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SIPART DR
Summary

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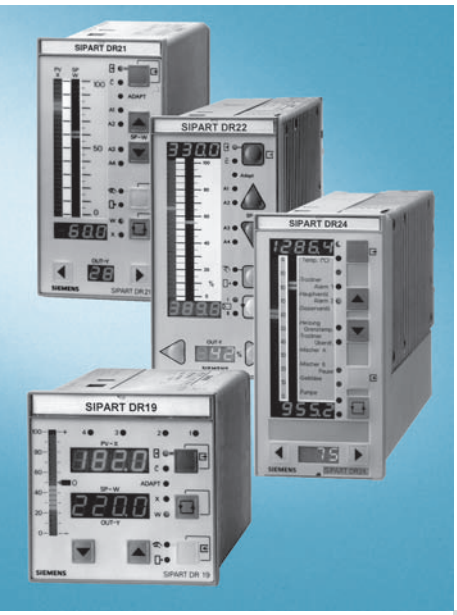

2/2 SIPART DR controllers - Overview

2/3 Fundamentals of control engineering

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Electronic controllers

Overview

SIPART DR Controllers - Overview

DR19

DR20

DR21

DR22

DR24

	SIPART DR19 industrial controller For all standard tasks	SIPART DR20 controller [4] For all standard tasks	SIPART DR21 controller For all standard tasks, with comprehensive displays	SIPART DR22 controller For complex controls	SIPART DR24 multi-function unit Freely-configurable control and computing unit, for complex controls
Input structure					
Fixed setpoint controller	■ (up to 5 setpoints)	■	■ (up to 2 setpoints)	■ (free connection)	■ (free connection)
Slave controller	■	■	■	■	■
(Controlled) ratio controller	■ / ■	■ / –	■ / ■	■ / ■	■ / ■
Cascade controller	–	–	–	■	■
Override controller	–	–	–	■	■
SPC / DDC controller	■ / –	■ / ■	■ / ■	■ / ■	■ / ■
Independent controllers	1	1	1	2	4
Program controller	■	–	–	–	■
Output structure					
Cont. controller (20 mA)	■	■ [2]	■	■	■
Step controller					
Binary signal (24 V)	■	Option	■	■	■
Relay	■	■ [3]	■	–	–
Two-position controller					
Binary signal (24 V)	■	Option	■	–	■
Relay	■	■ [3]	■	–	–
Input and output signals					
20-mA analog inputs	0, max. 3	2, max. 4	2, max. 4	3, max. 11	3, max. 11
Direct sensor connection	1, max. 3	0, max. 2	0, max. 2	0, max. 2	0, max. 2
Analog outputs	1	1 [2]	1	3, max. 9	3, max. 9
Binary inputs [1]	2, max. 7	1, max. 2	2, max 7	4, max. 14	4, max. 14
Binary outputs [1]	2, max. 8	1, max. 5	2, max. 8	8, max. 16	8, max. 16
Slot for option modules	4	4	4	5	5
Displays/signalling diodes					
Digital displays (LED)	2 × 4-digit	1 × 4-digit 1 × 2-digit	1 × 4-digit 1 × 2-digit	2 × 4-digit 1 × 3-digit	2 × 4-digit 1 × 3-digit
Analog displays (LED)	1 × 21 segments	1 × 21 segments	2 × 30 segments	2 × 30 segments	2 × 30 segments
Signal diodes / no. of alarms	11 / 4	6 / 2	11 / 4	11 / 4	11 / 4
Further characteristics					
Adaptation procedure	■	–	■	■	■
Arithmetic functions	–	–	–	■	■
RS 232 interface	Option	Option	Option	Option	Option
RS 485 interface	Option	–	Option	–	–
PROFIBUS DP interface	Option	Option	Option	Option	Option
PC configuration software	SIMATIC PDM	SIMATIC PDM	SIMATIC PDM	SIMATIC PDM	SIPROM DR24
Power supply AC/DC	24 V	24 V	24 V	24 V	24 V
AC	230 / 115 V	230 or 115 V	230 / 115 V	230 / 115 V	230 / 115 V
Format	96 mm × 96 mm	72 mm × 144 mm	72 mm × 144 mm	72 mm × 144 mm	72 mm × 144 mm
Mounting depth	199 mm	190 mm	197 mm	278 mm	278 mm

[1] The max. numbers of binary inputs and outputs are not possible simultaneously.
[2] Basic unit: K controller
[3] Basic unit: S controller
[4] Discontinued

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Fundamentals of control engineering

Introduction

With the advent of automation, the use of the term control generally suggests properties such as reliable functioning, high accuracy, special quality or increased flexibility. A topical example is the catalytic converter in a modern car.

Although the control principle is used to an increasingly varied extent in all types of processes, it is not a technical invention. It is a natural phenomenon which enables a particular state to be retained automatically despite external interferences. Many biological and environmental processes, but also sociological and economical processes, function according to this control principle.

Development of control engineering

Parallel to practical control engineering, the theory of control problems is also an important aspect.

In the course of time, control engineering has developed into an autonomous science applicable to many fields. The beginning of the technical use of control principles can be found, for example, in the centrifugal governor of the steam engine made by James Watt (1788) and continues with the first mathematical descriptions of control procedures at the start of the 20th century, followed by the introduction of fundamental, systematic methods (e.g. Oldenbourg and Sartorius 1944) and finally the appearance of modern, increasingly computer-based procedures (Kalman 1960).

Open-loop and closed-loop control

An initial impression of the basic problems encountered with control systems and a feeling for their mode of operation can best be explained using a simple example.

Consider a heater whose task is to achieve a specific room temperature (Fig. 2/1). A possibility would be to measure the outside temperature and to vary the flow of heat according to a defined characteristic by means of a motorized valve. The unpracticality of this solution is clearly evident: the room temperature can be influenced, for example, by opening a window. No correction is made to the position of the valve – and thus to the flow of heat – because the actual temperature in the room remains unconsidered.

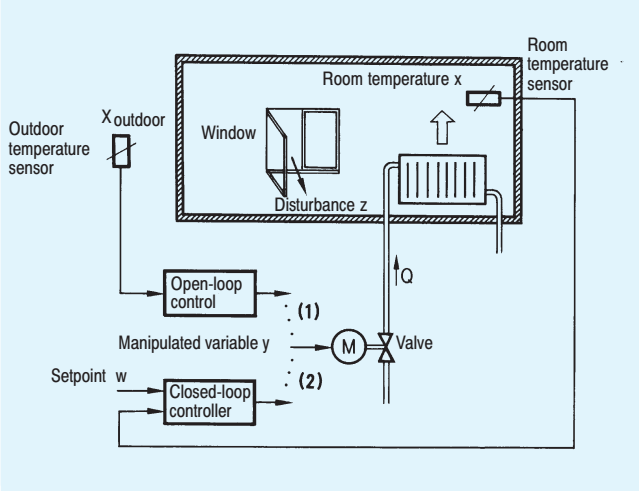

Fig. 2/1 Room heater: open-loop control (1) and closed-loop control (2), function diagram

This is a major characteristic of an open-loop control, i. e. a process is influenced according to a previously defined law, and any type of disturbance can affect the result.

This problem can be solved by a closed-loop control. The principle, in this case, is that the variable of interest (in this case the room temperature) has a feedback on the controlling variable (in this case the heat input).

In the example, the room temperature is measured constantly and compared with the desired temperature. A control device processes the difference such that this is reduced and finally eliminated by appropriately setting the valve position.

The following exactly defined control terms enable a more general description of the relationships.

Fundamental definitions

Closed-loop control is a procedure where a variable x (controlled variable, actual value) of a system is constantly measured, compared with a defined variable w (command variable, setpoint) and influenced in the sense of adaptation to the defined variable. The actions take place in a closed loop.

This general definition to DIN 19 226 is clarified by Fig. 2/2.

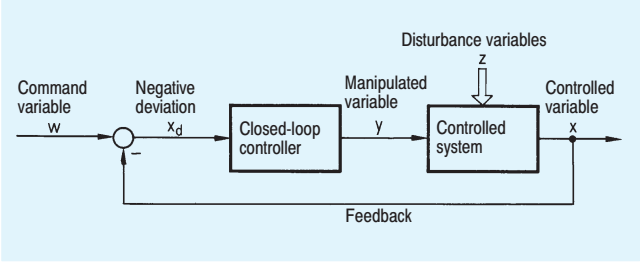

Fig. 2/2 Function diagram of closed-loop control

The closed-loop controller processes the negative deviation x_d calculated from the controlled variable x and the command variable w into a manipulated variable y. This is then the input variable of the process to be controlled, the so-called control loop, and counteracts the deviation of the controlled variable from its setpoint as caused by the disturbance z. The controlled variable is eventually returned to the value of one command variable and the disturbance is compensated.

The characteristic feature of a closed loop is thus the feedback of the controlled variable to the controller.

The quality of the control decisively depends on how well the controller response is tuned to the characteristics of the respective control loop. This tuning of the controller in accordance with the requirements is the main problem of control engineering.

The development of theoretical methods is based on various mathematical descriptions in the time or frequency domain. The transfer function representation is commonly used in cases where merely the input-output behaviour is of interest, since the processes are sufficiently linear and time-invariant.

If the response of the control loop to the influence of the command variable is observed, this is referred to as the response to setpoint changes. In a similar manner, the response to disturbance changes describes the influence of a disturbance variable on the relevant process variable.

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Fundamentals of control engineering

The operating state at which all changes have stopped and where the manipulated variable and controlled variable have settled at stationary values y_s and x_s is referred to as the working point.

Sensors and transmitters

The controlled variable may be any physical quantity. Variables frequently encountered in process engineering include e. g. pressure, temperature, flow and level. Certain sensors used to detect the actual value, such as resistance thermometers or thermocouples, can be directly connected to the controller. Otherwise, transmitters supplying an electrical output variable must be connected between the sensor and the controller. The controllers are usually designed for transmitters with standard output signals (0 to 20 mA or 4 to 20 mA).

Controllers

In the example shown for controlling the room temperature, it was not considered how the controller converts the negative deviation into the manipulated variable. The most simple solution – and thus that used most frequently – is to simply switch the supply of heat on or off depending on the sign of the negative deviation. A controller which only has the extreme conditions "ON" and "OFF" is referred to as a two-step controller. The disadvantage is the constant oscillation of the controlled variable around the setpoint.

Controllers for higher accuracy applications therefore operate continuously. They vary the manipulated variable continuously in order to obtain a negative deviation decaying to zero.

It is insufficient for a high-quality of control, however, if only the actual difference between the setpoint and actual value is used to generate the manipulated variable. The mean value with respect to time and the rate of change of the deviation should also contribute to determination of the manipulated variable. The result is then a controller with three different active components, a **p**roportional component, an **i**ntegral component and a **d**ifferential component. This is the well-known **PID controller.**

The PID operation

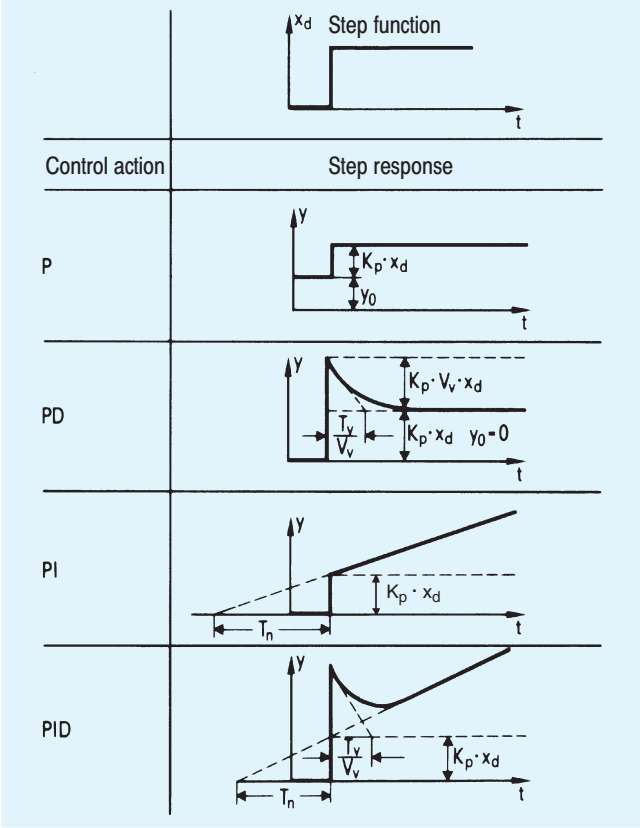
$$y(t) = K_P\{x_d(t) + \frac{1}{T_n}\int_0^t x_d(\tau)d\tau + T_v\dot{x}_d(t)\}$$

is, with small modifications, the core of most industrial controllers. The proportional gain K_P, the reset time T_n and the derivative action time T_V are the controller parameters which determine the function. A P, PD, PI or PID response can be achieved depending on the values set for these parameters.

Instead of the proportional gain K_P, the proportional band X_p (in %) is another way of expressing the parameter of the **P controller.** The following relationship then exists:

$$K_P = \frac{100}{X_P}.$$

A steady-state deviation offset is prevented in the **PI controller** independent of the working point, value of the setpoint and changes to the disturbance variables by means of the integrating component which can be defined using the reset time T_n.



K_p	Proportional gain	V_v	Derivative action gain
T_n	Reset time	x_d	Negative deviation
T_v	Derivative action time	y	Manipulated variable
t	Time	y_o	Working point

Fig. 2/3 Step responses with different values for the parameters

The **PID controller** achieves an improvement in the dynamic control performance by the addition of a D component. The characteristic parameter is the derivative action time T_V.

The effect of the controller's parameters can be seen in Fig. 2/3 from the response of the controlled variable following a step change in the negative deviation.

Final control elements and actuators

In most process engineering applications, the manipulated variable y acts on the controlled system via a valve, a damper or another mechanical positioning device. Three types of device are common for actuating such final control elements:

- Electric actuators, consisting of an electric motor and gear box (robust, low maintenance requirements, economical)
- Pneumatic actuators with compressed air as the supply and with electropneumatic converter (fast, explosion-proof)
- Hydraulic actuators with electrically driven oil pump and with electrohydraulic positioner (for large positioning forces).

In temperature control circuits with electric heating elements, relays, contactors or semiconductor switches are used as final control elements.

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Fundamentals of control engineering

Classification of controllers

The example of room temperature control already shows that controllers can be divided according to their mode of operation into

- continuous controllers and
- step controllers.

Another important difference is the type of controller characteristic implemented, e. g. the PID operation. Whereas electronic controllers were previously designed using analog technology, digital technology based on microprocessors and computers is now used. There is therefore a difference between

- analog controllers and
- digital controllers.

A characteristic of digital controllers is the implementation of the control function as an algorithm in the form of a program.

Compared to the continuously operating analog controller which acts almost without any delay, a digital controller can only process the current actual value and generate a new manipulated variable at discrete points in time. Analog-to-digital and digital-to-analog converters are also required to allow connection to the process.

Whereas the first digital controllers were implemented in process computers, they can be found today not only in complex process control and automation systems but primarily in the design of a compact controller.

Digital PID controller (Fig. 2/4)

Since the PID structure has been proven in practical applications and because a number of practical design procedures are available it has become a standard. Therefore, many attempts have been made to retain the advantages of the PID characteristics when converting from analog to digital control. This means that the digital controller operating at discrete points in time must approximate the dynamic response of the analog controller as well as possible.

How can this be envisaged?

- The controlled variable is measured ("sampled") and digitized in the processing cycle of the controller program, i. e. at discrete points in time

  $t_k = k\,T_A, \quad k = 0, 1, 2, \ldots$

- The PID operation is simulated by a PID algorithm contained in the controller firmware. A differential equation is then calculated at each sampling point using stored values of the process signals. The P, I and D components can be set independently of one another in the case of an algorithm implemented as a parallel interaction-free structure.

  A controller therefore, which generates a corresponding sequence of manipulated variables

  $y\,(t_k), \quad k = 0, 1, 2, \ldots$

  from a sequence of input values

  $x_d\,(t_k), \quad k = 0, 1, 2, \ldots$

  is also referred to as a sampling or discrete controller. The time between two updating operations is referred to as the sampling time or the sampling period T_A.

- The calculated manipulated variable is connected to the controlled system following digital-to-analog conversion and retained until the next value is applied. The manipulated variable therefore has a staircase response.

The demand for a quasi-continuous mode of operation for the digital PID controller can clearly be satisfied by sufficiently frequent sampling, i. e. by suitable selection of the sampling time.

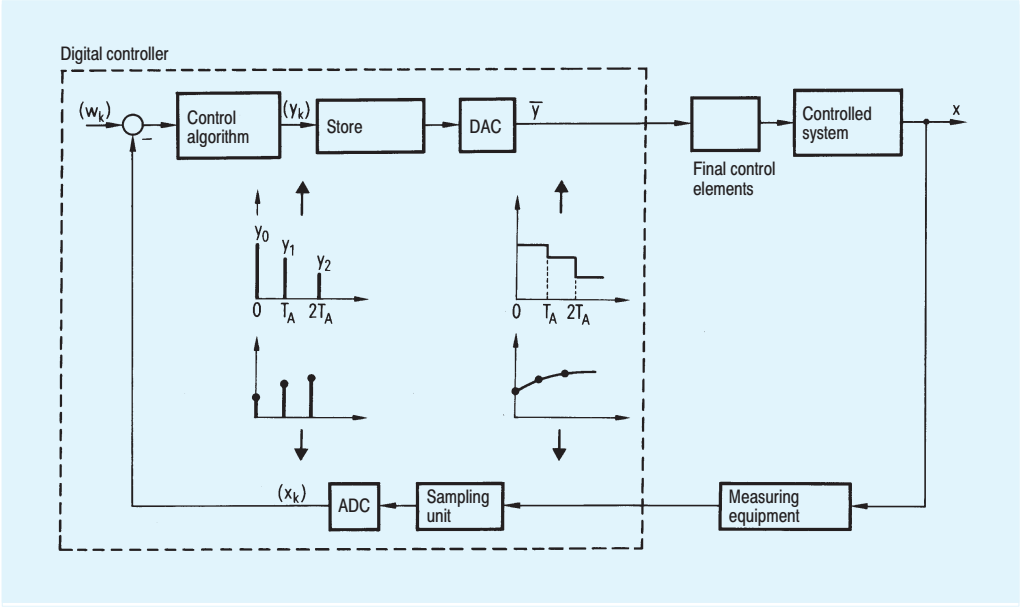

Fig. 2/4 Structure of digital closed-loop control

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Fundamentals of control engineering

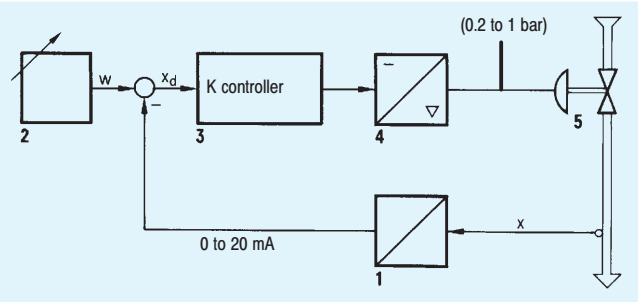
Advantages of digital controllers

The basic mode of operation of digital controllers is largely identical to that of analog controllers, but the former have a number of significant advantages:

- **Flexibility:** The control functions are implemented using software. They can be used flexibly by the user for many different applications.
- **Variety of functions:** Functions of any complexity can be implemented very easily using the software, e. g.

- Bumpless manual/automatic switchover
- Prevention of integral saturation (anti-reset-wind-up) on attainment of manipulated variable limits
- Adjustable limiting of setpoint and manipulated variable
- Parameterizable setpoint ramp
- Filtering of process variables containing noise.

- **Accuracy:** Digital parameters are drift-free. They can also be set exactly as required. Mathematical operations present no problems.



x Controlled variable
x_d Negative deviation
w Command variable
1 Transmitter
2 Setpoint adjuster
3 Continuous controller
4 Electropneumatic signal converter
5 Pneumatic final control element

Fig. 2/5 Structure of digital closed-loop control

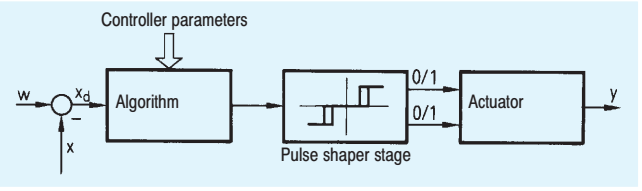


Fig. 2/6 Structure of digital closed-loop control

Types of manipulated variable output signal

The controller output signals must be suitable for different types of actuators. Two types of controller are common for most types of actuator:

- Continuous controllers (K controllers) for pneumatic and hydraulic actuators
- Step controllers (S controllers) for electric actuators.

These types of controllers are known as continuous controllers, because the valve can take all positions between “fully open” and “fully closed”.

- Continuous controllers

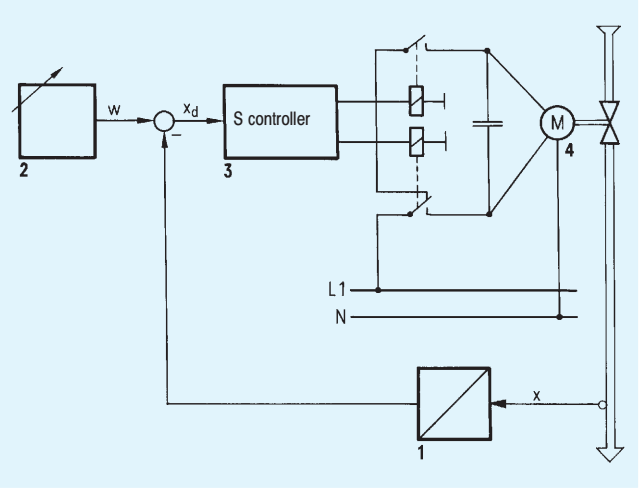
With the quasi-continuous mode of operation of the digital PID controller the controller output signal acts practically continuously on the final control element via a signal converter (Fig. 2/5).

- Step controller

The step controller is a switching controller with a three-position response which can only act on the controlled system together with a motor-driven, integral final control element. It switches the electric motor of the actuator by means of relays or semiconductor switches for activating a valve or damper for clockwise or counterclockwise rotation. The required position is set according to a cyclically calculated pulse length.

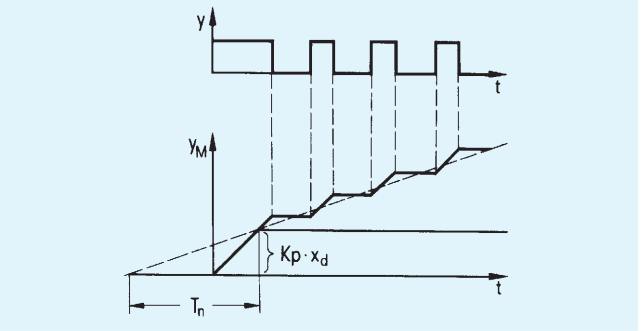
In the case of analog technology, the step controller is designed using a three-position element with hysteresis and a delayed feedback. The digital step controller (Figs. 2/6 and 2/7) again uses the PID algorithm. It delivers the positioning increment associated with the current negative deviation, and is usually parameterized with $T_v = 0$. The positioning increment is converted in a pulse shaper stage into a proportional positioning pulse length. The smallest possible positive value is defined in the form of a parameterized minimum pulse length taking into account the operating time of the final control element.

As shown in Fig. 2/8, the transient function generated on the final control element by the pulses of the step controller corresponds to that of a continuous PI controller. The parameters K_P and T_n can again be determined from the first point of intersection between the staircase function and its mean straight line.



x Controlled variable
x_d Negative deviation
w Command variable
1 Transmitter
2 Setpoint adjuster
3 Step controller
4 Actuator

Fig. 2/7 Structure of digital closed-loop control



K_P Proportional gain
T_n Reset time
t Time
x_d Negative deviation
y Manipulated variable
y_M Manipulated variable (motor)

Fig. 2/8 Structure of digital closed-loop control

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- Two-step and three-step controllers (stepped controllers)

The two-step controller (or three-step for heating/cooling) is used to operate relays, contactors, or thyristor switches in heating and cooling applications.

In the case of SIPART DR two- and three-step controllers, the switching operation is determined by the period, the control deviation and the parameters. The period is programmed in the controller as a constant. The control deviation, in conjunction with the parameters $K_P/T_n/T_v$, determines the cycle time within the period. This means that the switching operation is not just determined by changes in the process variable; if parameterized accordingly, the process variable x can remain more or less constant.

Whereas the positioning pulses of a step controller disappear when the negative deviation has decayed, positioning pulses are still output in the steady-state condition of a two or three-step controller according to the stationary value of the calculated manipulated variable.

Extended control structures

In practice the standard PID controller has a large number of functions and possible structures. Examples include:

- Cascade control

A cascade control is suitable for very fast compensation of disturbances. In this case a master controller does not act directly on the final control element but provides the setpoint for a subordinate slave controller. This reacts to disturbances before they affect the controlled variable.

- Disturbance variable feedforward

If a measurable disturbance variable acts on the input of a controlled system, it can be compensated for at an early point in time by adding it, weighted by a factor to the controller input or output signal.

- Ratio control

A command process variable x_2 is weighted in this case by a ratio w_v and is the setpoint for the controlled process variable x_1.

- Override control

A controller operating in normal mode is overriden by another controller as soon as the latter registers that a limit has been violated.

Adaptation

The most important degrees of freedom of a PID controller are its parameters K_P, T_n, T_v. These basically determine the quality of control, irrespective of the specific configurations made by the user.

Adjustment of the controller parameters according to the requirements is a fascinating theoretical problem but rather a burdensome one in practice.

The conventional procedure in the case of industrial process control

- is usually based on experience,
- often uses trial-and-error procedures,
- occasionally uses simple guidelines,
- only uses systematic, mathematical methods in exceptional cases.

These disadvantages always place the quality of the parameters in doubt. The actual controller adjustment always remains the responsibility of a person. This is totally different with an adaptive controller. This type of controller determines the optimum values of the parameters itself. This decisive innovation has only been made possible by digital technology.

The following methods are of most interest in cases where adaption, the automatic adjustment of the controller to differing process conditions, is being used:

- commissioning adaptation, which is normally initiated in manual mode (e. g. the adaptation procedure on the SIPART DR19 or SIPART DR21/22/24).

- Requested adaptation which is triggered by an event – for example a change in setpoint – and updates the controller parameters during operation.

To a certain extent, parameter control utilised in some conventional control devices can also be included amongst the adaptation procedures. In this case, defined sets of parameters for the controller are switched over depending on the working point.

The general structure of adaptive control is shown in Fig. 2/9. The two function blocks “Identification” and “Controller draft” are important. They represent the actions of a methodical control engineer and the fundamental sequence of processes in the software in digital controllers.

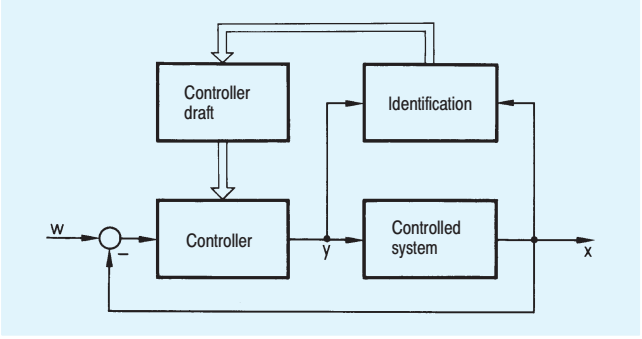

Fig. 2/9 General structure of adaptive control

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Fundamentals of control engineering

The SIPART DR controllers use adaptation procedures that have a specific effect on the process.

The adaptation procedure on the SIPART DR19 controller works on the basis of an oscillation of between 0 and 100 % as the result of changes in the manipulated variable. The process variable displays a control oscillation, which is evaluated according to the period and its amplitude, below the required setpoint value. The parameters K_P, T_n and T_v are derived from this oscillation data. Adaptation can be terminated in either manual or automatic mode.

The patented SIEPID procedure is used in the SIPART DR21, SIPART DR22 and SIPART DR24 controllers. This procedure was developed for processes involving compensation and damped response and is based on a concept that has been well proven in practice:

- The adaptation phase is started by triggering in the form of a change in manipulated variable in manual mode.
- The time response of the manipulated variable and controlled variable resulting at the input and output of the controlled system as a reaction to the above changes are determined and recorded.
- A criterion insensitive to interference determines the attainment of the new stationary final value and automatically initiates evaluation of the series of measurements.
- This task, referred to as identification, is handled by a particularly robust procedure for optimum model adaptation. During this procedure the parameters of a process model, mathematically matched to the problem are optimized by simulating the actual process response as exactly as possible.
- Based on the determined process model, the controller parameters are finally calculated according to the proven analytical rules for optimization of the amount.
- The resultant recommended values to be used for commissioning can however be altered by the user.

The convenient implementation of adaptation using the facilities of digital technology is an answer to the practical demands for saving time and costs, simple handling, reproducible control quality and improved product quality.

Compact controllers – universal components for process engineering

The compact controller is a design already encountered during the period of analog technology and which is of great practical significance for modern digital process technology because of its large number of attractive features.

The compact controller combines in a small housing all hardware and software components required to solve common control tasks in vastly different areas of process automation. Apart from the signal converters required in the case of non-electrical process variables, the power supply unit, A/D and D/A converters and the controls and displays are all built into the device.

The compact design means that this type of controller is particularly suitable for mounting in desks and switchboards, or even directly in machines and equipment.

The electronic compact controller is a device suitable for many applications. Its large range of functions means that it can do increasingly more than only control, is increasingly being offered in an adaptive version and is impressively simple to use despite its flexibility.

Configuring, i. e. the activation of specific partial functions according to the individual task, parameterization, i. e. definition of the characteristic data of the device within predefined ranges, and operation in process mode, e. g. changes to setpoints or manual/automatic switchover, all take place using pushbuttons on the front panel with the assistance of digital or bar analog displays.

Compact controllers, originally designed as stand-alone devices for process automation, increasingly offer more than just the reliability of an individual controller in that they can now be connected via serial interfaces to higher-level devices and systems such as personal computers and SIMATIC S5/S7 programmable controllers.

The extremely favorable price/performance ratio is the decisive factor for the success of digital compact controllers.

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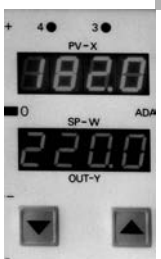
SIPART DR19 Controllers

3

3/2 Description
3/2 Application, design
3/3 Mode of operation
3/9 Function diagram
3/10 Control and display functions
3/13 Configuring switches, on-line/off-line parameters

3/14 Technical data

3/17 Ordering data



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Description

Fig. 3/1 SIPART DR19 controller

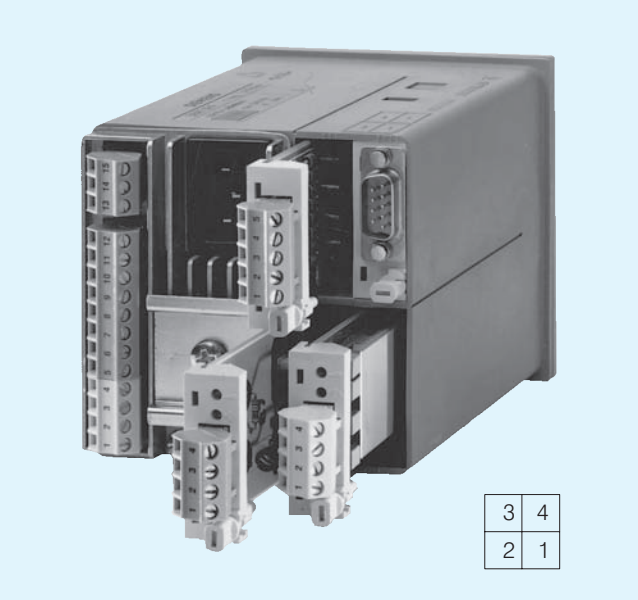

Fig. 3/2 SIPART DR19 controller - rear view, slots

Application

The SIPART DR19 process controller is a digital controller. It is mainly used for applications in mechanical engineering and device manufacture. Its internal program memory contains a large number of standard functions for the control of process engineering applications. A user with no programming knowledge can simply call up and execute these functions.

It includes as standard an input for direct connection of temperature sensors such as thermocouples (TC), Pt 100 resistance thermometers (RTD), resistance based sensors (R) or voltage signals in the mV range (also mA and V with adaptor plug).

The SIPART DR19 controller is very flexible and can be quickly and easily configured to meet the requirements of the application.

An adaptation process is built in as standard.

The SIPART DR19 controller can be used as a:

- Fixed setpoint controller with 2 internal setpoints, optionally for one, two or three-component control
- Fixed setpoint controller with up to 5 internal setpoints, optionally for one, two or three-component control
- Slave, synchro or SPC controller, with the option of internal/external switchover
- Fixed or controlled ratio controller with internal/external switchover
- M/A control station, process variable indicator or setpoint transmitter. The control algorithm is disabled in these cases
- Program controller/transmitter, optionally for one, two or three-component control.

Design

The SIPART DR19 controller is of modular design and consequently easy to service and simple to reconfigure or retrofit. The standard unit is fully functional.
Additional modules (signal converters) can be inserted into the slots at the rear of the closed unit in order to extend its range of applications (Fig. 3/2).

Slot assignments:

- slot 1 analog input 3 (AE3)
- slot 2 analog input 2 (AE2)
- slot 3 digital inputs/outputs (BE/BA)
- slot 4 interface modules

The standard unit comprises

- Front module (controls and displays with motherboard and CPU)
- Backplane
- Plastic moulded housing with fittings for installation in control panels, consoles or machines.

The backplane contains the power supply unit and connectors. It is installed in the rear of the housing and is connected to the front module by a ribbon cable.

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Description

The standard unit has a fixed analog input and two digital inputs. The analog input is designed for the connection of the following sensors:

- Pt 100 resistance thermometer with 2, 3 or 4-wire circuit.
- Thermocouples with internal reference junction (reference junction terminal 6DR2805-8A required) or with external reference junction.
- mV signals
- Resistance based sensors (potentiometers) with 2 wire circuit.
- 10 V and 20 mA signals via additional measuring range plug (6DR2805-8J).

The sensor and the measuring range are determined in the configuring levels StrS (configuring switches) and CAE1 (calibrate analog input 1).

The following are available for the output of the manipulated variable and the state signals:

- Analog output 0/4 to 20 mA
- 2 relay outputs
- 2 digital outputs.

The inputs and outputs can be extended by input/output modules.

Input/output modules are available for:

- current or voltage input (U/I)
- UNI module for TC/RTD/R/mV, also mA and V with adaptor
- Resistance input (potentiometer) (R)
- Digital inputs and outputs (BE/BA)
- Relay outputs (Rel)
- Serial interface (SES)
- PROFIBUS-DP module

Electrical supply for the transmitters is provided by a short-circuit-proof *L+* output.

The tagging label is replaceable.

Available versions

- 6DR1900-4 for 24 V AC/DC auxiliary supply
- 6DR1900-5 for 230 V AC auxiliary supply, switchable to 115 V AC.

Mode of operation

The SIPART DR19 controller is based on a modern, highly integrated microcontroller using C-MOS technology.

The instrument's internal program memory contains a large number of functions for the control of process engineering applications.

Configuring – the setting of parameters and configuring switches – enables the users themselves to select the functions required for their applications.

The instrument can be configured either from the front panel or via a PC using the SIMATIC PDM software package.

On leaving the factory, the SIPART DR19 controller is configured as a fixed setpoint controller. In most cases only a few additional settings therefore need to be made.

The instrument parameters are stored in non-volatile memory, and are consequently safe from the effects of a power failure. A backup battery is not required.

The SIPART DR19 controller can be operated as a P, PD, PI or PID controller.

Adaptation process

The adaptation process in the SIPART DR19 controller is easy to use and features short optimization times. Adaptation can be carried out in manual or automatic mode (closed loop). For temperature controllers with two-step outputs for heating and cooling, the splitting of the *y* control range is carried out automatically. This provides optimization of the parameters for the heating range and the cooling range.

Analog input

The SIPART DR19 controller has a total of 3 analog inputs that can be allocated to the "function inputs" *x*1, *x*2, *x*3/we, y_N, y_R and *z*.

One analog input is provided in the basic unit, 2 further inputs can be added as options.

The function inputs act as the analog input channels for the different types of controller. The role of the function inputs therefore depends on the configuration of the controller.

Function input *z* is used as an input for the feedforward control, where the disturbance *z* can either be connected dynamically via the D element or statically, weighted by a factor, to the manipulated variable *y*.

A 1st order filter for the suppression of external interference and a square root extractor can be connected in each analog input channel.

A linearizer with 13 vertices and knee-point smoothing can be connected to one of the analog inputs.

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Description

Program controller/transmitter

(configuring switch S1 = 5).

In this function. a programmer (time scheduler) is connected as a process variable to the controller module.

The programmer has the following features:

- A total of 15 program steps (intervals) that can be used as one program or divided into two programs P1 and P2 (10 and 5 steps)
- In all the intervals, the interval time and the target setpoint can be set at the end of the interval
- The interval times can be set in min/sec or hrs/min
- The following commands can be issued via the front panel or via digital signals:
  - start program
  - stop program
  - reset program sequence
- 6 digital outputs (time bars) for status indication of intervals 1 to 15
- Selectable start conditions following power failure, including start from last value before power failure.

For use as a program transmitter, the time-dependent setpoint can be output directly through the analog output.

Controller manipulated variables

- K controller (continuous output)

In this configuration of controller, the manipulated variable is output as a standardized current signal. The signal range (0/4 to 20 mA) is determined when the controller is configured.

- S controller (switching output)

It is preferably to use the floating relay contacts to output the manipulated variable. These contacts are pprovided with a protection circuit adapted to the contactor coils.

It is important to ensure that the maximum switching voltage is not exceeded. Phase shifting motors must therefore only be connected via intermediate switching devices.

The relay contacts are mutually interlocked. This interlock can be disabled for a universal digital output.

Digital outputs are at disposition to output the manipulated variable at a high switching rate.

Used as S controller, the analog output can then be used for output of an internal process quantity (*x, w* or x_d).

- Two-step controller

The manipulated variable *y* is output as a pulse duty factor with a variable period. In the case of two-step controllers with heating/cooling outputs, a different period can be allocated to each output. Each stage then runs through the pulse duty factor from 0 to 100 %. The dead zone between the heating/cooling stages can be entered as a parameter.

Main application for this type of controller: temperature controller that, for example, switches the heating or cooling power on and off, or that opens and closes a solenoid valve.

One of the outputs for heating and cooling may also be an analog signal of 0/4 to 20 mA.

Digital input and output

The 2 digital inputs and outputs in the standard controller are connected during configuring to the digital functions required for the application.

They are non-isolated and operate in either normal or inverted mode, depending on how the controller is configured.

The digital outputs are active. They provide a DC voltage signal.

The number of digital inputs and outputs can be increased by installing additional option modules.

In addition, a coupling relay module can be snapped onto the DIN rail on the rear of the controller. This module can have either 2 or 4 relays, each with 1 changeover contact for 250 V AC, 8 A, which are controlled from the digital outputs.

- Digital inputs

CB	Computer ready
He	Manual mode, external
N	Tracking
Si	Safety mode
P	Controller P mode
tS	Disable setpoint ramp time or reset program sequence
±yBL	Direction-dependent blocking of manipulated variable
BLB	Blocking of command level
BLS	Blocking of configuring
BLPS	Blocking of parameterisation and configuring
PU	Program switchover with program controller or setpoint selection with fixed setpoint controller with 4 (5) setpoints (in conjunction with CB)
tSH	Stopping the setpoint ramp

- Digital outputs

RB	Computer ready
RC	Computer mode
H	Manual mode
N_w	Setpoint tracking mode
A1,2,3,4	Alarm monitors A1, A2, A3, A4
MUF	Transmitter fault
±Δw	Incremental *w* adjustment (S1 = 4)

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Description

Display technology

The SIPART DR19 controller is equipped with easy to read displays.

There are digital indicators for both the actual value *x* (red) and the setpoint *w* (green, switchable between *w* and *y*), an analog indicator that can be configured for internal process values in the controller, and signal and status indicators.

The two four-figure digital LED indicators are arranged one above the other to allow direct setpoint/actual value comparison, and can be configured to show physical units or percentage values.

The analog display is implemented as a vertical LED bargraph.

For indication of operating status and alarms, 11 LEDs are provided on the front of the unit.

Some of these displays and controls may be assigned different functions in the configuring levels.

Configurable functions

Application-specific circuits are prewired in the EPROM of the SIPART DR19 controller and can be easily called up.

The configurable functions of the controller (configuring switch S1) are shown below as block diagrams and described briefly. For the sake of clarity, only the most important functions are discussed.

The constants c_1 to c_7 shown in the following diagrams can be entered as parameters.

An additional disturbance can be superimposed on the manipulated variable either dynamically via the D element or as a static value through the function input *z*.

- Configuring switch S1 = 0, fixed setpoint controller

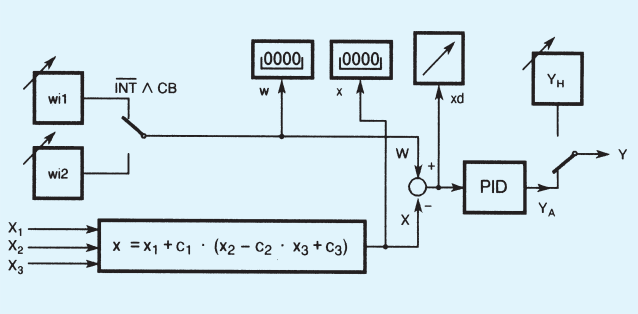

Fig. 3/3 Fixed setpoint controller with one or two independent setpoints as one, two or three-component controller

The setpoints w_{i1} and w_{i2} can be individually adjusted from the front module. The switchover function can be blocked.

- Configuring switch S1 = 1, fixed setpoint controller with 5 setpoints

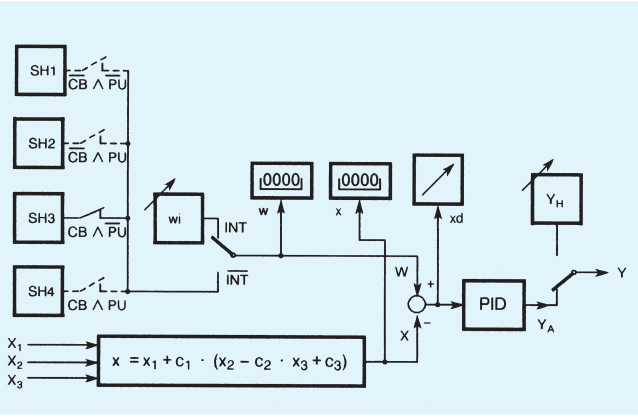

Fig. 3/4 Fixed setpoint controller with 5 independent setpoints as one, two or three-component controller

Setpoint w_i can be set from the front panel, setpoints SH1 to SH4 are set in the controller parameterization level.

Switching between the various setpoints is achieved by the internal/external button and the control signals CB and PU. The function of the internal/external button can be blocked.

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Description

- Configuring switch S1 = 2, slave, synchro or SPC controller

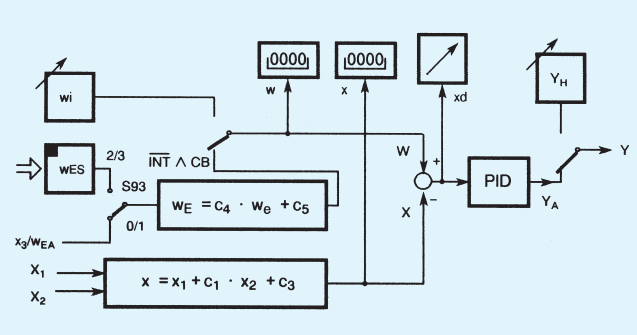

Fig. 3/5 Slave, synchro or SPC controller (Setpoint Control) with internal/external switchover

The remote setpoint can be entered in the controller as an analog signal through the function input x_3 or via the serial interface.

For synchronization purposes, the constant c_3 can be added to the setpoint, which can be also weighted by the factor c_4.

- Configuring switch S1 = 3, ratio controller

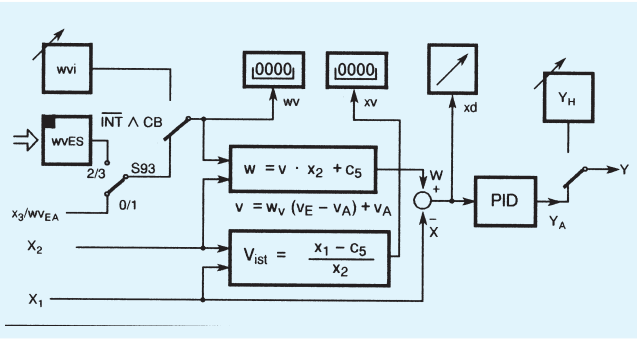

Fig. 3/6 Fixed or controlled ratio controller with internal/external switchover

The controlled variable and weighted command variable are entered in the controller through the function inputs x_2 and x_1. With this type of controller, the variable setpoint value is not an absolute value, but is specified as a factor v (w_V) derived from the ratio between the controlled variable and the command variable.

The standardized setpoint ratio w_V and actual ratio x_V are displayed in the 4-digit digital indicators, the control difference is displayed in the analog indicator.

The ratio factor can be controlled externally. In this case the switchover structure is the same as that of a slave controller. The instrument operates as a fixed ratio controller if internal/external switchover is blocked.

- Configuring switch S1 = 4, M/A control station/process variable indicator

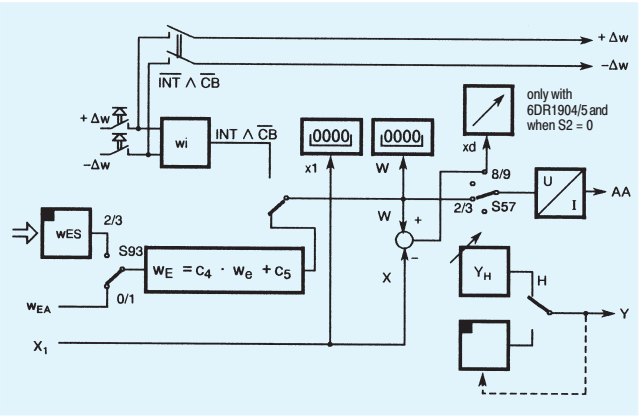

Fig. 3/7 M/A control station/process variable indicator

In this configuration, the SIPART DR19 controller is used as a:

- M/A control station for parallel process operation with a controller
- Manual control unit for the output of an analog or switching setpoint or manipulated variable value
- Process variable indicator for up to 3 measured values
  - Two digital indicators. If the measuring range is the same, the display can also be in physical value
  - An analog indicator 0 to 100 %
  - Monitoring of up to 4 variable limit values
  - Optional switchable display of limit values on the setpoint indicator.

The following output response is possible depending on how the controller is configured (configuring switch S2):

- K or dual setpoint output
- S output with internal feedback
- S output with external feedback.

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Description

- Configuring switch S1 = 5, program controller/transmitter

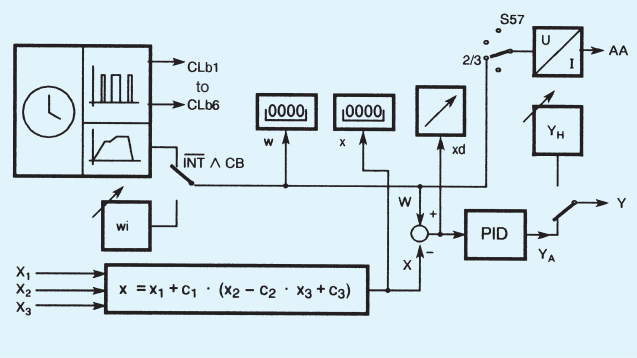

Fig. 3/8 Program controller/program transmitter

The function of the program controller is comparable to the fixed setpoint controller with two internal setpoints. The setpoint w_i has a fixed value, the time-dependent setpoint is determined by a program.

The start, stop and reset program functions are linked to the controller operation (manual/auto switchover button and internal/external switchover) and to the control signals CB, $\overline{tS}$ and PU.

When used as a program transmitter, the program output values are output via the analog output.

The input configuration is designed for one, two or three-component control.

Other configurable functions to enhance the ease of use and operational safety of the SIPART DR19 controller.

- Transmitter monitoring

A message is output on the 4-digit digital indicator "PV-X" whenever the measurements go out of limits (< –3 % or > +103 % of the signal range). A different message can be output for each input. A group fault message can be output on the MUF digital output.

