



Visualisation; Diagnostics

Easy to Configure

Programming IEC 61131-3

Rapid Installation

PSS u2 ES 4AI U

PILZ

THE SPIRIT OF SAFETY

- ▶ Control system PSS u2
- ▶ Remote I/O system PSS u2

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SD means Secure Digital

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1 Introduction

1.1 Validity of documentation

This operating manual explains the function and operation, describes the installation and provides guidelines on how to connect the product.

This documentation is valid for the product PSS u2 ES 4AI U. It is valid until new documentation is published.

1.2 Using the documentation

This document is intended for instruction. Only install and commission the product if you have read and understood this document. The document should be retained for future reference.

Please refer to the PSS u2 Installation Manual.

1.3 Definition of symbols

Information that is particularly important is identified as follows:



DANGER!

This warning must be heeded! It warns of a hazardous situation that poses an immediate threat of serious injury and death and indicates preventive measures that can be taken.



WARNING!

This warning must be heeded! It warns of a hazardous situation that could lead to serious injury and death and indicates preventive measures that can be taken.



CAUTION!

This refers to a hazard that can lead to a less serious or minor injury plus material damage, and also provides information on preventive measures that can be taken.



NOTICE

This describes a situation in which the product or devices could be damaged and also provides information on preventive measures that can be taken. It also highlights areas within the text that are of particular importance.



INFORMATION

This gives advice on applications and provides information on special features.

2 Overview

Module structure:

A module consists of

- ▶ an electronic module,
- ▶ a terminal block with cage clamp terminals and
- ▶ a module carrier









The electronic modules are plugged into the backplane and determine the function. The backplane is used for communication between the head module and the electronic modules and forms the carrier unit for the electronic modules. The terminal block is plugged into the electronic modules and is used to connect the field wiring.

Details of the terminal blocks that can be used are available under "Intended Use".

2.1 Module features

Application of the product PSS u2 ES 4AI U:

Electronic module with analogue inputs for standard applications

- ▶ 4 analogue inputs for voltage measurement
- ▶ Each input can be configured separately
- ▶ Resolution: 16 bit
- ▶ **Measuring ranges**  **12**:
 - -12.8 V ... +12.8 V
 - -6.4 V ... +6.4 V
 - -3.2 V ... +3.2 V
- ▶ **Data format**  **19**
 - 16 bit two's complement
 - 15 bit sign and magnitude representation + sign bit (MSB)
- ▶ **Scaling**  **15**
- ▶ **Moving average**  **14**
- ▶ **Monitoring in accordance with NAMUR NE43**  **13**
- ▶ **Range monitoring**  **17**
- ▶ **Threshold value monitoring**  **18**
- ▶ **LED displays**  **33** for:
 - Operating status per input
 - Module error

3 Safety

3.1 Intended use

The module provides analogue inputs. It may be used as an input module for standard functions.

Intended use includes making the electrical installation EMC-compliant. The module is designed for use in an industrial environment. Interference may occur if used in other areas.

The following is deemed improper use in particular

- ▶ Any component, technical or electrical modification to the module,
- ▶ Use of the module outside the areas described in this manual,
- ▶ Any use of the module that is not in accordance with the technical details.

The module PSS u2 ES 4AI U may be used in conjunction with the following terminal block:

- ▶ 16-pin terminal block

3.2 System requirements



INFORMATION

The module is supported by

- ▶ PASconfig from version 3.0
 - We recommend that you always use the latest version (download from www.pilz.com).

3.3 Safety regulations

3.3.1 Use of qualified personnel

The products may only be assembled, installed, programmed, commissioned, operated, maintained and decommissioned by competent persons.

A competent person is a qualified and knowledgeable person who, because of their training, experience and current professional activity, has the specialist knowledge required. To be able to inspect, assess and operate devices, systems and machines, the person has to be informed of the state of the art and the applicable national, European and international laws, directives and standards.

It is the company's responsibility only to employ personnel who

- ▶ Are familiar with the basic regulations concerning health and safety / accident prevention,
- ▶ Have read and understood the information provided in the section entitled Safety
- ▶ Have a good knowledge of the generic and specialist standards applicable to the specific application.

3.3.2 Warranty and liability

All claims to warranty and liability will be rendered invalid if

- ▶ The product was used contrary to the purpose for which it is intended,
- ▶ Damage can be attributed to not having followed the guidelines in the manual,
- ▶ Operating personnel are not suitably qualified,
- ▶ Any type of modification has been made (e.g. exchanging components on the PCB boards, soldering work etc.).

3.3.3 Disposal

- ▶ When decommissioning, please comply with local regulations regarding the disposal of electronic devices (e.g. Electrical and Electronic Equipment Act).

4 Function description

4.1 Block diagram

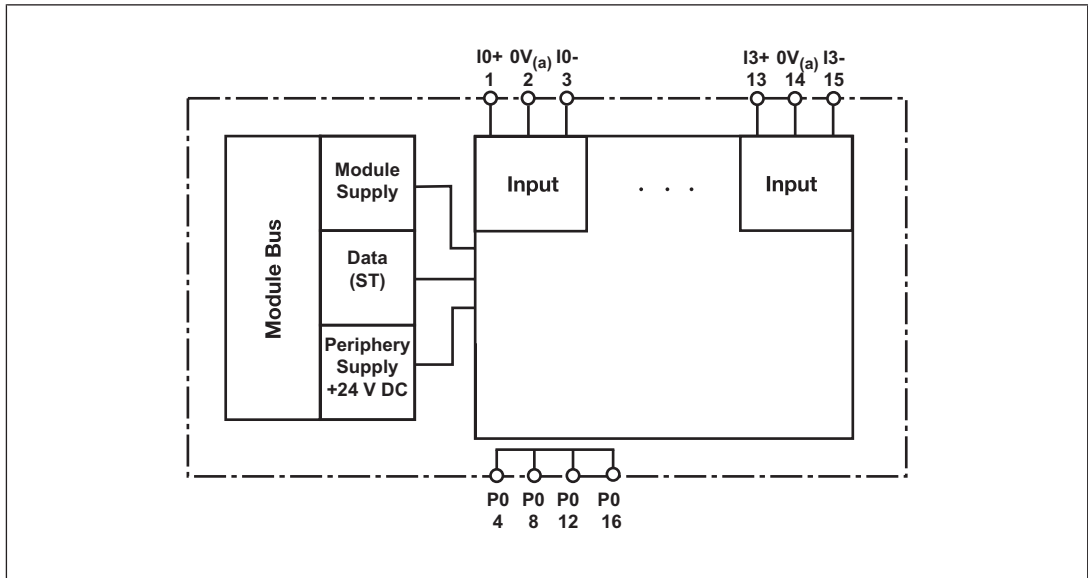


Fig.: Block diagram PSS u2 ES 4AI U

4.2 Supply

- ▶ The module is supplied with voltage via the head module.

4.3 Signal processing

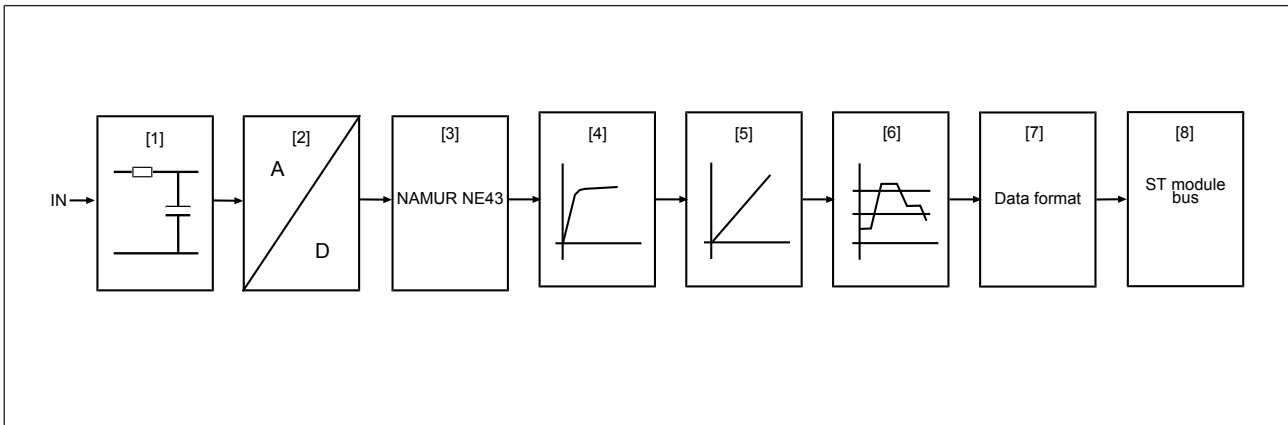


Fig.: Schematic representation of signal processing

- ▶ [1] Input filter
The analogue signal is pre-filtered.
- ▶ [2] A/D converter
The analogue signal is converted into a digital signal with a 16 bit resolution (65 536 steps).
- ▶ [3] Monitoring in accordance with NAMUR NE43
Workspace monitoring can be activated for the digital signal in order to detect wiring faults.
- ▶ [4] Moving averaging
A digital filter can be activated for the digital signal.
- ▶ [5] Scaling
The digital signal can be scaled to a 16 bit value.
- ▶ [6] Area and threshold value monitoring
The digital signal can be monitored to check if ranges and threshold values have been exceeded.
- ▶ [7] Data format
The data format enables the scaled value to be represented as a two's complement or as sign and magnitude.
- ▶ [8] ST module bus
The input signal is transmitted to the head module via the ST module bus. As an option the input module can send status information for each input. All the configuration data is stored in the head module and is assigned to the input module on restart. This way the configuration data is retained even if you change the input module.

