



▶ PSSu E F AI I(-T)(-R)

PILZ

THE SPIRIT OF SAFETY

Operating Manual-21981-EN-13

- Decentralised system PSSuniversal I/O



This document is the original document.

Where unavoidable, for reasons of readability, the masculine form has been selected when formulating this document. We do assure you that all persons are regarded without discrimination and on an equal basis.

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SD means Secure Digital

1	Introduction	5
1.1	Validity of documentation	5
1.1.1	Retaining the documentation	5
1.1.2	Terminology: System environment A and B	5
1.2	Definition of symbols	6
2	Overview	7
2.1	Module structure	7
2.2	Module features	7
2.3	Front view	8
3	Safety	10
3.1	Intended use	10
3.2	Safety regulations	13
3.2.1	Use of qualified personnel	13
3.2.2	Warranty and liability	13
3.2.3	Disposal	13
4	Function description	14
4.1	Block diagram	14
4.2	Module features	14
4.3	Measures for achieving process safety	16
4.3.1	Example of 1-channel operation with predefined safety-related accuracy	16
4.3.2	Example of 1-channel operation with increased safety-related accuracy	17
4.3.3	Example of 2-channel operation	19
4.4	Integrated protection mechanisms	20
4.5	Configuration	20
4.5.1	Converter characteristics/default value	20
4.5.2	Input/output data	21
5	Installation	22
5.1	General installation guidelines	22
5.1.1	Dimensions	22
5.2	Installing the base module	23
5.3	Inserting and removing an electronic module	24
5.3.1	Inserting an electronic module	25
5.3.2	Removing an electronic module	26
5.3.3	Changing an electronic module during operation	26
6	Wiring	27
6.1	General wiring guidelines	27
6.1.1	Mechanical connection of the base modules	28
6.2	Terminal configuration	30
6.3	Connecting the module	33
7	Operation	34
7.1	Messages	34
7.2	Display elements	34

7.2.1	Display elements for module diagnostics	34
7.2.2	Display elements for input status	35
8	Technical details	36
8.1	Safety characteristic data	40
9	Supplementary data	41
9.1	Permitted operating height	41
10	Order reference	42
10.1	Product	42
10.2	Accessories	42
11	EC declaration of conformity for PSSu E F AI I and PSSu E F AI I-T	43
12	UKCA-Declaration of Conformity for PSSu E F AI I and PSSu E F AI I-T	44

1 Introduction

1.1 Validity of documentation

This documentation is valid for the product types PSSu E F AI I, PSSu E F AI I-T and PSSu E F AI I-R. It is valid until new documentation is published.

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

1.1.1 Retaining the documentation

This documentation is intended for instruction and should be retained for future reference.

1.1.2 Terminology: System environment A and B

The PSSu system can be used in two different system environments. The module's application area is described in the chapter "Intended Use" of the manual.

The distinction is made between

- ▶ PSSu in system environment A
- ▶ PSSu in system environment B

The distinction is based on the application area of the PSSu system.

PSSu in system environment A may be used in the

- ▶ Decentralised system PSSu I/O
- ▶ **Not** in the automation system PSS 4000

PSSu in system environment B may be used in the

- ▶ Automation system PSS 4000, e.g. with
 - Decentralised system PSSu I/O with SafetyNET p
 - Control system PSSu PLC
 - Control system PSSu multi

The modules PSSu E F AI I and PSSu E F AI I(-T)(-R) are exclusively for use in system environment B (automation system PSS 4000).

1.2 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

2.1 Module structure

A module consists of

- ▶ Electronic module and
- ▶ Base module with
 - Screw terminals or
 - Cage clamp terminals

The base modules are the carrier units for the electronic modules and are used to connect the field wiring. The electronic modules are inserted on to the base modules and determine the module's function.

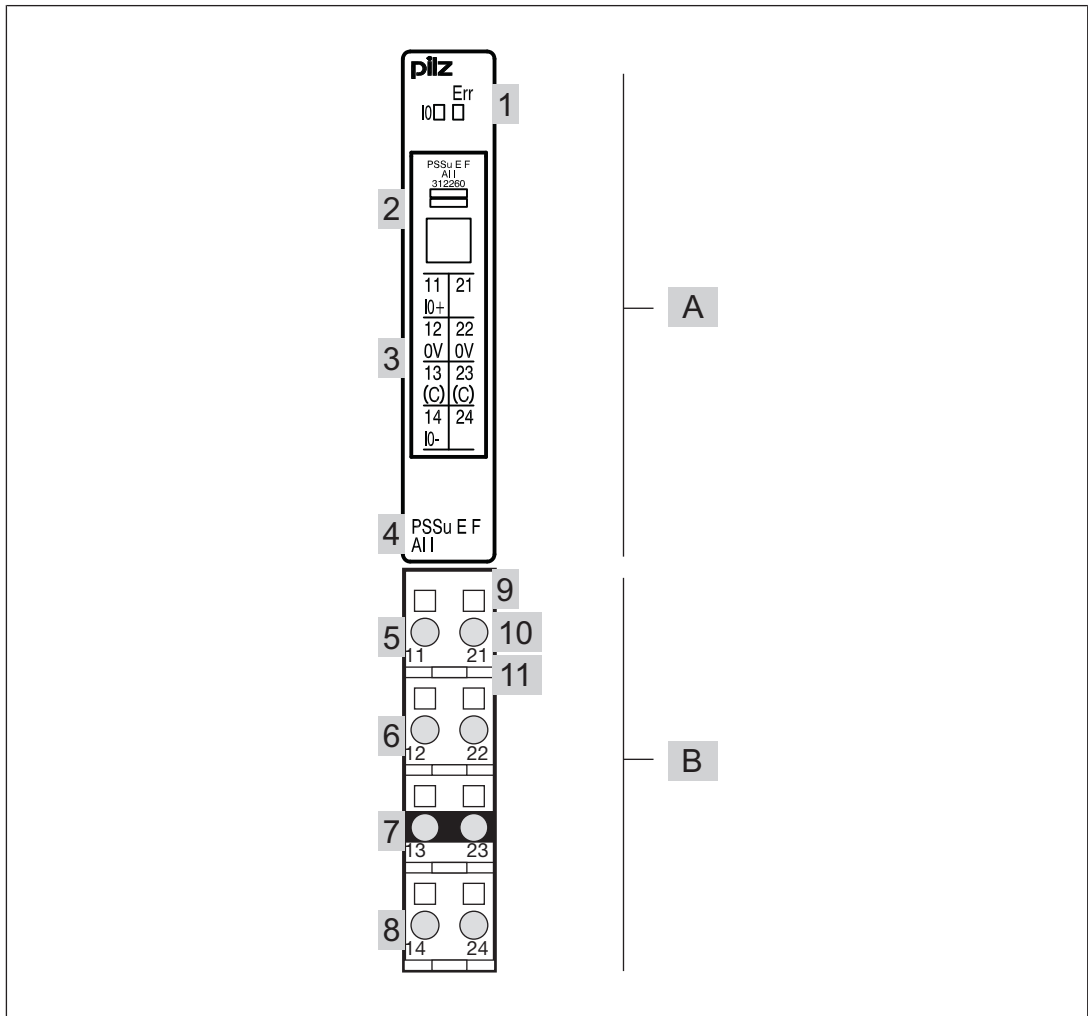
Details of the base modules that can be used are available in the chapter entitled “Intended Use”.

2.2 Module features

The product has the following features:

- ▶ 1 Analogue current input
- ▶ Current range:
0 ... 25.59375 mA Dual-pole, differential input
- ▶ Resolution:
12 Bit (representation of negative values in the two's complement)
- ▶ LEDs for:
 - Operating status per input
 - Module error
- ▶ For failsafe applications in system environment B (automation system PSS 4000)
- ▶ T-type:
PSSu E F AI I-T: for increased environmental requirements
- ▶ R-type:
PSSu E F AI I-R: for railway applications

2.3 Front view



Legend:

- ▶ A: Electronic module
- ▶ B: Base module
- ▶ 1: LEDs for
 - Module diagnostics
 - Status indicator
- ▶ 2: Labelling strip with:
 - Name of electronic module
 - Order number
 - Serial number
 - Hardware version number
 - 2D code
- ▶ 3: Labelling strip for the terminal configuration on the base module
- ▶ 4: Name of electronic module
- ▶ 5: Connection level 1

- ▶ 6: Connection level 2
- ▶ 7: Connection level 3
- ▶ 8: Connection level 4
- ▶ 9: Square mounting holes (connection levels 1, 2, 3 and 4)
 - With screw to loosen/tighten the screw terminal on base modules with screw terminals
 - With mechanism to operate the cage clamp on base modules with cage clamp terminals
- ▶ 10: Round connection holes (connection levels 1, 2, 3 and 4) for connecting the signal lines
- ▶ 11: Mounting slot for colour marker to label the connection level (connection levels 1, 2, 3 and 4)

3 Safety

3.1 Intended use



INFORMATION

If the module name is not explicitly named, the details apply to all the variants of the module.

Use in a PSSu system

The module may be used in a PSSu system in system environment B.

The head module establishes in what system environment a PSSu system can be used.

► System environment

A PSSu system in system environment B is a PSSu system in the h automation system PSS 4000. The PSSu system can belong to one of the following performance classes:

- Decentralised system PSSu I/O (with SafetyNET p)
- Control system PSSu PLC
- Control system PSSu multi

Failsafe applications

The module may be used for failsafe applications.