Furthermore, automatic switchover to manual mode, starting with the value of the last manipulated variable or the safety value, can be selected.

- Setpoint limitation

The effective setpoint value is always limited.

- Setpoint ramp

The t_s parameter specifies the rate of change of the setpoint value. The decimal point in the *w* display signals the active setpoint ramp (as moving script).

The setpoint ramp can be switched off by the t_s control signal.

- *x*-tracking

In manual and tracking mode, and also when the safety value is active, the setpoint *w* tracks the controlled variable *x*.

- Filter and response threshold of control difference

The control difference is controlled by an adaptive filter (tF) so that low-frequency interference can also be filtered out.

If the output of the controller needs to be stabilized more, a response threshold for the control difference can be entered.

- Varying the direction of control

The default setting of the controller is for normal-action control loops. The direction of action of the controller should be inverted in the case of reverse-action control loops.

- Special features of the control algorithm

The P(D) and PI(D) control algorithm for the controller is implemented as a non-interacting parallel structure and is independent of the output structure (S or K) of the controller.

The switchover from PI(D) to P(D) control is performed by a control signal (binary input). In P(D) mode, the specified K_P value multiplied by the constant c_7 is used.

The switchover from automatic to manual mode (and vice versa), plus the switchover to automatic from all other modes of operation, is bumpless.

This function is also operative in P(D) mode with automatic setting of the working point Y_o.

If this is undesirable, the working point in P(D) operation can be set manually if required (using parameter Y_o). Switchover to automatic will then not be bumpless. In the case of S controllers, P mode is only permitted with external position feedback.

- Limiting the manipulated variable

The parameters Y_A and Y_E can be used with K output and S output with external feedback to limit the manipulated variable.

Limiting the manipulated variable like this is – depending on how the controller is configured – only possible in automatic mode or in all modes.

In addition to the fixed limiting of the manipulated variable described here, an additional, direction-dependent limiting of the manipulated variable is provided in the SIPART DR19 controller. This limiting is activated by the control signals +yBL and –yBL and is effective in all modes of operation.

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Description

Limit monitor

The alarm functions A1/A2 and A3/A4 can be assigned in pairs to monitor all internal controller process variables. They can also be configured to monitor maximum-minimum, maximum-maximum or minimum-minimum values.

Violations of minimum/maximum values are indicated on the A1/A2 and A3/A4 LEDs and can be configured to output messages on the digital outputs, the logic of which can be inverted.

The limit values are normally specified in the parameterization level. The alarms may also be specified and displayed in the process operation level (*w* digital indicator).

The hysteresis for the pairs of limit monitors is specified as a parameter.

Restart conditions

Short dips in the mains voltage are, depending on the current loading of the instrument, handled by the buffering capability of the power supply unit.

In the case of a longer power failure, the parameters and configuring data that have been entered are retained in a non-volatile user program memory. The most recent mode of operation and the last setpoint and manipulated variable values are also held in non-volatile memory.

When power is restored following a power failure or after the controller is switched on, the controller automatically restarts using the configured mode of operation, setpoint and manipulated variable values. An optical signal can also be generated to indicate that power has been restored following a power failure.

Self-diagnosis

Comprehensive monitoring routines check the internal data traffic cyclically or following a POWER-ON or Watchdog reset.

If an error is detected, an error message is automatically output on the “PV-X” digital indicator. The error message indicates the cause of the error and how it can be remedied.

Communication with higher-level systems

The SIPART DR19 controller can transmit and receive status flags, process variables, parameters and configuring switch settings via a serial interface module.

The following interface modules are available:

PROFIBUS DP module

- Transmission rate up to 1.5 Mbits/s
- Up to 125 stations can be addressed (number of possible stations on the PROFIBUS by the master interface module, the data range of the interface module, and the number of parametrized process data)

SES Module RS 232/RS 485

- Transmission rate 9.6 kbits/s
- RS 232 as point-to-point connection
- RS 485 up to 32 stations

The advantages of the stand-alone SIPART DR19 controller can still be utilized to the full, even when used in conjunction with supervisory systems:

- Straightforward adaptation of each controller to meet the requirements of the task in hand
- Operational safety: if the supervisory system, or part of it, shuts down or fails, the SIPART DR19 controller continues to function as an independent controller under the same conditions as before
- Flexibility: modifications or additions to individual control loops are also possible while the system is in use
- Downloading the functions of the controller to individual devices in SPC mode lightens the load on the supervisory system.

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.

The coupling relay modules are snapped onto a DIN rail on the rear of the controller.

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Description

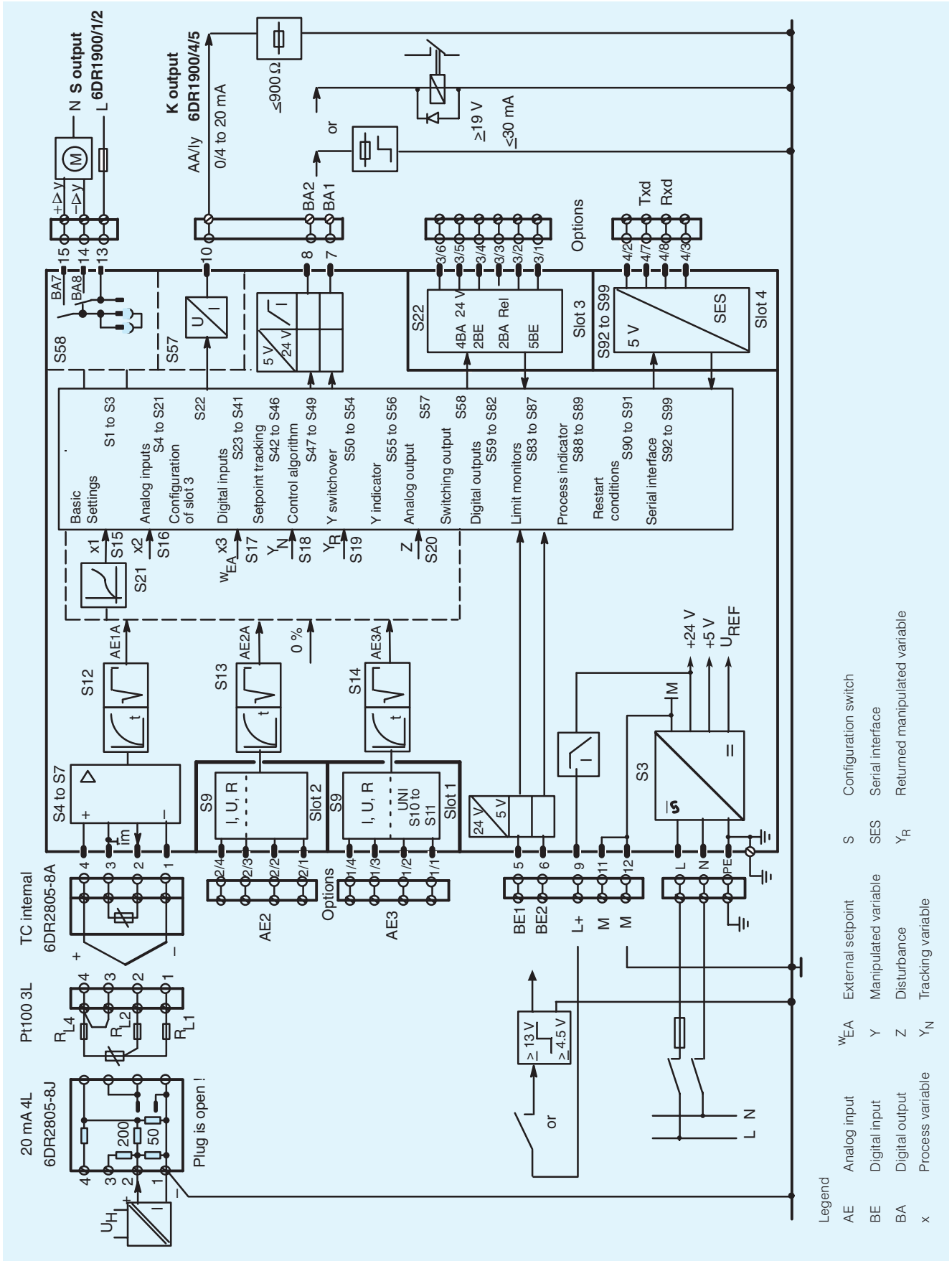

Fig. 3/9 SIPART DR19 controller, function diagram

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Description

Control and display functions

The setting of parameters is distributed over serveral configuring levels. This makes it very straightforward and simple to modify the controller configuration to the task in hand.

To enter the individual levels, several inputs have to be made explicitly within a specified time limit. Incorrect operation of the controller is therefore practically impossible.

Operation of the SIPART DR19 controller takes place at 3 levels:

- Process operation level
- Selection level
- Configuring level

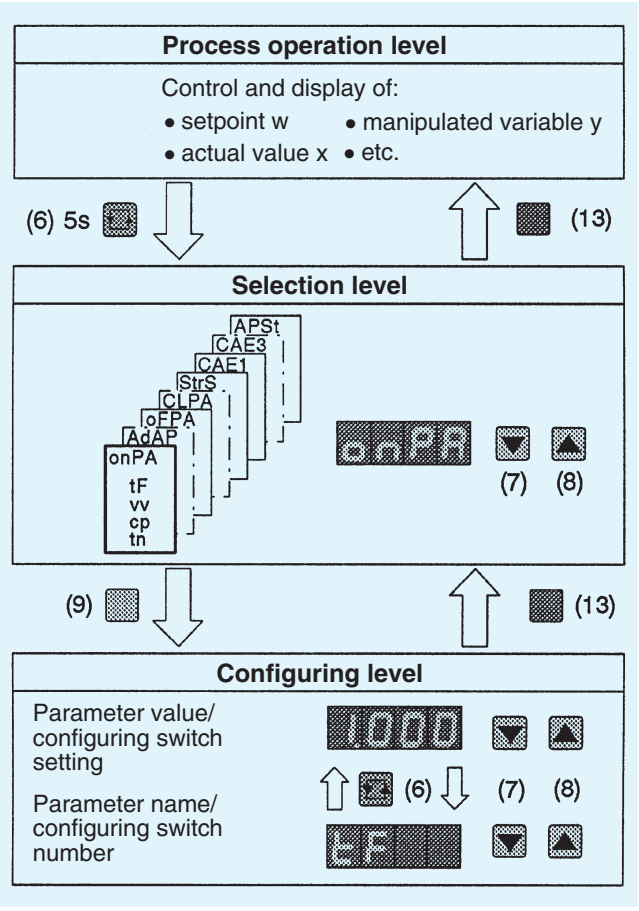

Fig. 3/10 Control levels of SIPART DR19 controller

Process operation level (Fig. 3/11)

The layout and color of controls, displays and the front fascia itself make operation of the SIPART DR19 controller in this mode self-explanatory.

The four-digit red digital indicator (1) shows either the actual value *x*, the four-digit green indicator shows the setpoint *w* or the manipulated value *y*. Optionally, limit values A1 to A4 can also be shown. Pushbutton (6) is used to select the indication.

The LED bar graph (3) can be used to display x_d, x_w or any desired process value.

The internal setpoint value or the manipulated variable *y* is set using pushbuttons (7) and (8). The controller must be in manual mode to set the manipulated variable.

Switchover to input of setpoint *w* can also be made in manual mode.

The rate of change of the setpoint and of the manipulated variable in the case of the K controller increases the longer a button is pressed.

Pushbutton (13) is used to toggle between internal and external setpoint. LED (15) illuminates when the internal setpoint is being used. Setpoint switchover is disabled when the controller is shipped from the factory.

The yellow pushbutton (9) toggles between manual and automatic mode. Which mode is active is signalled by the yellow LED (11).

Another yellow LED (10) indicates external modification of the manipulated variable, e. g. in tracking mode.

The output of actuating increments in all modes of the S and two-step controllers is shown in the setpoint and actual value indicators by LEDs (12).

Violation of limit values is indicated by the LEDs (17).

LED (16) signals the progress of parameter optimization during adaptation through either a steady or flashing light.

When operating as a program controller/program transmitter, the following indications, differing from the above are possible.

- Current setpoint *w* (2). This can be switched over to indication of target setpoint at the end of the interval.
- Current actual value *x* (1). This can be switched over to remaining time in interval.
- x_d/x_w indication on the LED bargraph (3). This can be switched over to program progress with current program step and end of program.
- Indication of selected program P1 or P2 with LEDs A1/A2 (17).

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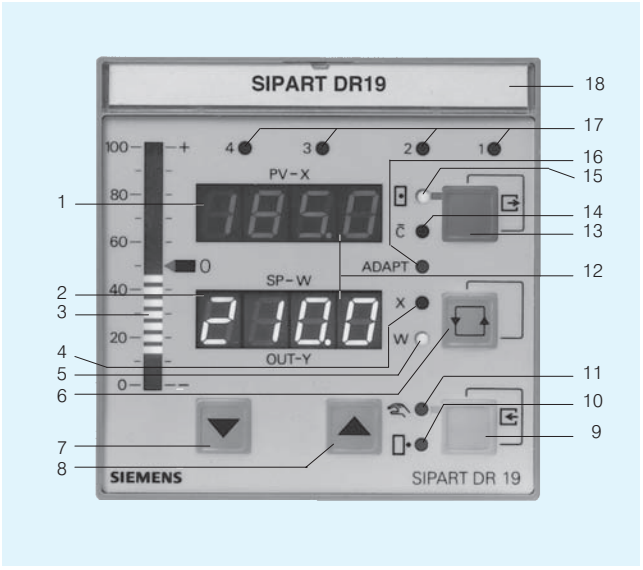
Description



1	Digital indicator “PV-X” for actual (process) value *x* (pv)
2	Digital indicator “SP-W” for setpoint *w* (sp) or manipulated value *y* (out), other values can be displayed
3	Analog indicator for e (x_d) or -e (x_w), other values can be displayed
4	Signal lamp “x”, illuminates if digital indicator PV-X (1) is active as input field
5	Signal lamp “w”, illuminates if *w* is being displayed on digital indicator SP-W (2)
6	Switchover button for digital indicator “SP-W” (2) Button to acknowledge flashing following restoration of power or entry button for selection level
7	Button to modify manipulated variable – down (up) or button “setpoint down”
8	Button to modify manipulated variable – up (down) or button “setpoint up”
9	Switchover button “manual/auto” or “enter” button to enter configuring level from the selection level
10	Signal lamp “external *y* mode”
11	Signal lamp “manual mode”
12	Signal lamps of Δ*y* digital outputs with S controller
13	Switchover button “internal/external setpoint” or “exit” button to exit configuring and selection level and return to the process operation level
14	Signal lamp “computer (with w_{ext}) switched off”
15	Signal lamp “internal setpoint”
16	Signal lamp “adaptation in progress”
17	Signal lamp “limit value violated” and for setpoint tracking functions L1 to L4
18	Tagging label

Fig. 3/11 Controls and displays

Selection and configuring levels

First of all, the function of the front control and display panel is switched from the process operation level to the selection level.

This is done by pressing and holding the pushbutton (6) until a flashing “PS” is displayed on the “SP-W” digital indicator. On releasing the pushbutton, the display “PS” changes to “onPA”. The controller is now in the selection level, from where the parameter lists, the configuring switch list or commissioning functions can be selected.

Use the pushbuttons (7 and 8) to page through the selection level.

Having changed to configuring level, the parameter and configuring switch settings of the selected lists can be displayed and modified.

Controller operation continues during the setting of the “on-line parameters”. The response of the control loop to changes in the control parameters can therefore be seen immediately.

The output of the controller is blocked when setting the configuring switches, the off-line parameters or the settings of the UNI module.

- The K controller freezes the last control current.
- The two-step controller freezes the last pulse duty factor.
- The S controller issues no more positioning pulses.

A zebra pattern is displayed in the analog indicator to indicate off-line mode.

The configuring levels

AdAP (adaptation)

CAE3 (calibration “UNI module” on analog input 3) and

CLPA (clock parameters, alternative version of unit)

are only displayed if they have been configured.

Lamp test

If pushbutton (6) is pressed and held for more than 5 sec., all LEDs on the front of the controller are illuminated, regardless of what is currently being displayed, until the button is released. The displays revert to their original form when the lamp test is complete.

Display of present firmware status

The present firmware status of the SIPART DR19 controller can be displayed if required.

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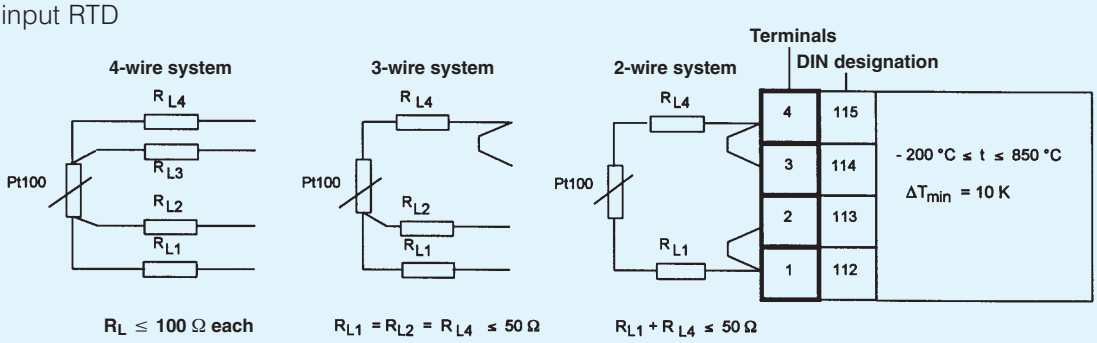
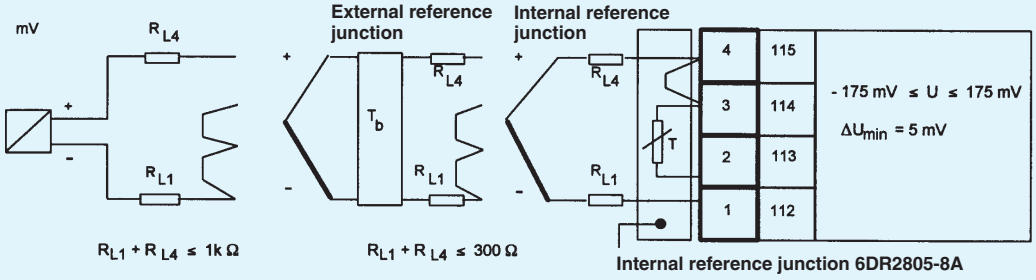
Description

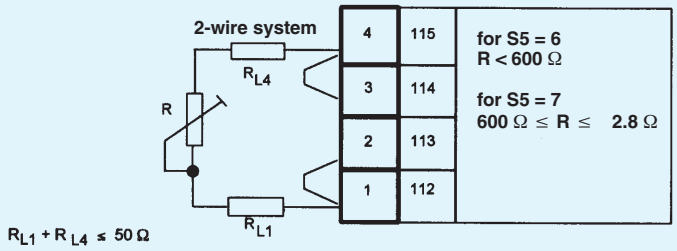
– Pt100 - input RTD



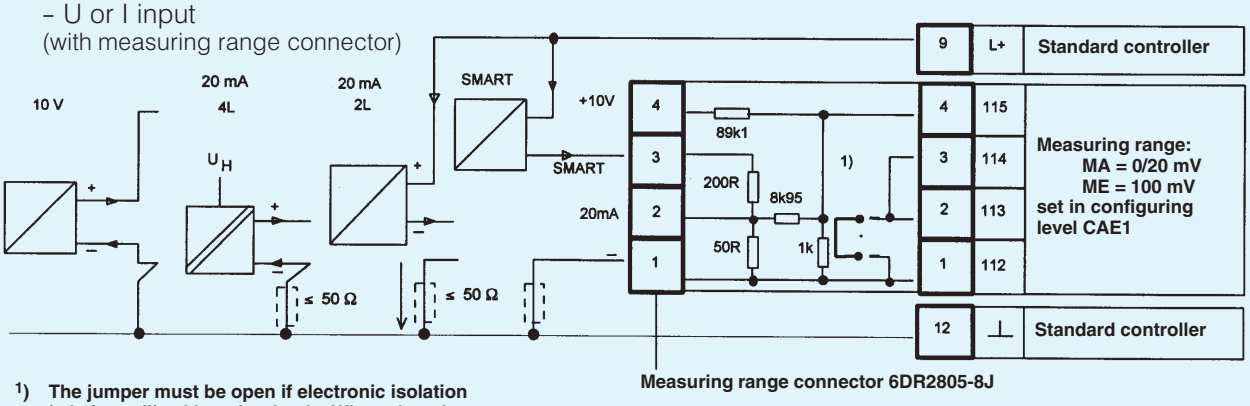
– Thermocouple T and mV source



– Resistance input R



– U or I input
(with measuring range connector)



1) The jumper must be open if electronic isolation is being utilized by other loads. When closed, it replaces the connection 1-12.

Fig. 3/12 Wiring of analog input AE1

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Description

Configuring switch list

Configuring switch	Function
S1	Type of controller
0	Fixed setpoint / three-component controller, both with 1 or 2 independent setpoints
1	Fixed setpoint / three-component controller, both with 5 independent setpoints
2	Slave / synchronization/ SPC controller
3	DDC controller
4	Ratio controller
5	Program controller
6	Fixed setpoint controller for coupling to a process control system, from firmware release A7 onwards
7	Slave controller for coupling to a process control system, from firmware release A7 onwards
S2	Output configuration
0	K controller
1	Two-step controller for heating/cooling
2	S controller with internal feedback
3	S controller with external feedback
S3	Mains frequency suppression
0	50 Hz
1	60 Hz
S4 to S7	Measured variable and type of sensor for analog input AE1
S8	Configuration of slot 2 (AE2)
S9 to S11	Specifying measured variable, type of sensor and engineering unit for slot 1 (AE3) when configured with UNI module
S12 to S14	Extract square root of analog inputs AE1 to AE3
S15 to S20	Assignment of function inputs x1, x2, x3/we, x4, yN, yR, z to analog inputs AE1 to AE3
S21	Assignment of lineariser to AE1 to AE3 or x1
S22	Configuration of slot 3
S23 to S34	Assignment of control signals CB, He, N, Si, P, ts, +yBL, –yBL, BLB, BLS, BLPS, PU to digital inputs BE1 to BE7
S35 to S41	Logic of control signals
S42	Effect of control signal CB, static or dynamic (pulse)
S43 to S46	Setpoint switchover
S47	Direction of action controller
S48	Feedforward control of D element
S49	Adaptation: type of adaptation
S50 to S54	Manual/Automatic output switchover, priority N or H, disable Iy, y limiting
S55 and S56	Manipulated variable display: Selection of displayed variable and logic
S57	Assignment of internal controller signals to the analog output
S58	Assignment of the +/–Δy outputs to the digital outputs BA1/BA2 or the relay outputs BA7 and BA8
S59 to S69	Assignment of alarm signals RB, RC, H, Nw, A1, A2, A3, A4, MUF, +Δw, –Δw to digital outputs BA1 to BA6 or the relay outputs BA7 and BA8
S70 to S75	Program controller, time bus status messages
S76 to S82	Logic of alarm signals
S83 and S84	Assignment of limit monitors A1/A2 and A3/A4 to internal process variables
S85 and S86	Function of limit monitors A1/A2 and A3/A4
S87 to S89	Selection of display values or display switchover
S90 and S91	Restart conditions following restoration of power supply
S92 to S99	Serial interface settings: station no., data transmission rate, parity
S100	Allocation of the tSH control signal to the digital inputs BE1 to BE7

On-line parameters

tF	Filter time constant for filter x_d/x_w (adaptive)
V_v	Derivative action gain
K_P	Proportional gain
T_n	Reset time
T_v	Derivative action time
AH	Response threshold
Y_0	Working point – P(D) controller
SH1 to SH4	Internal setpoints (fixed setpoint controller with 5 setpoints)
Y_A	Lower limit of manipulated variable
Y_E	Upper limit of manipulated variable
t_P	Increase y time / duration of heating period
t_M	Decrease y time / duration of cooling period
t_A	Min. positional pulse interval
t_E	Min. positional pulse length
t_1 to t_3	Filter time for the inputs AE1 to AE3
c1 to c7	Constants c1 to c7
dr	Display refresh rate

Off-line parameters

dP	Decimal point (w/x-digital indicator)
dA	Start-of-scale digital indicator
dE	Full-scale digital indicator
A1 to A4	Alarms A1 to A4
HA	Hysteresis A1 to A4
SA	Lower setpoint limit
SE	Upper setpoint limit
tS	Setpoint ramp time
vA	Lower ratio factor
vE	Upper ratio factor
YS	Safety manipulated variable
Y1	Two-step controller: split range left (heating)
Y2	Two-step controller: split range right (cooling)
L1 to L11	Output vertices for lineariser (input vertices are equidistant)

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Technical data

Technical data

• General	
Mounting position	Any
Climatic classes	
Storage: 1K2 according to DIN IEC 721 Part 3-1	–25 to +75 °C
Transport: 2K2 according to DIN IEC 721 Part 3-2	–25 to +75 °C
Operation: 3K3 according to DIN IEC 721 Part 3-3	0 to +50 °C
Protection according to EN 60 529	
Front	IP 64
Housing	IP 30
Terminals	IP 20

Controller design

Electrical safety
- to DIN EN 61 010 Part 1
- Protection class I
- Safe separation between supply connection and field signals
- Clearances and creepage paths for surge class III and pollution level 2 , unless stated otherwise

EC Certificate of Conformity no. 1225.00–03/01

CE marking — conformity concerning
- EMC Guideline 89/336/EWG and
- NS Guideline 73/23/EWG

is fulfilled without rectrictions

Emitted interference, immunity to interference to EN 61 326, NAMUR NE21 8/98

The SIPART DR19 controller has already acquired the following certifications:
- Certification of Germanischer Lloyd
  Certificate No. 97 973-96 HH
- Certificate of “DIN CERTCO, Berlin”,
  Approval as temperature control and limiting equipment for heat generators,
  Certificate of Conformity with DIN 3440:1984–07,
  Registration no.: TR 10702000 S
- TÜV certificate on approval of a component symbol for water level controller, test requirement according to VdTÜV instructions “water level 100” and “water level 100/1”,
  component symbol no. TÜV.WRS(WR).00-379K

Weight of standard controller	Approx. 1.2 kg
Color	
Fascia frame	RAL 7037
Fascia	RAL 7035
Material	
Housing and fascia frame	Polycarbonate, reinforced with glass fiber
Front foil	Polyester
Rear panels, modules	Polybutylene-terephthalate
Auxiliary supply connections	
115/230 V AC	3-pin earthed plug IEC 320/V DIN 49457A
24 V AC/DC	Special 2-pin plug
Connections for process signals	Multi-pin screw-type terminal blocks, protected against reversed polarity for cables of 1.5 mm² (AWG 14)
Protective earth connection	Earthing screw

A rail can be mounted on the rear panel of the power supply. The rail is included in the delivery of the coupling relay mode.

The connectors for the auxiliary supply and the screw-type terminal blocks for the process signals are part of the scope of the supply of the standard controller or the option modules.
Exception:
6DR2803-8C interface module and 6DR2803-8P PROFIBUS DP module.
The connectors have to be ordered separately..

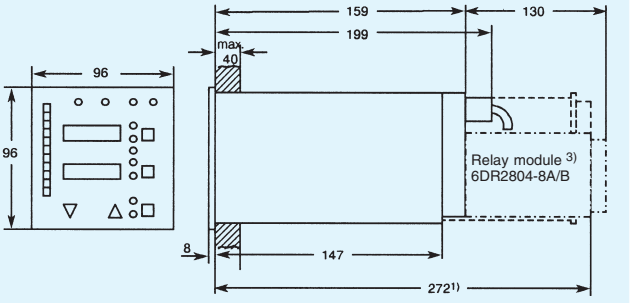
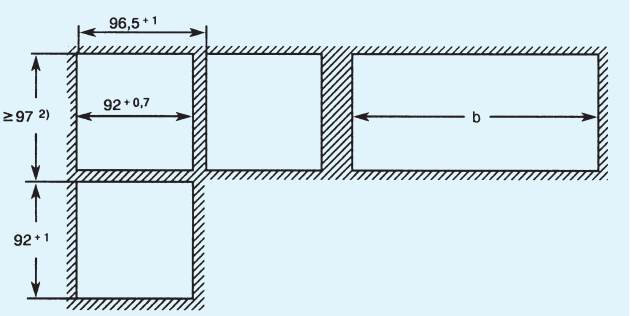


Fig. 3/13 SIPART DR19 controller, dimensions in mm



No. of devices	Cut-out width
2	188 + 1
3	284 + 1
4	380 + 1
.	.
.	.
10	956 + 1

Fig. 3/14 Panel cut-outs, dimensions in mm

1) Space required to change motherboard and module.

2) Observe ambient temperature when stacking with no intermediate spacing.

3) A relay module with 2 or 4 relays (6DR2804-8A/-8B) can be snapped onto the rear of the controller. This will increase the mounting depth by 130 mm.

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Technical data

Technical data (continued)

• Power supply

Rated voltage	Switchable 230 V AC	Switchable 115 V AC	24 V AC/DC	
Operating voltage range	195 to 264 V AC	97 to 132 V AC	20 to 28 V AC	20 to 35 V DC [1])
Frequency range	48 to 63 Hz			–
Peak voltages to IEC 801-5 Pulse: 1.2/50 µs				
symmetric	1 kV	1 kV	0.5 kV	0.5 kV
asymmetric	2 kV	2 kV	1 kV	1 kV
Total of all output currents ($L+$, BA, AA and SES)	max. 200 mA			
Power consumption Active power/ Apparent power (capacitive)				
Standard controller				
– No options, without I_{ext}	5 W/9 VA	5 W/9 VA	4 W/6 VA	4 W
– With options, without I_{ext}	11 W/15 VA	11 W/15 VA	8.5 W/12 VA	8.5 W
– With options, with I_{ext}	15 W/19 VA	15 W/19 VA	12 W/17 VA	12 W
Permitted voltage dips at 0.85 U_N Standard controller with options	≤ 20 ms			
Test voltages (1 min)				
– Primary-secondary	1.5 kV AC		500 V AC	
– Primary-protective conductor	1.5 kV AC		500 V AC	
– Secondary protective conductor	700 V DC		700 V DC	

• Program controller/transmitter

Program	P1 P2 P1 and P2 connected
Intervals per program	P1 = 10 P2 = 5
Variable ramp/stop time	All intervals can be used as ramps or stop time, interval and amplitude for interval end can be modified
Interval period on time basis – Hrs / Mins – Mins / Secs	 00 . 00 to 23 . 59 00 . 00 to 59 . 59
Time base	Same for all intervals
Status signals	6 digital outputs (time-controlled) Each interval can be signalled on each digital output
Program – Start – Stop	From front panel or digital input
Reset	From front panel or digital input

• Standard controller

Analog input AE1	See standard controller, analog input AE1
Transmitter supply $L+$	
Rated voltage	20 to 26 V
On-load current	≤ 60 mA, short-circuit proof
Short-circuit current	≤ 200 mA, pulsed
Digital inputs BE1 and BE2	
Signal status "0"	≤ 4.5 V or open
Signal status "1"	≥ 13 V
Input impedance	≥ 27 kΩ
Digital outputs BA1 and BA2 (with wired OR diodes)	
Signal status "0"	≤ 1.5 V
Signal status "1"	+19 to 26 V
On-load current	≤ 50 mA
Short-circuit current	≤ 80 mA, pulsed
Analog output /y (K controller)	
Rated signal range	0 to 20 mA or 4 to 20 mA
Output range	0 to 20.5 mA or 3.8 to 20.5 mA
Load voltage	–1 to +18 V
Max. permitted inductive load	0.1 H
Relay output (S controller)	
Contact material	Ag-Ni
Contact rating	
Max. switching voltage	250 V AC / 250 V DC
Max. switching current	8 A / 8 A
Max. switching capacity	1250 VA / 100 W at 24 V, 30 W at 250 V
Service life	
Mechanical	$2 \cdot 10^7$ switching operations
Electrical 230 V AC, Ω loading	$2 \cdot 10^6$ switching operations
Spark suppressor	22 nF and 220 Ω connected in series with a 420 V varistor wired in parallel
CPU data	
Cycle time	100 ms
A/D conversion	
Method	Successive approximation with > 120 measurements per input and averaging within 20 or 16.67 ms
Resolution	18 bit for AE1 11 bit for further AE and AA
Zero error	≤ 0.2 % of measuring span
Gain error	≤ 0.2 % of measuring span
Linearity deviation	≤ 0.2 % of measuring span
Display technology	
Digital x indicator	4-digit, red, 7-segment LED display
Digital w indicator	4-digit, green, 7-segment LED display
Character height	10 mm
Display range	Adjustable start and full scale
Numerical range	–1999 to +9999
Decimal point	Adjustable (fixed-point)
Refresh rate	0.1 to 9.9 s, variable
Analog indicator	Vertical row of 21 LEDs (red)
Display range	
– for x_d/x_w	± 5 % to ± 20 %
– internal process quantities	0 to 100 %

[1]) Includes harmonic content.

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Technical data

Technical data (continued)

- Standard controller, analog input AE1

Pt 100 resistance thermometer

Line resistance	
– 2-wire circuit	Lead resistance $R_{Ab} = R_{L1} + R_{L4}$ defined by parameters or automatic compensation via configuration $R_{L1} + R_{L4} \leq 50\ \Omega$
– 3-wire circuit	No compensation necessary if $R_{L1} = R_{L2} = R_{L4} \leq 50\ \Omega$
– 4-wire circuit	No compensation necessary R_L each $\leq 100\ \Omega$
Measuring current	400 µA
Configurable measuring range	
Start	$R_{tA} \geq 18.49\ \Omega$, $t_A \geq -200$ °C
End	$R_{tE} \leq 390.26\ \Omega$, $t_E \leq 850$ °C
Recommended min. span	10 K
Characteristic	Temperature linear
Filter time constant	≈ 10 ms
Input	Non-floating

Thermocouples

Thermocouples, configurable to DIN IEC 584, part 1		Type
	Cu-CuNi	T
	Fe-CuNi	J
	NiCr-Ni	K
	NiCr-CuNi	E
	Pt10Rh-Pt	S
	Pt13Rh-Pt	R
	Pt30Rh-Pt6Rh	B
	NiCrSi-NiSi	N
to DIN 43 710	Cu-CuNi	U
	Fe-CuNi	L

Compensating reference junction	
Internal	Reference junction terminal required
External	Temperature of external reference junction entered as parameter
Line resistance	≤ 300 Ω
Configurable measuring range	
Start	≥ –175 mV
End	≤ +175 mV
Recommended min. span	5 mV
Configurable characteristic	Linear with voltage or temperature
Filter time constant	≈ 10 ms
Input current	≤ 1 µA
Permitted common mode voltage	≤ 1 V
Stat. destruction limit across inputs	±35 V

mV source

Configurable measuring range	
Start	≥ –175 mV
End	≤ +175 mV
Recommended min. span	5 mV
Line resistance	≤ 1 kΩ
Characteristic	Voltage linear
Input current	≤ 1 µA
Permitted common mode voltage	≤ 1 V
Stat. destruction limit across inputs	±35 V

Resistance based sensor R

	Measuring range	
Configurable measuring range		
Measuring range limits incl. line resistance	$R_{tot} \leq 600\ \Omega$	600 Ω ≤ 2.8 kΩ
Recommended min. span	30 Ω	70 Ω
Input current	400 µA	140 µA
Linearity error	±60 mΩ	±0.2 Ω
Test voltage	500 V AC	
Input	Non-floating	

mA source
with additional measuring range connector 6DR2805-8J
(with impedance already included in Smart instruments)

Measuring range	
Start	0/4 mA ≙ 0/20 mV
End	20 mA ≙ 100 mV
Transformation error	0.3 %
Input resistance	50 Ω
Smart input resistance	250 Ω
Permitted common mode voltage	≤ 1 V
Stat. destruction limit across inputs	±40 mA

10 V voltage source
with additional measuring range connector 6DR2805-8J

Measuring range, can be compensated	
Start	0/2 V ≙ 0/20 mV
End	10 V ≙ 100 mV
Transformation error	0.2 %
Input resistance	90 kΩ
Permitted common mode voltage	≤ 1 V
Stat. destruction limit across inputs	±35 V

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Ordering data

Ordering data

	Order No.
SIPART DR19 industrial controller 96 x 96, with program function	
basic unit with - 1 analog input, - 2 digital inputs - 1 analog output - 2 relay outputs - 2 digital outputs	
power supply AC/DC 24 V	**6DR1900-4**
power supply AC 230 V, switchable to AC 115 V	**6DR1900-5**
Input/output modules	See Catalog Section 8

Analog signal module
- for current input 0/4 to 20 mA or voltage inputs 0/0.2 to 1 V or 0/2 to 10 V (6DR2800-8J)
- for resistance based sensor (R module) (6DR2800-8R)
- UNI module for TC/RTD/R/mV signals, programmable (6DR2800-8V)
- reference junction terminal for TC, internal (used in conjunction with AE1 or UNI module (6DR2805-8A))
- measuring range connector for *I* = 20 mA and *U* = 10 V (used in conjunction with AE1 or UNI module (6DR2805-8J))

Switching signal module
- with 5 digital inputs (6DR2801-8C)
- with 4 digital outputs and two digital inputs (6DR2801-8E)
- with 2 relay outputs (6DR2801-8D)

Coupling relay module
- With 4 relays (AC 250 V) (6DR2804-8A)
- With 2 relays (AC 250 V) (6DR2804-8B)

Interface modules
- For serial communications via RS 232 or RS 485 (6DR2803-8C)
- PROFIBUS DP module (6DR2803-8P)

	Order No.
Documentation	
Quick reference "Operating and configuring"	
- German/English - French/Spanish/Italian	**C73000-B7474-C140** **C73000-B7450-C140**
Assembly and installation instructions	
- German/English - French/Spanish/Italian	**C73000-M7474-C34** **C73000-M7450-C34**
Manual	
- German - English	**C73000-B7400-C142** **C73000-B7476-C142**

The following Instructions can be downloaded from Internet (see Section 10, Page 10/4):

SIPART DR
PROFIBUS interface / Instructions
(Description of the communication via PROFIBUS DP with the controller SIPART DR19/20/21/22/24)
- German
- English

SIPART DR19
Serial SIPART 6DR190x Bus interface / Instructions
(Description of the communication via RS 232, RS 485 or PROFIBUS DP with the controller SIPART DR19)
- German
- English

Scope of supply

The scope of supply of a SIPART DR19 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)
(please order internal cold junction for TC connection or measuring range connector separately, see Part 8)

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 catalog (German) for details of training courses for the controllers listed in this catalog (cf. also the appendix).

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Notes

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SIPART DR20 Controllers

4

Note
The SIPART DR20 controller has been discontinued.
Replacement model is SIPART DR21 (cf. chapter 5).

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Notes

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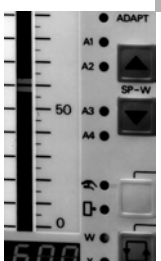
SIPART DR21 Controllers

5



5/2 **Description**
5/2 Application, design
5/3 Mode of operation
5/8 Control and display functions
5/10 Function diagram
5/11 Configuring switches, on-line/off-line parameters

5/12 **Technical data**

5/14 **Ordering data**

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SIPART DR21 Controllers

Description

Fig. 5/1 SIPART DR21 controller

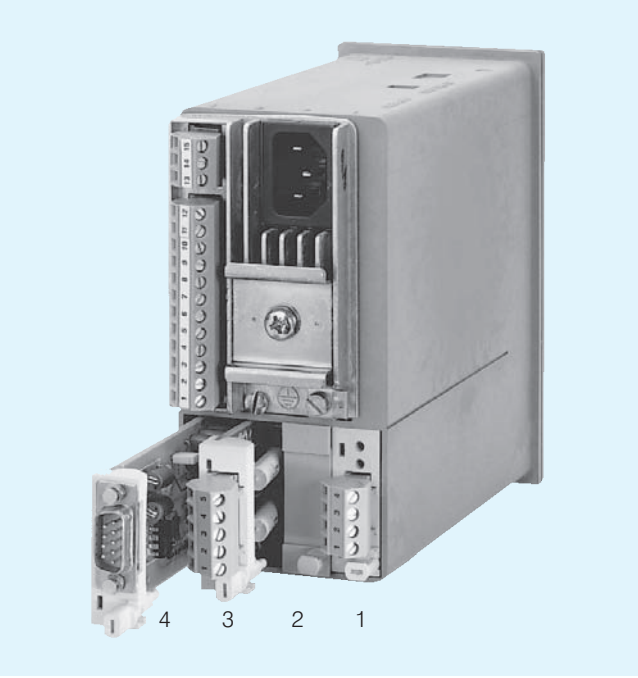

Fig. 5/2 SIPART DR21 controller – rear view, slots

5

Application

The SIPART DR21 process controller is a digital controller. Its internal program memory contains a large number of standard functions for the control of process engineering applications. A user with no programming knowledge can simply call up and execute these functions.

The SIPART DR21 controller is very flexible and can be quickly and easily configured to meet the requirements of the application.

An adaptation process is built in as standard.

The SIPART DR21 controller can be used as a:

- Fixed setpoint controller for one, two or three component control, with the option of two setpoint values
- DDC fixed setpoint controller for one, two or three component control
- Slave, synchro or SPC controller, with the option of internal/external switchover
- Fixed or controlled ratio controller with internal/external switchover
- M/A control station, process variable indicator or setpoint transmitter. The control algorithm is disabled in these cases.

Design

The SIPART DR21 process controller is of modular design and consequently easy to service and simple to reconfigure or retrofit. The standard unit itself is fully functional and extremely well equipped. Additional modules can be inserted in the slots in the rear of the closed unit in order to extend its range of applications (Fig. 5/2).

Slot assignments:

- slot 1 analog input 3 (AE3)
- slot 2 anlalog input 4 (AE4)
- slot 3 digital inputs/outputs (BE/BA)
- slot 4 interface modules

The standard unit comprises

- Front module (controls and displays with motherboard and CPU)
- Backplane
- Plastic moulded housing with fittings for installation in control panels, consoles or machines.

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Description

The backplane contains the power supply unit and connectors. It is installed in the rear of the housing and connected to the front module by a ribbon cable.

The standard controller has two fixed, non-isolated analog inputs for input current signals of 0/4 to 20 mA and two digital inputs.

The following outputs are available for the manipulated variable or the status signals:

- Analog output 0/4 to 20 mA
- 2 relay outputs
- 2 digital outputs.

The number of inputs and outputs can be increased by adding extra modules.

Input/output modules are available for:

- Current or voltage input (U/I)
- UNI module for TC/RTD/R/mV, also mA and V with adapter; galvanically isolated
- Resistance input (potentiometer) (R)
- Digital inputs and outputs (BE/BA)
- Relay outputs (Rel)
- Serial interface (SES)
- PROFIBUS DP module

Electrical supply for the transmitters is provided by a short-circuit-proof *L+* output.

The tagging label and scale can be replaced.

Available versions:

- 6DR2100-4 for power supply 24 V AC/DC
- 6DR2100-5 for power supply 230 V AC, switchable to 115 V AC.

Mode of operation

The SIPART DR21 controller is based on a modern, highly integrated microcontroller using C–MOS technology.

The instrument's internal program memory contains a large number of functions for the control of process engineering applications.

Configuring – the setting of parameters and configuring switches – enables the users themselves to select the functions required for their applications.

The instrument can be configured from either the front panel or via a PC using the SIMATIC PDM software package.

On leaving the factory, the SIPART DR21 controller is configured as a fixed setpoint controller. In most cases only a few additional settings therefore need to be made.

The instrument parameters are stored in non-volatile memory and are consequently safe from the effects of a power failure. A backup battery is not required.

The SIPART DR21 controller can be operated as a P, PD, PI or PID controller.

Adaptation procedure

SIPART DR21 utilises a rugged adaptation procedure that significantly simplifies the commissioning of even the most critical control loops.

The controller automatically calculates the optimum control parameters, and does not assume that the user has any prior knowledge of how the control loop might respond. The procedure used is suitable for loops with compensation and an aperiodic transient response. Dead times are also taken into account.

Analog input

The SIPART DR21 controller has a total of 4 analog inputs, 2 of which are already included in the standard unit. The other inputs can be configured if required.

Theses inputs can be connected to the "function inputs" x_1, x_2, x_3/w_e, y_N, y_R and z.

The function inputs act as the analog input channels for the different types of controller. What role the function inputs have therefore depends on the configuration of the controller.

Function input z is used as an input for feedforward control, where the disturbance z can either be connected dynamically via the D element or statically, weighted by a factor, to the manipulated variable y.

A 1st order filter for the suppression of external interference and a square-root extractor can be connected in each analog input channel.

A lineariser with 13 vertices and knee-point smoothing can be connected to one of the analog inputs.

Controller manipulated variables

- K controller (continuous output)

In this configuration of controller, the manipulated variable is output as a standardized current signal. The signal range (0/4 to 20 mA) is determined when the controller is configured.

- S controller (switching output)

It is preferably to use the floating relay contacts to output the manipulated variable. These contacts are pprovided with a protection circuit adapted to the contactor coils.

It is important to ensure that the maximum switching voltage is not exceeded. Phase shifting motors must therefore only be connected via intermediate switching devices.

The relay contacts are mutually interlocked. This interlock can be disabled for a universal digital output.

Digital outputs are at disposition to output the manipulated variable at a high switching rate.

Used as S controller, the analog output can then be used for output of an internal process quantity (x, w or x_d).

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Description

Two-step controller

The manipulated variable *y* is output as a pulse duty factor with a variable period. In the case of two-step controllers with heating/cooling outputs, a different period can be allocated to each output. Each stage then runs through the pulse duty factor from 0 to 100 %. The dead zone between the heating/cooling stages can be entered as a parameter.

Main application for this type of controller: temperature controller that, for example, switches the heating or cooling power on and off, or that opens and closes a solenoid valve.

One of the outputs for heating/cooling can alternatively be output as analog signal 4 to 20 mA.

Digital inputs and outputs

The 2 digital inputs and outputs in the standard controller are connected during configuring to the digital functions required for the application.

They are non-isolated and operate in either normal or inverted mode, depending on how the controller is configured.

The digital outputs are active. They provide a DC voltage signal.

The number of digital inputs and outputs can be increased by installing additional option modules.

In addition, a coupling relay module can be snapped onto the DIN rail on the rear of the controller. This module can have either 2 or 4 relays, each with 1 changeover contact for 250 V AC, 8 A, which are controlled from the digital outputs.

The following functions can be connected to the digital inputs and outputs.

Digital inputs

CB	Computer ready
He	Manual mode, external
N	Tracking
Si	Safety mode
P	Controller P mode
$\overline{\text{tS}}$	Disable setpoint ramp time
±yBL	Direction-dependent blocking of manipulated variable
BLB	Blocking of command level
BLS	Blocking of configuring
BLPS	Blocking of parameterization and configuring
tSH	Stopping of setpoint range

Digital outputs

RB	Computer relay
RC	Computer mode
H	Manual mode
N_w	Setpoint tracking mode
A1,2,3,4	Alarm monitor A1, A2, A3, A4
MUF	Transmitter fault
±Δw	Incremental *w* adjustment

Display technology

The SIPART DR21 controller is equipped with easy to read displays that conform to NAMUR requirements.

There is an analog indicator for both the actual value *x* and the setpoint value *w*, a digital indicator that can be switched between *x* and *w*, a digital indicator for the manipulated variable *y*, plus alarm and status indicators.

Both analog indicators are implemented as vertical LED bargraphs. As the actual value and setpoint indicators are located next to each other, a setpoint/actual comparison for dynamic trend purposes is very easy.

The red digital indicators for the actual and setpoint values have 4 digits and can be configured in an engineering unit or as a percentage value.

11 LEDs are situated on the front of the controller for indicating operating status and alarm conditions.

Some of these displays and controls may be assigned different functions in the configuring levels.

Configurable functions

Application-specific circuits are prewired in the EPROM of the SIPART DR21 controller and can be easily called up.

The configurable functions of the controller (configuring switch S1) are shown below as block diagrams and described briefly. For the sake of clarity, only the most important functions are discussed. Other configuring options applicable to all types of controller are described in the subsequent pages.

The constants c_1 to c_7 shown in the following diagrams can be entered as parameters.

An additional disturbance can be superimposed on the manipulated variable either dynamically via the D element or as a static value through the function input *z*.