4.4 Measuring range

The module has three measuring ranges:

- ▶ -12.8 ... + 12.8 V
- ▶ -6.4 ... +6.4 V
- ▶ -3.2 ... +3.2 V

The module is suitable for connecting sensors with a voltage output that lies inside the module's measuring ranges.

If the value moves outside the module's measuring range, the valid bit of the corresponding input in the user program is set to 0 and an error message is issued. The measured positive or negative maximum value will continue to be registered in the user program as the input value.

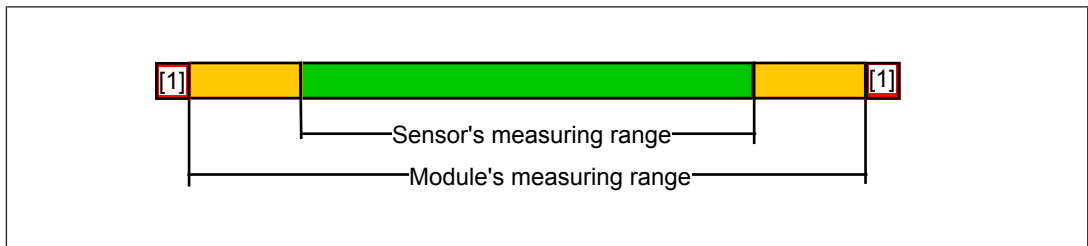


Fig.: Relationship between the module's measuring range and the sensor's measuring range

Legend

- [1] Measuring range exceeded
- Valid bit = 0

4.5 Monitoring in accordance with NAMUR NE43

For monitoring in accordance with NAMUR NE43, the default limit values for current signals as defined in the NAMUR NE43 recommendation have been transferred proportionally to the module's voltage ranges. If you monitor the input value in accordance with NAMUR NE43 you can define a workspace that is used to detect sensor faults or faults in the wiring, such as open circuit or short circuit. Monitoring in accordance with NAMUR NE43 works with the value before it is scaled. An error message is issued if the value moves outside the limit values. The fact that the values move outside the limit values will also be registered in the user program.

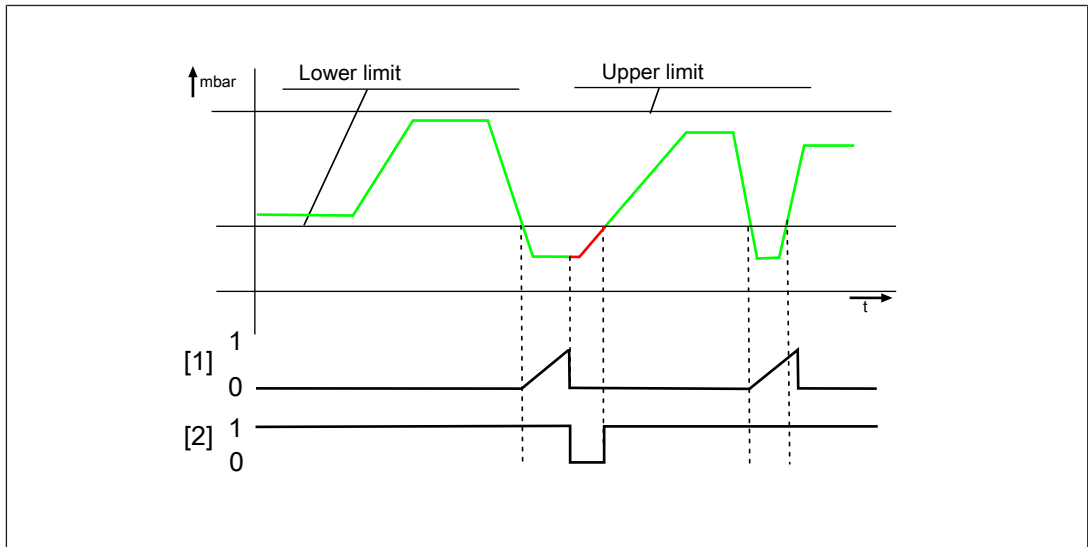


Fig.: Example of values moving outside the lower limit value

Legend

- [1] Configurable time for which values outside the limit values will be tolerated
- [2] The fact that the values moved outside the limit values in accordance with NAMUR NE43 is registered in the user program.

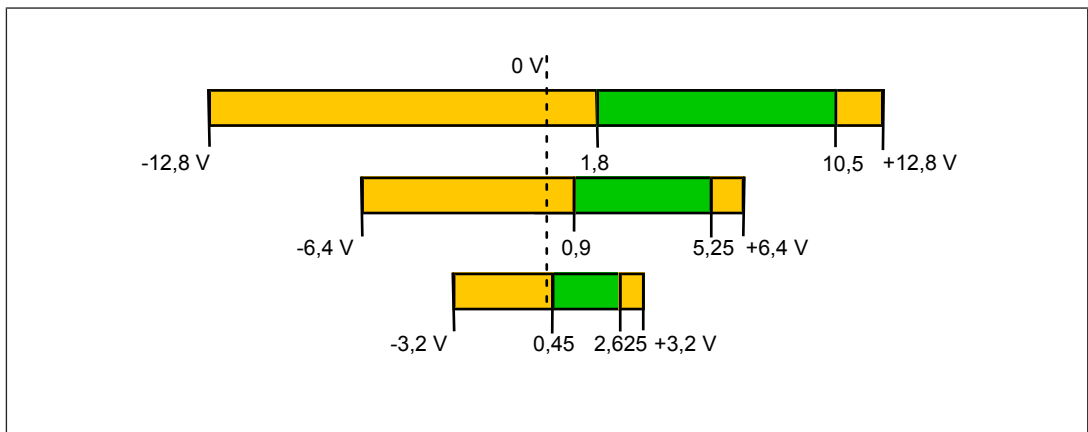


Fig.: Default limit values in accordance with NAMUR NE43, depending on the measuring ranges

The limit values and the duration can be configured. If the NAMUR NE43 recommendation is active, the following default values apply:

- ▶ **Lower limit value:** 4608_D (depending on the measuring range 1.8 V, 0.9 V, 0.45 V) (e.g. open circuit)

- ▶ **Upper limit value:** 26880_D (depending on the measuring range 10.5 V, 5.25 V, 2.625 V) (e.g. short circuit to the supply voltage or sensor fault)
- ▶ Period for which an overshoot or undershoot will be tolerated: 1 ms

The NAMUR recommendation NE 43 to standardise the signal level for failure Information can be activated. We recommend compliance with NAMUR recommendation NE 43.

4.6 Moving average

A digital filter can suppress interference frequencies in the input signals. The filter is implemented by forming the moving average. When forming the moving average, the sum of the latest sampled results is used to calculate an average. The module has a cycle time of 0.1 ms. With a cycle time of 0.1 ms, the input signal is sampled with a frequency of 10 kHz. The number of sampled results and the period over which the average is calculated is configurable in the following steps:

- ▶ 0.1 ms (no filtering)
- ▶ 0.2 ms
- ▶ 0.5 ms
- ▶ Default setting 1 ms
- ▶ 2 ms
- ▶ 5 ms
- ▶ 10 ms
- ▶ 17 ms, for 60 Hz interference attenuation
- ▶ 20 ms, for 50 Hz interference attenuation

Special features and examples:

- ▶ 0.1 ms
There is no filtering. The result corresponds to the sampled value.
- ▶ 0.2 ms
The moving average is calculated over 2 cycle times.
- ▶ 0.5 ms
The moving average is calculated over 5 cycle times.
- ▶ 1 ms
The prefilter is active (see section entitled "Operating principle of the prefilter"). The prefilter supplies an average as the result of averaging over 10 cycle times. No additional moving average is formed (division by 1).
- ▶ 2 ms
The prefilter is active (see section entitled "Operating principle of the prefilter"). The moving average for the filter is calculated from 2 averages from the prefilter.
- ▶ 5 ms
The prefilter is active (see section entitled "Operating principle of the prefilter"). The moving average for the filter is calculated from 5 averages from the prefilter.
- ▶ 10 ms
The prefilter is active (see section entitled "Operating principle of the prefilter"). The moving average for the filter is calculated from 10 averages from the prefilter.

