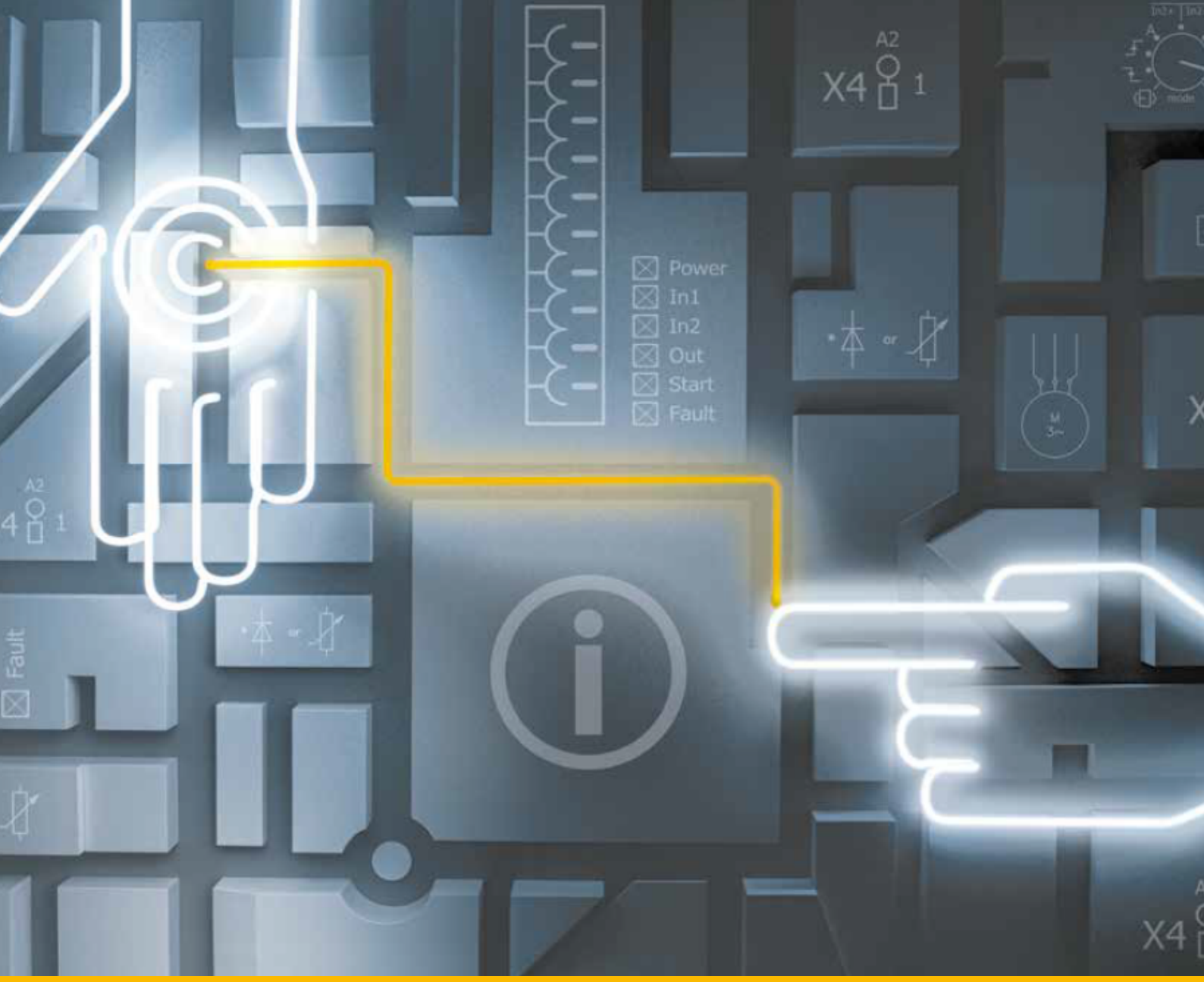

PSEN rd1.1

PILZ
THE SPIRIT OF SAFETY

Operating manual-1005737-EN-08
PSEN sensor technology

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

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Glossary of terms

#

1oo2

(one out of two) Type of multi-channel architecture where one area is monitored by two sensors at the same time.

A

Activated output (ON-state)

Output that switches from OFF to ON-state.

D

Dangerous area

Area to be monitored because it is dangerous for people.

Deactivated output (OFF-state)

Output that switches from ON to OFF-state.

Detection distance 1

Depth of the field of view configured for detection field 1.

Detection distance 2

Depth of the field of view configured for detection field 2.

Detection field 1

Area of the fieldset closer to the sensor. In the absence of detection field 2, it corresponds to the whole fieldset.

Detection field 2

Area of the fieldset that follows detection field 1.

Detection signal 1

Output signal that describes the monitoring status of detection field 1.

Detection signal 2

Output signal that describes the monitoring status of detection field 2.

E

ESPE (Electro-Sensitive Protective Equipment)

Device or system of devices used for the safety-related detection of people or parts of the body. ESPEs provide personal protection at machines and plants/systems where there is a risk of physical injury. These devices/systems cause the machine or plant/system to switch over to a safe status before a person is exposed to a dangerous situation.

F

Field of view

Sensor area of vision characterized by a specific angular coverage.

Fieldset

Structure of the field of view which can be composed of one or two detection fields.

FMCW

Frequency Modulated Continuous Wave

H

Horizontal angular coverage

Property of the field of view that corresponds to the coverage of 110° or 50° on the horizontal plane.

I

Inclination

Sensor rotation around the x-axis. The sensor inclination is the angle between a line perpendicular to the sensor and a line parallel to the ground.

M

Machinery

The system for which the dangerous area is monitored.

Monitored area

Area that is monitored by PSEN rd1.1 systems. It is composed of detection field 1 (e.g. used as alarm area) and detection field 2 (e.g. used as warning area) of all the sensors.

O

OSSD

Output Signal Switching Device

R

RCS

Radar Cross-Section. Measure of how detectable an object is by radar. It depends, among other factors, on the material, dimension and position of the object.

T

Tolerance area

Area of the field of view where detection or not of a moving object/person depends on the characteristics of the same object itself.

1. This manual

1.1 Information on this manual

1.1.1 Objectives of this instruction manual

This manual explains how to integrate PSEN rd1.1 systems for safeguarding machinery operators and how to install it, use it and maintain it safely.

This document includes all the information as Safety Manual according to IEC 61508-2/3 Annex D. Please refer in particular to "Safety parameters" on page 98 and to "System software" on page 125.

The functioning and safety of the machinery to which PSEN rd1.1 systems is connected is out of the scope of this document.

1.1.2 Obligations with regard to this manual

NOTICE: *this manual is an integral part of the product and must be kept for its entire working life.*

It must be consulted for all situations related to the life cycle of the product, from its delivery to decommissioning.

1.1.3 Provided documentation

Document	Code	Date	Distribution format
Operating manual (this manual)	Operating manual PSEN rd1.1 systems 1005737-EN-08	JUL 2025	online PDF PDF downloadable from the site www.pilz.com/manuals
PSEN rd 1.1/2 PROFIsafe communication interface Short form	Short form PSEN rd 1.1/2 PROFIsafe communication interface 1005792-EN-05	FEB 2024	online PDF PDF downloadable from the site www.pilz.com/manuals
PSEN rd 1.1/2 Modbus communication interface Short form	Short form PSEN rd 1.1/2 Modbus communication interface 1005899-EN-05	FEB 2024	online PDF PDF downloadable from the site www.pilz.com/manuals
PSEN rd 1.1/2 FSoE communication interface Short form	Short form PSEN rd 1.1/2 FSoE communication interface 1006766-EN-02	FEB 2024	online PDF PDF downloadable from the site www.pilz.com/manuals

1.1.4 Instruction manual updates

Publication date	Code	Hardware version	Firmware version	Updates
JUL 2025	Operating manual PSEN rd1.1 systems 1005737-EN-08	Analysing units: • Type A: 2.3 • Type B: 2.4 Sensors: • PSEN rd1.1: 2.1	Analysing units: • Type A: 2.0.0 • Type B: 2.0.0 Sensors: • PSEN rd1.1: 2.10	Updated standard list Added Acquisition Trigger as digital input function Added "Analysing unit compatibility" on page 25 Removed automatic node ID re-assignment Other minor changes
JUN 2024	PSEN_rd1_1_Operat_Man_1005737-EN-07	Analysing units: • Type A: 2.2 • Type B: 2.4 Sensors: • PSEN rd1.1: 2.1	Analysing units: • Type A: 2.0 • Type B: 2.0 Sensors: • PSEN rd1.1: 2.10	Layout fix.
FEB 2024	PSEN_rd1_1_Operat_Man_1005737-EN-06	Analysing units: • Type A: 2.2 • Type B: 2.4 Sensors: • PSEN rd1.1: 2.1	Analysing units: • Type A: 2.0 • Type B: 2.0 Sensors: • PSEN rd1.1: 2.10	Changed analysing unit maximum power into 11.2 W. Changed values for Case 4 in "Dynamic configuration through the digital inputs" on page 27. Updated covers

***Note**: the firmware of the analysing unit can be updated through the PSEN rd1 configurator. The latest firmware version available contains the features described in the manual at the system level. The sensor firmware cannot be updated.*

1.1.5 Intended users of this instruction manual

The recipients of the instruction manual are:

- the machinery manufacturer onto which the system will be installed
- system installer
- machinery maintenance technician

2. SAFETY

2.1 Safety information

2.1.1 SAFETY MESSAGES

Warnings related to the safety of the user and of the equipment as envisaged in this document are as follows:

WARNING! Indicates a hazardous situation which, if not avoided, may cause death or serious injury.

NOTICE: *indicates obligations that if not observed may cause harm to the equipment.*

2.1.2 SAFETY SYMBOLS ON THE PRODUCT

This symbol marked on the product indicates that the manual must be consulted. In particular, pay attention to the following activities:

- wiring of the connections (see "Terminal blocks and connector pin-outs" on page 101 and "Electrical connections" on page 103)
- cable operating temperature (see "Terminal blocks and connector pin-outs" on page 101)
- analysing unit cover, which was subjected to a low energy impact test (see "Technical data" on page 98)

2.1.3 PERSONNEL SKILLS

The recipients of this manual and the skills required for each activity presented herein are as follows:

Recipient	Assignments	Skills
Machinery manufacturer	• defines which protective devices should be installed and sets the installation specifications	• knowledge of significant hazards of the machinery that must be reduced based on risk assessment • knowledge of the entire machinery safety system and the system on which it is installed
Protection system installer	• installs the system • configures the system • prints configuration reports	• advanced technical knowledge in the electrical and industrial safety fields • knowledge of the dimensions of the dangerous area of the machinery to be monitored • receives instructions from the machinery manufacturer
Machinery maintenance technician	• performs maintenance on the system	• advanced technical knowledge in the electrical and industrial safety fields

2.1.4 SAFETY ASSESSMENT

Before using a device, a safety assessment in accordance with the Machinery Directive is required.

The product as an individual component fulfills the functional safety requirements in accordance with the standards stated in "Standards and Directives" on page 12. However, this does not guarantee the functional safety of the overall plant/machine. To achieve the relevant safety level of the overall plant/machine's required safety functions, each safety function needs to be considered separately.

2.1.5 INTENDED USE

PSEN rd1.1 systems is a human body detection system, certified SIL 2 according to IEC/EN 62061 and PL d according to EN ISO 13849-1.

It performs the following safety functions:

- **Access detection function**: access of one or more persons to a hazardous area deactivates the safety outputs to stop the moving parts of the machinery.
- **Restart prevention function**: prevents unexpected starting or restarting of the machinery. Detection of motion within the dangerous area maintains the safety outputs deactivated to prevent machinery starting.

It performs the following additional safety-related functions:

- **Stop signal** (Category 3, according to EN ISO 13849-1): it forces all the safety outputs to OFF-state. Only on PSEN rd1.x I/O PN and PSEN rd1.x SD I/O FSoE, it signals a stop request status with a specific safety message on the Fieldbus output interface.
- **Restart signal**: it enables the analysing unit to switch to ON-state the safety outputs related to all the detection fields with no motion detected. Only on PSEN rd1.x I/O PN and PSEN rd1.x SD I/O FSoE, it makes disappear a stop request status with a specific safety message on the Fieldbus output interface. It can be performed:
  - using single channel inputs/OSSDs (Category 2, according to EN ISO 13849-1)
  - using dual channel inputs/OSSDs (Category 3, according to EN ISO 13849-1)
- **Muting** (Category 3, according to EN ISO 13849-1): it inhibits the detection capability of one or a group of sensors (see "Muting" on page 48).
- **Dynamic configuration switch** (Category 3, according to EN ISO 13849-1): it allows the dynamic switch among previously set configurations (see "System configuration" on page 27).
- **Fieldbus controlled**: it monitors the input status through Fieldbus communication. It can be performed:
  - using single channel inputs/OSSDs (Category 2, according to EN ISO 13849-1): it provides the capability to safely redirect the value of the input data exchanged with the Fieldbus master to a physical status of the OSSDs.
  - using dual channel inputs/OSSDs (Category 3, according to EN ISO 13849-1): it provides the capability to safely redirect the status of the digital inputs to the output data exchanged with the Fieldbus master.

WARNING! the following faults makes the Fieldbus controlled safety-related function unavailable: POWER ERROR, TEMPERATURE ERROR, FIELDBUS ERROR, PERIPHERAL ERROR, FEE ERROR and FLASH ERROR.

WARNING! only for Stop signal, Restart signal, Muting and Dynamic configuration switch. Any fault on the sensors or the analysing unit brings the system to the safe state and makes the safety-related functions unavailable.

PSEN rd1.1 systems is suitable for protecting the human body in the following scenarios:

- dangerous area protection
- indoor and outdoor applications

2.1.6 IMPROPER USE

The following is deemed improper use in particular:

- any component, technical or electrical modification to the product
- use of the product outside the areas described in this document
- use of the product outside the technical details, see "Technical data" on page 98

2.1.7 EMC-COMPLIANT ELECTRICAL INSTALLATION

NOTICE: *The product is designed for use in an industrial environment. The product may cause interference if installed in other environments. If installed in other environments, measures should be taken to comply with the applicable standards and directives for the respective installation site with regard to interference.*

2.1.8 GENERAL WARNINGS

- Incorrect installation and configuration of the system decreases or inhibits the protective function of the system. Follow the instructions provided in this manual for correct installation, configuration and validation of the system.

- Changes to the system configuration may compromise the protective function of the system. After any changes made to the configuration, validate correct functioning of the system by following the instructions provided in this manual.
- If the system configuration allows access to the dangerous area without detection, implement additional safety measures (e.g., guards).
- The presence of static objects, in particular metallic objects, within the field of view may limit the efficiency of sensor detection. Keep the sensor field of view unobstructed.
- The system protection level (SIL 2, PL d) must be compatible with the requirements set forth in the risk assessment.
- Check that the temperature of the areas where the system is stored and installed is compatible with the storage and operating temperatures indicated in the technical data of this manual.
- Radiation from this device does not interfere with pacemakers or other medical devices.

2.1.9 WARNINGS FOR THE RESTART PREVENTION FUNCTION

- The restart prevention function is not guaranteed in blind spots. If required by the risk assessment, implement adequate safety measures in those areas.
- Machinery restarting must be enabled only in safe conditions. The button for the restart signal, when needed, must be installed:
  - outside of the dangerous area
  - not accessible from the dangerous area
  - in a point where the dangerous area is fully visible

2.1.10 RESPONSIBILITY

The machinery manufacturer and system installer are responsible for the operations listed below:

- Providing adequate integration of the safety output signals of the system.
- Checking the monitored area of the system and validating it based on the needs of the application and risk assessment.
- Following the instructions provided in this manual.

2.1.11 LIMITS

- The system cannot detect the presence of people who are immobile and not breathing or objects within the dangerous area.
- The system does not offer protection from pieces ejected from the machinery, from radiation, and objects falling from above.
- The machinery command must be electronically controlled.

2.1.12 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 operating 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.).

2.1.13 DISPOSAL

In safety-related applications, comply with the mission time reported in "General specifications" on page 98.

For decommissioning follow the instructions reported in "Disposal" on page 126.

2.2 Conformity

2.2.1 STANDARDS AND DIRECTIVES

Directives	2006/42/EC (MD - Machinery) 2014/53/EU (RED - Radio equipment)
Harmonized standards	EN ISO 13849-1: 2023 PL d EN ISO 13849-2: 2012 EN IEC 62061: 2021 ETSI EN 301 489-1 v2.2.3 (only emissions) ETSI EN 301 489-3 v2.1.1 (only emissions) ETSI EN 300 440 v2.1.1 IEC/EN 61010-1: 2010 EN IEC 61000-6-2:2019
Non-harmonized standards	EN IEC 61326-3-1:2017 IEC/EN 61508: 2010 Part 1-7 SIL 2 UL 61010-1:2023 CAN/CSA 61010-1 UL 61496-1 CRD of IEC 61496-3 EN IEC 61784-3-3:2021 for the PROFIsafe Fieldbus IEC/EN 61784-3-12:2010, A1:2019 for FSoE Fieldbus

***Note**: no type of failure has been excluded during the system analysis and design phase.*

All updated certifications can be downloaded from www.pilz.com/manuals.

2.2.2 CE

This product/these products meet the requirements of the following directives of the European Parliament and of the Council.

- 2006/42/EC on machines
- 2014/53/EC on radio equipment

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

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

2.2.3 UKCA

This product(s) complies with following UK legislation:

- Supply of Machinery (Safety) Regulations 2008
- Radio Equipment Regulations 2017

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

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

2.2.4 OTHER CONFORMITIES AND NATIONAL CONFIGURATIONS

For a complete, up-to-date list of product conformities and any national configurations, please refer to the National configuration addendum document. The PDF can be downloaded from the site www.pilz.com/manuals.

3. Get to know PSEN rd1.1 systems

Contents

This section includes the following topics:

3.1 PSEN rd1.1 systems **13**
3.2 Analysing units **14**
3.3 Analysing unit inputs **19**
3.4 Analysing unit outputs **20**
3.5 Sensors **24**
3.6 System configuration **27**

Product label description

The following table describes the information contained in the product label:

Part	Description
DC	"yy/ww" : year and week of the product manufacture
SRE	Safety Radar Equipment
Model	Product model (e.g., PSEN rd1.1, PSEN rd1.x I/O)
Type	Product variant, used for commercial purposes only
S/N	Serial number

3.1 PSEN rd1.1 systems

3.1.1 Definition

PSEN rd1.1 systems is an active protection radar system that monitors the dangerous areas of machinery.

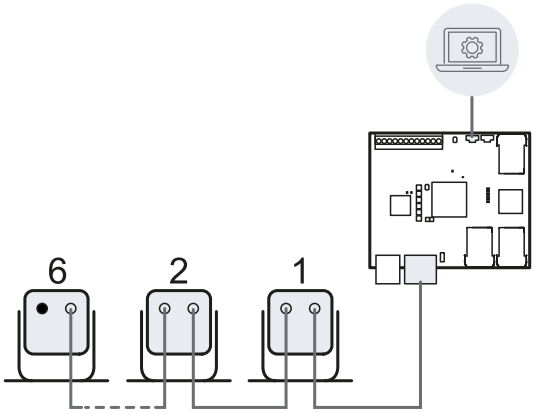
3.1.2 Special features

Some of the special features of this protection system are the following:

- up to two safe detection fields to signal proximity or prepare the machinery for stopping
- Safety Fieldbus to safely communicate with the PLC of the machinery (if available)
- possibility to switch dynamically between different preset configurations (max. 32 through Fieldbus, if available, and max. 8 with digital inputs)
- three configurable sensitivity levels
- muting on the entire system or only on some sensors
- immunity to dust and smoke
- reduction of undesired alarms caused by the presence of water or processing waste
- communication and data exchange through MODBUS (if available)

3.1.3 Main components

PSEN rd1.1 systems is composed of a analysing unit and up to six sensors. The system configurator allows system operation configuration and checks.



3.1.4 Analysing unit - sensor communication

The sensors communicate with the analysing unit via CAN bus using diagnostic mechanisms in compliance with standard EN 50325-5 to guarantee SIL 2 and PL d.

For correct functioning, each sensor must be assigned an identification number (Node ID).

Sensors on the same bus must have different Node IDs. By default, the sensor does not have a pre-assigned Node ID.

3.1.5 Analysing unit - machinery communication

The analysing units communicate with the machinery via I/O (see "Analysing unit inputs" on page 19 and "Analysing unit outputs" on page 20).

Moreover, according to the model-type, the analysing unit is provided with:

- a safe communication on a Fieldbus interface. The Fieldbus interface allows the analysing unit to communicate in real-time with the PLC of the machinery to send information about the system to the PLC (e.g., the position of the detected target) or to receive information from the PLC (e.g., to change the configuration dynamically). For details, see "Fieldbus communication (PROFIsafe)" on page 30 or see "Fieldbus communication (Safety over EtherCAT® - FSoE)" on page 31.
- an Ethernet port that allows unsafe communication on a MODBUS interface (see "MODBUS communication" on page 32).

3.1.6 Applications

PSEN rd1.1 systems integrates with the machinery control system: when performing safety functions or detecting failures, PSEN rd1.1 systems deactivates the safety outputs and keeps them deactivated, so the control system can put the area into a safe condition and/or prevent restarting of the machinery.

In the absence of other control systems, PSEN rd1.1 systems can be connected to the devices that control the power supply or machinery start-up.

PSEN rd1.1 systems does not perform normal machinery control functions.

For connection examples, see "Electrical connections" on page 103.

3.2 Analysing units

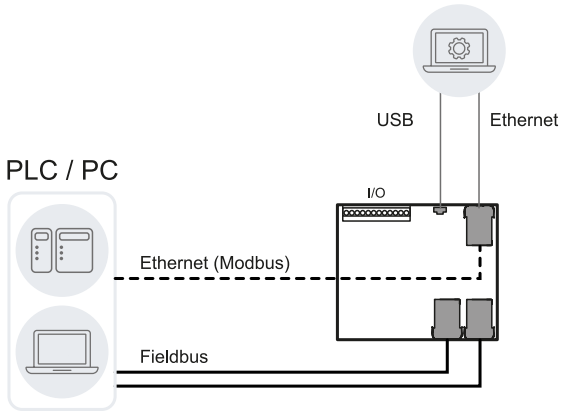
3.2.1 Interfaces

The PSEN rd1.1 systems supports different analysing units. The main difference among them is the connection ports, and therefore the communication interfaces available, and the presence of the microSD slot:

	Analysing unit	micro-USB port	Ethernet port	Fieldbus port	microSD slot
Type A	PSEN rd1.x I/O PN	x	x	x (PROFIsafe)	-
	PSEN rd1.x I/O	x	-	-	-
Type B	PSEN rd1.x SD I/O FSoE	x	x	x (FSoE)	x

3.2.2 Communication architecture

According to the model-type, this is the communication architecture between the analysing unit, PLC, and PC.

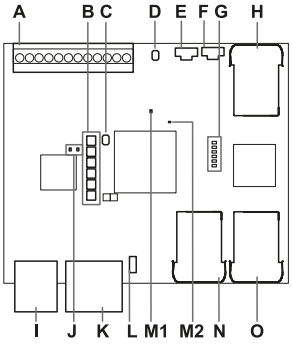


3.2.3 Functions

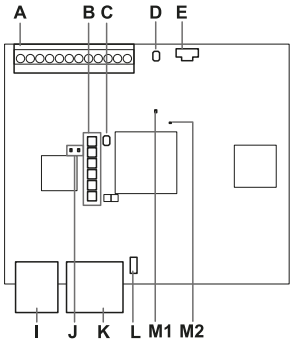
The analysing unit performs the following functions:

- Collects information from all the sensors via CAN bus.
- Compares the position of detected motion with the set values.
- Deactivates the selected safety output when at least one sensor detects motion in the detection field.
- Deactivates all the safety outputs if a failure is detected in one of the sensors or the analysing unit.
- Manages the inputs and outputs.
- Communicates with the PSEN rd1 configurator for all configuration and diagnostic functions.
- Allows dynamically switching between different configurations.
- Communicates with a safety PLC through the safe Fieldbus connection (if available).
- Communicates and exchanges data through MODBUS protocol (if available).
- Performs a backup and a restore system configuration and password to/from microSD card (if available).

3.2.4 Type A analysing units



PSEN rd1.x I/O PN



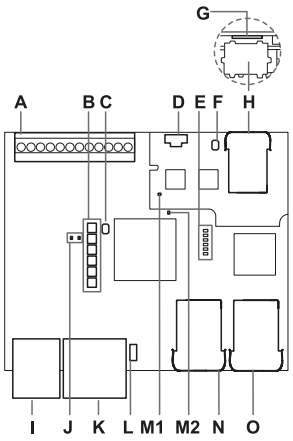
PSEN rd1.x I/O

Part	Description	PSEN rd1.x I/O PN	PSEN rd1.x I/O
A	I/O terminal block	x	x
B	System status LEDs	x	x
C	Network parameter reset button / Factory reset button	x	x
D	Reserved for internal use. Output reset button	x	x
E	Micro-USB port (micro-B type) for connecting the PC and communicating with the PSEN rd1configurator	x	x
F	Micro-USB port, if mounted (reserved)	x	-
G	Fieldbus status LEDs See "PROFIsafe Fieldbus status LEDs" on page 17 or "FSoE Fieldbus status LEDs" on page 18.	x	-

Part	Description	PSEN rd1.x I/O PN	PSEN rd1.x I/O
H	Ethernet port with LEDs for connecting the PC, communicating with the PSEN rd1configurator, and for MODBUS communication	x	-
I	Power supply terminal block	x	x
J	Power supply LEDs (steady green)	x	x
K	CAN bus terminal block for connecting the first sensor	x	x
L	DIP switch to turn on/off the bus termination resistance: • On (top position, default) = resistance included • Off (bottom position) = resistance excluded	x	x
M1	Status LED of hardware functions of the secondary micro-controller: • slow flashing orange: normal behavior • other status:contact Pilz	x	x
M2	Status LED of hardware functions of the primary micro-controller: • off: normal behavior • steady red:contact Pilz	x	x
N	Fieldbus port no. 1 with LEDs (PROFIsafe or FSoE IN)	x	-
O	Fieldbus port no.2 with LEDs (PROFIsafe or FSoE OUT)	x	-

***Note**: the processing direction is from the N connection to the O connection. In normal operation, the device receives the data from the controller on N and sends the outgoing data on O.*

3.2.5 Type B analysing units



PSEN rd1.x SD I/O FSoE

Part	Description
A	I/O terminal block
B	System status LEDs
C	Network parameter reset button / Factory reset button
D	Micro-USB port (micro-B type) for connecting the PC and communicating with the PSEN rd1configurator
E	Fieldbus status LEDs See "PROFIsafe Fieldbus status LEDs" on the next page or "FSoE Fieldbus status LEDs" on page 18.
F	SD Restore button
G	MicroSD slot
H	Ethernet port with LEDs for connecting the PC, communicating with the PSEN rd1configurator, and for MODBUS communication
I	Power supply terminal block
J	Power supply LEDs (steady green)

Part	Description
K	CAN bus terminal block for connecting the first sensor
L	DIP switch to turn on/off the bus termination resistance: • On (top position, default) = resistance included • Off (bottom position) = resistance excluded
M1	Status LED of hardware functions of the secondary micro-controller: • slow flashing orange: normal behavior • other status:contact Pilz
M2	Status LED of hardware functions of the primary micro-controller: • off: normal behavior • steady red:contact Pilz
N	Fieldbus port no. 1 with LEDs (PROFIsafe, CIP Safety™ or FSoE IN)
O	Fieldbus port no.2 with LEDs (PROFIsafe, CIP Safety™ or FSoE OUT)

***Note**: the processing direction is from the N connection to the O connection. In normal operation, the device receives the data from the controller on N and sends the outgoing data on O.*

3.2.6 System status LEDs

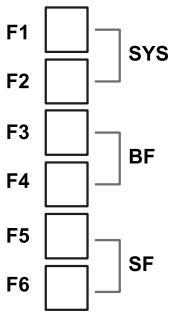
The LEDs are each dedicated to a sensor, and can display the following statuses:

Status	Meaning
Steady green	Normal sensor function and no motion detected
Orange	Normal sensor function and some motion detected
Flashing red	Sensor in error (see "Sensor LED" on page 83)
Steady red	System error (see "Analysing unit LED" on page 81)
Flashing green	Sensor in boot status (see "Analysing unit LED" on page 81)

3.2.7 PROFIsafe Fieldbus status LEDs

The LEDs reflect the status of the PROFIsafe Fieldbus, and their meanings are reported below.

LEDs



LEDs	Type	Description
F1	SYS	System status
F2		
F3	BF	Bus failure
F4		
F5	SF	System failure
F6		

Meaning of SYS LEDs

F1 status	F2 status	Meaning
Steady green	Off	Normal behavior
Flashing green	Off	Contact Pilz
Off	Flashing yellow	Contact Pilz
Off	Steady yellow	Contact Pilz
Off	Off	Contact Pilz

Meaning of BF LEDs

F3 status	F4 status	Meaning
Off	Off (not used)	Data exchange is running with the host
Flashing red	Off (not used)	No data exchange
Steady red	Off (not used)	No physical link

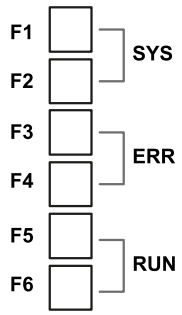
Meaning of SF LEDs

F5 status	F6 status	Meaning
Off	Off (not used)	Normal behavior
Steady red	Off (not used)	Diagnostic error at the PROFIsafe layer (wrong F Dest Address, watchdog timeout, or wrong CRC) or at the PROFINET layer (watchdog timeout, channel, generic or extended diagnosis present, or system error)
Flashing red	Off (not used)	DCP signal service is initiated via the bus

3.2.8 FSoE Fieldbus status LEDs

The LEDs reflect the status of the FSoE Fieldbus, and their meanings are reported below.

LEDs



LEDs	Type	Description
F1	SYS	System status
F2		
F3	ERR	Error code
F4		
F5	RUN	Current state of the State Machine
F6		

Meaning of SYS LEDs

F1 status	F2 status	Meaning
Steady green	Off	Normal behavior
Flashing green	Off	Contact Pilz
Off	Flashing yellow	Contact Pilz
Off	Steady yellow	Contact Pilz
Off	Off	Contact Pilz

Meaning of ERR LEDs

F3 status	F4 status	Meaning
Off	Off (not used)	Normal behavior
Flashing red	Off (not used)	Invalid configuration: General Configuration Error. Possible reason: State change commanded by master is impossible due to register or object settings
Single flash red	Off (not used)	Local error: Slave device application has changed the EtherCAT state autonomously. Possible reason 1: A host watchdog timeout has occurred. Possible reason 2: Synchronization error, the device enters Safe-Operational state automatically
Double flash red	Off (not used)	Application watchdog timeout. Possible reason: Sync Manager Watchdog timeout

Meaning of RUN LEDs

F5 status	F6 status	Meaning
Off (not used)	Off	INIT state
Off (not used)	Steady green	OPERATIONAL state
Off (not used)	Single flash green	SAFE-OPERATIONAL state
Off (not used)	Flashing green	SAFE-OPERATIONAL state

3.3 Analysing unit inputs

3.3.1 Introduction

The system has two type 3 dual channel digital inputs (according to IEC/EN 61131-2). Alternatively, the four channels can be used as single channel digital inputs (category 2). The ground reference is common for all the inputs (see "Technical references" on page 97).