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Description

Configuring switch S1 = 0, fixed setpoint controller

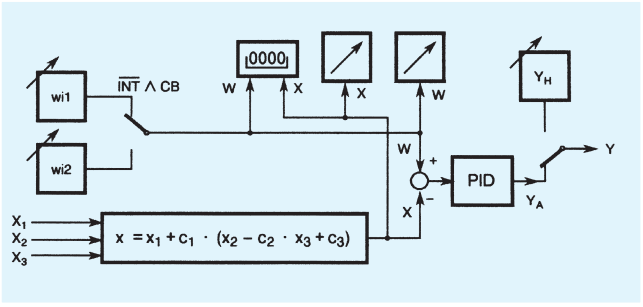

Fig. 5/3 Fixed setpoint controller with one or two independent setpoints as one, two or three-component controller

The setpoints w_{i1} and w_{i2} can be individually adjusted from the front module. The switchover function can be blocked.

Configuring switch S1 = 1, slave, synchro or SPC controller

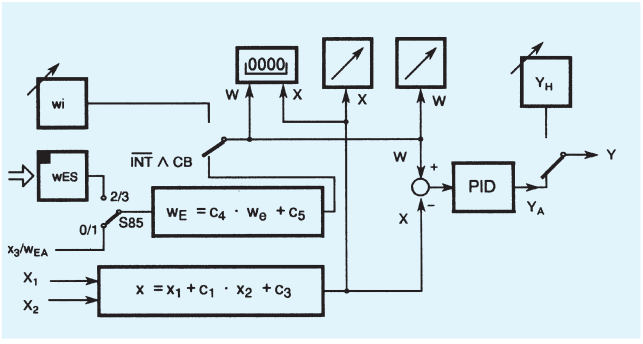

Fig. 5/4 Slave, synchro or SPC controller (Setpoint Control) with internal/external switchover

The remote setpoint can be entered in the controller as an analog signal through the function input x_3 or via the serial interface.

For synchronization purposes, the constant c_5 can be added to the setpoint, which can be also weighted by the factor c_4.

Configuring switch S1 = 2, DDC controller

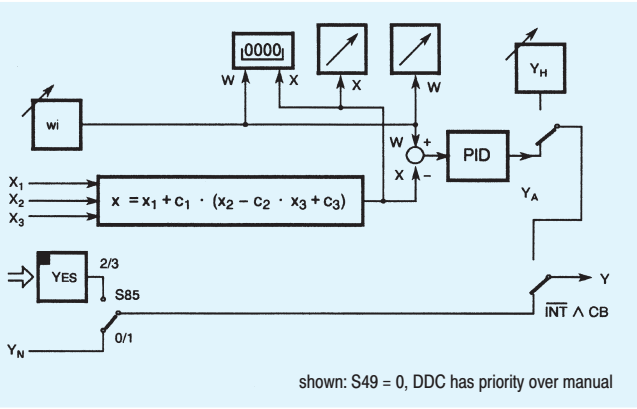

Fig. 5/5 DDC fixed setpoint controller as one, two or three-component controller

In DDC mode (Direct Digital Control) the control function is handled directly by a process computer. The function of the control loop is safeguarded in the event of a computer failure by having a compact controller wired in parallel.

Configuring switch S1 = 3, ratio controller

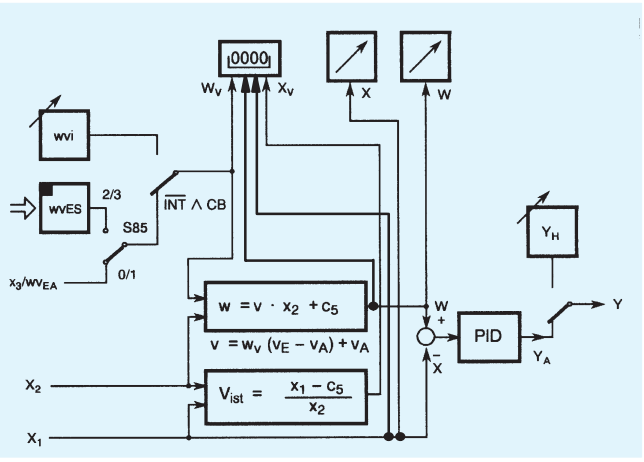

Fig. 5/6 Fixed or controlled ratio controller with internal/external switchover

The controlled variable and weighted command variable are entered in the controller through the function inputs x_2 and x_1. With this type of controller, the variable setpoint value is not an absolute value, but is specified as a factor v (w_V) derived from the ratio between the controlled variable and the command variable.

The standardized setpoint ratio w_V or actual ratio x_V can be displayed in the 4-digit digital indicator (switchable). The controlled variable x and the setpoint w can be displayed in the physical range if required. The controlled variable x and the weighted setpoint w are displayed in the analog indicators.

The ratio factor can be controlled externally. In this case the switchover structure is the same as that of a slave controller. As the switchover can be blocked, though, the instrument can also be used as a ratio controller in this configuration.

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Description

- Configuring switch S1 = 4, control station/process variable indicator

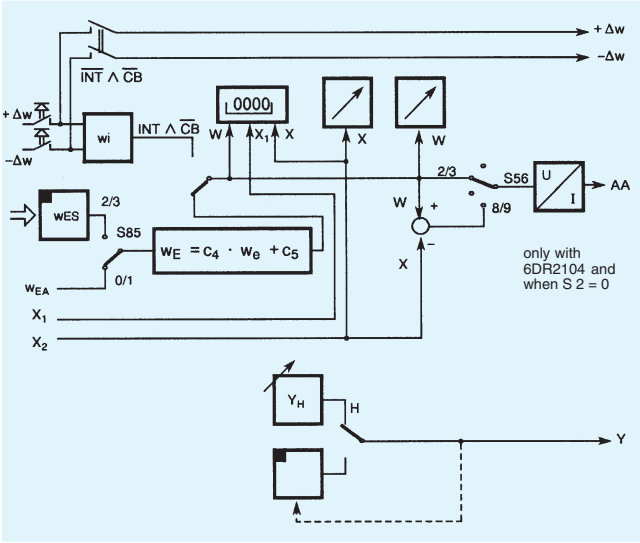

Fig. 5/7 M/A control station/process variable indicator

In this configuration, the SIPART DR21 is used as a:

- M/A control station for parallel process operation, e. g. with a SIPART DR22 controller
- Manual control unit for the output of an analog or switching setpoint or manipulated variable value
- Process variable indicator for up to 3 measured values.
  - two analog indicators with parallel digital indicator; if the measuring range is the same, the physical value can also be displayed
  - a digital indicator 0 to 100 %.
  - monitoring of up to 4 limit values
  - if analog indication is being used, the limit values can be output on the second analog indicator.

Other configurable functions to enhance the ease of use and operational safety of the SIPART DR21 controller

Transmitter monitoring

A message is output on the 4-digit digital indicator whenever the measurements go out of limits (< −3 % or > +103 % of the signal range). A different message can be output for each input. A group fault message can be output on the MUF digital output.

Furthermore, automatic switchover to manual mode, starting with the value of the last manipulated variable or the safety value, can be selected.

Setpoint limitation

The effective setpoint value is always limited.

Setpoint ramp

The *ts* parameter specifies the rate of change of the setpoint value.

x-tracking

In manual, tracking and DDC mode, and also when the safety value is active, the setpoint *w* tracks the controlled variable *x*.

Filter and response threshold of control difference

The control difference is controlled by an adaptive filter (tF) so that low-frequency interference can also be filtered out.

If the output of the controller needs to be stabilized more, a response threshold for the control difference can be entered.

Varying the direction of control

The default setting of the controller is for normal-action control loops. The direction af action of the controller should be inverted in the case of reverse-action control loops.

Special features of the control algorithm

The P(D) and PI(D) control algorithm for the controller is implemented as a non-interacting parallel structure and is independent of the output structure (S or K) of the controller.

The switchover from PI(D) to P(D) control is performed by a control signal. In P(D) mode, the specified K_P value multiplied by the constant c_7 is used.

The switchover from automatic to manual mode (and vice versa), plus the switchover to automatic from all other modes of operation, is bumpless.

This function is also operative in P(D) mode with automatic setting of the working point Y_0.

If this is undesirable, the working point in P(D) operation can be set manually if required (using parameter Y_0). Switchover to automatic will then not be bumpless. In the case of S controllers, P mode is only permitted with external position feedback.

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Description

Limiting the manipulated variable

The parameters YA and YE can be used with K output and S output with external feedback to limit the manipulated variable.

Limiting the manipulated variable like this is – depending on how the controller is configured – only possible in automatic mode or in all modes.

In addition to the fixed limiting of the manipulated variable described here, an additional, direction-dependent limiting of the manipulated variable is provided in the SIPART DR21 controller. This limiting is activated by the control signals +yBL and –yBL and is effective in all modes of operation.

Limit monitor

The alarm functions A1/A2 and A3/A4 can be assigned in pairs to monitor all internal controller process variables. They can also be configured to monitor maximum-minimum, maximum-maximum or minimum-minimum values.

Violations of minimum/maximum values are indicated on the A1/A2 and A3/A4 LEDs and can be configured to output messages on the digital outputs, the logic of which can be inverted.

The limit values are normally specified in the parameterization level. The alarms may also be specified and displayed in the process operation level (*x/w* digital indicator).

In addition, the limit values can be indicated continuously on the green LED bargraphs. The analog setpoint indicator is then omitted. The appropriate LED starts to flash when a limit value is violated.

The hysteresis for the pairs of limit monitors is specified as a parameter.

Restart conditions

Short dips in the mains voltage are, depending on the current loading of the instrument, handled by the buffering capability of the power supply unit.

In the case of a longer power failure, the parameters and configuring data that have been entered are retained in a non-volatile user program memory. The most recent mode of operation and the last setpoint and manipulated variable values are also held in non-volatile memory.

When power is restored following a power failure or after the controller is switched on, the controller automatically restarts using the configured mode of operation, setpoint and manipulated variable values.

An optical signal can also be generated to indicate that power has been restored following a power failure.

Self–diagnosis

Comprehensive monitoring routines check the internal data traffic cyclically or following a POWER-ON or Watchdog reset.

If an error is detected, an error message is automatically output on the *w/x* digital indicator. The errror message indicates the cause of the error and how it can be remedied.

Communication with higher-level systems

The SIPART DR21 controller can transmit and receive status flags, process variables, parameters and configuring switch settings via interface module (option).

The following interface modules are available:

PROFIBUS DP module

- Transmission rate up to 1.5 Mbits/s
- Address range up to 125
  (number of possible stations on the PROFIBUS is determined by the master interface module, the data range of the interface module, and the number of paramterized process data)

SES module RS 232/RS 485

- Transmission rate 9.6 kbits/s
- RS 232 as point-to-point connection
- RS 485 up to 32 stations

The advantages of the stand-alone SIPART DR21 controller can still be utilized to the full, even when used in conjunction with supervisory systems:

- Straightforward adaptation of each controller to meet the requirements of the task in hand
- Operational safety: if the supervisory system, or part of it, shuts down or fails, the SIPART DR21 controller continues to function as an independent controller under the same conditions as before
- Flexibility: modifications or additions to individual control loops are also possible while the system is in use
- Downloading the functions of the controller to individual devices in SPC mode lightens the load on the supervisory system
- The distributed structure of the system enhances overall clarity.

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.

Theses 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.

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Description

Control and display functions

The setting of parameters is distributed over several configuring levels. This makes it very straightforward and simple to modify the controller configuration to the task in hand.

To enter the individual levels, several inputs have to be made explicitly within a specified time limit. Incorrect operation of the controller is therefore practically impossible.

Operation of the SIPART DR21 controller takes place at 3 levels:

- Process operation level
- Selection level
- Configuring level

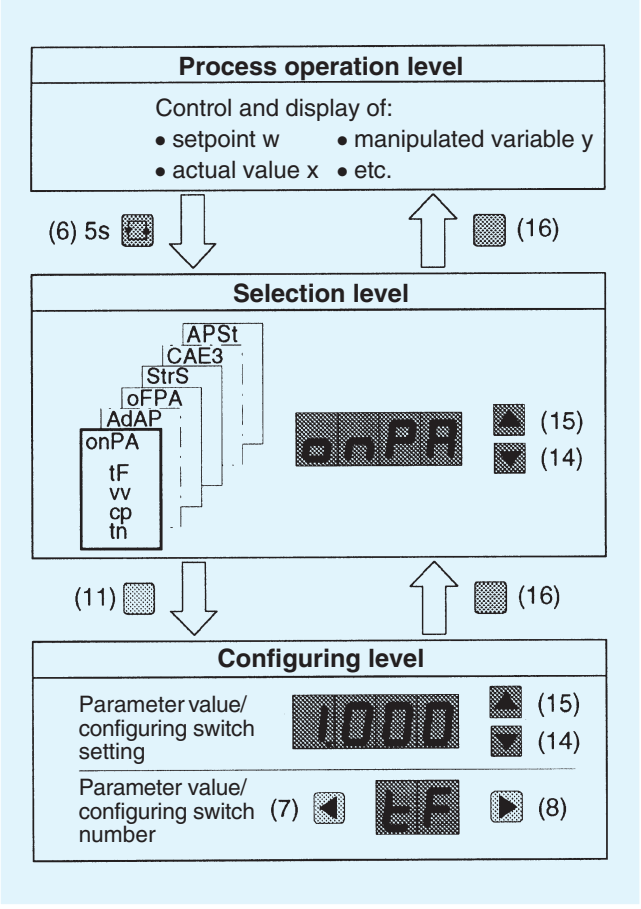

Fig. 5/8 Control levels of SIPART DR21 controller

Process operation level (Fig. 5/9)

The layout and color of controls, displays and the front fascia itself make operation of the SIPART DR21 controller in this mode self-explanatory.

Depending on the configuration, the four-digit digital indicator (3) shows either the actual value *x*, the setpoint *w* or the limit values A1 to A4. Use pushbutton (6) to toggle the indicator.

The LEDs (4 and 5) and the digital indicator (9) indicate which of the above mentioned variables is currently being displayed.

The green LED bargraph (2) shows the setpoint value or the enabled alarms, the red LED (1) the actual value.

The internal setpoint value of the SIPART DR21 controller is set using pushbuttons (14 and 15). The rate of change of the value increases the longer a button is pressed.

Pushbutton (16) is used to toggle between internal and external mode. LED (17) illuminates when in internal mode. Setpoint switchover is disabled when the controller is shipped from the factory.

The yellow pushbutton (11) toggles between manual and automatic mode. Which mode is active is signalled by the yellow LED (12).

Another yellow LED (13) indicates external modification of the manipulated variable, e. g. in tracking mode. The manipulated variable can be set in manual mode using the yellow pushbuttons (7 and 8). The value is displayed on the red, two-digit digital indicator (9).

On K controllers, the rate of change of the value increases the longer a button is pressed.

The red LEDs (10) display the +/–Δ increment in all modes of S and two-step controllers.

Violation of limit values is indicated by the LEDs (20).

LED (19) signals the progress of parameter optimization during adaptation through either a steady or flashing light.

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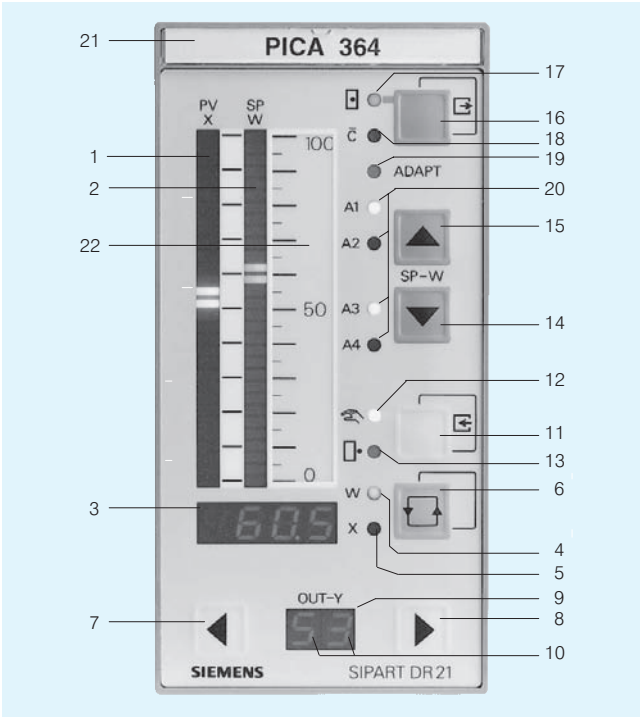
Description



1 Analog indicator actual value *x*
2 Analog indicator setpoint *w*
3 w/x digital indicator (other values can be displayed)
4 Signal lamp *w* – illuminates when *w* is being displayed
5 Signal lamp *x* – illuminates when *x* is being displayed
6 Toggle button for *w/x* digital indicator, button to acknowledge flashing following restoration of power and entry button for selection level
7 Button to modify manipulated variable – down (up)
8 Button to modify manipulated variable – up (down)
9 *y* digital indicator
10 Signal lamps of Δ*y* digital outputs on S controller
11 Toggle button Manual/Automatic and button to enter configuring level from selection level
12 Signal lamp Manual mode
13 Signal lamp "*y*-external mode"
14 Reduce setpoint value button
15 Increase setpoint value button
16 Toggle button – internal/external setpoint and button to exit configuring and selection levels and return to process operation level
17 Signal lamp "Internal setpoint"
18 Signal lamp "Computer (with w_{ext}) switched off"
19 Signal lamp "Adaptation in progress"
20 Alarm lamps "Limit value violated"
21 Tagging label
22 Scale

Fig. 5/9 Controls and displays

Selection and configuring levels

First of all, the function of the front control and display panel is switched from the process operation level to the selection level.

This is done by pressing and holding the pushbutton (6) until a flashing "PS" is displayed on the 2-digit digital indicator. On releasing the pushbutton, "PS" is displayed constantly and "onPA" appears in the *w/x* digital indicator (3). The controller is now in the selection level, from where the parameter lists, the configuring switch list or commissioning functions can be selected.

Use the pushbuttons (14 and 15) to page through the selection level.

Having changed to configuring level, the parameter and configuring switch settings of the selected lists can be displayed and modified.

You can switch to the relevant mode by pressing the Enter button (11) as soon as the letters indicating parameterization or configuring mode appear in the display (3). The parameter or configuring switch is selected using pushbuttons (7 and 8) and then modified according to the tables on page 5/11 using pushbuttons 14 and 15.

Press the Exit button (16) to quit the selected level.

Control mode remains active while the "on-line parameters" are being set. The response of the system to modifications to control parameters can therefore be seen immediately.

The output of the controller is blocked when setting the configuring switches, the off-line parameters or the settings of the UNI module.

- The K controller freezes the last control current.
- The two-step controller freezes the last pulse duty factor.
- The S controller issues no more positioning pulses.

A zebra pattern is displayed in the green analog indicator to indicate off-line mode.

The configuring levels

AdAP (adaptation) and

CAE3 (calibration "UNI module" on analog input 3)

are only displayed if they have been configured.

Lamp test

If pushbutton (6) is pressed and held for more than 5 sec., all LEDs on the front of the controller are illuminated, regardless of what is currently being displayed, until the button is released. The displays revert to their original form when the lamp test ist complete.

Display of firmware status

The present firmware status of the SIPART DR21 controller can be displayed if required.

5

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Description

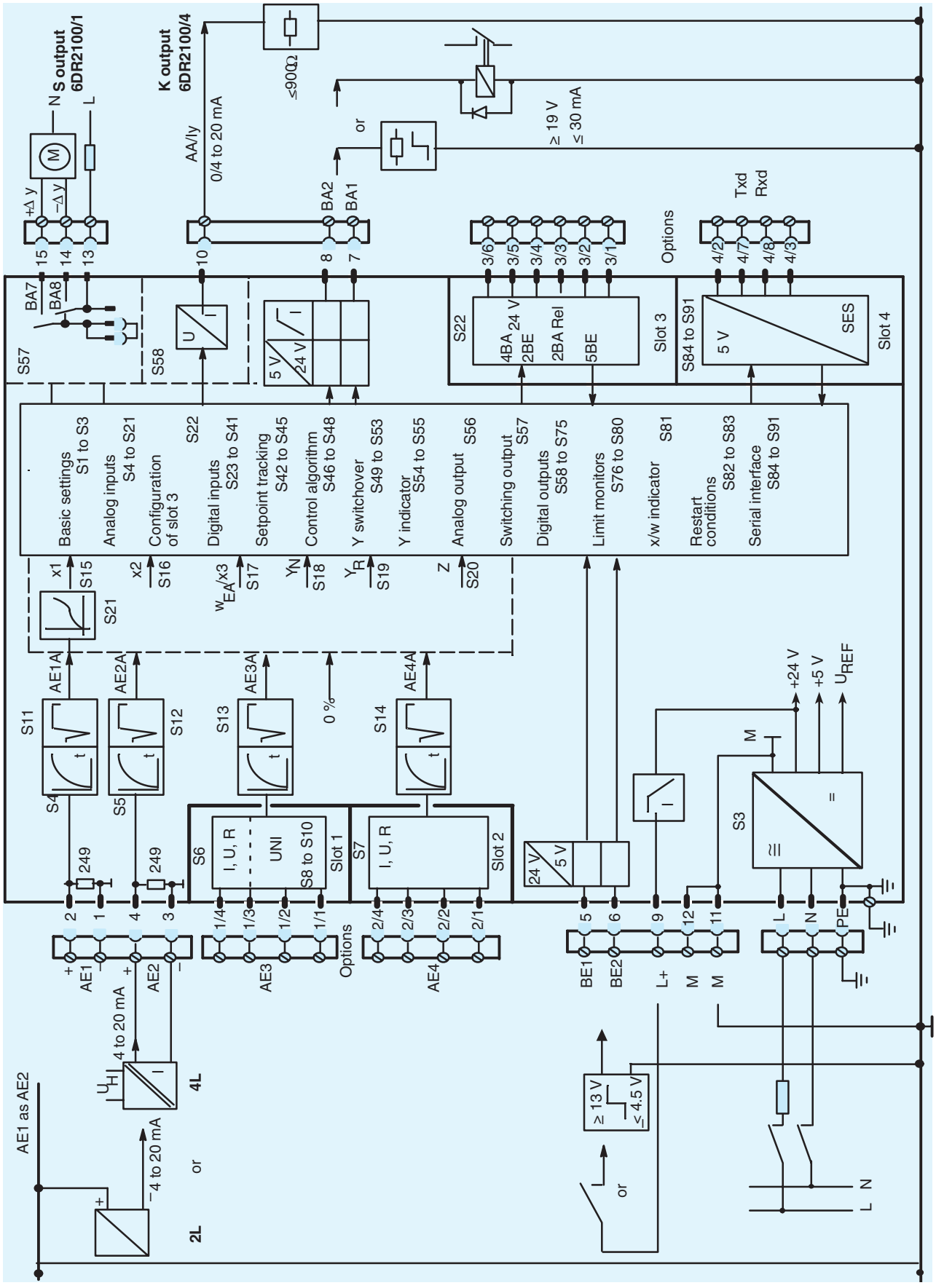

Fig. 5/10 SIPART DR21 controller, function diagram

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Description

Configuring switch list

Configuring switch	Function
S1	Type of controller
0	Fixed setpoint / three-component controller, both with 1 or 2 independent setpoints
1	Slave / synchronization/ SPC controller
2	DDC controller
3	Ratio controller
4	Control station / Process variable indicator
5	Fixed setpoint controller for coupling to a process control system, from firmware release A05 onwards
6	Slave controller for coupling to a process control system, from firmware release A7 onwards
S2	Output configuration
0	K controller
1	Two-step controller for heating/cooling
2	S controller with internal feedback
3	S controller with external feedback
S3	Mains frequency suppression
0	50 Hz
1	60 Hz
S4 and S5	Signal range 0 or 4 to 20 mA of analog inputs AE1 and AE2
S6 and S7	Configuration of slots 1 (AE3) and 2 (AE4)
S8 to S10	Specifying of measured variable, type of sensor and engineering unit for slot 1 (AE3) when configured with UNI module
S11 to S14	Extract square root of analog inputs AE1 to AE4
S15 to S20	Assignment of function inputs x_1, x_2, x_3/w_e, y_N, y_R, z to analog inputs AE1 to AE4
S21	Assignment of lineariser to AE1 to AE4 or x_1
S22	Slot 3 configuration
S23 to S33	Assignment of control signals CB, He, N, Si, P, ts, +yBL, –yBL, BLB, BLS, BLPS to digital inputs BE1 to BE7
S34 to S40	Logic of control signals
S41	Effect of control signal CB, static or dynamic (pulse)
S42 to S45	Setpoint switchover
S46	Direction of action of controller
S47	Feedforward control of D element
S48	Adaptation: type of adaptation
S49 to S53	Manual/Automatic, switchover, priority N or H, disable *ly, y* limiting
S54 and S55	Manipulated variable display: Selection of displayed variable and logic
S56	Assignment of internal controller signals to the analog output
S57	Assignment of the +/–Δy outputs to the digital outputs BA1/BA2 or the relay outputs BA7 and BA8
S58 to S68	Assignment of alarm signals RB, RC, H, Nw, A1, A2, A3, A4, MUF, +Δw, –Δw to digital outputs BA1 or BA6 or the relay outputs BA7 and BA8
S69 to S75	Logic of alarm signals
S76 and S77	Assignment of limit monitors A1/A2 and A3/A4 to internal process variables
S78 a. S79	Function of limit monitors A1/A2 and A3/A4
S80 and S81	Selection of display values for the *w/x* digital indicator
S82 and S83	Restart conditions following restoration of power supply
S84 to S91	Serial interface settings: station no., data transmission rate, parity
S92	Assignment of control signal tSH to digital inputs BE1 to BE7

On-line parameters

tF	Filter time constant for filter xd (adaptive)
Vv	Derivative action gain
K_P	Proportional gain
T_n	Reset time
T_v	Derivative action time
AH	Response threshold
Y_0	Working point – P(D) controller
YA	Lower limit of manipulated variable
YE	Upper limit of manipulated variable
tP	Increase *y* time / duration of heating period
tM	Decrease *y* time / duration of cooling period
tA	Min. positional pulse interval
tE	Min. positional pulse length
t1 to t4	Filter time for the inputs AE1 to AE4
c1 to c7	Constants c1 to c7
dr	Display refresh rate

Off-line parameters

dP	Decimal point (w/x digital indicator)
dA	Start-of-scale digital indicator
dE	Full-scale digital indicator
A1 to A4	Alarms A1 to A4
HA	Hysteresis A1 to A4
SA	Lower setpoint limit
SE	Upper setpoint limit
SH	Safety setpoint
tS	Setpoint ramp time
vA	Lower ratio factor
vE	Upper ratio factor
YS	Safety manipulated variable
Y1	Dual setpoint contr.: split range left (heating)
Y2	Dual setpoint contr.: split range right (cooling)
L 1 to L11	Output vertices for lineariser (input vertices are equidistant)
Pd	Decimal point } for S1 = 3 only
Ad	Start-of-scale value } for S1 = 3 only
Ed	Full-scale value } for S1 = 3 only

5

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Technical data

Technical data

General	
Mounting position	Any
Climatic classes	
– Storage: 1K2 according to DIN IEC 721 Part 3-1	–25 to +75 °C
– Transport: 2K2 according to DIN IEC 721 Part 3-2	–25 to +75 °C
– Operation: 3K3 according to DIN IEC 721 Part 3-3	0 to +50 °C
Protection acc. to EN 60 529	
Front	IP 64
Housing	IP 30
Terminals	IP 20

Controller design

Electrical safety
- to DIN EN 61 010 Part 1
- Protection class I
- Safe separation between supply connection and field signals
- Clearances and creepage paths for surge class III and pollution level 2 , unless stated otherwise

EC Certificate of Conformity no. 1243.00–05/01

CE marking conformity concerning
- EMC Guideline 89/336/EWG and
- NS Guideline 73/23/EWG

is fulfilled without rectrictions

Emitted interference, immunity to interference to EN 61 326, NAMUR NE21 8/98

The SIPART DR21 controller has already acquired the following certifications:
- Certification of Germanischer Lloyd Certificate No. 97 974-96 HH
- Certificate of "DIN CERTCO, Berlin", Approval as temperature control and limiting equipment for heat generators, Certificate of Conformity with DIN 3440:1984–07, Registration no.: TR 10692000 S
- TÜV certificate on approval of a component symbol for water level controller, test requirement according to VdTÜV instructions "water level 100" and "water level 100/1", component symbol no. TÜV.WRS(WR).00-378K

Weight of standard controller	Approx. 1.2 kg
Color	
Fascia frame	RAL 7037
Fascia	RAL 7035
Material	
Housing and fascia frame	Polycarbonate, reinforced with glass fiber
Front foil	Polyester
Power supply connections	
115/230 V AC	3-pin earthed plug IEC 320/V DIN 49 457A
24 V AC/DC	Special 2-pin plug
Connections for process signals	Multi-pin screw-type terminal blocks, protected against reversed polarity for cables of 1.5 mm^2 (AWG 14) diameter
Protective earth connection	Earthing screw

A rail can be mounted on the rear panel of the power supply. The rail is included in the delivery of the coupling relay mode.

The connectors for the auxiliary supply and the screw-type terminal blocks for the process signals are part of the scope of the supply of the standard controller or the option modules.
Exception:
6DR2803-8C interface module and 6DR2803-8P PROFIBUS DP module.
The connectors have to be ordered separately..

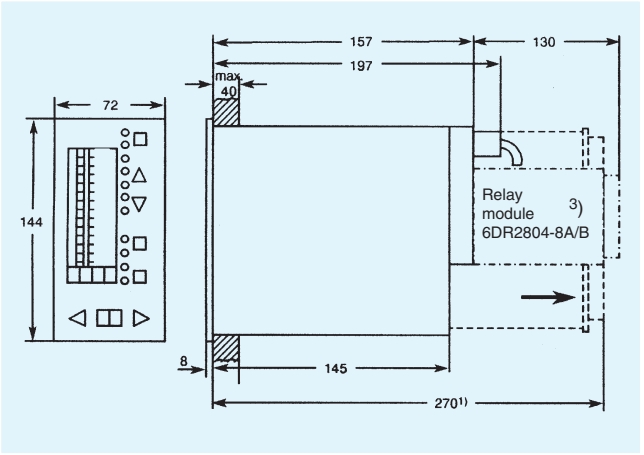
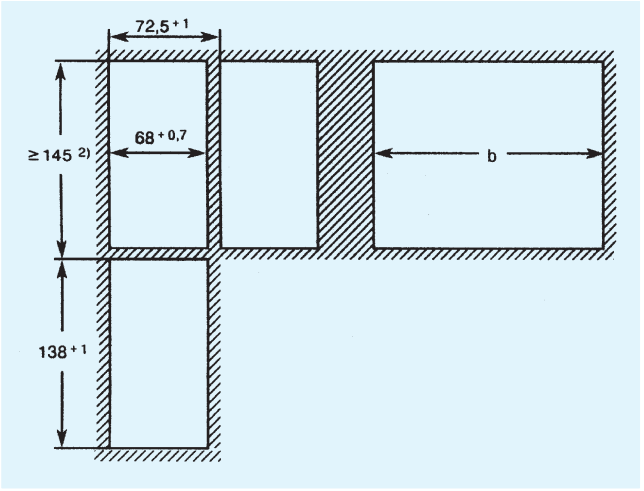


Fig. 5/11 SIPART DR21 controller, dimensions in mm



No. of devices	Cut-out width
2	140 + 1
3	212 + 1
4	284 + 1
.	.
.	.
10	716 + 1

Fig. 5/12 Panel cut-outs, dimensions in mm

1) Space required to change motherboard and module.

2) Observe ambient temperature when stacking with no intermediate spacing.

3) A relay module with 2 or 4 relays (6DR2804-8A/-8B) can be snapped onto the rear of the controller. This will increase the mounting depth by 130 mm.

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Technical data

Technical data (continued)

Power supply				
Rated voltage	Switchable 230 V AC	115 V AC	24 V AC/DC	
Operating voltage range	195 to 264 V AC	97 to 132 V AC	20 to 28 V AC	20 to 35 V DC [1]
Frequency range	48 to 63 Hz			–
Peak voltages to IEC 801-5 (Pulse: 1.2/50 µs)				
symmetric	1 kV	1 kV	0.5 kV	0.5 kV
asymmetric	2 kV	2 kV	1 kV	1 kV
Total of all output currents ($L+$, BA, AA and SES)	Max. 200 mA			
Power consumption				
Apparent power (capacitive)				
Standard controller				
– no options, without I_{Ext}	5 W/9 VA	5 W/9 VA	4 W/6 VA	4 W
– with options, without I_{Ext}	11 W/15 VA	11 W/15 VA	8.5 W/12VA	8.5 W
– with options, with I_{Ext}	15 W/19 VA	15 W/19 VA	12 W/17 VA	12 W
Permitted voltage dips at 0.85 U_N				
Standard controller with options	20 ms			
Test voltages (1 min)				
– Primary-secondary	1.5 kV AC		500 V AC	
– Primary-protective conductor	1.5 kV AC		500 V AC	
– Secondary-protective conductor	700 V DC		700 V DC	

Standard controller		
Analog inputs AE1, AE2		
Current	0/4 to 20 mA	
Input impedance	248 Ω	
Output range	–0.1 to +22 mA	
Filter time constant	10 ms	
Transmitter supply $L+$		
Rated voltage	20 to 26 V	
On-load current	≤ 60 mA, short-circuit proof	
Short-circuit current	≤ 200 mA, pulsed	
Digital inputs BE1 and BE2		
Signal status "0"	≤ 4.5 V or open	
Signal status "1"	≥ 13 V	
Input impedance	≥ 27 kΩ	
Digital outputs BA1 and BA2 (with wired 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, pulsed	
Analog output /y		
Rated signal range	0 to 20 mA or 4 to 20 mA	
Output range	0 to 20.5 mA or 3.8 to 20.5 mA	
Load voltage	–1 to +18 V	
Max. permitted inductive load	0.1 H	
Relay output		
Contact material	Ag-Ni	
Contact rating		
Max. switching voltage	250 V AC	250 V DC
Max. switching current	8 A	8 A
Max. switching capacity	1250 VA	100 W at 24 V 30 W at 250 V
Service life		
Mechanical	$2 \cdot 10^7$ switching operations	
Electrical 230 V AC, Ω loading	$2 \cdot 10^6$ switching operations	
Spark suppressor	22 nF and 220 Ω connected in series with a 420 V varistor wired in parallel	
CPU data		
Cycle time	100 ms	
A/D conversion		
Method	Successive approximation with > 120 measurements per input and averaging within 20 or 16.67 ms	
Resolution	11 bit ≙ 0.06 %	
Zero error	≤ 0.2 % of measuring span	
Gain error	≤ 0.2 % of measuring span	
Linearity deviation	≤ 0.2 % of measuring span	
Display technology		
Digital *x/w* indicator	4-digit, red, 7 segment LED display	
Character height	7 mm	
Display range	Adjustable start and full scale	
Numerical range	–1999 to +9999	
Decimal range	Adjustable (fixed-point)	
Refresh rate	0.1 to 9.9 s, variable	
Analog *x* indicator	Vertical row of 30 LEDs (red)	
Analog *w* indicator	Vertical row of 30 LEDs (green)	
Display range	0 to 100 %	
Resolution	1.7 %	
Digital *y* indicator	2-digit, red, 7 segment LED display	
Character height	7 mm	
Display range	0 to 100 %	
Resolution	1 %	
Refresh rate	0.1 to 9.9 s, variable	

[1]) Includes harmonic content.

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Ordering data

Ordering data

	Order No.
SIPART DR21 controller 72 x 144,	
Basic unit with	
– 2 analog inputs	
– 2 digital inputs	
– 1 analog output	
– 2 relay outputs	
– 2 digital outputs	
– power supply AC/DC 24 V	**6DR2100-4**
– power supply AC 230 V, switchable to AC 115 V	**6DR2100-5**
Input/output modules	See Catalog Section 8
Module for analog signals	
– 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 TC/RTD/R/mV signals, programmable (UNI module) (6DR2800-8V)	
– Reference junction terminal for TC, internal (to be used in conjunction with UNI module (6DR2805-8A))	
– Measuring range connector for *I* = 20 mA and *U* = 10 V (to be used in conjunction with UNI module (6DR2805-8J))	
Switching signal module for the output of limit signals	
– with 5 digital inputs (6DR2801-8C)	
– with 4 digital outputs and two digital inputs (6DR2801-8E)	
– with 2 relay outputs (6DR2801-8D)	
Coupling relay module	
– With 4 relays (AC 250 V) (6DR2804-8A)	
– With 2 relays (AC 250 V) (6DR2804-8B)	
Interface modules	
– for serials communications (SES) via RS 232	
– PROFIBUS DP module (6DR2803–8P)	

Ordering data

	Order No.
Documentation	
Quick reference "Operating and configuring"	
– German/English	**C73000-B7474-C141**
– French/Spanish/Italian	**C73000-B7450-C141**
Assembly and installation instructions	
– German/English	**C73000-M7474-C35**
– French/Spanish/Italian	**C73000-M7450-C35**
Manual	
– German	**C73000-B7400-C143**
– English	**C73000-B7476-C143**

The following Instructions can be downloaded from Internet (see Section 10, Page 10/4):

SIPART DR
PROFIBUS interface / Instructions
(Description of the communication via PROFIBUS DP with the controller SIPART DR19/20/21/22/24)
- German
- English

SIPART DR21
Serial SIPART 6DR210x Bus interface / Instructions
(Description of the communication via RS 232, RS 485 or PROFIBUS DP with the controller SIPART DR21)
- German
- English

Scope of supply

The scope of supply of a SIPART DR21 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 catalog (German) for details of training courses for the controllers listed in this catalog.

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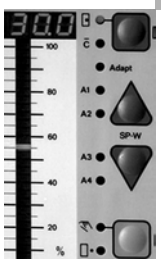
SIPART DR22 Controllers

6

6/2	**Description**
6/2	Application
6/2	Design
6/3	Mode of operation
6/6	Configurable functions
6/13	Further configurable functions
6/16	Control and display functions
6/18	Function diagram
6/22	**Technical data**
6/24	**Ordering data**
6/25	**SIPART DR22 input/output modules**
6/25	Overview: applications



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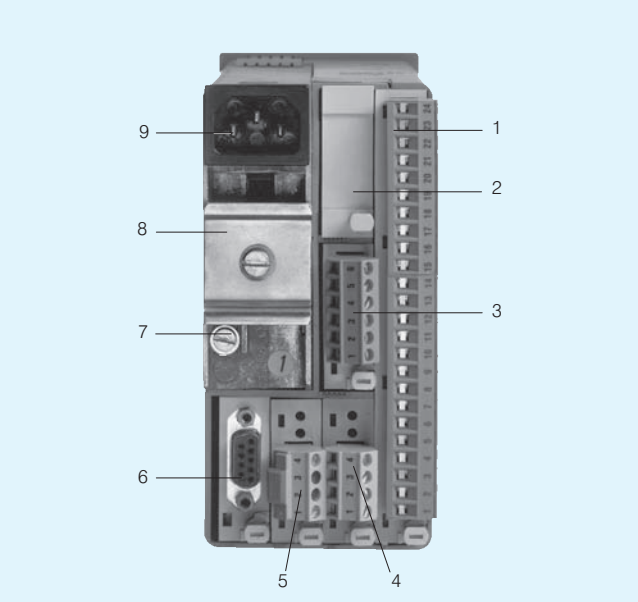
SIPART DR22 Controllers

6DR2210-.

Description

Fig. 6/1 SIPART DR22 controller



1 Slot 1, main circuit board
2 Slot 6, not fitted
3 Slot 5, fitted with module
4 Slot 2, not fitted
5 Slot 3, fitted with module
6 Slot 4, fitted with module
7 Earthing screw
8 Top-hat rail (included in delivery of relay modules)
9 Mains plug

Fig. 6/2 SIPART DR22 controller, rear view

6

Application

The SIPART DR22 process controller is a digital operating instrument with a “top class” performance. Within the internal program memory are a large number of functions for controlling processes, which can be simply retrieved by the user without any programming knowledge or accessories.

If required, function blocks for mathematical and logic functions can be easily added to the input connections, thus enabling optimum adaptation to more complex tasks.

The controller incorporates a versatile adaptation procedure which greatly simplifies commissioning, even of critical controlled systems. During this procedure, the controller automatically determines the optional parameters for stable control, even if the user has no preliminary knowledge of the controlled system’s response. The adaptation procedure is suitable for controlled systems with recovery times and aperiodic transient responses. Even large dead times are taken into account.

The SIPART DR22 controller can be used as

- Fixed setpoint controller for one, two or three-component controls, optionally also with two setpoints
- DDC fixed setpoint controller for one, two or three-component controls
- SPC controller
- Slave controller (synchronization controller), optionally with local/remote switchover
- Fixed or controlled ratio controller with local/remote switchover
- Cascade controller (dual-loop controller)
- Ratio cascade controller (dual-loop controller)
- Override controller (dual-loop controller)
- Dual-loop controller with two independent control channels.

The universal flexibility is made possible by the extensive hardware of the instrument, which can easily be extended as required by a wide range of input/output modules (e. g. communication via a serial interface with a higher-level system or personal computer).

The SIPART DR22 controller has a large number of displays. Both the process variable and the setpoint are indicated on an analog and digital display. A further digital display is used to indicate the manipulated variable.

The SIPART DR22 controller can be used as a continuous controller with a current output or as a three-position step output for connection to electromotive drives without changing the hardware equipment. The split-range mode of the K controllers is configurable.

Design

The SIPART DR22 process controller is of modular design.

The standard controller comprises:

- Front module with controls and displays
- Main circuit board with CPU and terminal strips
- Plastic housing with a connecting board and the power pack.

The main circuit board has a 10-way and a 14-way plug-in screw terminal block, to which all inputs and outputs of the standard controller are connected. Five further slots can be equipped with optional modules if the number of inputs and outputs within the standard controller is insufficient for the application. Field signals are connected to the input/output modules on each module by a pluggable terminal strip or connector (serial interface SES).

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Description

The standard controller comprises:

- 3 analog inputs for voltage (0/0.2 to 1 V or 0/2 to 10 V) or current (0/4 to 20 mA) signals.
  The inputs are electronically isolated and have high common mode rejection.
- 4 digital inputs 0/24 V and 8 digital outputs 0/24 V, which can be used for various functions and can act in normal or inverted mode.
- 3 analog outputs, each with a current signal 0 to 20 mA or 4 to 20 mA, which can be used for all controller variables.
- A short-circuit proof *L*+ output (DC 24 V, 100 mA) for powering transmitters.

The power supply unit is in a completely enclosed metal housing.

Available versions:

- 6DR2210-4 for AC/DC 24 V power supply
- 6DR2210-5 for AC 230 V power supply, switchable to AC 115 V.

The tagging label and the scale can be replaced.

The number of inputs and outputs can be extended by supplementary modules.

Modules are available for:

- Current or voltage input (U/I)
- UNI module for TC/RTD/R/mV, also for mA and V with adapter plug; with electrical isolation
- Resistance input (potentiometer) (R)
- Analog outputs and digital inputs
- Digital inputs and outputs (DI/DO)
- Relay outputs (Rel)
- Serial interface (SES)
- PROFIBUS-DP module

Refer to the table "Overview: applications" on page 6/25 for configurations for expanding the functions.

Mode of operation

The SIPART DR22 controller is based on a modern microcontroller with CMOS technology.

The ROM contains a large number of complete functions for controlling process engineering plants. The user configures the controller according to the respective task by selecting the desired function using the so-called configuring switches (cf. page 6/20). In order to solve more complex control tasks, the user can reconfigure the standard connections of the analog inputs and use other mathematical or analog logic functions in their place (cf. page 6/5).

Neither a special programming knowledge or a programming unit are required to configure the controller.

The application program produced in this manner is stored in non-volatile memory and thus protected in the event of a power failure. A back-up battery is not required. This user program memory can be replaced.

The SIPART DR22 controller can be configured as a P, PD, PI or PID controller.

Analog input connections

- Fixed input range

The analog inputs AE1 and AE11 can be freely-assigned to the function inputs FE1 to FE12 when configuring the controller. These function inputs then form the analog input channels for the various types of controller.

The significance of the function inputs FE1 to FE12 is determined by the configured controller type or the output structure of the controller.

Each analog input has a first order filter with a selectable time constant to suppress external noise and a selectable square root extractor.

A function generator (linearizer) with 13 vertices for linearizing input signals can be connected to the function inputs FE1 and FE3.
(The two linearizers can be freely-assigned in "Freely-connectable input range".)

- Freely-connectable input range

In this operating mode, additional arithmetic and logic functions can be inserted between the data sources (analog inputs, parameters, constants) and the data sinks (FE1 to FE12) (Fig. 6/3). Insertion is carried out – as with the further configuring of the controller – via the front module according to a menu-based question-and-answer procedure or via the interface.

The following data sources/sinks are present in the "Freely-connectable input range":

Data sources

Designation	Explanation
AE1.A to AEb.A	Analog signal input (filter/square-root)
P01 to P15	Parameters (setting in onPA)
-1.0 to +1.0	Constants
BE01 to BE09	Digital inputs BE1 to BE9
AE1 ↳ to AE5 ↳	Single message for sensor breakage (alarm)
AE↳	Group signal for sensor breakage (alarm)
A1 to A4	Alarms A1 to A4
Int1 and Int2	Status message for internal operating mode of controller 1 / controller 2
SPI 1 and SPI 2	Internal setpoint for controller 1 and controller 2
SP1 and SP2	Effective setpoint for controller 1 and controller 2
YI and YII	Manipulated variable Y for controller 1 and controller 2 (K controller)
SAA1 to SAA4	Serial analog input (can only be written via interface)
MA_.4 to no_.4 (see Fig. 6/3).	Outputs of the function blocks defined in FdEF (non-defined blocks are suppressed)

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Description

Data sinks

Designation	Explanation
FE01 to FE08	Function inputs "Analog values" for the configured controller or the hardware outputs of the controller
FE09 to FE12	Function inputs "Analog values" for the configured controller or analog/binary signals for the hardware outputs of the controller
ME_.1 to no_.3 (see Fig. 6/3)	Inputs of the function blocks defined in FdEF (non-defined blocks are suppressed)

The following functions can be inserted (Fig. 6/3):

- 6 arithmetic blocks (Ar1 to Ar6)

  Each of these 6 arithmetic blocks can be occupied as required by the 4 fundamental arithmetic operations or a combination of them.

- 2 function generators (Fu1 and Fu2)

  Each of these two function generators (linearizers) assigns an output variable A in the range from –199.9 to +199.9 % to each value of its input variable *E* in the range from –10 to +110 % using a function entered by the user; *A* = f (*E*).

  The function is entered via 13 vertices for the input signal from –10 to +110 % at intervals of 10 %. Parabolas are generated between the vertices by means of the calculation program and are combined tangentially at the vertices so that a continuous function results.

- 3 function blocks "Max. selection" (MA1/MA2/MA3)

  A maximum selection from 2 or 3 input variables can be made in each of these 3 function blocks. The function blocks can also be used for minimum limiting.

- 3 function blocks "Min. selection" (Mi1/Mi2/Mi3)

  A minimum selection from 2 or 3 input variables can be made in each of these 3 function blocks. The function blocks can also be used for minimum limiting.

- Correction computer (rE1)

  The correction computer is used to calculate the flow of gases using the differential pressure *p* flow measuring principle, correcting for fluctuations in pressure and temperature. Both mass flows and volume flows can be corrected when referred to the process operating conditions and volume flows also when referred to standard conditions (i. e. standard parameters). However, the medium must be in a pure phase. In other words, gas separation must not take place.
  The following relationship is applicable for the output *A*:

$$A = \sqrt{\Delta p} \cdot \sqrt{f(E_2,\ E_3)}$$

$$f(E_2,\ E_3) = \frac{(P_E - P_A)\ E_2 + P_A}{(t_E - t_A)\ E_3 + t_A}$$

The measuring ranges are standardized to the formula by using the parameters t_A, t_E, P_A and P_E. t_A and P_A are adjustable from 0.01 to 1.000, t_E and P_E from 1.000 to 99.99.

- 5 changeover switches for analog values (AS1 to AS5)
- 2 comparators with selectable hysteresis (Co1, Co2)
- 2 logic functions "NAND" (nA1, nA2)
- 2 logic functions "NOR" (no1, no2)

Analog output connections

The 9 analog outputs of the SIPART DR22 controller (3 on standard controller, 6 on optional module) output a current signal of 0 to 20 mA or 4 to 20 mA.
The outputs are not assigned to fixed variables. When configuring a controller they are assigned any internal controller variable that is required externally. Thus a split-range output is also possible.

When the optional *y*-hold module is inserted in analog output, the output is permanently assigned to the manipulated variable *y*.