Failsafe input

The module provides an analogue input.

The analogue input meets the requirements of EN IEC 62061: SIL CL 2. To achieve higher safety values, two analogue inputs will need to be used. PL e (Cat. 4) and SIL CL 3 can be achieved as a result of redundant input data.

The module guarantees functional safety, but not the safety of the entire process.


Please note the following during configuration and within the user program:

- With 1-channel operation, check the feasibility of the measured value with an anticipated measured value in order to detect measurement errors and offset errors on the sensor, or to detect open circuit and short circuit between sensor and module.
- With 1-channel operation, use a sensor that meets the requirements of EN IEC 62061: SIL CL 2.
- With 2-channel operation, check the plausibility by using two inputs and two sensors. Take appropriate measures to avoid common cause errors in the sensor technology, by using diverse sensors or a separate supply voltage for the sensors, for example.
- Monitor a defined measuring range to detect open circuit or short circuit: we recommend 4 ... 20 mA.
- If there is overcurrent at the input (> 40 mA), the value of the input resistance may change and the measured value may be falsified as a result. Take appropriate measures to protect against overcurrent. For example, connect a 50 mA quick blow fuse before the input (such a fuse triggers in sufficient time, before the input resistance is damaged).

The measured value is attenuated through the input filter. At the cutoff frequency, the amplitude of the measured value is 70 % of the amplitude of the input signal.


Particular application areas

► Increased environmental requirements


The module PSSu E F AI I-T is suitable for use where there are increased environmental requirements (see [Technical details](#)  36).

► Lift applications

The modules PSSu E F AI I and PSSu E F AI I-T can be used as a PESSRAL (programmable electronic system in safety-related applications for lifts) in accordance with the Lifts Directive 2014/33/EU. The modules meet the requirements in accordance with EN 81-20, EN 81-50 for passenger and goods lifts the requirements in accordance with EN 115-1 for escalators and moving walks.

The module/the safety controller should be installed in a protected environment. Example: Protected inside space or control cabinet with protection class and corresponding air conditioning specified in [Technical details](#)  36.

► Railway applications

The module PSSu E F AI I-R is **only** intended and certified for use in railway applications (CENELEC) where there are increased environmental requirements (see [Technical details](#)  36). Any other use is **not** permitted.


User program

We strongly recommend the use of the following function blocks:

- FS_AnalogueInputSingle (using one input)
- FS_AnalogueInputDual (using two inputs)

The function blocks contain "Feasibility check" (only on FS_AnalogueInputDual) and "Limit value monitoring" functions, which enable you to detect errors in the sensor as well as the wiring. For the "Range monitoring" function we recommend that you use a measuring range of 4 ... 20 mA.

Permitted operating height

With reference to the standard IEC 61131-2 the values stated in the technical details for ambient temperature are reduced at heights >2000 m operating height above sea level (see [Supplementary data](#)  41).

EMC-compliant installation

Intended use includes making the electrical installation EMC-compliant. Please refer to the guidelines stated in the "PSSuniversal Installation Manual". The module is intended for use in an industrial environment. Interference may occur if used within a domestic environment.

Improper use

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 operating manual,
- Any use of the module that is not in accordance with the technical details.

Software tools

The modules PSSu E F AI I and PSSu E F AI I-T are supported by:

- ▶ PAS4000 from Version 1.1.1

The module PSSu E F AI I-R is supported by:

- ▶ PAS4000 from Version 1.5.0



INFORMATION

We recommend that you always use the latest version of the software tool (download from www.pilz.com).

Base modules

The PSSu E F AI I module may be used in conjunction with the following base modules:

- ▶ PSSu BP 1/8 S
- ▶ PSSu BP 1/8 C
- ▶ PSSu BP 1/12 S
- ▶ PSSu BP 1/12 C
- ▶ PSSu BP-C 1/8 S
- ▶ PSSu BP-C 1/8 C
- ▶ PSSu BP-C 1/12 S
- ▶ PSSu BP-C 1/12 C

The PSSu E F AI I-T and PSSu E F AI I-R modules may be used in conjunction with the following base modules:

- ▶ PSSu BP 1/8 S-T
- ▶ PSSu BP 1/8 C-T
- ▶ PSSu BP 1/12 S-T
- ▶ PSSu BP 1/12 C-T
- ▶ PSSu BP-C 1/8 S-T
- ▶ PSSu BP-C 1/8 C-T
- ▶ PSSu BP-C 1/12 S-T
- ▶ PSSu BP-C 1/12 C-T

3.2 Safety regulations

3.2.1 Use of qualified personnel

The products may only be assembled, installed, programmed, commissioned, operated, maintained and decommissioned by persons who are competent to do so.

A competent person is a qualified and knowledgeable person who, because of their training, experience and current professional activity, has the specialist knowledge required. In order to inspect, assess and handle products, devices, systems, plant and machinery, this person must be familiar with 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.

3.2.2 Warranty and liability

All claims to warranty and liability will be rendered invalid if

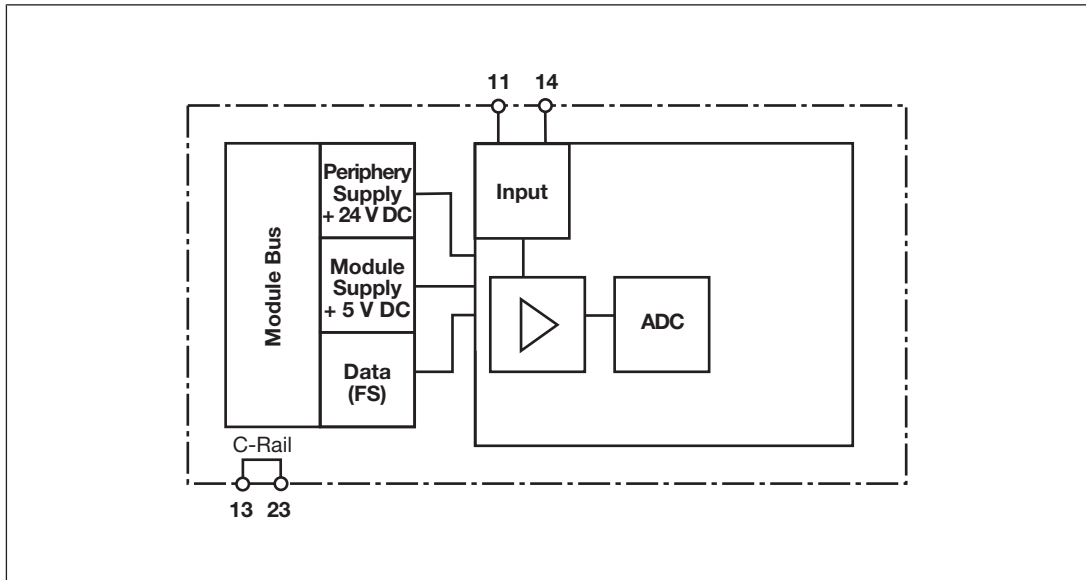
- ▶ The product was used contrary to the purpose for which it is intended,
- ▶ Damage can be attributed to not having followed the guidelines in the manual,
- ▶ Operating personnel are not suitably qualified,
- ▶ Any type of modification has been made (e.g. exchanging components on the PCB boards, soldering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

3.2.3 Disposal

- ▶ In safety-related applications, please comply with the mission time T_M in the safety-related characteristic data.
- ▶ 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



4.2 Module features

Module supply

- ▶ The module supply provides the module with voltage.

Input signal processing:

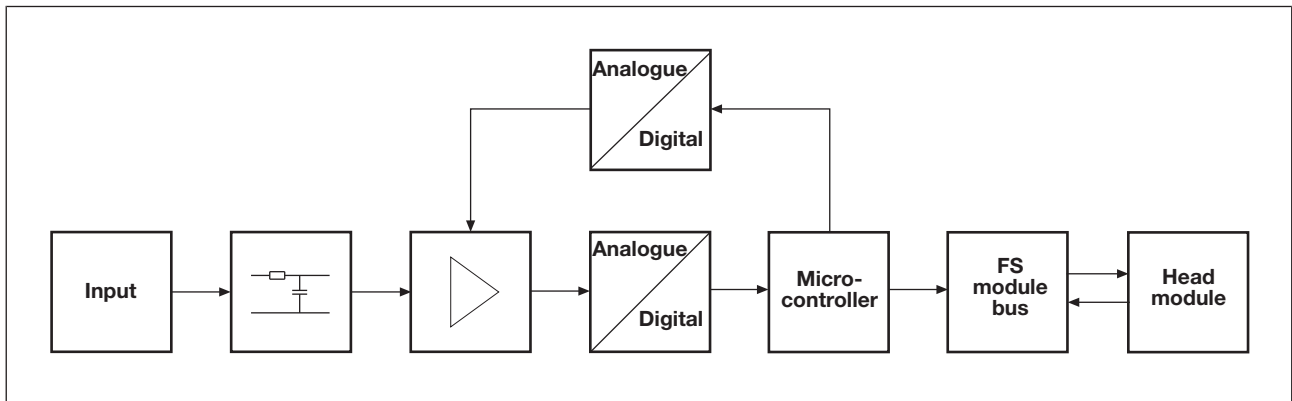
- ▶ The analogue input signal is prefiltered, amplified and stored as a digital measured value.
- ▶ To achieve functional safety, a test signal is generated in the microcontroller.
- ▶ The test signal is fed back to the amplifier via the D/A converter; there it is added to the measured value that has been read in.
- ▶ The test signal is subtracted again from this total value. The result is the test value.

$$\text{Test value} = (\text{measured value} + \text{test signal}) - \text{Test signal}$$

The test value is an input data of the analogue module. In order to make the test value available during the I/O assignment the analogue module must be configured appropriately (in the PSSu Module Editor, right-click the analogue module and select **Add test value to the process image**). The head module of the PSSu system must have a PSS 4000 Firmware Version $\geq 1.21.0$ and the PSS 4000 project must be created with a PAS4000 Version $\geq 1.21.0$.

