1 Description

1.1 Application

Analog input and output modules are used as process interface modules for the input and output of a wide range of analog process signals for programmable controllers which use the digital principle, such as the S5-130 W, -135 U, -150 K/S/U, -155 U and -210 A/B.

The analog input and output modules allow the implementation of control systems which require the processing of analog measured variables, or the continuous control of actuators.

1.2 Design

The modules are designed as plug-in PCBs for the ES 902 modular packaging system with a backplane and a plug connector which mates with a front connector. By means of screw terminals or crimp connections, the process signal lines can be directly connected to the front connector which is available separately.

Each module is equipped with a addressing switch (6 dip switches) for setting the module address. The analog input modules are additionally provided with two switches (8 dip switches) for selecting the mode and locations for range submodules.

The module is protected on both sides by covers. These covers are secured by means of thermally moulded plastic rivets.

1.3 Principle of Operation

Analog input and output modules whose signals are not fed via the process image are addressed over the address range 128 to 255 by the STEP-5 program. In principle, addressing over the range 0 to 127 is also possible with appropriate programming (refer to the load and transfer operations of the operations list).

The CPU emits an address byte (address bits ADB 0 to ADB 7) on the address bus, which contains the starting address of the module and the subaddress for selecting the input and output channels. This allows an arrangement in basic and extension units which is independent of the module locations.

The starting address of the module can be set on an addressing switch by the user. The subaddress (channel address) is decoded automatically on the module.

One data word (two data bytes) is required for processing an input or output. A module with 16 inputs thus occupies 32 byte addresses, and a module with 8 inputs or outputs occupies 16 byte addresses.

o **Overrange**

If the measurement range (4095 units) is exceeded, an overflow bit (bit 2^0 of the low byte) is set.
Applies only to 465-4UA11: This bit remains set for all the channels of the analog input module 465 when being operated in the cyclic mode. This is necessary, since, when only one channel is overdriven, the measured values of the subsequent channels may insignificantly be falsified too.

o **Cyclic scanning**

In this mode, the controller on the module continuously codes all measuring points. The digitized measured values are stored in the circulating memory under the channel-related address: the high byte under the address and the low byte under the address + 1. The measured values can then be read out of the circulating memory at any time without delay.

o **Single scanning**

In this mode, the coding of a measured value takes place on the initiative of the CPU. At the start of the conversion, the module must be addressed once by the CPU under the relevant channel address with a memory write (MEMW). During coding, an activity bit (T = 1) is set on the data bus.

If T = 0, the digital value is valid. Repeated scanning of the activity bit causes loading of the bus and CPU. With different measured values, this results in aperiodic measured-value acquisition, which is not desirable for control tasks.

A better method is that of time-controlled program processing. With this type of program processing, certain program segments (e.g. FB 13) are automatically inserted into the program processing sequence by a time-controlled block in the 100-ms clock (OB 13). A constant time reference is thus achieved and the bus and CPU are relieved.

```
FB 13          OPRS-B                                LEN=22      ABS
                                                                 PAGE 1

SEGMENT 1
NAME :SINGSCAN                          EXAMPLE: SINGLE SCANNING

0005      :
0006      :
0007      :L  PW128                     READ ANALOG VALUE
0008      :T  FW128                     IN AUXILIARY FLAG FW 128
0009      :A  F 129.2                   SCANNING ACTIVITY BIT = 1?
000A      :JC =END                      IF = 1, JUMP TO END
000B      :T  FW10                      IF = 0, MEASURED VALUE IN FW 10
000C      :T  PB128                     INITIALIZE SCANNING
000D END  :                             (1ST VALUE INVALID AFTER
000E      :                             INITIAL START)
000F      :
0010      :BE
```

3.4 Connecting the Signal Lines

The modules are fitted with 42-way plug connectors with blades of 2.4 mm x 0.8 mm.

For the connection of signal lines, front connectors are available with crimp terminals for mounting widths of 20 mm and 40 mm and with screw terminals for a mounting width of 40 mm. Stranded conductors should be used to facilitate handling of the front connector. With the screw terminals, sleeves are not required because the screw terminals are provided with wire protectors.

