </tbody> </table> <p>Approx. <math>2 \cdot 10^7</math> operations            Approx. <math>2 \cdot 10^6</math> operations with ohmic load</p> <p>Series connection 33 nF/220 <math>\Omega</math> varistor in parallel with <math>U_{rms} = 420</math> V</p> <p>20 to 26 V            60 mA, short-circuit-proof  <math>&lt; 200</math> mA, pulsed  <math>&lt; 10 \Omega</math></p>	Ag-Ni		Alternating current	Direct current	250 V	250 V	5 A	5 A	1250 VA	100 W at 24 V 50 W at 250 V
Ag-Ni											
Alternating current	Direct current										
250 V	250 V										
5 A	5 A										
1250 VA	100 W at 24 V 50 W at 250 V										
<p><b>CPU</b></p> <p>Arithmetic cycle time            Internal numerical representation            Resolution of mantissa</p>	<p>97.8 ms <math>\pm 1 \%</math></p> <p>3-byte floating-point representation</p> <p>16 bit (1 LSB <math>\triangleq</math> 0.0016 %)</p>										
<p><b>A/D conversion</b></p> <p>Method</p> <p>Resolution            Zero error            Full-scale error            Linearity error            Influencing effect of temperature</p>	<p>Successive approximation, per input <math>&gt; 120</math> conversions and averaging within 20 or 16.67 ms</p> <p>11 bit</p> <p><math>\leq 0.2 \%</math>  <math>\leq 0.3 \%</math>  <math>\leq 0.2 \%</math></p> <p><math>\leq 0.2 \%</math>/10 K</p>										
<p><b>Displays</b></p> <p>w/x display            Color/digit height            Display range            Decimal point            Refresh rate            Resolution</p> <p>Deviation display            Display length            Refresh rate            Resolution            Resolution in vicinity of 0</p> <p>y display            Color/digit height            Display range</p> <p>Refresh rate            Resolution</p> <p><b>General data</b></p> <p>Mounting position</p> <p>Climatic classes            - Storage: 1K2 according to DIN IEC 721 Part 3-1            - Transport: 2K2 according to DIN IEC 721 Part 3-2            - Operation: 3K3 according to DIN IEC 721 Part 3-3</p> <p>Degree of protection to EN 60 529            - Control and display unit            - Housing            - Connections (when inserted)</p> <p>Color            - Frame of control and display unit            - Front surface</p> <p>Weight (max. configuration)</p> <p>Dimensions</p>		<p>Four-digit, 7-segment display            Red/7 mm  <math>-1999</math> to <math>9999</math>            Adjustable            0.1 to 5 s, adjustable            1 digit</p> <p>21 LEDs            50.8 mm            Arithmetic cycle time            0.1 · display range            0.05 · display range</p> <p>Two-digit, 7-segment display            Red/7 mm  <math>-9</math> to <math>+99 \%</math>            (100 % = <math>h_0</math> to 109 % = <math>h_9</math>)            0.1 to 5 s, adjustable            1 digit <math>\triangleq</math> 1 %</p> <p>Any</p> <p><math>-25</math> to <math>+75</math> °C  <math>-25</math> to <math>+75</math> °C            0 to <math>+50</math> °C</p> <p>IP 64            IP 30            IP 20</p> <p>RAL 7037            RAL 7035</p> <p>Approx. 1.2 kg</p> <p>See Fig. 4/18</p>									
<p><b>Controller design</b></p> <p>- To DIN EN 61 010 (IEC 1010-1+A1)            - Protection class I to IEC 536            - Isolation between mains connection and field signals by double insulation or protective shield to DIN/VDE 0106, Part 101 (Nov. 1986) (IEC 536) for overvoltage class III and contamination class II to DIN/VDE 0110, Part 1 (Jan. 1989)            - Clearance and creepage paths, if not specifically stated otherwise, for overvoltage class III and contamination class II to DIN/VDE 0110, Part 1 (Jan. 1989)            - The output voltages are extra-low voltages to DIN/VDE 0100, Part 410 (Nov. 1983) (IEC 364-4-41)            - Isolation between the <math>\pm \Delta y</math> contacts of the S controller 6DR2001-... and the field signals by double insulation or protective shield to DIN/VDE 0106, Part 101 (Nov. 1986) (IEC 536) for overvoltage class III and contamination class II to DIN/VDE 0110, Part 1 (Jan. 1989)</p> <p><b>CE mark</b></p> <p>The controller conforms with the following harmonized standards:            EU Certificate of Conformance no. DR20-1/1995 with respect to EMC Guidelines 89/336 EWG, NS Guidelines 73/23 EWG</p> <p>- Emitted interference            EN 50 081 Part 2 Issued: 8/1993</p> <p>- Immunity to interference            EN 50 082 Part 2 Issued: 1995</p> <p>- NAMUR; NE 21 Issued: May 1993</p> <p>NS Guidelines 73/23/EWG</p> <p>- EN 61 010 Part 1 Issued: 09.03.1993            - EN 60 529 Issued: 26.06.1991</p>											

<sup>1)</sup> Referred to M.