- ▶ The test value is compared to the measured value that has originally been read in. The tolerance in this comparison process is 5 %. If this tolerance is exceeded, the analogue input signal is considered to be faulty. The module's safety-related accuracy is therefore 5 %. This must be considered in the application. It can also be reduced through certain measures. For further information see [Measures for achieving process safety](#) [16].


Schematic representation of signal processing:



Resolution of analogue-digital converter

- ▶ The resolution of the analogue-digital converter is 12 bits and therefore has 4096 quantisation levels.
- ▶ Due to the system, the LSB always changes by 2 bits instead of 1. The resolution remains unaffected.

4.3 Measures for achieving process safety

The module will detect internal module errors. Sensor errors and wiring errors can be detected using the blocks FS_AnalogueInputSingle and FS_AnalogueInputDual. See Chapter [Intended use](#) [ 10].

Please note that the overall accuracy must be considered when defining monitored limit values in the user program. Detailed information on calculating the overall accuracy can be found in the following examples.

4.3.1 Example of 1-channel operation with predefined safety-related accuracy

The overall accuracy is calculated by adding the following values:

- ▶ Module's safety-related accuracy of **5 %** (see "Technical details").
- ▶ Module's measuring accuracy

This value is calculated by adding all deviations from the measuring range limit value (see "Technical details"). The value "Max. measurement error during EMC test" need only be considered in environments with strong EMC interference. A measuring accuracy of **0.5 %** is assumed for this example.

- ▶ Sensor's measuring accuracy

This value is taken from the sensor's technical details. A value of **0.5 %** is assumed for this example (in relation to the overall measuring range of 0 ... 25.59375 mA).

Calculation of monitored limit values:

- ▶ In this example the overall accuracy as a % is therefore $5\% + 0.5\% + 0.5\% = 6\%$. The calculated overall accuracy refers to the overall measuring range of 0 ... 25.59375 mA.
- ▶ In relation to the overall measuring range, the overall accuracy in mA is: $25.59375\text{ mA} * 6\% = 1.54\text{ mA}$
- ▶ The sensor has a measuring range of 0 ... 100 °C at 4 ... 20 mA. The resolution of the sensor is $100\text{ °C} / (20 - 4\text{ mA}) = 6.25\text{ °C per mA}$.
- ▶ The overall accuracy in °C is therefore: $1.54\text{ mA} * 6.25\text{ °C per mA} = 9.63\text{ °C}$.

This overall accuracy must be considered when defining monitored limit values in the user program. For example, if a hazardous situation should arise at a temperature above 80 °C, a safe reaction must occur in the user program at a temperature above $80\text{ °C} - 9.63\text{ °C} = 70.37\text{ °C}$.

4.3.2 Example of 1-channel operation with increased safety-related accuracy

With 1-channel operation, the user can increase the safety-related accuracy when the analogue input signal and the test value are compared using the "Plausibility monitoring" function of the "FS_AnalogueInputDual" block. In this case, the tolerance configured at the block is used instead of the predefined safety-related accuracy of the module. This procedure can be used with input signals that slowly change.

The overall accuracy is calculated by adding the following values:

► Configured tolerance

The tolerance specifies the maximum permitted deviation between the analogue input signal and the [test value](#) [14]. Configure a value of 2 % as a tolerance at the "FS_AnalogueInputDual" block. When the height of the input value varies considerably or when there are EMC influences, we recommend a value for the tolerance of 2 ... 5 %. For the permitted period for which the tolerance may be exceeded, a value of 0 ms must be configured in each case.

In the Multi programming, the "Tolerance" and the "Period for which tolerance may be exceeded" are configured in the block's properties view. In the IEC 61131 programming, the I variables "Tolerance" and "ToleranceDelay" must be assigned the values.

The test value must be assigned to the "Input1" of the "FS_AnalogueInputDual" block and the analogue input value to the "Input0".

A tolerance of **3 %** has been set for the example.



WARNING!

Calculated overall accuracy does not match the actual overall accuracy!

Risk of serious injury and death!

- For the period for which tolerance may be exceeded, configure a value of **0 ms** at the "FS_AnalogueInputDual" block, otherwise the calculated overall accuracy does not match the actual overall accuracy.

► Module's measuring accuracy

This value is calculated by adding all deviations from the measuring range limit value (see "Technical details"). The value "Max. measurement error during EMC test" need only be considered in environments with strong EMC interference. A measuring accuracy of **0.5 %** is assumed for this example.

► Sensor's measuring accuracy

This value is taken from the sensor's technical details. A value of **0.5 %** is assumed for this example (in relation to the overall measuring range of 0 ... 25.59375 mA).

Calculation of monitored limit values:

- In this example the overall accuracy as a % is therefore $3\% + 0.5\% + 0.5\% = 4\%$. The calculated overall accuracy refers to the overall measuring range of 0 ... 25.59375 mA
- In relation to the overall measuring range, the overall accuracy in mA is: $25.59375\text{ mA} \cdot 4\% = 1.02\text{ mA}$

- ▶ The sensor has a measuring range of 0 ... 500 mbar at 4 mA ... 20 mA. The resolution of the sensor is $100 \text{ mbar} / (20 - 4 \text{ mA}) = \mathbf{31.25 \text{ mbar per mA}}$.
- ▶ The overall accuracy in mbar is therefore: $1.02 \text{ mA} * 31.25 \text{ mbar per mA} = \mathbf{32.00 \text{ mbar}}$.

This overall accuracy must be considered when defining monitored limit values in the user program. For example, if a hazardous situation should arise at a pressure above 300 mbar, a safe reaction must occur in the user program at a pressure above 300 mbar – 32.00 mbar = 268.00 mbar.



WARNING!

Limit values selected in the user program too low or too high!

Risk of serious injury and death!

- Consider the overall accuracy when defining the limit values in the user program.

4.3.3 Example of 2-channel operation

With 2-channel operation, two inputs and two sensors must be used, as well as the "Feasibility test" function of the block "FS_AnalogueInputDual". Instead of the module's safety-related accuracy, an empirically established tolerance is used with 2-channel operation.

The overall accuracy is calculated by adding the following values:

▶ Empirically established tolerance

This value must be established empirically. In the properties view of the block "FS_AnalogueInputDual", enter a value for the tolerance, at which availability is still maintained. The tolerance consists of the current deviation between two current measured values.

A deviation of **2 %** between the two analogue input values has been established for the example.

For availability reasons we recommend that you use a slightly higher value for the tolerance than the empirically established deviation. If the set tolerance is exceeded, the enable will be reset. A tolerance of **3 %** has been set for feasibility monitoring.

▶ Module's measuring accuracy

This value is calculated by adding all deviations from the measuring range limit value (see "Technical details"). The value "Max. measurement error during EMC test" need only be considered in environments with strong EMC interference. A measuring accuracy of **0.5 %** is assumed for this example.

▶ Sensor's measuring accuracy

This value is taken from the sensor's technical details. A value of **0.5 %** is assumed for this example (in relation to the overall measuring range of 0 ... 25.59375 mA).

Calculation of monitored limit values:

- ▶ In this example the overall accuracy as a % is therefore $3\% + 0.5\% + 0.5\% = 4\%$. The calculated overall accuracy refers to the overall measuring range of 0 ... 25.59375 mA
- ▶ In relation to the overall measuring range, the overall accuracy in mA is: $25.59375\text{ mA} \cdot 4\% = 1.02\text{ mA}$
- ▶ The sensor has a measuring range of 0 ... 500 mbar at 4 mA ... 20 mA. The resolution of the sensor is $100\text{ mbar} / (20 - 4\text{ mA}) = 31.25\text{ mbar per mA}$.
- ▶ The overall accuracy in mbar is therefore: $1.02\text{ mA} \cdot 31.25\text{ mbar per mA} = 32.00\text{ mbar}$.

This overall accuracy must be considered when defining monitored limit values in the user program. For example, if a hazardous situation should arise at a pressure above 300 mbar, a safe reaction must occur in the user program at a pressure above $300\text{ mbar} - 32.00\text{ mbar} = 268.00\text{ mbar}$.



WARNING!

Limit values selected in the user program too low or too high!

Risk of serious injury and death!

- Consider the overall accuracy when defining the limit values in the user program.

4.4 Integrated protection mechanisms

When the PSSu E F PS1(-T) or PSSu E F PS2(-T)(-R) is used to supply the system, the module supply is buffered for 20 ms if the supply voltage is interrupted.

The module detects the following errors:

- ▶ Start-up error
- ▶ Configuration error
- ▶ FS communication error
- ▶ Bus termination error

4.5 Configuration

4.5.1 Converter characteristics/default value


The table below shows the converted data formats of the analogue input currents. When the digital values are converted into I/O data elements, the three highest binary digits are filled with "0".