Digital input and output connections

The standard device has 4 digital inputs BE1 to BE4 as well as 8 digital outputs BA1 to BA8. When configuring the controller, the digital functions required for the respective application are assigned to these inputs and outputs. The number of digital inputs and outputs can be increased by using additional optional modules if the number in the basic device is insufficient. Slots 5 and 6 at the rear of the controller can be used for this purpose. Up to 14 digital inputs or up to 16 digital outputs are possible, depending on the equipment installed with options.

The digital inputs and outputs of the device are non-floating.

The digital outputs are active and provide a 24 V DC signal with a loading capacity of up to 50 mA per output.

Floating outputs are available, if a relay module with two digital outputs is used as an option. An interface relay module can also be snapped onto a top-hat rail on the rear of the controller. This additional module has either two or four relays each with 1 changeover contact rated at AC 250 V, 8 A, which are energized by the controller's digital outputs.

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Description

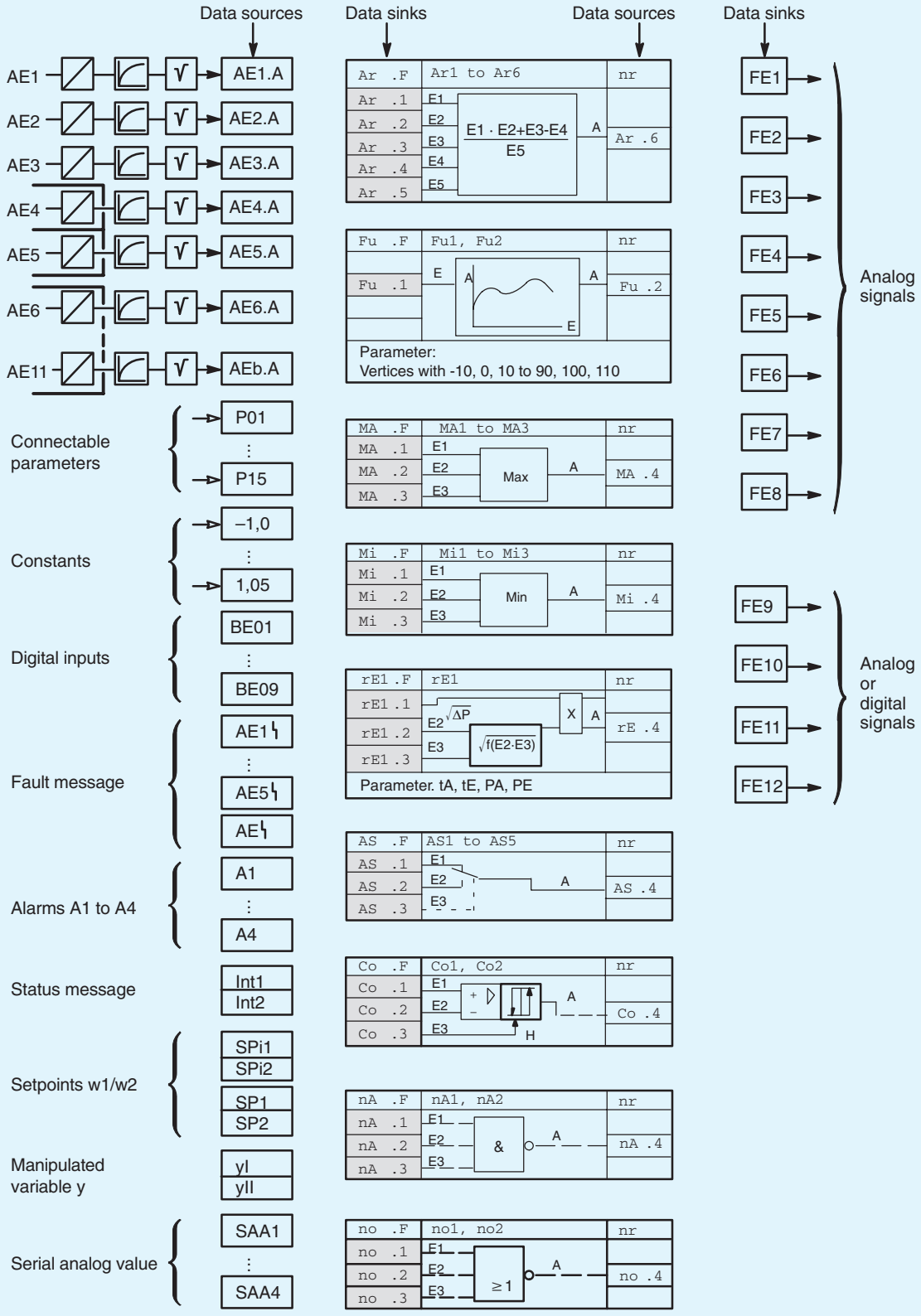

Fig. 6/3 Insertion of additional functions for the freely connectable input range

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Description

Digital inputs

The digital inputs have the following functions:

CB I/II Computer status (Controller 1/Controller 2)
Depending on the type of controller configured, this digital input together with the local/remote pushbutton either switches to a different setpoint, also SPC mode or it begins in the DDC mode. When the controller is being used in SPC or DDC mode this input indicates the central computer's status.

He I/II Remote manual (Controller 1/Controller 2)
This signal blocks the controller output and enables direct manual adjustment of the manipulated variable from the front panel.

N I/II Tracking (Controller 1/Controller 2)
This signal causes the output of the K controller and the three-position step controller with external position feedback to track the signal y_N.

Si I/II Safety mode (Controller 1/Controller 2)
The manipulated variable assumes the parameterized safety value in the case of K controllers and three-position step controllers with external position feedback. In the case of three-position step controllers with internal generation of the position, the manipulated variable moves in a defined manner towards 0 or 100 %.

$\overline{tS}$ I/II Setpoint ramp cut-off (Controller 1/Controller 2)

WSL I/II External setpoint switchover analog or via SES (Controller 1/Controller 2)

BLB Blocking of operation

BLS Blocking of configuring

BLPS Blocking of parameterization and configuring

P I P mode, controller I

P II P mode, controller II

PAU Parameter switchover / The parameter set I of the single controller can be switched over to the parameter set II with this digital signal.

$\pm \Delta w$ Incremental setpoint adjustment

$\pm \Delta y$ Incremental manipulated variable adjustment

$\pm \Delta y$BL I/II Direction-dependent blocking of manipulated variable (Controller 1/Controller 2)

Digital outputs

The digital outputs have the following functions:

$\overline{RB}$ I/II No computer readiness (Controller 1/Controller 2)

$\overline{RC}$ I/II No computer mode (Controller 1/Controller 2)

H I/II Manual mode (Controller 1/Controller 2)

N I/II Tracking mode (Controller 1/Controller 2)

A1/A2 Alarms 1 and 2

A3/A4 Alarms 3 and 4

MUF Transmitter fault

Int I/II Local mode (slave controller) (Controller 1/Controller 2)

FE9 to FE12 Function inputs (data sinks) with optional connections in input range.

The manipulated variable outputs $\pm \Delta y$ of a three-position step controller are always assigned to digital outputs BA7 and BA8. The manipulated variable outputs $\pm \Delta y$ are set to BA5 and BA6 when controller 2 of the dual-loop controller is configured as step controller. These digital outputs are then not available for optional assignment.

Displays

The SIPART DR22 controller has extensive display facilities. Both the setpoint and the process variable have bargraph and digital indication.

The 2 analog displays consist of vertical LED bargraphs. One or two LED's light up, the center of the illuminated field indicates the process variable. Comparison between the process variable and the setpoint is easy since both displays are side by side. Both displays provides a dynamic trend indication.

The process variable and setpoint digital displays can be scaled in an engineering unit or percentages. The process variable displays are red and the setpoint green. The associated pushbutton controls are also colored the same for simplified operation.

When configured as a dual-loop controller (cascade and override controls 2 independent control loops) the displays are switched from one loop to the other by the pushbutton controller I/controller II. This ensures that the display is clear and informative avoiding confusion.

A yellow three-digit display indicates the manipulated variable. This is always indicated in percent. The associated pushbutton controls are also yellow.

Status flags and alarms are also displayed on the front panel with 11 LEDs with a fixed assignment.

The display modes described refer to the process operation mode of the controller. Some of these displays have different functions in the selection and configuring modes (cf. page 6/16).

Configurable functions

Standard configurations used for process control applications are stored in the EPROM of the SIPART DR22 controller and can be easily selected. In conjunction with the optional connections of the input range, this device may be used in all closed-loop control tasks of the process engineering.

The standard configurations possible are shown below using schematic diagrams and are described in brief. Only the most important elements are detailed to avoid confusion. Other configuring possibilities, valid for all controller types, are described page 6/13.

The factors and constants c_1 to c_9 shown in the following Figs. as well as the setpoint ramp *tS* are adjusted in the parameter mode.

A disturbance variable can be applied to the manipulated variable via function input FE4 or FE7 either in dynamic mode via the D-element or in static mode directly to the output.

The function inputs are only shown in the Figs. if they have a fundamental function in the associated type of controller.

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Description

■ Configuring switch S1 = 0

Fixed setpoint controller with one or two independent setpoints as a single-component, two-component or three-component controller

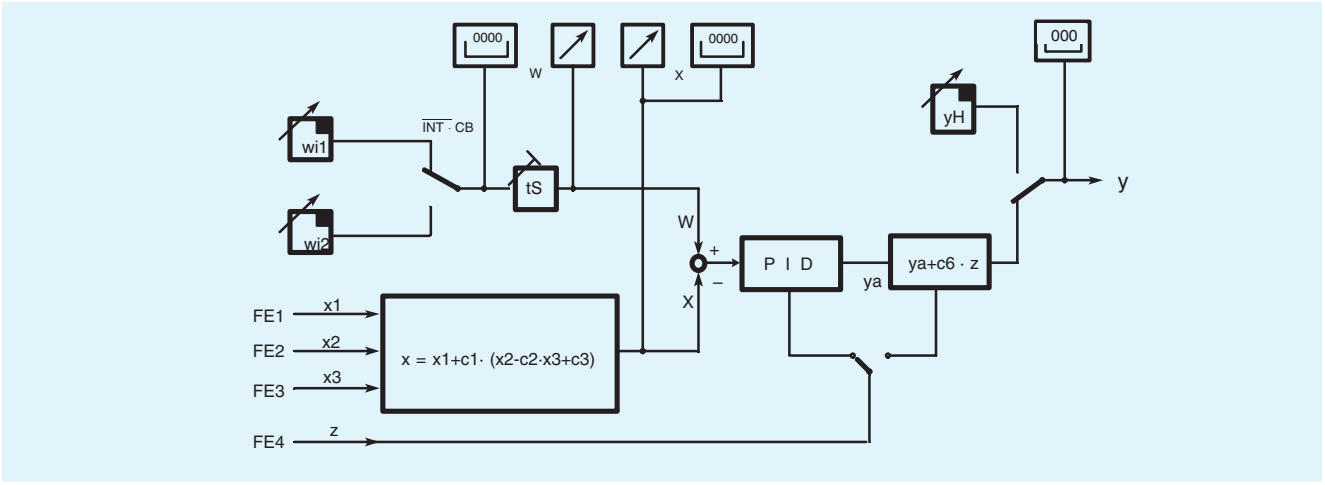

Fig. 6/4 Fixed setpoint controller with 2 independent setpoints, function diagram

As shown in Fig. 6/4 the controller can process logic operations on the analog input signals from the function inputs FE1, FE2 and FE3 as the controlled variable and can therefore be used as a single-component, two-component or three-component controller.

Two setpoints w_{i1} and w_{i2} can be adjusted independently on the front of the controller and selected using the local/remote push-button (2, Fig. 6/14) or the digital signal CB. The switchover between setpoint 1 and setpoint 2 either has a sudden jump or can be made to ramp up or down over a time period dependent on the setting of parameter *tS*. Since the switchover function can be blocked, this type of configuration is also used as a fixed setpoint controller with one setpoint.

■ Configuring switch S1 = 1

Fixed setpoint controller with two dependent setpoints as a single-component, two-component or three-component controller

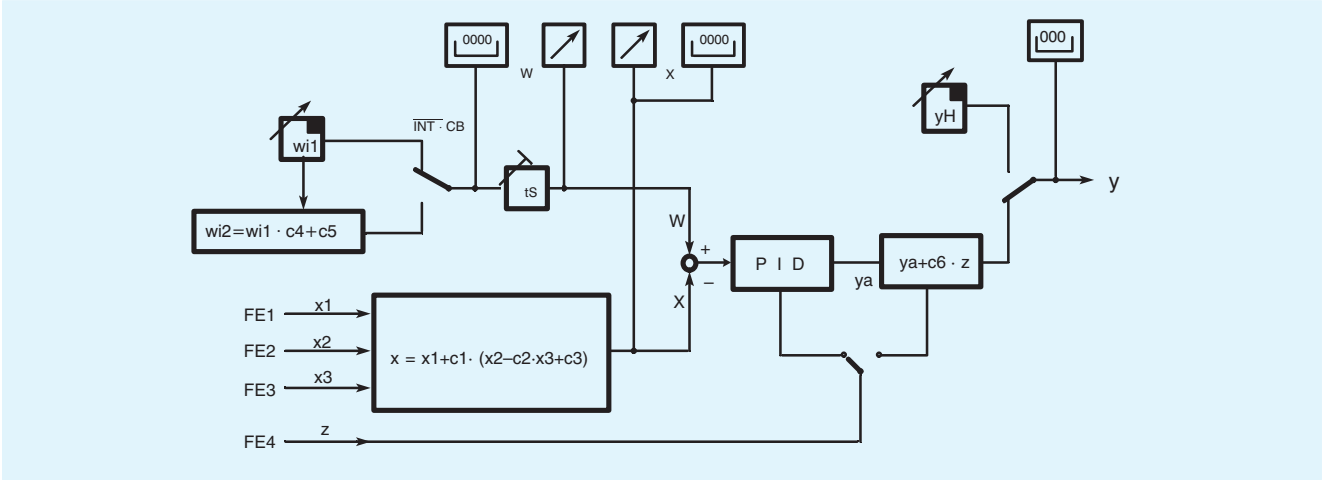

Fig. 6/5 Fixed setpoint controller with two dependent setpoints, function diagram

The functions of this controller are shown in Fig. 6/5. The controller can also process logic operations on the analog input signals from the function inputs FE1, FE2 and FE3 as the controlled variable. It can therefore be used as a single-component, two-component or three-component controller.

The setpoint w_{i1} can be adjusted on the front of the controller. A second setpoint can be derived according to the equation

$w_{i2} = w_{i1} \cdot c_4 + c_5$

w_{i2} then changes automatically if w_{i1} is changed. It is possible to switch between these 2 setpoints using the local/remote pushbutton (2, Fig. 6/14) or the CB signal. The switchover has a sudden jump or can be made to ramp up or down over a time period dependent on the setting of parameter *tS*.

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Description

- Configuring switch S1 = 2

DDC fixed setpoint controller as a single-component, two-component or three-component controller

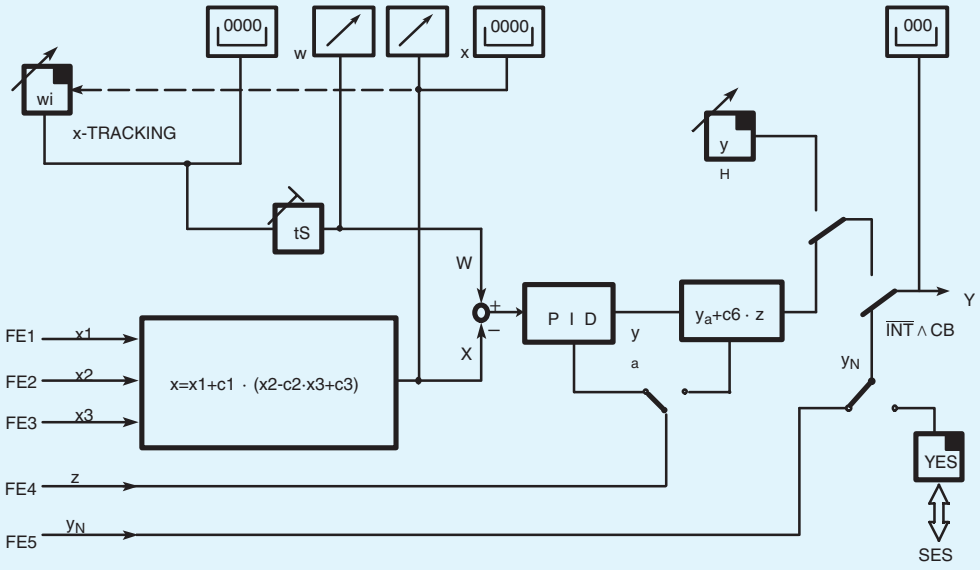

Fig. 6/6 DDC fixed setpoint controller, function diagram

With DDC control[1]), the control function is performed directly by a process computer. The control loops are protected by parallel compact controllers in the event of a computer failure.

The controller is on standby during DDC mode. It receives the manipulated variable from the process computer and tracks this with its own manipulated variable. This ensures that the control is continued in a bumpless manner when the process computer develops a fault. The switchover criterion is the CB signal or the local/remote pushbutton (2, Fig. 6/14). The controller then works autonomous in both cases.

The controller can process mathematical and logic operations on the analog signal from the function inputs FE1, FE2 and FE3. It can therefore be used as a single-component, two-component or three-component controller.

The setpoint is set as w_i on the front of the controller. The negative deviation is set to zero in DDC mode by *x*-tracking so that the switchover is drift-free as well as bumpless.

The SIPART DR22 controller can be connected to the process computer with a parallel connection via its hardware interfaces and outputs or also via a serial data bus.

[1]) DDC Direct Digital Control.

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Description

- Configuring switch S1 = 3, slave controller (synchronization controller) with local/remote switchover and SPC controller

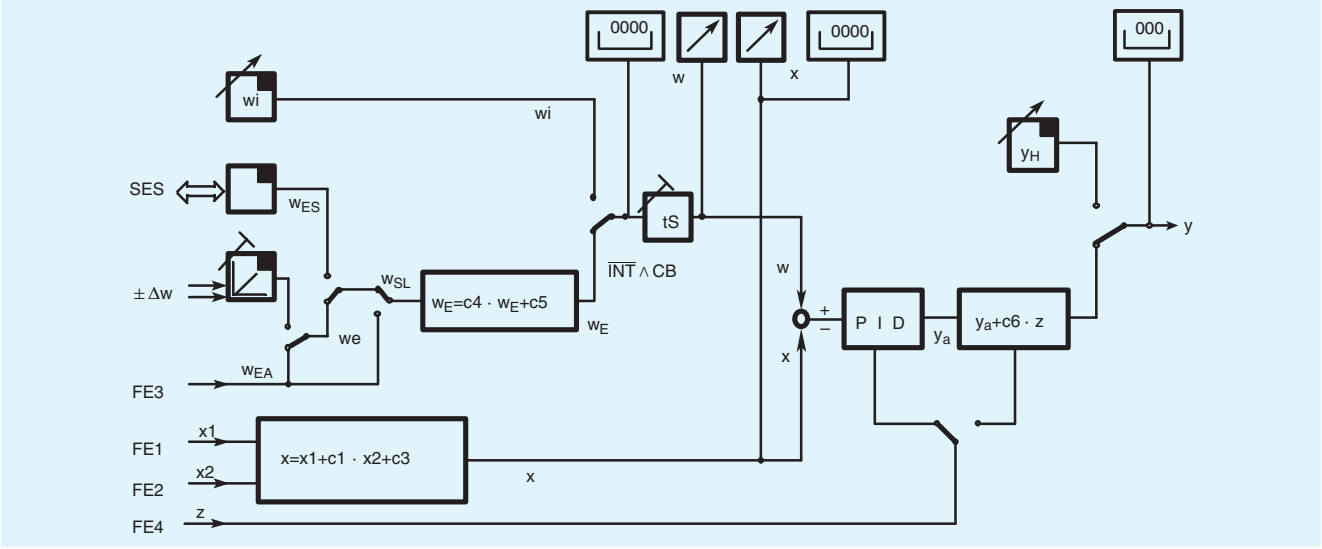

Fig. 6/7 Slave controller (synchronization controller), function diagram

This mode is used for SPC [1]) operation or for follow-up control.

The controller can process mathematical and logic operations from the function inputs FE1 and FE2.

The external setpoint can be input to the controller as an analog signal via function input FE3 or incrementally via two digital inputs ± Δ*w*, or via the serial interface. It can be biased for synchronization control by the factor c_4 or offset by a constant c_5.

With an incremental setpoint the setpoint ramp *tS* determines the rate of change.

The remote setpoint switchover is by either using the local/remote pushbutton (2, Fig. 6/14) or the CB signal. Following loss of the CB signal, the controller continues to operate with the last setpoint or uses the parameterized safety setpoint depending on the mode configured.

- Configuring switch S1 = 4, fixed ratio controller or controlled ratio controller with local/remote switchover

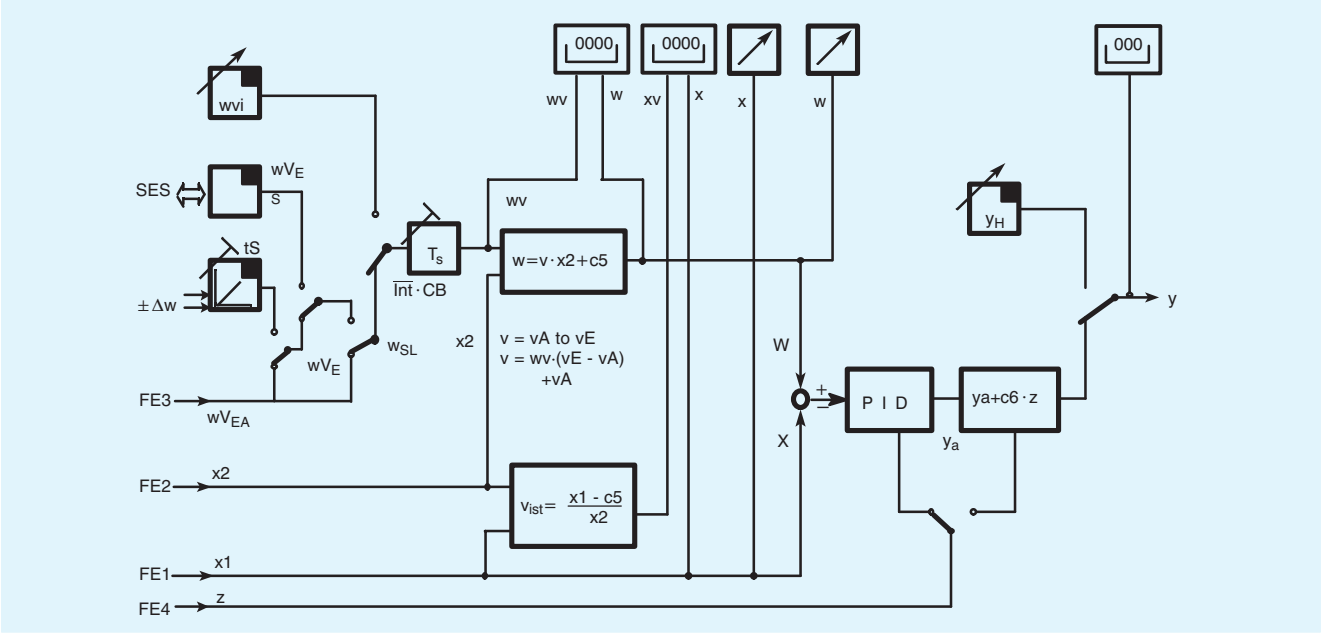

Fig. 6/8 Fixed or controlled ratio controller, function diagram

The master process variable is the signal x_2 of function input FE2. The controlled process variable *x*1 is input via FE1. The setpoint for this type of controller is not an absolute value but is the setpoint ratio between the controlled process variable and the master process variable as the factor *v* (w_v).

The relationship is as follows:

$$v = \frac{x_1 - c_5}{x_2}$$

[1]) SPC Setpoint Control.

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Description

The range of adjustment for the ratio factor $v = v_A$ to v_E is between 0.0 and 9.999 and is defined in parameter mode. Constant c_5 can be used as an offset.

The setpoint ratio v and the actual value v_{actual} are indicated on the four-digit displays. The controlled variable x and the effective setpoint w biased by the ratio factor are indicated on the analog displays. The controlled variable x and the effective setpoint w can also be indicated on the digital displays in the engineering range.

The ratio factor can be input remotely. The switchover conditions correspond to those of the slave controller. Since the switchover function can also be blocked, the controller can also be used as a fixed ratio controller with this configuration.

■ Configuring switch S1 = 5, cascade controller

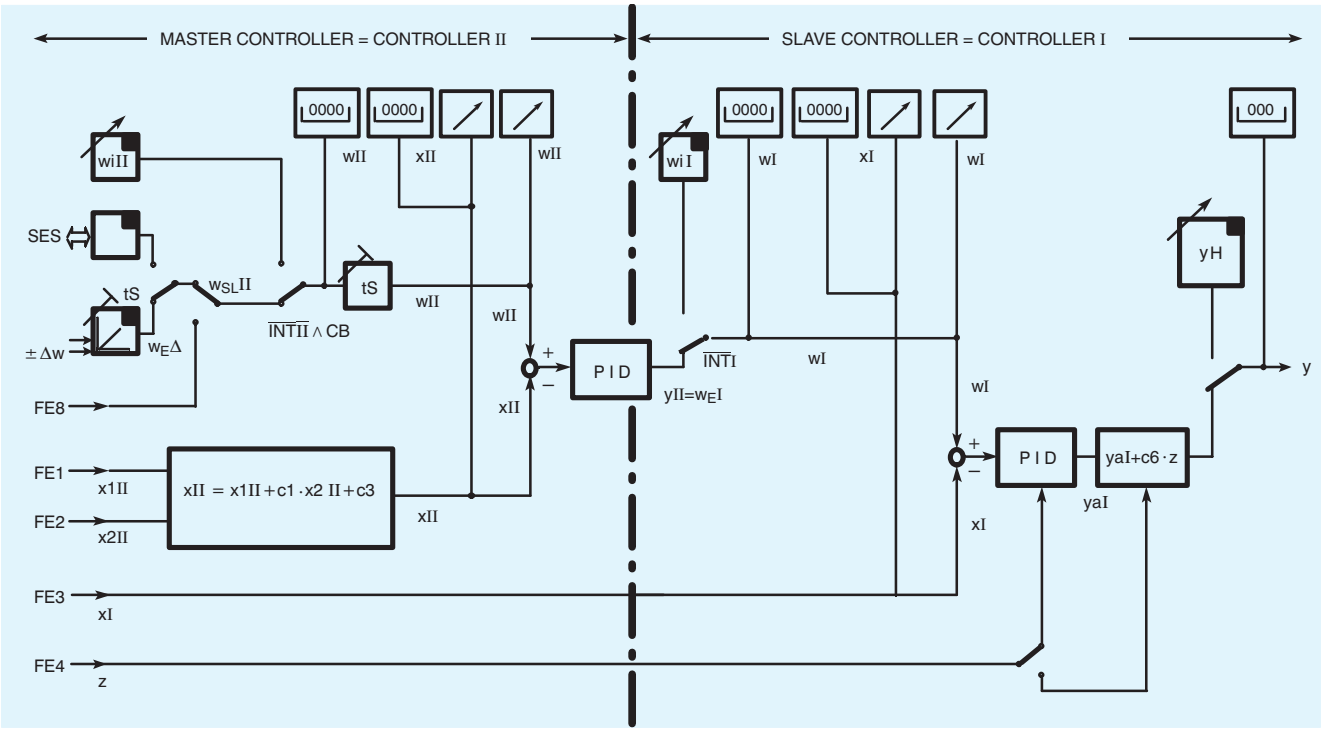

Fig. 6/9 Cascade controller, function diagram

This type of controller contains both the master controller (controller II) and the slave controller (controller I) of the cascade. The displays as well as the setpoint adjusters and the local/remote pushbutton of the controller have dual functions. Operation is clear and simple:

The controller selector (12, Fig. 6/14) including LEDs is used to switch between controller I and controller II. The displays as well as the pushbutton functions mentioned are assigned to the controller selected. In the Fig. 6/9, the corresponding functions are identified in each case by the suffixes I and II.

– Master controller (controller II)

This controller processes mathematical and logic operations on the input variables from FE1 and FE2. The controller operates as a fixed setpoint controller with the facility for a remote setpoint, either as analog signal (FE8), incrementally via two digital inputs $\pm \Delta w$ or via the serial interface. The switchover is then made using the local/remote pushbutton INT II or the CB signal.

The master controller operates with parameter set II.

– Slave controller (controller I)

The slave controller receives the manipulated variable of the master controller as its “remote” setpoint. Switching over to a local setpoint (cancellation of the cascade) is achieved by pressing the local/remote pushbutton INT I. The output of the master controller is then made to track the setpoint of the slave controller, and the x-tracking can be configured for both devices, ensuring that connection of the cascade is bumpless and drift-free.

The slave controller can be set to manual mode at any time using the M/A pushbutton. This pushbutton and the associated adjustment pushbuttons and the manipulated variable display are not switched over to the master controller.

The slave controller operates with parameter set I.

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Description

- Configuring switch S1 = 6, cascaded ratio controller

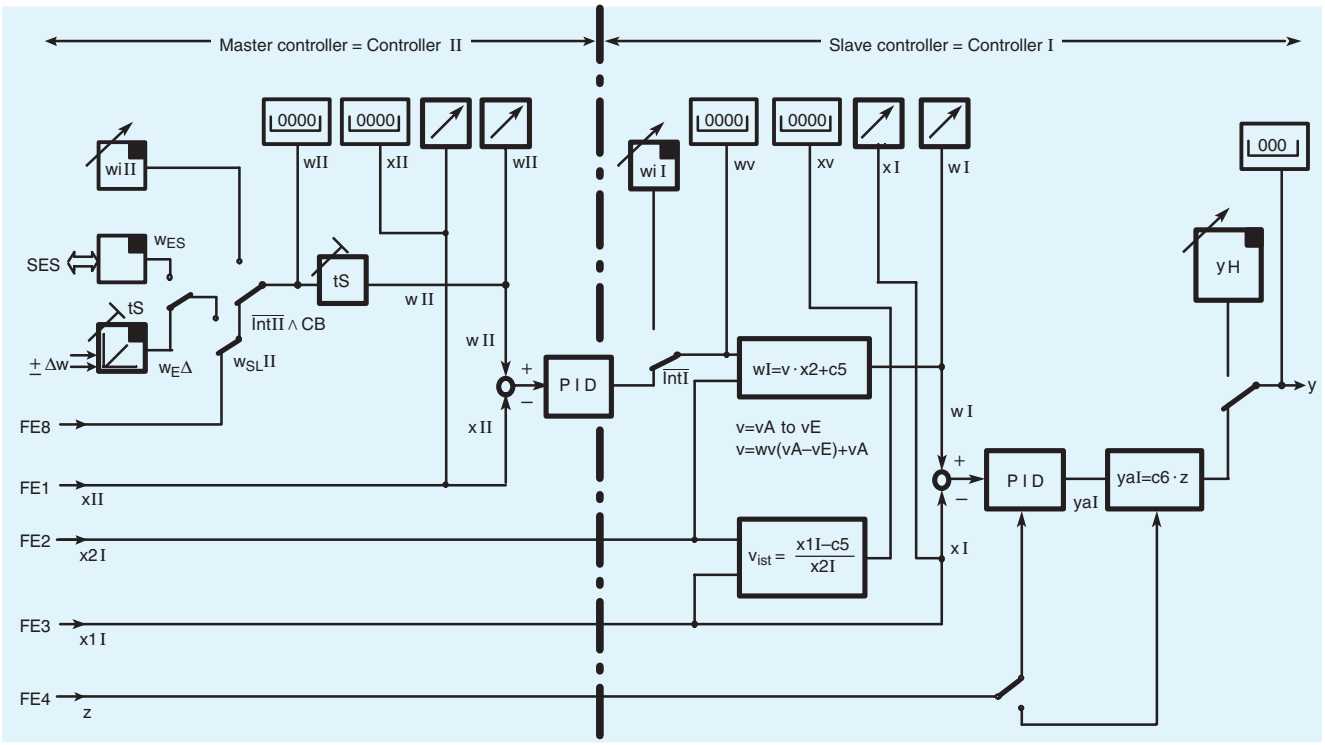

Fig. 6/10 Cascaded ratio controller, function diagram

With this configuration the device comprises the master controller (controller II) and the slave ratio controller (controller I) The displays, setpoint adjusters and local/remote pushbuttons also have dual functions.

The selector (12, Fig. 6/14) including LEDs is used to switch between controller I and controller II and to assign the displays and the pushbutton functions mentioned to the controller selected. The corresponding functions are identified in Fig. 6/10 by the suffixes I and II.

– Master controller (controller II)

The controlled process variable is applied to function input FE1. The controller operates as a fixed setpoint controller with the facility for a remote incremental input of the setpoint via two digital inputs or via the serial interface. The switchover is made using the local/remote pushbutton INT II or the CB signal.

The master controller operates with parameter set II.

– Ratio controller (controller I)

The command process variable is applied to this controller via function input FE2, the controlled process variable via input FE3. The "remote" setpoint for the controller is the manipulated variable of the master controller which is the setpoint ratio between the controlled process variable and the command process variable as a ratio v (w_v), where

$$v = \frac{x_1 - c_5}{x_2}$$

The range of adjustment for the ratio $v = v_A$ to v_E is between 0.0 and 9.999 and is defined in parameter mode.

The setpoint ratio v and the actual ratio v_{actual} are output on the four-digit displays. The controlled variable x and the effective setpoint w weighted by the ratio factor are output on the analog displays. The controlled process variable x_I and the effective setpoint w_I can be displayed on the digital indicators in the engineering range. Switching over to the local setpoint, and thus cancellation of the cascade is made using the local/remote pushbutton I (12, Fig. 6/14). The output of the master controller is made to track the setpoint of the ratio controller. x-tracking can be configured. This ensures that connection of the ratio cascade is bumpless and drift-free.

The ratio controller can be switched to manual mode at any time using the M/A pushbutton. This pushbutton, the associated adjustment pushbutton and the manipulated variable display are not switched over to the master controller.

The ratio controller operates with parameter set I.

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Description

■ Configuring switch S1 = 7/8

Override controller with maximum of *y*, Override controller with minimum of *y*

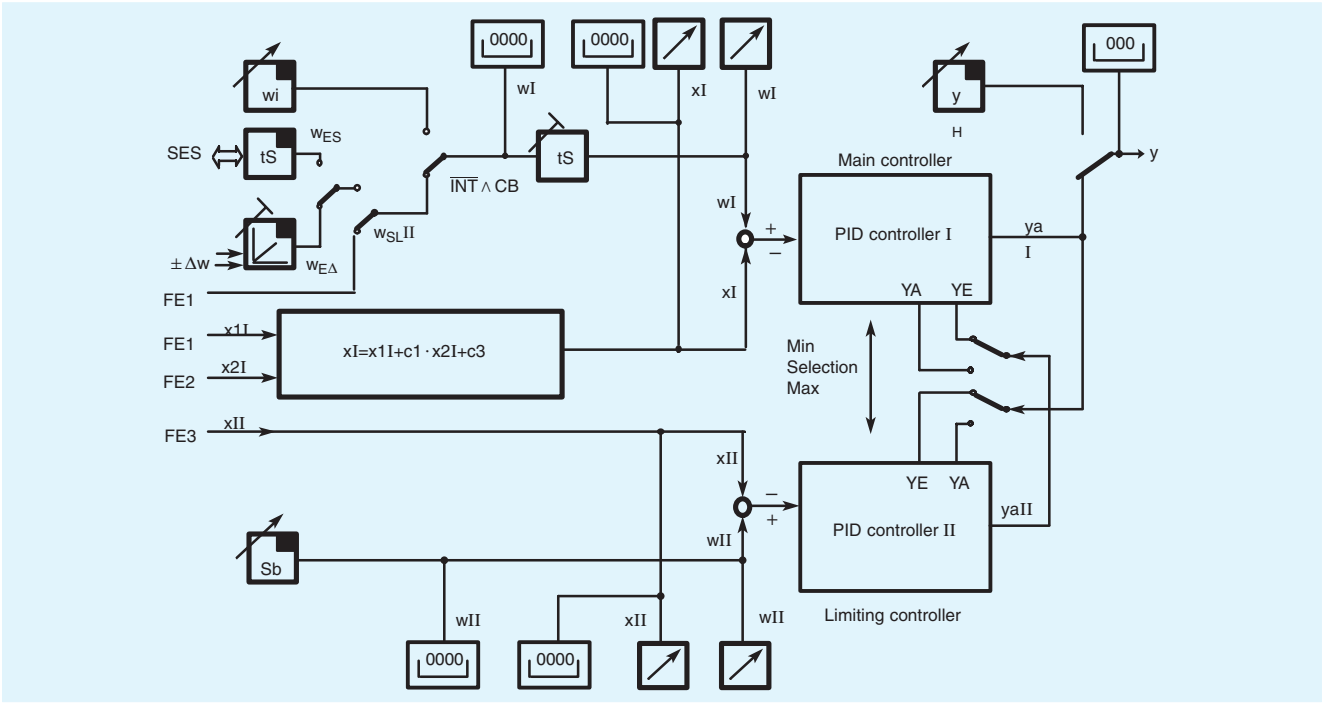

Fig. 6/11 Override controller with maximum/minimum limiting of *y*, function diagram

The override controller's function is to control a process variable without a second process variable exceeding a defined value. The two process variables are physically dependent on one another and are changed by the same final control element.

For example, the core temperature in a reactor is to be controlled without the jacket temperature exceeding or falling short of a certain value. For this task 2 controllers should be able to influence the final control element. Either the larger or the smaller of the two manipulated variables must be effective.

The manipulated variable signal is selected in many cases using an extreme-value selector connected in series with the controller. However, this solution suffers from dynamic problems as a result of integral saturation of the controller not involved in the intervention.

This disadvantage is overcome in configurable controllers because the selection is made by mutual control of the manipulated variable limits and not by an extreme-value selection circuit. The maximum limiting is achieved by controlling the lower limit y_A and the minimum limiting by controlling the upper limit y_E. These parameters are the absolute manipulated variable limits in automatic mode. The mutual control can only take place up to this limit. The parameters y_A and y_E are adjusted in the parameter set of the main controller (controller I). The corresponding parameters of the limiting controller (controller II) are automatically adjusted.

In manual, tracking, safety or blocking mode, both controllers track the effective manipulated variable *y*. Switching over of the display I or II is carried out manually. The M/A switchover and the manipulated variable display are the same for both controllers.

– Main controller (controller I)

The controller can process mathematical and logical operations on the input variables from FE1 and FE2 as the controlled variable. The main controller is a fixed setpoint controller with the facility for remote input of the setpoint.

The switchover is then made using the local/remote pushbutton or the CB signal. The main controller operates with parameter set I.

– Limiting controller (controller II)

The controlled variable is applied to the limiting controller via function input FE3. The limiting setpoint S_b is set as a parameter.

■ Configuring switch S1 = 9

Process variable display

With this configuration the SIPART DR22 controller does not act as a controller. The red digital and analog displays are connected in parallel to the function input FE1.

The green digital and analog displays are connected in parallel to the function input FE3.

The yellow digital display can be controlled via the function input FE6.

The limit monitors A1, A2, A3 and A4 can be assigned to the three function inputs already mentioned.

■ Configuring switch S1 = 10

This fixed setpoint controller is specially designed for the coupling to the control system. It is largely based on the fixed setpoint controller with S1 = 0 (Fig. 6/4). Since the controller only operates with an internal setpoint w_{i1}, the signals INT and CB are available via the serial interface SES for blocking control system operations.

■ Configuring switch S1 = 11

This follow-up controller is specially designed for the coupling to the control system. It is largely based on the follow-up controller with S1 = 3 (Fig. 6/7). Since the controller only operates with an external setpoint w_E, the signals INT and CB are available via the serial interface SES for blocking control system operations.

The limiting controller operates with parameter set II.

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Description

- Configuring switch S1 = 12

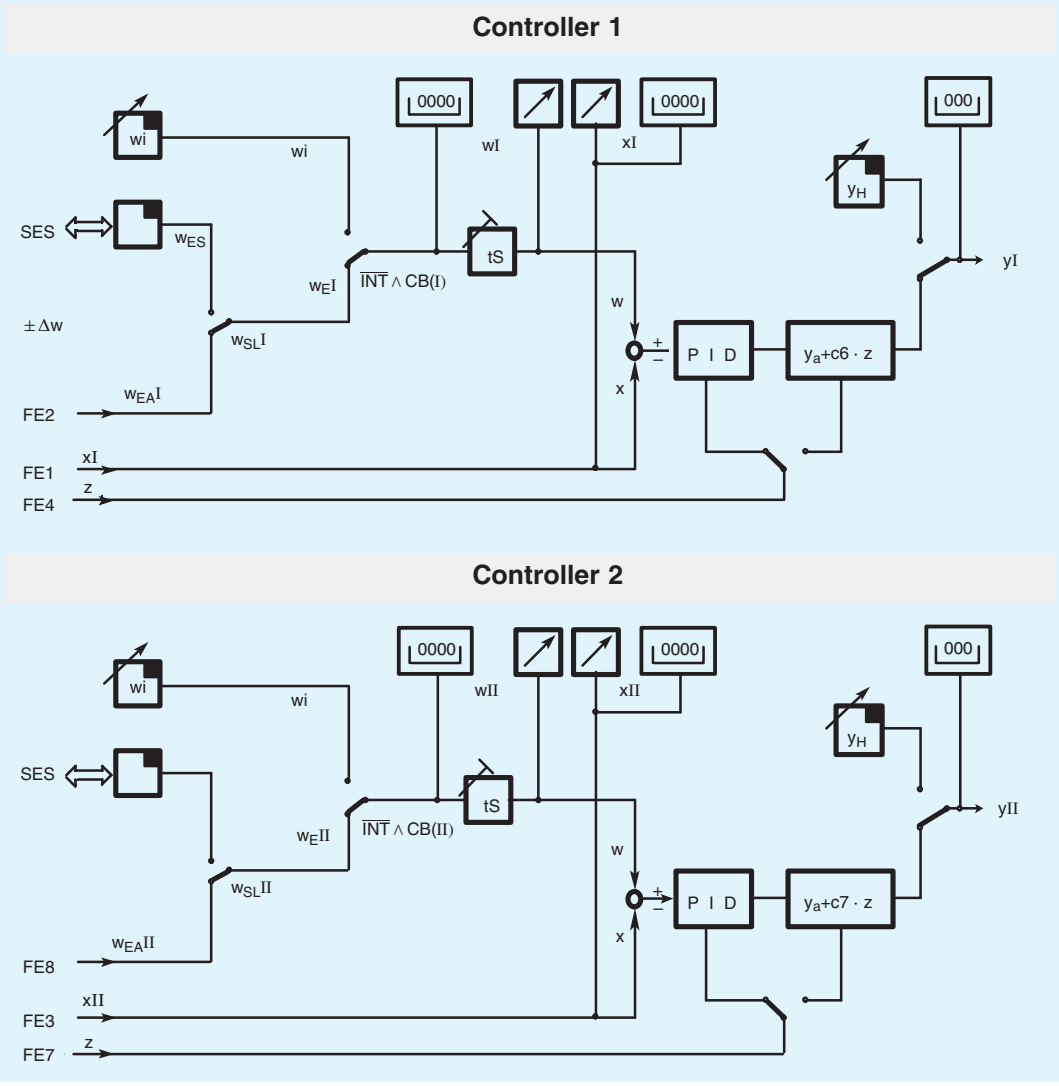

Fig. 6/12 Dual loop fixed-setpoint/follow-up controller, function diagram

When configuring as a dual-loop controller, the SIPART DR22 provides two completely independent control channels (PID). For operation and monitoring, the process operation level can be switched over for the display of controller I and controller II (x, w, y and the input keys).
The LEDs for the alarms A1, A2, A3 and A4 are not switched over at the same time. The alarms can be assigned to the various controlled variables of controller I and controller II.

Each control channel can be operated with an internal setpoint (fixed setpoint controller) or with an external setpoint (follow-up controller). Switching between the internal or external setpoint is possible using the front panel controls or a digital input (CB signal) providing this function has been enabled. The external setpoint is defined via the interface or an analog signal (switching over with binary signal w_{SL}).

The output structure can be selected independently as a K or S controller for each control channel.

Further configurable functions that enhance the flexibility and the operational safety of the SIPART DR22 controller

- Display in engineering units and linearization of process variables

The process variables (controlled variable *x* and command variable *w*) indicated on the two $4^1/_2$-digit displays can be scaled in percentages or engineering units. The start-of-scale value, the full-scale value and the position of the decimal point of the displays are set as parameters.

A non-linear input variable must be linearized before it can be indicated. The standard input connections contain two function generators (linearizers).

- Transmitter monitoring

The analog inputs can be monitored for full-scale or start-of-scale violations of the signals (< –3 % or > +103 %). The inputs to be monitored are selected using the configuring switches. In the event of a violation, a message appears – selective for the inputs AE1 to AE5 – on the four-digit display, indicating the faulty input signal. A common alarm is signalled via the digital output MUF.

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Description

In addition, it is also possible to configure automatic switchover to manual mode, starting with the last manipulated variable or a safety manipulated variable.

The fault message can be acknowledged using the pushbutton (12, Fig. 6/14).

Setpoint ramp, setpoint limiting and *x*-tracking

In addition to the ramp function, it is possible to limit the range in which the setpoint or ratio setpoint can be adjusted by the parameters SA and SE. Both the setpoint ramp and the setpoint limits are effective with local or remote setpoints.

It is possible to configure *x*-tracking. In manual, tracking and DDC mode as well as with the safety manipulated variable, the setpoint *w* is made to track the controlled variable *x* so that a deviation does not occur. When a return is made to automatic mode, the switchover is both bumpless and drift-free. The setpoint ramp is not effective with *x*-tracking. However, the setpoint limiting is effective.

Filter and response threshold of negative deviation

All analog inputs have a selectable 1st order filter. The filter time constants TF1 to TF11 can be adjusted between 0.1 and 1000 s. In addition, the negative deviations are also fed via adaptive filters TFI and TFII in order to filter out low-frequency interferences:

Repeated oscillations which occur within a band are detected by the filter as noise and suppressed by the parameterized time constant. Should a change occur that is outside the band it is applied to the control algorithm without delay in order that control of the process is maintained. If the level of noise changes as time progresses, these filters automatically adapt to the new level.

Dead band elements can be incorporated into the negative deviation if the output of the controller (or of both controllers) is to be smoothed further more. Thus a symmetrical range is removed as response threshold AHI and AHII.

Matching the direction of action

The standard configuration of the controller is valid for normal-action systems. Should the controller be used with a reversely acting controlled system, the sign of the proportional gains K_{PI} and K_{PII} must be inverted. This applies to both the P- and I-components. The D-component however, can operate independently either in the same or reverse direction of the controlled variable.

Special features of the control algorithm

The P(D) or PI(D) control algorithm is implemented in both controllers as an interaction-free parallel structure and is of the same type irrespective of the output configuration S or K.

Two different sets of parameters can be stored in the device. These are assigned to controllers I and II in the dual-loop controller. When configuring as a single-loop controller, the binary signal PAU can be used to switch between parameter set I and parameter set II.

The switchover from PI to P control is made using the digital inputs PI and PII.

Switchover from automatic mode to manual mode and vice versa, as well as switching from all other modes to automatic mode, is bumpless.

If the controller is in P mode the working point y_0 is set automatically. If this is not required the working point can also be set manually as a parameter between 0.1 and 100 % using y_{0I} and y_{0II}. However, the switchover between manual and automatic modes is not bumpless. In the case of three-position step controllers, P mode is only permissible with remote feedback of the final control elements position.

Limitation of manipulated variable

The manipulated variable of the K controller or an S controller with remote feedback can be limited by the parameters y_A and y_E. This limiting of the manipulated variable can be effective only in automatic mode or in all modes. If the manipulated variable reaches one of the limits y_A or y_E – depending on the setting – further integration is suppressed in addition to the limiting, and integral saturation cannot occur. Thus the manipulated variable is changed immediately if the polarity of the negative deviation changes.

If control is carried out outside the range y_A to y_E in manual, tracking, safety or DDC mode, the last manipulated variable is used bumplessly when returning to automatic mode. Modifications are only carried out in the direction of the limited range.

