6 Analog input module 07 AI 90-S, safety-related, 4...20 mA, 4 inputs, electrically isolated from the CS31 system bus

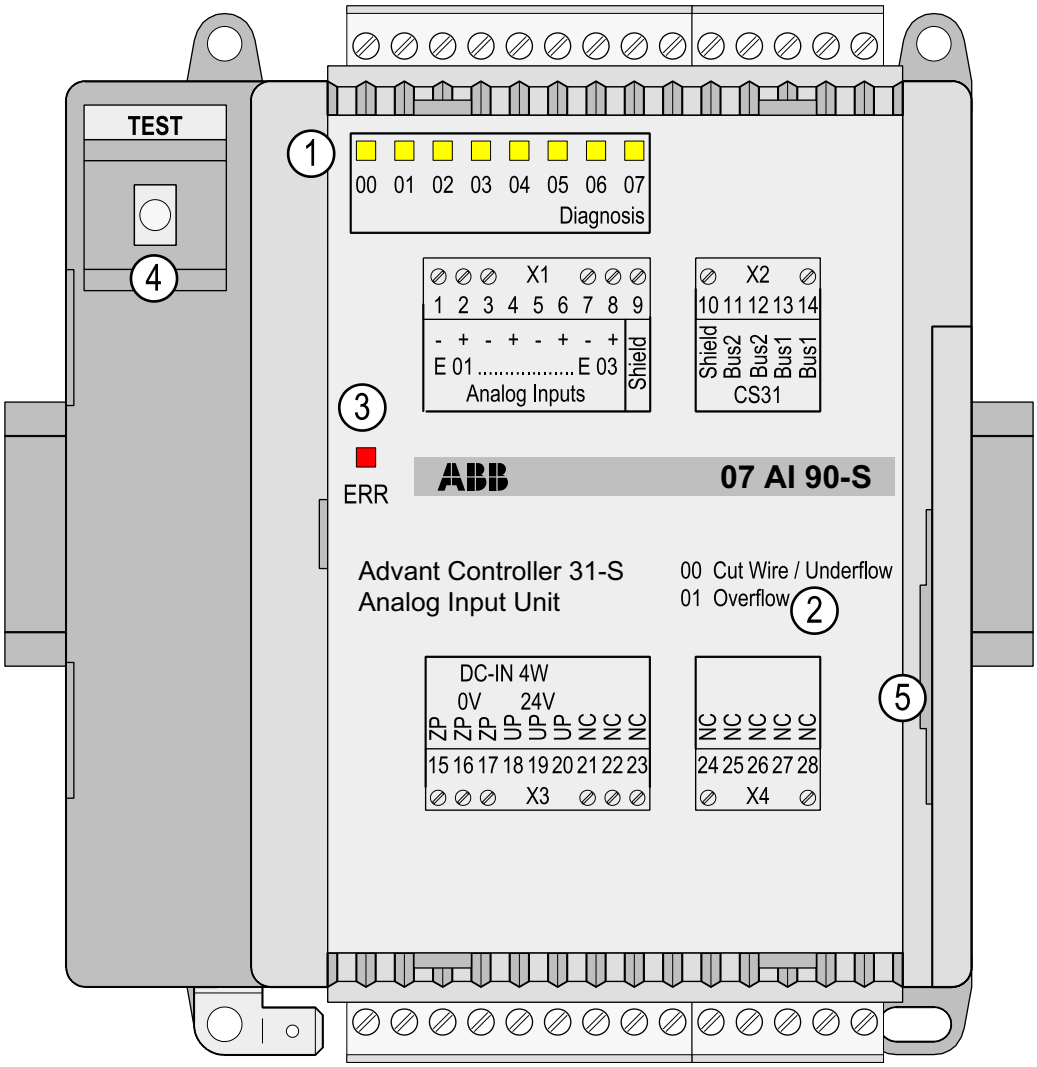


Figure 6-1: Safety-related analog input module 07 AI 90-S

Contents

Intended purpose

The module 07 AI 90-S is an analog input module with 4 input channels for 4...20 mA.

The module is part of the safety-related PLC (Advant Controller 31-S). It is used in safety-relevant automation systems to be classified under requirement classes 1...4 according to DIN V 19250.

It is used as a remote module and linked to the central unit 07 KT 94-S via the CS31 system bus.

The CS31 system bus interface is electrically isolated from the other circuitry of the module.

The input signals of the module 07 AI 90-S are read in by the AC31 central unit using special safety-related connection elements (CEs).