Analogue value	Digital value (12 Bit)			I/O data element "Data" (16 Bit)		
	Binary	Hexadecimal	Decimal	Binary	Hexadecimal	Decimal
25.59375 mA	0 1111 1111 1111	0FFF	4095	0000 1111 1111 1111	0FFF	4095
20.0 mA	0 1100 1000 0000	0C80	3200	0000 1100 1000 0000	0C80	3200
17.5 mA	0 1010 1111 0000	0AF0	2800	0000 1010 1111 0000	0AF0	2800
15.0 mA	0 1001 0110 0000	0960	2400	0000 1001 0110 0000	0960	2400
12.5 mA	0 0111 1101 0000	07D0	2000	0000 0111 1101 0000	07D0	2000
10.0 mA	0 0110 0100 0000	0640	1600	0000 0110 0100 0000	0640	1600
7.5 mA	0 0100 1011 0000	04B0	1200	0000 0100 1011 0000	04B0	1200
5.0 mA	0 0011 0010 0000	0320	800	0000 0011 0010 0000	0320	800
2.5 mA	0 0001 1001 0000	0190	400	0000 0001 1001 0000	0190	400
1.0 mA	0 0000 1010 0000	00A0	160	0000 0000 1010 0000	00A0	160
0.1 mA	0 0000 0001 0000	0010	16	0000 0000 0001 0000	0010	16
50 µA	0 0000 0000 1000	0008	8	0000 0000 0000 1000	0008	8
25 µA	0 0000 0000 0100	0004	4	0000 0000 0000 0100	0004	4
12.5 µA	0 0000 0000 0010	0002	2	0000 0000 0000 0010	0002	2
6.25 µA	0 0000 0000 0001	0001	1	0000 0000 0000 0001	0001	1
0.00 A	0 0000 0000 0000	0000	0	0000 0000 0000 0000	0000	0

If the measured value is invalid, the value 0x0000 (0000 hexadecimal) is output and the valid bit is set to "0".

4.5.2 Input/output data

Data access is via pre-defined I/O data types.

I/O data name	I/O data type	I/O data element	Meaning
I0(11, 14)	FS_I_AI	Data: SAFEWORD	Input data
TestValue	FS_I_AI	Data: SAFEWORD	(see Test value  14)

5 Installation

5.1 General installation guidelines

Please also refer to the PSSuniversal Installation Manual.



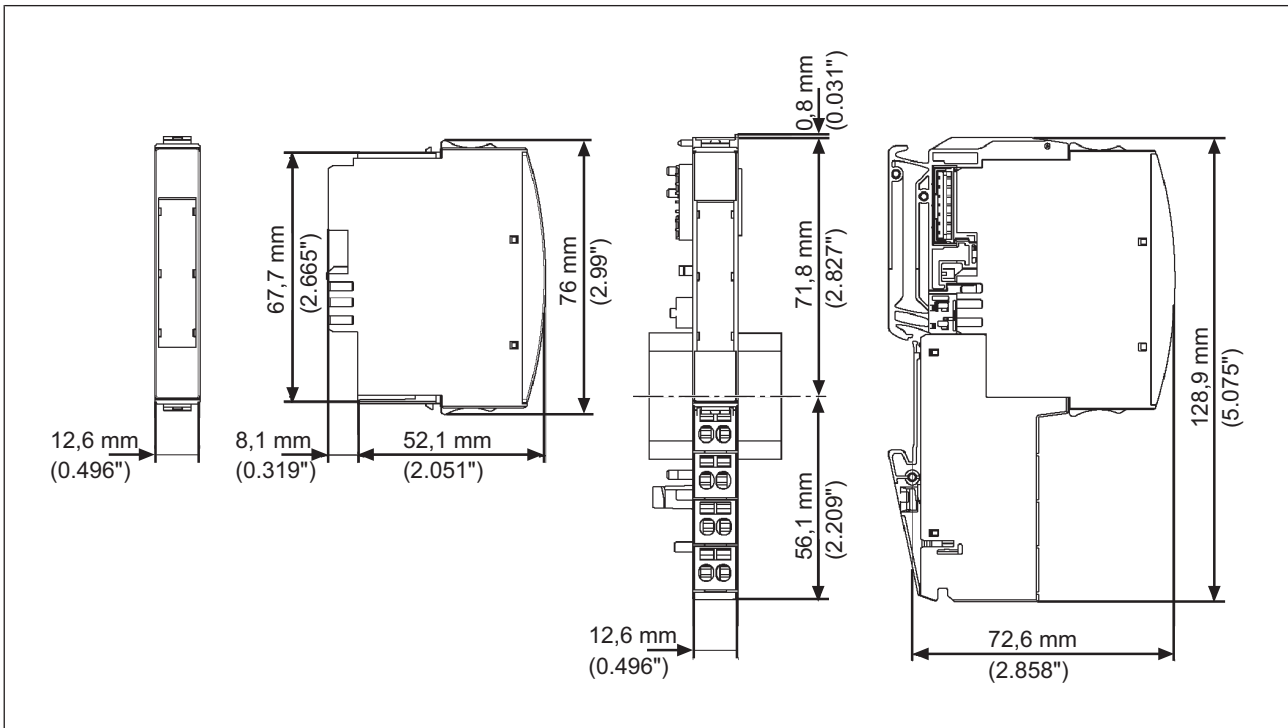
NOTICE

Damage due to electrostatic discharge!

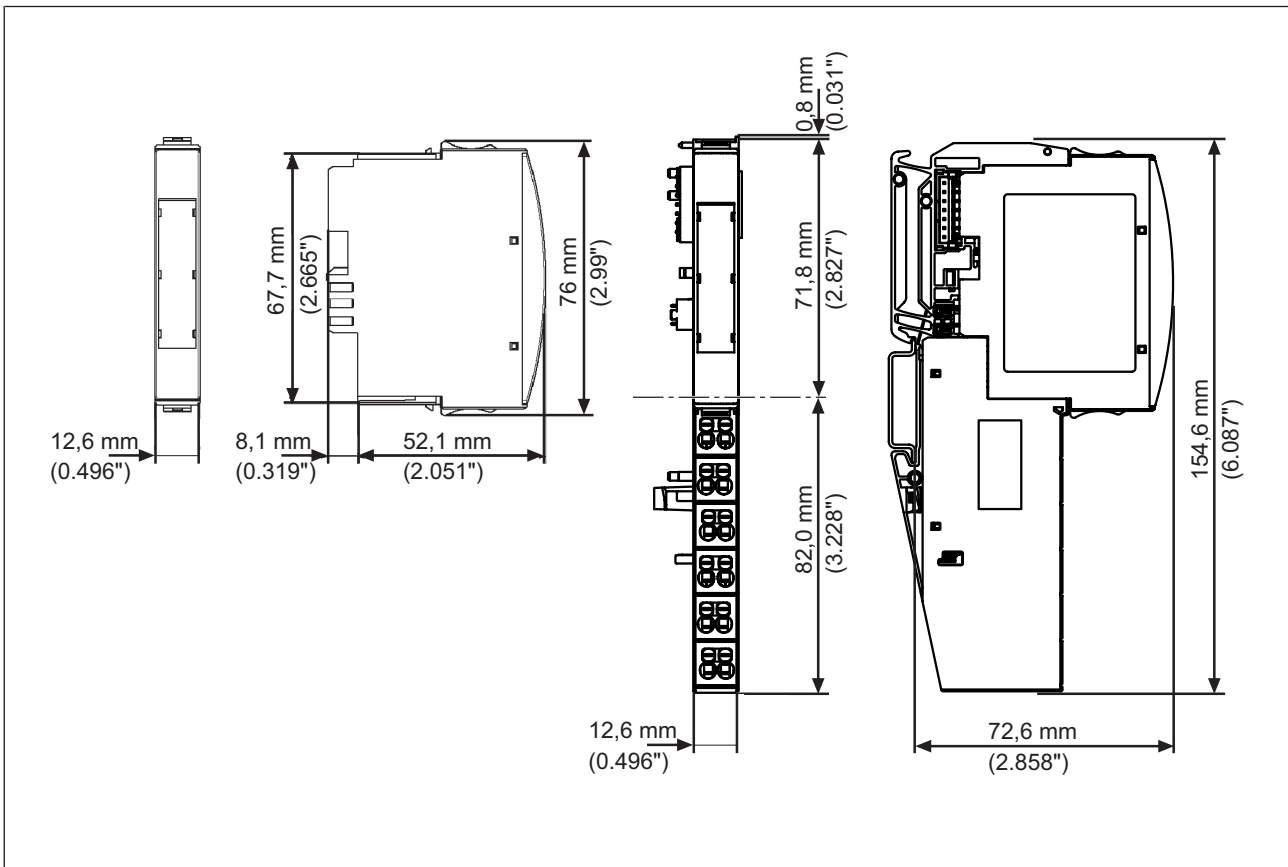
Electrostatic discharge can damage components. Ensure against discharge before touching the product, e.g. by touching an earthed, conductive surface or by wearing an earthed armband.

5.1.1 Dimensions

Base modules with four connection levels:



Base modules with six connection levels:



5.2 Installing the base module

Prerequisite:

- ▶ The head module must be installed.
- ▶ If the head module does not have an integrated power supply, a supply voltage module must be installed to the right of the head module.