In addition to this fixed limitation of the manipulated variable, the SIPART DR22 controller contains a further direction-dependent manipulated variable limitation. The limitation is activated in this case via the digital inputs ±*y*BL by remote signals. This limitation is effective in every mode.

Additional analog outputs, split-range mode

The total of 9 analog output can be assigned to all relevant, controller-internal variables, e.g. $x(x_v)$, $w(w_v)$, y, (50 % $+x_d$), (50 % $- x_d$), the inputs AE1A to AE11A or the function inputs FE1 to FE12.

It is possible to configure split-range mode if the SIPART DR22 controller is used as a K controller. As shown in Fig. 6/13, the output y_1 then always operates with a rising characteristic, a rising or falling characteristic can be selected for y_2. The ranges of y_1 and y_2 can be parameterized. The three-digit display indicates y_1 or y_2 depending on which output is currently effective.

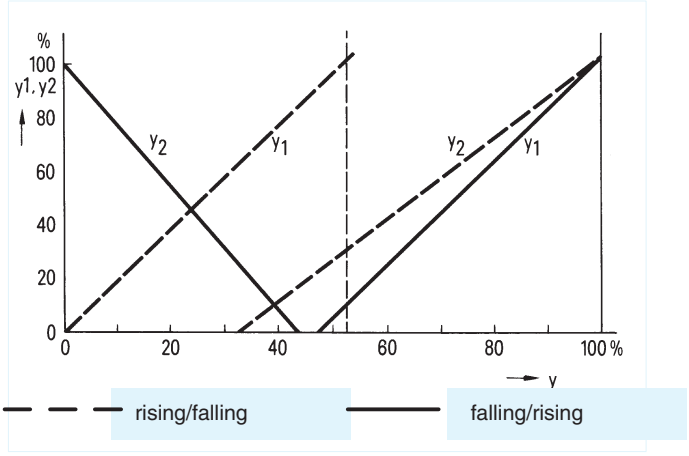

Fig. 6/13 Possibilities of split-range mode

Limit monitor

The alarm functions A1/A2 and A3/A4 can be assigned to the controller-internal process variables x_d, $x(x_v)$, $w(w_v)$, y, $(y_{1/2})$, the inputs AE1A to AE11A or the function inputs FE1 to FE12 for monitoring purposes. They can be configured to maximum or minimum monitoring.

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Description

Upward or downward violations are indicated by the LEDs A1/A2 and A3/A4 (5 and 7, Fig. 6/14) and can be used for remote signalling by the digital outputs.
The alarms are normally set in the parameter mode. It is also possible to display and set the alarms in the process operation mode. The hysteresis of limit monitors can be parameterized between 0.1 and 10 %.

Parameter control

The parameter control function in the SIPART DR22 controller can be used to specifically control the parameters of the device determined at different working points. Thus the same control quality can be achieved throughout the complete load range when used with non-linear controlled systems or final control elements.
The proportional gain K_P, reset time T_n, derivative action time T_v, response threshold *AH* and – with the P controller – also the working point y_o are calculated using a straight line function with 5 vertices depending on the magnitude of a controlling variable. The vertices are at 10, 30, 50, 70 and 90 % of the controlling variable. This variable can be one of the internal process variables $x(x_v)$, $w(w_v)$, y or $10 \cdot |x_d|$ or one of the input signals AE1A to AE11A or one of the function inputs FE1 to FE12. The parameters effective at the vertices must first be determined and entered.
This procedure can be used with the dual-loop controllers in controller I or in controller II since both parameter set I and parameter set II can be selected for the parameter control. With the single-loop controllers it is therefore possible to select either a fixed or a controlled parameter set by means of the digital signal PAU.

Adaptation procedure

The SIPART DR22 controller contains an adaptation procedure for determining the optimal controller parameters which is based on the proven SIEPID procedure. The complete controlled systems step response is recorded. Process parameters, system gain, time constant and order are calculated using a procedure for optimum adaptation of models. Previous knowledge of the system is not required.
The controller parameters determined are for either a PI or PID controller. They can then be accepted directly or influenced by the user.

Blocking of the operator input level as well as the parameterization and configuring level

The controller offers 3 binary signals with which the following input levels can be blocked:

- The binary function BLB blocks operator inputs on the controller
- The digital input BLS blocks the switchover to the configuring mode. The on-line control parameters as well as adaptation can nevertheless still be set in addition to normal process operation.
- On the other hand, the digital input BLPS blocks the complete switching of the device from the process operation mode. Only normal operations such as manual changeover, are possible.

Restart conditions

Short dips in the input power supply voltage are overcome by the storage function of the power pack depending on the respective loading of the controller. In the event of a longer power failure, the set parameters and configurations are retained in a non-volatile, plug-in user program memory.

The current operating mode, the current setpoint and the current manipulated variable are also loaded into a non-volatile memory.

If the SIPART DR22 controller is equipped with the *y*-hold module and this module is supplied from a separate power supply unit, the current manipulated variable (I_y) is held at the output in the event of a power failure of the K controller.
When the power returns after an interruption or when it is switched on again, processing starts automatically with the modes configured. If the *y*-hold module held the manipulated variable current during the power failure, the controller starts bumplessly when the power returns. It is possible to configure visual indication via the display following a power failure.

Self-diagnostics

The internal exchange of data between the microcontrollers, the memories and the analog output module (*y*-hold) are checked cyclically and also following POWER ON or a watchdog reset by comprehensive monitoring circuits.
If a fault is detected, an error message is automatically output on the front displays, from which the cause and possible means of elimination can be understood.
When using the analog output module (*y*-hold), its digital output $\overline{\text{St}}$ interrupts the HIGH signal present during fault-free operation.

Communication with higher-level systems

The SIPART DR22 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 125
  (number of possible stations on the PROFIBUS is determined by the master interface module, the data range of the interface module, and the number of parameterized process data)

SES module RS 232

- Transmission rate 9.6 kbits/s
- RS 232 as point-to-point connection

- RS 485 bus up to 32 stations

The advantages of the autonomous SIPART DR22 single-loop controller can also be fully utilized together with higher-level systems:

- Problem-free adaptation of every controller to the problem
- Operational reliability; if the higher-level system or a part thereof is switched off or fails, the SIPART DR22 controller continues to operate as an autonomous controller with the conditions previously defined
- Flexibility; modifications or extensions to individual control loops are possible during operation of the complete system
- Both SPC and DDC modes are possible
- The higher-level system is relieved of certain tasks in SPC mode if the control functions are handled by the individual controller
- Distributed design of system results in clarity.

The configuring switches “S0” and “S251” as shown in Fig. 6/15 are the switches used to activate or configure the relevant functions (see pages 6/16 to 6/21).

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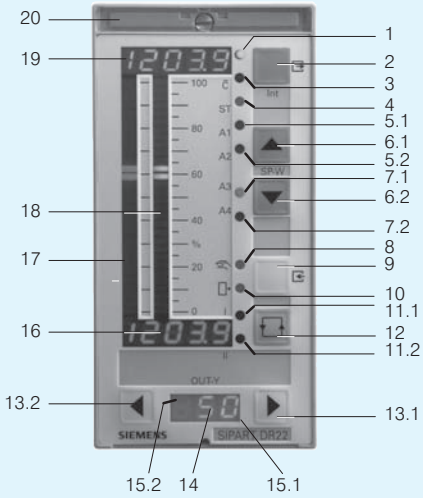
Description

Control and display functions

The SIPART DR22 controller can be operated in three main modes:

- Process operation
- Selection level
- Configuring level (parameterization and configuring mode)

The pushbuttons and displays on the front of the controller sometimes have different functions in these three modes.



Process operation (Fig. 6/14)

Operation of the SIPART DR22 controller in process mode is clear and simple as a result of the arrangement and colors of the front, the controls and the inscriptions:

- **Red** is the color of the process variable:
  The red display (16) and the red vertical LED bargraph (17) indicate the process variable.
- **Green** is the color of the setpoint:
  The green display (19) and the green LED bargraph (18) indicate the setpoint. The green pushbutton (2) is used to switch between the local and remote setpoints. The local setpoint can be adjusted using the green pushbuttons (6). The green LED (1) signals operation with the local setpoint, the LED (3) also lights up green if the digital input DC is not present.
- **Yellow** is the color of the manipulated variable:
  The yellow M/A pushbutton (9) is used to switch between manual and automatic modes, the yellow LED (8) signals by a steady or flashing light that a switch has been made to manual mode. Lighting up of the yellow LED (10) signals remote access to the manipulated variable, i. e. tracking, safety or blocking mode. The yellow pushbuttons (13) can be used in manual mode to adjust the manipulated variable which is displayed by the yellow digital display (14). The yellow LEDs (15) indicate the output of the positioning increment in all operating modes.

Upward or downward violations of limits are signalled when LEDs (5) and (7) light up. The LED (4) signals the process of parameter optimization during the adaptation procedure by means of a steady or flashing light.

The displays and setpoint pushbuttons are switched over in dual-loop controllers using the pushbutton (12). This pushbutton can also switch the display to indicate other setpoints and alarm values, when the SIPART DR22 controller is configured as a single-loop controller. The associated LED (11) indicates the status.

The label (20) is replaceable. The cover can be opened in the middle using a pointed tool and the label removed. A screw is then visible which can be used to remove the front module from the controller. The electrical connections between the front module and the basic unit are made via a ribbon cable.

1	LED ⊡ (green), signals “local setpoint”
2	Local/remote pushbutton/Exit pushbutton
3	LED $\overline{C}$ (green), signals “No computer mode”
4	LED ADAPT (yellow) Flashing light: adaptation in process Steady light: adaptation terminated
5.1	LED A1 (red), signals “Limit A1 reached”
5.2	LED A2 (red), signals “Limit A2 reached”
6.1	Pushbutton $+\Delta w$ } Pushbuttons for adjustment
6.2	Pushbutton $-\Delta w$ } of local setpoint
7.1	LED A3 (red), signals “Limit A3 reached”
7.2	LED A4 (red), signals “Limit A4 reached”
8	LED (yellow) Flashing light: manual mode, remote Steady light: manual mode, local
9	M/A pushbutton for selection of manual/automatic mode/ Enter pushbutton
10	LED (yellow), lights up with remote *y*-intervention
11.1	LED I (green), control/display functions for controller I Flashing light: display and effective functions are not identical Steady light: display and effective functions are identical
11.2	LED II (green), control/display functions for controller II Flashing light: display and effective functions are not identical Steady light: display and effective functions are identical
12	Switchover pushbutton, for controller I/controller II
13.1	Pushbutton $+\Delta y$ } Pushbuttons to adjust the
13.2	Pushbutton $-\Delta y$ } manual manipulated variable
14	Digital display (yellow) for manipulated variable *y*
15.1	LED $+\Delta y$ (yellow) for display of manipulated variable increment output with S controller
15.2	LED $-\Delta y$ (yellow) for display of manipulated variable increment output with S controller
16	Digital display (red) for process variable *x*
17	Analog display (red) for process variable *x*
18	Analog display (green) for setpoint *w*
19	Digital display (green) for setpoint *w*
20	Replaceable tagging label; screw for loosening the front module is behind this label

Fig. 6/14 SIPART DR22 controller, control and display elements

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Description

Selection level

The desired configuration menu is selected in the selection level. The controller switches back from the selection level to the process operation level after approx. 20 s.

The following configuration menus can be called:

onPA	Online parameters
oFPA	Offline parameters
PAST	Control parameters
Strs	Configuring switch
APst	All preset
FdEF FCon FPoS FPST	Menus for the freely-selectable input range [1])
AdAP	Adaptation [1])
CAE4	Calibration AE4 [1])
CAE5	Calibration AE5 [1])

[1]) Menu items are only displayed when enabled in StrS.

To call the selection level, the switchover pushbutton (12) must be held pressed until "PS" flashes in the digital y display. After releasing the pushbutton, "onPA" appears in the digital w display (19).
The controller is then in the selection level and operates in online mode.

Configuring level

The selected configuration menu can be called from the selection level, and settings can be carried out in this menu item.

Control mode is retained during configuring of the online parameters. The reaction of the controlled system to changes in the control parameters can thus be recognized immediately.

The controller output is blocked when adjusting the configuring switches of the offline parameters, the parameter control, the settings in the freely-selectable input area, or the setting of UNI mode:

- The K controller freezes the last manipulated variable current
- The S controller no longer outputs any positioning pulses.

The green analog display shows a striped pattern to indicate offline mode.

Lamp test

If the pushbutton (12) is pressed for longer than approx. 10 seconds, all LEDs on the front of the controller are triggered independent of the respective display, and remain on until the pushbutton is released. The original display is set again following the lamp function test.

Display of firmware release

The current firmware release of the SIPART DR22 controller can be displayed if required.

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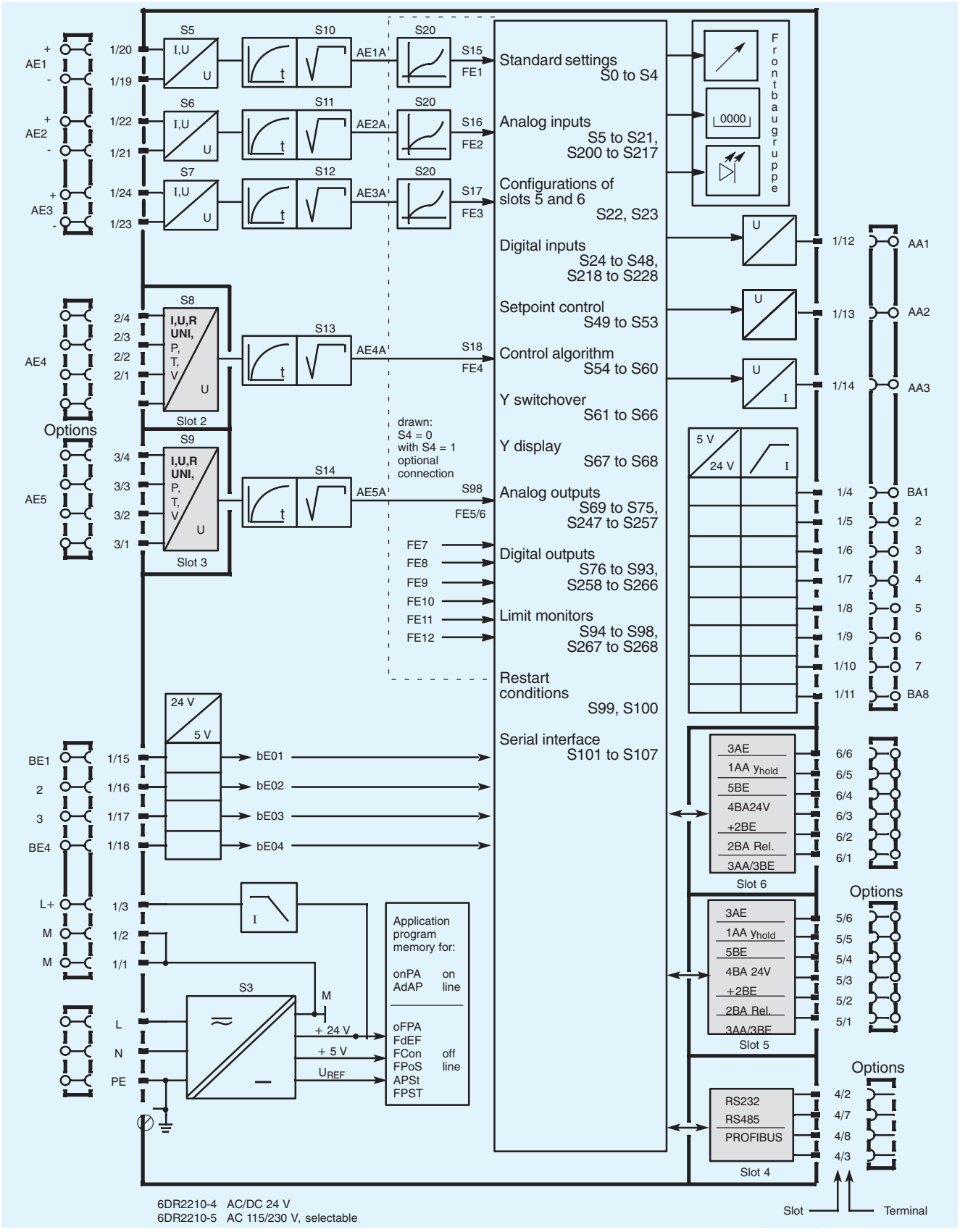
Description

Function diagram



Optional

Fig. 6/15 SIPART DR22 controller, function diagram

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Description

Adjustable on-line parameters

Parameter	Abbre-viation	Display	Display (18), range of adjustment	Dimension	Remarks
Filter time constant for *x*dI	TF I	tFI	oFF, 1 to 1000	s	
Derivative action gain	Vv I	uuI	0.1 to 10.0	1	
Proportional gain	Kp I	cPI	0.1 to 100.0	1	
Reset time	Tn I	tnI	1.000 to 9984	s	
Derivative action time	Tv I	tuI	oFF, 1.000 to 2992	s	
Response threshold of *x*dI	AH I	AHI	0.0 to 10.0	%	
Working point	yo I	YoI	Auto, 0.0 to 100.0	%	P controller
Manipulated variable limiting, start-of-scale	yA I	YAI	– 10.0 to 110.0	%	*y*A < *y*E
Manipulated variable limiting, full-scale	yE I	YEI	– 10.0 to 110.0	%	*y*E > *y*A
Filter time constant for *x*dII	TF II	tFII	oFF, 1 to 1000	s	
Derivative action gain	Vv II	uuII	0.1 to 10.0	1	
Proportional gain	Kp II	cPII	0.1 to 100.0	1	
Reset time	Tn II	tnII	1.000 to 9984	s	
Derivative action time	Tv II	tuII	oFF, 1.000 to 2992	s	
Response threshold *x*dII	AH II	AHII	0.0 to 10.0	%	
Working point	yo II	YoII	Auto, 0.0 to 100.0	%	P controller
Manipulated variable limiting, start-of-scale	yA II	YAII	– 10.0 to 110.0	%	*y*A < *y*E
Manipulated variable limiting, full-scale	yE II	YEII	– 10.0 to 110.0	%	*y*E > *y*A
Repetition rate of display	dr	dr	0.08 to 8.00	s	
Positioning time Controller I/II	Ty 1/2	tY/tYII	10 to 1000	s	
Min. positioning pulse pause Controller I/II	TA 1/2	tA/tAII	20 to 600	ms	
Min. positioning pulse length Controller I/II	TE 1/2	tE/tEII	20 to 600	ms	
Filter time constant AE 1	TF 1	tF1	oFF, 1 to 1000	s	
to					
Filter time constant AE 11	TF 11	tFb	oFF, 1 to 1000	s	
Constant c1	c 1	c1	– 1.999 to 9.999 or – 9.99 to 9.999	1 or 100 %	
to					
Constant c9	c 9	c9			
Connectable parameter 1	P 1	P01	– 1.999 to 9.999	1	Only with S4 = 1
to					
Connectable parameter 15	P 15	P15			

The decimal point, start-of-scale and full-scale values of the digital displays (16) and (19), response values and hysteresis of the pairs of alarms 1/2 and 3/4, setpoint limiting, safety setpoint and manipulated variable, setpoint ramp, ratio range, split ranges and the function generators (linearizers) are all set by **off-line parameters**.

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Description

Configuring switches

Configuring switch	Function
S0	Identification of plug-in user program memory
0	Code for factory setting (APSt)
1 . . . 255	Selectable codes for user program
S1	Type of controller
0	Fixed setpoint controller with 1 or 2 independent setpoints
1	Fixed setpoint controller with 1 or 2 dependent setpoints
2	DDC fixed setpoint controller
3	Slave/synchronization/SPC controller
4	Ratio controller
5	Cascade controller
6	Ratio cascade controller
7	Override controller, max. limiting of *y*
8	Override controller, min. limiting of *y*
9	Process variable display
10	Fixed setpoint controller for coupling to a process control system
11	Slave controller for coupling to a process control system
12	Dual loop controller
S2	Output configuration
0	K output
1	S output with internal feedback
2	S output with external feedback
S3	Mains frequency suppression
0	For 50 Hz
1	For 60 Hz
S4	Input connections
0	Standard connections
1	Optional connections (Fig. 6/3)
S5 to S9	Signal range 0 or 4 to 20 mA of analog inputs AE1 to AE5 or UNI Module AE4 and AE5
S10 to S14	Square-rooting of analog inputs AE1 to AE5
S15 to S19	Assignment of function inputs FE1 to FE6 to the analog inputs (with S4 = 0)
S20 and S21	Switching on/off linearizers FE1 and FE3 (only with S4 = 0)

Configuring switch	Function
S22 and S23	Fitting of slots 5 and 6
S24 to S38	Assignment of control signals CB, He, N, Si, BLS, BLPS, PI, PII, PAU, $\pm\Delta w$, $\pm\Delta y$, $\pm y$BL to the digital inputs BE1 to BE14 or FE9 to FE12
S39 to S46	Direction of action of control signals
S47 and S48	Direction of action of control signals CB and N, static or dynamic
S49 to S53	Setpoint control (tracking, source for remote setpoint, *x*-tracking)
S54 to S56	Direction of action of controller I/controller II
S55 to S57	D-element input of controller I/controller II, *z* feedforward
S58	Adaptation: selection of time response
S59 and S60	Parameter control: selection of controlled parameter and controlling variable
S61 to S66	Output switchover: priority N or H, source of external manipulated variable, function with split-range mode
S67 and S68	Manipulated variable display: selection of displayed variable and direction of action of display
S69 to S72	Signal range 0 or 4 to 20 mA of analog outputs AA1 to AA4
S73 to S75	Assignment of analog outputs AA1 to AA3 to controller signals
S76 to S85	Assignment of signals $\overline{\text{RB}}$, $\overline{\text{RC}}$, H, N, A1, A2, A3, A4, MUF and Int I to digital outputs BA1 to BA16
S86 to S93	Direction or action of signals $\overline{\text{RB}}$, $\overline{\text{RC}}$, H, N, A1/A2, A3/A4, MUF and Int I
S94 and S95	Assignment of limit monitors A1/A2 and A3/A4 to internal controller signals
S96 to S98	Function and setting of limit monitors
S99 and S100	Restart conditions following power failure
S101 to S107	Settings of serial interface: transmission rate, parity, station no.

The table above lists the configuring switches S0 to S4 of the SIPART DR22 controller with their possible settings in detail. Only the selectable functions are defined for the other configuring switches. A detailed list is provided in the operating instructions of the controller.

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Description

Configuring switches (continued)

Configuring switch	Function
S200 to S205	Signal range 0 or 4 to 20 mA of analog inputs AE6 to AE11
S206 to S211	Square-rooting of analog inputs AE6 to AE11
S212 to S217	Assignment of function inputs FE7 to FE12 to the analog inputs (with S4 = 0)
S218 to S228	Assignment of control signals BLB, CBII, HeII, NII, SiII, /tSII, /tSII, WSLI, WSLII, +yBLII, –yBLII to the digital inputs BE1 to BE14 or FE9 to FE12
S229 to S230	Direction of action of control signals tS und WSL
S231	Output structure of controller 2 (with dual-loop controller)
S232 to S235	Setpoint control of controller 2 (with dual-loop controller)
S237 to S238	Source of manipulated variable w1/w2
S239 to S244	Output circuit of controller 2 (with dual-loop controller)
S245 to S246	Effect of manipulated variable limiting
S247 to S251	Signal range 0 or 4 to 20 mA of analog outputs AA5 to AA9
S252 to S257	Assignment of analog outputs AA4 to AA9 to internal controller signals
S258 to S266	Assignment of signals and function inputs FE9 to FE12 to digital outputs BA1 to BA16
S267 to S268	Assignment of alarms A2 to A4 to internal controller signals

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SIPART DR22 Controllers

6DR2210-.

Technical data

Technical data

General	
Mounting position	Any
Climatic classes	
– Storage: 1K2 according to DIN IEC 721 Part 3-1	–25 to +75 °C
– Transport: 2K2 according to DIN IEC 721 Part 3-2	–25 to +75 °C
– Operation: 3K3 according to DIN IEC 721 Part 3-3	0 to +50 °C
Degree of protection to EN 60 529	
Front	IP 64
Housing	IP 30
Connections	IP 20

Controller design

Electrical safety
- to DIN EN 61 010 Part 1
- Protection class I
- Safe separation between supply connection and field signals
- Clearances and creepage paths for surge class III and pollution level 2 , unless stated otherwise

EC Certificate of Conformity no. 691.001

CE marking — conformity concerning
- EMC Guideline 89/336/EWG and
- NS Guideline 73/23/EWG

is fulfilled without rectrictions

Emitted interference, immunity to interference to EN 61 326, NAMUR NE21 8/98

Weight (standard controller without options)	Approx. 1.2 kg
Color	
Front module frame	RAL 7037
Front module facia	RAL 7035
Material	
Housing and front frame	Polycarbonate, glass-fiber reinforced
Front facia foil	Polyester
Power supply connection	
AC 115/230 V	3-pin earthed plug IEC 320/V
AC/DC 24 V	Special 2-pin plug
Connections for process signals	Multiple screw terminal blocks, cannot be confused when connecting, for conductor cross-section 1.5 mm² (AWG 14)
Protective earth connection	Earthing screw

A rail can be mounted on the rear panel of the power supply. The rail is included in the delivery of the coupling relay mode.

Power supply				
Rated voltage	Selectable AC 230 V	Selectable AC 115 V	AC/DC 24 V	
Operating voltage range	AC 187 to 276 V	AC 93 to 138 V	AC 20 to 28 V	DC 20 to 35 V [4]
Frequency range	48 to 63 Hz			–
Peak voltages, non periodic, to VDE 160				
1.3 ms	≤ 780 V	≤ 390 V	≤ 70 V	
10 µs	≤ 1500 V	≤ 1500 V	≤ 500 V	
External current I_{Ext} [5]	450 mA			
Power consumption				
Active power/ apparent power [6]				
Standard controller				
– Without options, without I_{Ext}	8 W/17 VA	8 W/13 VA	8 W/11 VA	8 W
– With options, without I_{Ext}	13 W/25 VA	13 W/20 VA	13 W/18 VA	13 W
– With options, with I_{Ext}	26 W/45 VA	26 W/36 VA	28 W/35 VA	28 W

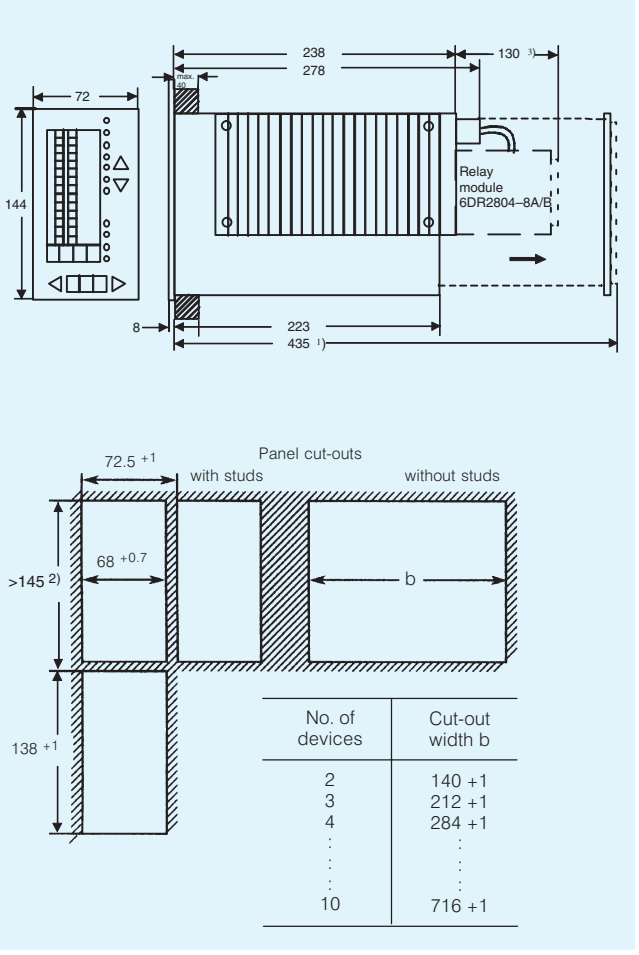

Fig. 6/16 SIPART DR22 controller and panel cut-outs, dimensions

1) Mounting depth required to enable replacement on the main circuit board.
2) Mounting one above the other without interspacing is permissible if the permissible ambient temperature is observed.
3) A relay module with 2 or 4 contacts (6DR2804-8A/-8B) can be snapped onto the rear of the controller; the mounting depth is then increased by 130 mm.
4) Including harmonics.
5) Consisting of $L+$, BA and AA.
6) Capacitive.

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Technical data

Technical data (continued)

Power supply (continued)				
Permissible voltage dips [1]				
Standard controller				
– Without options, without I_{Ext}	≤ 90 ms	≤ 70 ms	≤ 55 ms	≤ 30 ms
– With options, without I_{Ext}	≤ 80 ms	≤ 60 ms	≤ 50 ms	≤ 25 ms
– With options, with I_{Ext}	≤ 50 ms	≤ 35 ms	≤ 35 ms	≤ 20 ms
Test voltages (1 min)				
– Primary – secondary	AC 1.5 kV		AC 500 V	
– Primary – protective earth conductor	AC 1.5 kV		AC 500 V	
– Secondary – protective earth conductor	DC 700 V		DC 700 V	

Inputs and outputs, display technology	
Analog inputs AE1, AE2, AE3 and AE6 to AE11 (input module 6DR2800-8A)	
Input signal range	
Voltage	0/199.6 to 998 mV or 0/2 to 10 V
Current	0/4 to 20 mA
Input impedance	
Differential (voltage)	200 kΩ
Differential (current)	49.9 Ω ± 0.1 %
Common-mode	> 500 kΩ
Common-mode voltage	0 to 10 V
Filter time constant	50 ms
Effect of temperature	
Zero	0.05 %/10 K
Gain	0.1 %/10 K
Analog outputs AA1 to AA3	
Rated signal range	0 to 20 mA or 4 to 20 mA
Operating range	0 to 20.5 mA or 3.6 to 20.5 mA
Load voltage	–1 to +18 V
Max. inductive load	≤ 0.1 H
No-load voltage	≤ 26 V
Time constant	300 ms
Residual ripple 900 Hz	≤ 0.2 %
Resolution	≤ 0.1 %
Zero error	≤ 0.3 % of measuring span
Gain error	≤ 0.3 % of measuring span
Linearity error	≤ 0.05 % of measuring span
Load dependence	≤ 0.1 %
Effect of temperature	
Zero	≤ 0.1 %/10 K
Gain	≤ 0.1 %/10 K

Transmitter supply $L+$	
Rated voltage	20 to 26 V
On-load current	≤ 100 mA, short-circuit proof
Short-circuit current	≤ 200 mA pulsed
Digital inputs BE1 to BE4	
Signal status "0"	≤ 4.5 V or open
Signal status "1"	≥ 13 V
Static destruction limit	± 35 V
Input impedance	≥ 27 kΩ
Digital outputs BA1 to BA8 (connected via wired-OR diodes)	
Signal status "0"	≤ 1.5 V
Signal status "1"	+19 to 26 V
On-load current	< 50 mA
Short-circuit current	< 80 mA pulsed
Cycle time	> 60 ms, user program dependent
A/D conversion	
Method	Successive approximation with > 120 measurements per input and averaging over 20 or 16.67 ms
Resolution	11 bit ≙ 0.06 %
Zero error	≤ 0.2 % of the measuring span
Gain error	≤ 0.2 % of the measuring span
Linearity error	≤ 0.2 % of the measuring span
Effect of temperature	
Zero	≤ 0.05 %/10 K
Gain	≤ 0.1 %/10 K
Display technology	
Digital x, w displays	4½ digit, 7-segment LEDs
Color w display	Green
x display	Red
Digit height	7 mm
Display range	Adjustable start/full scale
Numeric range	–1999 to 19999
Decimal point	Variable
Refresh rate	0.08 to 8.0 s, adjustable
Resolution	1 digit, but not better than A/D converter
Display error	Corresponding to A/D converter and analog inputs
Digital y display	3-digit, 7-segment LEDs
Color	Yellow
Digit height	7 mm
Display range	0 to 100 %
Refresh rate	0.08 to 8.0 s, adjustable
Resolution	1 %
Analog displays	
Color w display	Green
x display	Red
Display range	LED array with 30 LEDs / 0 to 100 %
Resolution	1.7 % by alternate lighting of 1 or 2 LEDs, the center point of the illuminated LEDs acting as a pointer
Refresh rate	0.08 to 8.0 s, adjustable

[1] The load voltage of the analog outputs is reduced to 13 V, $L+$ to +15 V and the voltage at the digital outputs drops to +14 V.

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SIPART DR22 Controllers

6DR2210-.

Ordering data

Ordering data

	Order No.
SIPART DR22 controller 72 x 144	
Basic unit with – 3 analog inputs, – 3 analog outputs, – 4 digital inputs, – 8 digital outputs and – user program memory	
• power supply AC/DC 24 V	**6DR2210-4**
• power supply AC 230 V, switchable to AC 115 V	**6DR2210-5**
Input/output modules	See Catalog Section 8
Analog signal module – for current input 0/4 to 20 mA or voltage inputs 0/0.2 to 1 V or 0/2 to 10 V (6DR2800-8J) – for resistance based sensor (6DR2800-8R) – UNI module for TC/RTD/R/mV signals, programmable (6DR2800-8V) – Reference junction terminal for TC, internal (to be used in conjunction with UNI module (6DR2805-8A) – Measuring range connector for *I* = 20 mA and *U* = 10 V (to be used in conjunction with UNI module) (6DR2805-8J) – with 3 analog outputs 0/4 to 20 mA and 3 digital inputs (6DR2802-8B) – with 3 analog inputs 0/4 to 20 mA or 0/0.2 to 1 V or 0/2 to 10 V (6DR2800-8A) – *y*-hold module (6DR2802-8A)	
Switching signal module – with 5 digital inputs (6DR2801-8C) – with 4 digital outputs and two digital inputs (6DR2801-8E) – with 2 relay outputs (6DR2801-8D)	
Coupling relay module – With 4 relays (AC 250 V) (6DR2804-8A) – With 2 relays (AC 250 V) (6DR2804-8B)	
Interface modules – For serial communications (SES) via RS 232 or RS 485 (6DR2803-8C) – PROFIBUS-DP module (6DR2803-8P)	

Documentation	
SIPART DR22 controller	
– German – English	**C79000-G7400-C154** **C79000-G7476-C154**
Mounting and installation instructions, German/English	**C79000-M7474-C38**

The following Instructions can be downloaded from Internet (see Section 10, Page 10/4):

SIPART DR
PROFIBUS interface / Instructions
(Description of the communication via PROFIBUS DP with the controller SIPART DR19/20/21/22/24)
– German
– English

SIPART DR22
Serial SIPART 6DR22 Bus interface / Instructions
(Description of the communication via RS 232, RS 485 or PROFIBUS DP with the controller SIPART DR22)
– German
– English

Scope of supply

The scope of supply of a SIPART DR22 controller includes:

1 Controller as ordered
1 Power supply connector 115/230 V or a special connector for AC/DC 24 V supply
2 Clamping elements, pluggable
1 Mounting and installation instructions (German/English)

Available ex-stores

Items marked ▭ are available ex-stores.

Input/output modules and accessories

The input/output modules are described in Catalog Section 8.
Exception: 6DR2802-8B, see page 6/26.
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 catalog (German) for details of training courses for the controllers listed in this catalog.

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Overview: applications

Analog signal modules	SIPART DR22					Description see Section 8, Page
	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	
U/I module 6DR2800-8J	AI4	AI5	–	–	–	8/3
3 x U/I module 6DR2800-8A	–	–	–	AI9/10/11	AI6/7/8	8/4
R module 6DR2800-8R	AI4	AI5	–	–	–	8/5
Pt 100 module 6DR2800-8P	(AI4)*	(AI5)*	–	–	–	8/6
TC module 6DR2800-8T	(AI4)*	(AI5)*	–	–	–	8/7
UNI module 6DR2800-8V (TC/RTD/R/U/I)	AI4	AI5	–	–	–	8/8
y-hold module 6DR2802-8A	–	–		AO7	AO4	8/10
3AO/3DI module 6DR2802-8B	–	–	–	AO7/8/9 DI5/6/7	AO4/5/6 DI10/11/12	8/11

NEW

*) Use the UNI module 6DR2800-8V.

Switching signal modules	SIPART DR22					Description see Section 8, Page
	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	
5 DI 6DR2801-8C	–	–	–	DI5/6/7/8/9	DI 10/11/12/13/14	8/12
2 relays 6DR2801-8D	–	–	–	DO9/10	DO13/14	8/13
4DO/2DI 6DR2801-8E	–	–	–	DO9/10/11/12 DI5/6	DO13/14/15/16 DI10/11	8/14

Interface module	SIPART DR22					Description see Section 8, Page
	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	
SES module 6DR2803-8C						8/15
RS 232/SIPART bus	–	–	Yes	–	–	
RS 485	–	–	Yes	–	–	
PROFIBUS-DP module 6DR2803-8P	–	–	Yes	–	–	8/16

NEW

Coupling relay module can be installed on rear:	SIPART DR22	Description see Section 8, Page
with 4 relays 6DR2804-8A	Yes	8/17
with 2 relays 6DR2804-8B	Yes	8/17

Depending on the application, the following can be used in conjunction with the UNI module 6DR2800-8V:		Description see Section 8, Page
Reference junction terminal	6DR2805-8A	8/8
Measuring range connector	6DR2805-8J	8/8

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Notes

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SIPART DR24
Multi-function Unit

7

7/2 Description
7/2 Application
7/3 Design
7/3 Mode of operation
7/7 Basic functions
7/8 Complex functions
7/16 Serial interface

7/17 Technical data

7/19 Ordering data

7/20 SIPART DR24 input/output modules
7/20 Overview: applications

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SIPART DR24 Multi-function Unit

6DR2410-.

Description

Application

The SIPART DR24 multi-function unit is used in process engineering applications for calculation, closed-loop and open-loop control. The unit can be freely configured to suit the application. During configuring, functions stored in memory (Fig. 7/1) are, through simple allocation, selected and connected to one another, to the inputs and outputs, and to the indicators and pushbuttons of the control and display unit.

No programming knowledge is necessary.

The multi-function unit can be connected to higher level automation systems, control systems or process computers using analog, parallel interfaces, as well as via an addressable bus-based serial interface.

The multi-function unit can be installed in panels, desks or cabinets.

Application examples

- Calculator for mathematical equations, timing sequences, logic operations and arithmetic operations executed in parallel
- Programmer (clock), also in conjunction with calculations, open-loop and closed-loop controls
- Closed-loop controller with continuous manipulated variable and/or three-position step controller; inputs and outputs of controller blocks freely connectable, e. g. to calculation and open-loop control functions; as a single-loop controller or for parallel operation for up to 4 independent control loops, for selection controls, cascade control, SPC or DDC mode
- Program controller; up to 8 programs
- Boiler control with mathematical evaluation of process variables (min./max. selection, correction computer etc.)
- Closed-loop burner control with open-loop control functions
- Thermodynamic closed-loop process control and calculations (enthalpy)
- Closed-loop furnace and zone control with programmed setpoint control and linearization
- Open-loop and closed-loop test bed control
- Closed-loop control of transport systems (e. g. conveyor belts) with dead time element
- Surge limit control
- Transmitter for analog and digital process variables to and from the serial interface (SIPART SW program)
- Process monitoring (limit violations, failure alarms etc.)
- Dependent and mutually interlocking/overriding setpoint control
- Multiplexer for process variables and/or setpoints
- Weighted average calculation using sampled values

Mathematical functions

AbS	Absolute value
Add	Add
AMPL	Differential amplifier
div	Divide
FUL	Function generator (3)
FUP	Function generator (2)
LG	Log base 10
LinE	Straight line equation
Ln	Log base e
MuLt	Multiply, negation
Pot	Exponentiation
CPt	P/T correction computer (2)
root	Square root extraction
SUb	Subtract, negation
SPr	Splitrange (8)

Time functions

AFi	Adaptive filter (2)
diF	Differentiate (high-pass)
FiLt	Filter (low-pass)
Ain	Integrator, analog input (4)
bin	Integrator, digital input (6)
tiME	Timer
dti	Dead time element (2)
CLoc	Programmer (1)

Comparison functions

dEbA	Response threshold
LiMi	Limiter
MASE	Max. selection
MiSE	Min. selection
AMPL	Differential amplifier
CoMP	Comparator with hysteresis

Control functions

Ccn CSE CSi	PID controller with continuous output S controller with internal or external feedback (4)

Logic functions

And	AND
dFF	d flip-flop
Eor	Exclusive OR
nAnd	NAND, also inverted
nor	NOR, also inverted
or	OR
tFF	t flip-flop
tiME	Timer
CoUn	Counter
PUM	Pulse width modulation (4)

Switches

MUP	Multiplexer (2)
ASo	Analog variable selector
bSo	Digital variable selector
Cnt	Demultiplexer

Memory functions

AMEM	Analog value memory
dFF	d flip-flop
Ain	Integrator with analog input, tracked (see above)
bin	Integrator with digital input, tracked (see above)
MAME	Maximum memory
MiME	Minimum memory
tFF	T flip-flop

Programmer

CLoc	Clock (see above)

Functions marked (x) are complex functions that may be used x times (x = 1, 2 or 3). All other functions are basic functions that can be connected in any sequence and as often (max. = 109) as required.

The abbreviated function names are displayed in the seven-segment display during parameterization and configuring.

Fig. 7/1 Basic and complex functions of the multi-function unit

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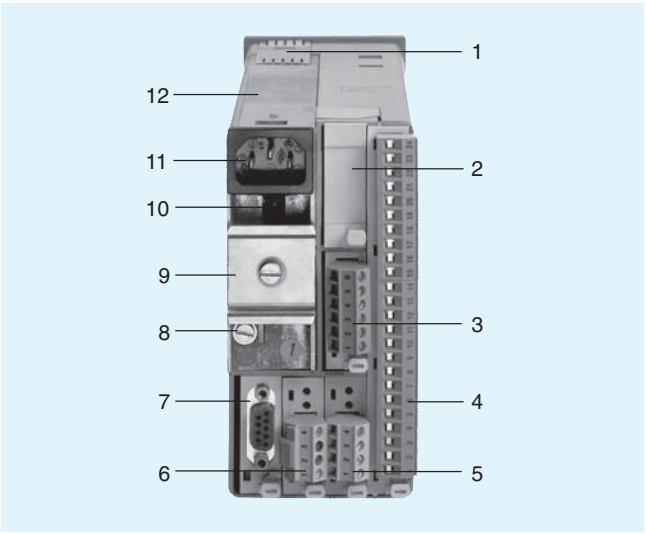
Description

Fig. 7/2 SIPART DR24 multi-function unit



1 PE conductor - contact spring
2 Slot 6
3 Slot 5
4 Slot 1 (main circuit board)
5 Slot 2
6 Slot 3
7 Slot 4 (SES: RS 232/RS 485, PROFIBUS-DP)
8 Earthing screw
9 Top-hat rail (included in delivery of relay modules)
10 Mains voltage selector
11 Mains plug
12 Power supply unit

Fig. 7/3 SIPART DR24 multi-function unit, rear view

Design

The SIPART DR24 multi-function unit is of modular design and consequently easy to service and simple to reconfigure or retrofit. It consists of a standard device, to which additional input/output modules can be added in order to extend its range of application. These modules are inserted in slots in the rear of the instrument (Fig. 7/3).

The standard device comprises:

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

Electrical connections between the various modules are made via the interface board fixed to the housing. The main circuit board is inserted in the rear of the unit in slot 1 and locked in place. The main board has 10-pin and 14-pin terminal blocks to which all inputs and outputs of the standard device are connected. If the number of signals in the standard device is insufficient for a particular application, a further five slots are available for additional option modules.

Electrical power for transmitters is provided by a short-circuit proof *L*+-output (DC 24 V, 100 mA).

The power supply unit, an electrically isolated, stabilised switched-mode power pack, is situated in a completely enclosed metal housing that is screwed to the plastic body of the instrument.

Versions available:

- 6DR2410-4 for AC/DC 24 V power supply
- 6DR2410-5 for AC 230 V power supply, switchable to AC 115 V.

Short dips in the power supply are bridged without affecting the instrument's functionality. All voltages generated by the power pack are stabilised and short-circuit proof (thermal fuse and current monitoring).

The input of the power pack is protected against overvoltages. A filter ensures that mains glitches cannot reach the instrument and that switching surges from the power pack are prevented from getting into the mains supply.

The output from the power pack is sufficient to provide a 24 V supply to a number of loads (active digital outputs, output modules) connected to earth (see Technical data).

Mode of operation

The SIPART DR24 multi-function unit is designed around a modern, highly-integrated CMOS microprocessor.

The task-specific program created by the user is stored in a non-volatile memory and is therefore protected against power failure.

Analog input area

The standard device has 3 electronically isolated analog inputs that can accept either standardized voltage (0/0.2 to 1 V or 0/2 to 10 V) or current (0/4 to 20 mA) signals.

In addition to these inputs, a module with 3 further inputs of identical types can be inserted into slots 5 and 6. These inputs can also be switched between 0 to 10 V and 0/4 to 20 mA. To handle complex control applications, or to connect other input signals, two additional input modules can be inserted in slots 2 and 3. Apart from processing standardized voltage and current signals, these input modules can also be used to connect Pt 100 resistance thermometers, thermocouples and resistance based sensors.

A total of 11 analog inputs are therefore available.

7

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SIPART DR24 Multi-function Unit

6DR2410-.

Description

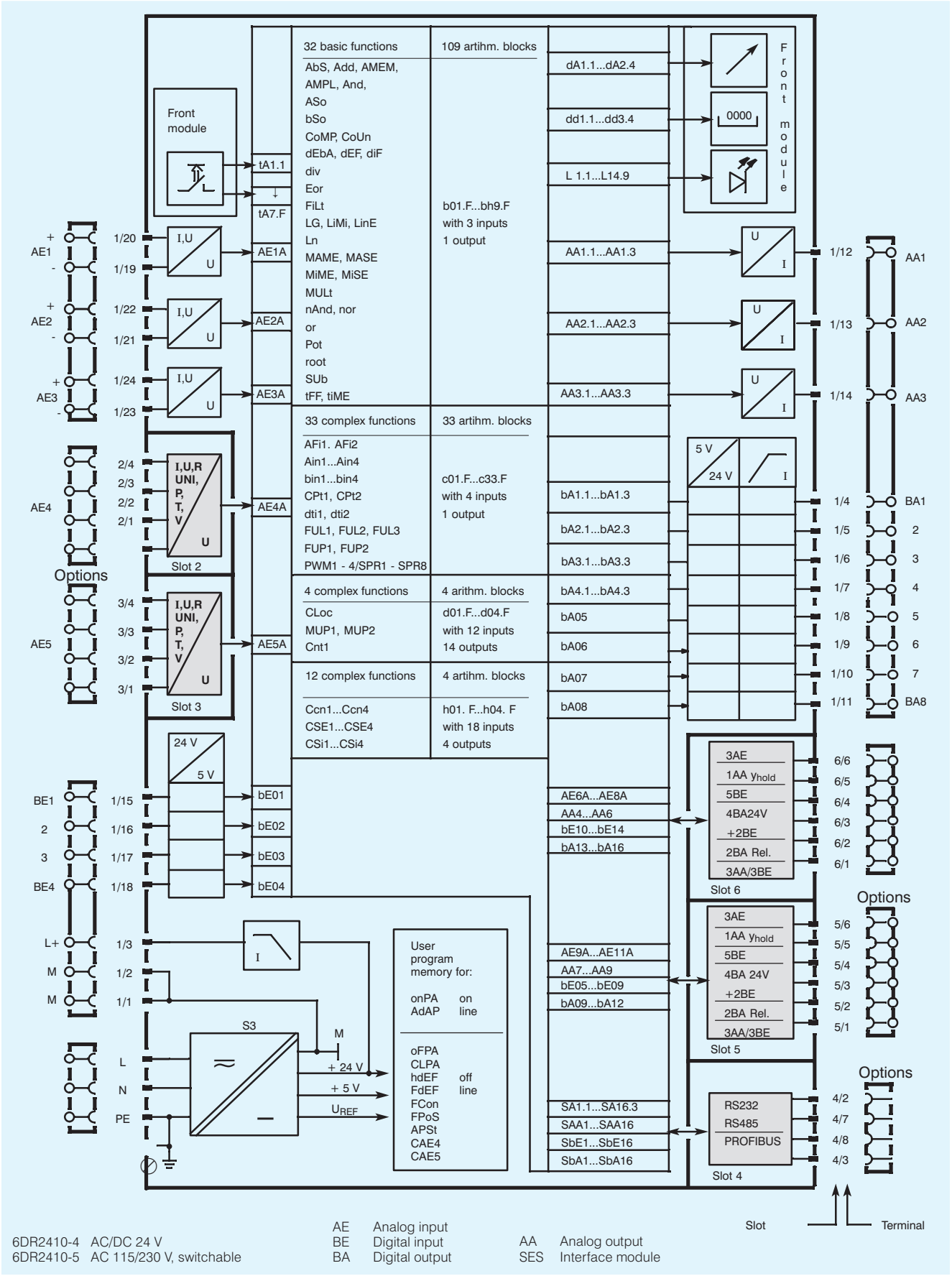

Fig. 7/4 SIPART DR24 multi-function unit, function diagram

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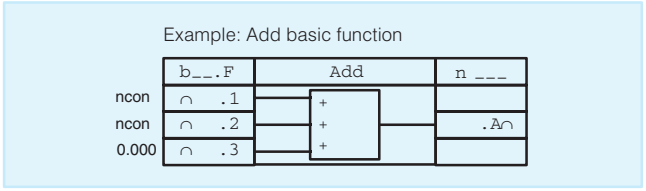
Description

Analog output area

The standard device has 3 analog outputs. In addition to these outputs, a module with 3 analog outputs and 3 digital inputs can be inserted into each of the slots 5 and 6. The total of 9 analog outputs generate a 0 to 20 mA or 4 to 20 mA signal.