When using digital inputs, it is mandatory that the additional SNS input "V+ (SNS)" is connected to 24 V DC and that the GND input "V- (SNS)" is connected to the ground in order to:

- perform the correct input diagnostic
- assure the system safety level

3.3.2 Input functions

The function of each digital input must be programmed through the PSEN rd1 configurator. The available functions are the following:

- **Stop signal**: additional safety-related function, which manages a specific signal to force all the safety outputs (detection signal 1 and detection signal 2, if present) to OFF-state.
- **Restart signal**: additional safety-related function, which manages a specific signal which enables the analysing unit to switch to ON-state the safety outputs related to all the detection fields with no motion detected.
- **Muting group “N”**: additional safety-related function, which manages a specific signal, allowing the analysing unit to ignore the information from a selected sensor group.
- **Dynamic configuration switch**: additional safety-related function, which allows the analysing unit to select a specific dynamic configuration.
- **Fieldbus controlled** (if available): additional safety-related function monitors the input status through Fieldbus communication. For example, a generic ESPE can be connected to the input, respecting electrical specifications.
- **System recondition**: configures the system without changing any settings.
- **Restart signal + System recondition**: according to the input signal duration, performs the **Restart signal** function or the **System recondition** function.
- **Acquisition Trigger**: manages a specific signal which allows using Multi-Analysing unit synchronization (for details, see "Multi-analysing unit Synchronization" on page 52)

For details about digital input signals, see "Digital input signals" on page 114.

3.3.3 Single or dual channel option

By default, each digital input function needs a signal on both channels to provide the redundancy required by Category 3.

The following digital input functions can also be used as a single channel (Category 2):

- **Restart signal**
- **Fieldbus controlled**
- **System recondition**
- **Restart signal + System recondition**

In the PSEN rd1 configurator in **Settings** > **Digital Input-Output**, set the digital input function to **Single channel (Category 2)** and then choose the input function for each channel.

3.3.4 Redundancy mode

Two types of redundancy mode are available for the dual channels input functions:

- **Coherent redundancy**

Input Channel 1	Input Channel 2	Input logic value
0	0	Low
1	1	High
0	1	Error
1	0	Error

- **Inverted redundancy**

Input Channel 1	Input Channel 2	Input logic value
0	1	Low
1	0	High
0	0	Error
1	1	Error

By default, the redundancy mode is coherent. For the following input functions, the inverted redundancy mode can be set to guarantee compatibility with different connected devices:

- **Muting group “N”** (only if pulse width = 0)
- **Restart signal**
- **Fieldbus controlled**
- **Dynamic configuration switch**
- **System recondition**
- **Restart signal + System recondition**

3.3.5 SNS input

The analysing unit is provided with an **SNS** input (high logic level (1) = 24 V) needed to check the correct functioning of the inputs.

NOTICE: *if at least one input is connected, the SNS input "V+ (SNS)" and the GND input "V- (SNS)" must also be connected.*

3.4 Analysing unit outputs

3.4.1 Outputs

The system has four digital OSSD short-circuit protected outputs that can be used individually (detection warning) or programmed as dual channel safety outputs (detection signal) to ensure the system safety level.

An output is activated when it switches from OFF to ON-state (from 0 V to 24 V) and deactivated when it switches from ON to OFF-state (from 24 V to 0).

3.4.2 Output functions

The function of each digital output must be programmed through the PSEN rd1 configurator.

The available functions are the following:

- **Detection signal "N"**: (e.g., alarm signal) switches the selected output to OFF-state when a sensor detects a motion in detection field N*, receives a stop signal from the related input, or when there is a system failure. The selected output remains in OFF-state for at least 100 ms.
  Note*: "N" is the number of the corresponding detection field (e.g.,* ***Detection signal 1*** *for detection field 1,* ***Detection signal 2*** *for detection field 2).*

  Note*: when an OSSD is configured as* ***Detection signal "N"****, a second OSSD is automatically assigned to it to provide a safe signal.*
- **Detection signal group 1** or **Detection signal group 2**: switches the selected output to OFF-state when at least one sensor detects a motion in a detection field belonging to the group (see "Detection signal group settings" on page 22), receives a stop signal from the related input, or when there is a system failure. The selected output remains in OFF-state for at least 100 ms.

***Note**: when an OSSD is configured as **Detection signal group 1** or **Detection signal group 2**, a second OSSD is automatically assigned to it to provide a safe signal.*

- **System diagnostic signal**: switches the selected output to OFF-state when a system fault is detected.
- **Muting enable feedback signal**: switches the selected output to ON-state in the following cases:
  - when a muting signal is received over the configured input and at least one group is in muting
  - when a muting command is received through Fieldbus communication (if available) and at least one sensor is in muting
- **Fieldbus controlled** (if available): allows the specific output to be set through the Fieldbus communication.
- **Restart feedback signal**: switches the selected output to ON-state when it is possible to manually restart at least one detection field (Restart signal). It can be set as **Standard** or **Pulsed**.
  - If all the used detection fields are configured as **Automatic** restart (in **Settings** > **Restart function**), the selected output is always in OFF-state;
  - If at least one detection field in use is configured as **Manual** or **Safe manual** restart (in **Settings** > **Restart function**), the behavior depends on the option selected (see "Restart feedback signal option settings" on the next page.
- **Acquisition Trigger**: manages a specific signal which allows using Multi-analysing unit Synchronization (for details, see "Multi-analysing unit Synchronization" on page 52).

Each output status can be retrieved by Fieldbus communication (if available).

3.4.3 Output configurations

The system installer can decide to configure the system as follows:

- two dual channel safety outputs (e.g., **Detection signal 1** and **Detection signal 2**, usually alarm and warning signals)
- one dual channel safety output (e.g., **Detection signal 1**) and two single channel output (e.g., **System diagnostic signal** and **Detection signal 2 (non-safe)**)
- each output as a single output (e.g., **System diagnostic signal**, **Muting enable feedback signal** and **Restart feedback signal**)

WARNING! To use PSEN rd1.1 systems for a category 3 safety system, both the channels of a safety output must be connected to the safety system. Configuring a safety system with only one channel safety output may result in serious injuries due to an output circuit fault and a failure of the machine to stop.

3.4.4 Dual channel safety output configuration

The dual channel safety output is automatically managed by the PSEN rd1 configurator and it only matches the single OSSD outputs as follows:

- OSSD 1 with OSSD 2
- OSSD 3 with OSSD 4

3.4.5 Restart feedback signal option settings

If at least one detection field in use is configured as **Manual** or **Safe manual** restart (in **Settings** > **Restart function**), the behavior of the **Restart feedback signal** depends on the option selected:

Option	Restart feedback signal behavior
Standard	• The selected output is activated (ON-state) if there is no more motion within at least one detection field configured as **Manual** or **Safe manual** restart. The ON-state lasts as long as there is an absence of motion within one or more detection fields (configured as **Manual** or **Safe manual** restart) and until the restart signal is activated on the selected input. • The selected output remains in OFF-state if: ◦ none of the detection fields (configured as **Manual** or **Safe manual** restart) are ready to be restarted, and as long as a motion (or a fault) is detected within at least one detection field (configured as **Manual** or **Safe manual** restart), or ◦ as long as no motion is detected within any detection fields configured as **Manual** or **Safe manual** restart, but none can be restarted yet.
Pulsed	• The selected output is activated (ON-state) if there is no more motion within at least one detection field configured as **Manual** or **Safe manual** restart. The ON-state lasts as long as there is an absence of motion within one or more detection fields (configured as **Manual** or **Safe manual** restart) and until the restart signal is activated on the selected input. • The selected output switches continuously between ON-state and OFF-state if none of the detection fields (configured as **Manual** or **Safe manual** restart) are ready to be restarted, and as long as a motion (or a fault) is detected within at least one detection field (configured as **Manual** or **Safe manual** restart) • The selected output remains in OFF-state as long as no motion is detected within any detection fields configured as **Manual** or **Safe manual** restart, but none can be restarted yet.

3.4.6 Detection signal group settings

Each detection field of each sensor can be assigned to a group to associate them with the same safety output.

Through the PSEN rd1 configurator (in **Settings > Detection field groups**), each detection field of each sensor can be associated with a group or both groups. By default, a detection field does not belong to any group.

WARNING! Consider the detection field dependency choice during the group's configuration. See "Detection fields dependency and detection signal generation" on page 36

Example

It is possible to configure that the following detection fields belong to group 1:

- Detection field 1 of Sensor 1

- Detection field 1 of Sensor 3

- Detection field 2 of Sensor 1

By doing so, a specific output assigned to **Detection signal group 1** will switch to the OFF-state when a movement is detected in one of these detection fields.

3.4.7 Output status of detection signal outputs

The output status is the following:

- activated output (24 V DC): idle signal, no motion detected, and normal functioning
- deactivated output (0 V DC): motion detected in the detection field or failure detected in the system

3.4.8 Pulse test for detection signal outputs

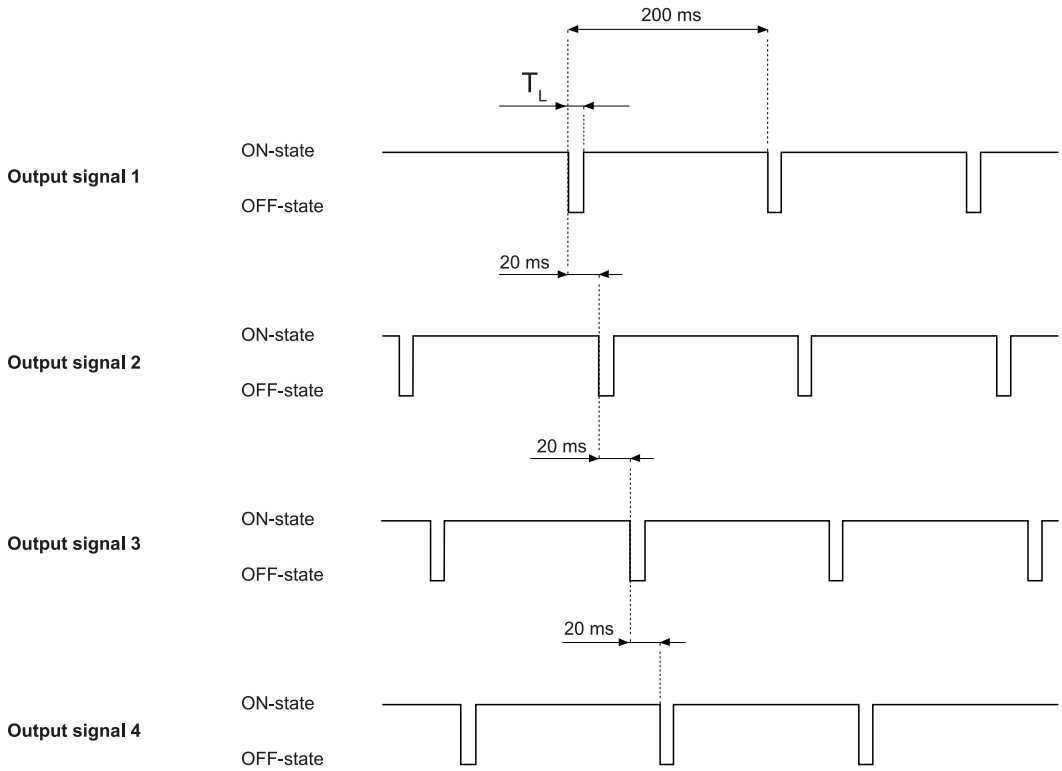
A pulse test is provided for the detection signal output, in particular for the outputs configured as follows:

- **Detection signal "N"**
- **Detection warning "N"**
- **Detection signal group "N"**
- **Detection warning group "N"**

The test is performed with the idle signal periodically pulsed to 0 V to detect short-circuits to either 0 V or 24 V.

The pulse duration at 0 V (T_L) can be set at 300 µs or 2 ms through the PSEN rd1 configurator (**Settings** > **Digital Input-Output** > **OSSD Pulse width**).

***Note**: the devices connected to the OSSD should not respond to these temporary, self-diagnostic 0 V pulses of the signal.*



For details, see "Technical references" on page 97.

3.4.9 OSSD diagnostic checks

Per default, the OSSD Diagnostic check (e.g., for short-circuits) is deactivated. This check can be activated through the PSEN rd1 configurator (**Settings** > **Digital Input-Output**).

If activated, the analysing unit will monitor:

- short-circuit between OSSDs
- 24 V short-circuit
- open circuit (only trips on demand, i.e., when the safety function is activated on the transition from 24 V to GND)

***Note**: the short-circuit to GND (fail-safe fault) is always monitored even if the OSSD diagnostic check is deactivated.*

WARNING! If an external common cause failure leads to a 24 V short-circuit on both the OSSDs, the analysing unit cannot communicate the safe state condition via OSSD. The integrator is responsible for avoiding this condition by monitoring the test pulses generated periodically on the OSSDs.

WARNING! To be compliant with the IEC TS 61496-5 standard, it is necessary to activate the OSSD diagnostic checks and set the Anti-masking sensitivity parameter to High.

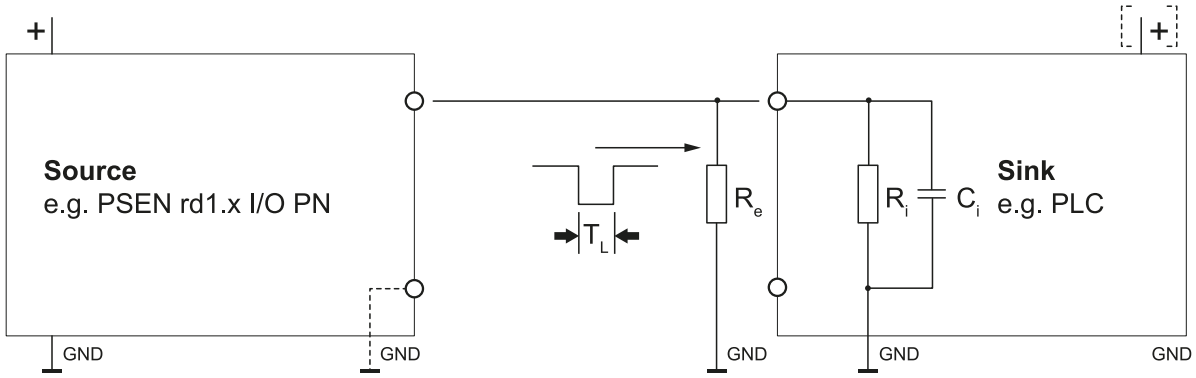
3.4.10 External resistor for OSSD outputs

To guarantee the correct connection between the OSSDs of the analysing unit and an external device, it may be necessary to add an external resistor.

If the pulse width set (**OSSD Pulse width**) is 300 µs, it is strongly recommended to add an external resistor to guarantee the discharge time of the capacitive load. If it is set at 2 ms, an external resistance must be added if the resistor of the external load is greater than the maximum resistive load allowed (see "Technical data" on page 98).

Below are some standard values for the external resistor:

OSSD Pulse width value	External resistor (R_e)
300 µs	1 kΩ
2 ms	10 kΩ



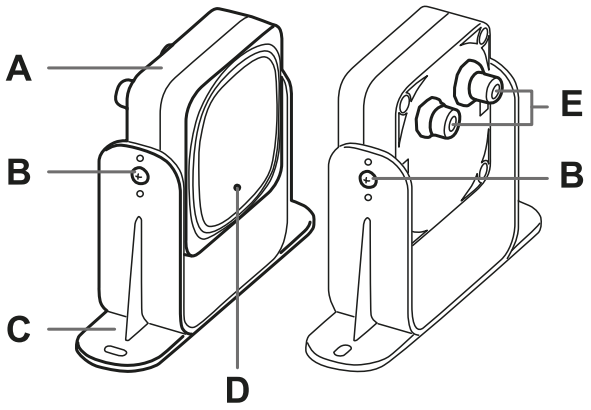
3.5 Sensors

3.5.1 Functions

The sensors perform the following functions:

- Detect motion in their field of view.
- Send the motion detection signal to the analysing unit through CAN bus.
- Signal to the analysing unit through CAN bus the failures or faults detected on the sensor during diagnostics.

3.5.2 Structure



Part	Description
A	Sensor
B	Screws for fastening the sensor at a specific inclination
C	Mounting bracket
D	Status LED
E	Connectors for connecting the sensors in a chain and to the analysing unit

3.5.3 Status LED

Status	Meaning
Steady on	Sensor is working. No motion detected.
Rapid flashing on (100 ms)	Sensor is detecting motion. Not available if the sensor is in muting.

Status	Meaning
Other conditions	Error (see "Sensor LED" on page 83)

3.5.4 Functions

The configurator permits the following main functions to be performed:

- Configure the system.
- Create the configuration report.
- Check system functioning.
- Download system log.

3.5.5 Analysing unit compatibility

	PSEN rd1 version							
Analysing unit firmware version	**2.02**	**2.2.2**	**2.3.x**	**2.4.x**	**2.5.x**	**2.6.x**	**2.7.x**	**2.8.x**
1.1.0	OK	NO	NO	NO	NO	NO	NO	NO
1.2.0	NO	OK	NO	NO	NO	NO	NO	NO
1.3.0	NO	NO	OK	OK	OK	OK	NO	NO
1.4.0	NO	NO	NO	OK	OK	OK	NO	NO
1.5.0	NO	NO	NO	NO	OK	OK	NO	NO
1.6.0	NO	NO	NO	NO	NO	OK	OK	OK
2.0.0	NO	NO	NO	NO	NO	NO	OK	OK
2.1.0	NO	NO	NO	NO	NO	NO	NO	OK

3.5.6 PSEN rd1 configurator usage

To use the configurator, the analysing unit must be connected to a computer with a data USB cable or, if the Ethernet port is available, an Ethernet cable. The USB cable allows to configure the system locally, whereas the Ethernet cable allows to do it remotely.

The Ethernet communication between the analysing unit and the PSEN rd1 configurator is secured by the most advanced security protocols (TLS).

3.5.7 Authentication

The configurator can be downloaded free of charge at www.pilz.com/manuals.

Different roles are available. The Administrator role is in charge of user management. All the passwords can be set through the configurator and then saved on the analysing unit.

3.5.8 Roles

These are the functions available for each role:

	Viewer	Limited Service	Engineer	Administrator	Service*
Read system configuration	x	x	x	x	x
Validation	-	x	x	x	x
Download log files	-	x	x	x	x
Sensor setup (e.g., Node ID) and configuration	-	-	x	x	-
Apply changes	-	-	x	x	-
Digital I/O configuration	-	-	x	x	-
Backup configuration	-	x	x	x	-
Restore configuration	-	-	x	x	-
Network and Fieldbus settings and System labels	-	-	-	x	-
Analysing unit firmware upgrade	-	-	-	x	-
User management	-	-	-	x	-

	Viewer	Limited Service	Engineer	Administrator	Service*
SD Backup and SD Restore (if available)	-	-	-	x	-
Technical support and maintenance	-	-	-	-	x
Debug and statistical information	-	-	-	-	x

Note*: Service user can be enabled/disabled by the administrator. Since only Pilz technicians are allowed to access as Service, the Service user is protected by an activation code.*

3.5.9 Main menu

Page	Function
Dashboard	Display main information on the configured system. ***Note****: the messages show the same information in the log files. For the meanings of the messages, see the chapters on logs in "Troubleshooting" on page 81.*
Configuration	Define the monitored area. Configure the sensors and the detection fields. Define the dynamic configurations. Choose the safety working mode. Set the restart timeout.
Settings	Configure the sensor groups. Choose the detection fields dependency. Enable the anti-tampering functions. Synchronize more analysing units. Configure the auxiliary inputs and outputs function. Perform the configuration backup and load a configuration. Download the log. Perform the sensor Node ID assignment. Other general functions.
Admin	Configure and manage the users. Enable the SD Backup and the SD Restore. Perform a factory reset. Configure, show, and change the Network parameters (if available). Configure, show and change the MODBUS parameters (if available). Configure, show and change the Fieldbus parameters (if available). Set labels for analysing units and sensors.
Monitoring	Start the validation procedure. ***Note****: the messages shown are those in the log file. To know the meaning of the messages, see the chapters on logs in "Troubleshooting" on page 81.*
REFRESH CONFIGURATION	Refresh configuration or ignore unsaved changes.
User	Change user profile. Modify account settings.
Analysing unit	Retrieve analysing unit information. Close the connection with the analysing unit and allow it to connect to another analysing unit.
	Change the language.

3.6 System configuration

3.6.1 System configuration

The analysing unit parameters have their own default values that can be modified via the PSEN rd1 configurator (see "Configuration configurator parameters" on page 111).

When a new configuration is saved, the system generates the configuration report.

***Note**: after a physical change of the system (e.g., new sensor installed), the system configuration must be updated and a new configuration report must be generated, too.*

3.6.2 Dynamic system configuration

PSEN rd1.1 systems allows a real-time adjustment of the most important system parameters, providing the means to switch dynamically among different preset configurations. Via the PSEN rd1 configurator, once the first system configuration (default configuration) has been set, it is possible to set alternative presets to allow a dynamic real-time reconfiguration of the monitored area. The alternative presets are 7 through digital input and 31 through Fieldbus (if available).

3.6.3 Dynamic system configuration parameters

These are the programmable parameters for each sensor:

- detection field (1 or 2)
- horizontal angular coverage (50° or 110° on the horizontal plane)

These are the programmable parameters for each detection field:

- detection distance
- safety working mode (**Access detection and restart prevention** or **Always-on access detection**) (see "Safety working modes and safety functions" on page 39)
- restart timeout

All the remaining system parameters cannot be changed dynamically and are considered static.

3.6.4 Dynamic system configuration switch

One of the preset configurations can be activated dynamically either through the digital inputs (**Dynamic configuration switch**) or through the safety Fieldbus (if available).

WARNING! If one or more digital inputs are configured as "Dynamic configuration switch", a switch through the safety Fieldbus is not considered.

3.6.5 Dynamic configuration through the digital inputs

To activate one of the preset configurations dynamically, one or both the digital inputs of the analysing unit can be used. The result is the following:

If...	Then it is possible to switch dynamically between...
only **one** digital input is configured as **Dynamic configuration switch**	**two** preset configurations (see "Case 1" on the next page and "Case 2" on the next page)
both digital inputs are configured as **Dynamic configuration switch** and the encoded channel option is disabled	**four** preset configurations (see "Case 3" on the next page)
both digital inputs are configured as **Dynamic configuration switch** and the encoded channel option is enabled	**eight** preset configurations (see "Case 4" on the next page)

***Note**: the configuration change is safe because two-channel inputs are used.*

***Note**: if the encoded channel option is enabled, any invalid combination that lasts more than 33 ms results in a fault on the inputs that brings the system to a safe state.*

Case 1

The first digital input has been configured as **Dynamic configuration switch**.

Dynamic configuration number	Input 1 (CH1 and CH2)	Input 2
#1	**0**	-
#2	**1**	-

0 = signal deactivated; 1 = signal activated

Case 2

The second digital input has been configured as **Dynamic configuration switch**.

Dynamic configuration number	Input 1	Input 2 (CH1 and CH2)
#1	-	**0**
#2	-	**1**

0 = signal deactivated; 1 = signal activated

Case 3

Both digital inputs have been configured as **Dynamic configuration switch**, and the encoded channel option is disabled.

Dynamic configuration number	Input 1 (CH1 and CH2)	Input 2 (CH1 and CH2)
#1	**0**	**0**
#2	**1**	**0**
#3	**0**	**1**
#4	**1**	**1**

0 = signal deactivated; 1 = signal activated

Case 4

Both digital inputs have been configured as **Dynamic configuration switch**, and the encoded channel option is enabled.

The valid combinations are only those that differ at least by two values, and they are listed below:

Dynamic configuration number	Input 1		Input 2	
	CH1	CH2	CH1	CH2
#1	**1**	**0**	**0**	**0**
#2	**0**	**1**	**0**	**0**
#3	**0**	**0**	**1**	**0**
#4	**0**	**0**	**0**	**1**
#5	**1**	**1**	**1**	**0**
#6	**1**	**1**	**0**	**1**
#7	**1**	**0**	**1**	**1**
#8	**0**	**1**	**1**	**1**

0 = signal deactivated; 1 = signal activated

3.6.6 Dynamic configuration through the safety Fieldbus

To activate one of the preset configurations dynamically, connect an external safety PLC that communicates through the safety Fieldbus to the analysing unit. This makes it possible to dynamically switch between all the preset configurations, therefore up to 32 different configurations. For all the parameters used for each configuration, see "Dynamic system configuration" on page 27.

For details about the supported protocol, please refer to the Fieldbus manual.

WARNING! Before activating one of the preset configurations through the safety Fieldbus, ensure that none of the digital inputs is configured as Dynamic configuration switch; otherwise, the PSEN rd1.1 systems ignores all the switches made through the safety Fieldbus.

WARNING! The firmware version 1.1.0 of the analysing unit does not support safety communication on the Fieldbus interface.

3.6.7 Safe configuration switch

WARNING! The new dynamic configuration is activated every time the command is received (via digital input or Fieldbus command) regardless of the system status. Verify that the safety of the area is still guaranteed before switching to another configuration.

The usage of the feature can be split in the following two main categories, resulting in different consequences on the safety of the area.

Sensor mounted on movable machinery

While the machinery with the mounted sensor is moving, in the dynamic switch between different preset configurations the safety is always guaranteed. The sensor itself is moving and any kind of configuration will trip an alarm as soon as a relative movement is detected, even in case of a still person.

When the machinery with the mounted sensor stops, see "Sensor mounted on fixed machinery" below.

Sensor mounted on fixed machinery

If the machinery with the mounted sensor is fixed, the dynamic switch between different preset configurations is safe only if no one is in the monitored area. In fact, for example, if the new configuration has a longer detection field and a person stands still in the new monitored area, it won't be detected until the person moves.

4. System communication

Contents

This section includes the following topics:

4.1 Fieldbus communication (PROFIsafe) 30
4.2 Fieldbus communication (Safety over EtherCAT® - FSoE) 31
4.3 MODBUS communication 32

4.1 Fieldbus communication (PROFIsafe)

4.1.1 PROFIsafe support

The safety communication using PROFIsafe is available on all the analysing units provided with the PROFIsafe interface. For details, see "Analysing units" on page 14.

4.1.2 Communication with the machinery

The Fieldbus makes the following actions possible:

- Choose from 1 to 32 preset configurations dynamically.
- Read the status of the inputs.
- Control the outputs.
- Read the target data.
- Mute the sensors.
- Enable the restart signal.
- Enable the system recondition signal.

For details, see the PSEN rd 1.1/2 PROFIsafe communication interface Short form.

4.1.3 Input data coming from the PLC

If neither digital input nor OSSD is configured as **Fieldbus controlled**, the behavior of the input data coming from the PLC is as described below:

Condition	Input data coming from the PLC	System behavior
IOPS (PLC provider status) = bad	the last valid value of the input variable is retained	the system keeps working in its normal operating state
Connection loss	the last valid value of the input variable is retained	the system keeps working in its normal operating state
After power-up	the initial values (set to 0) are used for the input variables	the system keeps working in its normal operating state

If at least one digital input or OSSD is configured as **Fieldbus controlled**, the behavior of the input data coming from the PLC is as described below:

Condition	Input data coming from the PLC	System behavior
IOPS (PLC provider status) = bad	the last valid value of the input variable is retained	the system keeps working in its normal operating state
Connection loss	the last valid value of the input variable is retained	the system transits to safe state, deactivating the OSSDs, until the connection is re-established.
After power-up	the initial values (set to 0) are used for the input variables	the system remains in a safe state with the OSSDs deactivated, until the input data are passivated.

4.1.4 Data exchanged through PROFIsafe

The following table details the data exchanged through the Fieldbus communication:

WARNING! The system is in the safe state if the analysing unit status byte of the System configuration and status module PS2v6 or PS2v4 is different from "0xFF".

Data type	Description	Communication direction
Safe	SYSTEM STATUS DATA Analysing unit: • internal status • status of each of the four OSSDs • status of each single channel and dual channel input Sensor: • status of each detection field (target detected or not) or error status • muting status	from the analysing unit
Safe	SYSTEM SETTING COMMAND Analysing unit: • set the ID of the dynamic configuration that shall be activated • set the status of each of the four OSSDs • save the reference for the anti-rotation around axes • enable the restart signal • enable the system recondition signal Sensor: • set the muting status	to the analysing unit
Safe	DYNAMIC CONFIGURATION STATUS • ID of the dynamic configuration currently active • signature (CRC32) of the dynamic configuration ID currently active	from the analysing unit
Safe	TARGET DATA • Current distance of the target detected by each sensor connected to the analysing unit. For each sensor, only the closest target to the sensor is considered.	from the analysing unit
Unsafe	DIAGNOSTIC DATA Analysing unit: • internal status with an extended description of the error condition Sensor: • internal status with an extended description of the error condition	from the analysing unit
Unsafe	SYSTEM STATUS AND TARGET DATA	from the analysing unit

4.2 Fieldbus communication (Safety over EtherCAT® - FSoE)

4.2.1 FSoE support

The safety communication using FSoE is available on all the analysing units provided with the FSoE interface. For details, see "Analysing units" on page 14.

4.2.2 Communication with the machinery

The Fieldbus makes the following actions possible:

- Choose dynamically from 1 to 32 preset configurations.
- Read the status of the inputs.
- Control the outputs.

- Mute the sensors.
- Enable the restart signal.
- Enable the system recondition signal.

For details, see the PSEN rd 1.1/2 FSoE communication interface Short form.

4.2.3 Data exchanged through FSoE

The following table details the data exchanged through the Fieldbus communication:

WARNING! The system is in the safe state if Byte 0 of the selected TxPDO has at least one of its bits equal to 0, except for bit 4, which can assume any value.

Data type	Description	Communication direction
Safe	SYSTEM STATUS DATA Analysing unit: • internal status • status of each of the four OSSDs • status of each of single channel inputs and dual channel inputs Sensor: • status of each detection field (target detected or not) or error status • status of Static object detection for each detection field • muting status	from the analysing unit
Safe	SYSTEM SETTING COMMAND Analysing unit: • set the ID of the dynamic configuration that shall be activated • set the status of each of the four OSSDs • enable the system recondition signal • enable the restart signal Sensor: • set the muting status	to the analysing unit
Safe	DYNAMIC CONFIGURATION STATUS • ID of the dynamic configuration currently active • signature (CRC32) of the dynamic configuration ID currently active	from the analysing unit
Unsafe	DIAGNOSTIC DATA Analysing unit: • internal status with an extended description of the error condition Sensor: • internal status with an extended description of the error condition	from the analysing unit
Unsafe	SYSTEM STATUS	from the analysing unit

4.3 MODBUS communication

4.3.1 MODBUS support

MODBUS communication is available on all the analysing units provided with the MODBUS interface. For details, see "Analysing units" on page 14.

4.3.2 MODBUS communication enabling

In the PSEN rd1 configurator, click on **Admin** > **MODBUS Parameters** and check that the feature is enabled (**ON**).

Within the Ethernet network, the analysing unit acts like a server. The client must send requests to the IP address of the server on the MODBUS listening port (default port is 502).

To show and change the address and the port, click on **Admin** > **Network Parameters** and **Admin** > **MODBUS Parameters**.