Indicators and operating elements on the front panel

(1) 8 yellow LEDs for indication of errors, diagnosis data and analog values

(2) List of the diagnosis information referred to the LEDs if these are used for diagnosis data

(3) Red LED for error indication

(4) Test button

(5) DIL switch for address setting under the cover

Functional description

As the following Figure 6-2 shows, the analog value processing is largely configured in dual-channel technique. In this way, the following tasks can be fulfilled:

- Signal states are safely detected, wire cuts and short-circuits of signals are safely differentiated.
- Single faults are detected and lead to a safe shut-down.

Principle of function

The input current flowing through the shunt of approx. 200 Ω generates a voltage drop which is transferred to two evaluation channels with identical construction via high-value resistors. The high-resistivity of the resistors guarantees a non-interaction between both channels.

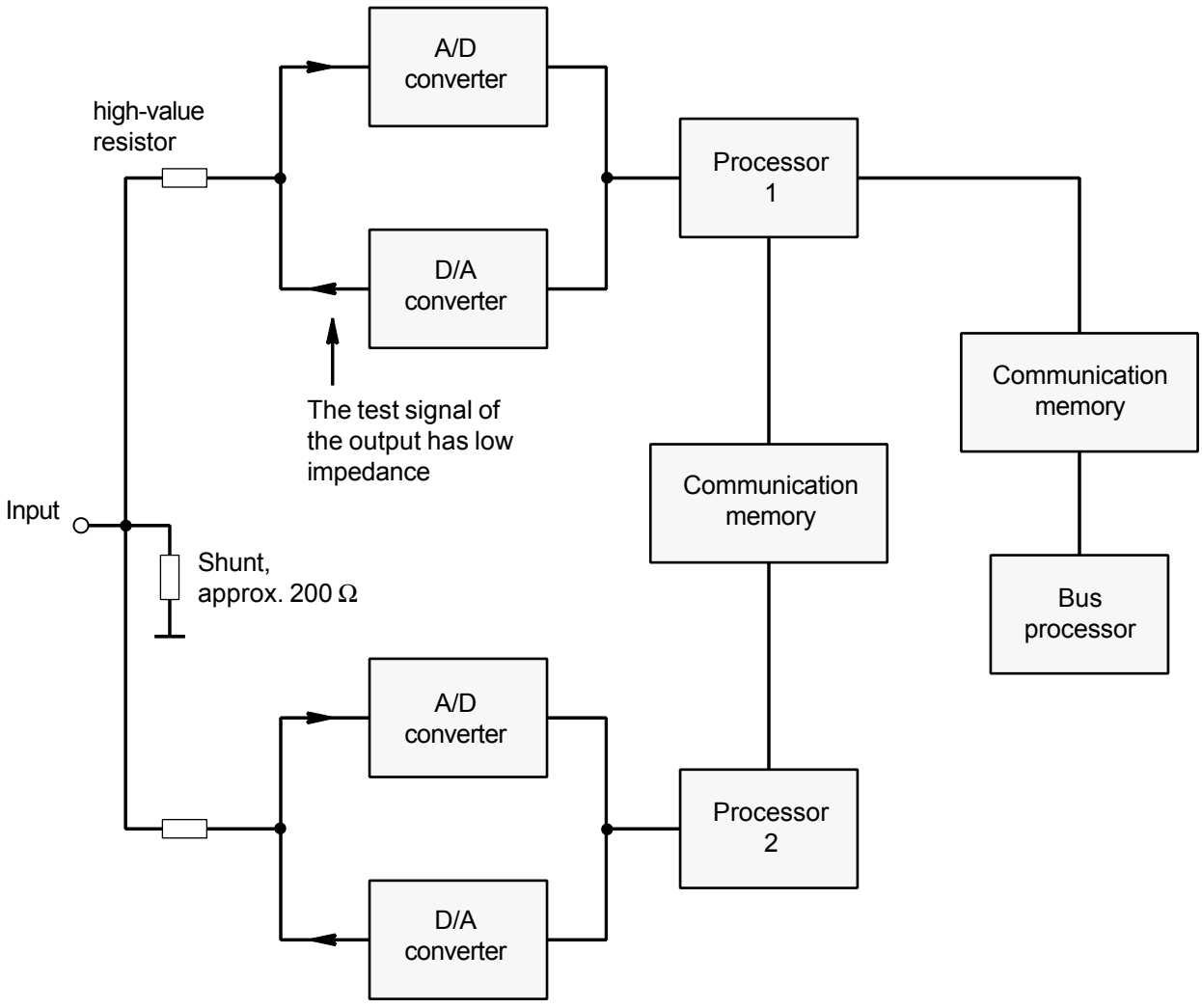


Figure 6-2: Safety-related analog input module 07 AI 90-S, block diagram

Both channels mutually supervise each other, by

- their processors comparing the converted values to each other;
- their processors generating analog values themselves in test cycles via D/A converter and comparing the data converted by the A/D converter to the expected value;
- their processors mutually checking each other for their function ability.