Slots 5 and 6 can be optionally fitted with an analog output module (y-hold). This module consists of a microprocessor which outputs the manipulated variable it receives from the CPU on the main circuit board. It also contains an alarm output $\overline{St}$. In normal mode the module is powered by the controller's power pack. It can, however, also be powered via an external DC 20 to 30 V supply, in which case the internal and external supply are ORed.

This analog output module holds the most recent value of the output variable should communications between the controller's CPU and the y-hold processor fail.



A = E1 + E2 + E3
ncon Inputs not connected

Fig. 7/5 Basic function block, adder; the preallocated inputs (e. g. E3 = 0.000) can be easily overwritten if required

Digital I/O area

The standard device has 4 digital inputs (BE1 to BE4) and 8 digital outputs (BA1 to BA8). If more are required, the number of digital inputs and outputs can be increased by using additional option modules. Slots 5 and 6 at the rear of the controller are used for this purpose. Both these slots can be used to accommodate either a module with 5 digital inputs, or one with four DC 24 V digital outputs, or a module with two relay outputs (≤ AC/DC 35 V, ≤ 5 A).

The digital outputs are active and generate a DC 24 V signal.

Floating outputs are available, if the relay module with two digital outputs is used. An interface relay module can also be snapped onto a DIN rail on the rear of the controller. This additional module has either two or four relays, which are energized directly by the digital outputs. Each relay has a single CO contact.

Function area

The function area is located between the input and output areas. It contains

32 basic functions, that can be used as required up to 109 times, and

15 reusable complex functions.

The function area also contains variable parameters and a number of constants and alarms that may also be connected as necessary.

In the configuring mode, the required functions can be selected or defined (configuring mode FdEF), connected (configuring mode FCon) and positioned in the processing sequence (configuring mode FPoS).

The software connections are freely configurable. Any data source can be connected to any number of data sinks. Configuring is minimised by eliminating the data sources and sinks of undefined function blocks and by removing any illogical source/sink (e. g. analog to digital) connections.

Certain parameters can be modified during operation (on-line parameters). The remaining dedicated parameters (e. g. programmer parameters) are set off-line in configuring mode.

Arithmetic

Analog variables are processed using floating-point arithmetic within a decimal range of -10^{19} to $+10^{19}$.

The input and output variables of the multi-function unit are input or output in the signal range 0/4 to 20 mA or 0 to 10 V, corresponding to 0 to 100 %. These ranges represent the arithmetic values 0 to 1. Arithmetical operations are performed using these numeric values.

- Connectable parameters

The linear parameters PL1 to PL40 can be adjusted with a resolution of 4 digits. The parameters Pd1 to Pd40 – which should preferably be used as time constants – can be adjusted over a very large logarithmic range. PL and Pd parameters can be modified on-line in process operation.

- Back-up battery RAM

Actual values of counters, timer and memory functions can all be stored in the event of a power supply failure.

Function area "Basic and complex functions"

Configuring mode FdEF is used to define any number of function blocks in any sequence. The data sinks (inputs) can be connected (FCon) to any data source (output), e. g. to outputs from other blocks, to parameters or arithmetic variables. The basic functions and their abbreviated names are shown in Fig. 7/1. The basic function blocks and their characteristic features are listed on page 7/7.

The complex function blocks and their characteristic features are listed on pages 7/8 to 7/16.

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Mode of operation

Communication with higher-level systems

The SIPART DR24 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 125
  (number of possible stations on the PROFIBUS is determined by the master interface module, the data range of the interface module, and the number of parametrized process data)

SES module RS 232/RS 485

- Transmission rate 9.6 kbits/s
- RS 232 as point-to-point connection
- RS 485 bus up to 32 stations

Monitoring function

The multi-function unit contains monitoring functions. Alarms are available as data sources and can be used to activate digital outputs, initiate function sequences or, for example, set analog outputs to their safety values.

Self-diagnosis

Comprehensive self-diagnostics circuits cyclically control the internal data transfer, or also following a power-on reset or watchdog reset.

An error message is displayed automatically on the front module when an error is detected. This message provides enough information to identify the cause of the error and shows how it can be rectified.

If the analog output module is being used, the $\overline{\text{SI}}$ digital output on this module interrupts the High signal present during normal operation.

Restart conditions

Depending on the actual loading on the instrument, short dips in the power supply are bridged by the storage capability of the power pack. During a longer power cut, the parameters and configurations being used are saved in a non-volatile, plug-in user program memory. The most recent mode of operation, setpoint value and manipulated variable are also loaded into fail-safe memory.

If the SIPART DR24 is equipped with an analog output module and is being supplied from a separate, fail-safe source, the most recent output value is maintained.

Blocking of operator input as well as parameterization and configuring modes

Switching over to parameterization and configuring mode can be blocked using digital signals.

The digital input BLS blocks the switchover to configuring mode. However, on-line control parameters can still be set and adaptation, as well as normal process operation, performed.

The digital input BLPS, on the other hand, prevents the instrument from being switched out of process operation mode.

The binary function bLB blocks operation of the device.

Indicators (Fig. 7/2)

The SIPART DR24 multi-function unit is equipped with digital and analog indicators.

The two analog indicators consist of a red and a green vertical LED array. One or two diodes light up alternately, with the measured value indicated by the center of the field.

The resolution of both indicators is 1.7 %. The green LED array on the right can be configured as a digital indicator, in which case digital signals are output to 10 equally spaced LEDs. Two of the three digital indicators have 4½-digit displays, and one has a 3-digit display. They can all be dimensioned in either engineering units or percentage.

13 additional LEDs are located on the front of the instrument to display status flags, alarm conditions etc. All LEDs can be connected as required.

Process operation (Fig. 7/2)

7 freely connectable pushbuttons are provided on the front panel, which are operator-accessible by pressing the curved foil.

All control and display elements (indicators, LEDs and input pushbuttons) on the front panel can be switched over to 4 data sources or sinks for multiple applications.

Customised descriptions can be inserted on the front panel.

The rating plate can also be replaced.

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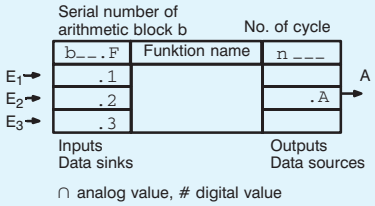
Description

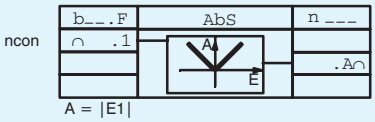
Basic functions

A total of 32 basic functions can be used up to 109 times in any sequence: b01.F to bh9.F

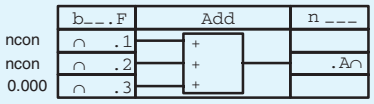
ncon	Input not yet connected
Hi; Lo; 1.00;	Present for input; can be overwritten
Hi	High level
Lo	Low level



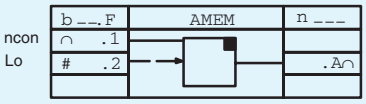
∩ analog value, # digital value



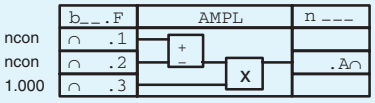
A = |E1|



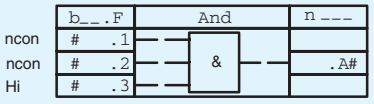
A = E1+E2+E3



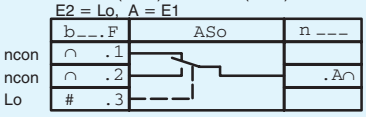
E2 = Hi (t = 0) → A = E1 (t = 0)
E2 = Lo, A = E1

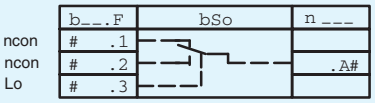


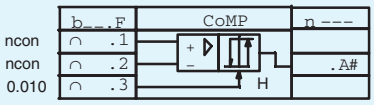
A= (E1-E2) · E3



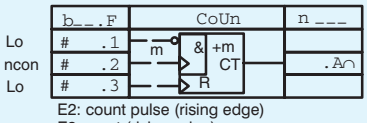
A = E1 ∧ E2 ∧ E3



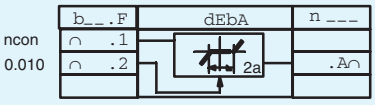




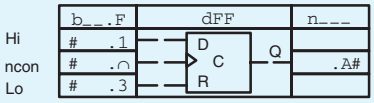
A = Hi if E1 ≥ E2+H/2
E3: hysteresis



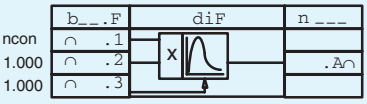
E2: count pulse (rising edge)
E3: reset (rising edge)
E1 = Hi: block; m = 0.001



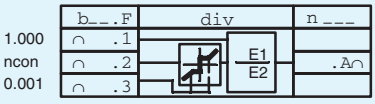
E2: dead zone ± a when E1 = 0



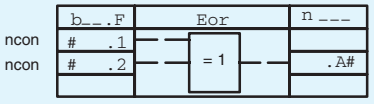
rising edge on E2: A = E1
E3 = Hi: A = Lo



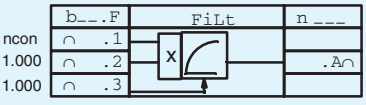
A = E1 · E2 · $e^{-t/E3}$
$E_2 = V_v$, E3 = τ_v; E2 · E3 = T_v



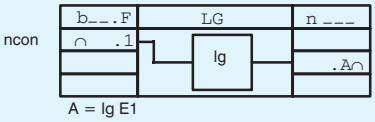
A = E1/E2: also A = 1/E2
E3: limit E2 towards 0



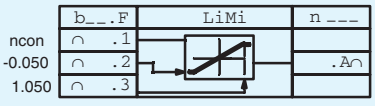
A = ($\overline{E1}$ ∧ E2) ∨ (E1 ∧ $\overline{E2}$)



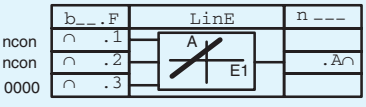
A = E1 · E2 · (1 - $e^{-t/E3}$)
E2 gain; E3 time constant



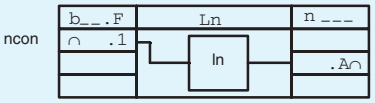
A = lg E1



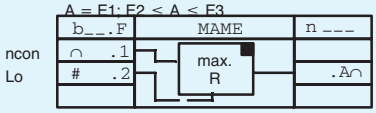
E2: Min., E3: Max., E2 < E3
A = E1; E2 < A < E3



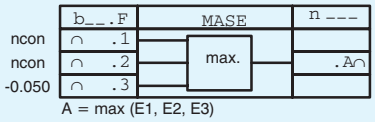
A = E1 · E2 + E3



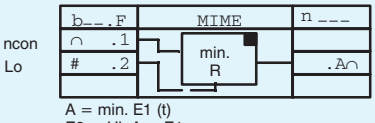
A = ln E1



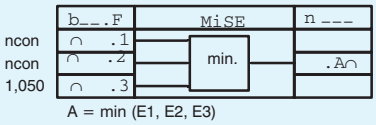
A = max. E1 (t)
E2 = Hi: A = E1



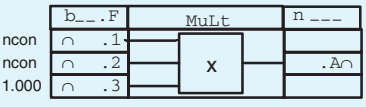
A = max (E1, E2, E3)



A = min. E1 (t)
E2 = Hi: A = E1

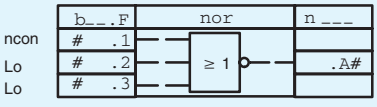


A = min (E1, E2, E3)

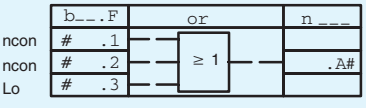


A = E1 · E2 · E3

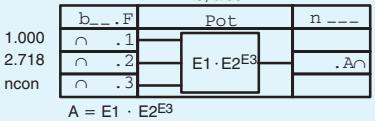
A = $\overline{E1 \wedge E2 \wedge E3}$, also A = $\overline{E1}$



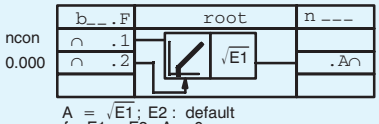
A = $\overline{E1 \vee E2 \vee E3}$, also A = $\overline{E1}$



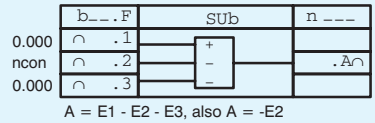
A = E1 ∨ E2 ∨ E3



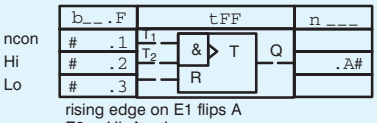
A = E1 · $E2^{E3}$



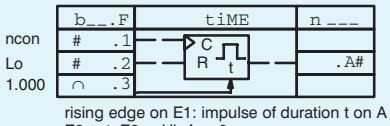
A = $\sqrt{E1}$; E2 : default
for E1 < E2 : A = 0



A = E1 - E2 - E3, also A = -E2



rising edge on E1 flips A
E3 = Hi: A = Lo
E2 = Lo: E1 disabled



rising edge on E1: impulse of duration t on A
E3 = t; E2 = Hi; A = 0
retriggerable

7

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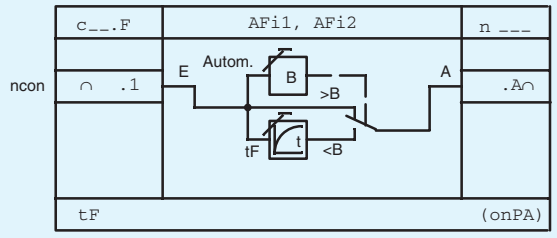
Description

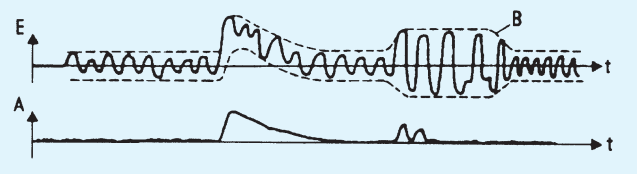
Complex functions (functions with dedicated parameters)

Adaptive filters AFi1 and AFi2



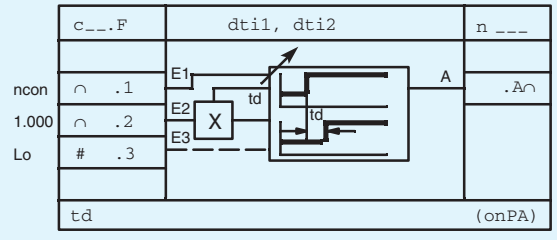
The adaptive filter AFi* dampens oscillations in the input variable, which occur repeatedly within a band *B*, using a variable time constant *tF*. Changes outside the band are applied unfiltered to the output. If the noise level changes, the band is automatically adapted to the new level. Noise – e.g. from a process variable – is thus suppressed without affecting the detection of rapid changes. This is important in controlled systems where rapid settling is required.

Filter time constant
tF = oFF, 1 to 9984 s



A Output signal B Filter band E Input signal
Fig. 7/6 Effect of the adaptive non-linear filter

Dead-time elements dti1 and dti2



Output = input offset by time *td*:

Dead time t_d 1 to 9984 s

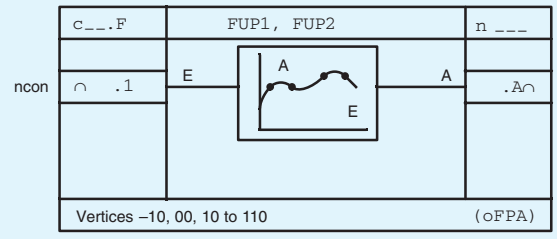
Stored values $100/t_d$, max. 1/cycle

After "Power on": A = 0 for $t \leq t_d$

This dead time is multiplied with a factor in E2 and is therefore changed from outside. The dead time element can be "stopped" at any time via input 3. The profile remains during "standstill".

E3 = Hi → "standstill".

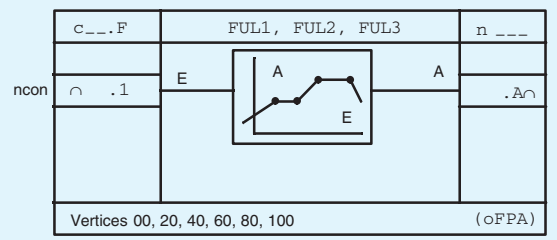
Function generators FUP1 and FUP2



Curve calculator with 13 vertices between –10 and +110 % of the input signal range:
parabolic approximation

Output –199.9 to +199.9 %; magnitude per vertex can be parameterized.

Function generators FUL1, FUL2 and FUL3

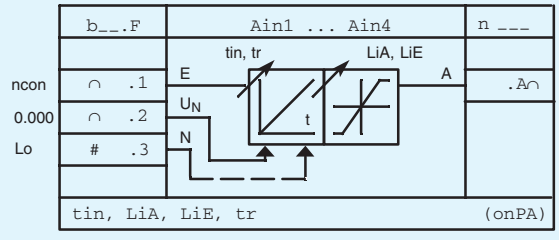


Curve calculator with 6 vertices between 0 and 100 % of the input signal range.

The output function is formed by the straight sections between the vertices.

The function generators can be used, for example, for parameter control in the controller function blocks h_.F.

Integrator with analog input Ain1 to Ain4



The analog variable on input .1 is integrated.
Tracking mode (*N* = Hi): the memory *A* of the integrator is made to track the value of the analog variable U_N with t_r. Input .1 has no effect as long *N* = Hi. The integrator acts as an analog value memory when E.1 = 0 and N = Lo.

$$A = 1/tin \int E.1 dt + U_{No}$$

N Tracking signal
U_N Tracking variable

tin	1 to 9984 s	Integrating time	
LiA	–199.9 to +199.9 %	Start-of-scale value	} memory limitation
LiE	–199.9 to +199.9 %	Full-scale value	
tr	off, 1 to 9984 s	Tracking time (ramp)	

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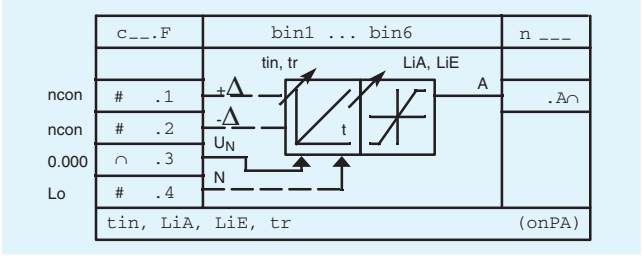
Description

Integrator with digital inputs bin1 to bin6



Digital input signals can be generated e. g. by pressing pushbuttons.

Possible applications:

- adjustment of analog values using front panel pushbuttons
- ramp functions.

The variables *N* and U_N enable the stored value to track external variable (U_N) with *tr*, e. g. for *x*-tracking, for adaptation of w_{int} to w_{ext}, or for adaptation of y_H to y_a for automatic, bumpless switchover when using the controller.

Integration is enabled by the digital signals on .1 or .2.

Tracking mode (*N* = Hi): memory *A* of the integrator is made to track the value of the analog variable U_N with *tr*. The inputs .1 and .2 have no effect as long as *N* = Hi.

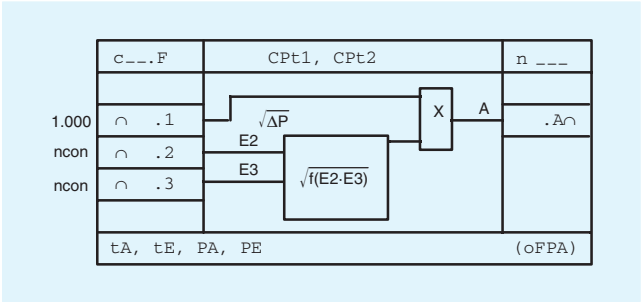
The integrator acts as an analog value memory when E.1 = 0 and E.2 = 0 and N = Lo.

$$A = 1/tin \int E.1dt + U_{No}$$

The integration time is progressive (100 % approx. 23 s) and constant when *tin* = 1 to 9984 s.

LiA	–199.9 to +199.9 %	Start-of-scale value	} memory limitation
LiE	–199.9 to +199.9 %	Full-scale value	
tr	off, 1 to 9984 s	Tracking time (ramp)	

Correction computers CPt1 and CPt2



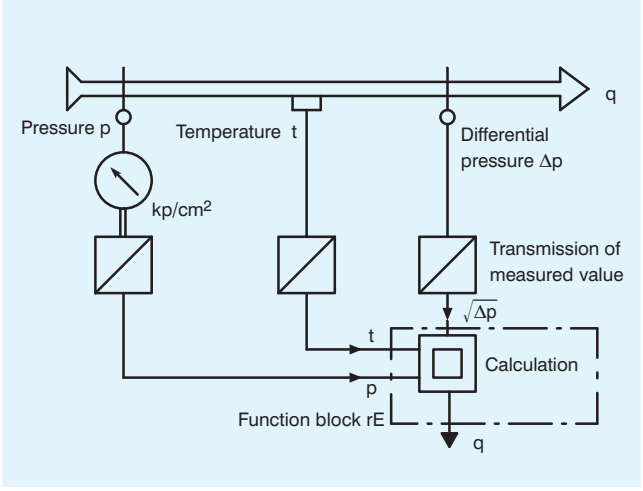
Correction computers are used to calculate the rate of flow of gases from the differential pressure *p*, correcting for fluctuations in pressure and temperature. Mass flow and volume flow based on the operational state can be corrected, as well as volume flow based on standard state. The medium must be in a pure state, i. e. separation must not occur. The output variable A is calculated as follows:

$$A = \sqrt{\Delta p} \times \sqrt{f(E_2, E_3)}$$

$$f(E_2, E_3) = \frac{(P_E\text{-}P_A)\,E_2 + P_A}{(t_E\text{-}t_A)\,E_3 + t_A}$$

The measuring range is standardised to the formula using the parameters t_A, t_E, P_A and P_E. t_A and P_A can take a value between 0.01 to 1.000, t_E and P_E between 1.000 to 99.99.

This flow correction computer corrects errors caused by changes in the state variables of the medium (pressure, temperature).



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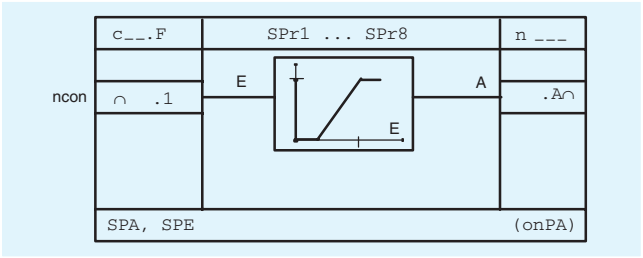
SIPART DR24 Multi-function Unit

6DR2410-.

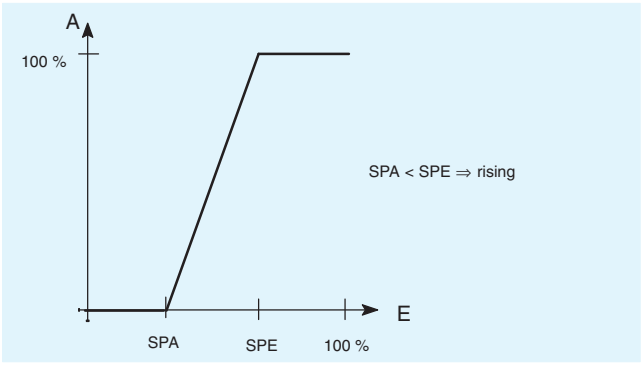
Description

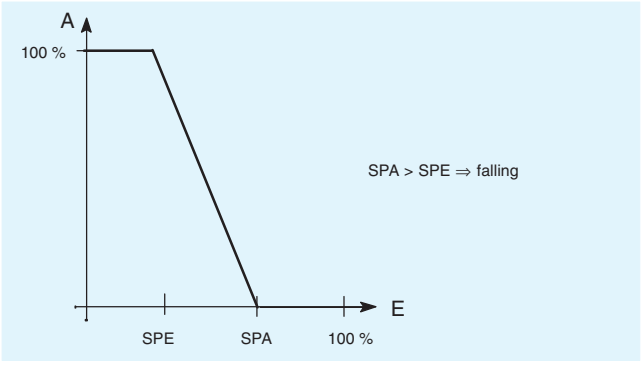
Split range SPr1 to SPr8



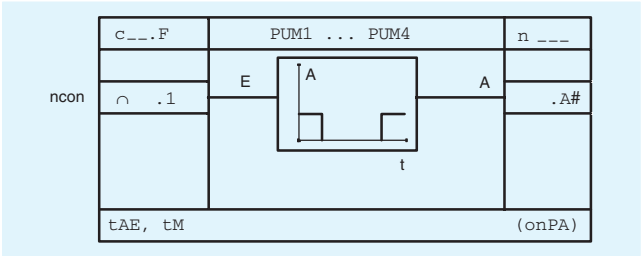
The split range function comprises a straight-line equitation between the base point SPA (output value 0) and the turning point SPE (output value 1).

Outside this range, the output is limited to 0 or 1. By setting the two private onPA parameters SPA and SPE it is possible to implement both rising and falling sections.





Pulse-width modulator



The pulse-modulator converts an analog signal into a pulse-width-modulated binary signal.

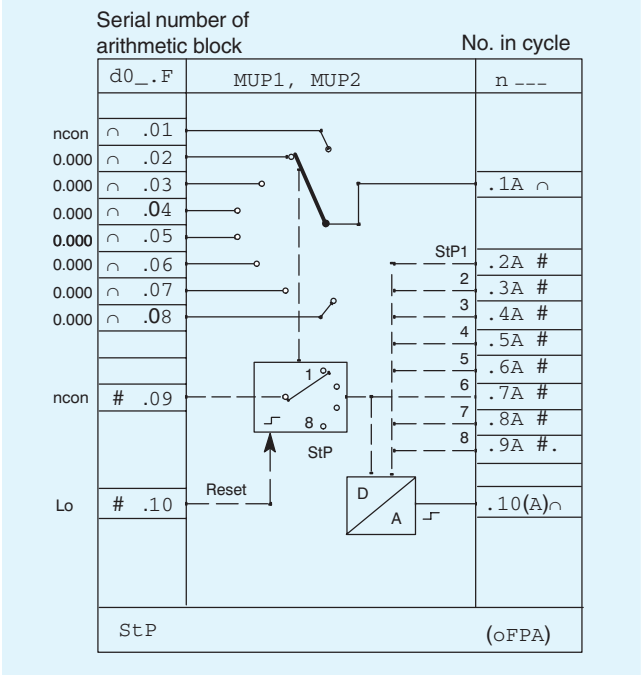
Private parameters (onPA)

tM	Period
tAE	Minimum on time

Example:

Input value:	0.3
Period:	4 s
⇒	On time 1.2 s
	Pause time 2.8 s

Measuring-point selector MUP1, MUP2 (multiplexer)



The multiplexer enables up to 8 analog inputs to be switched through to a single output. This switching operation is controlled by the signal on the cycle input d0*.09 (switch over in a closed ring). Each switching signal is indicated by a Hi signal on a separate output. These signals can, for example, be connected to the programmer's inputs to select a particular program. In addition, the current position can be displayed by connecting the d0*.10 output to the digital display dd3.

The StP parameter (number of switching steps) is used to select the maximum number of measuring points (2 to 8). The factory setting is 8.

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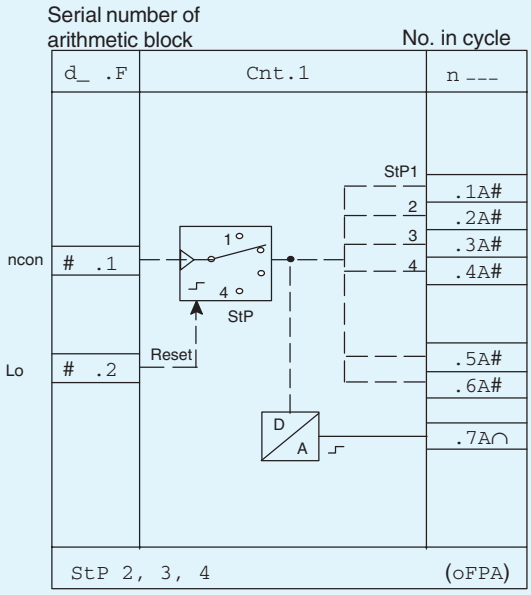
Description

Demultiplexer Cnt1



The demultiplexer is primarily used for switching over the display and control elements (multiple controller, max. 49).

It can be defined once. The demultiplexer is used to output the counter value in binary code according to the following table. Enabling is carried out controlled by the edge at the clock input d*.1 (switching over in closed ring, limited by private parameter StP).

The counter can be set to position 1 by a High signal via the Reset input d*.2. The postion can be displayed by connecting the output to display dd3.

StP	1A	2A	3A	4A	5A	6A
1	1	0	0	0	0	0
2	0	1	0	0	1	0
3	0	0	1	0	0	1
4	0	0	0	1	1	1

Controller blocks Ccn1 to Ccn4, CSi1 to CSi4 and CSE1 to CSE4

Four of the controller blocks listed below can be used in each instrument, independent of the type of controller.

Input signal conditioning takes place outside the controller block. The controllers have inputs for the control deviation.

Inputs

h0*.01 : Av — Enable adaptation input

h0*.02 : x — Resulting controlled variable for adaptation

h0*.03 : y_z — Disturbance variable feedforward to manipulated variable y_a

h0*.04 : xd_p
h0*.05 : xd_I
h0*.06 : xd_D
} control deviation inputs

The controlled variable or another process variable can be differentiated instead of the deviation x_d (dynamic disturbance variable feedforward)

h0*.07 : P — Control signal for changing structure
P = Lo: PI, PID
P = Hi: P, PD

P = Lo → PID (z):

$$y_a = y_z + x_{wP} \cdot K_P + y_{wI} + x_{wI} \cdot K_P (1 + 1/j\omega T_n) + x_{wD} \cdot K_P \cdot j\omega T_v / (1 + j\omega T_v / V_v)$$

P = Hi → PD (z):

$$y_a = y_z + x_{wP} \cdot K_P + y_0 + x_{wD} \cdot K_P \cdot j\omega T_v / (1 + j\omega T_v / V_v)$$

with Y_o = AUto: Working point automatically adjusted in manual mode so that $Y_o = Y_H$ in each case

with $Y_o \neq$ AUto: Working point fixed at Y_o

h0*.08 : H — Control signal for switching operating mode of controller
H = Lo: $y = y_a$ (automatic mode)
H = Hi: $y = y_H$ (manual mode)

h0*.09 : $+\Delta y$
h0*10 : $-\Delta y$
} Digital inputs for incremental adjustment of manipulated variables (tracking or manual mode)

h0*.11 : $+y_{BL}$
h0*12 : $-y_{BL}$
} Digital inputs for direction-dependent blocking of manipulated variables

h0*13 : SG1
h0*14 : SG2
h0*15 : SG3
} Controlled variable inputs for parameterized control of control parameters K_P, T_n and T_v.

h0*16 : N — Digital input for manual or tracking mode

h0*17 : Y_N — Analog input for manual manipulated variable

Parameters

cP — Proportional gain
tn — Reset time
tv — Derivative action time
vv — Derivative action gain
AH — Response threshold
Y_o — Working point
Y_A — Manipulated variable limitation, minimum
Y_E — Manipulated variable limitation, maximum
t_Y — Actuating time
t_A — Minimum pulse length
t_E — Minimum pulse interval

7

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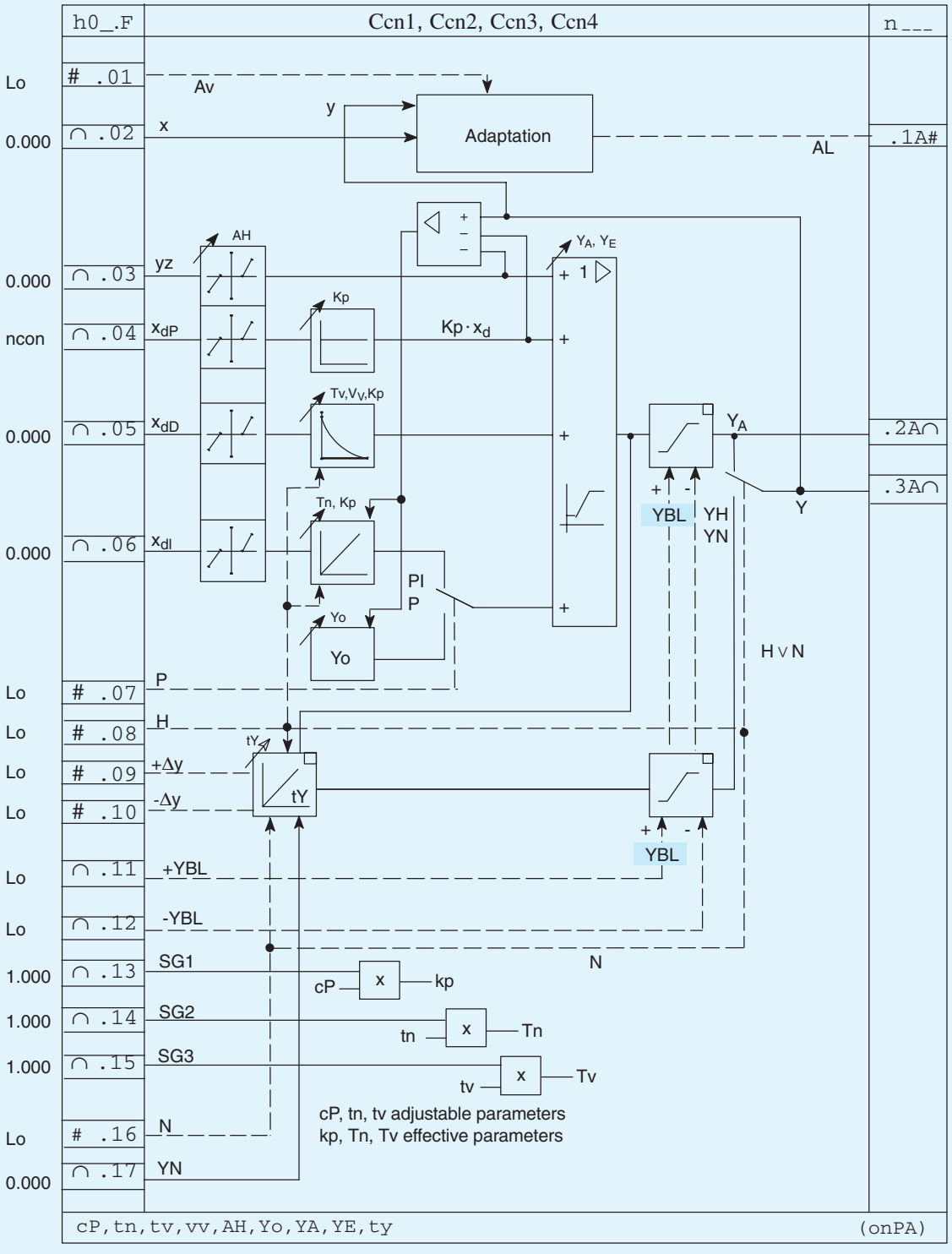
SIPART DR24 Multi-function Unit

6DR2410-.

Description

K controller (with continuous output) Ccn 1 to Ccn4



Outputs:

h0*.1A: Digital output signal “Adaptation in progress”
h0*.2A: Controller manipulated variable output signal (automatic mode)
h0*.3A: Manipulated variable output signal (manual, tracking or automatic mode)

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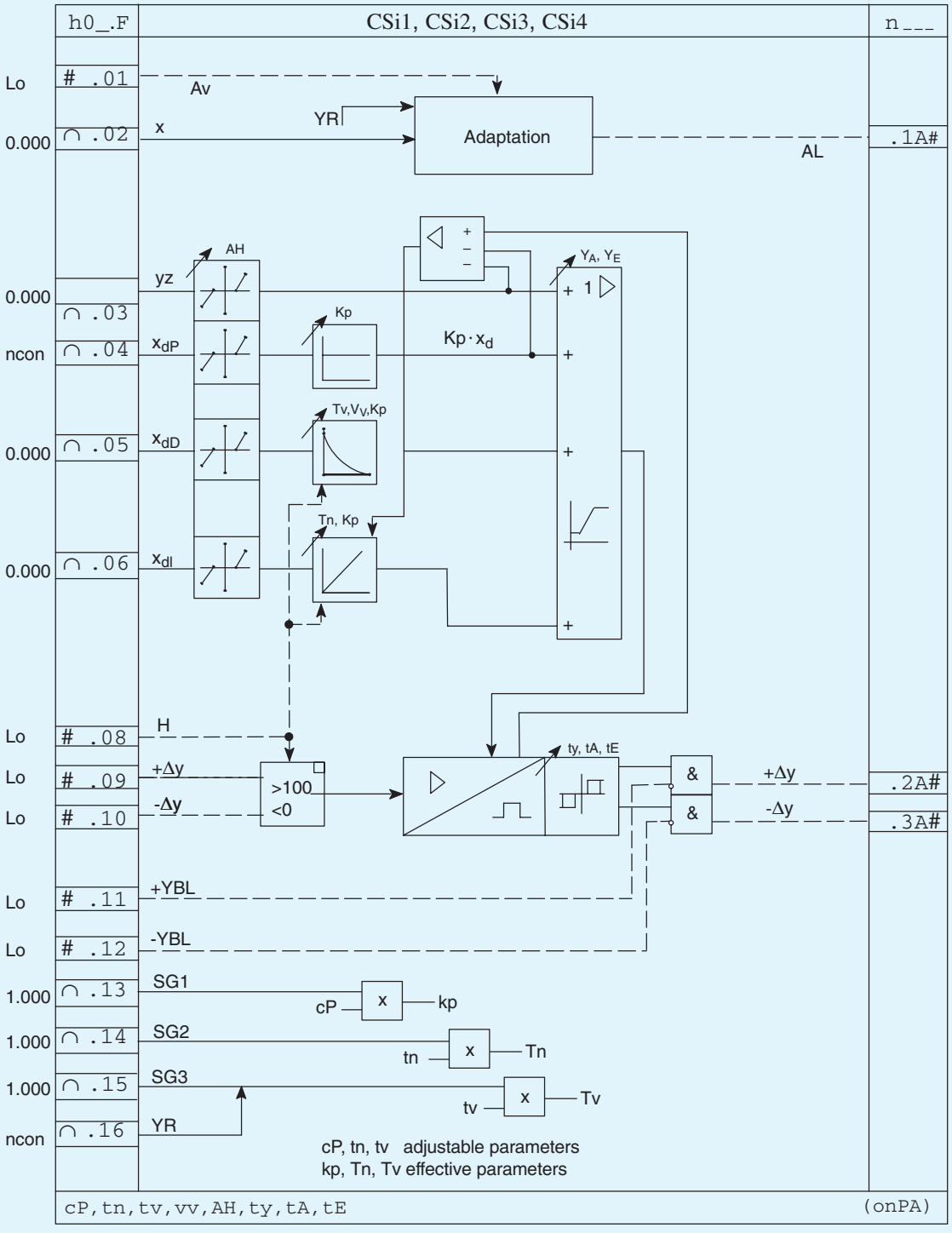
Description

S controller (with three-position step controller and internal positional feedback) CSi1 to CSi4.
A positional feedback is not required with this controller, as the time response of the actuating motor is simulated by an integrator in the controller.



Outputs:

h0*.2A:	$+\Delta y$	} positional increments for the actuator
h0*.3A:	$-\Delta y$	
h0*.16:	Y_R	position feedback (for display only)

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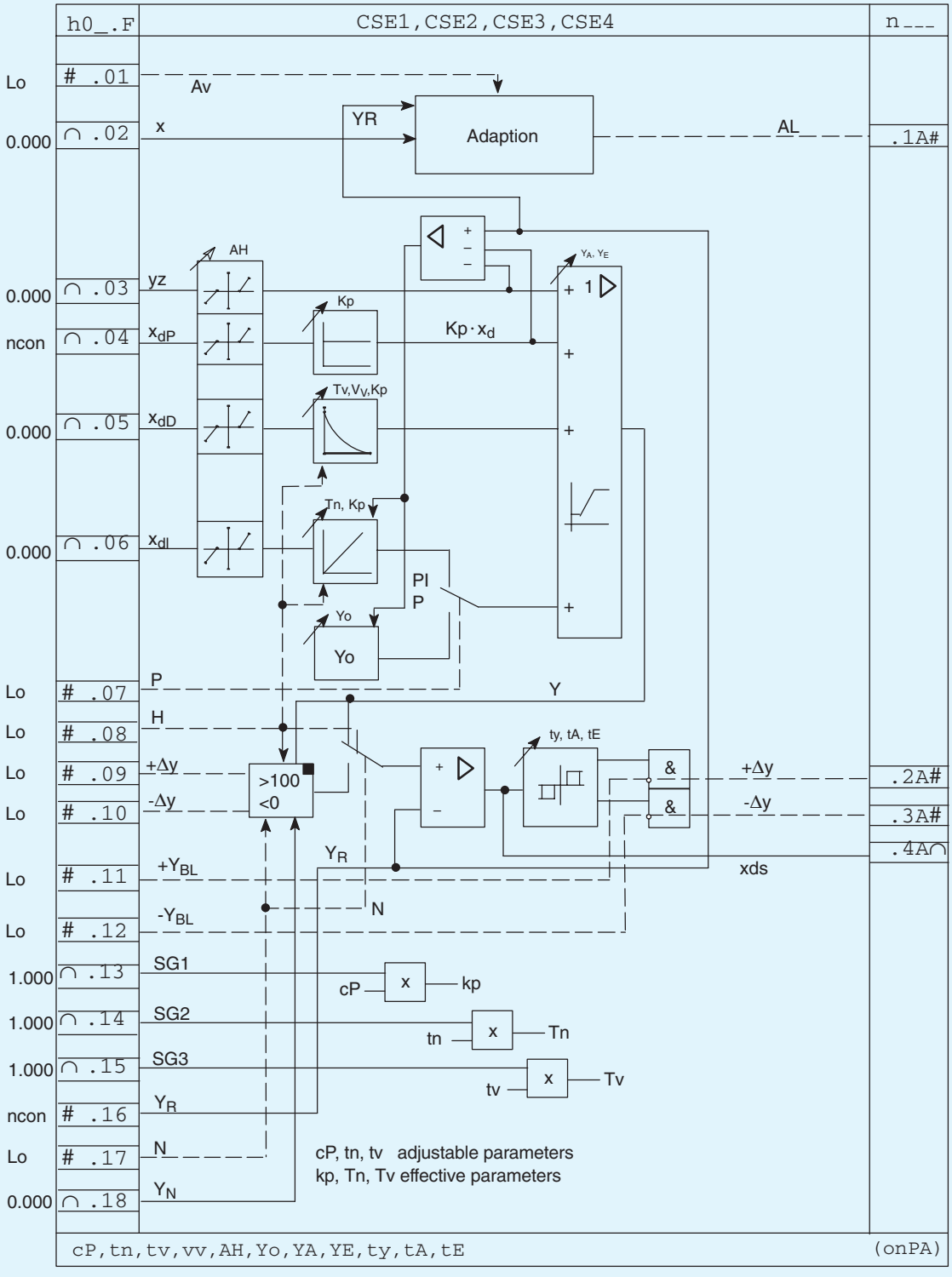
SIPART DR24 Multi-function Unit

6DR2410-.

Description

S controller (with three-position step controller and external positional feedback) CSE1 to CSE4



Outputs:

h0*.2A:	+Δy	} positional increments for the actuator
h0*.3A:	-Δy	
h0*.4A:	xds	control deviation of positional control loop
h0*.16:	Y_R	position feedback

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Description

Programmers

The programmer enables 2 analog outputs and 8 digital outputs to be assigned a common time basis with a maximum of 40 time intervals. These 40 intervals can be divided among up to 8 independent programs, each of which is assigned an appropriate number of time intervals.

The time intervals for the programs are entered in the selected format in either h/min or min/s. The values of analog outputs and/or the status of digital outputs are then allocated to each time interval. The specified programs can be executed once, more than once, and also cyclically. The clock can also be speeded up for testing purposes.

The clock is controlled via the Start, Stop, Reset and High-speed inputs. The program to be executed is selected using the d0*.05 to d0*.12 inputs, and started by setting Start = Hi. The timing sequence can be monitored via the "time from start", "time in interval", "interval" and "stop clock" outputs.

Parameters

CLFo : Clock format: h/min or min/s

CLCY: Number of cycles

CLSb : Acceleration factor

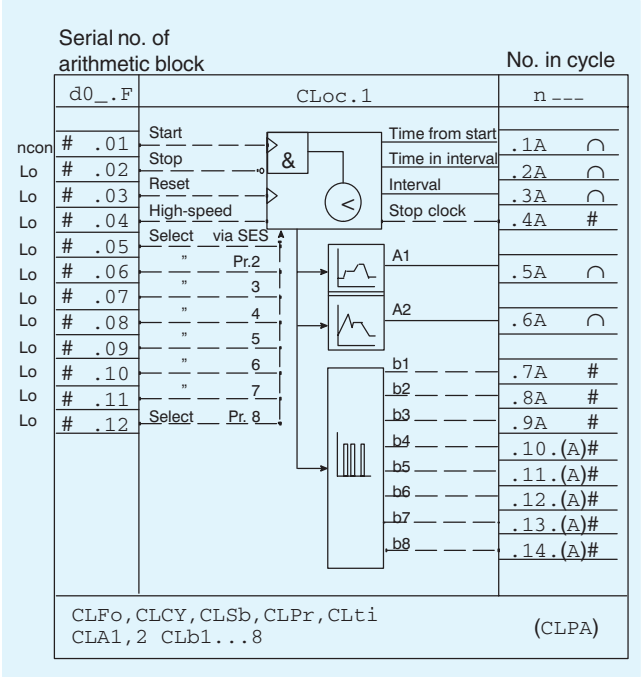
Acceleration factor	Time			
	1 week	1 day	1 hr	1 min
360	28 min	4 min	10 s	–
168	60 min	–	–	–
120	84 min	12 min	30 s	0.5 s
60	168 min	24 min	1 min	1 s
24	7 h	1 h	2.5 min	2.5 s
12	14 h	2 h	5 min	5 s
6	28 h	4 h	10 min	10 s
3	56 h	8 h	20 min	20 s

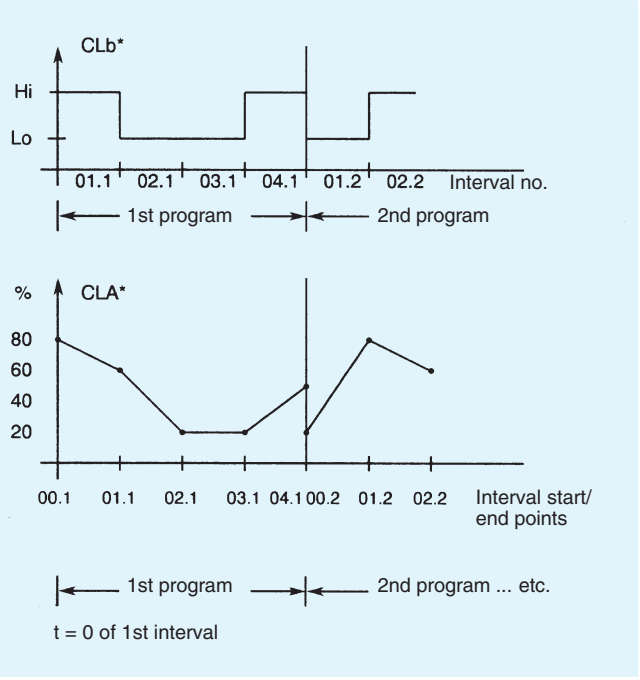
CLPr : Number of intervals/program

CLti : Length of interval

CLA1, 2 : Analog output value 1 or 2

CLb1 to CLb8 : Digital status Hi or Lo in respective interval





Interval	CLA..	CLb..	Meaning of interval indicator with CLA	with CLb
00.1	80 %	–	↑ Start 1st interv. (t=0)	–
01.1	60 %	Hi	End 1st interval	1st interval
02.1	20 %	Lo	1st progr. End 2nd interval	2nd interval
03.1	20 %	Lo	↓ End 3rd interval	3rd interval
04.1	50 %	Hi	End 4th interval	4th interval
00.2	20 %	–	↑ Start 1st interv. (t=0)	–
01.2	80 %	Hi	End 1st interval	1st interval
02.2	60 %	Lo	2nd progr. End 2nd interval	2nd interval

↑ Interval no. in display dd3 ↑ Program no.