Width of the screwdriver blade: 3.5 mm.

Type of connection	Connector type 6ES5 497-	Max. no. of terminals	Wire cross-section: Signal or supply line	Wire cross-section: Additional jumper in connector [1]	Connector for rated voltage	Mounting width of module	
Crimp contact	-4UA12 [2]	42	0.5 mm²	0.5 mm²	5...60 V⎓	20 mm	Operation with fan
	-4UA22 [2]	42	0.5 mm²	0.5 mm²	5...60 V⎓	40 mm	Operation without fan
Screw contact	-4UB12	42	0.5...2.5 mm²	0.5...1.0 mm²	5...60 V⎓	40 mm	
	-4UB31	42	0.5...1.5 mm²	0.5...1.0 mm²	5...60 V⎓	20 mm	

3.5 Connecting Sensors to Analog Input Modules

3.5.1 Connecting Current-type or Voltage-type Sensors

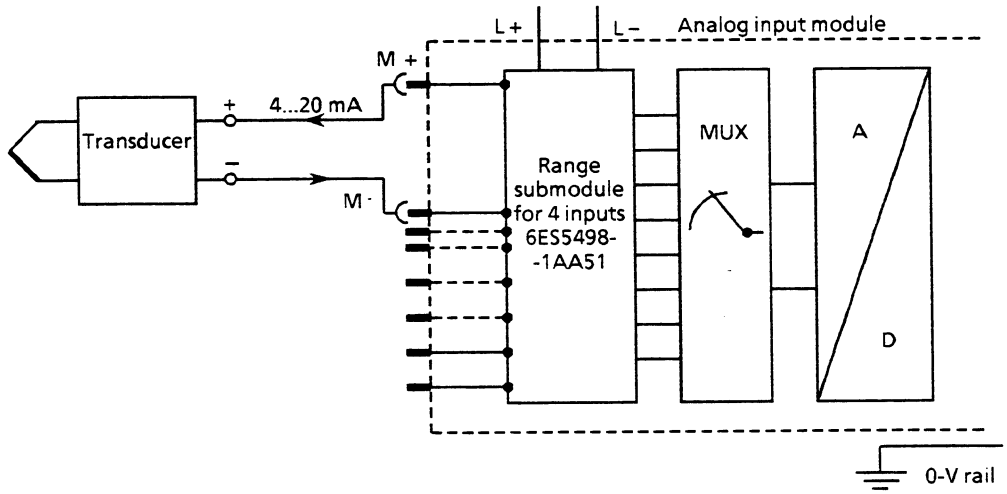
In the case of floating sensors it may occur that the measuring circuit assumes a potential against ground which exceeds the permissible potential difference U_{CM} (see maximum values of the individual modules). In order to prevent this, the negative potential of the sensor must be connected to the reference potential of the module (0-V rail).

[1]) To provide multiple supply and earth potential connections and for connection of the enable input.

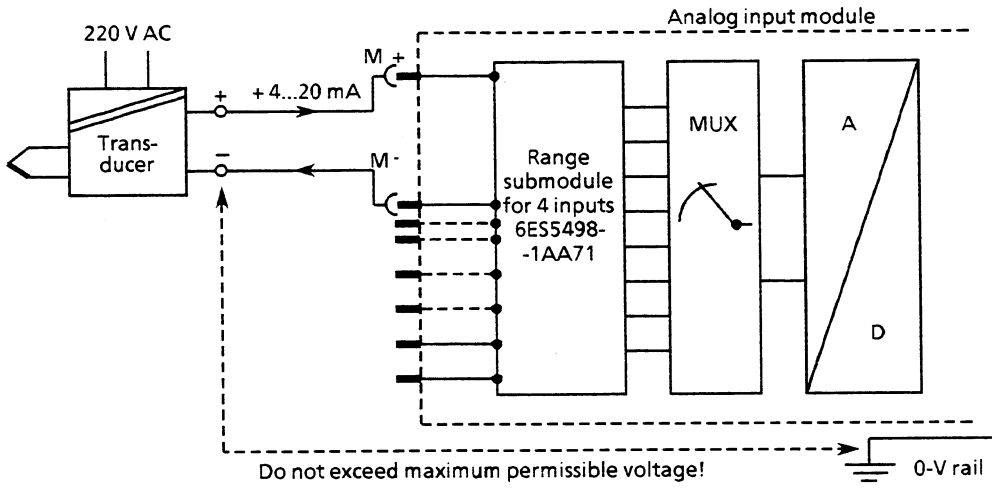
[2]) For these connector types crimp contacts must be ordered separately.