The dual-channel principle terminates at the bus processor with a special safety-related telegram.

Conversion

The input current flowing through the shunt of approx. 200 Ω is converted into a binary value within the range of 0...24 mA.

By digital numerical conversion, the numerical range for 4...20 mA is extracted and assigned to the hexadecimal values 0000...0FFF$_H$. These hex values are output by the module.

Using a digital threshold logic, the input currents lower than 3.6 mA or higher than 20.4 mA are evaluated as underflow or overflow, respectively.

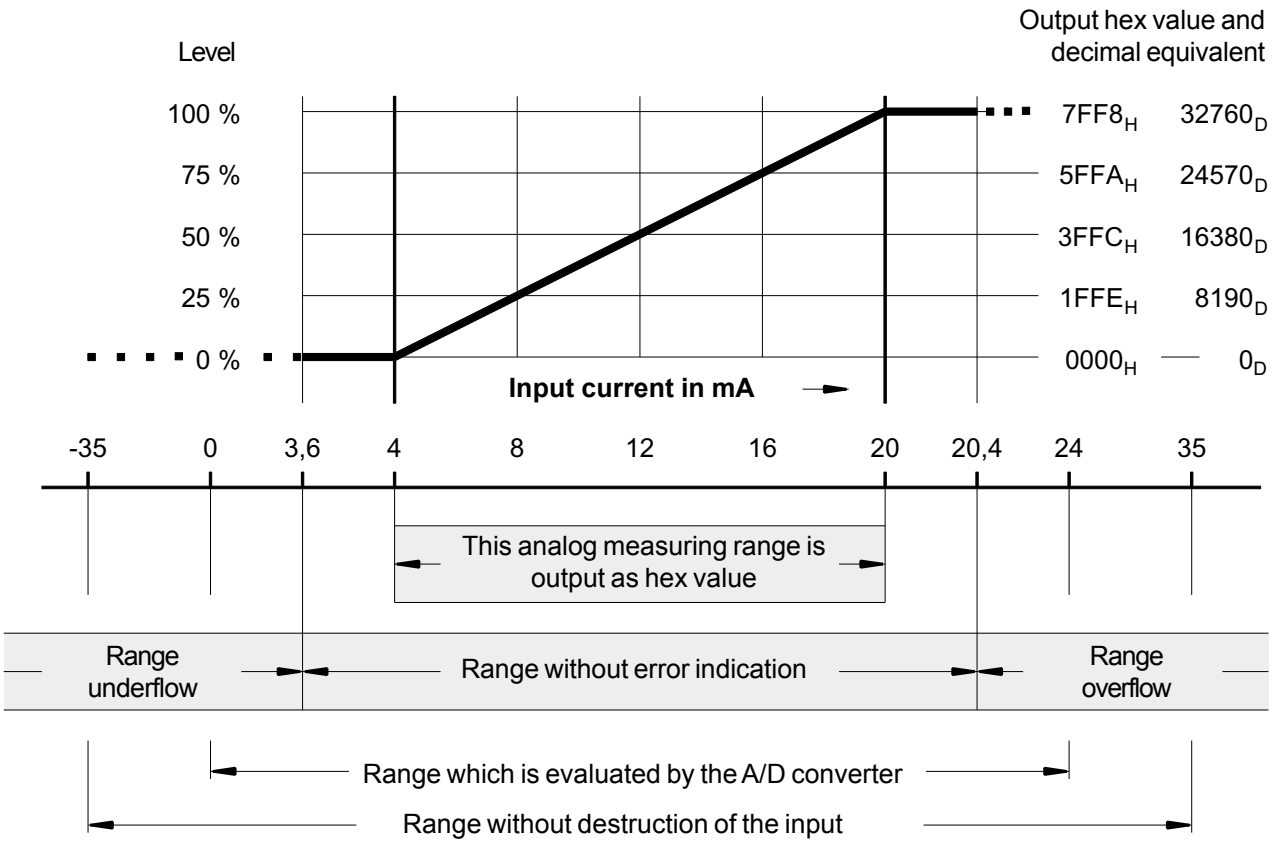
System bus interface

The CS31 system bus interface, which is electrically isolated, provides for the data exchange via the bus. There is no electrical isolation between the process supply voltage and the analog inputs.