7

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SIPART DR24 Multi-function Unit

6DR2410-.

Description

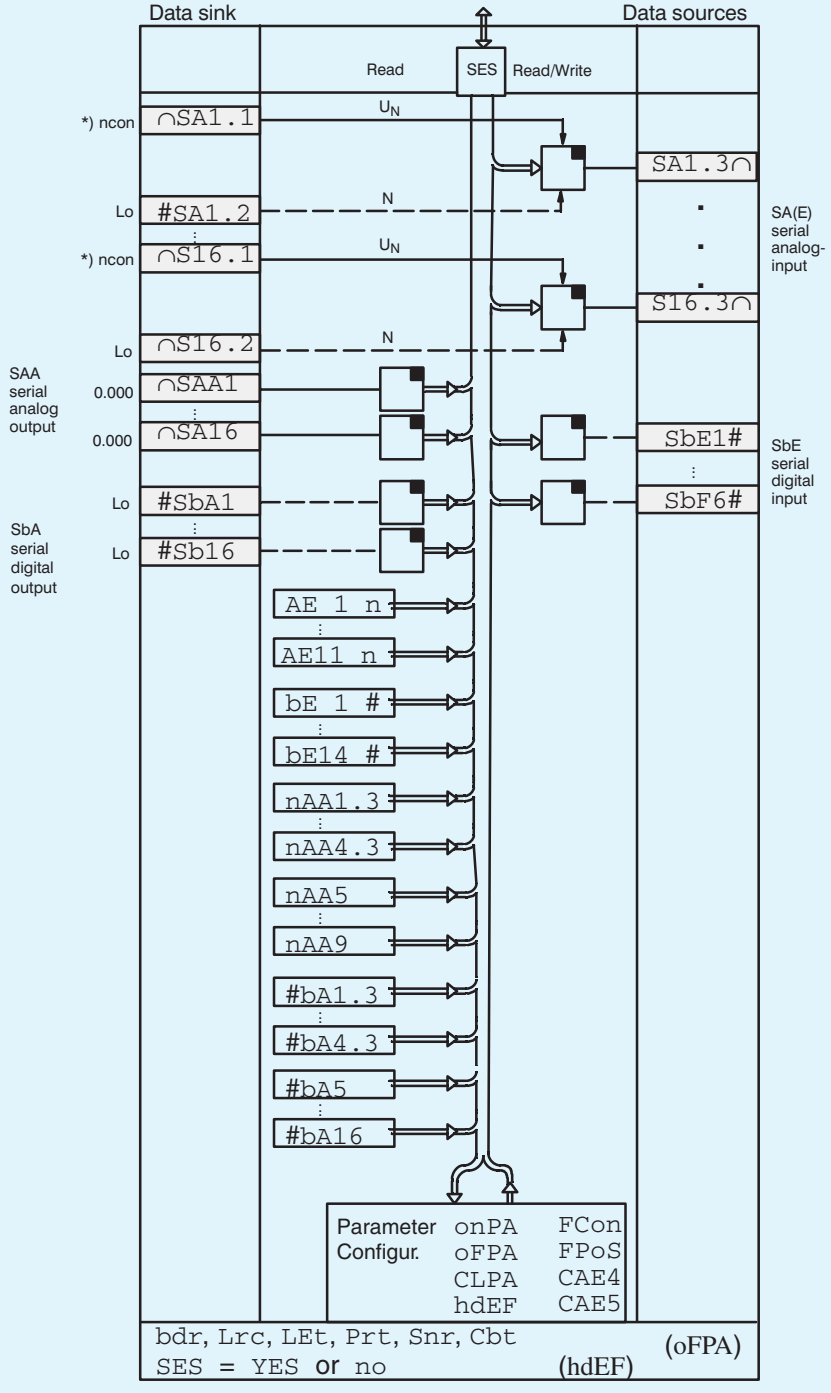
Serial interface

Input and output functions of the serial interface

Freely connectable inputs and outputs (SAE, SbE and SAA, SbA respectively) and dedicated read-only inputs and outputs (AI, DI and AO, DO respectively) of the multi-function unit can be read/written by the SES. Parameters and configuring data can also be read/written.

The data sinks SA(E).1 (tracking variable) and SA(E).2 (tracking control signal) are used to track the data source SA.3 if a bumpless changeover towards (SA(E).3 is to be made between this data source and another.

A cyclical watch-dog function can be used to monitor traffic on the interface. A monitoring period can be specified using the parameter Cbt; when the elapsed time between two telegrams exceeds this period, the digital input SbE1 is set to Lo. If required, this could be used to trigger changeovers within the multi-function unit.



*) Default setting: 0.000

Data sink and data sources are not displayed in FCon if SES = no in hdEF

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Technical data

Technical data

General data	
Mounting position	Any
Climatic classes	
– Storage: 1K2 according to DIN IEC 721 Part 3-1	–25 to +75 °C
– Transport: 2K2 according to DIN IEC 721 Part 3-2	–25 to +75 °C
– Operation: 3K3 according to DIN IEC 721 Part 3-3	0 to +50 °C
Degree of protection to EN 60 529	
Front module	IP 64
Housing	IP 30
Connections	IP 20

Controller design

Electrical safety
- to DIN EN 61 010 Part 1
- Protection class I
- Safety separation between supply connection and field signals
- Clearances and creepage paths for surge class III and pollution level 2 , unless stated otherwise

EC Certificate of Conformity no. 691.001

CE marking conformity concerning
- EMC Guideline 89/336/EWG and
- NS Guideline 73/23/EWG

Emitted interference, immunity to interference to EN 61 326, NAMUR NE21 8/98

Weight, standard device without options	Approx. 1.2 kg
Colour	
Front module frame	RAL 7037
Front surface	RAL 7035
Material	
Housing and front frame	Polycarbonate, reinforced with fiber glass
Front foil	Polyester
Power supply connection	
AC 115/230 V	3-pin earthed plug IEC 320/V
AC/DC 24 V	Special 2-pin plug
Process signal connections	Multiple screw terminal blocks, cannot be confused when connecting, for conductor cross-section 1.5 mm^2 (AWG 14)
Protective earth connection	Earth screw

A rail can be mounted on the rear panel of the power supply. The rail is included in the delivery of the coupling relay mode.

Power supply				
Rated voltage	Switchable AC 230 V	Switchable AC 115 V	AC/DC 24 V	
Operating voltage range	AC 187 to 276 V	AC 93 to 138 V	AC 20 to 28 V	DC 20 to 35 V [4]
Frequency range	48 to 63 Hz			–
Peak voltages not periodic to VDE 160				
1.3 ms	≤ 780 V	≤ 390 V	≤ 70 V	
10 µs	≤ 1500 V	≤ 1500 V	≤ 500 V	
External current I_{ext} [5]	450 mA			
Power consumption				
Active power/ apparent power [6]				
Stand. contr.				
– without options, without I_{Ext}	8 W/17 VA	8 W/13 VA	8 W/11 VA	8 W
– with options, without I_{Ext}	13 W/25 VA	13 W/20 VA	13 W/18 VA	13 W
– with options, with I_{Ext}	26 W/45 VA	26 W/36 VA	28 W/35 VA	28 W

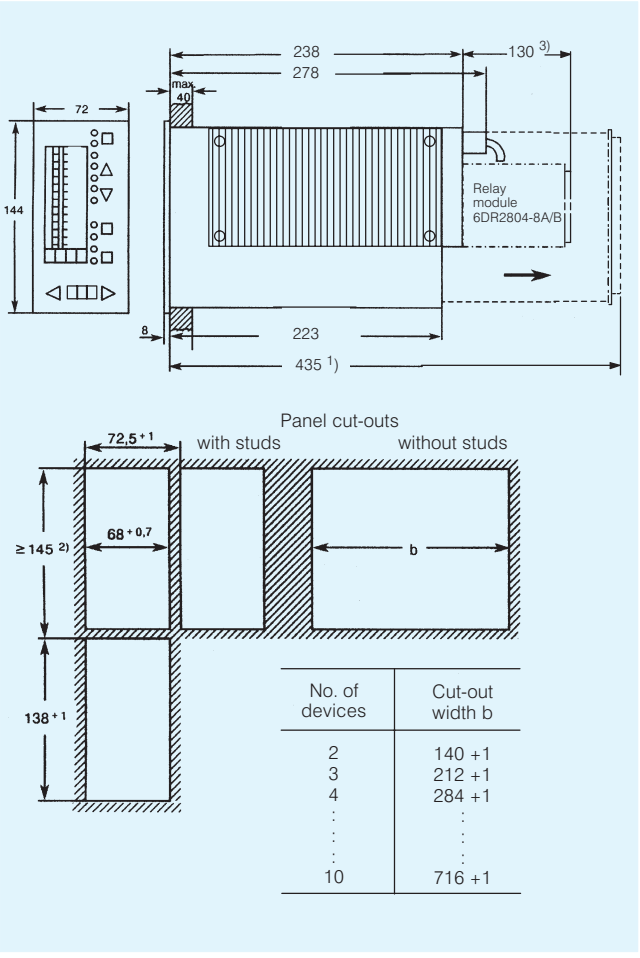

Fig. 7/7 SIPART DR24 multi-function unit and panel cut-outs, dimensions

[1]) Space required for removal of main circuit board.

[2]) Observe permitted ambient temperature when stacking without intermediate spacing.

[3]) A relay module containing 2 or 4 relay contacts (6DR2804-8A/-8B) can be snapped onto the rear of the multi-function unit, in which case the mounting depth increases by 130 mm.

[4]) Includes harmonic content.

[5]) Derived from *L*+, BA and AA.

[6]) Capacitive.

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SIPART DR24 Multi-function Unit

6DR2410-.

Technical data

Technical data (continued)

Power supply (continued)

Permitted voltage dips[1]				
Stand. contr.				
– without options, without I_{Ext}	≤ 90 ms	≤ 70 ms	≤ 55 ms	≤ 30 ms
– with options, without I_{Ext}	≤ 80 ms	≤ 60 ms	≤ 50 ms	≤ 25 ms
– with options, with I_{Ext}	≤ 50 ms	≤ 35 ms	≤ 35 ms	≤ 20 ms
Test voltages (1 min)				
– primary – secondary	AC 1.5 kV		AC 500 V	
– primary – prot. cond.	AC 1.5 kV		AC 500 V	
– secondary – prot. cond.	DC 700 V		DC 700 V	

Inputs and outputs, display technology

• Analog inputs AE1, AE2, AE3 and AE6 to AE11 (input module 6DR2800-8A)

Input signal range	
Voltage	0/199.6 to 998 mV or 0/2 to 10 V
Current	0/4 to 20 mA
Input impedance	
Differential (voltage)	200 kΩ
Differential (current)	49.9 Ω ± 0.1 %
Common-mode	> 500 kΩ
Common-mode voltage	0 to 10 V
Filter time constant	50 ms
Effect of temperature	
Zero	0.05 %/10 K
Gain	0.1 %/10 K

• Analog outputs AA1 to AA3

Rated signal range	0/4 to 20 mA
Operating range	0 to 20.5 mA or 3.6 to 20.5 mA
Load voltage	–1 to +18 V
Max. inductive load	≤ 0.1 H
No-load voltage	≤ 26 V
Time constant	300 ms
Residual ripple 900 Hz	≤ 0.2 %
Resolution	≤ 0.1 %
Zero error	≤ 0.3 % of measuring span
Gain error	≤ 0.3 % of measuring span
Linearity error	≤ 0.05 % of measuring span
Load dependence	≤ 0.1 %
Effect of temperature	
Zero	≤ 0.1 %/10 K
Gain	≤ 0.1 %/10 K

• Transmitter supply $L+$

Rated voltage	20 to 26 V
On-load current	≤ 100 mA, short-circuit proof
Short-circuit current	≤ 200 mA pulsed

• Digital inputs BE1 to BE4

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

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

Signal status 0	≤ 1.5 V
Signal status 1	19 to 26 V
On-load current	≤ 50 mA
Short-circuit current	≤ 80 mA pulsed

• Cycle time	> 60 ms, user program dependent

• A/D conversion

Method	Successive approximation with > 120 measurements per input and averaging over 20 or 16.67 ms
Resolution	11 bit ≡ 0.06 %
Zero error	≤ 0.2 % of the measuring span
Gain error	≤ 0.2 % of the measuring span
Linearity error	≤ 0.2 % of the measuring span
Effect of temperature	
Zero	≤ 0.05 %/10 K
Gain	≤ 0.1 %/10 K

• Parameters

Adjusting	
Rate	tA 2/3 (more-less)
Precision	
Time parameters	≤ ± 0.05 ‰ troughout the complete temperature range
All others	Absolute, depending on resolution

• Display technology

Digital dd1, dd2 displays	4½ digit, 7-segment LEDs
Colour dd1	Green
dd2	Red
Digit height	7 mm
Display range	Adjustable start-full scale
Numeric range	–1999 to 19999
Decimal point	Variable
Refresh rate	1 to 100 cycles/display
Resolution	1 digit, but not better than A/D converter
Display error	Corresponding to A/D converter and analog inputs
Digital dd3 display	3-digit, 7-segment LEDs
Colour	Yellow
Digit height	7 mm
Display range	Adjustable start-full scale
Numeric range	–199 to 999
Decimal point	Variable
Refresh rate	1 to 100 cycle/display, variable
Resolution	1 digit, but not better than A/D converter
Display error	Corresponding to A/D converter and analog inputs
Analog dA1, dA2 displays	
Colour dA1	Red
dA2	Green
Display range	LED array with 30 LEDs
Signal range	–199.9 to 199.9 %, variable
Overflow	< –0.85 % of display range; 1st LED flashes > 100.85 % of display range; 30th LED flashes
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

[1] Load voltage of analog outputs thereby reduced to 13 V, $L+$ reduced to + 15 V and voltage on digital outputs drops to + 14 V.

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Ordering data

Ordering data

	Order No.
SIPART DR24 multi-function unit 72 x 144,	
basic unit with - 3 analog inputs - 3 analog outputs - 4 digital inputs - 8 digital outputs - user program memory	
• for AC/DC 24 V power supply	**6DR2410-4**
• for switchable AC 230/115 V supply	**6DR2410-5**
Input/output modules	See Catalog Section 8
Analog signal module - for current input 0/4 to 20 mA or voltage inputs 0/0.2 to 1 V or 0/2 to 10 V (6DR2800-8J) - for resistance based sensor (R module) (6DR2800-8R) - for TC/RTD/R/mV signals, programmable (UNI module) (6DR2800-8V) - Reference junction terminal for TC, internal (to be used in conjunction with UNI module (6DR2805-8A) - Measuring range connector for *I* = 20 mA and *U* = 10 V (to be used in conjunction with UNI module) (6DR2805-8J) - with 3 analog outputs 0/4 to 20 mA and 3 binary inputs (6DR2802-8B) - with 3 analog inputs 0/4 to 20 mA or 0/0.2 to 1 V or 0/2 to 10 V (6DR2800-8A) - *y*-hold module (6DR2802-8A)	
Switching signal module - with 5 digital inputs (6DR2801-8C) - with 4 digital outputs and two digital inputs (6DR2801-8E) - with 2 relay outputs (6DR2801-8D)	
Coupling relay module - With 4 relays (AC 250 V) (6DR2804-8A) - With 2 relays (AC 250 V) (6DR2804-8B)	
Interface modules - For serial communications via RS 232 or RS 485 (6DR2803-8C) - PROFIBUS-DP module (6DR2803-8P)	

Documentation	
SIPART DR24 multi-function unit manual	
- German - English	**C79000-G7400-C153** **C79000-G7476-C153**
Mounting and instatallation instructions, German/English	**C79000-M7474-C38**

The following Instructions can be downloaded from Internet (see Section 10, Page 10/4):

SIPART DR
PROFIBUS interface / Instructions
(Description of the communication via PROFIBUS DP with the controller SIPART DR19/20/21/22/24)
- German
- English

SIPART DR24
Serial SIPART 6DR24 Bus interface / Instructions
(Description of the communication via RS 232, RS 485 or PROFIBUS DP with the controller SIPART DR24)
- German
- English

Scope of supply

The scope of supply of a DR24 multi-function unit includes:

1 multi-function unit as ordered
1 power supply connector 115/230 V or a special connector for 24 V AC/DC supply
2 clamping elements, pluggable
1 mounting and installation instructions (German/English)

Available ex-stores

Items marked are available ex-stores.

Input/output modules and accessories

The input/output modules are described in Catalog Section 8.
Section 9 of the catalog contains details about software for parameterizing the multi-function unit 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.

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SIPART DR24 Input/Output Modules

6DR2410–.

Overview: applications

Analog signal modules	SIPART DR24					Description see Section 8, Page
	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	
U/I module 6DR2800-8J	AI4	AI5	–	–	–	8/3
3 x U/I module 6DR2800-8A	–	–	–	AI9/10/11	AI6/7/8	8/4
R module 6DR2800-8R	AI4	AI5	–	–	–	8/5
Pt 100 module 6DR2800-8P	(AI4)*	(AI5)*	–	–	–	8/6
TC module 6DR2800-8T	(AI4)*	(AI5)*	–	–	–	8/7
UNI module 6DR2800-8V (TC/RTD/R/U/I)	AI4	AI5	–	–	–	8/8
y-hold module 6DR2802-8A	–	–		AO7	AO4	8/10
3AO/3DI module 6DR2802-8B	–	–	–	AO7/8/9 DI5/6/7	AO4/5/6 DI10/11/12	8/11

NEW

*) Use the UNI module 6DR2800-8V.

Switching signal modules	SIPART DR24					Description see Section 8, Page
	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	
5 DI 6DR2801-8C	–	–	–	DI5/6/7/8/9	DI 10/11/12/13/14	8/12
2 relays 6DR2801-8D	–	–	–	DO9/10	DO13/14	8/13
4DO/2DI 6DR2801-8E	–	–	–	DO9/10/11/12 DI5/6	DO13/14/15/16 DI10/11	8/14

Interface module	SIPART DR24					Description see Section 8, Page
	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	
SES module 6DR2803-8C						8/15
RS 232/SIPART bus	–	–	Yes	–	–	
RS 485	–	–	Yes	–	–	
PROFIBUS-DP module 6DR2803-8P	–	–	Yes	–	–	8/16

NEW

Coupling relay module can be installed on rear:	SIPART DR24	Description see Section 8, Page
with 4 relays 6DR2804-8A	Yes	8/17
with 2 relays 6DR2804-8B	Yes	8/17

Depending on the application, the following can be used in conjunction with the UNI module 6DR2800-8V:		Description see Section 8, Page
Reference junction terminal	6DR2805-8A	8/8
Measuring range connector	6DR2805-8J	8/8

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SIPART DR Input/Output Modules

8

8/2	**Overview: Input/output module applications**	
8/3	**Analog signal modules**	
8/3	U/I module	6DR2800-8J
8/4	3 x U/I module	6DR2800-8A
8/5	R module	6DR2800-8R
8/6	Pt100 module	6DR2800-8P
8/7	TC module	6DR2800-8T
8/8	UNI module	6DR2800-8V
	Reference junction terminal	
	Measuring range connector	
8/10	y-hold module	6DR2802-8A
8/11	**Analog and switching signal module**	
8/11	3AO/3DI module	6DR2802-8B
8/12	**Switching signal modules**	
8/12	5DI module	6DR2801-8C
8/13	2DO relay module	6DR2801-8D
8/14	4DO/2DI module	6DR2801-8E
8/15	**Interface modules**	
8/15	SES module	6DR2803-8C
8/16	PROFIBUS DP module	6DR2803-8P
8/17	**Coupling relay module**	
8/17	Coupling relay	6DR2804-8A/-8B
8/18	**Ordering data**	

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SIPART DR Input/Output Modules

Overview: Input/output module applications

Analog signal modules		SIPART DR19 Slot	SIPART DR20 [1] Slot	SIPART DR21 Slot	SIPART DR22 Slot	SIPART DR24 Slot	Description see page
U/I module	6DR2800-8J	1/2	1/2	1/2	2/3	2/3	8/3
3 U/I modules	6DR2800-8A	–	–	–	5/6	5/6	8/4
R module	6DR2800-8R	1/2	1/2	1/2	2/3	2/3	8/5
Pt 100 module	6DR2800-8P	1/2	1/2	1/2	2/3	2/3	8/6
TC module	6DR2800-8T	1/2	1/2	1/2	2/3	2/3	8/7
UNI module (TC/RTD/R/U/I)	6DR2800-8V	1	–	1	2/3	2/3	8/8
y-hold module	6DR2802-8A	–	–	–	5/6	5/6	8/10
3AO/3DI module	6DR2802-8B	–	–	–	5/6	5/6	8/11

Switching signal modules		SIPART DR19 Slot	SIPART DR20 Slot	SIPART DR21 Slot	SIPART DR22 Slot	SIPART DR24 Slot	Description see page
5 DI	6DR2801-8C	3	–	3	5/6	5/6	8/12
2 relays	6DR2801-8D	3	GW	3	5/6	5/6	8/13
4DO/2DI	6DR2801-8E	3	GW	3	5/6	5/6	8/14

Interface module		SIPART DR19 Slot	SIPART DR20 Slot	SIPART DR21 Slot	SIPART DR22 Slot	SIPART DR24 Slot	Description see page
SES module	6DR2803-8C						8/15
RS 232/SIPART bus		4	4	4	4	4	
RS 485		4	–	4	–	–	
PROFIBUS DP module	6DR2803-8P	4	4	4	4	4	8/16

Coupling relay module can be installed on rear of following controllers		SIPART DR19	SIPART DR20	SIPART DR21	SIPART DR22	SIPART DR24	Description see page
with 4 relays	6DR2804-8A	Yes	–	Yes	Yes	Yes	8/17
with 2 relays	6DR2804-8B	Yes	–	Yes	Yes	Yes	8/17

Depending on the application, the following can be used in conjunction with the UNI module 6DR2800-8V and SIPART DR19/AE1		Description see page
Reference junction terminal	6DR2805-8A	8/8
Measuring range connector	6DR2805-8J	8/8

[1]) The SIPART DR20 controller has been discontinued.

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Analog signal modules

- U/I module 6DR2800-8J for current and voltage input

This input/output module enables a current or voltage signal to be connected. The module is used to extend the number of analog inputs and provides electronic isolation through a differential amplifier with high common mode rejection.

The changeover between current and voltage input is handled by coding jumpers on the module itself. In addition, the wiring of the connector is different.

The signal range 0 to 20 mA, 4 to 20 mA, 0 to 1 V, 0.2 to 1 V, 0 to 10 V or 2 to 10 V as well as the assignment to the function inputs is determined when the controller is configured.

The input impedance is 49.9 Ω if the module is being used as a current input. Owing to the high common mode rejection, several inputs or another consumer can be connected in series.

The input impedance is 200 kΩ if the module is being used as a voltage input.

The screw-type terminal is part of the scope of supply.

Technical data 6DR2800-8J

U/I module	Current	Voltage
Start of measuring range	0 or 4 mA	0 or 0.2 V or 2 V
End of measuring range	20 mA	1 V or 10 V
Output range	–0.8 to 23 mA	–4 % to 115 %
Input impedance		
– difference	49.9 Ω ± 0.1 %	200 kΩ
– common mode	500 kΩ	≥ 200 kΩ
Permitted common mode voltage (rated range)	0 to +10 V	0 to +10 V
Filter time constant ± 20 %	50 ms	
Error without A/D conversion		
– zero	≤ 0.3 %	≤ 0.2 %
– gain	≤ 0.5 %	≤ 0.2 %
– linearity	≤ 0.05 %	≤ 0.05 %
– common mode	≤ 0.07 %/V	≤ 0.02 %/V
Variation with temperature without A/D conversion		
– zero	≤ 0.05 %/10 K	≤ 0.02 %/10 K
– gain	≤ 0.1 %/10 K	≤ 0.1 %/10 K

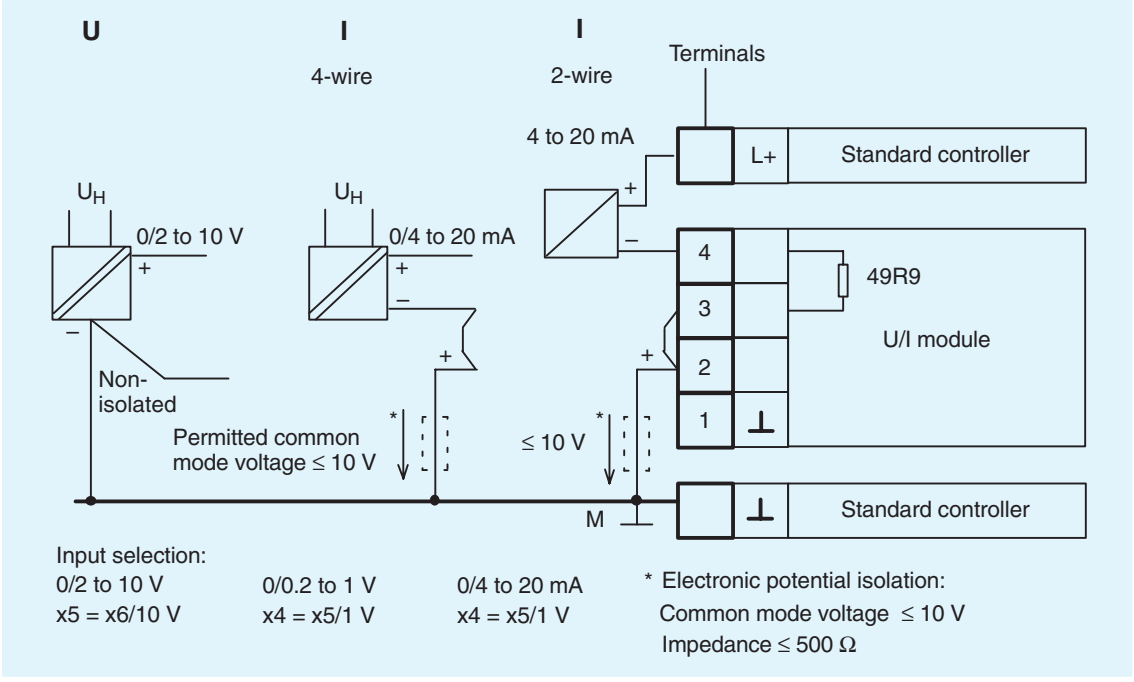

Fig. 8/1 Wiring of U/I module 6DR2800-8J

8

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Analog signal modules

- Three 6DR2800-8A U/I modules for current and voltage input

This input/output module has 3 channels (inputs) for connecting current or voltage signals. The module is used to extend the number of analog inputs in the SIPART DR22 controller or in the SIPART DR24 multi-function unit and provides electronic isolation through a differential amplifier with high common mode rejection.

The changeover between current and voltage input is handled by coding jumpers on the module itself. In addition, the wiring of the connector is different.

The signal range 0 to 20 mA, 4 to 20 mA, 0 to 1 V, 0.2 to 1 V, 0 to 10 V or 2 to 10 V as well as the assignment to the function inputs is determined when the controller is configured.

The input impedance is 49.9 Ω if the module is being used as a current input. Owing to the high common mode rejection, several inputs or another consumer can be connected in series.

The input impedance is 200 kΩ if the module is being used as a voltage input.

The screw-type terminal is part of the scope of supply.

Technical data 6DR2800-8A

Three U/I modules	Current	Voltage
Start of measuring range	0 or 4 mA	0 or 0.2 V or 2 V
End of measuring range	20 mA	1 V or 10 V
Output range	–0.8 to 23 mA	–4 % to 115 %
Input impedance		
– difference	49.9 Ω ± 0.1 %	200 kΩ
– common mode	500 kΩ	≥ 200 kΩ
Permitted common mode voltage (rated range)	0 to +10 V	0 to +10 V
Filter time constant ± 20 %	50 ms	
Error without A/D conversion		
– zero	≤ 0.3 %	≤ 0.2 %
– gain	≤ 0.5 %	≤ 0.2 %
– linearity	≤ 0.05 %	≤ 0.05 %
– common mode	≤ 0.07 %/V	≤ 0.02 %/V
Variation with temperature without A/D conversion		
– zero gain	≤ 0.05 %/10 K	≤ 0.02 %/10 K
– gain	≤ 0.1 %/10 K	≤ 0.1 %/10 K

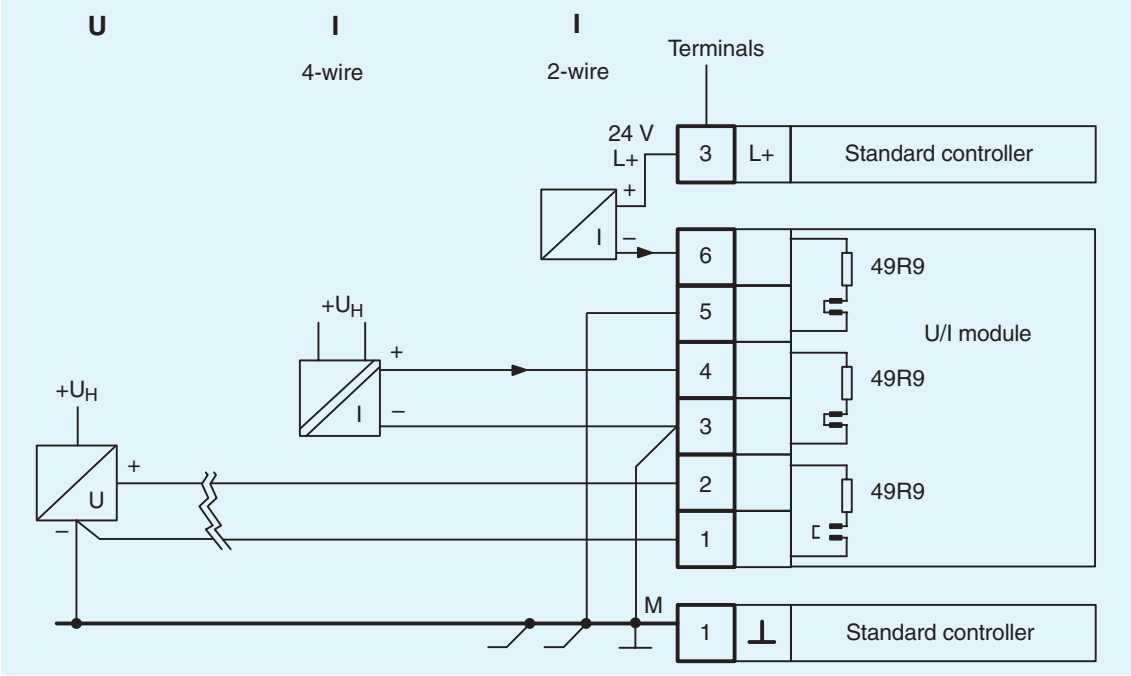

Fig. 8/2 Three U/I modules 6DR2800-8A

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Analog signal modules

- R module 6DR2800-8R for resistance input (potentiometer)

This input/output module allows a potentiometer with a rated resistance of between 80 and 1200 Ω to be connected. The signal range (80 to 220 Ω, 200 to 500 Ω or 470 to 1200 Ω) is selected using jumpers on the module.

Trimming of the start of scale and full scale values is performed once the module is inserted using a potentiometer on the rear of the module.

The assignment to the function inputs is determined when the controller is configured.

This module can also be configured as a current input. It is best used when the start of scale and full scale values of the current signal do not exactly match the standard signal ranges and need to be trimmed. The input impedance is 49.9 Ω in this case.

The input is not isolated.

The screw-type terminal is part of the scope of supply.

Technical data 6DR2800-8R	
R module	
Start of measuring range	0 Ω
– span, min.	$\Delta R \geq 0.3 \cdot R$
– max. zero suppression	$R_A \leq 0.2 \cdot R$
– end	$R_A + 1.1 \cdot R$
	R in 3 spans
	200 – 500 – 1000 Ω adjustable
Output range	–5 % to 105 %
Supply current	5 mA ± 5 %
Line resistors R_i	
– two-wire circuit	–
– three-wire circuit	< 10 Ω each
– four-wire circuit	–
Filter time constants ± 20 %	50 ms
Error without A/D conversion	
– zero	≤ 0.2 %
– gain	≤ 0.2 %
– linearity	≤ 0.2 %
Variation with temperature without A/D conversion	
– zero	≤ 0.1 %/10 K
– gain	≤ 0.3 %/10 K

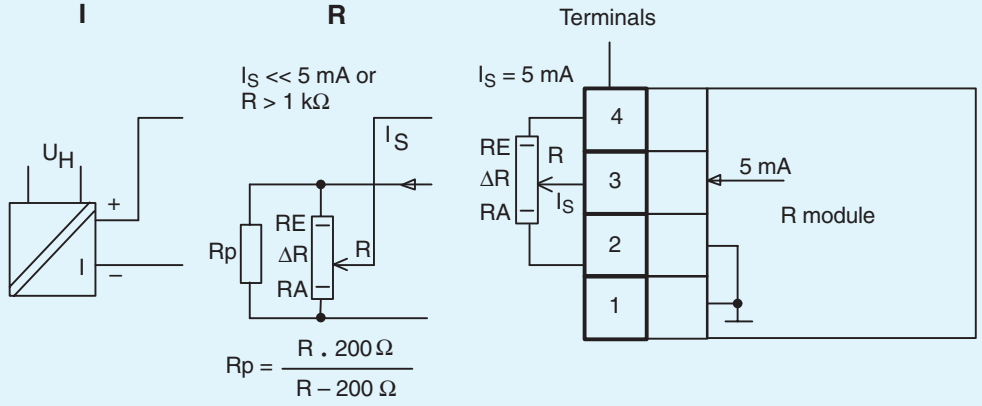

Fig. 8/3 Wiring of R module 6DR2800-8R

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Analog signal modules

- Pt100 module 6DR2800-8P for Pt100 resistance thermometers

Via this input/output module, a Pt100 resistance thermometer (RTD) can be connected.

Note:

The type of connection, two-wire, three-wire or four-wire, and the start of scale and full scale values are selected using jumpers on the module. The jumper settings can be found in the SIPART DR20 manual.

Trimming of the start of scale and full scale values is performed once the module is inserted using a potentiometer on the rear of the module.

The output signal is temperature linear.

The screw-type terminal is part of the scope of supply.

Technical data 6DR2800-8P	
Pt100 module	
Start of measuring range	$R_{tA} \geq 80.25\ \Omega$ ($t_A \geq -50$ °C)
– span, min.	$\Delta R = 19\ \Omega$ ($\Delta t = 50$ °C)
– max. zero suppression	$R_{tA} \leq 5 \cdot \Delta R$
– end	$R_{tE} \leq 390.26\ \Omega$ ($t_E \leq 850$ °C)
Supply current	100 mV/ΔR
Line resistors R_j	
– two-wire circuit	$R_{L1} + R_{L2} \leq 10\ \Omega$
– three-wire circuit	$R_{L1} = R_{L2} = R_{L3} \leq 50\ \Omega$
– four-wire circuit	$R_L \leq 80\ \Omega$
Filter time constants ± 20 %	50 ms
Error without A/D conversion	
– zero	≤ 0.1 %
– gain	≤ 0.1 %
– linearity	≤ 0.3 %
Variation with temperature without A/D conversion	
– zero	≤ 0.2 %/10 K
– gain	≤ 0.3 %/10 K

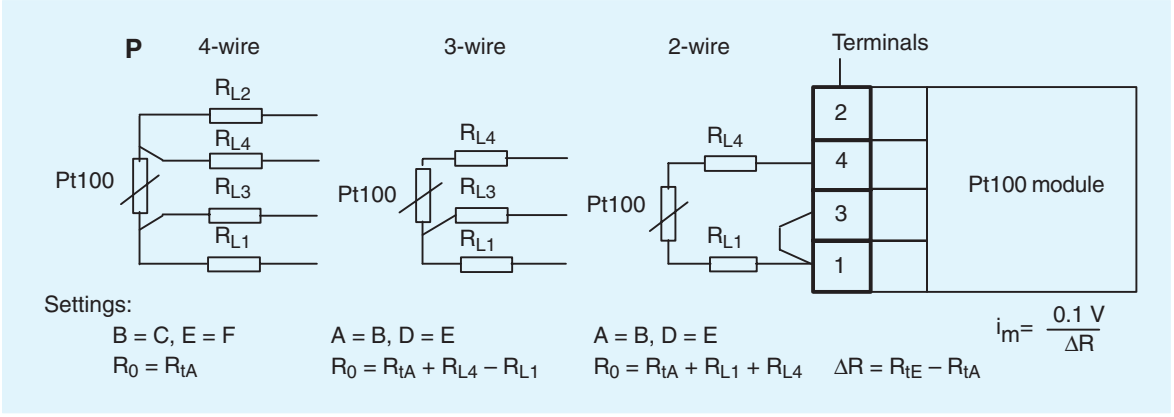

Fig. 8/4 Wiring of Pt 100 module 6DR2800-8P

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Analog signal modules

- TC module 6DR2800-8T for thermocouples or other mV signals

A thermocouple or other voltage source can be connected directly using the TC module.

Reference junction compensation can take place either internally or externally. Internal compensation is implemented through a temperature sensor (included with the TC module) mounted on the terminal block.

The type of thermocouple, reference junction compensation method, start of scale and span, plus the response in the event of a sensor break (output goes high or low) are all determined using jumpers on the module.

The input/output module works on voltage linear principles and can be used for all thermoelectric e.m.f. or mV signals. Linearization must be performed using the linearizer in the standard controller if thermocouples are connected.

Note:

The jumper settings can be found in the SIPART DR20 manual.

Trimming of the start of scale and full values is performed once the module is inserted using a potentiometer on the rear of the module.

The following thermocouple pairs can be connected:

according 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)

according to DIN 43 710

- Cu-CuNi (Type U)
- Fe-CuNi (Type L)

This input/output module is electronically isolated.

The screw-type terminal is part of the scope of supply.

Technical data 6DR2800-8T	
TC module	
Start of measuring range – span, min. – max. zero suppression – end Output range	$-5 \cdot \Delta U$ ... 0 ... $+5 \cdot \Delta U$ ΔU = 10 mV $\lvert U \rvert \leq 5 \cdot \Delta U$ $U \leq$ 60 mV –5 to 105 %
Input impedance – difference – common mode Permitted common mode voltage (rated range) Line resistances	 2 MΩ 1 MΩ –10 to +10 V $R_{L1} + R_{L2} \leq 300\ \Omega$
Filter time constant ± 20 %	20 ms
Error without A/D conversion – zero – gain – linearity – common mode – reference junction compensation	 ≤ 0.1 % ≤ 0.1 % ≤ 0.1 % ≤ 0.1 %/V ≤ 2 °C
Variation with temperature without A/D conversion – zero – gain – reference junction compensation	 ≤ 0.3 %/10 K ≤ 0.3 %/10 K ≤ 0.5 %/10 K

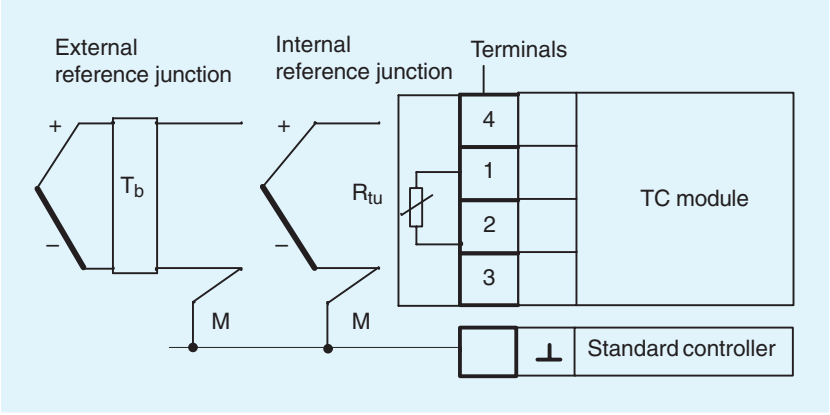

Fig. 8/5 Wiring of TC module 6DR2800-8T

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Analog signal modules

- UNI module 6DR2800-8V for connecting
  - Pt100 resistance thermometers (RTD)
  - Thermocouples (TC)
  - mV sources
  - Potentiometers (R)
  - U/I input (10 V/20 mA)
- Reference junction terminal 6DR2805-8A
- Measuring range connector 6DR2805-8J

This input/output module has galvanic isolation.

The following sensors can be connected.

- Pt100 resistance thermometers in 2-, 3- or 4-wire circuits
- Thermocouples with internal (reference junction terminal 6DR2805-8A required) or external reference junction
- mV signals
- Resistance based sensor (potentiometer) in 2-wire circuit
- 10 V and 20 mA signals via an additional measuring range connector (6DR2805-8J)

The module is designed for use with the SIPART DR19/21/22 and SIPART DR24 controllers. The module is configured and set up in the configuring level StrS (configuring switches) and CAE (calibrate analog input) of these controllers. No settings need be made on the module itself.

The screw-type terminal is part of the scope of supply.

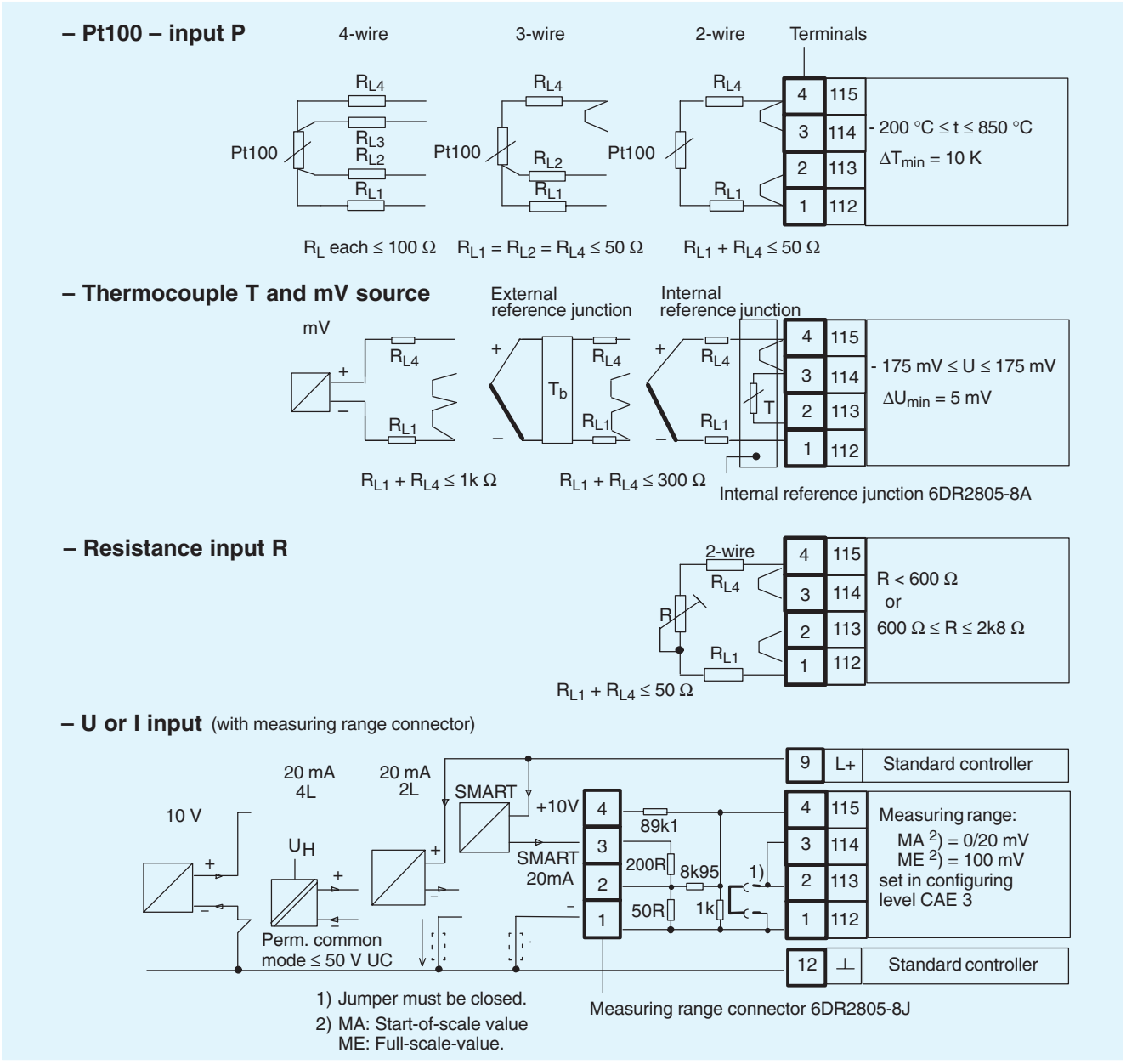

Fig. 8/6 Wiring of UNI module 6DR2800-8V

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Analog signal modules

Technical data 6DR2800-8V

Pt 100 resistance thermometer	
Line resistance	
– 2-wire circuit	Line resistance configurable $R_{Ab} = R_{L1} + R_{L4}$, or automatic calibration when configuring $R_{L1} + R_{L4} \leq 50\ \Omega$
– 3-wire circuit	No compensation necessary when $R_{L1} = R_{L2} = R_{L4}$ $R_{L1}, R_{L2}, R_{L4} \leq 50\ \Omega$
– 4-wire circuit	R_{L1} to $R_{L4} \leq 100\ \Omega$
Measuring current	400 µA
Measuring range, configurable	
start	MA ≥ –200 °C
end	ME ≤ +850 °C
Recommended min. span	10 K
Characteristic	Temperature linear
Filter time constant	< 2 s adaptive
Potential isolation	
permitted common mode voltage	≤ 50 V AC/DC
Test voltage	500 V AC

Thermocouples		
Thermocouples, configurable according to DIN IEC 584 Part 1		Type
	Cu-CuNi	T
	Fe-CuNi	J
	NiCr-Ni	K
	NiCr-CuNi	E
	Pt10Rh-Pt	S
	Pt13Rh-Pt	R
	Pt30Rh-Pt6Rh	B
	NiCrSi-NiSi	N
according to DIN 43 710	Cu-CuNi	U
	Fe-CuNi	L
Reference junction compensation		
internal	Reference junction terminal required	
external	Temperature of the external reference junction configurable	
Line resistance	≤ 300 Ω	
Measuring range, configurable		
start	≥ –175 mV	
end	≤ +175 mV	
Recommended min. span	5 mV	
Characteristic, configurable	Voltage or temperature linear	
Filter time constant	< 2 s adaptive	
Input current	≤ 1 µA	
Potential isolation		
permitted common mode voltage	≤ 50 V AC/DC	
test voltage	500 V AC	
Stat. destruction limit across inputs	± 35 V	

mV source	
Measuring range, configurable	
start	≥ –175 mV
end	≤ +175 mV
Recommended min. span	5 mV
Line resistance	≤ 1 kΩ
Characteristic	Voltage linear
Input current	≤ 1 µA
Potential isolation	
permitted common mode voltage	≤ 50 V AC/DC
test voltage	500 V AC
Stat. destruction limit across inputs	± 35 V

Resistance based sensor R		
	Measuring range	
Measuring range, configurable Measuring range limits incl. line resistance	$R_{tot} \leq 600\ \Omega$	$600\ \Omega \leq R_{tot} \leq 2.8\ k\Omega$
Recommended min. span.	30 Ω	70 Ω
Input current	290 µA	60 µA
Linearity error	± 60 mΩ	± 0.2 Ω

mA source with additional measuring range connector 6DR2805-8J	
Measuring range, can be compensated	
start	0/4 mA ≙ 0/20 mV
end	20 mA ≙ 100 mV
Transformation error	0.3 %
Input resistance	50 Ω
Smart input resistance	250 Ω
Potential isolation	
permitted common mode voltage	≤ 50 V AC/DC
Stat. destruction limit across inputs	± 40 mA

10 V-voltage source with additional measuring range connector 6DR2805-8J	
Measuring range, can be compensated	
start	0/2 V ≙ 0/20 mV
end	10 V ≙ 100 mV
Transformation error	0.2 %
Input resistance	90 kΩ
Potential isolation	
permitted common mode voltage	≤ 50 V AC/DC
Stat. destruction limit across inputs	± 100 V

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Analog signal modules

- *y*-hold module 6DR2802-8A
  analog output module with alarm output

The y-hold module is designed for use with the SIPART DR22 and SIPART DR24 controllers. It has a 0/4 to 20 mA analog output and a digital output for the CPU alarm signal ($\overline{St}$ = High).