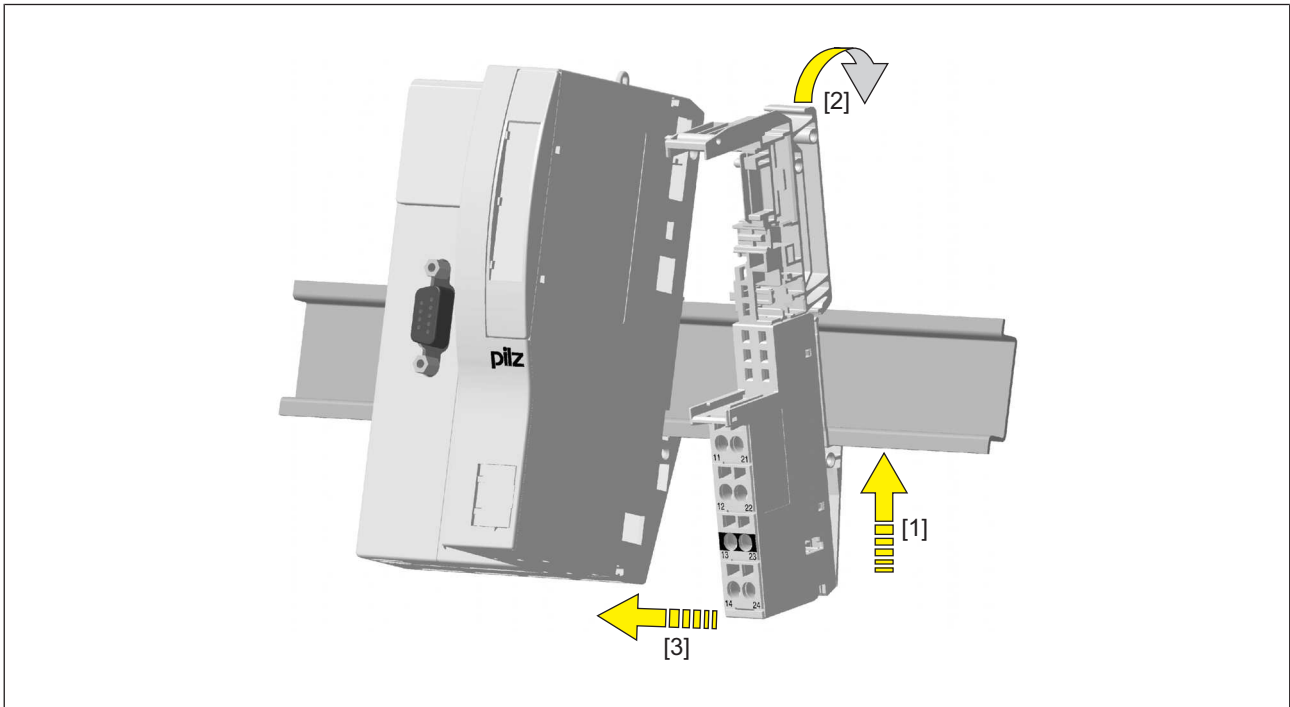
Please note:

- ▶ For mechanical reasons it is not possible to mix base modules with screw terminals and base modules with cage clamp terminals.
- ▶ All contacts should be protected from contamination.
- ▶ The mechanics of the base modules are designed for 50 plug in/out cycles.

Procedure:

- ▶ We recommend that you wire up the base modules before inserting the electronic modules.
- ▶ Slot the groove on the base module on to the mounting rail from below [1].
- ▶ Push the base module back [2] until you hear it lock into position.
- ▶ On the mounting rail, slide the base module to the left until you hear the two lateral mounting hooks on the adjacent module lock into position [3].

Schematic representation:



5.3 Inserting and removing an electronic module

Please note:

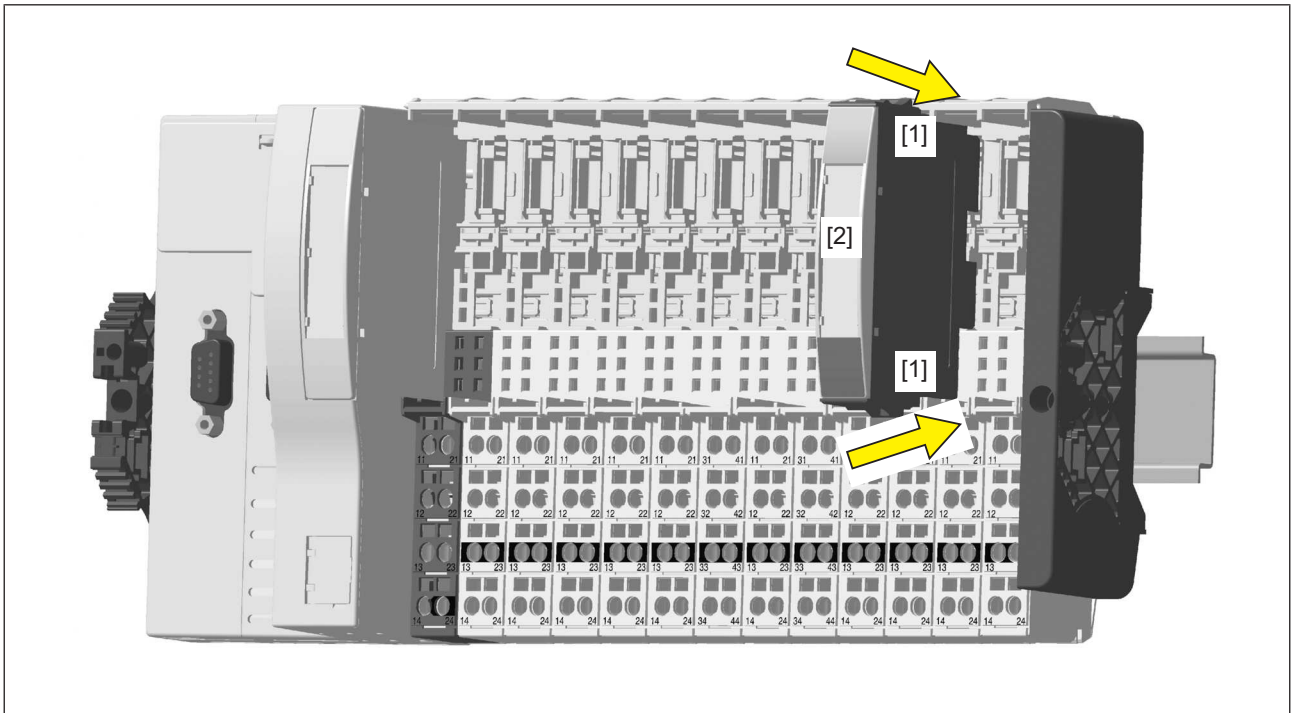
- ▶ Only insert on to base modules that are already installed.
- ▶ Preferably these base modules should be ready wired.
- ▶ Electronic modules with outputs may only be inserted and removed when the load is switched off. Unforeseeable error reactions may be triggered if modules are inserted and removed under load.
- ▶ When an electronic module is plugged into a base module for the first time, one part of the coding element remains on the electronic module, while its counterpart is fixed on to the base module. This is how the base module is coded.
- ▶ The mechanics of the electronic modules are designed for 50 plug in/out cycles.

5.3.1 Inserting an electronic module

Procedure:

- ▶ The electronic module must audibly lock into position [1].
- ▶ Mark the electronic module using the labelling strips [2].

Schematic representation:

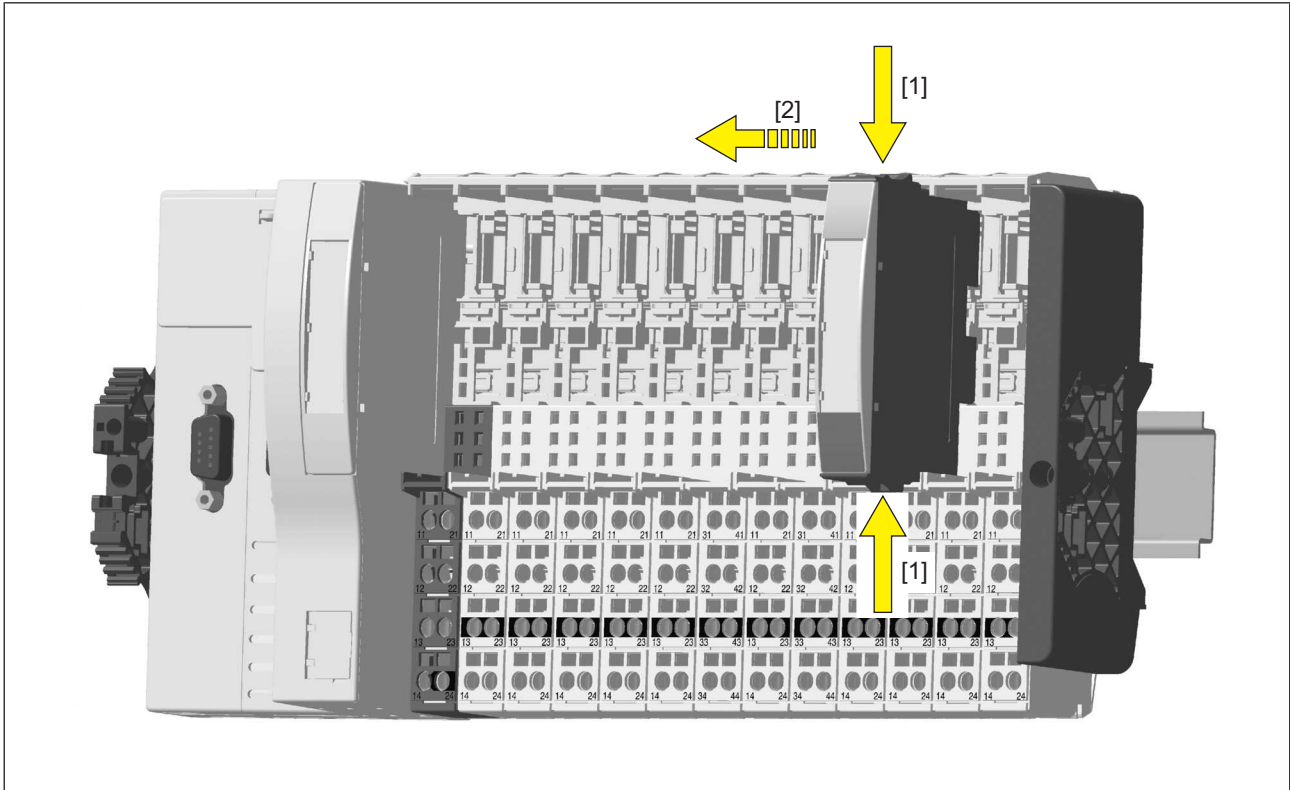


5.3.2 Removing an electronic module

Procedure:

- ▶ Press the locking mechanisms [1] together simultaneously.
- ▶ Pull out the electronic module [2].

Schematic representation:



5.3.3 Changing an electronic module during operation

It is possible to change an electronic module during operation. The configuration data is retained when a module is changed.

Effects:

- ▶ System environment A:
 - In the event of a potential FS communication error, the FS section of the PSSu system and all relevant I/O-Groups (SafetyBUS p) switch to a STOP condition.
- ▶ System environment B:
 - All FS hardware outputs on the PSSu system switch to a safe condition.
 - The substitute values are used for the modules' FS outputs, with Valid Bits = FALSE.



CAUTION!

Sparking can cause interference and errors!

Only change the module when the load is switched off!

6 Wiring

6.1 General wiring guidelines

Please note:

- ▶ The supply voltages for actuators and sensors must be extra low voltages with protective electrical separation (PELV or SELV) in accordance with VDE 0100, Part 410. Failure to do so could result in electric shock.
- ▶ We recommend that you use shielded signal lines.
- ▶ On base modules with C-rail:
 - Connect the shield to the terminals on the C-rail.
 - Connect the C-rail with low impedance to the functional earth.
- ▶ On base modules without C-rail:
 - Connect the shield as shown in the terminal configuration section. The module connects the shield to the mounting rail.
 - Connect the mounting rail to the functional earth via an earthing terminal.
- ▶ In environments with strong EMC interference, base modules without a C-rail provide better protection if the shield is connected.
- ▶ 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.



WARNING!

Potential loss of safety function due to a falsified measured value

Depending on the application, serious injury or death may result. If there is overcurrent at the input (> 40 mA), the value of the input resistance may change and the measured value may be falsified as a result.

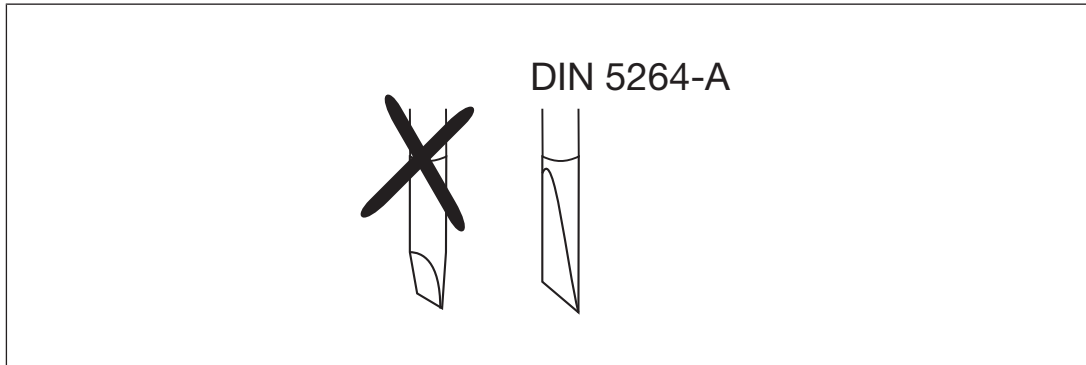
- Take appropriate measures to protect against overcurrent. For example, connect a 50 mA quick blow fuse before the input (such a fuse triggers in sufficient time, before the input resistance is damaged).

- ▶ The terminal configuration as stated on the front plate applies for base modules with C-rail. The terminal configuration as stated in the technical documentation applies for all other base modules.

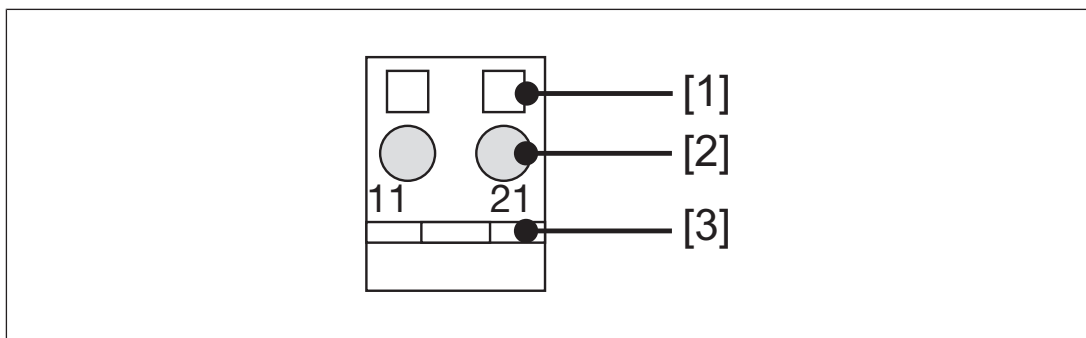
6.1.1 Mechanical connection of the base modules

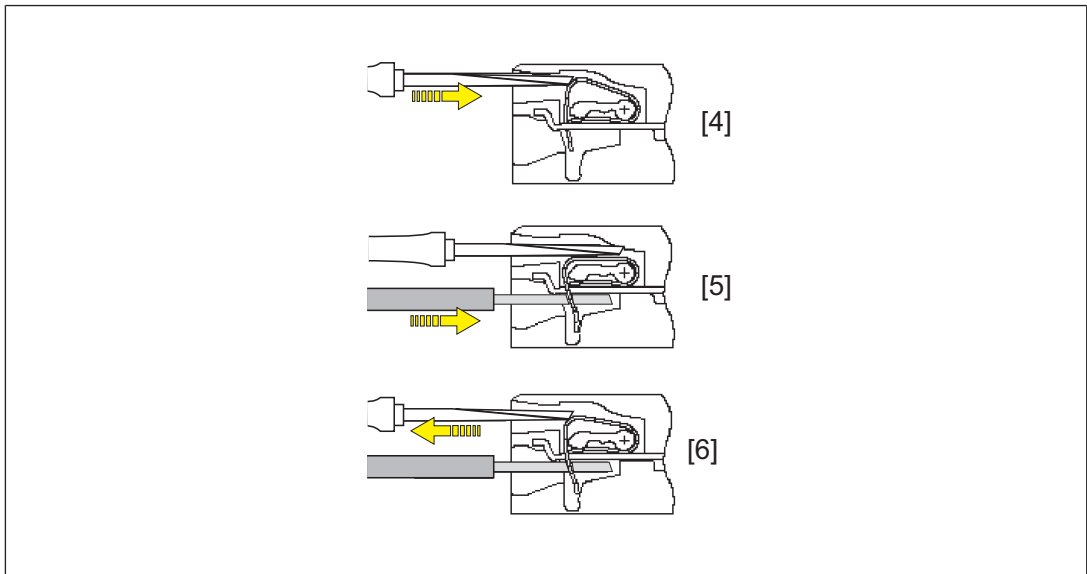
Procedure:

- ▶ Use a flat blade screwdriver (DIN 5264-A)!



- ▶ Strip the wire back 8 mm.
- ▶ If necessary, label the connection level with a colour marker [3].
- ▶ Base module with screw terminals:
 - Use a screwdriver to loosen the screw on the screw terminal [1]
 - Insert the stripped cable into the round fixing hole [2], as far as it will go.
 - Tighten up the screw on the screw terminal.
 - Check that the cable is firmly seated.
- ▶ Base module with cage clamp terminals:
 - Insert the screwdriver [4] into the square hole [1].
 - Insert the stripped cable into the round fixing hole [2], as far as it will go [5].
 - Pull out the screwdriver [6].
 - Check that the cable is firmly seated.