4.3.3 Data exchanged through MODBUS

The following table details the data exchanged through the MODBUS communication:

Data type	Description	Communication direction
Unsafe	SYSTEM STATUS DATA Analysing unit: • internal status • status of each of the four OSSDs • status of each single channel and dual channel input • revision information Sensor: • status of each detection field (target detected or not) or error status • muting status • revision information	from the analysing unit
Unsafe	DYNAMIC CONFIGURATION STATUS • ID of the dynamic configuration currently active • signature (CRC32) of the dynamic configuration ID currently active	from the analysing unit
Unsafe	TARGET DATA • Current distance of the target detected by each sensor connected to the analysing unit. For each sensor, only the closest target to the sensor is considered.	from the analysing unit
Unsafe	DIAGNOSTIC DATA Analysing unit: • internal status with an extended description of the error condition Sensor: • internal status with an extended description of the error condition	from the analysing unit

5. Functioning principles

Contents

This section includes the following topics:

5.1 Sensor functioning principles 34
5.2 Detection fields 35
5.3 System category (according to EN ISO 13849) 36

5.1 Sensor functioning principles

5.1.1 Introduction

The sensor is an FMCW (Frequency Modulated Continuous Wave) radar device based on a proprietary detection algorithm. It is also a single target sensor that sends pulses and receives information, analyzing the reflection of the nearest moving target that it encounters.

Each sensor has its own fieldset. The fieldset corresponds to the structure of the field of view, which is composed of detection fields (see "Detection fields" on the next page).

5.1.2 Factors that influence the sensor field of view and object detection

WARNING! The presence of conductive material on the sensor could affect its field of view and, thus, object detection. For proper and safe system operation, validate the system under this condition.

5.1.3 Factors that influence the reflected signal

The signal reflected by the object depends on several characteristics of the same object:

- Metallic objects have a very high reflection coefficient, while paper and plastic reflect only a small portion of the signal
- The greater the surface exposed to the radar, the greater the reflected signal
- All other factors being equal, objects positioned directly in front of the radar generate a more significant signal than objects to the side
- Motion speed
- Inclination

All these factors have been analyzed for a human body during the safety validation of PSEN rd1.1 systems and cannot lead to a dangerous situation. These factors may occasionally influence the behavior of the system causing spurious activation of the safety function.

This behavior can be minimized with an ad hoc installation and a metal protector kit.

5.1.4 Detected and missed objects

The signal analysis algorithm considers only those objects that move within the field of view, ignoring completely static objects.

Furthermore, a *falling objects* algorithm allows ignoring undesired alarms generated by small work waste products that fall in the first part of the sensor's field of view.

5.1.5 Interference with pacemakers or other medical devices

Radiation from PSEN rd1.1 systems does not interfere with pacemakers or other medical devices.

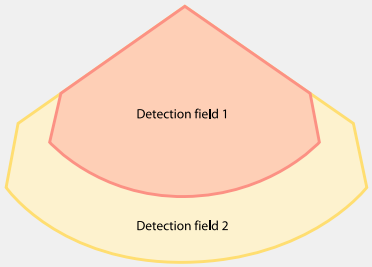
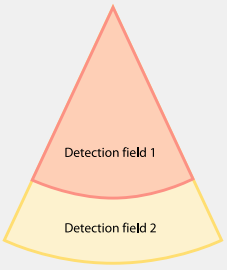
5.2 Detection fields

5.2.1 Introduction

The field of view of each sensor can be composed of up to two detection fields. Each of the two detection fields has a dedicated detection signal.

WARNING! Configure the detection fields and associate them with the dual channel safety outputs according to the risk assessment requirements.

Detection field examples

Horizontal angular coverage	Detection fields
110°	
50°	

5.2.2 Detection field parameters

These are the programmable parameters for each sensor:

- horizontal angular coverage (50° or 110°)

These are the programmable parameters for each detection field:

- detection distance
- safety working mode (**Access detection and restart prevention**, **Always-on access detection** or **Always-on restart prevention**, see "Safety working modes and safety functions" on page 39)

5.2.3 Detection fields dependency and detection signal generation

If a sensor detects motion within a detection field, its detection signal changes status and, when configured, the related safety output is deactivated. The behavior of the outputs related to the following detection fields depends on the detection field dependency set:

If...	Then...
the **Dependent mode** is set and thus detection fields are dependent on each other	• if a sensor detects motion within detection field 1, the output related to detection field 2 is also deactivated. Example Detection field configured: 1, 2 Detection field with target detected: 1 Detection field in alarm status: 1, 2 • if a sensor detects motion within detection field 2, only the output related to detection field 2 is deactivated. Example Detection field configured: 1, 2 Detection field with target detected: 2 Detection field in alarm status: 2
the **Independent mode** is set and thus detection fields are independent from each other	• if a sensor detects motion within detection field 1, only the output related to detection field 1 is deactivated. Example Detection field configured: 1, 2 Detection field with target detected: 1 Detection field in alarm status: 1 • if a sensor detects motion within detection field 2, only the output related to detection field 2 is deactivated. Example Detection field configured: 1, 2 Detection field with target detected: 2 Detection field in alarm status: 2

WARNING! If detection fields are independent, an evaluation of the safety of the monitored area must be performed during the risk assessment. PSEN rd1.1 is a single target sensor. This means that when a target is detected in detection field 1 of a sensor, detection field 2 becomes temporarily blind.

In the **PSEN rd1** configurator, click on **Settings** > **Advanced** > Detection field dependency to set the dependency mode of the detection fields.

5.3 System category (according to EN ISO 13849)

5.3.1 System safety degree

All analysing unit (PSEN rd1.x I/O PN, PSEN rd1.x I/O and PSEN rd1.x SD I/O FSoE) and PSEN rd1.1 are classified PL d according to EN ISO 13849-1, and SIL 2 according to IEC/EN 62061.

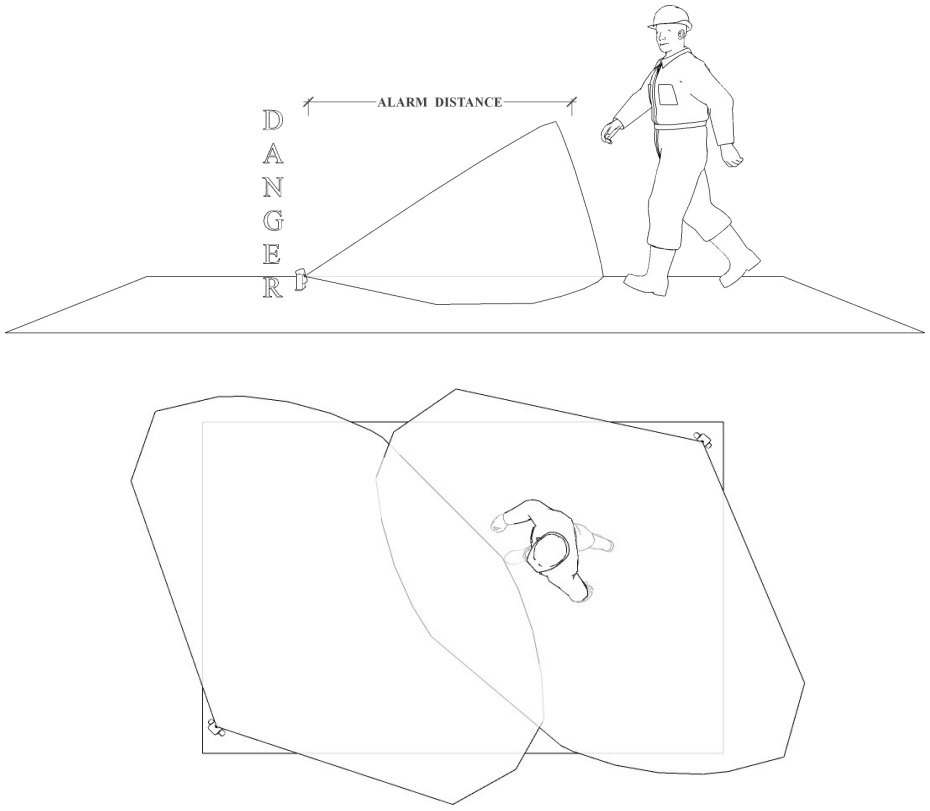
According to EN ISO 13849-1, the architectures of the analysing unit and PSEN rd1.1 sensor are classified respectively as category 3 equivalent and category 2. Since PSEN rd1.1 systems is composed of the analysing unit and sensors together, it can be classified category 2 or category 3 equivalent based on the installation configuration and layout.

PSEN rd1.1 systems compliance with PL d, category 2 architecture is always guaranteed, and does not require the installer to perform any additional operation. There is no parameter combination that can lead to a configuration which has a risk reduction lower than PL d, category 2.

On the contrary, compliance with PL d, category 3 equivalent architecture requires a specific configuration of the system sensors.

5.3.2 PL d, category 2 configuration

Sensors connected to the same analysing unit operate independently. They can have different positions, configurations and safety working modes (see "Safety working modes and safety functions" on page 39). Some architecture examples are as follows:



5.3.3 PL d, category 3 configuration

Requirements

Sensors must be installed with a redundant configuration to cover the same dangerous area, thus creating a 1oo2 multi-channel architecture.

To reach a category 3 equivalent architecture, the following requirements must be met:

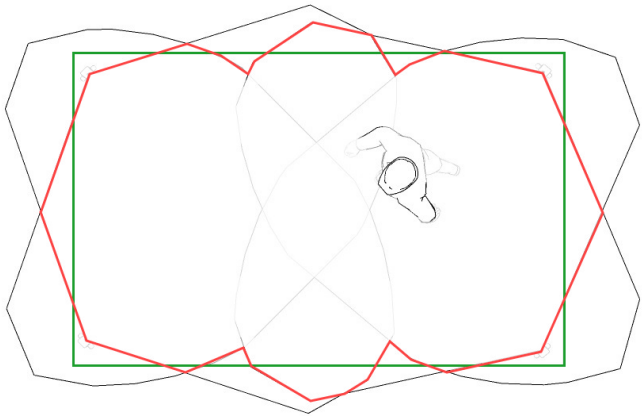
- At least two sensors must monitor the same dangerous area at the same time.
- Sensors that monitor the same area must have the same safety working mode. Assuming that an area is monitored by two sensors, the valid safety working mode combinations are the following:
  - Sensor 1: access detection, Sensor 2: access detection
  - Sensor 1: both access detection and restart prevention, Sensor 2: both access detection and restart prevention
  - Sensor 1: restart prevention, Sensor 2: restart prevention
- Sensors that monitor the same area must have the same restart timeout.
- The muting of sensors that monitor the same area must be enabled or disabled at the same time.

If multiple configurations were stored on the analysing unit, each individual configuration should comply with the requirements listed above in order to classify the system as category 3 equivalent.

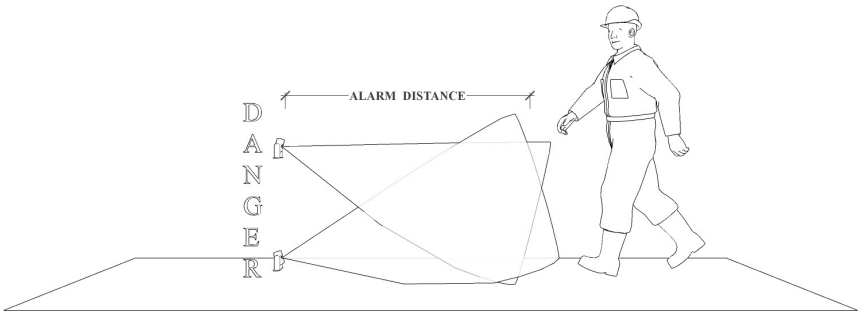
Position

Two sensors covering the same area should not necessarily be installed in the same position. The system monitored area is defined as the area covered by two or more sensor detection fields. Following are some examples:

- Actual monitored area in category 3 (red) and dangerous area (green) covered by the detection fields of two or more sensors that comply with a category 3 equivalent architecture:



- Sensors belonging to each pair that are installed on two different heights and have the same detection fields:



NOTICE: *for the safety parameters of the category 3 architecture that apply (see "Technical references" on page 97).*

6. Safety functions

Contents

This section includes the following topics:

6.1 Safety working modes and safety functions 39
6.2 Safety working mode: Access detection and restart prevention (default) 43
6.3 Safety working mode: Always-on access detection 44
6.4 Safety working mode: Always-on restart prevention 44
6.5 Features of the restart prevention function 45

6.1 Safety working modes and safety functions

6.1.1 Introduction

Each sensor can perform the following safety working modes:

- **Access detection and restart prevention**
- **Always-on access detection**
- **Always-on restart prevention**

Each safety working mode is composed of one or both of the following safety functions:

Function	Description
Access detection	The machinery is reverted into a safe status when one or more persons enter the dangerous area.
Restart prevention	The machinery is prevented from restarting if people are in the dangerous area.

6.1.2 Safety working modes

Via the PSEN rd1 configurator, you can select which safety working mode each sensor will employ for each of its detection fields:

- **Access detection and restart prevention** (default):
  - The sensor performs the access detection function when it is in normal operation (**No alarm** status).
  - The sensor performs the restart prevention function when it is in alarm status (**Alarm** status).
- **Always-on access detection**:
  - The sensor always performs the access detection function (**No alarm** status + **Alarm** status).
- **Always-on restart prevention**:
  - The sensor always performs the restart function (**No alarm** status + **Alarm** status)

Inside the field of view of each sensor you can set up to two detection fields:

- Detection field 1, e.g., used as alarm area
- Detection field 2, e.g., used as warning area

6.1.3 Access detection speed limits

The speed limits of the movements detected by the access detection function are reported below:

- minimum: 0.1 m/s ([0.33 ft/s)
- maximum: 1.6 m/s (5.25 ft/s)

6.1.4 Safety working modes examples

The following examples show the four possible combinations of the safety working modes of PSEN rd1.1 systems and what changes if the motion is detected in detection field 1 or detection field 2.

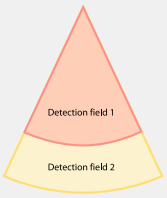
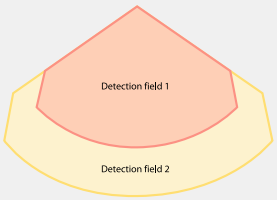
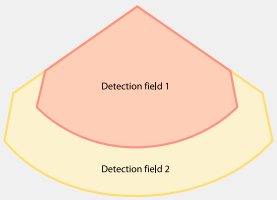
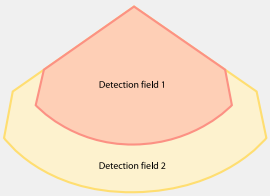
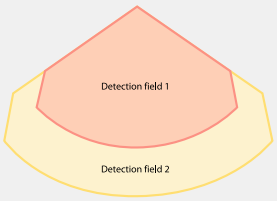
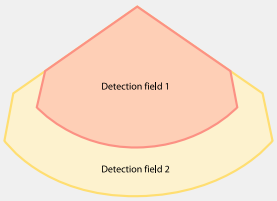
Example 1

The combination is the following:

- Detection field 1: **Access detection and restart prevention**
- Detection field 2: **Access detection and restart prevention**

Once an alarm is notified, a sensor set with a 50° horizontal angular coverage changes its angular coverage to 110°.

NOTICE: *during the configuration phase, take this aspect into consideration to avoid generating undesired alarms.*

Horizontal angular coverage	No alarm status	Detection in detection field 1	Detection in detection field 2
50°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function
110°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function

If the motion is detected in the...	Then the output of detection field 1...	And the output of detection field 2...
detection field 1	is deactivated and switches to the restart prevention function	is deactivated and switches to the restart prevention function
detection field 2	remains active and switches to the restart prevention function	is deactivated and switches to the restart prevention function

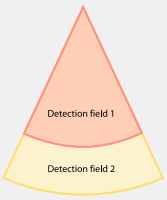
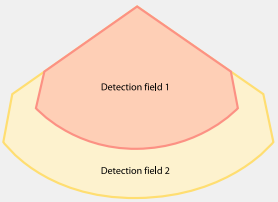
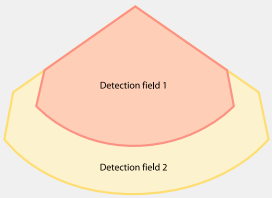
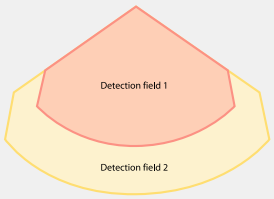
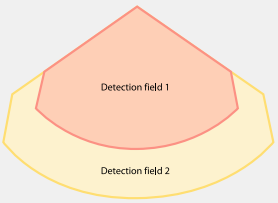
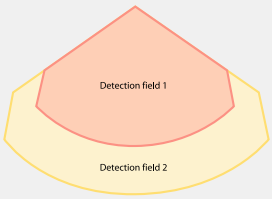
Example 2

The combination is the following:

- Detection field 1: **Access detection and restart prevention**
- Detection field 2: **Always-on access detection**

Once an alarm is notified, a sensor set with a 50° horizontal angular coverage changes its angular coverage to 110°.

NOTICE: *during the configuration phase, take this aspect into consideration to avoid generating undesired alarms.*

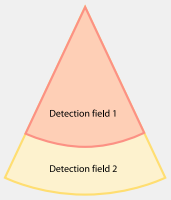
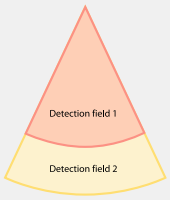
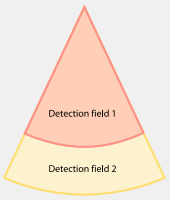
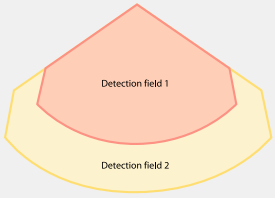
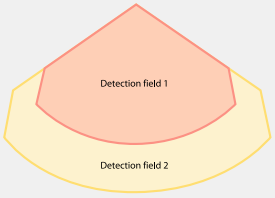
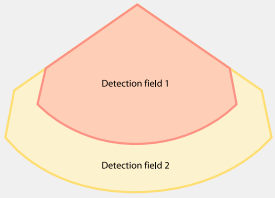
Horizontal angular coverage	No alarm status	Detection in detection field 1	Detection in detection field 2
50°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function	 • Detection field 1: access detection function • Detection field 2: access detection function
110°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function	 • Detection field 1: access detection function • Detection field 2: access detection function

If the motion is detected in the...	Then the output of detection field 1...	And the output of detection field 2...
detection field 1	is deactivated and switches to the restart prevention function	is deactivated and switches to the restart prevention function
detection field 2	remains active and switches to the access detection function	is deactivated and remains in the access detection function

Example 3

The combination is the following:

- Detection field 1: **Always-on access detection**
- Detection field 2: **Always-on access detection**

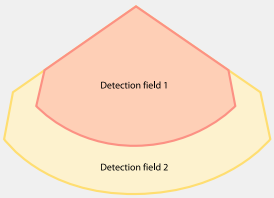
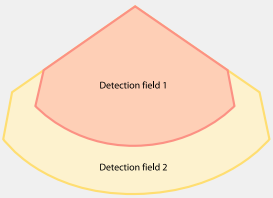
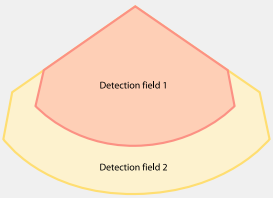
Horizontal angular coverage	No alarm status	Detection in detection field 1	Detection in detection field 2
50°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: access detection function • Detection field 2: access detection function
110°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: access detection function • Detection field 2: access detection function

If the motion is detected in the...	Then the output of detection field 1...	And the output of detection field 2...
detection field 1	is deactivated and remains in the access detection function	is deactivated and remains in the access detection function
detection field 2	remains active and in the access detection function	is deactivated and remains in the access detection function

Example 4

The combination is the following:

- Detection field 1: **Always-on restart prevention**
- Detection field 2: **Always-on restart prevention**

Horizontal angular coverage	No alarm status	Detection in detection field 1	Detection in detection field 2
110°	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function

If the motion is detected in the...	Then the output of detection field 1...	And the output of detection field 2...
detection field 1	is deactivated and remains in the restart prevention function	is deactivated and remains in the restart prevention function
detection field 2	remains active and in the restart prevention function	is deactivated and remains in the restart prevention function

6.2 Safety working mode: Access detection and restart prevention (default)

6.2.1 Introduction

This safety working mode is composed of the following safety functions:

- access detection
- restart prevention

6.2.2 Safety function: access detection

Access detection allows what follows:

When...	Then...
no motion is detected in the detection field	the safety outputs remain active
motion is detected in the detection field (see "Access detection speed limits" on page 39)	• the safety outputs are deactivated • the restart prevention function is activated

6.2.3 Safety function: restart prevention

The restart prevention function remains active and the safety outputs deactivated as long as motion is detected in the detection field.

The sensor can detect micro-movements of just a few millimeters, such as breathing movements (with normal breathing or a short apnea) or the movements necessary for a person to remain in balance in an upright or squatting position.

The system sensitivity is higher than the sensitivity that characterizes the access detection function. For this reason, the system reaction to vibrating and moving parts is different.

The sensor guarantees the detection of people moving at any speed from 0 up to 1.6 m/s (5.25 ft/s)*, provided that the guidelines described in "Sensor positioning guidelines" on page 45 are fulfilled.

Note*: a stationary person still has static residual movements that the radar can detect.*

WARNING! When the restart prevention function is active all the sensors have a 110° horizontal angular coverage.

WARNING! When the restart prevention function is active the monitored area may be affected by the position and inclination of the sensors, as well as by their installation height and angular coverage (see "Sensor position" on page 56).

6.2.4 Restart timeout parameter

When the system does not detect motion anymore, the OSSD outputs remain in OFF-state for the time set in the **Restart timeout** parameter.

The default and minimum certified value is 10 s (Certified Restart Timeout, CRT) while the maximum value is 60 s.

6.3 Safety working mode: Always-on access detection

6.3.1 Safety function: access detection

This is the only safety function available for the **Always-on access detection**. Access detection allows what follows:

When...	Then...
no motion is detected in the detection field	the safety outputs remain active
motion is detected in the detection field	• the access detection function remains active • the safety outputs are deactivated • the horizontal angular coverage and sensitivity remain as they were before the motion detection

WARNING! If the Always-on access detection is selected, additional safety measures must be introduced to ensure the restart prevention function.

6.3.2 T_{OFF} parameter

If the safety working mode is **Always-on access detection**, when the system does not detect motion anymore, the OSSD outputs remain in OFF-state for the time set in the **T_{OFF}** parameter.

The T_{OFF} value can be set from 0.1 s to 60 s.

6.4 Safety working mode: Always-on restart prevention

6.4.1 Safety function: restart prevention

This is the only safety function available for the **Always-on restart prevention**.

The restart prevention allows what follows:

When...	Then...
no motion is detected in the detection field	the safety outputs remain active
motion is detected in the detection field	• the safety outputs are deactivated • the restart prevention function remains active • the horizontal angular coverage and sensitivity remain as they were before motion detection

The sensor can detect micro-movements of just a few millimeters, such as breathing movements (with normal breathing or a short apnea) or the movements necessary for a person to remain in balance in an upright or squatting position.

The system sensitivity is higher than the sensitivity that characterizes the access detection function. For this reason, the system reaction to vibrating and moving parts is different.

The sensor guarantees the detection of people moving at any speed from 0 up to 1.6 m/s (5.25 ft/s)*, provided that the guidelines described in "Sensor positioning guidelines" on the next page are fulfilled.

***Note**: a stationary person still has static residual movements that the radar can detect.*

WARNING! When the restart prevention function is active all the sensors have a 110° horizontal angular coverage.

WARNING! When the restart prevention function is active the monitored area may be affected by the position and inclination of the sensors, as well as by their installation height and angular coverage (see "Sensor position" on page 56).

6.4.2 Restart timeout parameter

When the system does not detect motion anymore, the OSSD outputs remain in OFF-state for the time set in the **Restart timeout** parameter.

The default and minimum certified value is 10 s (Certified Restart Timeout, CRT) while the maximum value is 60 s.

6.5 Features of the restart prevention function

6.5.1 Sensor positioning guidelines

The restart prevention function is effective if the sensor can detect a person's movements or their static residual movements. To detect people who are not standing or squatting, it is important that the sensor can clearly detect the person's chest.

Particular attention should be paid to the following situations:

- There are objects that limit or prevent the sensor from detecting motion.
- The risk assessment requires the detection of a lying person.
- The sensor does not detect a sufficient portion of the body or does not properly detect the person's chest.

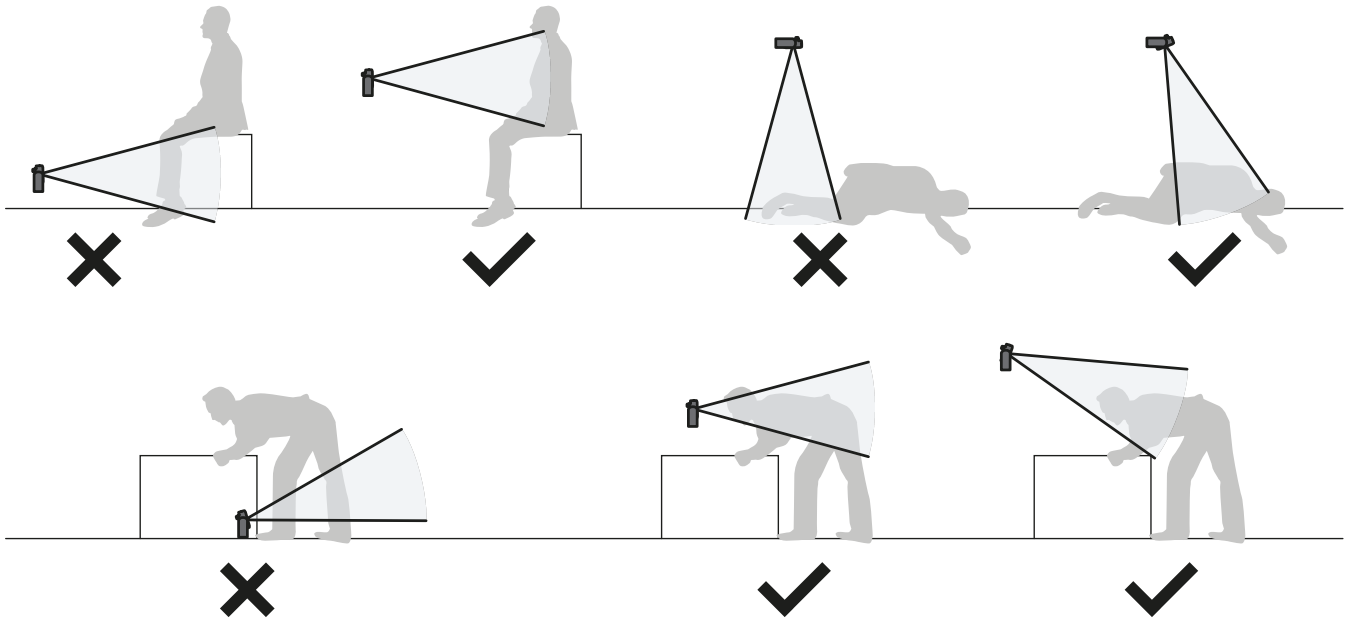
A validation procedure (see "Validate the safety functions" on page 74) must be performed when one or more of the above conditions are met.

If the conditions described above limit the performance of the sensor, take the following steps to reach an appropriate level of performance:

- Increase the **Restart timeout** parameter.
- Change the position of the sensors.
- Add more sensors.

If one or more of the above actions are taken, it is recommended to perform a validation procedure (see "Validate the safety functions" on page 74).

Below are some examples of situations where the above conditions are not met (X) and how to properly position the sensor (✓). These examples are not meant to be exhaustive.



6.5.2 Types of managed restart

NOTICE: *it is the responsibility of the machinery manufacturer to assess if an automatic restart can guarantee the same level of safety as a manual restart (as defined in standard EN ISO 13849-1, section 5.2.2).*

For each detection field independently, the system manages three types of restart:

Type	Conditions for enabling machinery restart	Safety working mode allowed
Automatic	The time interval set through the PSEN rd1 configurator (**Restart timeout**) has passed since the last motion detection*.	All
Manual	The **Restart signal** was received correctly** (see "Restart signal (dual channel, redundancy mode coherent)" on page 117).	**Always-on access detection**
Safe manual	• The time interval set through the PSEN rd1 configurator (**Restart timeout**) has passed since the last motion detection* and • The **Restart signal** was received correctly** (see "Restart signal + System recondition (dual channel, redundancy mode coherent)" on page 120).	**Access detection and restart prevention, Always-on restart prevention**

WARNING! If the Automatic restart is set with the Safety working mode Always-on access detection, the restart prevention safety function is not performed, and consequently, the system does not guarantee the detection of a person within the monitored area.

Note*: machinery restart is enabled if no motion is detected up to 30 cm (11.8 in) beyond the detection field.*

Note**: (for all types of restart) other dangerous system statuses may prevent the restart of the machinery (e.g., diagnostic fault, sensor masking, etc.)*

6.5.3 Precautions for preventing unexpected restarting

To prevent unexpected restarting the following rules must be followed:

- the set restart timeout must be greater than or equal to 10 s.
- if the sensor is installed at a height of less than 30 cm (11.8 in) from the ground, a minimum distance of 30 cm (11.8 in) from the sensor must be guaranteed.

6.5.4 Configure the restart function

WARNING! If the Restart signal function has been enabled both through the safety Fieldbus and the digital inputs, the functionality can be activated from both of them.

Type	Procedure
Automatic	1. In the PSEN rd1 configurator in **Settings** > **Restart function**, select **Automatic**. 2. In the PSEN rd1 configurator, in **Configuration** for each detection field in use with automatic restart, select the desired **Safety working mode** and set the **Restart timeout** (or the $\mathbf{T_{OFF}}$ parameter, if present).
Manual	1. In the PSEN rd1 configurator in **Settings** > **Restart function**, select **Manual**. 2. If there is a digital input configured as **Restart signal** (**Settings** > **Digital Input-Output**), connect the machinery button for the restart signal as convenient (see "Electrical connections" on page 103). 3. To use the Fieldbus communication for the restart signal, make sure that no digital input is configured as **Restart signal** (**Settings** > **Digital Input-Output**). See the Fieldbus protocol for details. 4. In the PSEN rd1 configurator, in **Configuration** for each detection field in use with manual restart, set the $\mathbf{T_{OFF}}$ parameter value. ***Note****: the **Safety working mode** is automatically set to **Always-on access detection** for all the detection fields in use with manual restart.*

Type	Procedure
Safe manual	1. In the PSEN rd1 configurator in **Settings** > **Restart function**, select **Safe manual**. 2. If there is a digital input configured as **Restart signal** (**Settings** > **Digital Input-Output**), connect the machinery button for the restart signal as convenient (see "Electrical connections" on page 103). 3. To use the Fieldbus communication for the restart signal, make sure that no digital input is configured as **Restart signal** (**Settings** > **Digital Input-Output**). See the Fieldbus protocol for details. 4. In the PSEN rd1 configurator, in **Configuration** for each detection field in use with safe manual restart, select the **Safety working mode** among those allowed and set the **Restart timeout** parameter value.

7. Other functions

Contents

This section includes the following topics:

7.1 Muting 48
7.2 Anti-tampering functions: anti-rotation around axes 49
7.3 Anti-tampering functions: anti-masking 50
7.4 Multi-analysing unit Synchronization 52
7.5 Electromagnetic Robustness 55

7.1 Muting

7.1.1 Description

The muting function is an additional safety-related function that inhibits the sensing capability of the sensor on which it is activated. It can be activated for a specific sensor or for a group of sensors. This results in keeping the ON-state of the OSSD or the safety Fieldbus even when the muted sensors detect motion.

When the muting function is enabled, its effective activation on one or more sensors occurs only as soon as the conditions permit (see "Muting activation conditions" below).

7.1.2 Muting enabling

The muting function can be enabled through digital input (see "Enable muting signal characteristics" on the next page) or safety Fieldbus (if available).