Technical data

Technical data (continued)			
Power supply			
Rated voltage	AC 230 V	AC 115 V	AC/DC 24 V
Operating voltage range	AC 195 to 276 V	AC 97 to 138 V	AC 20 to 28 V DC 20 to 35 V
Frequency range	48 to 63 Hz	48 to 63 Hz	48 to 63 Hz
Peak voltages acc. to IEC 801-5 (1.2/50 μs)			
- symmetric	1 kV	1 kV	0.5 kV
- asymmetric	2 kV	2 kV	1 kV
Permissible voltage dips at max. load 1)	≤ 30 ms	≤ 30 ms	≤ 30 ms
Power consumption at max. load			
- Apparent power	≤ 21 VA	≤ 21 VA	≤ 18 VA
- Active power	≤ 13 W	≤ 13 W	≤ 13 W
Power supply connection	Three-pin plug IEC 320/V Special two-pin plug		
AC 115 V, 230 V AC/DC 24 V			
Connections for process signal transmitters	Multi-way screw terminal blocks, plug-in, cannot be confused		
Permissible conductor cross-section	1.5 mm <sup>2</sup> (AWG 14)		
Protective earth connection	Earthing screw		

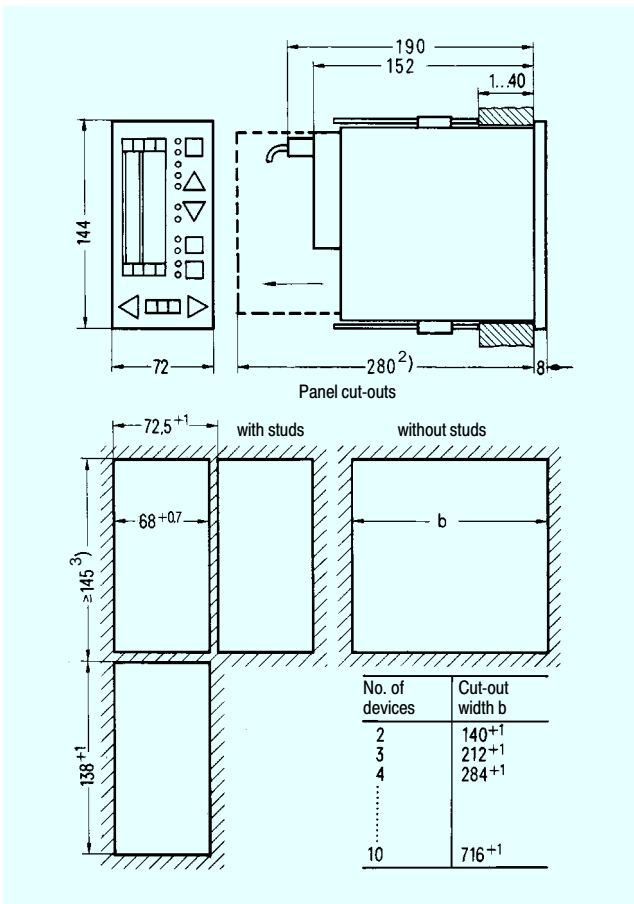


Fig. 4/18 SIPART DR20 controller and panel cut-outs, dimensions

1) The transmitter supply voltage may drop by up to 5 V and the maximum compliance voltage of the manipulated variable current  $I_T$  from 18 to 11 V.  
 2) Mounting depth required to replace the I/O modules.  
 3) Mounting above each other without intermediate spacing is permissible if the ambient temperature range is observed.



## Ordering data

Ordering data	
	Order No.
<b>SIPART DR20 controller, 72 x 144,</b> basic unit with 2 analog inputs, 1 digital input and 1 digital output • With S output  - power supply AC 230 V - power supply AC 115 V - power supply AC/DC 24 V • With K output  - power supply AC 230 V - power supply AC 115 V - power supply AC/DC 24 V	   <b>6DR2001-1</b> <b>6DR2001-2</b> <b>6DR2001-4</b>    <b>6DR2004-1</b> <b>6DR2004-2</b> <b>6DR2004-4</b>
<b>Input/output modules</b>  <b>Module for analog signals</b> - For current input 0/4 to 20 mA or 0/0.2 to 1 V or 0/2 to 10 V voltage input (6DR2800-8J) - For resistance-based sensor (R module) (6DR2800-8R) - For Pt 100 resistance thermometers (6DR2800-8P) - For thermocouples or other mV signals (6DR2800-8T)  <b>Switching signal module</b> for the output of limit signals - with 2 relay outputs (6DR2801-8D) - with 4 digital outputs and a digital input (6DR2801-8E)  <b>Interface modules</b> - for serial communications (SES) via RS232 (6DR2803-8C) - PROFIBUS DP module (6DR2803-8P)	See Catalog Section 8
<b>Documentation</b>  <b>Planning manual</b> - German - English  <b>Operating instructions</b> - German/English/French/Italian/Spanish (These instructions are part of the scope of delivery of the controller)  <b>Instructions "Serial V.28 interface"</b> - German - English	  <b>6ZB5600-0AA01-0BA1</b> <b>6ZB5600-0AA02-0BA0</b>   <b>C73000-M7464-C30</b>   <b>C73000-B7400-C128</b> <b>C73000-B7476-C128</b>

### Scope of supply

The scope of supply of a SIPART DR20 controller includes:

- 1 controller as ordered
- 1 power supply connector 115/230 V or a special connector for 24 V AC/DC supply
- 2 clamping elements, pluggable
- 1 Quick Reference (English/German)
- 1 Assembly and Installation Instructions (English/German)

### Available ex-stores

Items marked   are available ex-stores.

### Input/output modules and accessories

The input/output modules are described in section 8.

Section 9 of the catalog contains details about software for parameterizing the controller from a PC, interfacing to systems and the necessary accessories (connectors, line drivers, etc.).

### Training

Refer to ITC (German) catalog for details of training courses for the controllers listed in this catalog.