▶ 17 ms

The prefilter is active (see section entitled "Operating principle of the prefilter"). The moving average for the filter is calculated from 17 averages from the prefilter.

This setting includes interference frequency suppression of 60 Hz.

▶ 20 ms

The prefilter is active (see section entitled "Operating principle of the prefilter"). The moving average for the filter is calculated from 20 averages from the prefilter.

This setting includes interference frequency suppression of 50 Hz.

Operating principle of the prefilter

- ▶ The prefilter is activated from a filter setting ≥ 1 ms. The prefilter cycle time is 1 ms. The prefilter records 10 measured values in the space of one module cycle time of 0.1 ms. Of these 10 measured values, the largest and the smallest recorded measured values are rejected and an average is calculated from the remaining 8 values. The prefilter supplies a new value every 1 ms.



INFORMATION

A filter always results in attenuation and a delay of the (input) signal.

4.7

Scaling

The scaling function can be used to convert the digitalised measured value into a scaled digital value. The scaled measured value is represented with a 16 bit resolution (-32768D... 32767D) and is registered in the user program. The default values are selected to give a scaling with gradient **m** of 256 and an offset (y axis intercept) of 0. If the scaled digital value is outside the range of values that can be represented, the input's valid bit is set to 0 and an error message is issued.

Scaling can only be used with linear input variables.

- ▶ The digitalised measured value signal is scaled over a two-point characteristic.
- ▶ Any two points on a straight line can be selected.
- ▶ The two points are configured as follows:
 - Lower limit value of the measuring range (MeasuringLow): Point 1 on the X-axis
 - Upper limit value of the measuring range (MeasuringHigh): Point 2 on the X-axis
 - Lower limit value of the scaled range (ScaledLow): Point 1 on the Y-axis
 - Upper limit value of the scaled range (ScaledHigh): Point 2 on the Y-axis

Calculating the scaled digital value from the digitalised measured value:

- ▶ Calculating the gradient **m**:

$$m = ((\text{ScaledHigh} - \text{ScaledLow}) * 256) / (\text{MeasuringHigh} - \text{MeasuringLow})$$

- ▶ Calculating the offset **b**:

$$b = ((\text{ScaledHigh} * 256) - (m * \text{MeasuringHigh})) / 256$$

- ▶ Calculating the scaled value **y**:

$$y = ((m * x) / 256) + b$$
- ▶ The value **y** is available as a scaled digital value in the user program.
- ▶ The default values are selected to give a scaling with gradient **m** of 256 and an offset of 0.

Example:

In this example, a pressure of 0 to 10,000 mbar is monitored.

MeasuringLow	Lower limit value of the measuring range	4608D
MeasuringHigh	Upper limit value of the measuring range	26880D
ScaledLow	Lower limit value of the scaled range	0 bar
ScaledHigh	Upper limit value of the scaled range	10 000 mbar

- ▶ **Gradient m** = $((\text{ScaledHigh} - \text{ScaledLow}) * 256) / (\text{MeasuringHigh} - \text{MeasuringLow}) = ((10000D - 0D) * 256 / (26880D - 4608D)) = 114$
- ▶ **Offset b** = $((\text{ScaledHigh} * 256) - (m * \text{MeasuringHigh})) / 256 = ((10\ 000D * 256) - (114 * 26\ 880D)) / 256 = -1970D$

Scaled digital value y = $((m * x) / 256) + b = (114 * x) / 256 - 1970D$

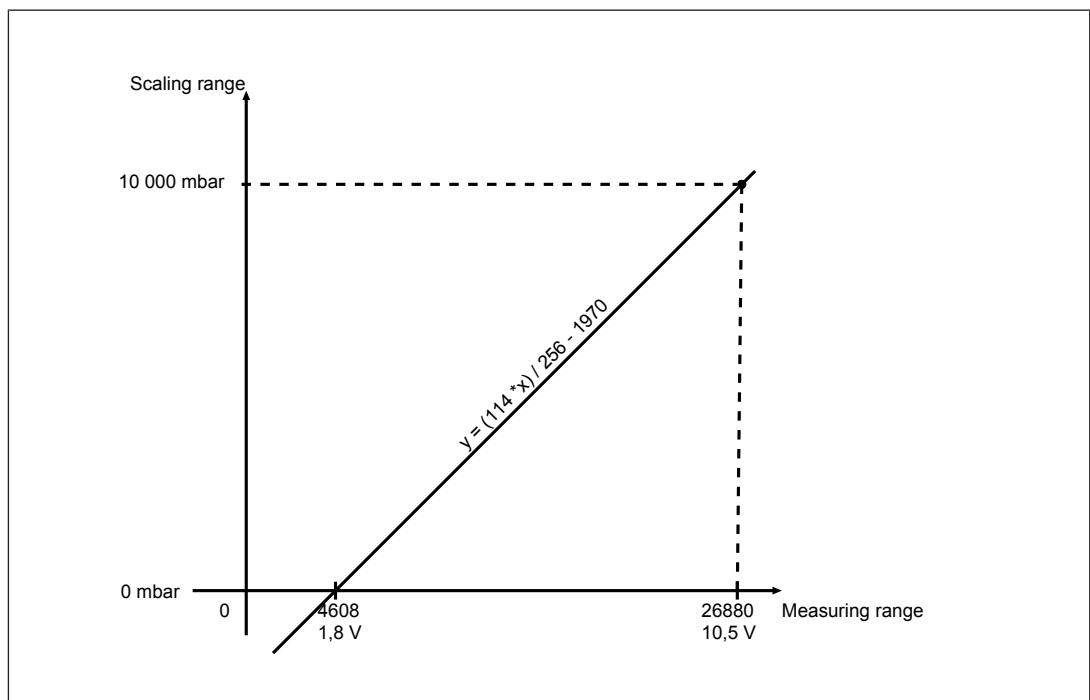


Fig.: Scaling

Legend

Scaling range Scaled values
 Measuring range Measured voltage values

**INFORMATION**

Scaling may influence the accuracy of the digitalised measured value.

4.8 Range monitoring

Range monitoring works with the scaled digital value. Up to 4 individually configurable ranges can be monitored per input. Range monitoring compares the upper and lower limit value for each configured range with the digital value after scaling and registers the result of the comparison in the user program. If a value moves outside a range, the measured scaled digital value will continue to be registered in the process image.

The result is "1" when the following condition is met:

- ▶ Configured lower limit value \leq Scaled digital value \leq Configured upper limit value

If the scaled digital value is outside a range's lower or upper limit value, then the result for this range will be "0".

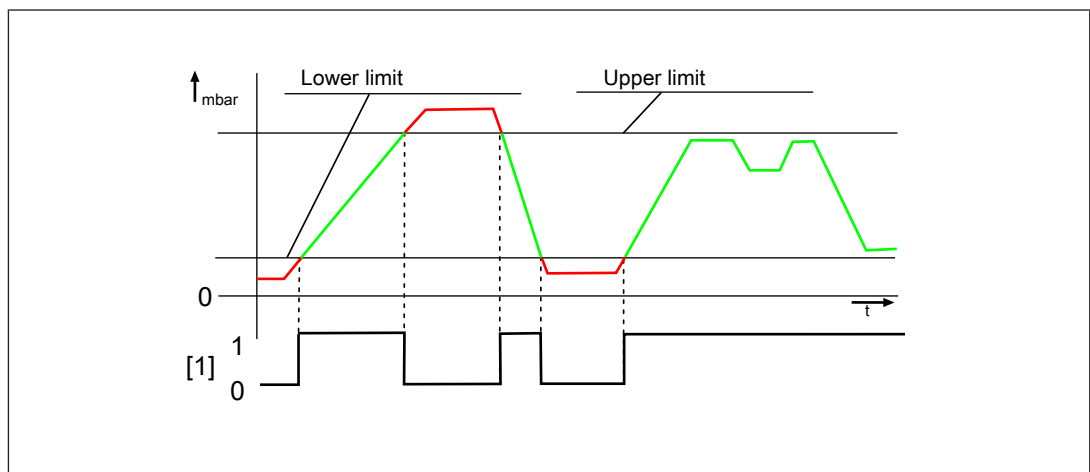


Fig.: Range monitoring

Legend

[1] Evaluation of range monitoring in the user program

Example:

In this example, the scaled values from 0 to 10,000 mbar from the [Scaling \[17\]](#) chapter are to be used. If the pressure falls below 2,000 mbar or exceeds 8,000 mbar, the fact that the range has been exceeded is to be registered in the user program.