WARNING! If the muting function has been enabled through the safety Fieldbus and the digital inputs, only the digital inputs enabling is considered for the function.

WARNING! When the sensor is in muting, no sensor error is available (see"ERROR events (sensor)" on page 92).

Through the safety Fieldbus (if available) the muting function can be enabled for each sensor individually.

Through digital inputs the muting function can be enabled for all the sensors simultaneously or only for a group of sensors. Up to two groups can be configured, each associated with a digital input.

Through the PSEN rd1 configurator, the following must be defined:

- for each input, the group of managed sensors
- for each group, the sensors that belong to it
- for each sensor, whether it belongs to a group or not

***Note**: if the muting function is enabled for one sensor, it is enabled for all the detection fields of the sensor, regardless if the detection fields are dependent or independent and the anti-tampering functions are disabled for that sensor.*

See "Configure the inputs and outputs" on page 73.

7.1.3 Muting activation conditions

The muting function is activated on a specific sensor only in the following conditions:

- All the detection fields involved are motion-free, and the restart timeout has expired for all of them.
- There is no tampering signal or fault signal for that sensor.

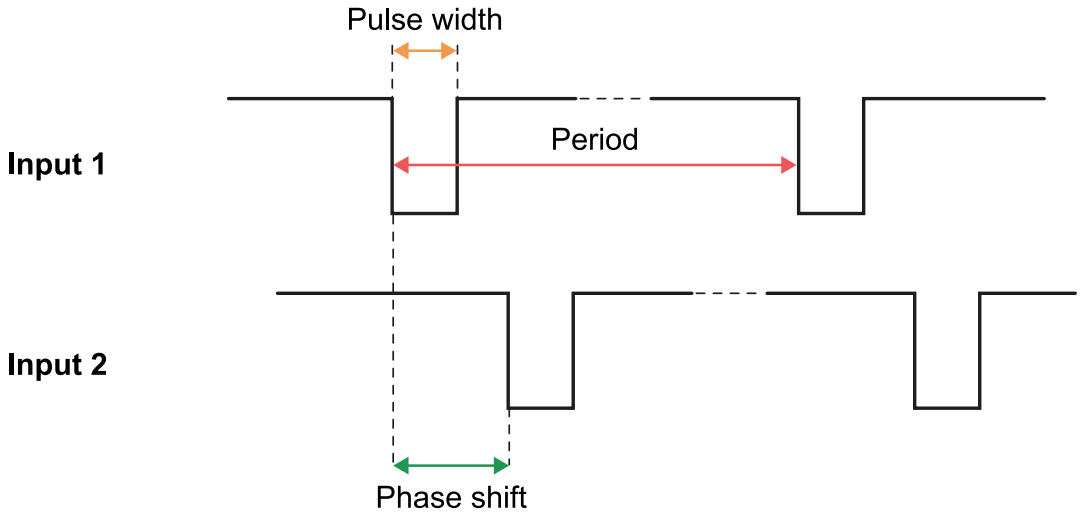
When the muting is enabled for a group of sensors, the function is activated as soon as there is no detection in the monitored area of all sensors.

WARNING! Enable the muting signal on sensors monitoring the same dangerous area once the whole area is safe and nobody can access it. If the muting is enabled on single sensors through Fieldbus and sensors monitoring the same dangerous area are still detecting a movement, a person could move into a space monitored by a muted sensor, compromising the safety of the whole area.

7.1.4 Enable muting signal characteristics

The muting function is enabled only if both logic signals of the dedicated input meet certain characteristics.

Below is a graphic representation of the signal characteristics.



In the **PSEN rd1** configurator, in **Settings** > **Digital Input-Output** it is necessary to set the parameters that define the signal characteristics.

***Note**: with pulse duration = 0, it is sufficient that the input signals are at high logic level (1) to enable muting.*

7.1.5 Muting status

Any output dedicated to the muting status (Muting enable feedback signal) is activated if at least one of the groups of sensors is in muting.

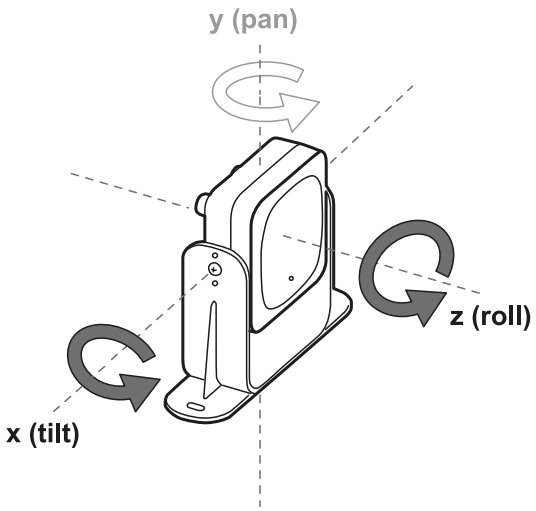
***NOTICE:** it is the responsibility of the machinery manufacturer to assess whether the indication of the muting status is necessary (as defined in section 5.2.5 of EN ISO 13849-1 standard).*

7.2 Anti-tampering functions: anti-rotation around axes

7.2.1 Anti-rotation around axes

The sensor detects rotation around its x-axis and z-axis.

***Note**: the axes are those represented in the figure below, regardless of the installation position of the sensor.*



When the system configuration is saved, the sensor also saves its position. Later, if the sensor detects changes in rotation around these axes, it sends a tamper alert to the analysing unit. Upon reception of a tampering signal, the analysing unit deactivates the safety outputs.

***Note**: when the position is modified with respect to the saved references (i.e., when a sensor is rotated) and the anti-rotation around axes function is enabled, the PSEN rd1.1 systems detects the tampering and sends the message within 5 s.*

7.2.2 Enable the anti-rotation around axes function

The anti-rotation around axes function is disabled by default.

WARNING! If the function is disabled, the system cannot signal a change in the rotation of the sensor around the x-axis and the z-axis and, therefore, cannot signal any changes in the monitored area. See "Checks when the anti-rotation around axes function is disabled" below.

The function can be enabled and configured for each axis of each sensor individually. In the PSEN rd1 configurator, in **Settings** > **Anti-tampering**, click on the specific option to enable the function for a sensor.

7.2.3 When to enable

Enable the anti-rotation around axes function only if it is necessary to detect a change in the rotation of a sensor around a specific axis.

7.2.4 Checks when the anti-rotation around axes function is disabled

When the anti-rotation around axes function is disabled, perform the following checks.

Safety function	Schedule	Action
Access detection function	Before each machinery restart	Check that the sensor is positioned as defined in the configuration. Check that the monitored area is the same as defined by the configuration. See "Validate the safety functions" on page 74.
Restart prevention function	Each time the safety outputs are deactivated	

7.3 Anti-tampering functions: anti-masking

7.3.1 Masking signal

The sensor detects the presence of objects that could obstruct the field of view. When the system configuration is saved, the sensor memorizes the surrounding environment. If the sensor subsequently detects variations in the environment that could influence the field of view, it sends a masking signal to the analysing unit. Upon receiving a masking signal, the analysing unit deactivates the safety outputs.

***Note**: the masking signal is not guaranteed in the presence of objects which cause reflection effects that bring their RCS below the minimum detectable threshold.*

***Note**: when the position is modified with respect to the saved references (i.e., when a sensor is masked) and the anti-rotation around axes function is enabled, the PSEN rd1.1 systems detects the tampering and notifies it within 5 s.*

7.3.2 Environment memorization process

The sensor starts the surrounding environment memorization process when the PSEN rd1 configurator configuration is saved. From that moment, it waits for the system to exit the alarm status and for the scene to be static up to 20 seconds, then scans and memorizes the environment.

***NOTICE:** if the scene is not static during the 20 seconds interval, the system remains in a fault status (SIGNAL ERROR) and the system configuration must be saved again.*

It is recommended to start the memorization process after at least 3 minutes from turning on the system to guarantee that the sensor has reached the operating temperature.

Only at the conclusion of the memorization process it is possible for the sensor to send masking signals.

7.3.3 Causes of masking

Possible causes of masking signals are the following:

- An object that obstructs the field of view of the sensor has been placed in the detection field.
- The environment in the detection field changes significantly, for example, if the sensor is installed on moving parts or if there are moving parts inside of the detection field.
- The configuration was saved with sensors installed in an environment that is different from the working environment.
- There were temperature fluctuations.

7.3.4 Masking signal when the system is turned on

If the system was off for several hours and there were temperature fluctuations, the sensor might send a false masking signal when it is turned on. The safety outputs activate automatically within 3 minutes when the sensor reaches its working temperature. This does not happen if this temperature is still very far from the reference temperature.

7.3.5 Sensitivity level

The anti-masking function has four levels of sensitivity:

Level	Description	Example application
High	The sensor has the highest sensitivity to changes in the environment. (Suggested level when the field of view is empty up to a meter)	Installations with an empty environment and a height of less than one meter, where objects could occlude the sensor.
Medium	The sensor has low sensitivity to changes in the environment. Occlusion must be evident (deliberate tampering).	Installations with a height of more than one meter, where masking is likely to occur only if voluntary.
Low	The sensor detects masking only if the sensor occlusion is complete and the objects are highly reflective (e.g., metal, water) near the sensor.	Installations on moving parts, where the environment is changing continuously, but where static objects may be near the sensor (obstacles on the route).
Disabled	The sensor does not detect changes in the environment. **WARNING! If the function is disabled the system cannot signal the presence of objects that might impede normal detection (see "Checks when the anti-masking function is disabled" below).**	See "When to disable" on the next page.

To change the sensitivity level or disable the function, in the PSEN rd1 configurator, click **Settings** and then **Anti-tampering**.

7.3.6 Checks when the anti-masking function is disabled

When the anti-masking function is disabled, perform the following checks.

Safety function	Schedule	Action
Access detection function	Before each machinery restart	Remove any objects that obstruct the field of view of the sensor. Reposition the sensor according to the initial installation.
Restart prevention function	Each time the safety outputs are deactivated	

7.3.7 When to disable

The anti-masking function should be disabled under the following conditions:

- (With restart prevention function) The monitored area includes moving parts that stop in different and unpredictable positions.
- The monitored area includes moving parts that vary their position while the sensors are in muting.
- The sensor is positioned on a part that can be moved.
- The presence of static objects is tolerated in the monitored area (e.g., loading/unloading area).

7.4 Multi-analysing unit Synchronization

7.4.1 Introduction

The multi-analysing unit synchronization function is necessary when multiple PSEN rd1.1 systems are sharing the same area and it allows the interferences between their sensors to be removed using a time synchronization signal.

***Note**: the function can be used only if all the sensors have the safety working mode set to **Always-on restart prevention**.*

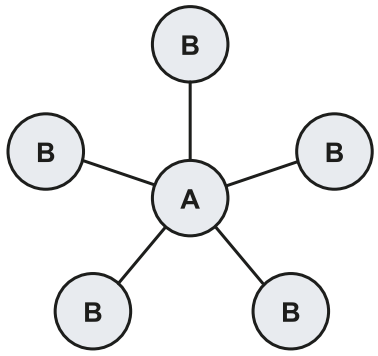
***Note**: the function also works if the analysing units are of different types (Type A and Type B).*

7.4.2 Network topology

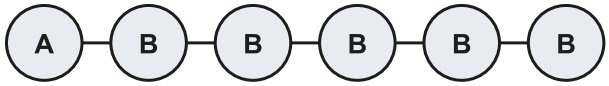
The analysing units must be connected in a master/slave cabling topology. The following topologies are allowed:

***Note**: the maximum number of slaves that can be connected is 8.*

- Star: every peripheral node (slave **B**, i.e., analysing unit) is connected to a central node (master **A**, i.e., analysing unit, PLC, or square wave generator).



- Daisy chain (linear): this is accomplished by connecting each slave **B** (analysing unit) in series after the master **A** (analysing unit, PLC, or square wave generator).



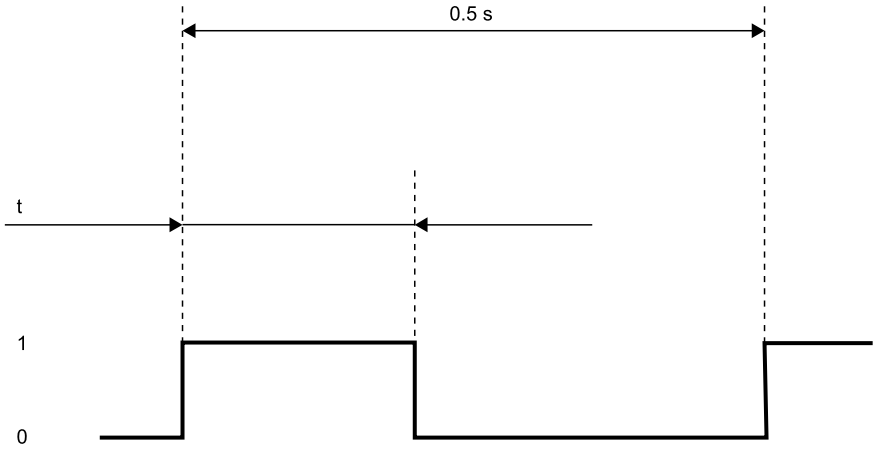
7.4.3 Trigger source

The following synchronization sources are allowed:

- Internal source: the source is the analysing unit, which acts as the network master.
- External source: the source is a PLC or a square wave generator, which acts as the network master.

7.4.4 Required signal

The analysing units need a 2 Hz ± 20% synchronization signal frequency. The digital signal required from the trigger (master) to all the analysing units (slaves) is described in the image below.



With *t* in the range [50 ms, 250 ms].

Synchronization takes place on the rising edge of the signal.

***Note**: if the trigger source is internal, the signal is automatically generated by the analysing unit (master).*

***Note**: if the topology is daisy chain (linear), the signal is automatically propagated between the slaves without any relevant delay.*

7.4.5 Enable the multi-analysing unit synchronization function

1. For each analysing unit, in the PSEN rd1 configurator click **Settings** > **Multi-analysing unit synchronization** and assign a different **Analysing unit channel**.
   ***Note**: if there are more than four analysing units, the analysing units with the same channel must have their monitored areas as far from each other as possible.*
2. Click Configuration and set the **Safety working mode** parameter to **Always-on restart prevention** for all the sensors.
3. Click **Settings** > **Digital Input-Output** and set the digital input-output as follows:

If the network topology is...	And the analysing unit is...	Then...
star	master*	Configure two of the digital outputs as **Acquisition Trigger**.
	slave	Configure one of the digital inputs as **Acquisition Trigger**.
daisy chain (linear)	master*	Configure two of the digital outputs as **Acquisition Trigger**.
	slave (except the last in the chain)	1. Configure one of the digital inputs as **Acquisition Trigger** 2. Configure two of the digital outputs as **Acquisition Trigger**.
	slave (last of the chain)	Configure one of the digital inputs as **Acquisition Trigger**.

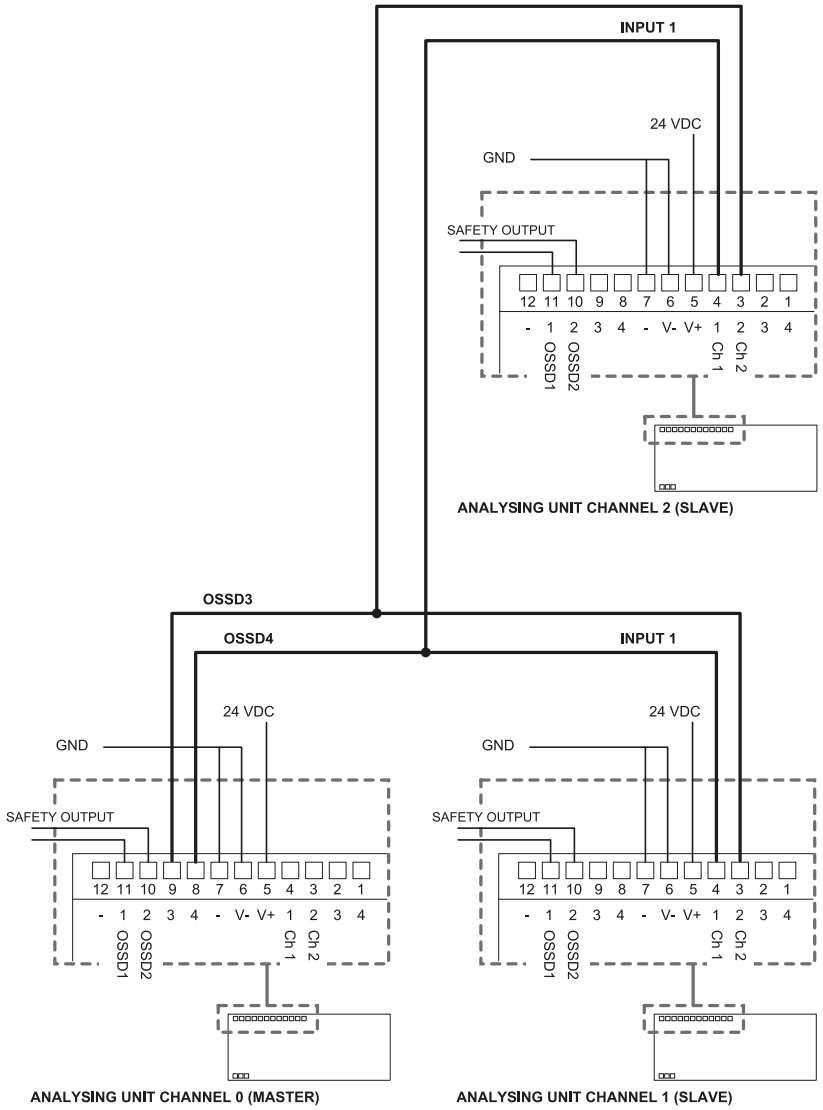
Note: present only if the trigger source is internal.*

4. Connect the cables on the I/O terminal blocks of the analysing unit. See "Electrical connections" on the next page for more details.

7.4.6 Electrical connections

Star example

Internal trigger source (analysing unit Master) + 2 analysing units (Slaves)

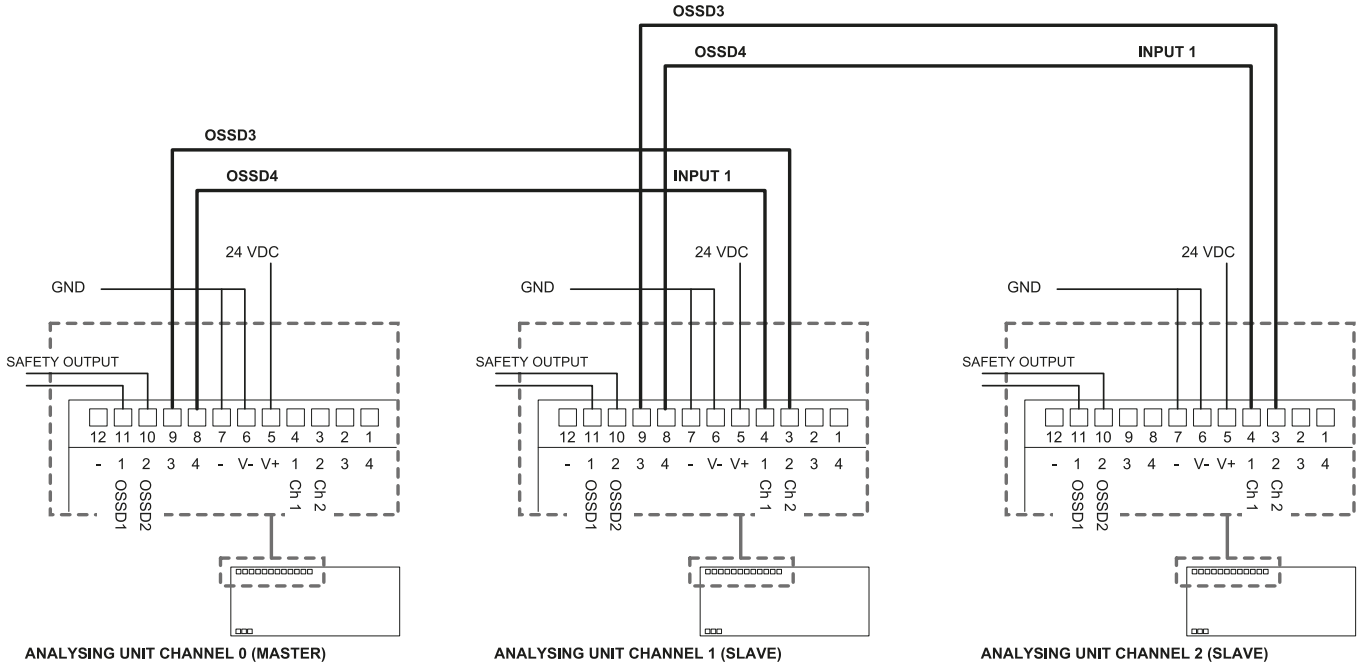


In this example:

- Analysing unit channel 0 (Master) has OSSD3 and OSSD4 configured as **Acquisition Trigger**.
- Analysing unit channel 1 (Slave) has Digital Input 1 configured as **Acquisition Trigger**.
- Analysing unit channel 2 (Slave) has Digital Input 1 configured as **Acquisition Trigger**.

Daisy chain (linear) example

Internal trigger source (analysing unit Master) + 2 analysing units (Slaves)



In this example:

- Analysing unit channel 0 (Master) has OSSD3 and OSSD4 configured as **Acquisition Trigger**.
- Analysing unit channel 1 (Slave) has OSSD3 and OSSD4 configured as **Acquisition Trigger**, and Digital Input 1 configured as **Acquisition Trigger**.
- Analysing unit channel 2 (Slave) has Digital Input 1 configured as **Acquisition Trigger**.

7.5 Electromagnetic Robustness

7.5.1 Electromagnetic robustness parameter

With the **Electromagnetic robustness** parameter, it is possible to increase the robustness of the system to electromagnetic interference (e.g., due to sensors of different systems installed too close to each other or problems on the CAN bus).

In the PSEN rd1 configurator in **Settings** > **Advanced**, the following levels of robustness can be set:

- **Standard** (default)
- **High**
- **Very High**

WARNING! The parameter impacts the system response time for the access detection safety function. According to the chosen level, the maximum guaranteed response time is 100 ms (Standard), 150 ms (High), or 200 ms (Very High).

8. Sensor position

Contents

This section includes the following topics:

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8.3 Dangerous area calculation 58
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8.6 Outdoor installations 65

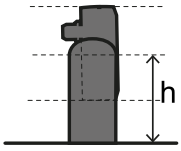
8.1 Basic concepts

8.1.1 Determining factors

The sensor installation height and inclination should be decided together with the angular coverage and the detection distances in order to have optimal coverage of the dangerous area.

8.1.2 Sensor installation height

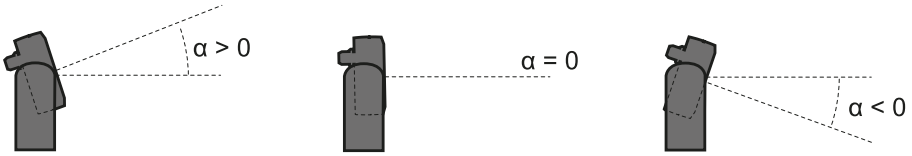
The installation height (h) is the distance between the center of the sensor and the ground or reference plane of the sensor.



8.1.3 Sensor inclination

Sensor inclination is the rotation of the sensor around its x-axis. Inclination is defined as the angle between a line perpendicular to the sensor and a line parallel to the ground. Three examples are presented as follows:

- sensor tilted upwards: α positive
- straight sensor: α = 0
- sensor tilted downwards: α negative



8.2 Sensor field of view

8.2.1 Types of field of view

During the configuration phase, for each sensor, it is possible to select the horizontal angular coverage of the field of view:

- 110°
- 50°

The actual detection field of the sensor also depends on the sensor installation height and inclination (see "Calculation of position for sensor height ≤ 1 m" on page 60 and "Calculation of position for sensor height > 1 m" on page 64).

8.2.2 Features of the 50° field of view

For the access detection function, the 50° field of view makes the sensor more resistant to interference from materials such as iron and water, which reflect the radar signal (e.g., iron shavings, water splatters, rain). It is therefore also suitable for outdoor installations.

WARNING! When the restart prevention function is active all the sensors have a 110° horizontal angular coverage, regardless of the set angular coverage.

NOTICE: *during the configuration phase, take this aspect into consideration to avoid generating undesired alarms.*

8.2.3 Areas and dimensions of the field of view

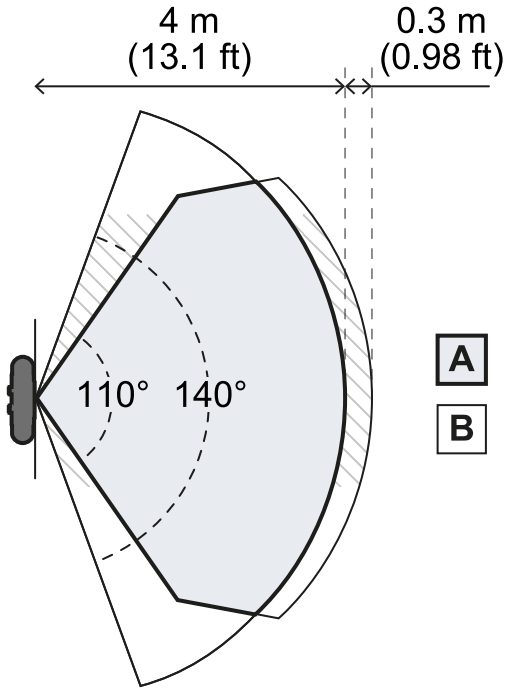
The sensor field of view is composed of two areas:

- detection field: where the detection of objects similar to humans in any position is guaranteed
- tolerance area: where the actual detection of a moving object/person depends on the characteristics of the object itself (see "Factors that influence the reflected signal" on page 34).

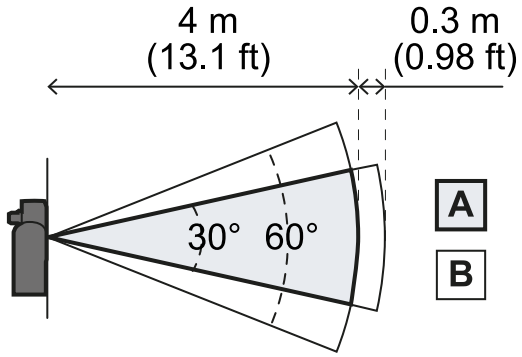
8.2.4 Dimensions of the 110° field of view

Below are the maximum field of view dimensions **[A]** and the relative tolerance area **[B]**.

The tolerance area dimensions are the same for maximum angular coverage (as described in the figures below) and smaller coverages.



Top view

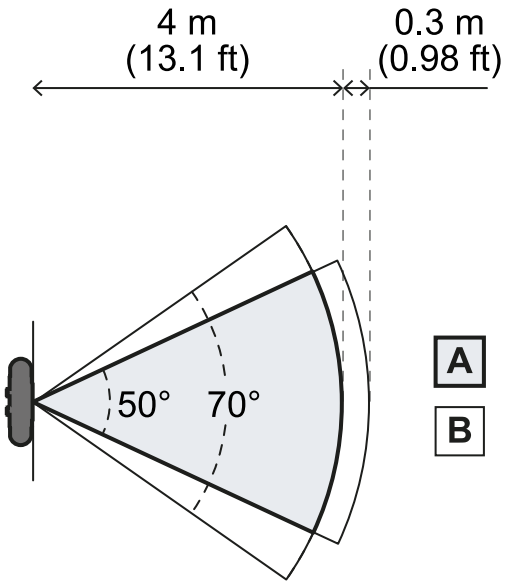


Side view

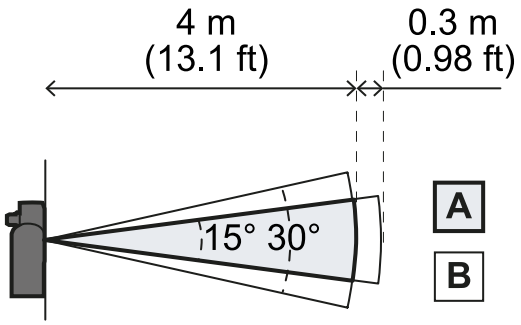
8.2.5 Dimensions of the 50° field of view

Below are the maximum field of view dimensions **[A]** and the relative tolerance area **[B]**.

The tolerance area dimensions are the same for maximum angular coverage (as described in the figures below) and smaller coverages.



Top view



Side view

8.2.6 Sensitivity

The system sensitivity level can be defined for the access detection function as well as the restart prevention function. The sensitivity defines the ability of the system to prevent undesired alarms. Only for the access detection function, it also defines the reaction times to motion detection: with high sensitivity the system is more prone to undesired alarms, but detection is faster.

For example, it is recommended to set a lower level of sensitivity for the access detection function if people or objects are in transit at the perimeters of the dangerous area (e.g., forklifts or trucks).

8.3 Dangerous area calculation

8.3.1 Introduction

The dangerous area of the machinery to which PSEN rd1.1 systems is applied must be calculated as indicated in standards ISO 13855:2010. For PSEN rd1.1 systems the fundamental factors for calculation are height (h) and inclination (α) of the sensor (see "Sensor position" on page 56).

8.3.2 Sensor height ≤ 1 m

To calculate the depth of the dangerous area (S) for sensors with installation heights less than or equal to 1 m, use the following formula:

$$S = K * T + C_h + C_\alpha$$

Where:

Variable	Description	Value	Measurement unit
K	Maximum dangerous area access speed	1600	mm/s
T	Total system stopping time (PSEN rd1.1 systems + machinery)	0.1 + Machinery stopping time (calculated in accordance with standard ISO 13855:2010)	s

Variable	Description	Value	Measurement unit
C_h	Variable that takes into account the sensor installation height (h) according to standard ISO 13855:2010	1200 - 0.4 * H ***Note**: minimum value = 850 mm. If the result of the calculation is a value less than the minimum, use 850 mm.*	mm
C_α	Variable that takes into account the sensor inclination (α)	If H < 500 = (20 - α) * 16 If H ≥ 500 = (-α) * 16 ***Note**: minimum value = 0 mm. If the result of the calculation is a value less than the minimum, use 0 mm.*	mm

***Note**: when using Fieldbus, add the communication and processing time required for the signal to reach the machine after the safety output is activated.*

Example 1

- Machinery stopping time = 0.5 s
- Sensor installation height (H) = 100 mm
- Sensor inclination (α) = 10°

T = 0.1 s + 0.5 s = **0.6 s**

C_h = 1200 - 0.4 * 100 = **1160 mm**

C_α = (20 - 10) * 16 = **160 mm**

S = 1600 * **0.6** + **1160** + **160** = **2280 mm**

Example 2

- Machinery stopping time = 0.2 s
- Sensor installation height (H) = 800 mm
- Sensor inclination (α) = -20°

T = 0.1 s + 0.2 s = **0.3 s**

C_h = 1200 - 0.4 * 800 = **880 mm**

C_α = (-(-20))* 16 = **320 mm**

S = 1600 * **0.3** + **880** + **320** = **1680 mm**

8.3.3 Sensor height > 1 m

To calculate the depth of the dangerous area (S) for sensors with installation heights greater than 1 m, use the following formula:

$$S = K * T + C_h$$

Where:

Variable	Description	Value	Measurement unit
K	Maximum dangerous area access speed	1600	mm/s
T	Total system stopping time (PSEN rd1.1 systems + machinery)	0.1 + Machinery stopping time (calculated in accordance with standard ISO 13855:2010)	mm/s
C_h	Constant that takes into account the sensor installation height (h) according to standard ISO 13855:2010	850	mm

***Note**: when using Fieldbus, add the communication and processing time required for the signal to reach the machine after the safety output is activated.*

Example 1

- Machinery stopping time = 0.5 s

T = 0.1 s + 0.5 s = **0.6 s**

S = 1600 * **0.6** + **850** = **1810 mm**

8.4 Calculation of position for sensor height ≤ 1 m

8.4.1 Introduction

The formulas for calculating the optimum position of the sensor for sensors with installation heights less than or equal to 1 m (3.3 ft) are reported as follows.