3.5.6 Connecting Transducers

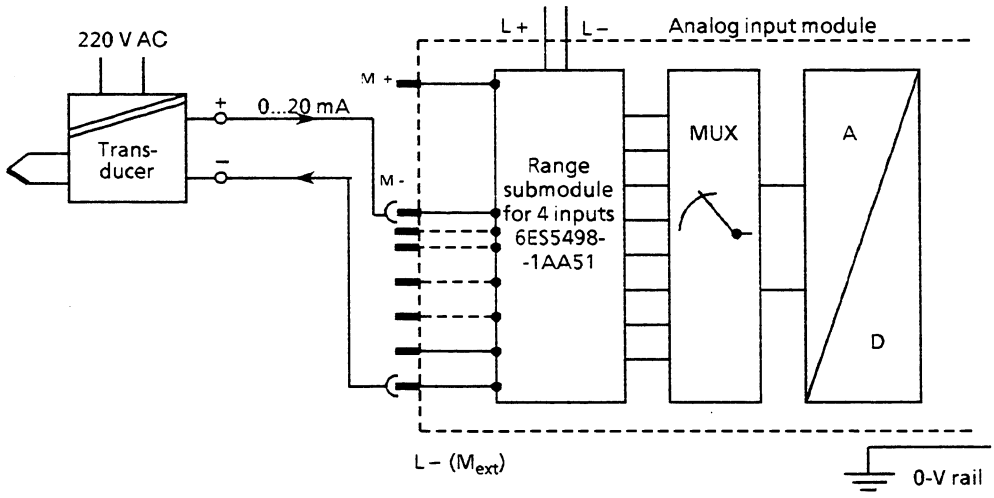
o 2-wire transducer (short-circuit-protected supply voltage via the range submodule of the analog input module)



o 4-wire transducer (transducer with separate supply voltage)



o 4-wire transducer connected to a 2-wire transducer module



5.2 Analog Input Module 6ES5 460-4UA12

5.2.1 Technical Data

Rated input range with submodules for 4 channels each	
6ES5498-1AA11	±12.5 mV/±50 mV/±500 mV/Pt 100 [1]
6ES5498-1AA21	±1 V
6ES5498-1AA31	±10 V
6ES5498-1AA41	±5 mA/±20 mA
6ES5498-1AA51	4 to 20 mA for 2-wire transd.
6ES5498-1AA61	±5 V
6ES5498-1AA71	4 to 20 mA for 4-wire transd.
Number of inputs	8 voltage/current inputs or 8 resistance inputs (Pt 100)
Measured-value representation	13 bits (two's complement) or 12 bits + sign; ±2048 units in rated range; 512 to 2560 units for 4 to 20 mA
Measuring principle	Integrating
Conversion principle	Voltage-time conversion (dual slope)
Isolation	Yes; 8 inputs between 0-V ref. and between inputs (not between Pt 100 inputs)
Permissible potential difference between the reference potentials of sensors and the module (U_{CM}), and between the sensors (channels)	Max. 60 V AC/75 V DC
Power supply	
- Digital section from system bus	5 V ± 5%; typ. 150 mA
- Analog section from load voltage	24 V; approx. 100 mA [2]
- Module enable F+/F-	24 V; approx. 5 mA
- Test current disable L+	24 V; approx. 5 mA
Constant current source for Pt 100 connection I_{c+}/I_{c-}	2.5 mA; TC = $\pm 5 \times 10^{-5}$/K
Integration time	20 ms at 50 Hz; $16^2/_3$ ms at 60 Hz
Coding time per measured value	60 ms at 50 Hz; 50 ms at 60 Hz