Figure 6-4 on the next page illustrates the evaluation of the analog signals.

Conversion diagram

The following conversion diagram shows the values as output by the module (hex values, indication of underflow and overflow) depending on the input current.



Equation for the input current: I_E = 4 mA + (3,91 µA dec. equivalent)

Figure 6-3: Conversion diagram

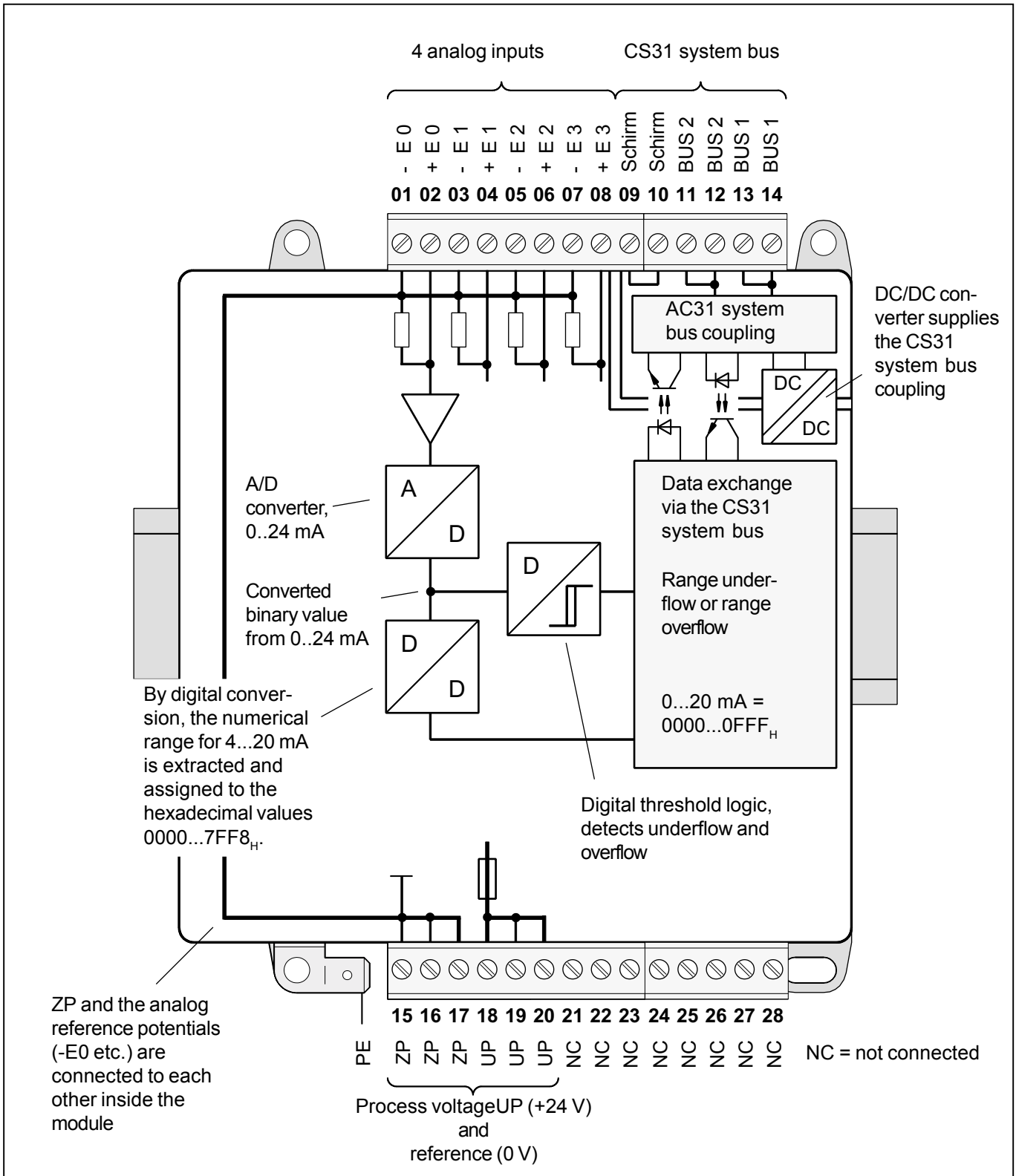


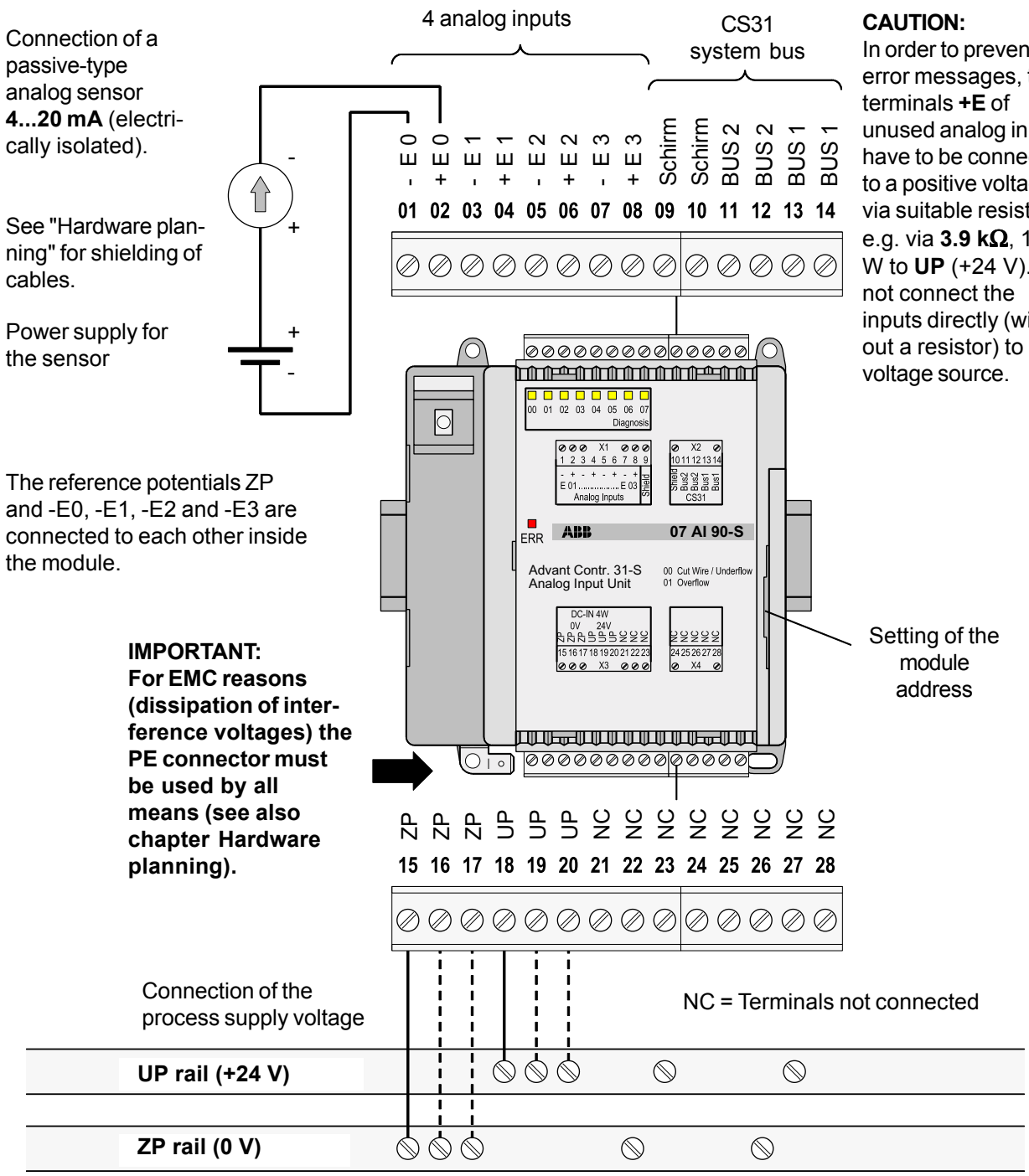
Figure 6-4: 07 AI 90-S, evaluation of the analog input signals

Electrical connection

For the planning of the AC31-S, the safety manual for the AC31-S (this file) must be observed. Here, both the architecture of the PLC program and the construction of the hardware components and their wiring are described in detail.

The module is either snapped-on to a DIN rail or directly screwed on the control cabinet's rear wall. The electrical connection is realized via pluggable terminal blocks. All terminal blocks must be plugged even those which are not used.

The figure on the next page shows the terminal assignment of the module.



CAUTION:
In order to prevent error messages, the terminals **+E** of unused analog inputs have to be connected to a positive voltage via suitable resistors, e.g. via **3.9 kΩ**, 1/2 W to **UP** (+24 V). Do not connect the inputs directly (without a resistor) to a voltage source.