Configuration:

Lower limit value: 2,000 mbar

Upper limit value: 8,000 mbar

4.9 Threshold value monitoring

8 thresholds per input can be defined; these can be used to monitor the scaled signal. As a result, various warning and fault levels can be set up when monitoring physical values, for example.

Each threshold consists of a lower and an upper threshold value. The result of monitoring is registered in the user program. For each threshold it is possible to configure whether to register in the user program that the value has exceeded the upper threshold value or fallen below the lower threshold value.

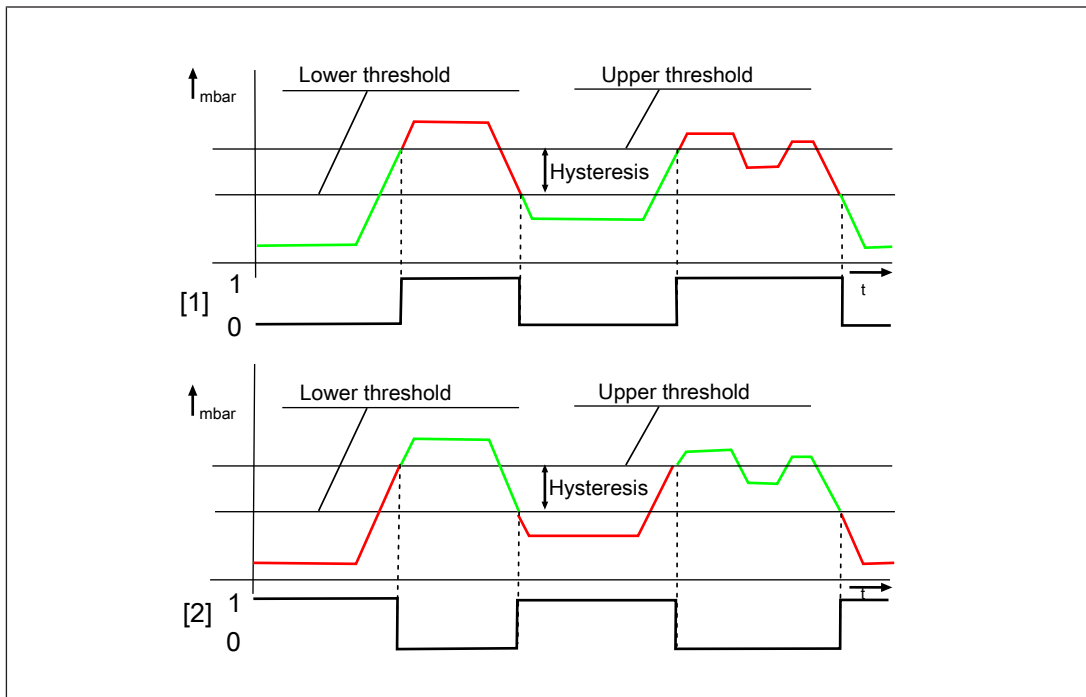


Fig.: Threshold value monitoring

Legend

- [1] Configuration-dependent evaluation of the threshold value in the user program:
 - ▶ Threshold value is set when the value has exceeded the upper threshold value.
 - ▶ Threshold value is reset when the value falls below the lower threshold value.
- [2] Configuration-dependent evaluation of the threshold value in the user program:
 - ▶ Threshold value is set when the value falls below the lower threshold value.
 - ▶ Threshold value is reset when the value exceeds the upper threshold value.

Example:

In this example, the scaled values from 0 to 10,000 mbar from the [Scaling \[17\]](#) chapter are to be used. If the pressure of 8,000 mbar is exceeded, the fact that the threshold value has been exceeded is to be registered in the user program.

Configuration:

Lower threshold value: 2,000 mbar

Upper threshold value: 8,000 mbar

4.10 Data format

The data format enables the scaled digital value to be represented as:

► Two's complement

The scaled digital values are transferred with 16 bits.

► Sign and magnitude

The scaled digital values are transferred with 15 bits plus a sign bit (MSB). The MSB is "1" with negative values and "0" with positive values.

Sign and magnitude representation and two's complement representation differ only on negative values.

Analogue value in a two's complement with default values for scaling:

Analogue value -3.2 V ... +3.2 V	Analogue value -6.4 V ... +6.4 V	Analogue value -12.8 V ... +12.8 V	Binary	Hexadecimal	Decimal
3.199902344 V (3.2 V – 1 LSB)	6.399804688 V (6.4 V – 1 LSB)	12.799609375 V (12.8 V – 1 LSB)	0111 1111 1111 1111	7FFF _H	32767
2.5 V	5 V	10 V	0110 0100 0000 0000	6400 _H	25600
1.875 V	3.75 V	7.5 V	0100 1011 0000 0000	4B00 _H	19200
1.25 V	2.5 V	5 V	0011 0010 0000 0000	3200 _H	12800
0.625 V	1.25 V	2.5 V	0001 1001 0000 0000	1900 _H	6400
0.125 V	0.25 V	0.5 V	0000 0101 0000 0000	0500 _H	1280
12.5 mV	25 mV	50 mV	0000 0000 1000 0000	0080 _H	128
6.25 mV	12.5 mV	25 mV	0000 0000 0100 0000	0040 _H	64
3.125 mV	6.25 mV	12.5 mV	0000 0000 0010 0000	0020 _H	32
1.5625 mV	3.125 mV	6.25 mV	0000 0000 0001 0000	0010 _H	16
781.25 µV	1.5625 mV	3.125 mV	0000 0000 0000 1000	0008 _H	8
390.625 µV	781.25 µV	1.5625 mV	0000 0000 0000 0100	0004 _H	4
195.3125 µV	390.625 µV	781.25 µV	0000 0000 0000 0010	0002 _H	2
97.65625 µV	195.3125 µV	390.625 µV	0000 0000 0000 0001	0001 _H	1
0 V	0 V	0 V	0000 0000 0000 0000	0000 _H	0
- 97.65625 µV	- 195.3125 µV	- 390.625 µV	1111 1111 1111 1111	FFFF _H	- 1
- 195.3125 µV	- 390.625 µV	- 781.25 µV	1111 1111 1111 1110	FFFE _H	- 2
- 1.25 V	- 2.5 V	- 5 V	1100 1110 0000 0000	CE00 _H	- 12800
- 2.5 V	- 5 V	- 10 V	1001 1100 0000 0000	9C00 _H	- 25600
- 3.2 V	- 6.4 V	- 12.8 V	1000 0000 0000 0000	8000 _H	- 32768

Analogue value in a sign and magnitude with default values for scaling:

Analogue value -3.2 V ... +3.2 V	Analogue value -6.4 V ... +6.4 V	Analogue value -12.8 V ... +12.8 V	Binary	Hexadecimal	Decimal
3.199902344 V (3.2 V – 1 LSB)	6.399804688 V (6.4 V – 1 LSB)	12.799609375 V (12.8 V – 1 LSB)	0111 1111 1111 1111	7FFF _H	32767
2.5 V	5 V	10 V	0110 0100 0000 0000	6400 _H	25600
1.875 V	3.75 V	7.5 V	0100 1011 0000 0000	4B00 _H	19200
1.25 V	2.5 V	5 V	0011 0010 0000 0000	3200 _H	12800
0.625 V	1.25 V	2.5 V	0001 1001 0000 0000	1900 _H	6400
0.125 V	0.25 V	0.5 V	0000 0101 0000 0000	0500 _H	1280
12.5 mV	25 mV	50 mV	0000 0000 1000 0000	0080 _H	128
6.25 mV	12.5 mV	25 mV	0000 0000 0100 0000	0040 _H	64
3.125 mV	6.25 mV	12.5 mV	0000 0000 0010 0000	0020 _H	32
1.5625 mV	3.125 mV	6.25 mV	0000 0000 0001 0000	0010 _H	16
781.25 µV	1.5625 mV	3.125 mV	0000 0000 0000 1000	0008 _H	8
390.625 µV	781.25 µV	1.5625 mV	0000 0000 0000 0100	0004 _H	4
195.3125 µV	390.625 µV	781.25 µV	0000 0000 0000 0010	0002 _H	2
97.65625 µV	195.3125 µV	390.625 µV	0000 0000 0000 0001	0001 _H	1
0 V	0 V	0 V	0000 0000 0000 0000	0000 _H	0
- 97.65625 µV	- 195.3125 µV	- 390.625 µV	1000 0000 0000 0001	8001 _H	- 1
- 195.3125 µV	- 390.625 µV	- 781.25 µV	1000 0000 0000 0010	8002 _H	- 2
- 1.25 V	- 2.5 V	- 5 V	1011 0010 0000 0000	B200 _H	- 12800
- 2.5 V	- 5 V	- 10 V	1110 0100 1100 1000	E4C8 _H	- 25600
- 3.2 V	- 6.4 V	- 12.8 V	1111 1111 1111 1111	FFFF _H	- 32767

4.11 Summary of configuration options

The module has the following configuration options:

Configurable properties	Default value	Meaning
Measuring range	-12.8 V ... +12.8 V	Module's largest measuring range
Use NAMUR NE43 monitoring	No	deactivated
NAMUR NE43 lower limit value	4608 _D	1.8 V
NAMUR NE43 upper limit value	26880 _D	10.5 V
NAMUR NE43 Timeout	1 ms	Period for which an overshoot or undershoot will be tolerated
Filter time for averaging	1 ms	The prefilter supplies an average as the result of averaging over 10 cycle times (see section "Operating principle of the prefilter").