[1] 0 to 200 ohms ≙ -220 to 266°C
0 to 400 ohms ≙ -220 to 850°C
(overdriving range)

[2] Plus 20 mA max. per 2-wire transducer connected

Cycle time for 8 measured values with 2048 units (max. delay time of measured-value acquisition)	Approx. 0.48 s at 50 Hz
Input impedance (with sub-module) for input ranges	
- ±12.5 mV/±50 mV/±500 mV/Pt 100	≥ 10 Mohms
- ±1 V	90 kohms
- ±5 V/±10 V	50 kohms
- ±5 mA/±20 mA	25 ohms
- 4 to 20 mA	31.25 ohms
Fault signal, specific to measuring points,	
- on overflow	Yes
- on open circuit	Yes, configurable (at ±12.5 mV, ±50 mV, ±500 mV and Pt 100 [1]))
Max. permissible input voltage without destruction	±18 V; 75 V for max. of 1 ms and duty factor of 1:20
Noise suppression for f = n x (50/60 Hz ± 1%)	
- with common-mode interference	≥ 100 dB
- with differential-mode interference	≥ 40 dB, noise voltage amplitude, but 100% of measurement range referred to peak value
Error, referred to rated value	
- linearity	±1 unit
- tolerance	
with ≥50 mV	±1 unit
with ±12.5 mV	±3 units
- reversal error	
with ≥50 mV	±1 unit
with ±12.5 mV	±2 units
- temperature error	1×10^{-4}/K
Error caused by submodules in input range	
- ±1 V/±5 V/±10 V	2×10^{-3}; TC = $\pm 10 \times 10^{-5}$/K
- ±20 mA/4 to 20 mA	10^{-3}; TC = $\pm 5 \times 10^{-5}$/K
Insulation voltage according to VDE 0160	Between inputs and ground point: tested with 500 V AC
Impulse test according to IEC 266-4	Between inputs and L-: U_s = 1 kV; 1.2/50 µs
Service life of relays	10^9 cycles; ≥ 12 years of cyclic operation with 400-ms cycle

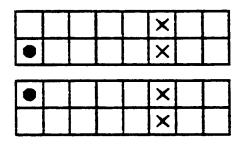
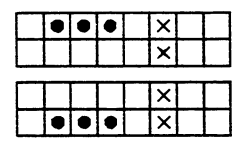
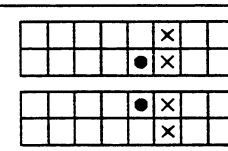
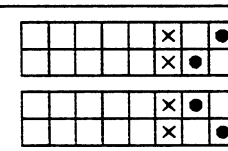
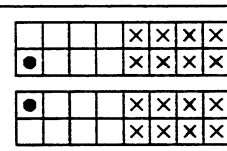
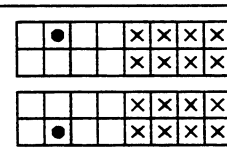
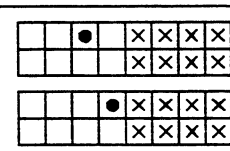
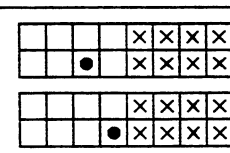
[1]) In the event of an open circuit in current-carrying lines I_c+ and I_c-, digital value 0 is indicated.

5.2.2 Selecting the Mode

The desired mode of the analog input module is selected by setting mode switches I and II according to the check list.