CAUTION: **It is very important to observe the correct voltage polarity: UP = +24 V, ZP = 0 V (reference potential)**

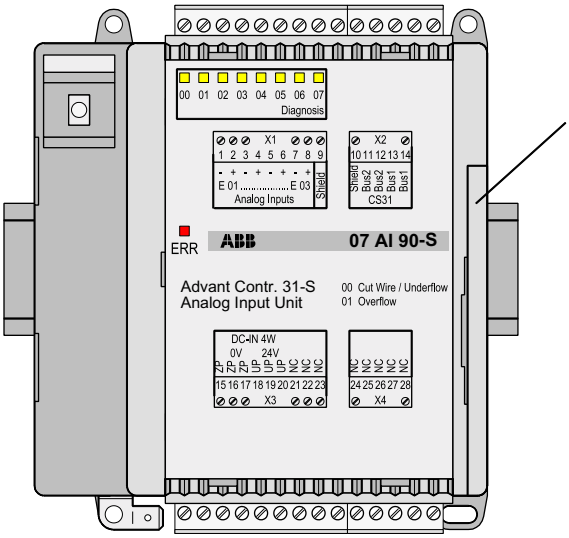
The terminals ZP and UP are intended for the module's supply (see above).

If ZP and UP are looped through from module to module, the following points must be observed:

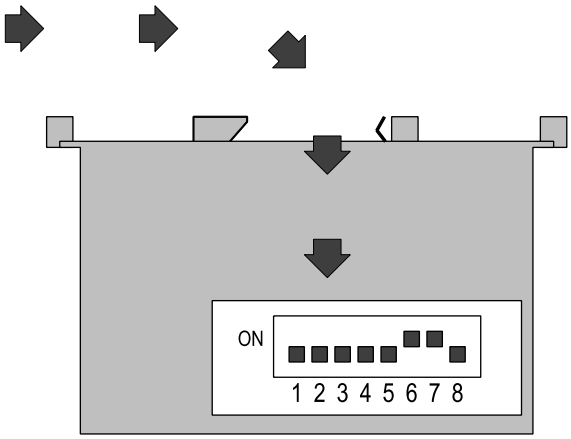
- When unplugging the terminal block, the power supply to the modules connected in series is switched off.
- At the terminals (and the plug-in connections) a total current of 4 A must not be exceeded.

Figure 6-5: 07 AI 90-S, terminal assignment and connection example for a current sensor

Addressing (setting the module address)



Setting the module address (**0...5**) is done using a DIL switch. The switch is accessible after removing the lateral cover. Pull the cover towards the front while tilting it lightly to the right. The switch is provided with a lid.



Meaning of the 8 switches:

Switch 1: must always be set to OFF
Switch 2: must always be set to OFF

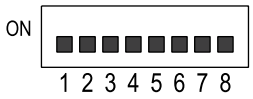
Switch 3: Module addresse bit Bit 4, --> OFF
Switch 4: Module addresse bit Bit 3, --> OFF
Switch 5: Module addresse bit Bit 2, significance 4
Switch 6: Module addresse bit Bit 1, significance 2
Switch 7: Module addresse bit Bit 0, significance 1

The sum of the significance values of the switches in ON position is the set module address,
e.g.: switch 6 = ON, significance = 2 and
switch 7 = ON, significance = 1
results in module address 3.

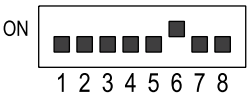
Switch 8: must always be set to OFF

Examples:

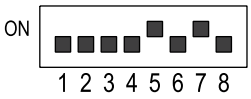
Module address 0
EW 00,00 *



Module address 2
EW 02,00 *



Module address 5
EW 05,00 *



* Address entry at connection element S_LEA

Figure 6-6: 07 AI 90-S, setting of module address at the DIL switch
(see also chapter 3.3 "Configuration data for the I/O modules")

Auxiliary and diagnosis functions

Start-up behaviour

After switching the power supply (UP) on, the LED 'ERR' will light up for approx. 15 sec. during the switch-on self-test of the module.

After that, the LED 'ERR' flashes until the module has been adopted in the CS31 bus cycle.

After the 'ERR' signal has gone out, this shows the correct selftest as well as the end of the initialization and adoption in the CS31 system bus.

If, however, the LED 'ERR' is lighting permanently (>15 sec) after switching on the power supply, an internal error has been detected.

If no external error is present, the LEDs remain dark until the initialization is completed. After that, they indicate an estimate value of the first input channel E0 as follows:

- If the input current is $\leq$ 4 mA, none of the LEDs is lighting.
- With rising input current, first of all LED 01, then additionally LED 02 etc. will light up.
- If the input current is $\geq$ 20 mA, all LEDs light up.