WARNING! Define the optimum sensor position according to the risk assessment requirements.

8.4.2 Overview of possible installation configurations

The configurations with possible heights (**h**) and inclinations (**α**) are presented as follows:

- **1** = Configuration 1: the field of view of the sensor never intersects the ground
- **2** = Configuration 2: the upper portion of the field of view of the sensor never intersects the ground
- **3** = Configuration 3: the upper portion and the bottom portion of the field of view always intersect the ground
- **X** = Configuration not possible

WARNING! With configurations not listed in these tables or marked with an “x”, safety functions are not guaranteed.

110° field of view

Installation configuration		α (°)				
		-20	**-10**	**0**	**10**	**20**
h (cm | in)	0 | 0	x	x	x	2	1
	10 | 3.9	x	x	x	2	1
	20 | 7.9	x	x	2	2	1
	30 | 11.8	x	x	2	2	x
	40 | 15.7	x	x	2	2	x
	50 | 19.7	x	2	2	2	x
	60 | 23.6	3	2	2	x	x
	70 | 27.5	3	2	2	x	x
	80 | 31.5	3	2	2	x	x
	90 | 35.4	3	2	2	x	x
	100 | 39.4	3	2	2	x	x

50° field of view

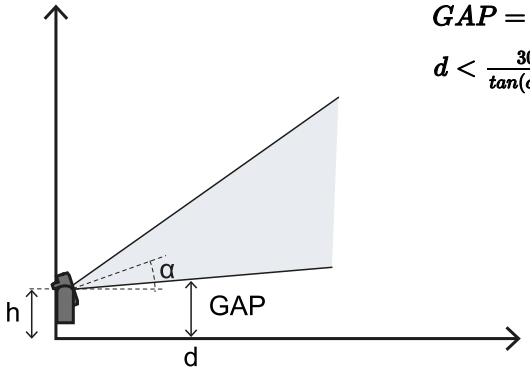
Installation configuration		α (°)				
		-20	-10	0	10	20
h (cm | in)	0 | 0	x	x	x	1	1
	10 | 3.9	x	x	x	1	1
	20 | 7.9	x	x	2	1	x
	30 | 11.8	x	x	2	x	x
	40 | 15.7	x	x	2	x	x
	50 | 19.7	x	3	2	x	x
	60 | 23.6	x	3	2	x	x
	70 | 27.5	x	3	2	x	x
	80 | 31.5	3	3	2	x	x
	90 | 35.4	3	3	2	x	x
	100 | 39.4	3	3	2	x	x

8.4.3 Configuration 1

To guarantee that the sensor also detects access by people crawling, respect the following condition:

$$GAP < 30cm$$

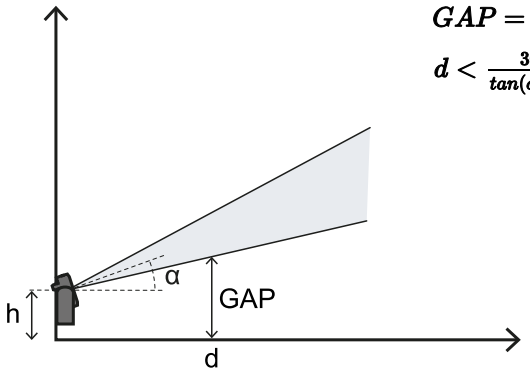
110° field of view



$$GAP = h + d * tan(\alpha - 15^\circ)$$

$$d < \frac{30-h}{tan(\alpha-15^\circ)}$$

50° field of view



$$GAP = h + d * tan(\alpha - 7.5^\circ)$$

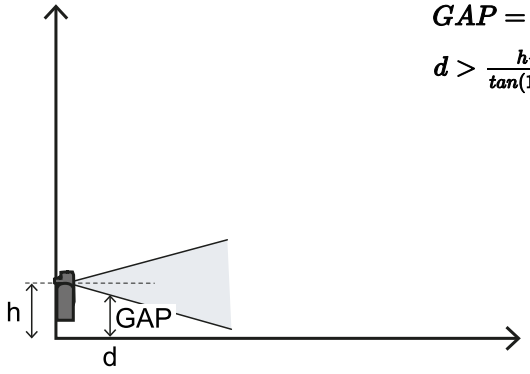
$$d < \frac{30-h}{tan(\alpha-7.5^\circ)}$$

8.4.4 Configuration 2

To guarantee that the sensor also detects the presence of people crawling near the sensor, respect the following condition:

$$GAP < 30cm$$

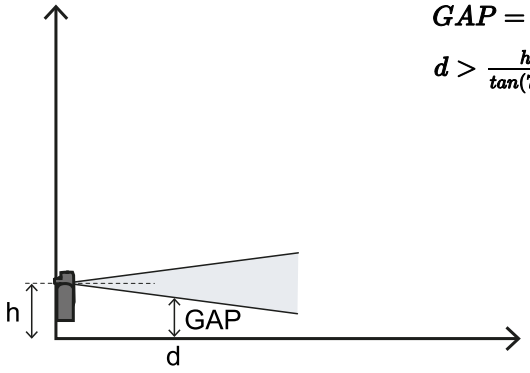
110° field of view



$$GAP = h - d * tan(15^\circ - \alpha)$$

$$d > \frac{h-30}{tan(15^\circ - \alpha)}$$

50° field of view



$$GAP = h - d * tan(7.5^\circ - \alpha)$$

$$d > \frac{h-30}{tan(7.5^\circ - \alpha)}$$

8.4.5 Configuration 3

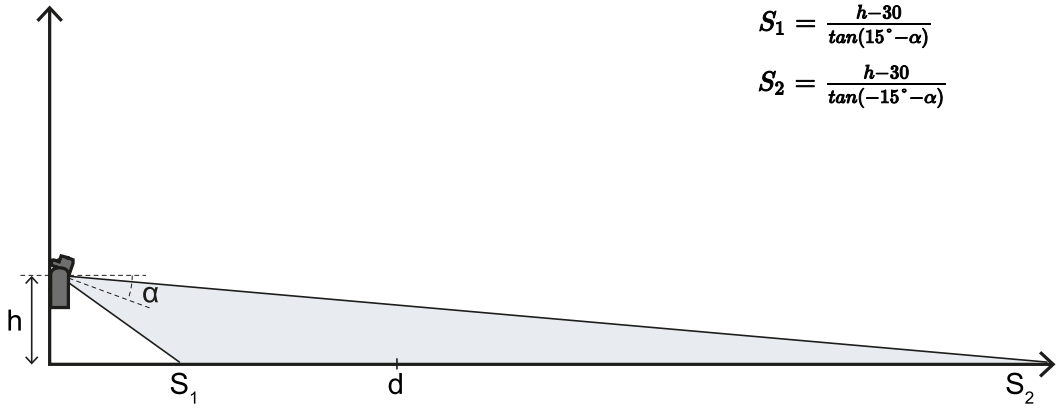
To guarantee optimum performance, respect the following conditions:

$$S_1 < d < S_2$$

110° field of view

$$S_1 = \frac{h-30}{tan(15^\circ-\alpha)}$$

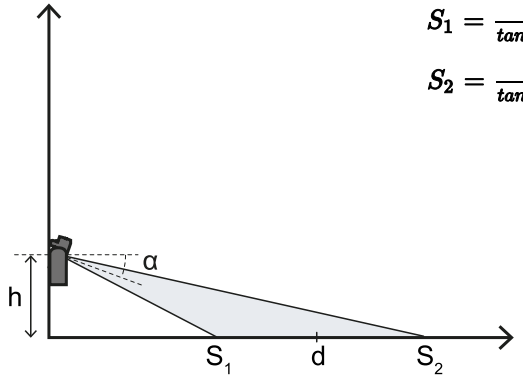
$$S_2 = \frac{h-30}{tan(-15^\circ-\alpha)}$$



50° field of view

$$S_1 = \frac{h-30}{tan(7.5^\circ-\alpha)}$$

$$S_2 = \frac{h-30}{tan(-7.5^\circ-\alpha)}$$

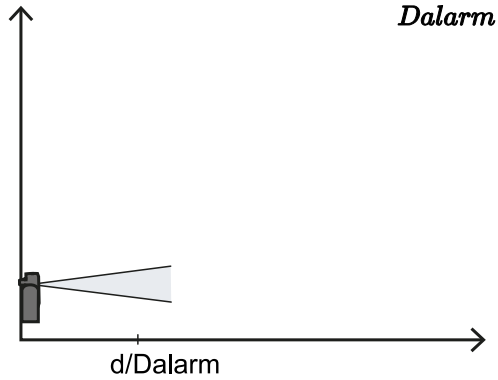


8.4.6 Calculate the real detection distance

The actual detection distance **Dalarm** is the value to be entered on the **Configuration** page of the PSEN rd1 configurator.

Dalarm indicates the maximum distance between the sensor and the object to be detected.

$$Dalarm = d$$



8.5 Calculation of position for sensor height > 1 m

8.5.1 Introduction

The formulas for calculating the optimum position of the sensor for sensors with installation heights greater than 1 m (3.3 ft) are reported as follows.

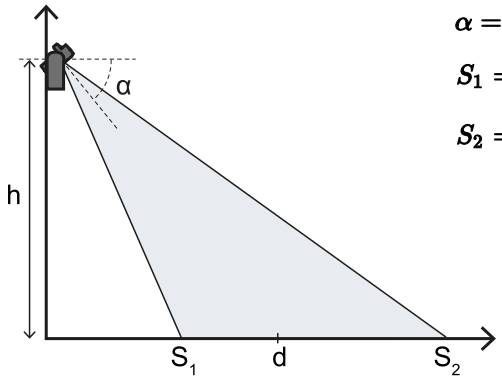
WARNING! Define the optimum sensor position according to the risk assessment requirements.

***Note**: the sensor inclination can only be downwards (α negative).*

Element	Description	Measurement unit
α	Sensor inclination	degrees
h	Sensor installation height	cm
d	Detection distance (linear)	cm
Dalarm	Detection distance (real)	cm
S_1	Start detection distance	cm
S_2	End detection distance	cm

8.5.2 110° field of view

WARNING! It is only possible to check if the other configurations respect the performance levels required by the configurator through the validation procedure (see "Validate the safety functions" on page 74).



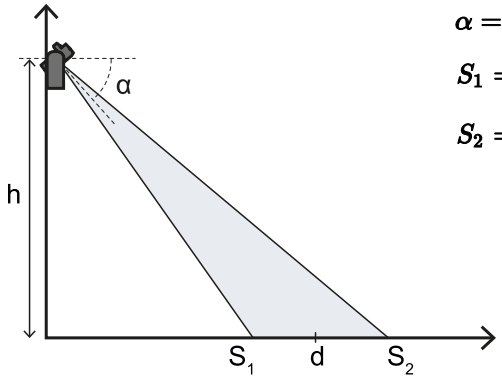
$$\alpha = -(15^\circ + tan^{-1}(\frac{h-60}{d}))$$

$$S_1 = \frac{h}{tan((-\alpha)+15^\circ)}$$

$$S_2 = \frac{h}{tan((-\alpha)-15^\circ)}$$

8.5.3 50° field of view

WARNING! It is only possible to check if the other configurations respect the performance levels required by the configurator through the validation procedure (see "Validate the safety functions" on page 74).



$$\alpha = -(7.5^\circ + tan^{-1}(\frac{h-60}{d}))$$

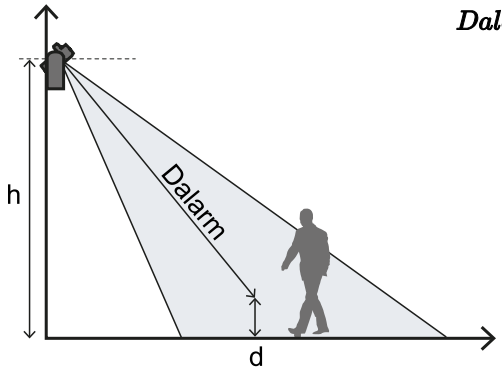
$$S_1 = \frac{h}{tan((-\alpha)+7.5^\circ)}$$

$$S_2 = \frac{h}{tan((-\alpha)-7.5^\circ)}$$

8.5.4 Calculate the real detection distance

The actual detection distance **Dalarm** is the value to be entered on the **Configuration** page of the PSEN rd1 configurator.

Dalarm indicates the maximum distance between the sensor and the object to be detected.



$$Dalarm = \sqrt{d^2 + (h - 30)^2}$$

8.6 Outdoor installations

8.6.1 Position exposed to precipitation

If the sensor installation position might be exposed to precipitation that can cause undesired alarms, it is recommended to take the following precautions:

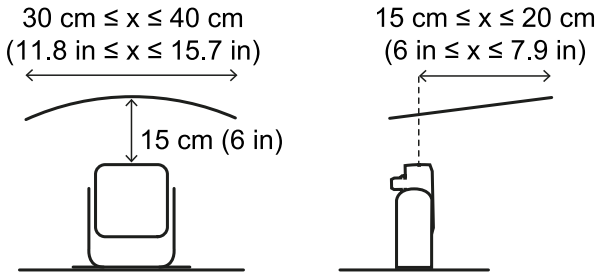
- Make a cover to protect the sensor from rain, hail or snow.
- Position the sensor so that it does not frame the ground where puddles might form.

NOTICE: *Weather conditions outside specifications can prematurely age the device.*

8.6.2 Recommendations for covering the sensor

Below are some recommendations for creating and installing a sensor cover:

- height from sensor: 15 cm (6 in)
- width: minimum 30 cm (11.8 in), maximum 40 cm (15.7 in)
- protrusion from the sensor: minimum 15 cm (6 in), maximum 20 cm (7.9 in)
- water outflow: at the sides or behind but not in front of the sensor (the cover should be arched and/or tilted backwards)

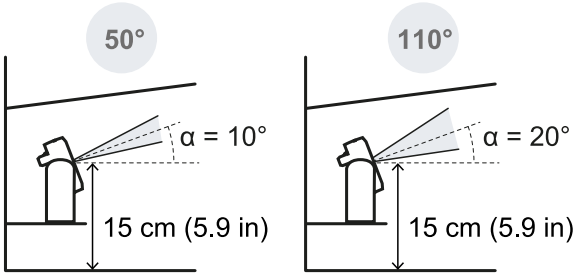


8.6.3 Recommendations for positioning the sensor

Below are some recommendations for defining the sensor position:

- installation height (from the ground to the center of the sensor): minimum 15 cm (5.9 in)
- suggested inclination: 10° for 50° field of view and 20° for 110° field of view

Before installing a sensor facing downwards, make sure there are neither liquids nor radar reflective materials on the floor.



***Note**: during the restart prevention function or if the sensor has a 110° field of view, undesired alarms may occur due to the higher sensitivity of the system.*

8.6.4 Position not exposed to precipitation

If the installation position of the sensor is not exposed to precipitation, no special precautions are required.

9. Installation and use procedures

Contents

This section includes the following topics:

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9.2 Install PSEN rd1.1 systems **68**
9.3 Configure PSEN rd1.1 systems **72**
9.4 Validate the safety functions **74**
9.5 Fieldbus network integration **77**
9.6 Manage the configuration **78**
9.7 Other procedures **79**

9.1 Before installation

9.1.1 Materials required

- Two tamper-proof screws (see "Side screw specifications" on page 101) to mount each sensor.
- Cables to connect the analysing unit to the first sensor and the sensors to one another (see "CAN bus cables recommended specifications" on page 100).
- A data USB cable with a micro-USB connector (micro-B type) or, only if the Ethernet port is available, an Ethernet cable to connect the analysing unit to the computer.
- A bus terminator (product code: C1000058) with resistance of 120 Ω for the last sensor of the CAN bus.
- A screwdriver for tamper-proof screws (see "Side screw specifications" on page 101) to be used with the Hex pin security bit supplied in the analysing unit package.
- If necessary, to protect the sensor and to prevent reflections from generating undesired alarms, one Metal protector kit (product code: 6B000004) per sensor. See the instructions supplied with the kit for installation instructions.
  ***Note**: the Metal protector kit is particularly recommended if the sensor is installed on parts that are moving, vibrating or that are near vibrating parts.*

9.1.2 Operating system required

- Microsoft Windows 64 bit 11 or later
- Apple OS X 14.0 Sonoma or later

9.1.3 Install the PSEN rd1 configurator

***Note**: if the installation fails, the dependencies needed by the configurator may be missing. Update your operating system or contact Pilz to receive assistance.*

1. Download the configurator from the www.pilz.com/manuals website and install it on the computer.
2. With Microsoft Windows operating system, download and install from the same site also the driver for USB connection.

9.1.4 Initiate PSEN rd1.1 systems

1. Calculate the position of the sensor (see "Sensor position" on page 56) and the depth of the dangerous area (see "Dangerous area calculation" on page 58).
2. " Install PSEN rd1.1 systems".
3. "Configure PSEN rd1.1 systems".
4. "Validate the safety functions".

9.2 Install PSEN rd1.1 systems

9.2.1 Install procedure

1. "Install the analysing unit".
2. "Install sensors on the floor".
3. "Install the sensors on the machinery".
4. "Connect the sensors to the analysing unit".
   ***Note**: connect the sensors to the analysing unit off-site if access to the connectors becomes difficult once installed.*

9.2.2 Install the analysing unit

WARNING! To prevent tampering, make sure the analysing unit is only accessible to authorized personnel (e.g., key-locked electrical panel)

1. Mount the analysing unit on the DIN rail.
2. Make electrical connections (see "Terminal blocks and connector pin-outs" on page 101 and "Electrical connections" on page 103).

***NOTICE:** if at least one input is connected, the SNS input "V+ (SNS)" and the GND input "V- (SNS)" must also be connected.*

***NOTICE:** when powered, the system takes about 2 s to start.During that period, the outputs and the diagnostic functions are deactivated, and the green sensor status LEDs of the connected sensors in the analysing unit flash.*

***NOTICE:** make sure to avoid any EMC interference during the analysing unit installation.*

***Note**: to correctly connect the digital inputs, see "Voltage and current limits for digital inputs" on page 102.*

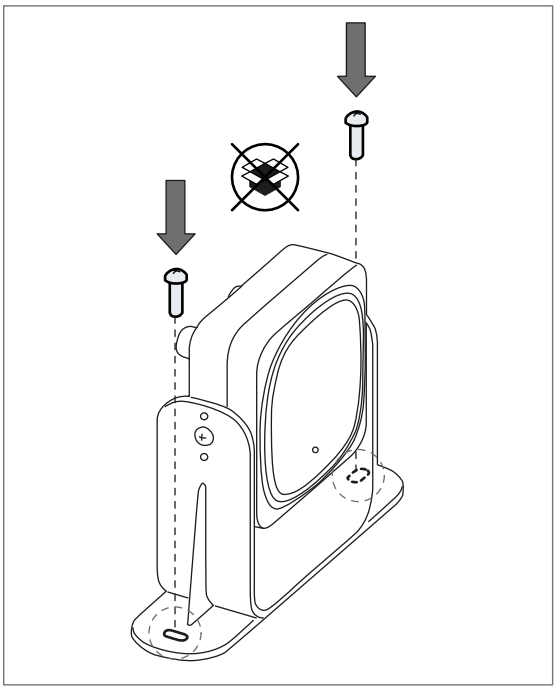
9.2.3 Install sensors on the floor

***Note**: for installation with Metal protector kit (product code 6B000004), see the instructions supplied with the kit.*

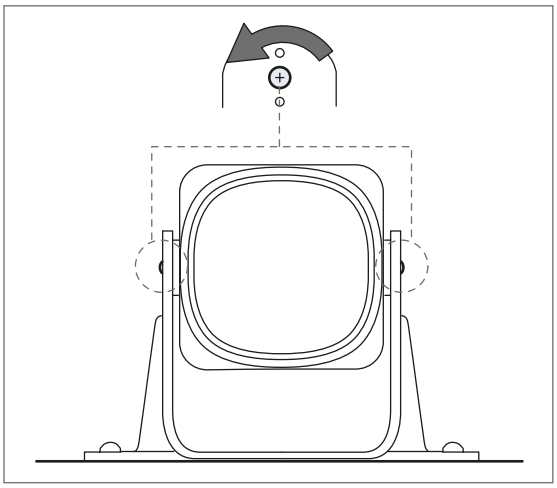
***Note**: the usage of a thread-locking fluid on the threads of fasteners is suggested, especially when the sensor is installed on a moving or vibrating part of the machinery.*

1. Position the sensor as indicated in the configuration report and fasten the bracket with two tamper-proof screws directly onto the floor or another support.

   ***NOTICE:** make sure the support does not inhibit machinery commands.*

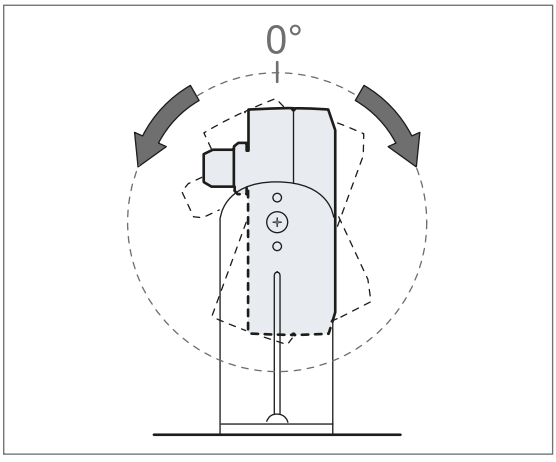


2. Loosen the side screws to tilt the sensor.

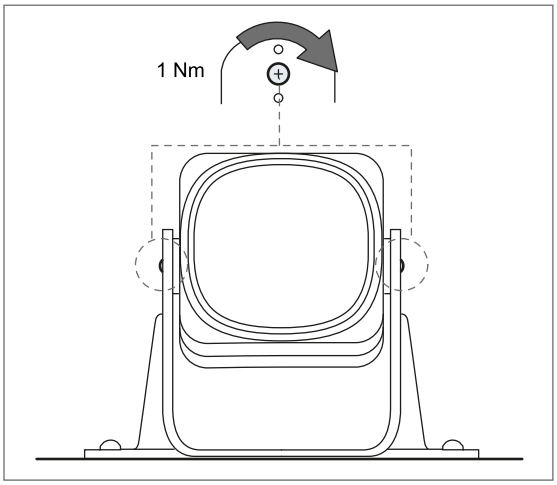


3. Tilt the sensor to the desired inclination (see "Sensor position" on page 56).

   ***Note**: a notch is equal to a 10° of inclination.*



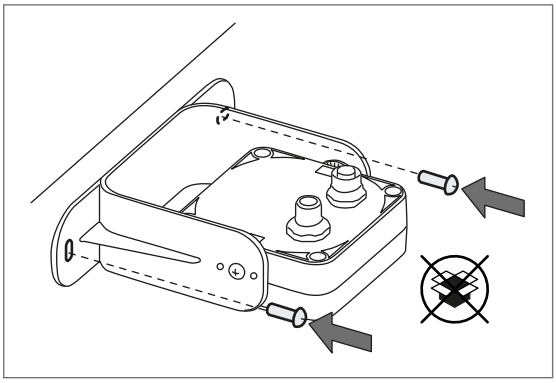
4. Tighten the screws.



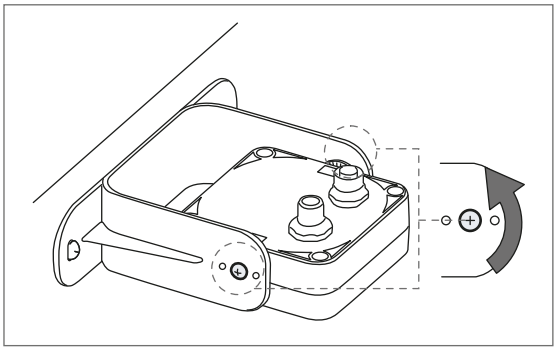
9.2.4 Install the sensors on the machinery

***Note**: if the sensor is installed on parts that vibrate and objects are present in the field of view, the sensor could generate undesired alarms.*

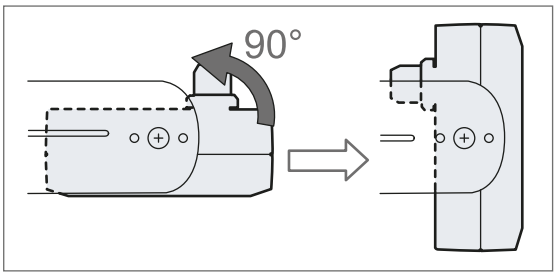
1. Position the sensor as indicated in the configuration report and fasten the bracket with two screws to a machinery support. To select installation height see "Sensor position" on page 56.



2. Loosen the side screws to tilt the sensor.

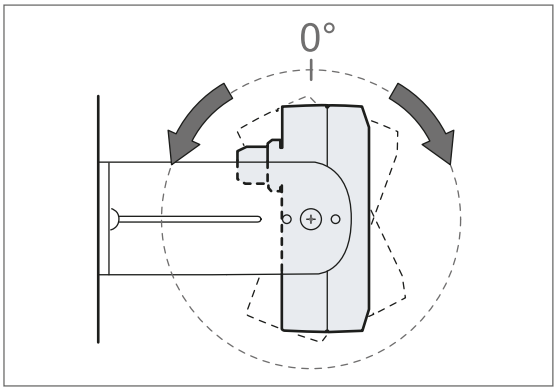


3. Position the sensor parallel to the machinery support.

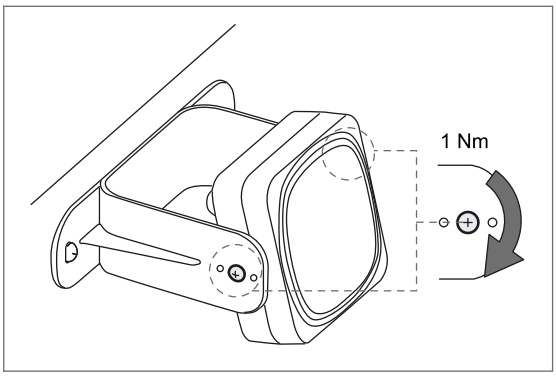


4. Tilt the sensor up to the desired inclination (see "Sensor position" on page 56).

   ***Note**: a notch is equal to a 10° of inclination.*



5. Tighten the screws.



9.2.5 Connect the sensors to the analysing unit

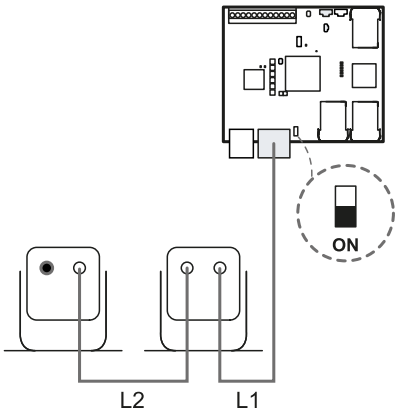
***Note**: the maximum length of the CAN bus line from the analysing unit to the last sensor in the chain is 30 m (98.4 ft).*

***Note**: when replacing a sensor, in the PSEN rd1 configurator, click **APPLY CHANGES** to confirm the change.*

1. Decide if the analysing unit will be positioned at the end of the chain or inside it (see "Chain examples" below).
2. Set the DIP switch of the analysing unit based on its position in the chain.
3. Connect the desired sensor directly to the analysing unit.
4. To connect another sensor, connect it to the last sensor in the chain or directly to the analysing unit to start a second chain.
5. Repeat step 4 for all the sensors to be installed.
6. Insert the bus terminator (product code: C1000058), into the free connector of the last sensor of the chain(s).

9.2.6 Chain examples

Chain with analysing unit at the end of the chain and a sensor with bus terminator (two sensors)

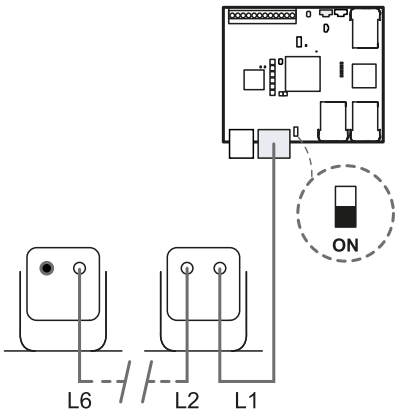


***Note**: for cables specifications see "CAN bus cables recommended specifications" on page 100.*

In order to have enough voltage at the sensors, consider the following rules:

L1 + L2 = max. 30 m (98.4 ft)

Chain with analysing unit at the end of the chain and a sensor with bus terminator (more than two sensors)

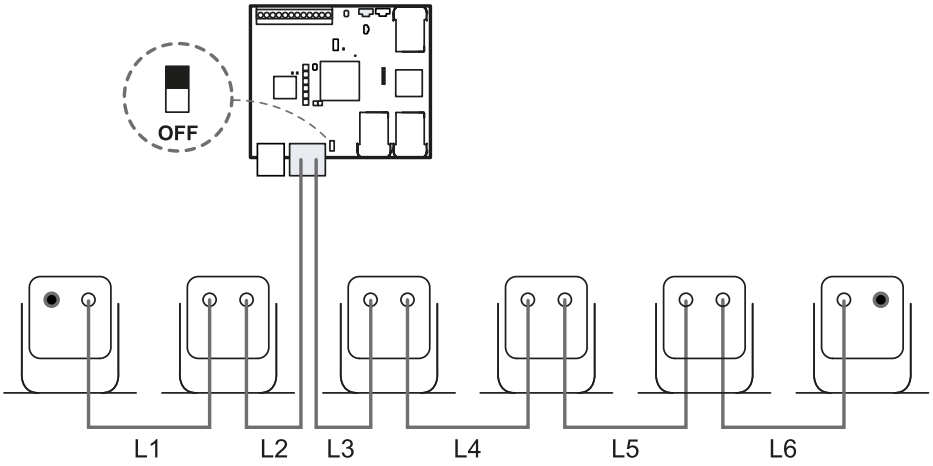


***Note**: for cables specifications see "CAN bus cables recommended specifications" on page 100.*

In order to have enough voltage at the sensors, consider the following rules:

L1 + ... + L6 = max. 30 m (98.4 ft)

Chain with analysing unit inside the chain and two sensors with bus terminator



***Note**: for cables specifications see "CAN bus cables recommended specifications" on page 100.*

In order to have enough voltage at the sensors, consider the following rules:

L1 + L2 = max. 30 m (98.4 ft)

L3 + ... + L6 = max. 30 m (98.4 ft)

9.3 Configure PSEN rd1.1 systems

9.3.1 Configure procedure

1. "Start the PSEN rd1 configurator".
2. "Define the area to be monitored".
3. "Configure the inputs and outputs".
4. "Save and print the configuration".
5. Optional. "Re-assign the Node IDs".
6. Optional. "Synchronize the analysing units".