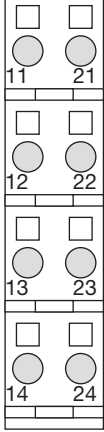
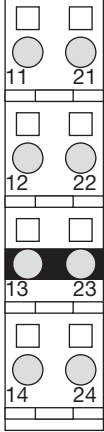


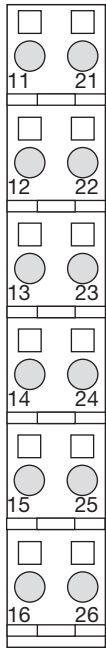


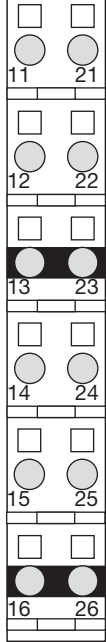
Please note:

- ▶ The minimum cable cross section for field connection terminals on the base modules is 0.14 mm² (AWG26).
- ▶ The maximum cable cross section for field connection terminals is:
 - Digital inputs: 1.5 mm² (AWG16)
 - Digital outputs: 2.0 mm² (AWG14)
 - Inputs/outputs on the counter modules: 1.5 mm² (AWG16)
 - Analogue inputs/outputs: 1.5 mm² (AWG16)
 - Communication cables: 1.5 mm² (AWG16)
 - Test pulse outputs: 1.5 mm² (AWG16)
 - Power supply: 2.5 mm² (AWG12)
 - Functional earth: 2.5 mm² (AWG12)
- ▶ On base modules with screw terminals:
 - If you use a multi-strand cable to connect the I/Os, it is recommended that you use ferrules conforming to Parts 1 and 2 of DIN 46228, 0.14 ... 1.5 mm², Form A or C, although this is not essential. To crimp the ferrules you can use crimp pliers (crimp form A or C) conforming to EN 60947-1, such as the PZ 1.5 or PZ 6.5 from Weidmüller, for example.
 - Maximum torque setting: 0.8 Nm
- ▶ Use copper wiring.

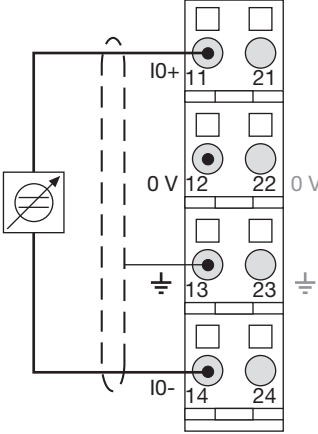
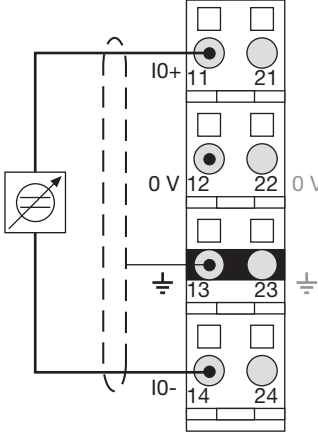
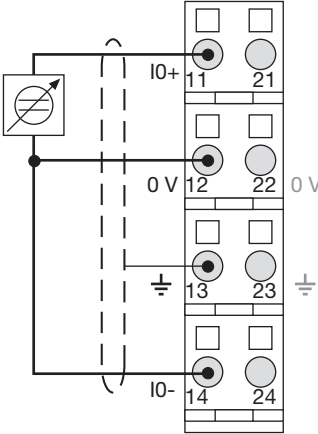
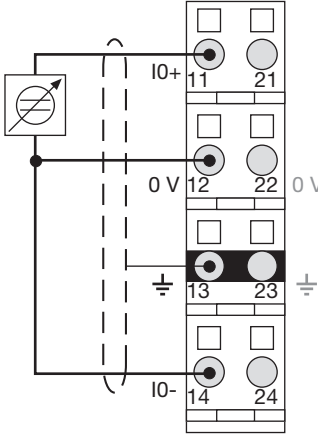
6.2 Terminal configuration

Base module	Terminal configuration	
<p>Screw terminals: PSSu BP 1/8 S PSSu BP 1/8 S-T</p> <p>Cage clamp terminals: PSSu BP 1/8 C PSSu BP 1/8 C-T</p>	<p>Without C-rail:</p> <p>11: Input I0+</p> <p>21: Not connected</p> <p>12 -22: 0 V analogue (12-22 linked within the base module)</p> <p>13 -23: Shield connection (13-23 linked within the base module)</p> <p>14: Input I0-</p> <p>24: Not connected</p>	
<p>Screw terminals: PSSu BP-C 1/8 S PSSu BP-C 1/8 S-T</p> <p>Cage clamp terminals: PSSu BP-C 1/8 C PSSu BP-C 1/8 C-T</p>	<p>With C-rail:</p> <p>11: Input I0+</p> <p>21: Not connected</p> <p>12 -22: 0 V analogue (12-22 linked within the base module)</p> <p>13 -23: C-rail supply, shield connection (13-23 linked within the base module)</p> <p>14: Input I0-</p> <p>24: Not connected</p>	

Base module	Terminal configuration	
<p>Screw terminals: PSSu BP 1/12 S PSSu BP 1/12 S-T</p> <p>Cage clamp terminals: PSSu BP 1/12 C PSSu BP 1/12 C-T</p>	<p>Without C-rail:</p> <p>11: Input I0+</p> <p>21: Not connected</p> <p>12 -22: 0 V analogue (12-22-15-25 linked within the base module)</p> <p>13 -23: Shield connection (13-23-16-26 linked within the base module)</p> <p>14: Input I0-</p> <p>24: Not connected</p> <p>15 -25: 0 V analogue (12-22-15-25 linked within the base module)</p> <p>16 -26: Shield connection (13-23-16-26 linked within the base module)</p>	

Base module	Terminal configuration	
<p>Screw terminals: PSSu BP-C 1/12 S PSSu BP-C 1/12 S-T</p> <p>Cage clamp terminals: PSSu BP-C 1/12 C PSSu BP-C 1/12 C-T</p>	<p>With C-rail:</p> <p>11: Input I0+</p> <p>21: Not connected</p> <p>12 -22: 0 V analogue (12-22 linked within the base module)</p> <p>13 -23: C-rail supply, shield connection (13-23 linked within the base module)</p> <p>14: Input I0-</p> <p>24: Not connected</p> <p>15 -25: 0 V analogue (12-22-15-25 linked within the base module)</p> <p>16 -26: C-rail supply, shield connection (13-23-16-26 linked within the base module)</p>	

6.3 Connecting the module

Input circuit	Without C-rail	With C-rail
<p>Current range 0 ... 25.59375 mA dual-pole, differential input</p>		
<p>Current range 0 ... 25.59375 mA measurement referenced to earth In a noise susceptible environment</p>		



INFORMATION

To achieve the safety values PL e (Cat. 4) and SIL CL 3 , two analogue inputs will need to be used.

7 Operation

7.1 Messages




A module error is displayed via the "Err" LED, signalled to the head module and then entered in the head module's diagnostic log.

The module can detect the following errors:

Error	Explanation	Remedy
Start-up error	Error as the PSSu system starts up	Change faulty module.
Configuration error	Incorrect module type configured.	The configured hardware registry does not match the actual hardware registry.
FS communication error	Error during FS communication	Change faulty module.
Bus termination error	There is no terminating plate or there is a bad contact with the module bus.	Install a terminating plate with integrated end bracket or insert the base modules together correctly.

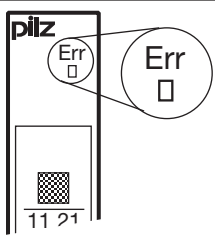


7.2 Display elements

Legend

-  LED on
-  LED flashes
-  LED off

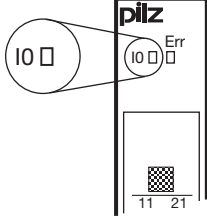
7.2.1 Display elements for module diagnostics

The module has an LED for displaying module errors ("Err" LED).

	LED			Meaning
	Designation	Colour	Status	
	Err	---	●	No error
		red		Module error
	Measuring range exceeded / A/D converter faulty			

7.2.2 Display elements for input status

The input is assigned an LED for displaying the input status (LED "I0").

	LED			Meaning		
	Description	Colour	Status	Signal	Input	Terminal
	I0	---	●	Invalid value or no value detected	I0 (Input 1)	11/14
	green	☀	Valid value detected			

8 Technical details

General	312260	314260	315260
Certifications	CE, EAC, KOSHA, TÜV, UKCA, cULus Listed	CE, EAC, KOSHA, TÜV, UKCA, cULus Listed	CE, EAC, TÜV, UKCA
Application range	Failsafe	Failsafe	Failsafe
Module's device code	0B10h	0B10h	0B10h
Number of FS input bits	16	16	16
Application in system environment B			
from FS firmware version, head modules	1.0.0	1.0.0	1.5.0
Electrical data	312260	314260	315260
Internal supply voltage (module supply)			
Module's power consumption	0,22 W	0,22 W	0,22 W
Periphery's supply voltage (periphery supply)			
Voltage range	16,8 - 30 V	16,8 - 30 V	16,8 - 30 V
Module's current consumption with no load	34 mA	34 mA	34 mA
Module's power consumption with no load	0,58 W	0,58 W	0,58 W
Max. power dissipation of module	0,8 W	0,8 W	0,8 W
Analogue inputs	312260	314260	315260
Number of analogue inputs	1	1	1
Type of analogue inputs	Current	Current	Current
Input area	0 ... 25.59375 mA	0 ... 25.59375 mA	0 ... 25.59375 mA
Input filter	RC filter	RC filter	RC filter
Cutoff frequency	71 Hz	71 Hz	71 Hz
Current measurement			
Value of least significant bit (LSB)	6,25 µA	6,25 µA	6,25 µA
Input resistance	115 Ohm	115 Ohm	115 Ohm
Max. continuous current	40 mA	40 mA	40 mA
Resolution	12 Bit	12 Bit	12 Bit
Safety-related accuracy (1 input)	5 %	5 %	5 %