Configurable properties	Default value	Meaning
Scaling lower limit value of the measuring range	-32768 _D	Lower measuring range limit
Scaling upper limit value of the measuring range	32767 _D	Upper measuring range limit
Scaling lower limit value of the measuring range	-32768 _D	Lower limit of the number range that can be represented
Scaling upper limit value of the scaled range	32767 _D	Upper limit of number range that can be represented
Range monitoring lower limit value	-32768 _D	Lower limit of the number range that can be represented
Range monitoring upper limit value	32768 _D	Upper limit of number range that can be represented
Threshold monitoring lower threshold value	-32768 _D	Lower limit of the number range that can be represented
Threshold monitoring upper threshold value	32768 _D	Upper limit of number range that can be represented
Operator for threshold monitoring	Value below the lower threshold value	Undershooting of the lower threshold value is signalled in the user program.
Data format	Two's complement	Two's complement is activated

4.12 Reaction times

When calculating reaction times, please note that a used digital filter in the form of a moving averaging always results in attenuation and a delay of the (input) signal.

Detailed information on the reaction times is available in the operating manual of the head modules.

4.13 Energy-saving functions

The energy-saving levels are controlled by the head module and are not configurable. The module supports the following energy-saving levels:

► Switching off the LEDs

The LEDs have two energy-saving levels:

- Switching off the LEDs to display the terminal status
- Switching off the LEDs to display the module and terminal status

► Standby mode

- All module functions are inactive.
- The LEDs for displaying the module and terminal status are switched off.

5 Structure of the process image

Byte	Input	Bit	Meaning	Values
0	I0	0	Valid bit	1: Input value is valid 0: Input value is invalid
		1	NAMUR NE43	1: Inside the range 0: Outside the range
		2	---	---
		3	---	---
		4	Range monitoring 1	1: Inside the defined range 0: Outside the defined range
		5	Range monitoring 2	1: Inside the defined range 0: Outside the defined range
		6	Range monitoring 3	1: Inside the defined range 0: Outside the defined range
		7	Range monitoring 4	1: Inside the defined range 0: Outside the defined range
1		0 ... 7	Threshold value monitoring Threshold 1 (Bit 0) to threshold 8 (Bit 7)	1: Exceeds or falls below threshold value 0: Does not exceed or fall below threshold value
2	I1	0	Valid bit	1: Input value is valid 0: Input value is invalid
		1	NAMUR NE43	1: Inside the range 0: Outside the range
		2	---	---
		3	---	---
		4	Range monitoring 1	1: Inside the defined range 0: Outside the defined range
		5	Range monitoring 2	1: Inside the defined range 0: Outside the defined range
		6	Range monitoring 3	1: Inside the defined range 0: Outside the defined range
		7	Range monitoring 4	1: Inside the defined range 0: Outside the defined range
3		0 ... 7	Threshold value monitoring Threshold 1 (Bit 0) to threshold 8 (Bit 7)	1: Exceeds or falls below threshold value 0: Does not exceed or fall below threshold value

Byte	Input	Bit	Meaning	Values
4	I2	0	Valid bit	1: Input value is valid 0: Input value is invalid
		1	NAMUR NE43	1: Inside the range 0: Outside the range
		2	---	---
		3	---	---
		4	Range monitoring 1	1: Inside the defined range 0: Outside the defined range
		5	Range monitoring 2	1: Inside the defined range 0: Outside the defined range
		6	Range monitoring 3	1: Inside the defined range 0: Outside the defined range
		7	Range monitoring 4	1: Inside the defined range 0: Outside the defined range
5		0 ... 7	Threshold value monitoring Threshold 1 (Bit 0) to threshold 8 (Bit 7)	1: Exceeds or falls below threshold value 0: Does not exceed or fall below threshold value
6	I3	0	Valid bit	1: Input value is valid 0: Input value is invalid
		1	NAMUR NE43	1: Inside the range 0: Outside the range
		2	---	---
		3	---	---
		4	Range monitoring 1	1: Inside the defined range 0: Outside the defined range
		5	Range monitoring 2	1: Inside the defined range 0: Outside the defined range
		6	Range monitoring 3	1: Inside the defined range 0: Outside the defined range
		7	Range monitoring 4	1: Inside the defined range 0: Outside the defined range
7		0 ... 7	Threshold value monitoring Threshold 1 (Bit 0) to threshold 8 (Bit 7)	1: Exceeds or falls below threshold value 0: Does not exceed or fall below threshold value
8, 9	I0		Scaled input value of I0	-32768D ... 32767D
10, 11	I1		Scaled input value of I1	-32768D ... 32767D
12, 13	I2		Scaled input value of I2	-32768D ... 32767D

Byte	Input	Bit	Meaning	Values
14, 15	I3		Scaled input value of I3	-32768D ... 32767D

6 Installation

6.1 General installation guidelines



NOTICE

Damage due to electrostatic discharge!

Electrostatic discharge can damage components. Ensure against discharge before touching the product, e.g. by touching an earthed, conductive surface or by wearing an earthed armband.

6.1.1 Dimensions

The dimensions include the backplane, electronic module and terminal block.