9.3.2 Start the PSEN rd1 configurator

1. Connect the analysing unit to the computer using a data USB cable with a micro-USB connector or the Ethernet cable (if an Ethernet port is available).
2. Supply power to the analysing unit.
3. Start the PSEN rd1 configurator.
4. Choose the connection mode (USB or Ethernet).
   ***Note**: the default IP address for the Ethernet connection is 192.168.0.20. The computer and the analysing unit must be connected to the same network.*
5. Set a new admin password, memorize it, and provide it only to authorized people.
6. Select the system (PSEN rd1.1 systems) and the number of sensors.
7. Set the working frequency. If the system is installed in one of the countries with national restrictions, select the restricted band, otherwise select the full band.
   ***Note**: this setting does not have any effect on system performance or safety. The country selection is requested during the first installation of the system to configure the system's radio profile, which must comply with the national regulations of the installation country.*

9.3.3 Define the area to be monitored

WARNING! The system is disabled during configuration. Prepare opportune safety measures in the dangerous area protected by the system before configuring the system.

1. In the PSEN rd1 configurator click **Configuration**.
2. Optional. Add the desired number of sensors in the plane.
3. Define the position and inclination of each sensor.
4. Define the angular coverage of the field of view for each sensor.
5. Define the selected safety working modes, the detection distance and the restart timeout for each detection field of each sensor.

9.3.4 Configure the inputs and outputs

1. In the PSEN rd1 configurator, click **Settings**.
2. Click **Digital Input-Output** and define the input and output functions.
3. If the muting is managed, click **Settings** > **Muting** and assign the sensors to the groups according to the logic of the digital inputs.
4. **Settings** > **Restart function** and choose the type of managed restart.
5. Click **APPLY CHANGES** to save the configuration.

9.3.5 Save and print the configuration

1. In the configurator, click **APPLY CHANGES**: the sensors will save the inclination set and the surrounding environment. The configurator will transfer the configuration to the analysing unit, and once transfer is complete it will generate a configuration report.
2. Click to save and print the report.
   ***Note**: to save the PDF, a printer must be installed on the computer.*
3. Ask the authorized person for a signature.

9.3.6 Re-assign the Node IDs

Type of assignment

***Note**: if the connected sensors do not already have a Node ID assigned (e.g., at first startup), the system automatically assigns them a Node ID during the installation procedure.*

Three types of assignment are possible:

- Manual: to assign the Node ID to a sensor at a time. Can be performed with all the sensors already connected or after each connection. Useful for adding a sensor or to change Node ID to a sensor.
- Semi-automatic: wizard for connecting the sensors and assign the Node ID one sensor at a time.

Procedure

1. Start the configurator.
2. Click **Configuration** and verify that the number of sensors in the configuration is the same as those installed.
3. Click **Settings** > **Node ID Assignment**.
4. Proceed according to the type of assignment:

If the assignment is...	Then...
manual	1. Click **DISCOVER CONNECTED SENSORS** to display the connected sensors. 2. To assign a Node ID, click **Assign** for the unassigned Node ID in the **Configured sensors** list. 3. To change a Node ID, click **Change** for the already assigned Node ID in the **Configured sensors** list. 4. Select the SID of the sensor and confirm.
semi-automatic	Click **ASSIGN NODE IDS** > **Semi-automatic** and follow the instructions displayed.

9.3.7 Synchronize the analysing units

If there is more than one analysing unit in the area, see "Enable the multi-analysing unit synchronization function" on page 53 to configure the system and perform the electrical connections.

9.4 Validate the safety functions

9.4.1 Validation

The validation is addressed to the machinery manufacturer and the system installer.

Once the system has been installed and configured, check that the safety functions are activated/deactivated as expected and that the dangerous area is monitored by the system.

The machinery manufacturer must define all the required tests based on the application conditions and the risk assessment.

WARNING! The system response time is not guaranteed during the validation procedure.

WARNING! The PSEN rd1 configurator facilitates the installation and configuration of the system. Nevertheless, the validation process described below is still required to complete the installation.

9.4.2 Validation procedure for the access detection function

The access detection safety function must be operative, and the following requirements must be fulfilled:

- The target (for stationary applications) or the machinery/vehicle on which the sensor is installed (for mobile applications) must move in compliance with the maximum allowed speed. For details, see "Access detection speed limits" on page 39.
- No objects should completely occlude the target.

Starting conditions

- Machinery switched off (Safe condition)
- PSEN rd1.1 systems configured to fulfill the access detection safety function
- Detection signals monitored via digital outputs or safety Fieldbus

Test setup

The following tests aim to validate the sensor's performance for the access detection safety function.

In stationary applications, all the tests share these parameters:

Target type	Human
Target speed	In the range [0.1, 1.6] m/s ([0.33, 5.25] ft/s), with particular attention to the minimum and the maximum speeds.
Acceptance criteria	The system reaches the safe state via digital outputs or Fieldbus when the target accesses the area during the test.

In mobile applications, all the tests share these parameters:

Target type	Human
Machinery/Vehicle speed	In the range [0.1, 1.6] m/s ([0.33, 5.25] ft/s), with particular attention to the minimum and the maximum speeds.
Target movement	Stationary
Acceptance criteria	The system reaches the safe state via digital outputs or Fieldbus when, during the movement of the machinery/vehicle, the sensor's field of view reaches the target.

Validation test

The validation procedure of PSEN rd1.1 systems is reported below:

1. Identify the test positions, including those locations where the operator could access during the production cycle:
    a. boundaries of the dangerous area
    b. intermediate points between sensors
    c. positions that are partially hidden by existing or presumed obstacles during the operating cycle
    d. positions indicated by the risk assessor
2. Check that the corresponding detection signal is active or wait for its activation.
3. Perform the test according to the test setup previously defined, moving toward one of the test positions.

4. Check that the test acceptance criteria previously defined are fulfilled. If the test acceptance criteria are not fulfilled, see "Troubleshooting validation" on page 77.
5. Repeat steps 2, 3, and 4 for each test position.

9.4.3 Validation procedure for the restart prevention function

The restart prevention safety function must be operative, and the following requirements must be fulfilled:

- The person must breathe normally.
- No objects should completely occlude the person.

Starting conditions

- Machinery switched off (safe condition)
- PSEN rd1.1 systems configured to fulfill the restart prevention safety function
- Detection signals monitored via digital outputs or safety Fieldbus

Test setup

The following tests aim to validate the performance of the sensor restart prevention safety function.

All the tests share the following parameters:

Configured radar restart timeout	At least 10 s
Target type	Human according to ISO 7250, breathing normally
Target speed	0 m/s (0 ft/s)
Target pose	Standing or crouching (or other poses if requested by specific risk assessment)
Test duration	At least 30 s
Acceptance criteria	The detection signal remains deactivated during the test. When the operator leaves the area; the detection signal is activated.

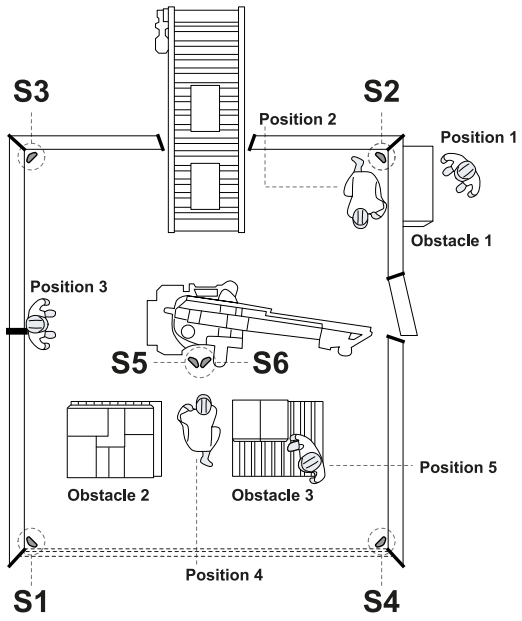
Validation test

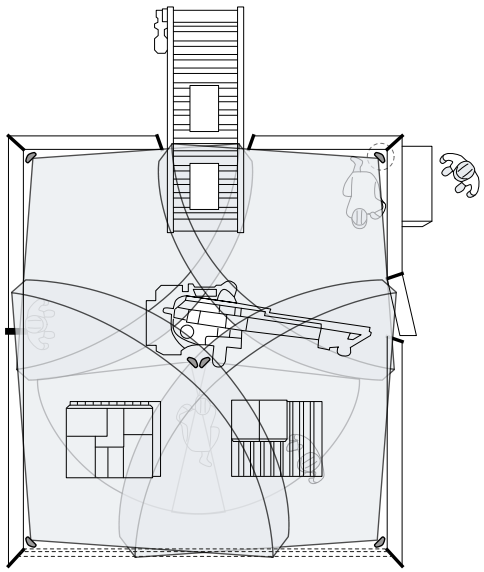
The validation procedure of the PSEN rd1.1 systems system is reported below:

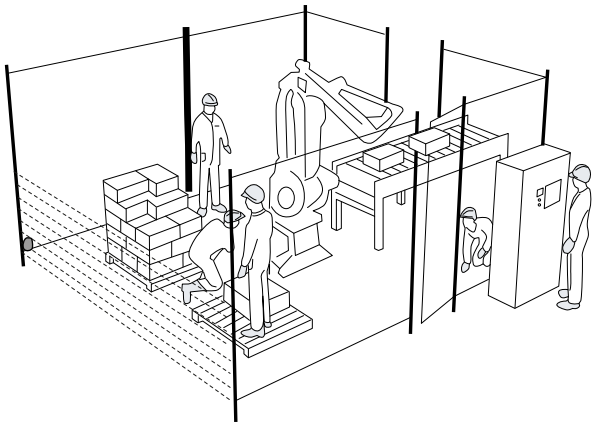
1. Identify the test positions, including those locations where the operator should normally be located during the production cycle:
   - boundaries of the dangerous area
   - intermediate points between sensors
   - positions that are partially hidden by already present or presumed obstacles during the operating cycle
   - positions indicated by the risk assessor
2. Access the dangerous area and go to one of the test positions: the corresponding detection signal should be deactivated.
3. Perform the test according to the test setup previously defined.
4. Check that the test acceptance criteria previously defined are fulfilled.
5. If the test acceptance criteria are not fulfilled, see "Validate the system with PSEN rd1" on page 77.
6. Repeat steps 2, 3, and 4 for each test position.

Example of test positions

The following images show examples of positions to be tested and suggestions about identifying other possible positions of interest.







Position 1: position outside the dangerous area

Position 2: position hidden from the operator's viewpoint at "Position 1". Any other similar hidden position should be tested.

Position 3: position at the center distance between two sensors and/or close to the boundaries of the dangerous area (e.g., along safety fences). This position is suggested to verify that the detection fields of different sensors overlap without leaving uncovered areas. Standing close to the fences also allows for verifying that the sensors are rotated correctly, covering both the right and the left side.

Position 4: possible hidden position by elements in the environment that are present or not present during the validation process. Examples: Obstacle 2 precludes detection by Sensor 1 **(S1)**. Obstacle 3 is partially present during the Validation process but will likely be present during the normal operating cycle and will preclude the detection of Sensor 4 **(S4)**. This position must be covered by additional Sensor 5 **(S5)** and Sensor 6 **(S6)** that should be added within a proper feasibility study.

Position 5: any raised and walkable position indicated by the risk assessor.

Other positions can be indicated by the risk assessor or the machine manufacturer.

9.4.4 Validate the system with PSEN rd1

WARNING! When the validation function is active, the system response time is not guaranteed.

The PSEN rd1 configurator is helpful during the safety functions validation phase and allows the actual field of view of the sensors to be checked based on their installation position.

1. Click **Monitoring**: the validation starts automatically.
2. Move in the monitored area as indicated in "Validation test" on page 75 and "Validation procedure for the restart prevention function" on page 75.
3. Check that the sensor behaves as expected.
4. Check that the distance where the motion is detected is the expected value.

9.4.5 Additional checks for safety Fieldbus

- Refer to the relevant documentation to integrate the Fieldbus properly, see "Fieldbus network integration" below.
- Check safety Fieldbus connection cables and make certain they function as intended.
- Check the safety Fieldbus settings in the configuration.

9.4.6 Troubleshooting validation

Problem	Cause	Solution
The detection signal does not remain deactivated during the restart prevention test, or it does not deactivate during the access detection test	Presence of objects obstructing the field of view	If possible, remove the object. Otherwise, implement additional safety measures in the area where the object is present (e.g., adding new sensors).
	Position of one or more sensors	Position the sensors to ensure that the monitored area is adequate for the dangerous area (see "Sensor position" on page 56).
	Inclination and/or installation height of one or more sensors	1. Change the sensor’s inclination and/or installation height to ensure the monitored area is adequate for the dangerous area (see "Sensor position" on page 56). 2. Note or update the inclination and installation height of the sensors in the printed configuration report.
	Inadequate restart timeout	Change the **Restart timeout** parameter through the PSEN rd1 configurator and verify that it is set to at least 10 seconds for each sensor (**Configuration** > select the affected sensor and detection field)
After that the operator leaves the area, the detection signal does not activate	Presence of moving objects in the sensor's field of view (including vibrations of metal parts where the sensors are installed or vibration of brackets)	Identify the moving objects/brackets and, if possible, tighten all the loose parts
	Reflections of signals	Change the sensor positions or adjust the detection fields reducing the detection distance

9.5 Fieldbus network integration

9.5.1 Integration procedure

The integration into the Fieldbus network may differ depending on the analysing unit model and type. Refer to the relevant additional manuals:

- PSEN rd1.x I/O PN and [C201B-P]: PSEN rd 1.1/2 PROFIsafe communication interface Reference guide (Inxpect 100S_200S PROFIsafe RG_7_[DocLangCode]_en)

- [C201A-F] and PSEN rd1.x SD I/O FSoE: PSEN rd 1.1/2 FSoE communication interface Reference guide (Inxpect 100S_200S FSoE RG_7_[DocLangCode]_en)

9.6 Manage the configuration

9.6.1 Configuration checksums

In the PSEN rd1 configurator in **Settings** > **Configuration checksums**, it is possible to consult:

- the configuration report hash, a unique alphanumeric code associated with a report. It is computed considering the entire configuration, plus the time of the **APPLY CHANGES** operation, and the name of the computer which did it
- dynamic configuration checksum, associated with a specific dynamic configuration. It considers both common and dynamic parameters

9.6.2 Configuration reports

After changing the configuration, the system generates a configuration report with the following information:

- configuration data
- unique hash
- date and time of configuration change
- name of the computer used for the configuration

The reports are documents that cannot be changed and can only be printed and signed by the machinery safety manager.

***Note**: to save the PDF, a printer must be installed on the computer.*

9.6.3 Change the configuration

WARNING! The system is disabled during configuration. Prepare opportune safety measures in the dangerous area protected by the system before configuring the system.

1. Start the PSEN rd1 configurator.
2. Click **User** and enter the admin password.
   ***Note**: after five wrong password entries, configurator authentication is blocked for one minute.*
3. Depending on what you want to change, follow the instructions below:

To change...	Then...
Monitored area and sensors configuration	Click **Configuration**
System sensitivity	Click **Settings** > **Sensors**
Node ID	Click **Settings** > **Node ID Assignment**
Function of inputs and outputs	Click **Settings** > **Digital Input-Output**
Detection field groups configuration	Click **Settings** > **Detection field groups** and select the group for each detection field of each connected sensor. Then click **Settings** > **Digital Input-Output** and set a digital output as **Detection signal group 1** or **Detection signal group 2** function
Muting	Click **Settings** > **Muting**
Sensor number and positioning	Click **Configuration**

4. Click **APPLY CHANGES**.
5. Upon conclusion of transfer of the configuration to the analysing unit, click to print the report.
   ***Note**: to save the PDF, a printer must be installed on the computer.*

9.6.4 Display previous configurations

In **Settings**, click **Activity History** and then click **Configuration reports page**: the reports archive opens.

9.7 Other procedures

9.7.1 Change language

1. Click .
2. Select the desired language. The language changes automatically.

9.7.2 Change the admin password

In **Settings** > **Account**, click **CHANGE PASSWORD**.

9.7.3 Restore factory default settings

WARNING! The system is provided without any valid configuration. Therefore the system maintains the safe state at the first start-up until a valid configuration is applied through the PSEN rd1 configurator by clicking APPLY CHANGES.

WARNING! The procedure resets both the configuration and the password of all the users.

To restore the configuration parameters to the default settings, follow the procedures reported below:

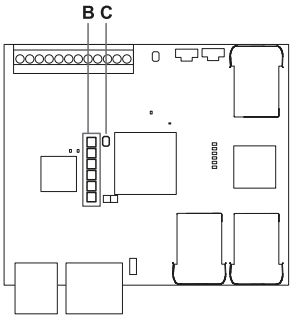
Procedure using the PSEN rd1 configurator

1. Log in to the PSEN rd1configurator as the Administrator user.
2. In **Admin** > **FACTORY RESET**.

Procedure using the reset button on the analysing unit

1. Press and hold the button **[C]** for longer than 10 seconds: all the system status LEDs **[B]** turn on (steady orange), and the system is ready to be reset.
2. Release the button **[C]**: all the system status LEDs **[B]** turn on (flashing green), and the reset procedure starts. The procedure can last up to 30 seconds. Do not switch off the system during the reset.

***Note**: if the button is pressed for longer than 30 seconds, the status of the LEDs switches to red, and the reset is not performed even after the button is released.*



For the default values of the parameters, see "Configuration configurator parameters" on page 111.

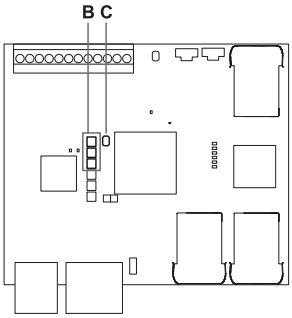
9.7.4 Reset the analysing unit Ethernet parameters

1. Ensure the analysing unit is turned on.
2. Press the Network parameter reset button and hold it down during steps 3 and 4.
3. Wait for five seconds.
4. Wait until all the six LEDs on the analysing unit turns steady green: the Ethernet parameters are set to their default values (see "Ethernet connection (if available)" on page 99).
5. Configure the analysing unit again.

9.7.5 Restore network parameters

WARNING! After the restore network parameters procedure, the system goes into the safe state. The configuration must be validated and, if necessary, modified through the PSEN rd1 configurator by clicking APPLY CHANGES.

1. To restore the network parameters to the default settings, press and hold the reset button **[C]** on the analysing unit for 2 to 5 seconds: the first three system status LEDs **[B]** turn on (steady orange) and the network parameters are ready to be reset.
2. Release the button **[C]**: the reset is performed.



For the default values of the parameters, see "Configuration configurator parameters" on page 111.

9.7.6 Identify a sensor

In **Settings** > **Node ID Assignment** or **Configuration**, click **Identify by LED** near the desired sensor Node ID: the LED on the sensor flashes for 5 seconds.

9.7.7 Set network parameters

In **Admin** > **Network Parameters**, set the IP address, the netmask, and the gateway of the analysing unit as desired.

9.7.8 Set MODBUS parameters

In **Admin** > **MODBUS Parameters**, enable/disable the MODBUS communication and modify the listening port.

9.7.9 Set Fieldbus parameters

In **Admin** > **Fieldbus Parameters**, depending on the Fieldbus interface, set the parameters below:

- for the PROFIsafe interface, the F-addresses, and the Fieldbus Endianness
- for the Safety over EtherCAT® interface, and the Safe address

9.7.10 Set system labels

In **Admin** > **Modbus labels**, choose the desired labels for the analysing unit and the sensors.

10. Troubleshooting

Machinery maintenance technician

The machinery maintenance technician is a qualified person with the administrator privileges required to modify the configuration of PSEN rd1.1 systems through the software and perform maintenance and troubleshooting.

Contents

This section includes the following topics:

10.1 Troubleshooting procedures **81**
10.2 Event log management **84**
10.3 INFO events **88**
10.4 ERROR events (analysing unit) **90**
10.5 ERROR events (sensor) **92**
10.6 ERROR events (CAN bus) **93**

10.1 Troubleshooting procedures

***Note**: if requested by Pilz, in **Settings** > **Activity History**, click **Download sensor debug info** to download the files and forward them to Pilz for debugging.*

10.1.1 Analysing unit LED

For more details about the LEDs in the analysing unit, see "Analysing units" on page 14 and "System status LEDs" on page 17.

LED	Status	Configurator messages	Problem	Solution
S1*	Steady red	ANALYSING UNIT POWER ERROR	At least one voltage value on the analysing unit is wrong	If at least one digital input is connected, check that the SNS input and the GND input are connected. Check that the input power supply is the specified type (see "General specifications" on page 98).
S1 + S3	Steady red	BACKUP or RESTORE ERROR	Error during the backup and restore to/from microSD card	Check if the microSD card is inserted. Check if the configuration file on the microSD card is present and not corrupted.
S2	Steady red	ANALYSING UNIT TEMPERATURE ERROR	Analysing unit temperature value is wrong	Check that the system is operating at the correct operating temperature (see "General specifications" on page 98).
S3	Steady red	OSSD ERROR or INPUT ERROR	At least one input or output is in error	If at least one input is used, check that both the channels are connected and that there is no short-circuit on the outputs. If the problem persists, please contact Pilz.

LED	Status	Configurator messages	Problem	Solution
S4	Steady red	PERIPHERAL ERROR	At least one of the analysing unit peripherals is in error	Check the status of the terminal block and connections. If the problem persists, please contact Pilz.
S5	Steady red	CAN ERROR	Communication error with at least one sensor	Check connections of all sensors in the chain starting from the last sensor in error. Check that all the sensors have an assigned ID (in PSEN rd1 **Settings** > **Node ID Assignment**). Check that the firmware of the analysing unit and sensors are updated to the compatible versions.
S6	Steady red	FEE ERROR, FLASH ERROR or RAM ERROR	Configuration saving error, configuration not performed or memory error	Reconfigure or configure the system (see "Manage the configuration" on page 78). If the error persists, please contact Pilz.
All LEDs from S1 to S6 together	Steady red	FIELDBUS ERROR	Communication error on the Fieldbus	At least one input or output is configured as **Fieldbus controlled**. Check that the cable is correctly connected, communication with the host is correctly established, watchdog timeout is configured correctly, and exchanged data are not maintained passivated.
All LEDs from S1 to S5 together	Steady red	DYNAMIC CONFIGURATION ERROR	Error in the selection of the dynamic configuration: invalid ID	Check the preset configurations within the PSEN rd1 configurator.
All LEDs from S1 to S4 together	Steady red	SENSOR CONFIGURATION ERROR	Error during the configuration of the sensors	Check the sensors connected and try again to perform the configuration of the system via the PSEN rd1 configurator. Check that the firmware of the analysing unit and sensors are updated to compatible versions.
At least one LED	Flashing red	See "Sensor LED" on the next page	Sensor corresponding to the flashing LED in error ** (see"Sensor LED" on the next page)	Check the problem through the LED on the sensor.
At least one LED	Flashing green	See "Sensor LED" on the next page	Sensor corresponding to the flashing LED in error ** (see"Sensor LED" on the next page)	If the issue persists longer than one minute, please contact Pilz.
All LEDs	Steady orange	-	The system is starting up.	Wait for a few seconds.

LED	Status	Configurator messages	Problem	Solution
All LEDs	Flashing green one after the other in sequence	-	The analysing unit is in boot state.	Open the latest available version of the PSEN rd1 configurator, connect to the device and proceed with the automatic recovery procedure. If the issue persists, please contact Pilz.
All LEDs	Off	In **Dashboard** > **System status** ⚠ icons	Configuration not yet applied to the analysing unit.	Configure the system.
All LEDs	Off	Progress icon	Configuration transfer to the analysing unit in progress.	Wait for the transfer to be completed.

***Note**: fault signal on the analysing unit (steady LED) takes priority over a faulty sensor signal. For the status of the single sensor, check the sensor LED.*

Note: S1 is the first from the top.*

Note*: S1 corresponds to the sensor with ID 1, S2 corresponds to the sensor with ID 2 and so on.*

10.1.2 Sensor LED

Status	Configurator messages	Problem	Solution
2 flashes *	CAN ERROR	ID not assigned	Assign a Node ID to the sensor (see "Connect the sensors to the analysing unit" on page 71).
3 flashes *	CAN ERROR	Error in communication with the analysing unit	Check connections of all sensors in the chain starting from the last sensor in error.
4 flashes *	SENSOR TEMPERATURE ERROR or SENSOR POWER ERROR	Wrong power supply voltage or temperature value	• Check the sensor connection and that the length of the cables respects maximum limits. • Check that the ambient temperature where the system is functioning complies with the operating temperatures indicated in the technical data in this manual
5 flashes *	MASKING, SIGNAL ERROR	Masking, micro-controller, micro-controller peripherals, radar or radar control in error	Check that the sensor is correctly installed and that the area is free of any objects that obstruct the field of view of the sensors.
	PERIPHERAL ERROR	Error detected by diagnostics relative to the internal micro-controller, its internal peripherals or memories	If the issue persists, please contact Pilz.
6 flashes *	ACCELEROMETER ERROR	Inclination of the sensor different from the installation inclination	Check if the sensor has been tampered with or if the side screws or fastening screws are loose.

***Note ***: flashes at 200 ms intervals and then with a 2 s pause.*

10.1.3 Other problems

Problem	Cause	Solution
Undesired detections	Transit of people or objects in close proximity to the detection field	Change the configuration (see "Change the configuration" on page 78).
Machinery in safe status without motion in the detection field	No power supply	Check electrical connection. Contact Pilz if necessary.
	Failure of the analysing unit or one or more sensors	Check the status of the LEDs on the analysing unit (see "Analysing unit LED" on page 81). Access the PSEN rd1 configurator. On the **Dashboard** page, mouse-over ⊗ at the analysing unit or the sensor.
The voltage value detected on the SNS input is zero	The chip that detects inputs is faulty	Contact Pilz.
The system does not function correctly	Analysing unit error	Check the status of the LEDs on the analysing unit (see "Analysing unit LED" on page 81). Access the PSEN rd1 configurator. On the **Dashboard** page, mouse-over ⊗ at the analysing unit or the sensor.
	Sensor error	Check the status of the LEDs on the sensor (see "Sensor LED" on the previous page). Access the PSEN rd1 configurator. On the **Dashboard** page, mouse-over ⊗ at the analysing unit or the sensor.

10.2 Event log management

10.2.1 Introduction

The event log recorded by the system can be downloaded from the PSEN rd1 configurator in a PDF file. The system saves up to 4500 events, divided in two sections. In each section the events are displayed from the most recent to the least recent. Above this limit, the oldest events are overwritten.

10.2.2 Download the system log

WARNING! The system response time is not guaranteed while downloading the log file.

1. Start the PSEN rd1 configurator.
2. Click **Settings** and then **Activity History**.
3. Click **DOWNLOAD LOG**.
   ***Note**: to save the PDF, a printer must be installed on the computer.*

10.2.3 Log file sections

The first line of the file reports the NID (Network ID) of the device and the date of the download.

The rest of the file log is divided in two sections:

Section	Description	Content	Size	Reset
1	Event log	Information events Error events	3500	At every firmware update or on demand using the PSEN rd1 configurator
2	Diagnostic event log	Error events	1000	Not possible

10.2.4 Log line structure

Each line in the log file reports the following information, separated by tab character:

- Timestamp (seconds counter from the latest boot)
- Timestamp (absolute/relative value)
- Event type:
  - [ERROR] = diagnostic event
  - [INFO] = information event
- Source
  - ANALYSING UNIT = if the event is generated by the analysing unit
  - SENSOR ID = if the event is generated by a sensor. In this case, the Node ID of the sensor is also provided
- Event description

10.2.5 Timestamp (seconds counter from the latest boot)

An indication of the instant when the event occurred is provided as relative time from the latest boot, in seconds.

Example: 92

Meaning: the event occurred 92 seconds after the latest boot

10.2.6 Timestamp (absolute/relative value)

An indication of the instant when the event occurred is provided.

- After a new system configuration, it is provided as absolute time.

  Format: *YYYY/MM/DD hh:mm:ss*

  Example: 2020/06/05 23:53:44

- After a reboot of the device, it is provided as relative time from the latest boot.

  Format: *Rel. x d hh:mm:ss*

  Example: Rel. 0 d 00:01:32

***Note**: when a new system configuration is performed, even the older timestamps are updated in absolute time format.*

***Note**: during system configuration, the analysing unit is receiving the local time of the machine where the software is running.*

10.2.7 Event description

A complete description of the event is reported. Whenever possible, depending on the event, additional parameters are reported.

In case of a diagnostic event, an internal error code is also added, useful for the purpose of debug. If the diagnostic event disappears, the label “(Disappearing)” is reported as an additional parameter.

Examples

Detection access (field #3, 1300 mm/40°)

System configuration #15

CAN ERROR (Code: 0x0010) COMMUNICATION LOST

CAN ERROR (Disappearing)

10.2.8 Log file example

Event logs of ISC NID UP304 updated 2020/11/18 16:59:56
[Section 1 - Event logs]

380 2020/11/18 16:53:49 [ERROR] SENSOR#1 CAN ERROR (Disappearing)

375 2020/11/18 16:53:44 [ERROR] SENSOR#1 CAN ERROR (Code: 0x0010) COMMUNICATION LOST

356 2020/11/18 16:53:25 [INFO] ANALYSING UNIT System configuration #16

30 2020/11/18 16:53:52 [ERROR] SENSOR#1 ACCELEROMETER ERROR (Disappearing)

27 2020/11/18 16:47:56 [ERROR] SENSOR#1 ACCELEROMETER ERROR (Code: 0x0010) TILT ANGLE ERROR

5 2020/11/18 16:47:30 [ERROR] SENSOR#1 SIGNAL ERROR (Code: 0x0012) MASKING

0 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Dynamic configuration #1

0 2020/11/18 16:47:25 [INFO] ANALYSING UNIT System Boot #60

92 Rel. 0 d 00:01:32 [INFO] ANALYSING UNIT Detection exit (field #2)

90 Rel. 0 d 00:01:30 [INFO] ANALYSING UNIT Detection exit (field #1)

70 Rel. 0 d 00:01:10 [INFO] SENSOR#1 Detection access (field #2, 3100 mm/20°)

61 Rel. 0 d 00:01:01 [INFO] SENSOR#1 Detection access (field #1, 1200 mm/30°)

0 Rel. 0 d 00:00:00 [INFO] ANALYSING UNIT Dynamic configuration #1

0 0 d 00:00:00 [INFO] ANALYSING UNIT System Boot #61

[Section 2 - Diagnostic events log]

380 Rel. 0 d 00:06:20 [ERROR] SENSOR #1 CAN ERROR (Disappearing)

375 Rel. 0 d 00:06:15 [ERROR] SENSOR #1 CAN ERROR (Code: 0x0010) COMMUNICATION LOST

356 Rel. 0 d 00:05:56 [INFO] ANALYSING UNIT System configuration #16

30 Rel. 0 d 00:00:30 [ERROR] SENSOR #1 ACCELEROMETER ERROR (Disappearing)

27 Rel. 0 d 00:00:27 [ERROR] SENSOR #1 ACCELEROMETER ERROR (Code: 0x0012) TILT ANGLE ERROR

5 Rel. 0 d 00:00:05 [ERROR] SENSOR #1 SIGNAL ERROR (Code: 0x0014) MASKING

10.2.9 Event list

The event logs are listed below:

Event	Type
Diagnostic errors	ERROR
System Boot	INFO
System configuration	INFO
Factory reset	INFO
Stop signal	INFO
Restart signal	INFO
Detection access	INFO
Detection exit	INFO
Dynamic configuration in use	INFO
Muting status	INFO
Fieldbus connection	INFO

Event	Type
MODBUS connection	INFO
Session authentication	INFO
Validation	INFO
Log download	INFO

For further information about the events, see "INFO events" on the next page and " ERROR events (analysing unit)" on page 90.

10.2.10 Verbosity level

There are six verbosity levels for the log. The verbosity can be set during the configuration of the system via the PSEN rd1 configurator (**Settings** > **Activity History** > **Log verbosity level**).