When used with the SIPART DR22 controller, the analog output is permanently assigned the manipulated variable *y*.

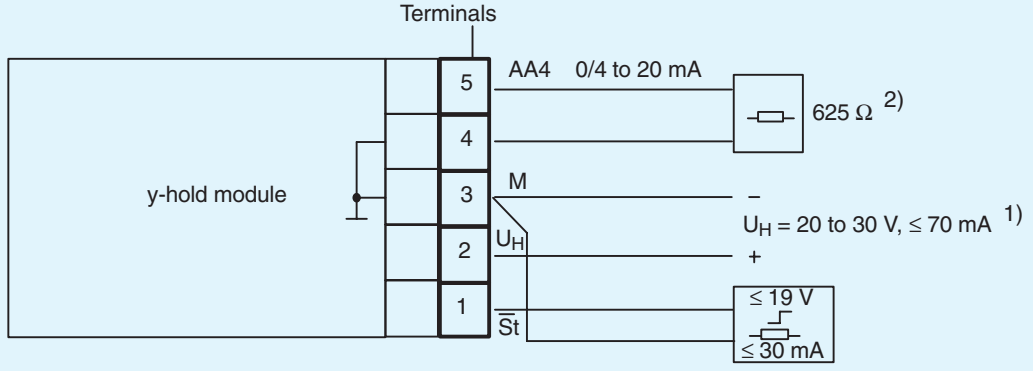
The module contains a microprocessor that transfers data in serial mode to and from the processor in the controller. If the transfer of data is interrupted, the analog output retains the last manipulated variable and the CPU alarm output is triggered ($\overline{St}$ = Low).

The module can be powered via an external supply, which is ORed with the internal supply on the module. This enables the manipulated variable *y* to be retained if:

- the controller's power supply fails
- the *y*-hold module is removed and the controller replaced.

The screw-type terminal is supplied with the module.

Technical data 6DR2802-8A	
***y*-hold module**	
Analog output	
Rated signal range	0 to 20 mA or 4 to 20 mA
Load voltage	
– Supplied from controller	–1 to +18 V
– External supply (U_H > 22.5 V)	–1 to +15 V
Max. permitted inductivity	≤ 0.1 H
Digital output $\overline{St}$	
Signal status 0	≤ 1.5 V
Signal status 1	+19 to 26 V
On-load current	≤ 30 mA
Short-circuit current	≤ 50 mA pulsed
Power supply U_H	
– Voltage range	20 to 30 V
– Power consumption of U_H when on external supply	≤ 70 mA
when supplied from controller	Approx. 6 mA



1) U_H need only be connected if the output current has to be retained should the power supply to the multi-function unit fail or the module is removed when servicing.

2) Up to 900 Ω possible, depending on the power supply.

Fig. 8/7 *y*-hold module 6DR2802-8A

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Analog and switching signal module

- 3AO/3DI module 6DR2802-8B
  for the extension of the analog outputs and the digital inputs

The 3AO/3DI module is suitable for use in the SIPART DR22 and DR24 controllers.

Assignment of functions and the logic is performed using the controllers adjustments.

The screw-type terminal is supplied with the module.

Technical data 6DR2802-8B	
3AO/3DI module	
Analog outputs	
Rated signal range (0 to 100 %)	0 to 20 mA or 4 to 20 mA
Output range	0 to 20.5 mA or 3.8 to 20.5 mA
Load voltage	from -1 V to 18 V
No-load voltage	≤ 26 V
Inductive load	≤ 0.1 H
Time constant	10 ms
Residual ripple 900 Hz	≤ 0.2 %
Resolution	10 bits
Load dependence	≤ 0.1 %
Zero error	≤ 0.3 %
Final value error	≤ 0.3 %
Linearity	≤ 0.05 %
Digital inputs	
Signal status "0"	≤ 4.5 V or open
Signal status "1"	≥ 13 V
Input resistance	≥ 27 kΩ
Static destruction limit across inputs	± 35 V

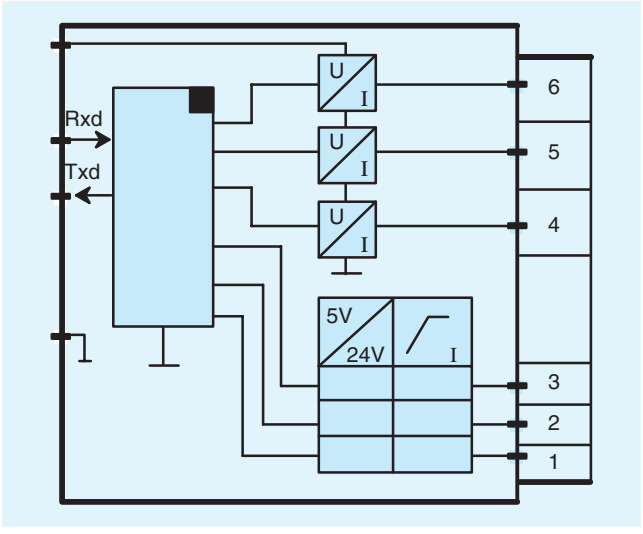

Fig. 8/8 Wiring of 3AO/3DI module

Assignment of the terminals to the analog outputs (AO) and the digital inputs (DI); depending on slot

	SIPART DR22 and DR24	
Terminal	Analog outputs	
	Slot 5	Slot 6
6	AA9	AA6
5	AA8	AA5
4	AA7	AA4
Terminal	Digital inputs	
	Slot 5	Slot 6
3	BE7	BE12
2	BE6	BE11
1	BE5	BE10

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Switching signal modules

- 5DI module 6DR2801-8C for additional digital inputs

Module with 5 digital inputs.

Assignment of functions and the logic is performed using the configuring switches.

The screw-type terminal is supplied with the module.

Technical data 6DR2801-8C	
5DI module	
Signal status “0”	≤ 4.5 V or open
Signal status “1”	≥ 13 V
Input resistance	≥ 27 kΩ
Static destruction limit across inputs	± 35 V

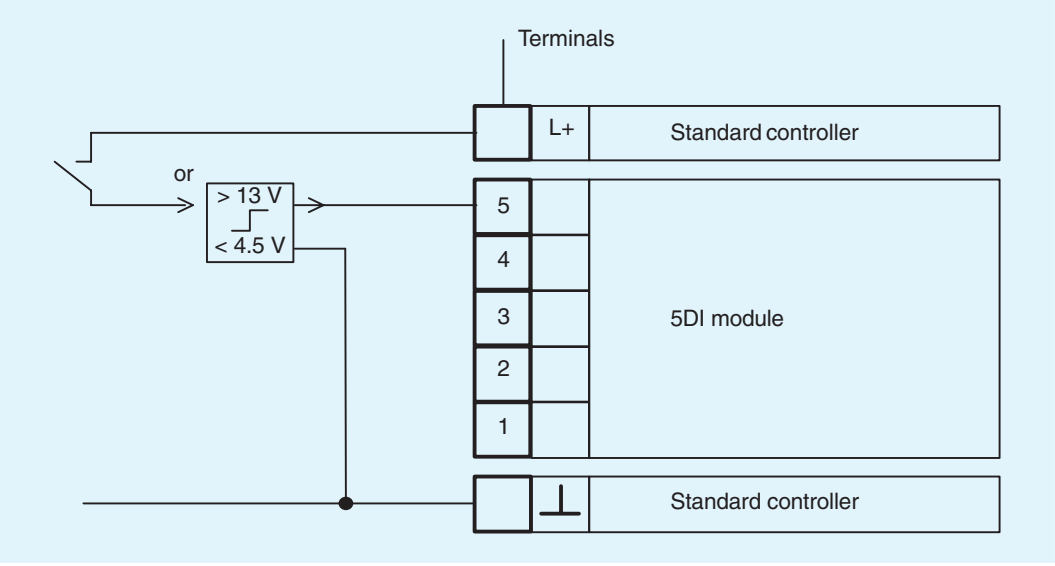

Fig. 8/9 Wiring of 5DI module 6DR2801-8C

8

Assignment of the terminals to the digital input (DI); depending on device version and slot

Terminal	Digital input with:		
	SIPART DR19 and DR21	SIPART DR22 and DR24	
		Slot 5	Slot 6
5	BE7	BE9	BE14
4	BE6	BE8	BE13
3	BE5	BE7	BE12
2	BE4	BE6	BE11
1	BE3	BE5	BE10

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Switching signal modules

- 2DO relay module 6DR2801-8D
  for additional digital outputs

Relay output module for 2 digital outputs.
Floating changeover contact, can take up to 35 V.

Assignment of functions and the logic is performed using the configuring switches.

The RC networks of the spark suppressors all lie parallel to the NC and NO contact. The current flowing via the spark suppressor capacitor (1 µF) when the contact is open (e. g. contactor withstand current) can cause interference in the case of AC consumers with a very low rating. Should this happen, the capacitors should be replaced by ones with a lower rating or be removed altogether.

The 68 V suppressor diodes connected in parallel to the contacts also have an effect and limit the induced voltage.

The screw-type terminal is supplied with the module.

Technical data 6DR2801-8D		
2DO relay module		
Contact material	Ag/Ni	
Contact rating	AC	DC
Max. switching voltage	≤ 35 V	≤ 35 V
Max. switching current	≤ 5 A	≤ 5 A
Max. switching capacity	≤ 150 VA	≤ 100 W at 24 V ≤ 80 W at 30 V
Service life		
Mechanical	$2 \cdot 10^7$ switching operations	
Electrical 24 V, 4 A, Ω loading	$2 \cdot 10^6$ switching operations	
Electrical 24 V, 1 A, inductive	$2 \cdot 10^5$ switching operations	
Spark suppressor	1 µF and 22 Ω connected in series, with 68 V suppressor diodes wired in parallel	

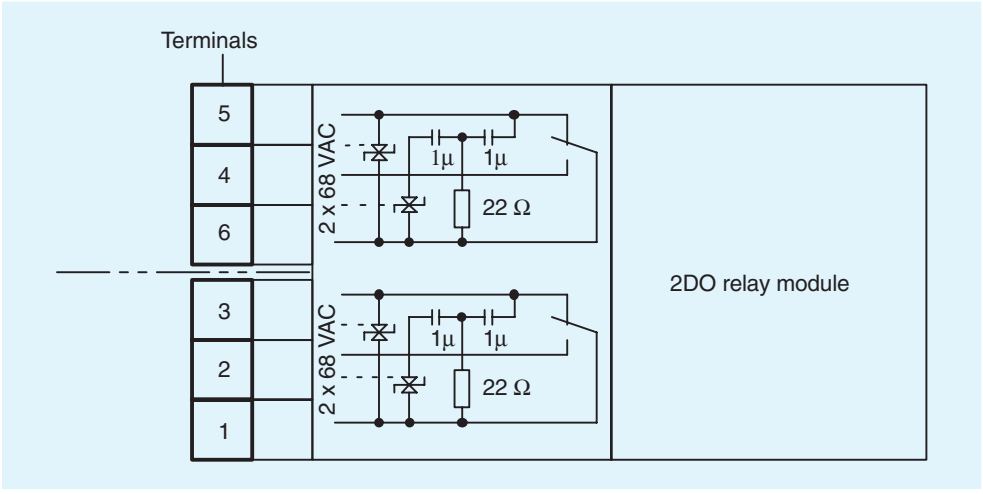

Fig. 8/10 Wiring of 2DO relay module 6DR2801-8D

Assignment of the terminals to the digital output (DO); depending on device version and slot

Terminals	Relay output with:			
	SIPART DR19 and DR21	SIPART DR20	SIPART DR22 and DR24	
			Slot 5	Slot 6
4, 5, 6	BA4	A1	BA10	BA14
1, 2, 3	BA3	A2	BA9	BA13

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Switching signal modules

- 4DO/2DI module 6DR2801-8E for additional digital inputs and outputs

Module with 2 digital inputs and 4 active digital outputs.

Assignment of functions and the logic is performed using the configuring switches.

The screw-type terminal is supplied with the module.

With the SIPART DR22 and DR24 devices, the digital input on terminal 6 cannot be used.

Technical data 6DR2801-8E	
4DO/2DI module	
Digital inputs	
Signal status "0"	≤ 4.5 V or open
Signal status "1"	≥ 13 V
Input resistance	≥ 27 kΩ
Static destruction limit across inputs	± 35 V
Digital outputs	
Signal status "0"	≤ 1.5 V
Signal status "1"	19 to 26 V
On-load current	≤ 30 mA
Short-circuit current	≤ 50 mA, pulsed
Static destruction limit across inputs	–1 V or +35 V

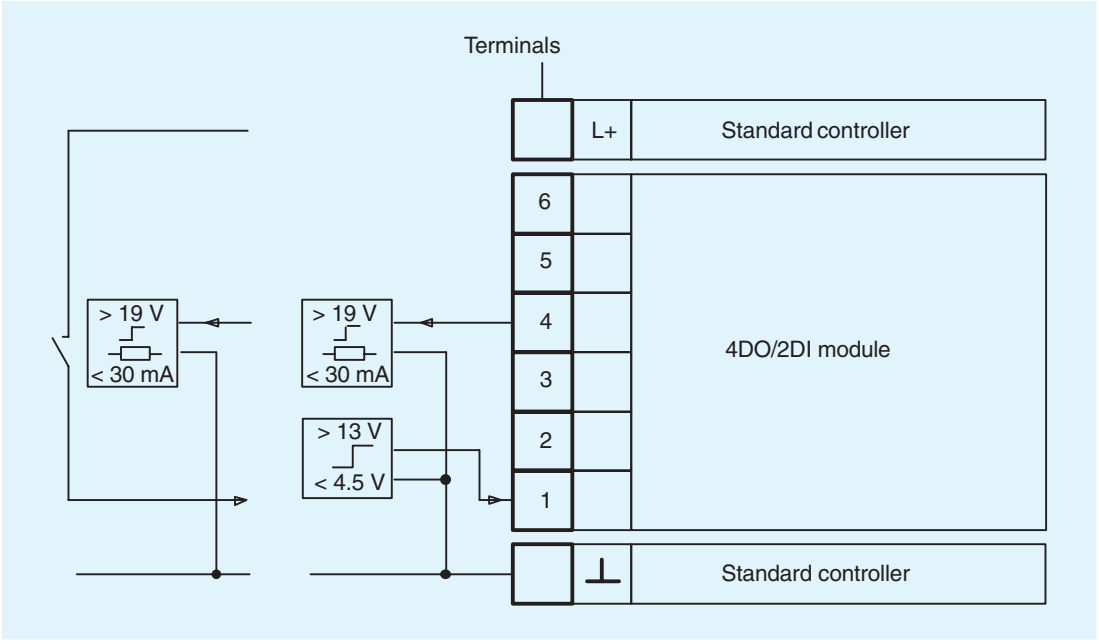

Fig. 8/11 Wiring of 4DO/2DI module 6DR2801-8E

Assignment of the terminals to the digital input (DI) and the digital output (DO); depending on device version and slot

Terminal	Digital input, digital output with:			
	SIPART DR19 and DR21	SIPART DR20	SIPART DR22 and DR24	
			Slot 5	Slot 6
6	BE4	-	-	-
5	BA6	+Δy	BA12	BA16
4	BA5	-Δy	BA11	BA15
3	BA4	A2	BA10	BA14
2	BA3	A1	BA9	BA13
1	BE3	BLPS [1])	BE5	BE10

[1]) BLPS = Blocking, parameterization and configuring.

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Interface modules

- SES module 6DR2803-8C
  Serial interface module for RS 232 and RS 485

All process variables, status flags, setpoints, manipulated variables, parameters and configuring switch settings can be transmitted and received via the serial interface module.

Serial data transfer can take place on a point-to-point basis via the RS 232 interface.

If used in the SIPART DR19, DR21, DR22 and DR24 controllers, data can also be transferred across a serial bus using the RS 485 interface.

Which method is used (RS 232, RS 485) is determined using jumpers on the module.

Should you want to write your own interface software, a detailed technical description of the telegram traffic is provided for each type of controller.

The interface module provides galvanic isolation between the individual controllers and the higher-level system.

Technical data 6DR2803-8C	
SES module	
Transmittable signals	RS 232 or RS 485
Transmittable data	Status values, process variables, parameters and configuring data
Tpye of transmission	According to DIN 66 258 A or B
Character format	10 bits (start bit, 7 data bits (ASCII format), parity bit and stop bit)
Transmission rate	300 to 9600 bit/s
Transmission	Asynchronous, half-duplex
Addressable stations	32
Watchdog timer for data traffic	1 to 25 s or none
Galvanic isolation	Up to 50 V AC/DC
RS 232 point-to-point	
– Line capacity[1])	≤ 2.5 nF
– Line length recommendations	
Unscreened ribbon cable	≤ 50 m
Screened flat cable	≤ 25 m
RS 485 bus	
– Line capacity[1])	≤ 200 nF
– Line length recommendations	
Unscreened ribbon cable	≤ 1200 m
Screened round cable	≤ 600 m

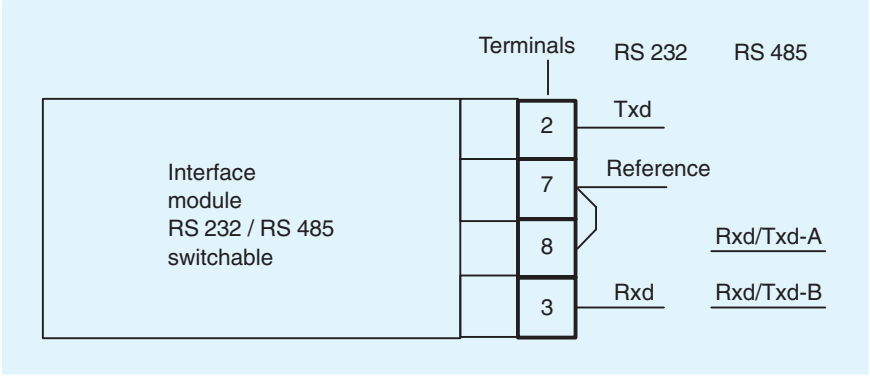

Fig. 8/12 Wiring of the SES module 6DR2803-8C

[1]) The cable capacity restricts the permitted line length.

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Interface modules

- Module 6DR2803-8P
  PROFIBUS DP interface for SIPART DR

The PROFIBUS DP interface for the SIPART DR controllers is designed as a plug-in option module. It can be used in all previously delivered SIPART DR controllers in the slot provided for the SES interface.

The interface module directly satisfies the PROFIBUS DIN 19 245, Parts 1 and 3 (without additional line driver).

The module has a 9-contact Sub-D socket for connection to the PROFIBUS DP. Standardized PROFIBUS plugs can be used here.

Data transmission is via a twisted RS 485 two-core cable. The power supply to the module is obtained internally direct from the controller.

The firmware of the SIPART DR19/21/22/24 controllers has been extended to the address range 0 to 125 for deliveries from 6/96 onwards. Earlier controllers of these types (address range 0 to 31) can be easily converted.

When connecting the SIPART DR 20 controllers (address range 0 to 31) to the PROFIBUS DP, they must be arranged in the corresponding address range.

The SIMATIC driver programs (function blocks) are available for connection of the SIPART DR controllers to SIMATIC S5/S7 via the PROFIBUS DP.

Technical data 6DR2803-8P	
Transmittable signals	RS 485, PROFIBUS DP protocol
Transmittable data	Status flags, process variables, parameters and configuring switches
Transmission procedure PROFIBUS DP protocol	To DIN 19 245 Parts 1 and 3
Certification by the PROFIBUS user organization e.V.	Certificate No.: Z00177 dated 16.09.1996
Transmission rate	9.6 kbits/s to 1.5 Mbits/s
Station No.	0 to 125 (note software version of controller) (0 to 31 with SIPART DR20)
Electrical isolation between RxD/TxD -P/-N and the device	Max. UC 50 V common-mode voltage
Test voltage	AC 500 V
Repeater control signal CNTR-P	5 V –0.4 V/+0.2 V, short-circuit-proof
Cable lengths: per segment at 1.5 Mbits/s	200 m; for further data see ET 200 manual 6ES5 998-3ES12

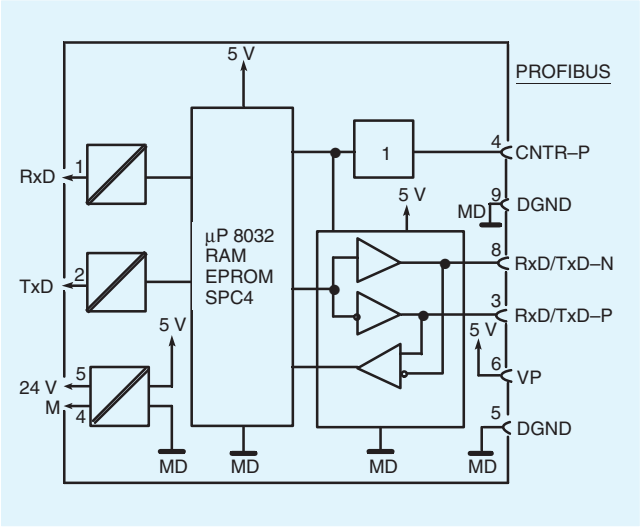

Fig. 8/13 Block diagram

The GSD file (basic device data) file is required to connect the SIPART DR controllers to other systems. The DP master interface is parameterized using these data.

The following Instructions can be downloaded from Internet (see Section 10, Page 10/7):

- **SIPART DR**
  PROFIBUS interface / Instructions
  (Description of the communication via PROFIBUS DP with the controller SIPART DR19/20/21/22/24)
  - German
  - English
- GSD file in "Controller"

The plug and cable must be ordered separately (e.g. from the Siemens catalog IK PI, also with integrated terminating resistor).

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Coupling relay module

- 6DR2804-8A coupling relay 230 V, 4 relays
  6DR2804-8B coupling relay 230 V, 2 relays
  for snapping onto the rear of the controller

Note: observe max. switching voltages! (resonance magnification on phase shift motors)

The coupling relays can be snapped onto a mounting rail on the rear of the SIPART DR19, SIPART DR21, SIPART DR22 and SIPART DR24 controllers.

The mounting rail is supplied with the coupling relay.

The 6DR2804-8A coupling relay contains 4 relays. Two terminal strips with 9 terminals each are provided for connection purposes.

Technical data 6DR2804-8A and -8B		
2 or 4 coupling relays		
Relay design	CO contact with spark suppressor	
Contact material	Silver/Cadmium Oxide	
Contact rating[1])	AC	DC
Max. switching voltage	≤ 250 V	≤ 250 V
Max. switching current	≤ 8 A	≤ 8 A
Max. switching capacity	≤ 1250 VA	≤ 100 W at 24 V ≤ 30 W at 250 V
Service life		
Mechanical	$2 \cdot 10^7$ switching operations	
Electrical 230 V AC, Ω loading	$2 \cdot 10^6$ switching operations	
Spark suppressor	22 nF and 220 Ω connected in series, with 420 V varistor wired in parallel	
Excitation coil[1])		
Voltage	+19 to 30 V	
Resistance	1.2 kΩ ± 180 Ω	
Degree of protection EN 60 529		
Housing	IP 50	
Terminals inserted	IP 20	
Housing material	Polyamide 66	
Fitting to mounting rail	On NS 35/7.5 to DIN EN 50 022 or NS 35/15 according to DIN EN 50 035 NS 32 according to DIN EN 50 035	

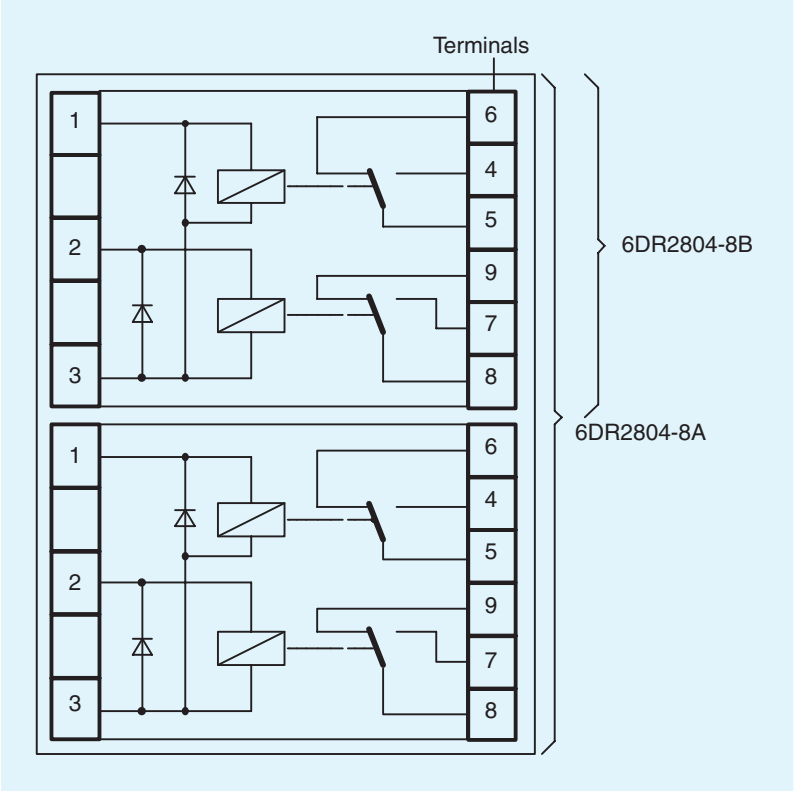

Fig. 8/14 Coupling relay module 6DR2804-8A and 6DR2804-8B

[1]) Excitation coil and contacts safely isolated through the use of reinforced insulation conforming to DIN/VDE 0106 Part 100 (Nov. 1986). Ventilation and creepage paths for surge class III and pollution level 2 according to DIN/VDE 0110 Part 1 January 1989.

Contacts on a relay module safely isolated through the use of reinforced insulation conforming to DIN/VDE 0106 Part 101 (Nov. 1986). Ventilation and creepage paths for surge class II and pollution level 2 according to DIN/VDE 0110 Part 1 January 1989.

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Ordering data

Ordering data

	Order No.
Analog signal modules	
U/I module for current input 0/4 to 20 mA or voltage input 0/0.2 to 1 V or 0/2 to 10 V	**6DR2800-8J**
3 U/I modules with 3 analog inputs 0/4 to 20 mA or 0/0.2 to 1 V or 0/2 to 10 V (SIPART DR24 only)	**6DR2800-8A**
R module for resistance-based sensor	**6DR2800-8R**
Pt 100 module for Pt 100 resistance thermometer	**6DR2800-8P**
TC module for thermocouples or other mV signals	**6DR2800-8T**
UNI module for TC/RTD/R/mV signals, programmable (SIPART DR19/DR21 only)	**6DR2800-8V**
***y*-hold module** (SIPART DR22/DR24 only)	**6DR2802-8A**
3AO/3DI module for the extension of the analog outputs and the digital inputs	**6DR2802-8B**
Switching signal modules	
5DI module with 5 digital inputs (not with SIPART DR20)	**6DR2801-8C**
2DO relay module with 2 relay outputs	**6DR2801-8D**
4DO/2DI module with 4 digital outputs and 2 digital inputs	**6DR2801-8E**
Interface modules	
SES module for serial communication via RS232/RS485 interface	**6DR2803-8C**
PROFIBUS DP module for direct communication via the PROFIBUS DP	**6DR2803-8P**
Coupling relay module	
Coupling relay module with 2 relays (AC 250 V) with 4 relays (AC 250 V)	**6DR2804-8B** **6DR2804-8A**
Reference junction terminal for TC, internal (for use in conjunction with SIPART DR19/AE1 and UNI module)	**6DR2805-8A**
Measuring range connector for I = 20 mA and U = 10 V (for use in conjunction with SIPART DR19/AE1 and UNI module)	**6DR2805-8J**

Available ex-stores:

Items marked ■ are available ex-stores.

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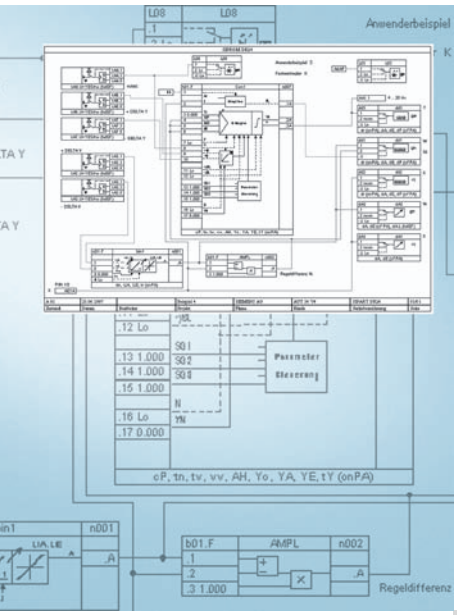
SIPART Software

9

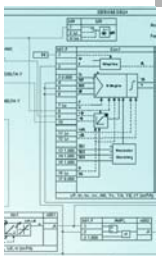


9/2	**Serial interface/hardware**
9/3	**Communication driver for S7/ PCS 7**
9/4	**SIPART device driver WinCC**
9/5	**Graphic configuration using SIPROM DR24**

Notes:

Parameterization and configuration of the controllers SIPART DR19, DR21 and DR22 with SIMATIC PDM software!
For detailed information about SIMATIC PDM see catalog FI 01.

The whole programs mentioned in this catalog section are class B software products. The „Agreement concerning the use of software products with a unique payment“ is valid for these programs.



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Serial interface/hardware

Application

The SIPART DR compact controllers are microprocessor-controlled autonomous devices and can be used for reliable automation of processes. Process operation and monitoring as well as parameterization and configuring are carried out on the front module (control unit) of these controllers.

In addition to their use as individual devices in stand-alone mode, the SIPART DR compact controllers also enable serial communication with automation systems or personal computers for central operation and monitoring or for parameterization and configuring. The controllers are equipped with an RS 232/485 or PROFIBUS DP interface module for these tasks.

The RS 232/485 interface module 6DR2803-8C provides electrical isolation between the individual controllers and the higher-level system. Any combination of up to 32 SIPART DR devices can be connected via the addressable interfaces.

In RS 232 mode, the interface is implemented as a point-to-point. The SIPART DR controllers (see Overview Section 8) can also communicate with higher-level systems using an RS 485 interface.

The PROFIBUS DP interface module 6DR2803-8P permits up to 122 controllers to be connected as slaves to master modules in a programmable controller such as e.g. SIMATIC S5 or S7. The controllers are connected via a common line (2-wire copper or fiber-optic cable). Refer to Catalog IK PI for the PROFIBUS accessories (Order No.: E86060-K6710-A101-A9-7600).

Design

In RS 485 mode (see Overview Section 8), a bus driver is not required. The controllers are connected directly to the central unit or the interfaces (see Fig. 9/1).

In PROFIBUS DP mode the controllers are connected to a DP master module in series using a 2-wire copper cable (Fig. 9/3). SIMATIC NET repeaters or optical link modules (OLM) are required to cover longer distances (see Catalog IK PI).

Hardware components

- Serial interface (SES) 6DR2803-8C

The interface module has a nine-way subminiature connector to connect it to the bus cable. Jumpers on the interface module enable a choice to be made between RS 232 mode (point-to-point) or RS 485 mode.
The terminating resistor required for RS 485 operation is already present on the interface module.

- PROFIBUS DP interface (6DR2803-DP)

The interface module directly satisfies the PROFIBUS DIN 19245, Parts 1 and 3 (without additional bus driver). The module has a 9-contact Sub-D socket for connection to the PROFIBUS DP. Standardized PROFIBUS plugs can be used (see Catalog IK PI).

- Connecting cable

1. SIPART DR19/DR21/DR22 "New"/DR24 "New" controller – system from other manufacturer connection using RS 485

   The communication to higher-level systems takes place with a 2-wire connection via an RS 485 interface.
   The 9-way female connector for round cables is preferred for the connection.

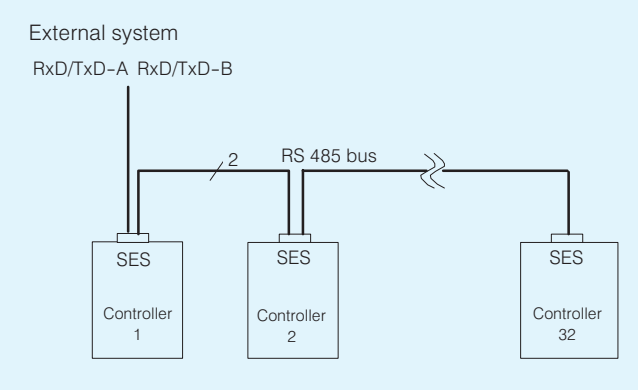

Fig. 9/1 Serial interface using RS 485

2. Controller – Personal Computer as point-to-point connection

   Two different cables with different connectors are available:

   - 25-way male connector (e.g. COM 1 of SIMATIC programmers) and a 9-way female connector to the controller.
   - 9-way female connector (e.g. COM 1/2 with standard personal computers) and a 9-way female connector to the controller.

3. Controller – PROFIBUS-DP connection

   PROFIBUS provides a comprehensive range of bus components for electrical and optical transmission (see Catalog IK PI).
   Different connecting cables (for point-to-point connection) for controller configuring via PROFIBUS-DP are available e.g.:
   6ES7 901-4BD00-0XA0 (IK PI)
   6ES7 901-0BF00-0AA0 (IK PI)

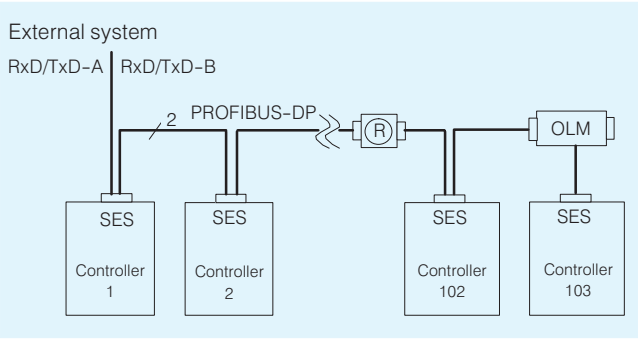

Fig. 9/2 Serial interface using PROFIBUS DP

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Serial interface/hardware

Technical data

Connectable devices	For PROFIBUS DP up to address 125
SIPART DR19 controllers SIPART DR20 controllers	Software release B01 or newer Software release B07 or newer (max. Adr. 31)
SIPART DR21 controllers SIPART DR22 / DR22N controllers	Software release A07 or newer Software release B07 / (C03) or newer
SIPART DR24 / DR24N multi-function unit	Software release B04 / (C03) or newer
Serial interface 6DR2803-8C	
Transmittable signals	V.24/V.28 signals to CCITT-V.24: TxD (103), RxD (104) and GROUND (102) or SIPART bus or RS 485 2-wire system (with SIPART DR19, DR21, DR 22N or DR24N only)
Transmittable data	Status flags, process variables, parameter settings and configuring switch settings
No. of addressable devices per connection	Max. 32
Transmission	Asynchronous, half-duplex
Transmission rate	300, 600, 1200, 2400, 4800 or 9600 bit/s
Character frame	10 bit (start bit, 7 data bits of an ASCII character starting with the LSB, parity bit and stop bit), even or odd parity
Transmission procedure	To DIN 66 258, Part 1, configuration A or B, optionally with or without longitudinal redundancy check LRC, before or after the end-of-message ETX, normal or complementary longitudinal redundancy check
Galvanic isolation	Between TxD, Rxd and the controller
PROFIBUS-DP interface 6DR2803-8P	
Transmittable signals	RS 485, PROFIBUS-DP/V1 protocol
Transmittable data	Status flags, process variables, parameters and configuring switches
Transmission procedure PROFIBUS DP/V1 protocol	To DIN 19 245 Parts 1 and 3 European standard: EN 50 170
Transmission rate	9.6 kbits/s to 1.5 Mbits/s
Station No.	0 to 125 (note software version of controller) (0 to 31 with SIPART DR20)
Electrical isolation between RxD/TxD -P/-N and the device	Max. UC 50 V common-mode voltage
Test voltage	AC 500 V
Repeater control signal CNTR-P	5 V -0.4 V/+0.2 V, short-circuit-proof
Cable lengths: per segment at 1.5 Mbits/s	200 m; for further data see IK PI

Ordering data

	Order No.
RS 232/RS 485 interface module (SES), switchable for SIPART DR compact controllers	**6DR2803-8C**
PROFIBUS-DP module for SIPART DR compact controllers for direct communication via the PROFIBUS DP	**6DR2803-8P**
RS 232 connecting cable for point-to-point connection, for controller to PC on COM interface	
- 9-way female to 9-way female	**6DR2902-8AB**
- 25-way male from PC to 9-way female on controller	**6DR2902-8AC**
Length: 5 m	
Connection for ribbon cable/round cable	
Female connector 9-way for round cable (screw-type, for interface module)	**C73451-A347-D39**
PROFIBUS-DP connecting cable point-to-point connection for controller to PC/PG with CP 5611, 5511 or MPI interface	(see Catalog IK PI)
PROFIBUS con. cable: 3 m (IK PI) MPI cable 5 m (IK PI)	**6ES7 901-4BD00-0XA0** **6ES7 901-0BF00-0AA0**
Operating Instructions "V.28 Serial Interface" These instructions are only required if you wish to write your own communications software. The interfaces are described in the controller manuals and operating instructions.	
For SIPART DR20 controller (Internet) - German - English	**C73000-B7400-C128** **C73000-B7476-C128**

The following Instructions can be downloaded from Internet (see Section 10, Page 10/7):

SIPART DR
PROFIBUS interface / Instructions
(Description of the communication via PROFIBUS DP with the controller SIPART DR19/20/21/22/24)
- German
- English

SIPART DR19, 21, 22 and 24
Serial SIPART 6DRxx Bus interface / Instructions
(Description of the communication via RS 232, RS 485 or PROFIBUS DP)
- German
- English

Available ex-stores:
Items marked are available ex-stores.

Communication driver for S7 / PCS 7

All replacement products of 6DR1126-xxxxx will be delivered via SIEMENS A&S IT PS 2.

Contact: Roland Heid
E-Mail: Roland.Heid@siemens.com

9

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SIPART device driver WinCC

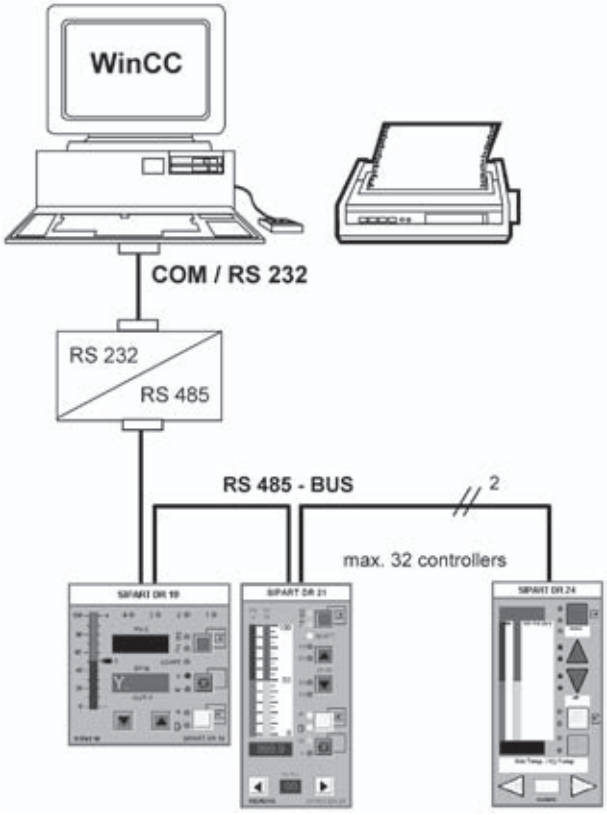

Fig. 9/3 System configuration

WinCC functions

WinCC provides powerful function packages for visualization, message processing, archiving of measured values and user data, and for logging.
With its versatile connection possibilities (bus systems and serial), WinCC also supports the simultaneous operation of SIMATIC and SIPART DR.

WinCC is available as a software package or as a system (OP or PC with completely installed software, complete or runtime versions) and is offered in various performance and price classes with different options. You can obtain technical information and ordering data on WinCC from your SIMATIC contact (see also Catalog ST 80).

Application

The SIPART device driver WinCC permits incorporation of the SIPART DR controllers into WinCC. WinCC then has access to all device data of the various SIPART DR controllers for operation and monitoring.

The data to be visualized, operated and logged are defined by configuring. The configuring of WinCC for SIPART DR is particularly simple by using "Standards" (pre-configured and documented display blocks for each type of controller).
Modifications during the test and commissioning phase present no problem as a result of online configuring.

WinCC is connected to the DR19, DR20, DR21, DR22 and DR24 compact controllers via the device driver for SIPART DR (channel DLL). WinCC supports up to 4 SIPART buses with max. 32 process controllers each.

Hardware and software requirements

- Personal computers with Windows XP, NT or Windows 9x, with Pentium processor ≥ 166 MHz, main memory configuration at least 32 Mbyte, vacant hard disk capacity ≥ 1 Gbyte, CD-ROM drive
- WinCC software (complete or runtime version as desired)
- The SIPART DR19, DR21, DR22 "New" and DR24 "New" controllers are connected in RS 485 mode (see Fig. 9/1)

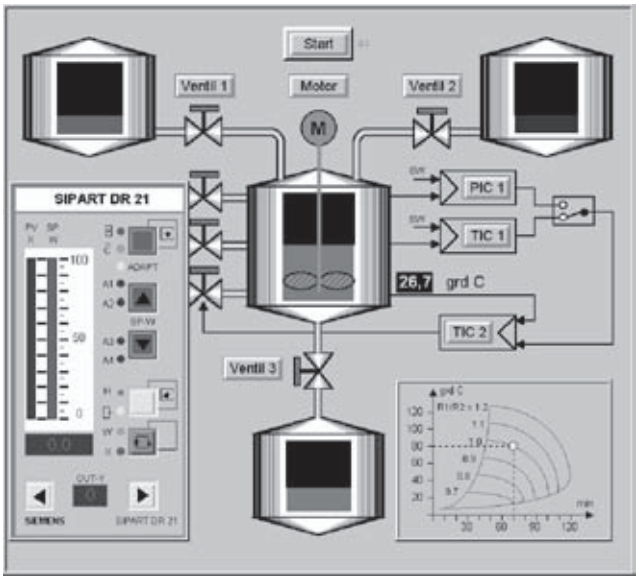

Fig. 9/4 WinCC full graphics and windows

Ordering data

	Order No.
SIPART device driver for WinCC for the SIPART DR19, DR20, DR21, DR22 and DR24 controllers for connection to a standard COM interface on the PC	**6DR1127-1AA00**
Update	**6DR1127-1AA00-0UD3**

Scope of supply

SIPART device driver for WinCC
- DISK 1/3: Pre-configured and documented blocks for every type of controller; Demo project V5 SP1
- DISK 2/3: Documentation of examples in German, English and French in WINWORD format
  DISK 3/3: Demo project V6
- Installation Manual in German, English and French

Update note

The update ordering requires the proof of an old complete individual license!

9

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Graphic configuration using SIPROM DR24

Application

The SIPROM DR24 program is used for the graphic programming of the SIPART DR24 multi-function unit. It includes all the configuration and parameterization of the multi-function unit using a graphic operator interface (MS Windows).

SIPROM DR24 runs on the following computers:

1. Personal computer with operating system MS-Windows 95/98/NT/2000/XP
2. SIMATIC PG as programmable controller with operating system MS-Windows 95/98/NT/2000/XP

The core functions of the SIPROM DR24 are:

- Documentation updating of complete user programs in the SIPART DR24 in tabular form. Controller data can be modified in the PC, saved, and downloaded again to the multi-function unit
- Function library containing all of the SIPART DR24 function elements.
- Positioning of the elements with a mouse click on maximum 100 sheets. Positioning can be carried out within one sheet or more (FDEF)
- Connection of function blocks from data source to data sink (FCON) where the analog and digital signals can be differentiated by their color
- Positioning (FPOS) of the function blocks i. e. the order of the software processing is automatically fixed. It can be changed at any time by a mouse click
- Parameter input in tabular form (ONPA, OFPA, CLPA)
- Transmission of complete graphic configuration to SIPART DR24, to the printer and on floppy or hard disk
- Duplication of user programs. The programs stored in a user program memory are fetched and then copied from the PC to other empty program memories.
- Documentation of complete multi-function unit: front assignment and rear including all inputs and outputs
- Moving of blocks without destroying interconnections.
- Insertion of text strings where required
- Symbol alignment using grid points (can be toggled on and off)
- Choice of graphical or tabular configuration
- Layout check over 2 pages
- Page by page storage and loading of partial circuits
- Multiple use of constants
- UNDO facility (can be toggled on and off)
- When processing a graphics circuit scaling up or reducing is possible (zooming)
- Controller data generated by previous SIPROM DR24 software versions can be edited.

Hardware and software requirements

- Hardware

  Personal Computer, permissible for MS-Windows XP

  - Hard disk ≥ 500 Mbyte
  - Memory capacity ≥ 64 Mbyte
  - CD-ROM drive
  - Color grafics card, supported by Microsoft Windows but at least with SuperVGA functionality (from 800*600 pixels upward)
  - Printers, plotters, supported by Microsoft Windows
  - DP master module for PC:
    CP 5611: 6GK1 561-1AA00
    DP master module for laptops:
    CP 5511: 6GK1 551-1AA00
  - SIMATIC PG with built-in MPI Interface

  - Serial interface on the SIPART DR24:
    RS 232: 6DR2803-8C
    PROFIBUS-DP: 6DR2803-8P
  - Connecting cable:
    for RS 232/"point-to-point" 6DR2902-8AB/-8AC
    for PROFIBUS-DP/3 m: 6ES7 901-4BD00-0XA0 see IK PI
    for PROFIBUS-DP/5 m: 6ES7 901-0BF00-0AA0 see IK PI

- Software
  - Operating system Microsoft Windows XP or operating system Microsoft Windows 95/98 (32-bit version only), 2000, NT 4
  - PROFIBUS-DP driver "Softnet DP" Version ≥ 2.2 for PCs/PGs, Order No. 6GK1 704-5DW61-3AA0 [1])

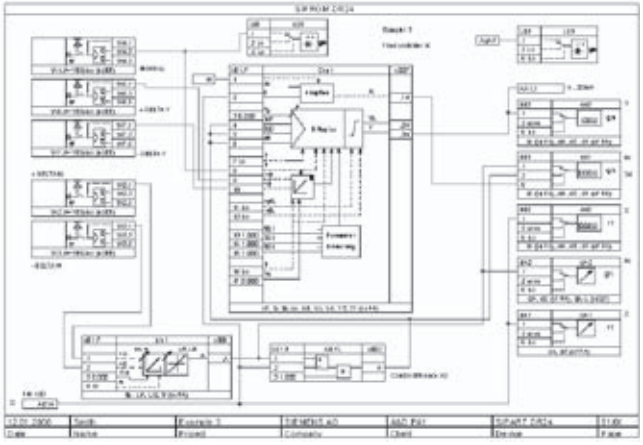

Fig. 9/5 SIPROM DR24

Ordering data

	Order No.
SIPROM DR24 program for SIPART DR24 controllers - German/English	**6DR1127-1BA00**
Update - German/English	**6DR1127-1BA00-0UD3**

Scope of supply SIPROM DR24
Program and manual (English and German) on CD-ROM

Training
Refer to the ITC catalog (German) for details of training courses for these programs.

Update note
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[1]) The required drivers are not included in the SIMATIC programmable controller delivery.

9

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