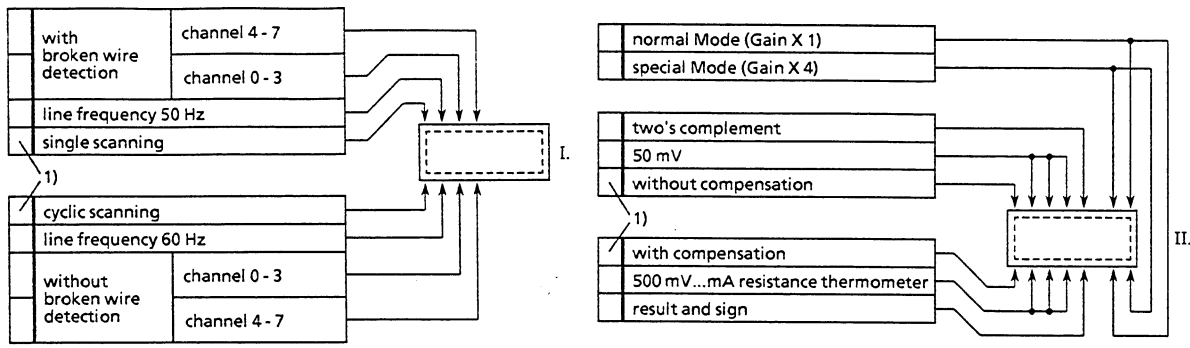
It should be noted that all individual dip switches of the two mode switch blocks marked with a dot must be set.

For selecting the desired operating mode, the switches are pressed downwards on the side marked with a dot.

Mode	Mode switch I (digital section)	Mode switch II (analog section)
Reference junction compensation with without		
Range 50 mV 500 mV; mA		
Absolute value and sign Two´s complement		
Gain x 1 (normal setting) Gain x 4		
Scanning cyclic single		
Mains frequency 50 Hz 60 Hz		
Channels 0..3 with open-circuit signal Channels 4...7		
Channels 0..3 without open-circuit signal Channels 4...7		

X: switch is not used, any switch position is allowed.

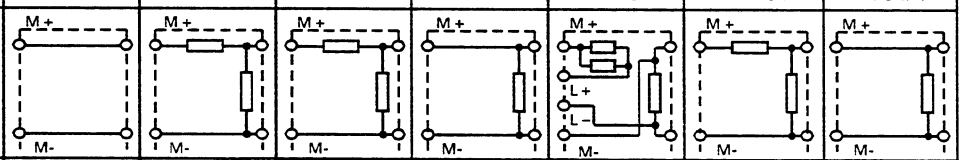
Labelling of the switches on the module cover:



5.2.3 Range Submodule Complement

Two submodules for connecting 4 inputs respectively can be plugged into one analog input module 460, being held in place by means of a screw.

Voltage divider, shunt and continuity submodules for the various measurement ranges are available.

	Range submodule type 6ES5 498-						
	-1AA11	-1AA21	-1AA31	-1AA41	-1AA51	-1AA61	-1AA71
Submodule circuits, 4x in each case							
Mode 500 mV/ mA/Pt 100 + Gain x 1	± 500 mV Pt 100	± 1 V	± 10 V	± 20 mA	4...20 mA 2-wire transducer	± 5 V	4...20 mA 4-wire transducer
Mode 500 mV + Gain x 1	± 50 mV	(± 100 mV) 2)	(± 1 V) 2)	(± 2 mA) 2)	-	(± 500 mV) 2)	-
Mode 500 mV/mA + Gain x 4	± 125 mV 2)	± 250 mV 2)	± 2,5 V 2)	± 5 mA 2)	-	± 1,25 V 2)	-
Mode 50 mV + Gain x 4	± 12,5 mV 2)	± 25 mV 2)	-	± 1,25 mA 2)	-	-	-

For one specified mode (50 mV or 500 mV), submodules of different measurement ranges can be plugged in for every 4 inputs. For the 500-mV mode, for example:

4 inputs, measurement range ±500 mV; 1 submodule 6ES5498-1AA11
4 inputs, measurement range ±10 V; 1 submodule 6ES5498-1AA31