Analogue inputs	312260	314260	315260
Deviations from the measuring range limit value			
Linearity error	0,05 %	0,05 %	0,05 %
Output variable error at 25 °C	0,4 %	0,4 %	0,4 %
Temperature coefficient	0,003 %/K	0,003 %/K	0,003 %/K
Max. measurement error during EMC test	1 %	1 %	1 %
Conversion method	Successive approximation	Successive approximation	Successive approximation
Potential isolation between input and periphery supply			
	Yes	Yes	Yes
Inputs	312260	314260	315260
Potential isolation between input and internal module bus voltage			
	Yes	Yes	Yes
Environmental data	312260	314260	315260
Application site			
in accordance with the standard	–	–	EN 50125-3
Application site	–	–	Track area (1 m - 3 m)
in accordance with the standard	–	–	EN 61373
Application site	–	–	Category 1, Class A + B
Climatic suitability	EN 60068-2-1, EN 60068-2-14, EN 60068-2-2, EN 60068-2-30, EN 60068-2-78	EN 60068-2-1, EN 60068-2-14, EN 60068-2-2, EN 60068-2-30, EN 60068-2-78	EN 50125-1, EN 50125-3, EN 50155, EN 60068-2-1, EN 60068-2-14, EN 60068-2-2
Ambient temperature			
in accordance with the standard	EN 60068-2-14	EN 60068-2-14	EN 50155
Temperature range	0 - 60 °C	-40 - 70 °C	-40 - 70 °C
in accordance with the standard	–	–	EN 50125-1
Temperature range	–	–	-40 ... +70 °C
in accordance with the standard	–	–	EN 50125-3
Temperature range	–	–	-40 ... +70 °C
Storage temperature			
in accordance with the standard	EN 60068-2-1/-2	EN 60068-2-1/-2	EN 60068-2-1/-2
Temperature range	-40 - 70 °C	-40 - 70 °C	-40 - 70 °C
Climatic suitability			
in accordance with the standard	EN 60068-2-78	EN 60068-2-78	EN 60068-2-78
Humidity	93 % r. h. at 40 °C	93 % r. h. at 40 °C	97 % r. h. at 40 °C

Environmental data	312260	314260	315260
Condensation during operation	Not permitted	EN 60068-2-30, short-term	EN 50155, EN 60068-2-30, short-term
Max. operating height above SL	2000 m	5000 m	2000 m
EMC	EN 12015, EN 12016, EN 61000-6-2, EN 61000-6-4, EN 61131-2	EN 12015, EN 12016, EN 61000-6-2, EN 61000-6-4, EN 61131-2	EN 50121-3-2, EN 50124-1, EN 61000-6-2, EN 61000-6-4
Vibration			
in accordance with the standard	EN 60068-2-6	EN 60068-2-6	–
Frequency	10 - 150 Hz	10 - 150 Hz	–
Acceleration	10 m/s²	10 m/s²	–
Broadband noise			
in accordance with the standard	–	EN 60068-2-64	–
Frequency	–	5 - 500 Hz	–
Acceleration	–	19 m/s² eff.	–
in accordance with the standard	–	–	EN 61373
Frequency	–	–	5 ... 150 Hz
Acceleration	–	–	7,9 m/s² eff.
in accordance with the standard	–	–	EN 50125-3
Frequency	–	–	5 - 2.000 Hz
Acceleration	–	–	2,3 m/s² eff.
Shock stress			
in accordance with the standard	EN 60068-2-27	EN 60068-2-27	–
Number of shocks	6	6	–
Acceleration	150 m/s²	150 m/s²	–
Duration	11 ms	11 ms	–
in accordance with the standard	–	–	EN 50125-3
Number of shocks	–	–	6
Acceleration	–	–	20 m/s²
Duration	–	–	11 ms
in accordance with the standard	–	–	EN 61373
Number of shocks	–	–	6
Acceleration	–	–	50 m/s²
Duration	–	–	30 ms

Environmental data	312260	314260	315260
Airgap creepage			
in accordance with the standard	EN 61131-2	EN 61131-2	–
Overvoltage category	II	II	–
Pollution degree	2	2	–
in accordance with the standard	–	–	EN 50124-1
Overvoltage category	–	–	OV2
Pollution degree	–	–	PD2
Protection type			
in accordance with the standard	EN 60529	EN 60529	–
Housing	IP20	IP20	–
Terminals	IP20	IP20	–
in accordance with the standard	–	–	EN 60529
Mounting area	–	–	IP51
Housing	–	–	IP20
Terminals	–	–	IP20
Mounting area (e.g. control cabinet)	IP54	IP54	–
Mechanical data	312260	314260	315260
Material			
Bottom	PC	PC	PC
Front	PC	PC	PC
Coding	PA	PA	PA
Mounting type	plug-in	plug-in	plug-in
Dimensions			
Height	76 mm	76 mm	76 mm
Width	12,6 mm	12,6 mm	12,6 mm
Depth	60,2 mm	60,2 mm	60,2 mm
Weight	36 g	37 g	38 g
Mechanical coding			
Type	K	K	K
Colour	Yellow	Yellow	Yellow

Where standards are undated, the 2022-01 latest editions shall apply.

8.1 Safety characteristic data



NOTICE

You must comply with the safety characteristic data in order to achieve the required safety level for your plant/machine.

Operating mode	EN ISO 13849-1: 2015 PL	EN ISO 13849-1: 2015 Category	EN IEC 62061 SIL CL/ maximum SIL	EN IEC 62061 PFH _D [1/h]	EN/IEC 61511 SIL	EN/IEC 61511 PFD	EN ISO 13849-1: 2015 T _M [year]
1-channel	–	–	SIL CL 2	1,56E-08	SIL 2	1,37E-03	20
2-channel	PL e	Cat. 4	SIL CL 3	4,37E-09	SIL 3	2,99E-05	20

If the module is operated at an ambient temperature above 60° C, the values stated in the table for PFH_D and PFD will need to be doubled when a safety function is calculated.

All the units used within a safety function must be considered when calculating the safety characteristic data.



INFORMATION

A safety function's SIL/PL values are **not** identical to the SIL/PL values of the units that are used and may be different. We recommend that you use the PASCAL software tool to calculate the safety function's SIL/PL values.

9 Supplementary data

9.1 Permitted operating height

The values stated in the technical details apply to the use of the device in operating heights up to max. 2000 m above SL. When used at higher levels, restrictions of the ambient temperature (standard IEC 61131-2) must be taken into account.

Operating height above SL [m]	Multiplication factors for the devices' ambient temperature
0 ... 2000	1.0
3000	0.9
4000	0.8
5000	0.7

10 Order reference

10.1 Product

Product type	Features	Order no.
PSSu E F AI I	Electronic module, base type	312260
PSSu E F AI I-T	Electronic module, T-type	314260
PSSu E F AI I-R	Electronic module, R-type	315260

10.2 Accessories

Base modules

Product type	Features	Order no.
PSSu BP 1/8 S	Base module without C-rail with screw terminals	312600
PSSu BP 1/8 S-T	Base module without C-rail with screw terminals, T-type	314600
PSSu BP 1/8 C	Base module without C-rail with cage clamp terminals	312601
PSSu BP 1/8 C-T	Base module without C-rail with cage clamp terminals, T-type	314601
PSSu BP-C 1/8 S	Base module with C-rail and screw terminals	312610
PSSu BP-C 1/8 S-T	Base module with C-rail and screw terminals, T-type	314610
PSSu BP-C 1/8 C	Base module with C-rail and cage clamp terminals	312611
PSSu BP-C 1/8 C-T	Base module with C-rail and cage clamp terminals, T-type	314611
PSSu BP 1/12 S	Base module without C-rail with screw terminals	312618
PSSu BP 1/12 S-T	Base module without C-rail with screw terminals, T-type	314618
PSSu BP 1/12 C	Base module without C-rail with cage clamp terminals	312619
PSSu BP 1/12 C-T	Base module without C-rail with cage clamp terminals, T-type	314619
PSSu BP-C 1/12 S	Base module with C-rail and screw terminals	312620
PSSu BP-C 1/12 S-T	Base module with C-rail and screw terminals, T-type	314620
PSSu BP-C 1/12 C	Base module with C-rail and cage clamp terminals	312621
PSSu BP-C 1/12 C-T	Base module with C-rail and cage clamp terminals, T-type	314621

11 EC declaration of conformity for PSSu E F AI I and PSSu E F AI I-T

This product/these products meet the requirements of the directive 2006/42/EC on machinery of the European Parliament and of the Council. The complete EC Declaration of Conformity is available on the Internet at www.pilz.com/downloads.

Representative: Pilz GmbH & Co. KG, Felix-Wankel-Str. 2, 73760 Ostfildern, Germany

12 UKCA-Declaration of Conformity for PSSu E F AI I and PSSu E F AI I-T

This product(s) complies with following UK legislation: Supply of Machinery (Safety) Regulation 2008.

The complete UKCA Declaration of Conformity is available on the Internet at www.pilz.com/downloads.

Representative: Pilz Automation Technology, Pilz House, Little Colliers Field, Corby, Northamptonshire, NN18 8TJ United Kingdom, eMail: mail@pilz.co.uk

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