Depending on the selected verbosity level, the events are logged in accordance to the following table:

Event	Level 0 (default)	Level 1	Level 2	Level 3	Level 4	Level 5
Diagnostic errors	x	x	x	x	x	x
System Boot	x	x	x	x	x	x
System configuration	x	x	x	x	x	x
Factory reset	x	x	x	x	x	x
Stop signal	x	x	x	x	x	x
Restart signal	x	x	x	x	x	x
Detection access	-	See "Verbosity level for detection access and exit events" below				
Detection exit	-	See "Verbosity level for detection access and exit events" below				
Dynamic configuration in use	-	-	-	-	x	x
Muting status	-	-	-	-	-	x

10.2.11 Verbosity level for detection access and exit events

Depending on the selected verbosity level, the detection access and exit events are logged as follows:

- LEVEL 0: no detection info is logged
- LEVEL 1: the events are logged at the analysing unit level, and the additional information is the detection distance (in mm) at detection access

  Format:

  ANALYSING UNIT Detection access (distance mm)

  ANALYSING UNIT Detection exit

- LEVEL 2: the events are logged in a single field at the analysing unit level, and the additional information is: detection field, detection distance (in mm) at access, and detection field at exit

  Format:

  ANALYSING UNIT Detection access (field #n, distance mm)

  ANALYSING UNIT Detection exit (field #n)

- LEVEL 3 / LEVEL 4 / LEVEL 5 The events are logged:
  - in a single field at the analysing unit level, and the additional information is: detection field, detection distance (in mm) at access, and detection field at exit
  - at the sensor level and the additional information read by the sensor is: detection distance (in mm) at access, and detection field at exit

  Format:

  ANALYSING UNIT #k Detection access (field #n, distance mm)

  SENSOR #k Detection access (distance mm)

ANALYSING UNIT Detection exit (field #n)

SENSOR #k Detection exit

10.3 INFO events

10.3.1 System Boot

Every time the system is powered up, the event is logged reporting the incremental count of the boot from the beginning of the life of the device.

Format: *System Boot #n*

Example:

0 2020/11/18 16:47:25 [INFO] ANALYSING UNIT SYSTEM BOOT #60

10.3.2 System configuration

Every time the system is configured, the event is logged reporting the incremental count of the configuration from the beginning of the life of the device.

Format: *System configuration #3*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT System configuration #3

10.3.3 Factory reset

Every time a factory reset is required, the event is logged.

Format: *Factory reset*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Factory reset

10.3.4 Stop signal

If configured, every change of the Stop Signal is logged as ACTIVATION or DEACTIVATION.

Format: *Stop signal ACTIVATION/DEACTIVATION*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Stop signal ACTIVATION

10.3.5 Restart signal

If configured, every time the system is waiting for the restart signal or the restart signal is received, the event is logged as WAITING or RECEIVED.

Format: *Restart signal WAITING/RECEIVED*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Restart signal RECEIVED

10.3.6 Detection access

Every time motion is detected, a detection access is logged with additional parameters depending on the selected verbosity level: the detection field number, the sensor which detected the motion, the detection distance (in mm). See "Verbosity level for detection access and exit events" on the previous page.

Format: *Detection access (field #n, distance mm/azimuth°)*

Example:

20 2020/11/18 16:47:25 [INFO] SENSOR #1 Detection access (field #1, 1200 mm/30°)

10.3.7 Detection exit

After at least one detection access event, a detection exit event related to the same field is logged when the detection signal returns to its default no-motion status.

Depending on the selected verbosity level additional parameters are logged: the detection field number, the sensor which detected the motion.

Format: *Detection exit (field #n)*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Detection exit (field #1)

10.3.8 Dynamic configuration in use

At every change of the dynamic configuration, the new ID of the dynamic configuration selected is logged.

Format: *Dynamic configuration #1*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Dynamic configuration #1

10.3.9 Muting status

Every change of the muting status of each sensor is logged as disabled or enabled.

***Note**: the event indicates a change of the muting status of the system. It does not correspond to the muting request.*

Format: *Muting disabled/enabled*

Example:

20 2020/11/18 16:47:25 [INFO] SENSOR#1 Muting enabled

10.3.10 Fieldbus connection

The Fieldbus communication status is logged as CONNECTED, DISCONNECTED or FAULT.

Format: *Fieldbus connection CONNECTED/DISCONNECTED/FAULT*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Fieldbus connection CONNECTED

10.3.11 MODBUS connection

The MODBUS communication status is logged as CONNECTED or DISCONNECTED.

Format: *MODBUS connection CONNECTED/DISCONNECTED*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT MODBUS connection CONNECTED

10.3.12 Session authentication

The status of the session authentication and the interface used (USB/ETH) are logged.

Format: *Session OPEN/CLOSE/WRONG PASSWORD/UNSET PASSWORD/TIMEOUT/CHANGE PASSWORD via USB/ETH*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Session OPEN via USB

10.3.13 Validation

Every time a validation activity starts or ends on the device, it is logged. The interface used (USB/ETH) is logged as well.

Format: *Validation STARTED/ENDED via USB/ETH*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Validation STARTED via USB

10.3.14 Log download

Every time a log download is performed on the device, it is logged. The interface used (USB/ETH) is logged as well.

Format: *Log download via USB/ETH*

Example:

20 2020/11/18 16:47:25 [INFO] ANALYSING UNIT Log download via USB

10.4 ERROR events (analysing unit)

10.4.1 Introduction

A diagnostic error is logged every time the periodic diagnostic functions detect a coming or going fault on the analysing unit.

10.4.2 Temperature errors (TEMPERATURE ERROR)

Error	Meaning
BOARD TEMPERATURE TOO LOW	Board temperature below minimum
BOARD TEMPERATURE TOO HIGH	Board temperature above maximum

10.4.3 Analysing unit voltage errors (POWER ERROR)

Error	Meaning
Analysing unit voltage UNDERVOLTAGE	Undervoltage error for the indicated voltage
Analysing unit voltage OVERVOLTAGE	Overvoltage error for the indicated voltage
ADC CONVERSION ERROR	ADC conversion error in the micro-controller

The following table describes the analysing unit voltage:

Screen printing	Description
VIN	Power supply voltage (+24 V DC)
V12	Internal supply voltage
V12 sensors	Sensors power supply voltage
VUSB	USB port voltage
VREF	Inputs reference voltage (**VSNS Error**)
ADC	Analog-digital converter

10.4.4 Peripheral error (PERIPHERAL ERROR)

Error detected by diagnostics relative to the micro-controller, its internal peripherals or memories.

10.4.5 Configuration errors (FEE ERROR)

Indicates that the system must still be configured. This message can appear when the system is first turned on or after reset to default values. It can also represent another error on the FEE (internal memory).

10.4.6 Output errors (OSSD ERROR)

Error	Meaning
OSSD 1 SHORT-CIRCUIT	Short-circuit error on MOS output 1
OSSD 2 SHORT-CIRCUIT	Short-circuit error on MOS output 2
OSSD 3 SHORT-CIRCUIT	Short-circuit error on MOS output 3
OSSD 4 SHORT-CIRCUIT	Short-circuit error on MOS output 4
OSSD 1 NO LOAD	No load on OSSD 1
OSSD 2 NO LOAD	No load on OSSD 2
OSSD 3 NO LOAD	No load on OSSD 3
OSSD 4 NO LOAD	No load on OSSD 4

10.4.7 Flash errors (FLASH ERROR)

A flash error represents an error on the external flash.

10.4.8 Dynamic configuration error (DYNAMIC CONFIGURATION ERROR)

A dynamic configuration error indicates an invalid dynamic configuration ID.

10.4.9 Internal communication error (INTERNAL COMMUNICATION ERROR)

Indicates that there is an internal communication error.

10.4.10 Input error (INPUT ERROR)

Error	Meaning
INPUT 1 REDUNDANCY	Error in the redundancy on Input 1
INPUT 2 REDUNDANCY	Error in the redundancy on Input 2
ENCODING	Invalid encoding when the encoded channel option is enabled
PLAUSIBILITY	0->1->0 transition not compliant with input functionality specification

10.4.11 Fieldbus error (FIELDBUS ERROR)

At least one of the inputs and outputs has been configured as **Fieldbus controlled**, but the Fieldbus communication is not established or not valid.

Error	Meaning
NOT VALID COMMUNICATION	Error on the Fieldbus

10.4.12 RAM error (RAM ERROR)

Error	Meaning
INTEGRITY ERROR	Wrong integrity check on the RAM

10.4.13 SD Backup or restore error (SD BACKUP OR RESTORE ERROR)

Error	Meaning
GENERIC FAIL	Unknown fault
TIMEOUT	Writing and reading internal operation timeout
NO_SD	microSD not present
WRITE OPERATION FAILED	Writing error on the microSD card
CHECK OPERATION FAILED	File corrupted or no file during restore from microSD card

10.4.14 Sensor configuration errors (SENSOR CONFIGURATION ERROR)

Error occurred on the sensors during the configuration process or at the system power up. At least one of the connected sensors did not get the correct configuration.

As details, the list of sensors not configured is reported.

10.5 ERROR events (sensor)

10.5.1 Introduction

A diagnostic error is logged every time the periodic diagnostic functions detect a coming or going fault on the sensor.

WARNING! No sensor errors are available if the sensor is in muting.

***Note**: if requested by Pilz, in **Settings** > **Activity History**, click **Download sensor debug info** to download the files and forward them to Pilz for debugging.*

10.5.2 Radar signal errors (SIGNAL ERROR)

Error	Meaning
HEAD FAULT	Radar not functioning
HEAD POWER OFF	Radar off
MASKING	Presence of object obstructing the field of view of the radar
SIGNAL DYNAMIC	Wrong signal dynamic
SIGNAL MIN	Signal with dynamic below minimum
SIGNAL MIN MAX	Signal with out of range dynamic
SIGNAL MAX	Signal with dynamic over maximum
SIGNAL AVG	Flat signal

10.5.3 Temperature errors (TEMPERATURE ERROR)

Error	Meaning
BOARD TEMPERATURE TOO LOW	Board temperature below minimum
BOARD TEMPERATURE TOO HIGH	Board temperature above maximum

10.5.4 Sensor voltage errors (POWER ERROR)

Error	Meaning
Sensor voltage **UNDERVOLTAGE**	Undervoltage error for the indicated voltage
Sensor voltage **OVERVOLTAGE**	Overvoltage error for the indicated voltage
ADC CONVERSION ERROR	(only for the ADC) ADC conversion error in the micro-controller

The following table describes the sensor voltage:

Screen printing	Description
VIN	Power supply voltage (+12 V DC)
V3.3	Internal chip power supply voltage
V1.2	Micro-controller power supply voltage
V+	Radar reference voltage
VDCDC	Main chip power supply internal voltage
VOPAMP	Operational amplifier voltage
VADC REF	Analog-digital converter (ADC) reference voltage
ADC	Analog-digital converter

10.5.5 Anti-tampering sensor (ACCELEROMETER ERROR)

Error	Meaning
TILT ANGLE ERROR	Sensor inclination around the x-axes
ROLL ANGLE ERROR	Sensor inclination around the z-axes
ACCELEROMETER READ ERROR	Accelerometer reading error

10.5.6 Peripheral error (PERIPHERAL ERROR)

Error detected by diagnostics relative to the micro-controller, its internal peripherals or memories.

10.6 ERROR events (CAN bus)

10.6.1 Introduction

A diagnostic error is logged every time the periodic diagnostic functions detect a coming or going fault on the CAN bus communication.

Depending on the communication bus side, the logged source can be the analysing unit or a single sensor.

10.6.2 CAN errors (CAN ERROR)

Error	Meaning
TIMEOUT	Timeout on message to sensor/analysing unit
CROSS CHECK	Two redundant messages do not coincide
SEQUENCE NUMBER	Message with sequence number different from the expected number
CRC CHECK	Packet control code does not match
COMMUNICATION LOST	Impossible to communicate with the sensor
PROTOCOL ERROR	Analysing unit and sensors have different and incompatible firmware versions
POLLING TIMEOUT	Timeout on data polling

NOTICE: *A shielded cable between the analysing unit and the first sensor, and between the sensors is strongly recommended. Nevertheless, route the CAN cables separately from high-potential power lines or through an exclusive conduit.*

11. Maintenance

Contents

This section includes the following topics:

11.1 Planned maintenance **94**
11.2 Extraordinary maintenance **95**

11.1 Planned maintenance

Generic maintenance technician

The generic maintenance technician is a person qualified only to perform basic maintenance without the administrator privileges required to modify the configuration of PSEN rd1.1 systems through the configurator.

11.1.1 Cleaning

Keep the sensor clean and free of any work residues and conductive material to prevent masking and/or poor system operation.

11.1.2 Spare parts

Part	Product code	Description
Analysing unit	6B000001 PSEN rd1.x I/O PN	I/O PN analysing unit
	6B000005 PSEN rd1.x I/O	I/O analysing unit with USB interface
	6B000007 PSEN rd1.x SD I/O FSoE	I/O FSoE analysing unit with microSD slot
Sensor	6B000002 PSEN rd1.1	Sensor
Shield kit	6B000004	PSEN rd1.1 sensor shield kit
Cable & Connector	C1000044	Cable/CA/M12-5AFX/A/005/XXXX/SH
	C1000045	Cable/CA/M12-5AFX/A/010/XXXX/SH
	C1000046	Cable/CA/M12-5AFX/A/015/XXXX/SH
	C1000047	Cable/CA/M12-5AFX/M12-5AM/A/003/XXXX/SH
	C1000048	Cable/CA/M12-5AFX/M12-5AM/A/005/XXXX/SH
	C1000049	Cable/CA/M12-5AFX/M12-5AM/A/010/XXXX/SH
	C1000050	Cable/CA/M12-5AFX/M12-5AM/A/015/XXXX/SH
	C1000058	Connector/CA/M12-5SMX/A/TR

11.2 Extraordinary maintenance

11.2.1 Machinery maintenance technician

The machinery maintenance technician is a qualified person with the administrator privileges required to modify the configuration of PSEN rd1.1 systems through the PSEN rd1 configurator and perform maintenance and troubleshooting.

11.2.2 Analysing unit firmware update

1. Download the latest PSEN rd1 configurator version from the www.pilz.com/manuals website and install it on your computer.
2. Connect to the analysing unit via Ethernet and log in as Administrator role.
3. In **Settings** > **General**, check if a new update is available.
4. Update without disconnecting from or turning off the device.

11.2.3 Replace a sensor: System recondition function

The system recondition function is useful for replacing an existing sensor without changing current settings. The function can be enabled through digital inputs (**System recondition** or **Restart signal + System recondition**) or via Fieldbus (**System recondition** only).

WARNING! If the system recondition function has been configured through the safety Fieldbus and the digital inputs, the function can be used from both.

***Note**: keep the scene static while running the system recondition function so that the anti-tampering functions can save their references.*

***Note**: while running the system recondition function, the system goes to the safe state, deactivating the OSSDs, until the process is completed.*

1. Configure the digital inputs or Fieldbus to perform the system recondition function.
2. Connect a sensor without Node ID in the same position of the CAN bus line as the replaced sensor.
   ***Note**: only one sensor at a time must be connected to complete the procedure correctly.*
3. Activate the function (via digital inputs or Fieldbus) and wait for the operation to be performed. See "Analysing unit LED" on page 81 to know which is the system status.

The following actions are performed:

- The first available Node ID is assigned to the new sensor.
- The previous configuration of the system is applied (**APPLY CHANGES** operation). The operation is saved in the event log as a standard **System configuration** event.
- The event is logged in the reports archive (**Settings** > **Activity History** > **Configuration reports page**) with the following strings in the **User, PC** column:
  - “sys-recondition-i” when the function is performed via digital input
  - “sys-recondition-f” when Fieldbus is used

***Note**: for more details, see "Digital input signals" on page 114.*

11.2.4 Back up the configuration to a PC

The current configuration can be backed up, including the input/output settings. The configuration is saved in a .cfg file, which can be used to restore the configuration or to facilitate configuration of several PSEN rd1.1 systems.

1. In **Settings** > **General**, click **BACKUP**.
2. Select the file destination and save.

***Note**: user login credentials are not saved using this backup mode.*

11.2.5 Back up the configuration to a microSD card

If the analysing unit is provided with a microSD slot, a backup file of the system settings, and (optionally) the login credentials of all the users, can be stored on the microSD card. The SD Backup function can be enabled/disabled through the PSEN rd1 configurator, as well as the backup of the login credentials of all the users. By default, both options are disabled.

1. To enable the SD Backup function, in **Admin** > **SD Card** select **Automatic backup creation**.
2. To enable the saving of all users' login credentials, select **Users data included**.

3. To perform the backup, insert a microSD card into the analysing unit memory card slot.
   ***Note**: the microSD card is not supplied with the analysing unit. For details about the microSD card specifications, see "microSD card specifications" below*
4. In the PSEN rd1 configurator, click **APPLY CHANGES**: the backup is automatically performed.

***Note**: the settings of the **Automatic backup creation** options are not saved during the microSD Backup.*

11.2.6 Load a configuration from a PC

1. In **Settings** > **General**, click **RESTORE**.
2. Select the previously saved .cfg file (see "Back up the configuration to a PC" on the previous page) and open it.

***Note**: a re-imported configuration requires new downloading onto the analysing unit and approval according to the safety plan.*

11.2.7 Load a configuration from a microSD card

If the analysing unit is provided with a microSD slot, the administrator can restore both the system settings and (if any) the login credentials of all the users. This requires a valid backup file saved on a microSD. The SD Restore function can be enabled/disabled through the PSEN rd1 configurator. By default the option is enabled.

***Note**: this SD Restore function also includes a System recondition operation, see "Replace a sensor: System recondition function" on the previous page.*

1. To perform the restore, insert the microSD card with the saved configuration into the memory card slot of the new analysing unit.
   ***Note**: the microSD card is not supplied with the analysing unit. For details about the microSD card specifications, see "microSD card specifications" below*
2. Press the SD Restore button on the analysing unit for at least 5 seconds: the system status LEDs turn off, and when the reset is performed, the LEDs return to the previous state.

Note**: to disable the SD Restore function, in **Admin** > **SD Card** deselect **Enable restore by button

The following actions are performed:

- The system configuration is applied (**APPLY CHANGES** operation).
- The event is logged in the reports archive (**Settings** > **Activity History** > **Configuration reports page**) with the string **Restore-via-sdcard**.

11.2.8 microSD card specifications

Type	microSD
File system	FAT32
Recommended capacity	32 GB or less

12. Technical references

Contents

This section includes the following topics:

12.1 Technical data **98**
12.2 Terminal blocks and connector pin-outs **101**
12.3 Electrical connections **103**
12.4 Configuration configurator parameters **111**
12.5 Digital input signals **114**

12.1 Technical data

12.1.1 General specifications

Detection method	Motion detection algorithm based on FMCW radar
Frequency	Working band: 24–24.25 GHz Maximum radiated power: 12.6 dBm EIRP (at +25° C) Maximum radiated power: 16.5 dBm EIRP (at -40° C) Modulation: FMCW
Detection interval	From 0 to 4 m (from 0 to 13.1 ft)
Detectable target RCS	0.17 m²
Field of view	• 110° (sensor horizontal plane: 110°, sensor vertical plane: 30°) • 50° (sensor horizontal plane: 50°, sensor vertical plane: 15°)
CRT (Certified Restart Timeout)	10 s
Guaranteed response time	Access detection: < 100 ms * Restart prevention: 10 s **WARNING! During the real-time validation and the download of the log file, the response time is not guaranteed.**
Total consumption	Max. 14 W (analysing unit and six sensors)
Electrical protections	Polarity inversion Overcurrent through resettable integrated fuse (max. 5 s @ 8 A)
Overvoltage category	II
Altitude	Max. 2000 m ASL
Air humidity	Max. 95%
Noise emission	Negligible**

Note*: the value depends on the Electromagnetic robustness level set through the PSEN rd1 configurator, see "Electromagnetic Robustness" on page 55.*

Note**:** *the A-weighted emission sound pressure level does not exceed 70 dB(A).*

12.1.2 Safety parameters

SIL (Safety Integrity Level)	2
HFT	0
SC*	2
TYPE	B
PL (Performance Level)	d
ESPE Type (EN 61496-1)	3
Category (EN ISO 13849)	3 for analysing units 2 for sensors
Communication protocol (sensors-analysing unit)	CAN complies with standard EN 50325-5
Mission time	20 years
$MTTF_D$	42 years
PFH_D- category 2	With Fieldbus communication: • Access detection: 4.63E-08 [1/h] • Restart prevention: 4.63E-08 [1/h] • Muting: 6.37E-09 [1/h] • Stop signal: 6.45E-09 [1/h] • Restart signal: 6.45E-09 [1/h] • Dynamic Configuration Switch: 6.37E-09 [1/h] • Fieldbus controlled: 6.45E-09 [1/h] Without Fieldbus communication: • Access detection: 4.53E-08 [1/h] • Restart prevention: 4.53E-08 [1/h] • Muting: 5.37E-09 [1/h] • Stop signal: 5.45E-09 [1/h] • Restart signal: 5.45E-09 [1/h] • Dynamic Configuration Switch: 5.37E-09 [1/h] • Fieldbus controlled: 5.45E-09 [1/h]
PFH_D - category 3	With Fieldbus communication: • Access detection: 9.02E-09 [1/h] • Restart prevention: 9.02E-09 [1/h] • Muting: 6.37E-09 [1/h] • Stop signal: 6.45E-09 [1/h] • Restart signal: 6.45E-09 [1/h] • Dynamic Configuration Switch: 6.37E09 [1/h] • Fieldbus controlled: 6.45E-09 [1/h] Without Fieldbus communication: • Access detection: 8.02E-09 [1/h] • Restart prevention: 8.02E-09 [1/h] • Muting: 5.37E-09 [1/h] • Stop signal: 5.45E-09 [1/h] • Restart signal: 5.45E-09 [1/h] • Dynamic Configuration Switch: 5.37E09 [1/h] • Fieldbus controlled: 5.45E-09 [1/h]
SFF	≥ 99.21%
DCavg	≥ 98.27%
MRT**	< 10 min
Safe state when a fault occurs	At least one channel for each safety output is in OFF-state. Stop message sent on Fieldbus (if available) or communication interrupted

Note*: the systematic capability is guaranteed only if the user uses the product according to the instructions of this manual and uses the product in the appropriate environment.*

Note***: the MRT considered is the Technical Mean Repair Time, i.e., it takes in consideration availability of skilled personnel, adequate tools and spare parts. Considering the type of device, the MRT corresponds to the time necessary for the device replacement.*

12.1.3 Ethernet connection (if available)

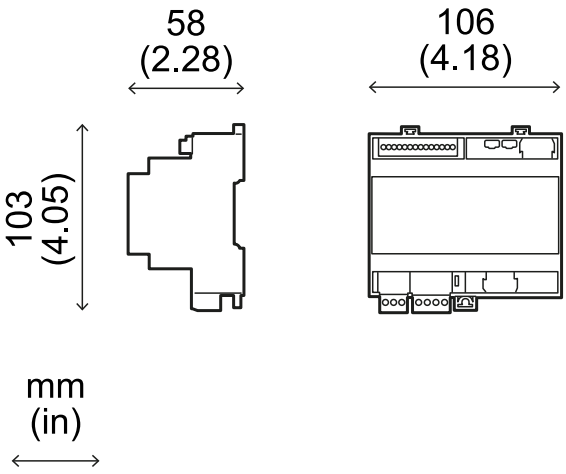
Default IP address	192.168.0.20
Default TCP port	80
Default netmask	255.255.255.0
Default gateway	192.168.0.1

12.1.4 Analysing unit features

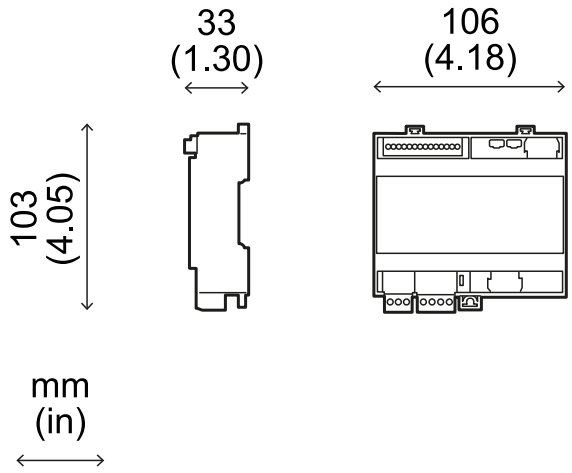
Outputs	Configurable as follows: • 4 Output Signal Switching Devices (OSSDs) (used as single channels) • 2 dual channel safety outputs • 1 dual channel safety output and 2 Output Signal Switching Devices (OSSDs)
OSSD characteristic	• Maximum resistive load: 100 KΩ • Minimum resistive load: 70 Ω • Maximum capacitive load: 1000 nF • Minimum capacitive load: 10 nF
Safety outputs	High-side outputs (with extended protection function) • Maximum current: 0.4 A • Maximum power: 11.2 W The OSSDs provide what follows: • ON-state: from Uv-1V to Uv (Uv = 24V +/- 4V) • OFF-state: from 0 V to 2.5 V r.m.s.
Inputs	Configurable as follows: • 4 single channel (cat. 2) type 3 digital inputs with common GND • 2 dual channel (cat. 3) type 3 digital inputs with common GND • 1 dual channel (cat. 3) and 2 single channels (cat. 2) type 3 digital inputs with common GND See "Voltage and current limits for digital inputs" on page 102.
Fieldbus interface (if available)	Ethernet based interface with different standard Fieldbus
Power supply	24 V DC (20–28 V DC) * Maximum current: 1 A
Consumption	Max. 5 W
Assembly	On DIN rail
Weight	For Type A: with cover: 170 g (6 oz) For Type B: with cover: 160 g (5.7 oz)
Degree of protection	IP20
Terminals	Section: 1 mm² (16 AWG) max. Maximum current: 4 A with 1 mm² cables (16 AWG)
Impact test	For Type A: 0.5 J, 0.25 kg ball from a 20 cm height For Type B: 1 J, 0.25 kg ball from a 40 cm height
Shock/Bump	For Type A: in accordance with IEC/EN 61496-1:2013 sec. 5.4.4.2 (IEC 60068-2-27) For Type B: in accordance with IEC/EN 61496-1:2020 sec. 5.4.4.2 class 5M3 (IEC 60068-2-27)
Vibration	For Type A: in accordance with IEC/EN 61496-1:2013 sec. 5.4.4.1 (IEC 60068-2-6) For Type B: in accordance with IEC/EN 61496-1:2020 sec. 5.4.4.1 class 5M3 (IEC 60068-2-6 and IEC 60068-2-64)
Pollution degree	2
Outdoor use	No
Operating temperature	From -30 to +60 °C (from -22 to +140 °F)
Storage temperature	From -40 to +80 °C (from -40 to +176 °F)

Note*: the unit shall be supplied by an isolated power source which complies with the standard IEC/EN 60204-1 and fulfils the requirements of:

- *Limited-Energy Circuit in accordance with IEC/UL/CSA 61010-1/ IEC/UL/CSA 61010-2-201 or*
- *Limited Power Source (LPS) in accordance with IEC/UL/CSA 60950-1 or*
- *(For North America and/or Canada only) a Class 2 supply source which complies with the National Electrical Code (NEC), NFPA 70, Clause 725.121 and Canadian Electrical Code (CEC), Part I, C22.1. (typical examples are a Class 2 transformer or a Class 2 power sources in compliance with, UL 5085-3/ CSA-C22.2 No. 66.3 or UL 1310/CSA-C22.2 No. 223).*



Type A

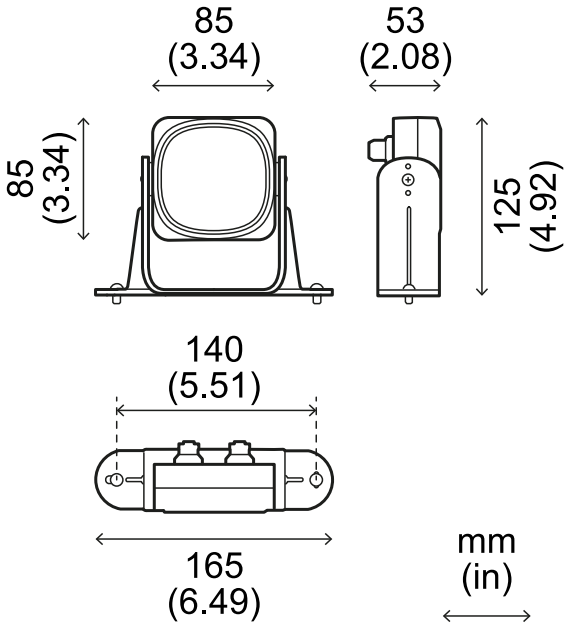


Type B

12.1.5 Sensor features

Connectors	2 5-pin M12 connectors (1 male and 1 female)
CAN bus termination resistance	120 Ω (not supplied, to be installed with a bus terminator)
Power supply	12 V DC ± 20%, through analysing unit
Consumption	Max. 1.5 W
Degree of protection	Type 3 enclosure, according to UL 50E, in addition to IP 67 rating
Material	Sensor: PA66 Bracket: PA66 and glass fiber (GF)
Weight	With bracket: 220 g (7.8 oz)
Impact test	5 J, 0.5 kg ball from a 100 cm height
Shock/Bump	In accordance with IEC/EN 61496-1:2013 sec. 5.4.4.2 (IEC 60068-2-27)
Vibration	In accordance with IEC/EN 61496-1:2013 sec. 5.4.4.1 (IEC 60068-2-6)
Pollution degree	4
Outdoor use	Yes
Operating temperature	From -30 to +60 °C (from -22 to +140 °F)*
Storage temperature	From -40 to +80 °C (from -40 to +176 °F)

Note*: in environmental conditions where the operating temperature can reach values higher than the supported range, install a cover to shield the sensor from sun rays.*

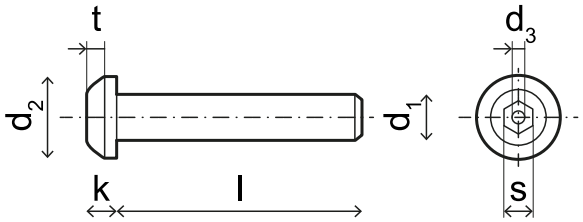


12.1.6 CAN bus cables recommended specifications

Section	2 x 0.34 mm² (22 AWG) power supply 2 x 0.22 mm² (24 AWG) data line
Type	Two twisted pairs (power supply and data) and one drain wire (or shield)
Connectors	5-pole M12 (see "Connectors M12 CAN bus" on page 102) Connectors shall be type 3 (raintight)
Impedance	120 Ω ±12 Ω (f = 1 MHz)
Shield	Shield with twisted wires in tin-plated copper. To be connected to ground circuit on the power supply terminal block of the analysing unit.
Standards	Cables shall be listed in accordance with application as described in the National Electrical Code, NFPA 70, and in the Canadian Electrical Code, C22.1. Maximum length of each line (from the analysing unit to the last sensor): 30 m (98.4 ft)

12.1.7 Side screw specifications

Pin Hex button head security screw



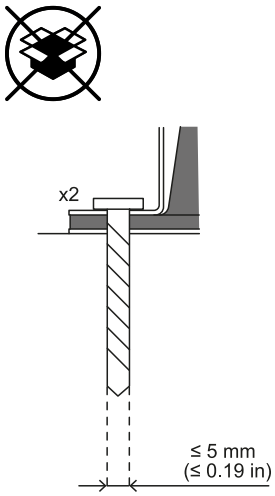
d_1	M4
l	10 mm (0.39 in)
d_2	7.6 mm (0.30 in)
k	2.2 mm (0.09 in)
t	min 1.3 mm (0.05 in)
s	2.5 mm (0.10 in)
d_3	max. 1.1 mm (0.04 in)

12.1.8 Bottom screws specifications

The bottom screws can be:

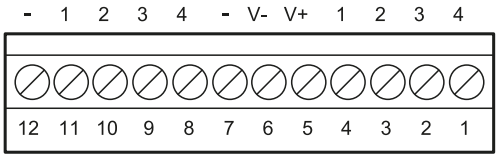
- cheese head
- button head

***Note**: avoid using countersunk head screws.*



12.2 Terminal blocks and connector pin-outs

12.2.1 Digital inputs and outputs terminal block



***Note**: facing the analysing unit so that the terminal block is on the top left, number 12 is the closest to the analysing unit corner.*

Terminal block	Symbol	Description	Pin
Digital In	**4**	Input 2, Channel 2, 24 V DC type 3 - INPUT #2-2	1
	3	Input 2, Channel 1, 24 V DC type 3 - INPUT #2-1	2
	2	Input 1, Channel 2, 24 V DC type 3 - INPUT #1-2	3
	1	Input 1, Channel 1, 24 V DC type 3 - INPUT #1-1	4
	V+	V+ (SNS), 24 V DC for diagnostics of the digital inputs (mandatory if at least one input is used)	5
	V-	V- (SNS), common reference for all digital inputs (mandatory if at least one input is used)	6
Digital Out	**-**	GND, common reference for all digital outputs	7
	4	Output 4 (OSSD4)	8
	3	Output 3 (OSSD3)	9
	2	Output 2 (OSSD2)	10
	1	Output 1 (OSSD1)	11
	-	GND, common reference for all digital outputs	12

***Note**: the cables used must have a maximum length of 25 m (82 ft) and the maximum operating temperature must be at least 80 °C.*

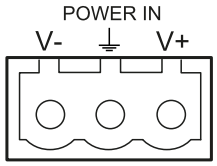
***Note**: use only copper wires with a minimum gauge of 18 AWG and a torque of 0.62 Nm (5.5 lbs in).*

12.2.2 Voltage and current limits for digital inputs

The digital inputs (input voltage 24 V DC) adhere to the following voltage and current limits, in accordance with standard IEC/EN 61131-2:2003.