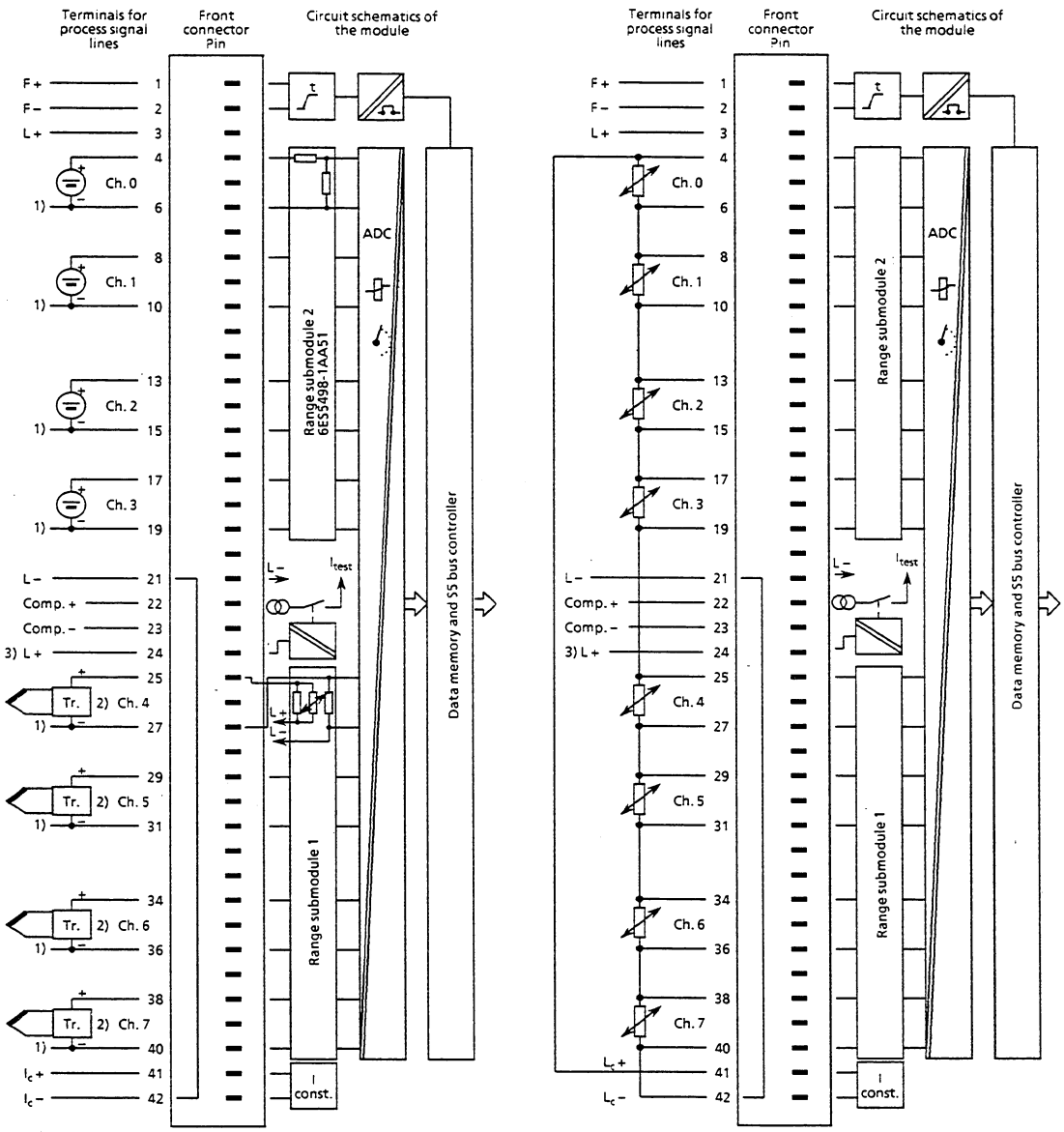
Unused inputs need not be short-circuited.

1) These fields are provided to mark the selected switch position.
2) Possible combination for 50 mV, but with greater error

5.2.4 Pin Assignments of the Front Connector

Voltage or current input
or connection of 2-wire
transducer

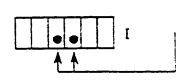
Resistance thermometers



Connection of 2-wire transducers is only possible with 500-mV mode.

Connect L- to central ground point (reference potential).

1) Keep to the permissible potential difference between the sensor ground and the reference potential of the modules, and between the sensor grounds
2) 2-wire transducer
3) Only necessary for switching off the test current with open-circuit signalling inactive; 0 V to L- (see Chap. 1.3.1)

Position of switch I with open-circuit signalling inactive  without broken wire detection