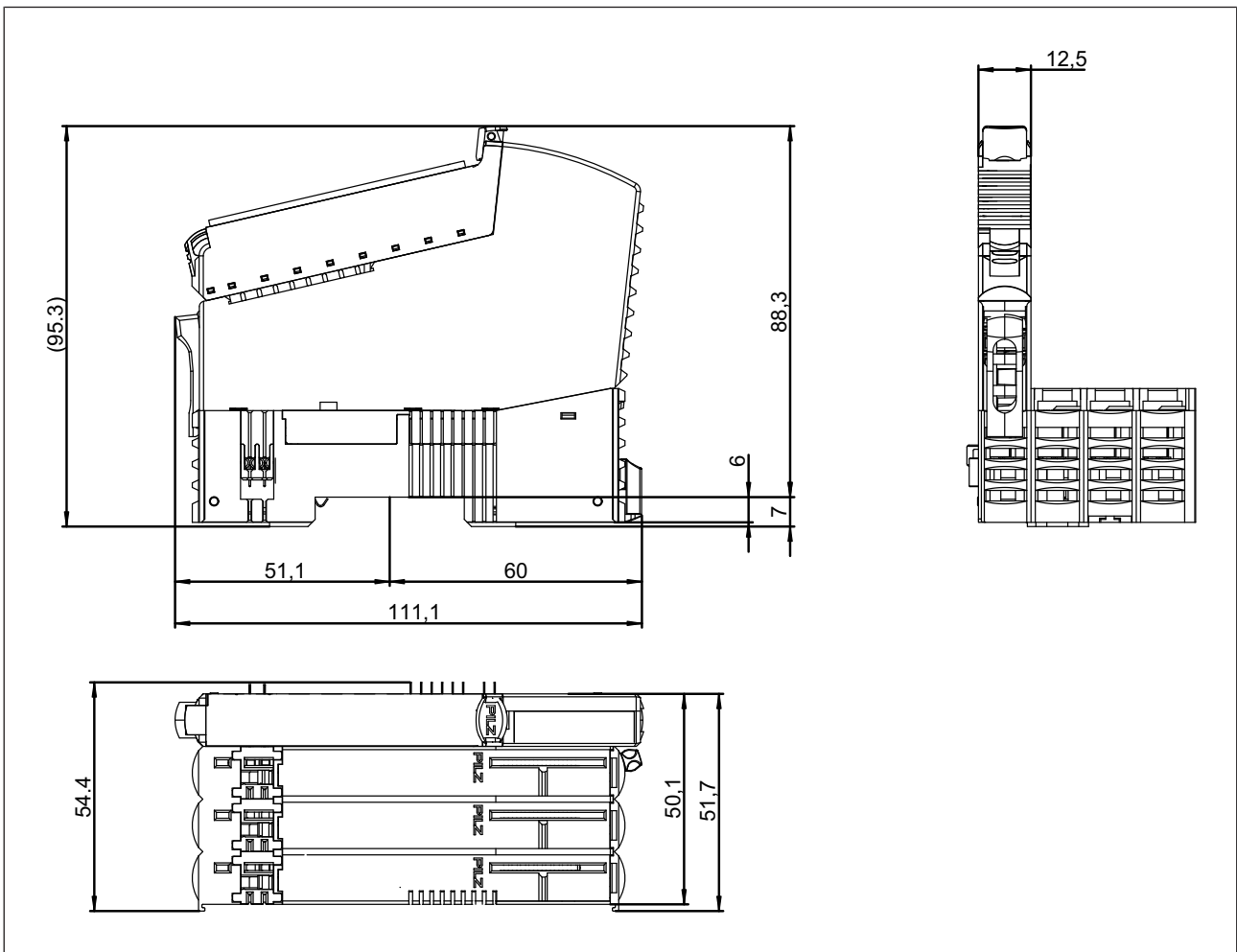


Fig.: Dimensions in mm, including backplane, electronic module and terminal block

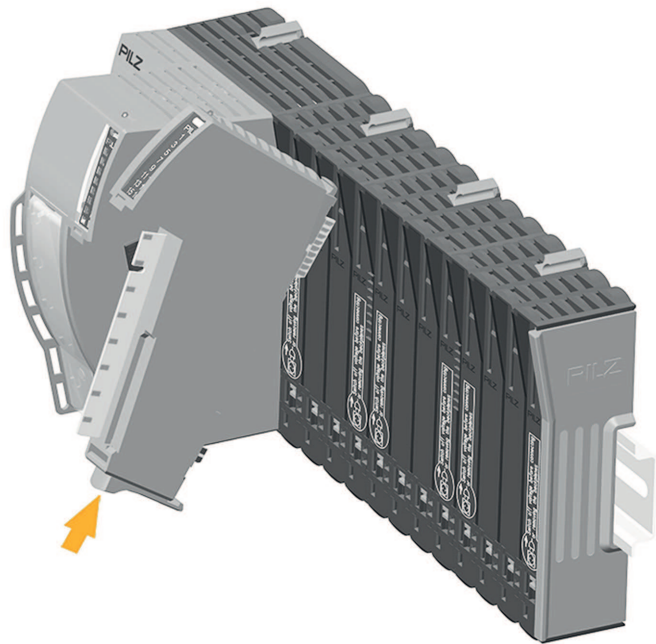
6.2 Inserting and removing an electronic module

Please note:

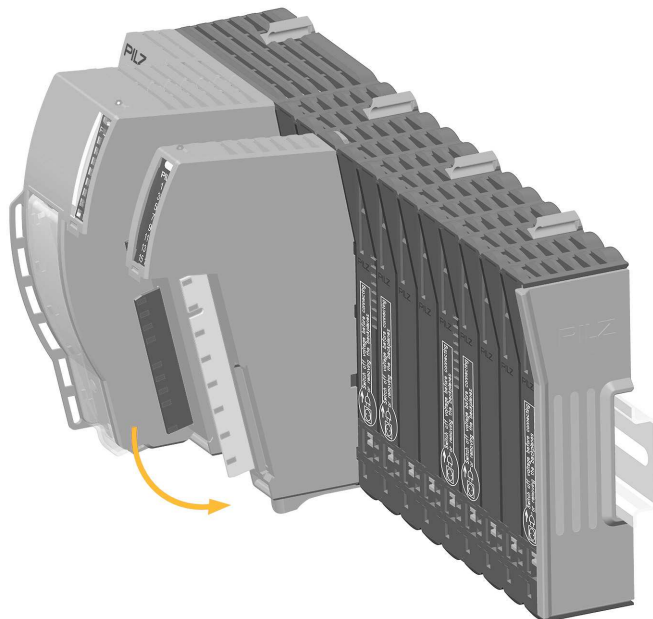
- ▶ Backplane must be installed first.
- ▶ Electronic modules may only be plugged or unplugged if the terminal block has been removed first.
- ▶ The mechanics of the electronic modules are designed for 20 plug in/out cycles.

6.2.1 Inserting an electronic module

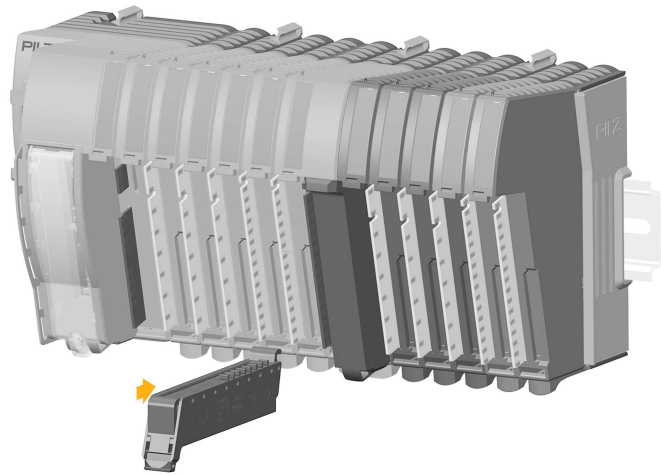
1. Insert the electronic module into the suspension lug on the backplane.



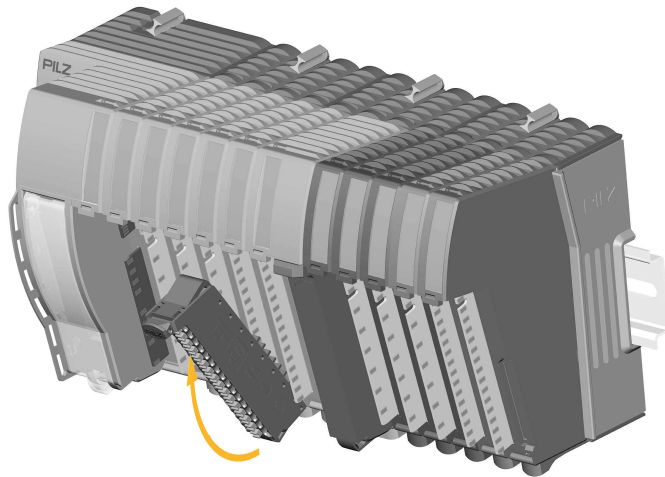
2. Swivel the electronic module downwards until you hear it click into place.



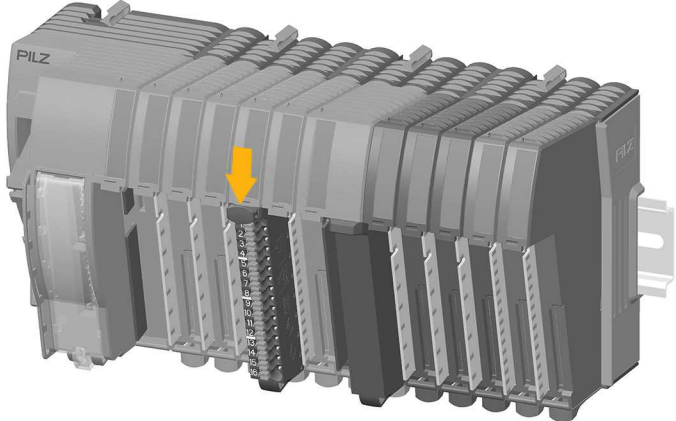
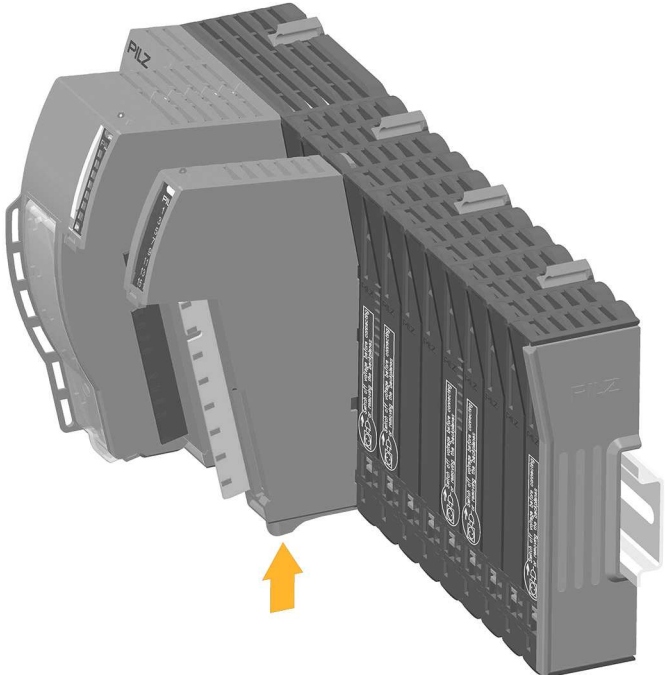
3. Insert the terminal block into the suspension lug on the module.