Example:

Input current = 14 mA, the first 5 LEDs are lighting

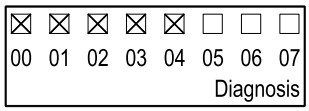


Figure 6-7: Display of the analog input signal with 8 yellow LEDs

After pressing the test pushbutton for the first time, the channel E0 is selected: the related LEDs start flashing. After releasing the pushbutton, the analog value for channel E0 is displayed. The same process can be repeated for channels E1, E2 and E3.

Further diagnosis information are included in the "Worksheet for troubleshooting in terminal mode" in volume 7.

Fuses

The module has an integrated solder-in-type micro-fuse for the supply voltage UP. If this fuse blows, the following error indication takes place:

- The module has no function any more.
- All LEDs are off.

The module has to be replaced.

Diagnosis at the module

The module distinguishes between 2 different error types:

- External errors:
  - Underflow / Cut Wire
    (Input current < 3.6 mA, sensor supplies too little current or the wire is cut)
  - Overflow
    (Input current > 20.4 mA, sensor supplies too much current)
- Internal errors:
  - all other errors

  Remark: For safety reasons, only those errors unambiguously diagnosed by the module as an "External error" are indicated as "External errors". Errors such as "Input signal slightly outside tolerance band" or "Rise of input signal slower than specified" can also lead to an "Internal error" For this reason, the indication of an "Internal error" alone is not a definite indication that the module is defective.

Reaction to external errors:

- The LED 'ERR' starts flashing.
- At the faulty channel, the signal measured last is frozen.
- The error can be requested via the test button of the module.
- The error-free input channels continue the signal processing.
- The channel is marked as faulty via the CE 'S_LEA' for the AC31 central unit.
- After error recovery, the error can be acknowledged with the test button.

Reaction to internal errors:

- The LED 'ERR' and all input channel LEDs are lighting permanently.
- The module stops the processing of all input signals.
- The entire module is marked as faulty via the CE 'S_LEA' for the AC31 central unit.
- After error recovery, the error can be acknowledged by switching the power supply UP OFF and then ON again.

Diagnosis of external errors:

- By pressing the "TEST" pushbutton, the channels are selected subsequently. After pressing this key, the LED of the selected channel starts flashing. After releasing the pushbutton, the error indication of the selected channel (e.g. LED 01 for Underflow) is displayed in the channel LEDs for approx. 2 seconds.

After that, the module switches back to the status indication of an input channels. Now, the next channel can be selected.

- After selecting and querying channel 3, an LED test will be carried out after pressing the test pushbutton (all channel LEDs light up). After releasing the pushbutton, the set module address is displayed for approx. 2 seconds.
- The acknowledgement of external errors is made by pressing the test pushbutton somewhat longer (approx. 5 seconds).

Technical data

Process and supply voltage UP (power supply according to VDE 0551 is necessary)	
rated voltage	24 V DC ± 5 % ripple
upper limit value	24 V DC + 20 % = 28,8 V (± 5 % ripple)
lower limit value	24 V DC - 15 % = 20,4 V (± 5 % ripple)
The supply voltage must rise to at least 19 V within 0 to 40 msec after being switched on.	
Buffered voltage interruption time	> 10 ms
Reference potential ZP	0 V for process voltage UP
Protection against reversed polarity for UP	yes
Number of analog inputs per module	4
Input data	
Measuring range of analog input current	4...20 mA
Output hex values in this range	0000_H....$7FF8_H$, corresponding to 0....32760 decimal
Range of no error indication	3,6...20,4 mA (see Figure 6-3 on page 6-3)
Error indication "Underflow"	if input current < 3.6 mA
Error indication "Overflow"	if input current > 20.4 mA
Range converted by analog converter	0...24 mA
Input can be destroyed	if the input current is > 35 mA or < -35 mA
Measuring error within the entire temperature range	< 1 % of full scale
Resolution	3.91 µA (12 bits)
Input resistance	208.5 Ω
Input delay	typ. 9 ms, monitoring over 30 ms
Max. input frequency	20 Hz
Refresh time	9 ms
Edge steepness with square-wave or saw-tooth signals	0...50 □s or > 50 ms (signals of 50 □s...50 ms lead to an external or to an internal error)
Cable lengths with cables laid in parallel	
shielded	max. 1000 m
Conductor cross section of process terminals	max. 1 x 2.5 mm^2
tightening torque	max. 0.5 Nm
Electrical isolation	from the CS31 system bus
Rated insulation voltage, process terminals from CS31 system bus:	
acc. to VDE 0160, rated direct voltage	0...50 V
test voltage for reinforced insulation	800 V DC
Current consumption (UP)	150 mA
Total power dissipation	max. 4 W
Address setting	see page 6-5
Display of input signals	rough analog value with 8 yellow LEDs, only one channel can be displayed at a time
Error indication	one red LED (ERR)
Safety-related CE (S-CE) in the PLC software	S_LEA : Read analog S-input module
Module-specific CS31 bus transmission time	1050 µs
Dimensions (width x height x depth) in mm	120 x 140 x 85 mm (see next page)
Weight	400 g
Order number 07 AI 90-S	GJR5 2512 00 R202

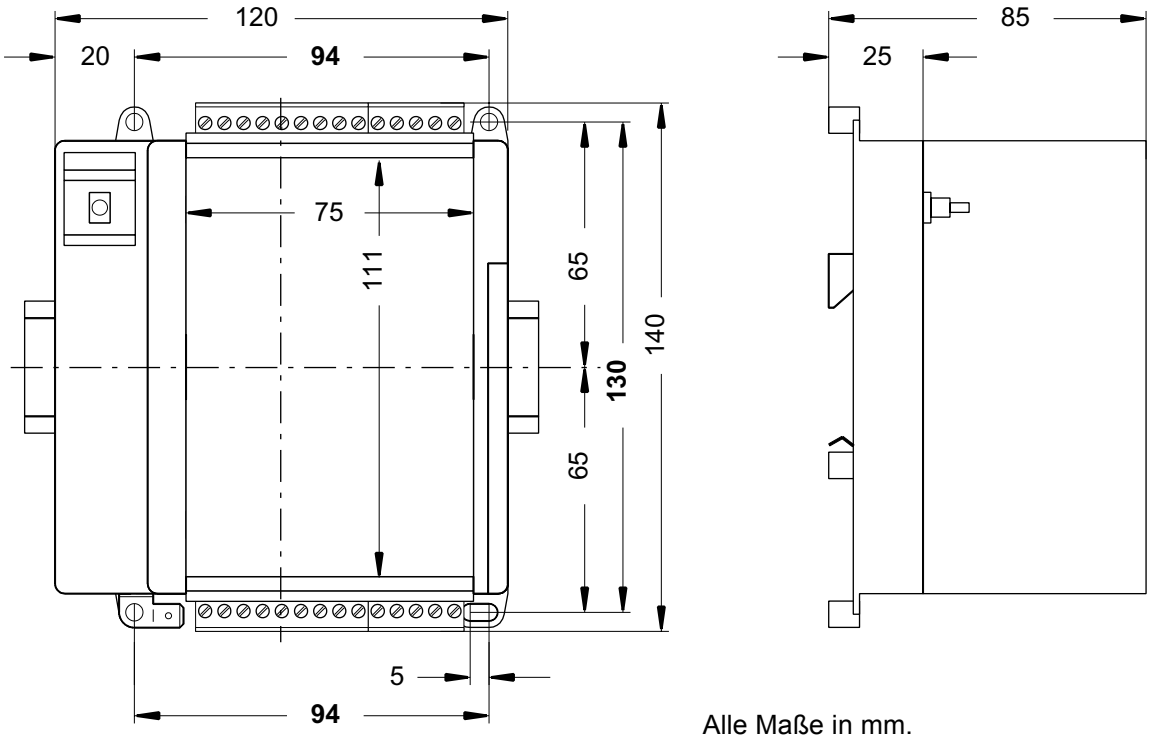
Installation and dimensions

Fixing the module on a DIN rail

The easiest and fastest way to install the module is to snap it on to a DIN rail (acc. to DIN EN 50022-35, 15 mm deep). Neither for the assembly nor for the disassembly, any tools are required. The DIN rail is centered between upper and lower edge of the module.

Fixing the module by screwing

Using 4 M4 screws, the module can be fastened on an assembly surface (e.g. rear wall of the control cabinet). The following drawing shows the position of the fixing holes as well as all important assembly dimensions.



Alle Maße in mm.

The device is 85 mm deep. If a DIN rail is used, the mounting depth is increased by the overall depth of the rail.

Figure 6-8: 07 AI 90-S, outline dimensions, **dimensions for assembly holes are printed in bold**

Mounting hints

Mounting position	Vertical, terminals above and below
Cooling	The natural convection cooling must not be hindered by cable ducts or other material mounted in the control cabinet.