4. Swivel the terminal block upwards until you hear it click into place.



6.2.2 Removing an electronic module

<p>1. Press the unlocking mechanism on the terminal block that is shown by the arrow and pull off the terminal block forward.</p>	
<p>2. Press the unlocking mechanism that is shown by the arrow and pull off the electronic module upwards.</p>	



6.2.3 Changing an electronic module during operation

An electronic module can be hot swapped.

Effects:

- ▶ Module bus communication between the other modules is not interrupted.
- ▶ The configuration data is retained.
- ▶ The module is detected automatically as soon as the module is re-inserted.

Procedure:

1. [Removing an electronic module](#) [ 28]
2. [Inserting an electronic module](#) [ 26]

A new electronic module can be inserted during operation.

Procedure:


- ▶ [Inserting an electronic module](#)  26]

Effects:

- ▶ Module bus communication between the other modules is not interrupted.
- ▶ To detect the new module the following steps can be necessary:
 - Creating a new configuration or changing an existing configuration
 - Download of the configuration to the head module
 - Restart of the head module. After a restart, the system behaves as after a warm reset using a reset pushbutton (see operating manual of the head module, chapter "Reset pushbutton", section "Carrying out a warm reset (restart)").

7 Wiring

7.1 General wiring guidelines

- ▶ The supply voltages of the actuators and encoders must meet the regulations for extra low voltages with safe separation (SELV, PELV). Failure to do so could result in electric shock.
- ▶ When connecting sensors please note the following requirements:
 - Connect all the input signals to a common reference potential or
 - connect only potentially isolated input signals or
 - use only one input of the module.
- ▶ Use shielded signal cables. The optional shield connection element can be used to connect the shield (see [Accessories](#) [ 38]).
- ▶ Use copper wiring.
- ▶ Analogue input modules detect even very small signal changes. They are therefore much more sensitive than digital inputs. In a particularly disturbed environment it can happen that signal changes caused by interferences are also detected.

In these cases, we recommend the following measures:

- Earth the mounting rail on both sides of the modules.
- Earth the shield connection of the cables on both sides (on the sensor and either on the module or directly on the point where the cable enters the control cabinet).
- Ensure that no transient currents flow across the cable screening, which may damage the cables or the connectors.

7.2 Terminal configuration

Terminal	Terminal configuration
1	I0+ voltage input positive
2	0V _(a) ground analogue input
3	I0- voltage input negative
4	P0 shield connection
5	I1+ voltage input positive
6	0V _(a) ground analogue input
7	I1- voltage input negative
8	P0 shield connection
9	I2+ voltage input positive
10	0V _(a) ground analogue input
11	I2- voltage input negative
12	P0 shield connection
13	I3+ voltage input positive
14	0V _(a) ground analogue input

Terminal	Terminal configuration
15	I3- voltage input negative
16	P0 shield connection

7.2.1 Connection examples

In an EMC-disturbed environment, the sensors must be supplied from separate voltage sources and the analogue ground $0V_{(a)}$ must not be connected.

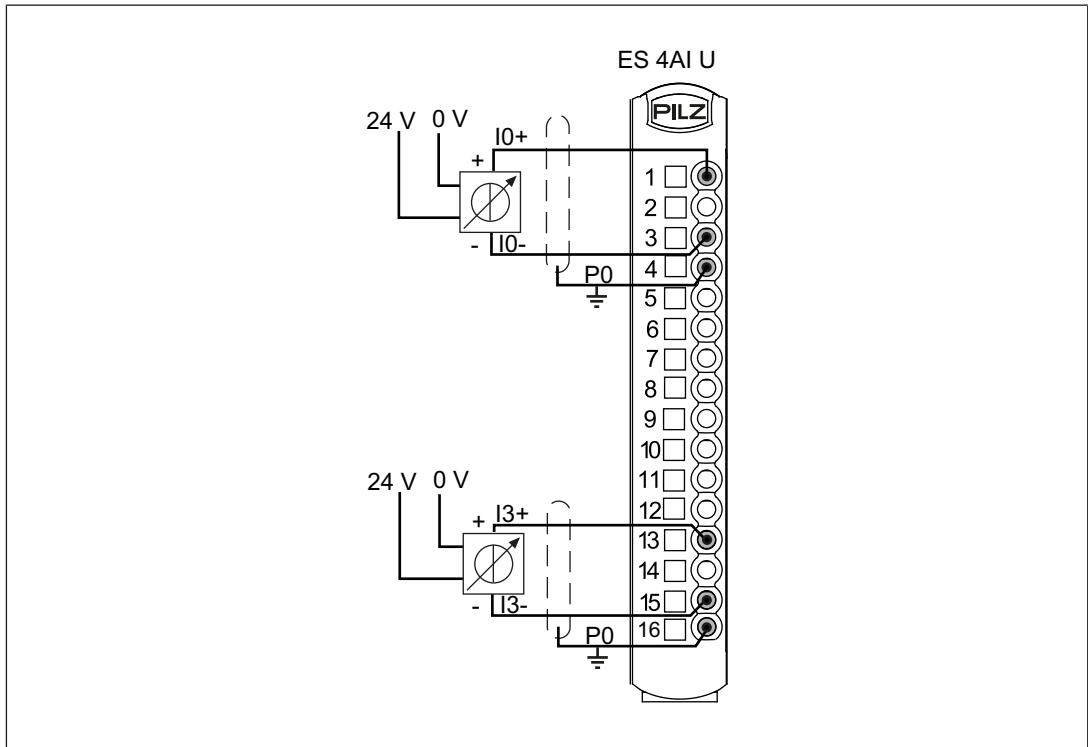


Fig.: Voltage measurement in an EMC-disturbed environment

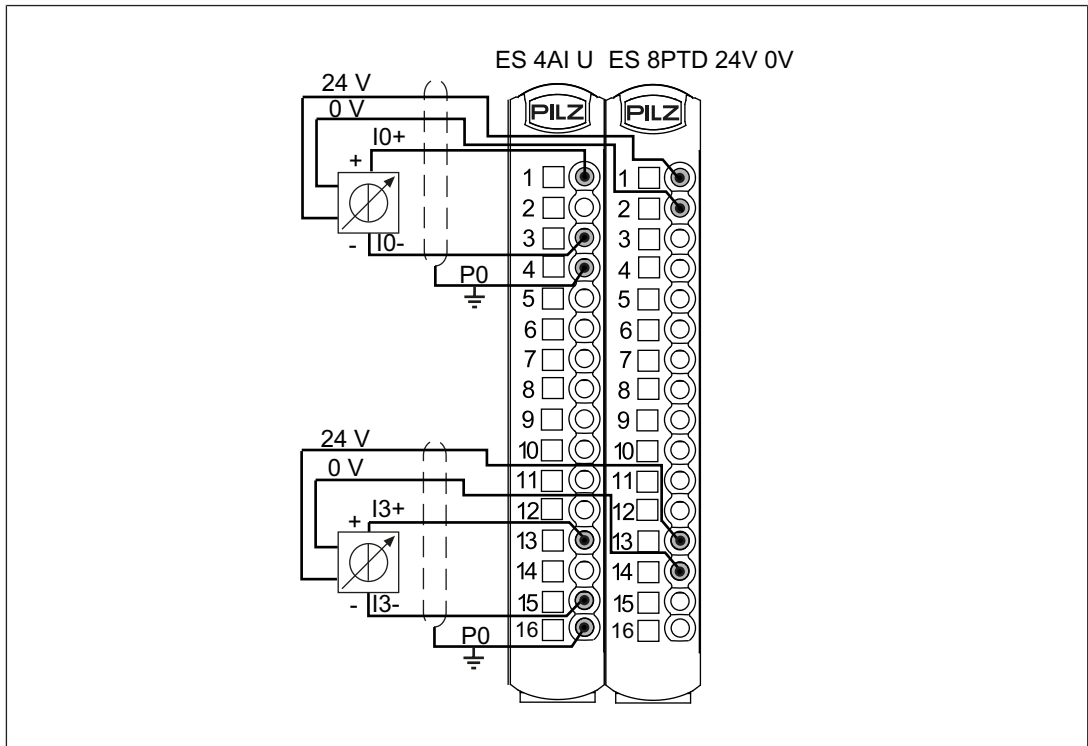


Fig.: Voltage measurement in a sufficiently EMC-protected environment

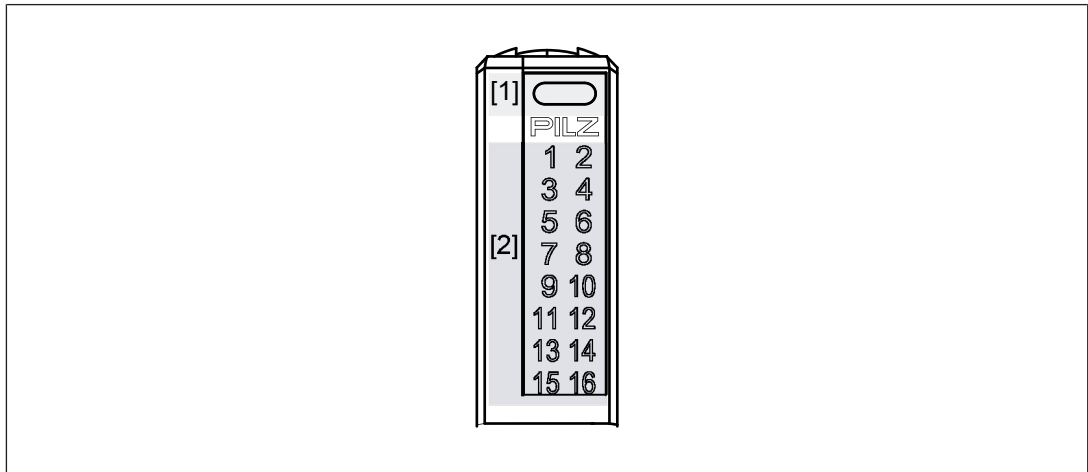
Please note that in the connection type "Voltage measurement in a sufficiently EMC-protected environment", the module can be damaged by surge voltages.

8 Operation

The status of the module is displayed via a red and a green LED. The status of the terminals is displayed via a green LED. If there is a module error, the module status display will light up red. The error will be signalled to the head module and will be entered in the head module's diagnostic log.

8.1 Display elements and messages

Only the terminal status displays 1,3,5,7,9,11,13 and 15 are active.





Legend

[1] Module status display





[2] Terminal status display

The module can detect the following module states:

[1]	Colour [1]	[2]	Colour [2]	Meaning	Further information
●	--	●		Module not ready for operation	
●	Green	●		Module ready for operation	
☀	Green	☀	Green	Module in operation and there is a valid input value at the relevant input	
●	Red	●	--	Configuration error Module was inserted in the wrong slot.	
☀	Red	●	--	Internal errors	See module's diagnostic log
●	Red	●	Green	The module status display and both terminal status displays on the relevant input flash synchronously Measuring range error/scaling error	See module's diagnostic log
●	Red	☀	Green	Temperature warning: Too warm (1)	See module's diagnostic log

[1]	Colour [1]	[2]	Colour [2]	Meaning	Further information
	Red		Green	The module status display and all terminal status displays flash synchronously Periphery supply is missing/temperature error: Too hot (1)	See module's diagnostic log

Legend

-  LED on
-  LED flashes
-  LED flashes briefly
-  LED off

9 Technical details

General	
Certifications	CE
Application range	Standard
Module's device code	0021h
Number of ST input bits	64
Number of ST status bits	56
Electrical data	
Internal supply voltage (module supply)	
Module's power consumption	0,21 W
Periphery's supply voltage (periphery supply)	
Module's power consumption with no load	0,2 W
Max. power dissipation of module	0,4 W
Analogue inputs	
Number of analogue inputs	4
Type of analogue inputs	Voltage
Measuring ranges	
Type	Differential input
Measuring range	-12,8 V - +12,8 V
Type	Differential input
Measuring range	-6,4 V - +6,4 V
Type	Differential input
Measuring range	-3,2 V - +3,2 V
Input filter	RC filter, 1st order
Cutoff frequency	700 Hz
Voltage measurement	
Value of least significant bit (LSB)	195,3125 μV (-6,4 V - +6,4 V), 390,625 μV (-12,8 V - +12,8 V), 97,65625 μV (-3,2 V - +3,2 V)
Input resistance	1 MOhm
Max. continuous voltage	30 V
Resolution	16 Bit
Deviations from the measuring range limit value	
Linearity error	0,05 %
Output variable error at 25 °C	0,3 %
Temperature coefficient	0,003 %/K
Repetition accuracy at 25 °C	0,05 %
Monotony without error codes	yes
Conversion method	Successive approximation
Max. processing time tProclM of analogue input	tInput filter + 0.1 ms
Software filter time (averaging)	0,1 ms, 0,2 ms, 0,5 ms, 1 ms, 2 ms, 5 ms, 10 ms, 17 ms, 20 ms
Potential isolation	yes

Environmental data	
Climatic suitability	EN 60068-2-1, EN 60068-2-14, EN 60068-2-2, EN 60068-2-30, EN 60068-2-78
Ambient temperature	
In accordance with the standard	EN 60068-2-14
Temperature range	0 - 60 °C
Storage temperature	
In accordance with the standard	EN 60068-2-1/-2
Temperature range	-40 - 70 °C
Climatic suitability	
In accordance with the standard	EN 60068-2-78
Humidity	93 % r. h. at 40 °C
Condensation during operation	Not permitted
Max. operating height above sea level	2000 m
EMC	EN 61131-2 (Zone B)
Vibration	
In accordance with the standard	EN 60068-2-6
Frequency	8,4 - 150 Hz
Acceleration	10 m/s²
Shock stress	
In accordance with the standard	EN 60068-2-27
Acceleration	150 m/s²
Duration	11 ms
Airgap creepage	
In accordance with the standard	EN 61131-2
Overvoltage category	II
Pollution degree	2
Protection type	
In accordance with the standard	EN 60529
Housing	IP20
Mounting area (e.g. control cabinet)	IP54
Potential isolation	
Potential isolation between	Analogue input and Module Supply
Type of potential isolation	Functional insulation
Rated surge voltage	2500 V
Potential isolation between	Analogue input and Periphery Supply
Type of potential isolation	Functional insulation
Rated surge voltage	2500 V
Potential isolation between	Periphery supply and module supply
Type of potential isolation	Functional insulation
Rated surge voltage	2500 V
Mechanical data	
Material	
Housing	PPE
Mounting type	plug-in

Mechanical data

Dimensions

Height **110,8 mm**

Width **12,5 mm**

Depth **72,5 mm**

Weight **36 g**

Where standards are undated, the 2015-08 latest editions shall apply.

10 Order reference

10.1 Product

Product type	Features	Order no.
PSS u2 ES 4AI U	Standard electronic module for recording analogue signals	328 500

10.2 Accessories

Terminal block

Product type	Features	Order No.
PSS u2 T 16 (1 pc.)	Terminal block 16-pin, 1 piece	328 850
PSS u2 T 16 (10 pcs.)	Terminal block 16-pin, 10 pieces	328 851
PSS u2 T 16 (5 x 10 pcs.)	Terminal block 16-pin, 50 pieces	328 852

Label holder

Product type	Features	Order No.
PSS u2 A LC E1 (10 pcs.)	Label holder 23.5 x 10.5 mm, 10 pieces	328 910
PSS u2 A LC E2 (10 pcs.)	Label holder 103 x 10.5 mm, 10 pieces	328 911
PSS u2 A LA E1 (10 pcs.)	Labelling strips 23.5 x 10.5 mm (10 x DIN A4 sheet)	328 913
PSS u2 A LA E2 (10 pcs.)	Labelling strips 103 x 10.5 mm (10 x DIN A4 sheet)	328 914

Plastic clip terminal block

Product type	Features	Order no.
PSS u2 A LC T3 (10 pcs.)	Plastic clip terminal block 61 x 11.5 mm, 10 pieces	328 912

Coding elements

Product type	Features	Order no.
PSS u2 A CE E (10 pc.)	Coding elements for electronic modules, 10 pieces	328 860

Backplanes

Product type	Features	Order no.
PSS u2 B 1	Backplane, 1 slot	328 811
PSS u2 B 4	Backplane, 4 slots	328 810

Product type	Features	Order no.
PSS u2 A SH 4	Shield connection element for backplane with 4 slots	328 820