	Type 3
Voltage limits	
0	from - 3 to 11 V
1	from 11 to 30 V
Current limits	
0	15 mA
1	from 2 to 15 mA

12.2.3 Power supply terminal block



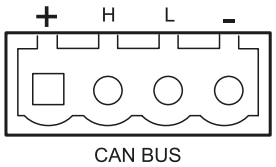
***Note**: connector front view.*

Symbol	Description
V-	GND
⏚	Earth
V+	+ 24 V DC

***Note**: the maximum operating temperature of the cables must be at least 70 °C.*

***Note**: use only copper wires with a minimum gauge of 18 AWG and a torque of 0.62 Nm (5.5 lbs in).*

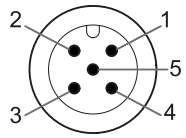
12.2.4 CAN bus terminal block



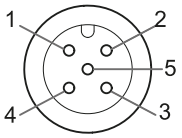
Symbol	Description
+	+ 12 V DC output
H	CAN H
L	CAN L
-	GND

***Note**: the maximum operating temperature of the cables must be at least 70 °C.*

12.2.5 Connectors M12 CAN bus



Male connector

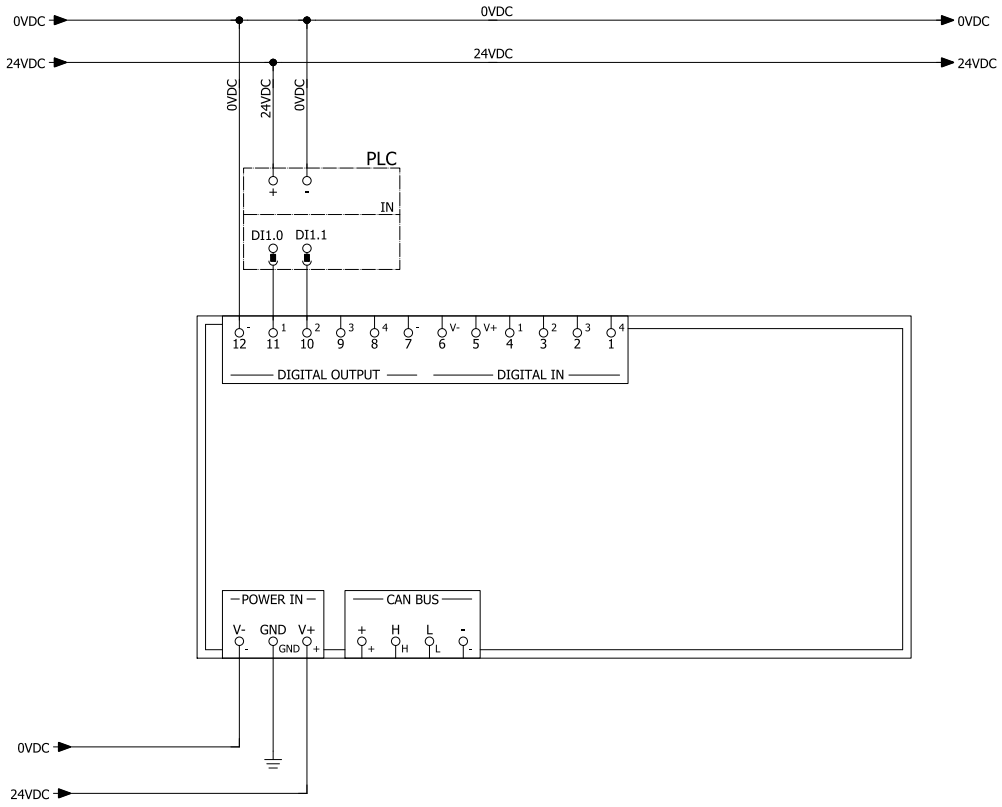


Female connector

Pin	Function
1	Shield to be connected to the functional earth on the power supply terminal block of the analysing unit.
2	+12 V dc
3	GND
4	CAN H
5	CAN L

12.3 Electrical connections

12.3.1 Connection of safety outputs to the Programmable Logic Controller



***Note**: for the connection to input to PNOZmulti or PSSu2 systems, activate in the corresponding function block the suppression of the test pulses.*

Digital I/O settings (through the PSEN rd1 configurator)

Digital input #1 Not configured

Digital input #2 Not configured

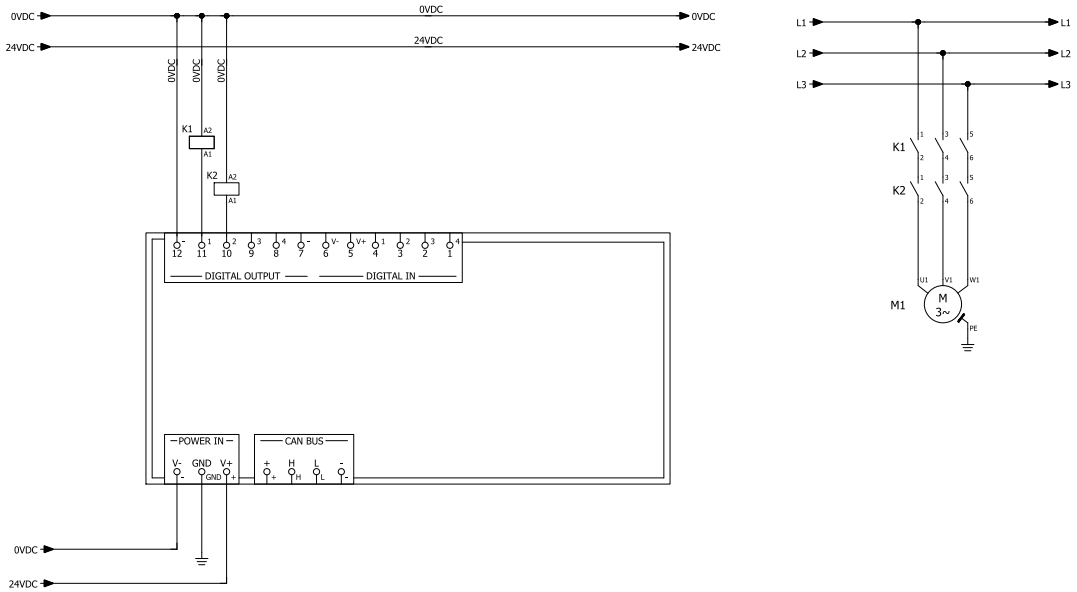
Digital output #1 Detection signal 1

Digital output #2 Detection signal 1

Digital output #3 Not configured

Digital output #4 Not configured

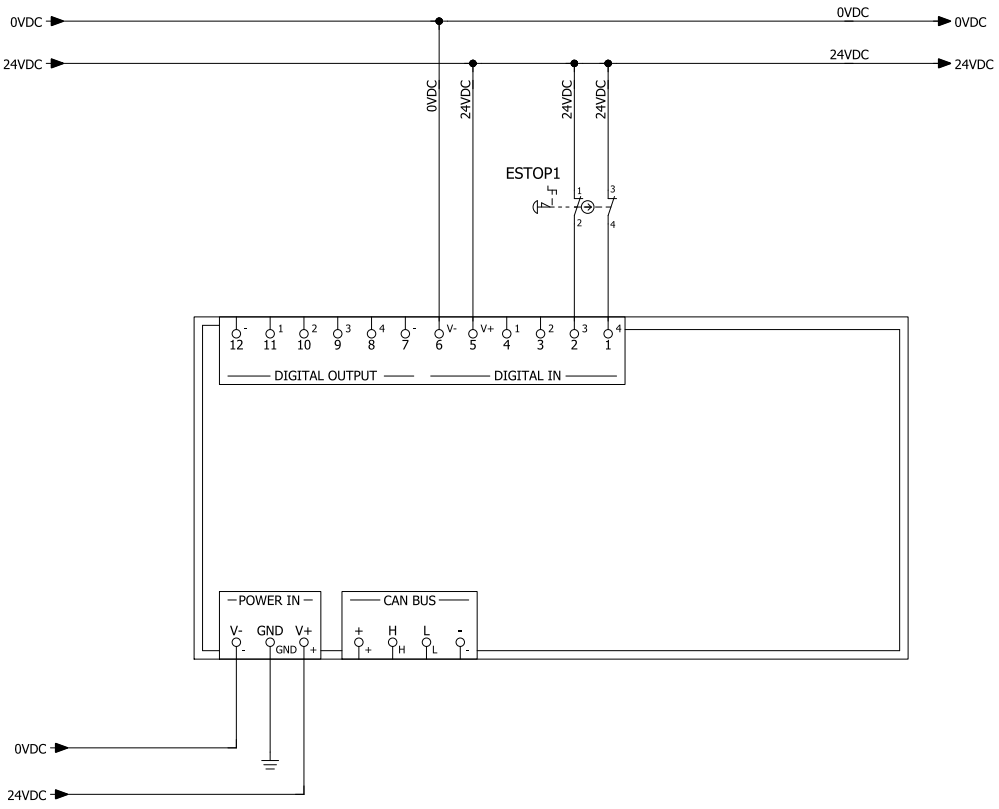
12.3.2 Connection of safety outputs to an external safety relay



Digital I/O settings (through the PSEN rd1 configurator)

Digital input #1 Not configured
Digital input #2 Not configured
Digital output #1 Detection signal 1
Digital output #2 Detection signal 1
Digital output #3 Not configured
Digital output #4 Not configured

12.3.3 Connection of stop signal (Emergency button)



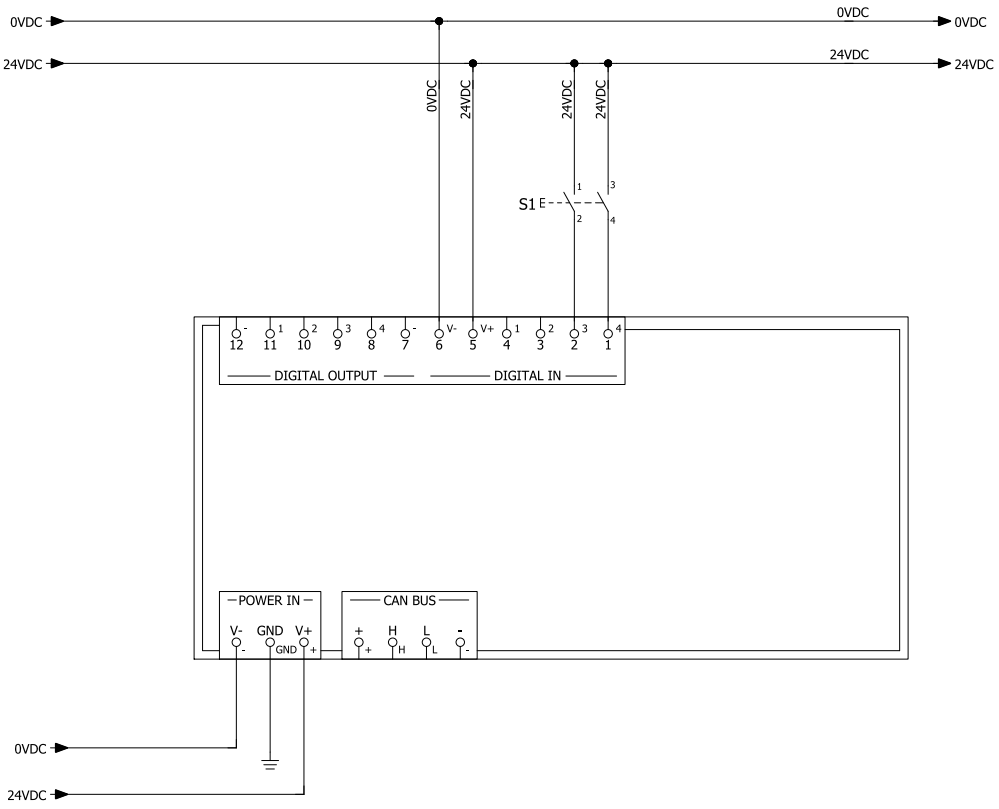
***Note**: the indicated emergency button opens the contact when pressed.*

***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

Digital I/O settings (through the PSEN rd1 configurator)

Digital input #1 Not configured
Digital input #2 Stop signal
Digital output #1 Not configured
Digital output #2 Not configured
Digital output #3 Not configured
Digital output #4 Not configured

12.3.4 Connection of restart signal (dual channel)



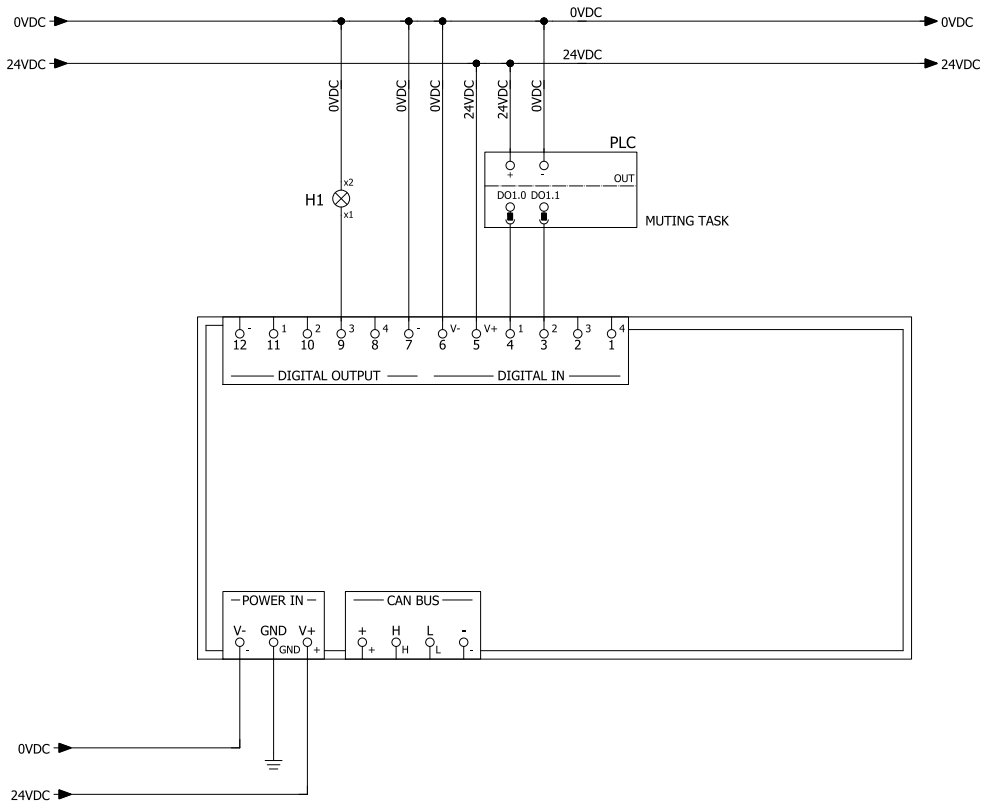
***Note**: the button indicated for the restart signal closes the contact when pressed.*

***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

Digital I/O settings (through the PSEN rd1 configurator)

Digital input #1 Not configured
Digital input #2 Restart signal
Digital output #1 Not configured
Digital output #2 Not configured
Digital output #3 Not configured
Digital output #4 Not configured

12.3.5 Connection of the muting input and output (one group of sensors)

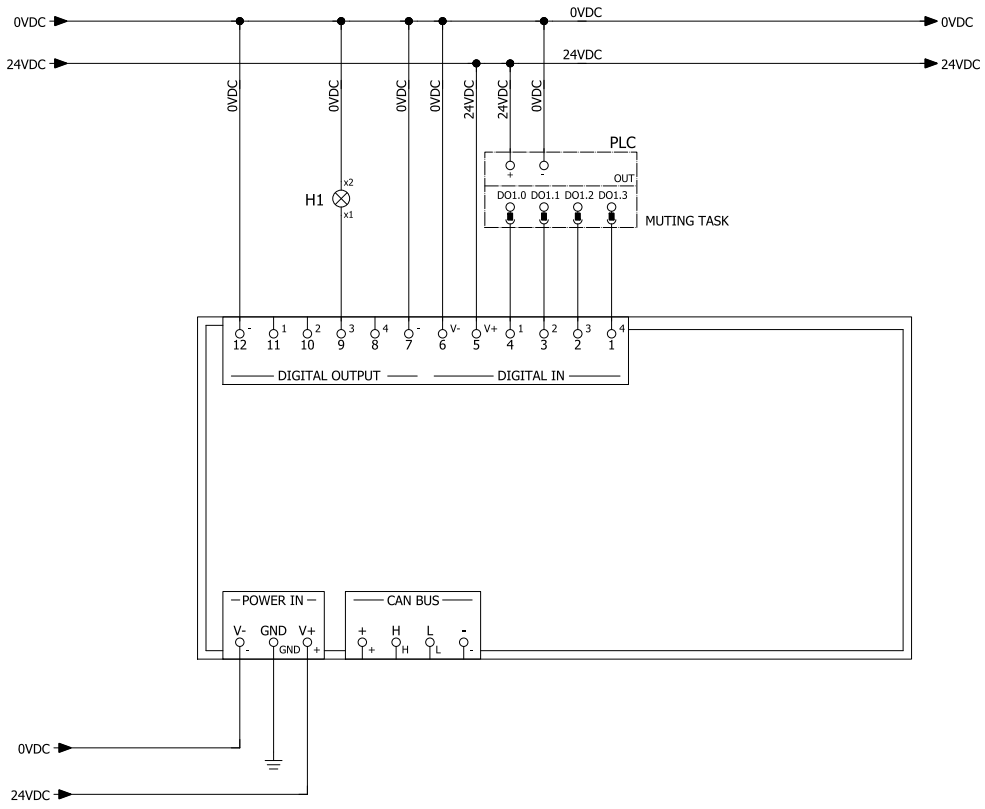


***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

Digital I/O settings (through the PSEN rd1 configurator)

Digital input #1 Muting group 1
Digital input #2 Not configured
Digital output #1 Not configured
Digital output #2 Not configured
Digital output #3 Muting enable feedback signal
Digital output #4 Not configured

12.3.6 Connection of the muting input and output (two groups of sensors)

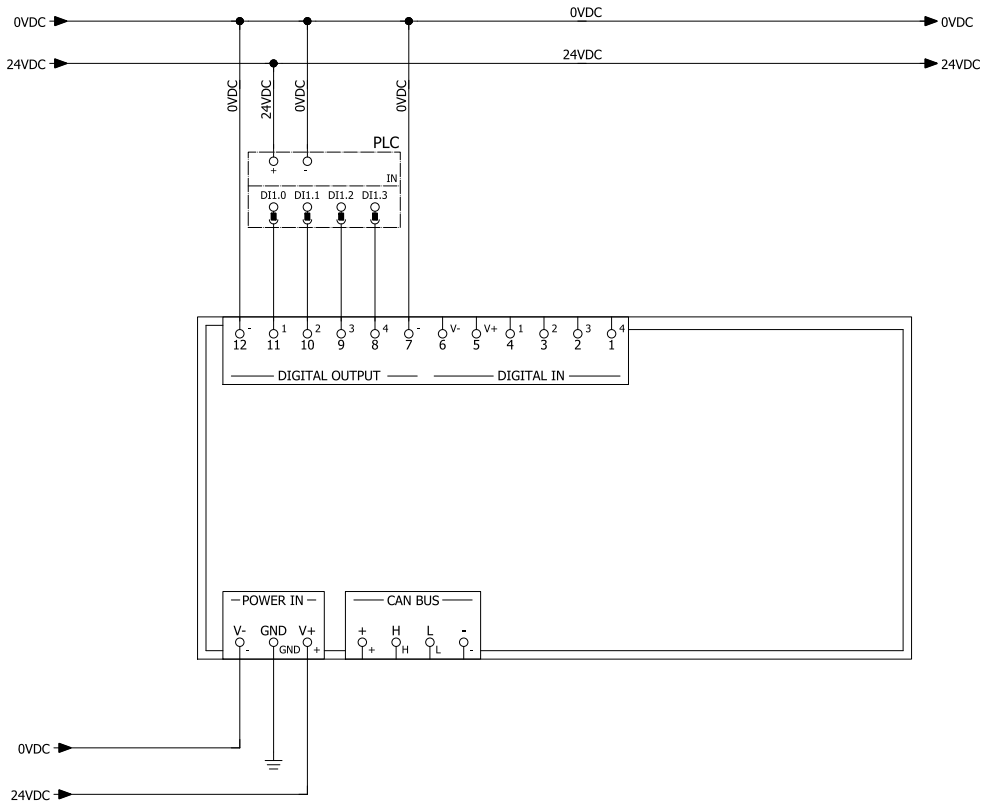


***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

Digital I/O settings (through the PSEN rd1 configurator)

Digital input #1 Muting group 1
Digital input #2 Muting group 2
Digital output #1 Not configured
Digital output #2 Not configured
Digital output #3 Muting enable feedback signal
Digital output #4 Not configured

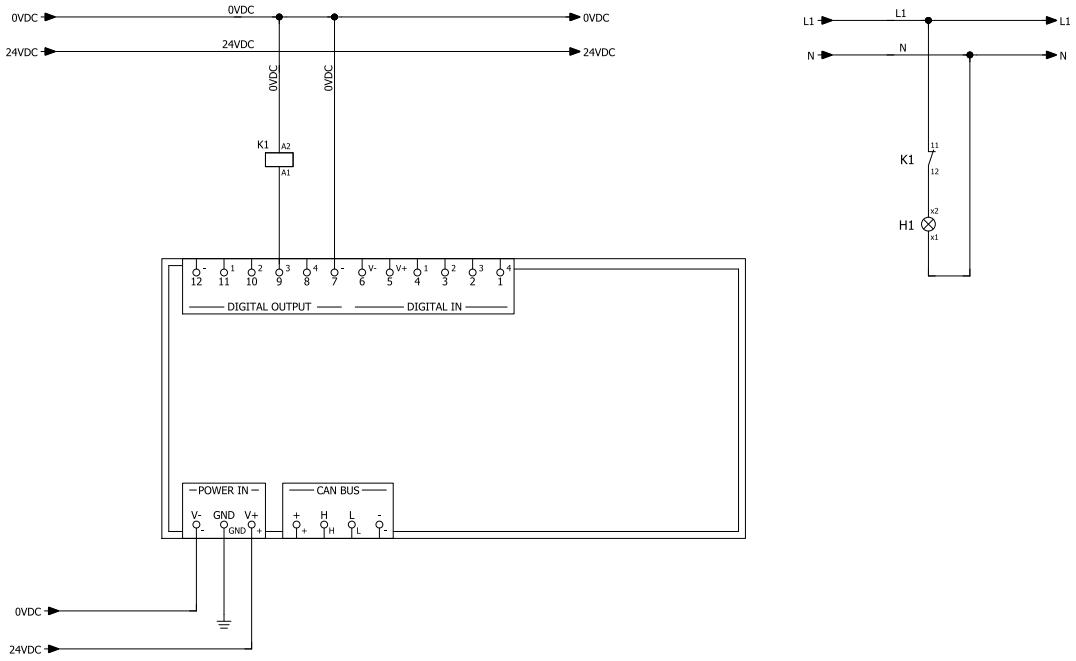
12.3.7 Detection signal 1 and 2 connection



Digital I/O settings (through the PSEN rd1 configurator)

Digital input #1 Not configured
Digital input #2 Not configured
Digital output #1 Detection signal 1
Digital output #2 Detection signal 1
Digital output #3 Detection signal 2
Digital output #4 Detection signal 2

12.3.8 Diagnostic output connection

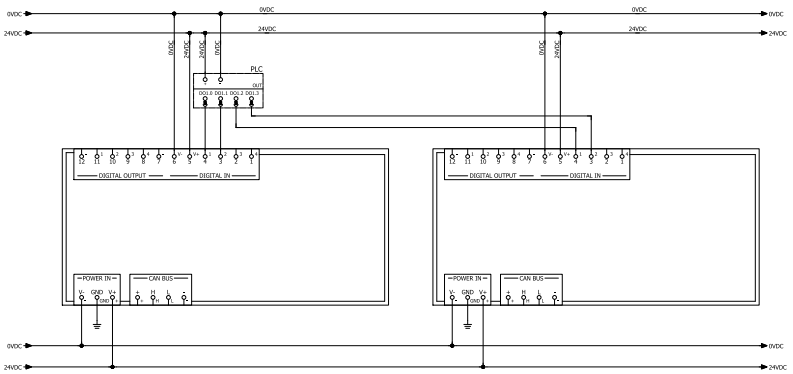


***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

Digital I/O settings (through the PSEN rd1 configurator)

Digital input #1 Not configured
Digital input #2 Not configured
Digital output #1 Not configured
Digital output #2 Not configured
Digital output #3 System diagnostic signal
Digital output #4 Not configured

12.3.9 Multi-analysing unit Synchronization



***Note**: only if the PSEN rd1 configurator supports the function.*

Digital I/O settings (through the PSEN rd1 configurator)

Analysing unit #1

- Analysing unit channel 0
- Digital input #1 Acquisition Trigger

Analysing unit #2

- Analysing unit channel 1
- Digital input #1 Acquisition Trigger

12.4 Configuration configurator parameters

12.4.1 Parameter list

Parameter	Min	Max	Default value
Settings > Account			
Password	-	-	Not available
Settings > General			
System	PSEN rd1.1 systems, PSEN rd1.2 systems		PSEN rd1.1 systems
Operational frequency	Full BW, Restricted BW		Full BW
Configuration			
Number of installed sensors	1	6	1
Plane	Dim. X: 1000 mm Dim. Y: 1000 mm	Dim. X: 20000 mm Dim. Y: 65000 mm	Dim. X: 8000 mm Dim. Y: 4000 mm
Position (for each sensor)	X: 0 mm Y: 0 mm	X: 65000 mm Y: 65000 mm	X: 1000 mm Y: 1000 mm
Rotation 1 (for each sensor)	0°, 90°, 180°, 270°		0°

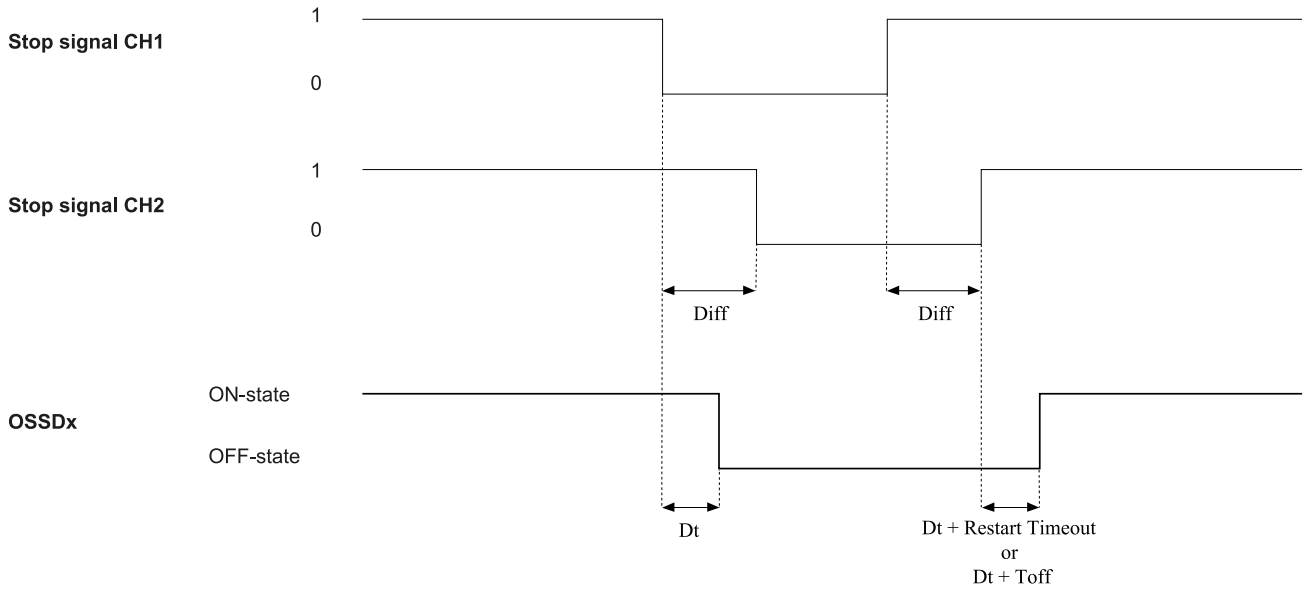
Parameter	Min	Max	Default value
Rotation 2 (for each sensor)	0°	359°	0°
Rotation 3 (for each sensor)	-90°	90°	0°
Sensor installation height (for each sensor)	0 mm	10000 mm	0 mm
Detection Distance 1 (for each sensor)	0 mm	4000 mm	1000 mm
Detection Distance 2 (for each sensor)	0 mm	3000 mm	0 mm
Horizontal angular coverage (for each sensor)	110°, 50°		110°
Safety working mode (for each detection field of each sensor)	Access detection and restart prevention, Always-on access detection, Always-on restart prevention		Access detection and restart prevention
Restart timeout (for each detection field of each sensor)	0 ms	60000 ms	10000 ms
T_{OFF}	100 ms	60000 ms	100 ms
Settings > Advanced			
Detection field dependency	Enabled, Disabled		Enabled
Electromagnetic robustness	Standard, High, Very High		Standard
Access sensitivity	Normal, High, Very High		Normal
Restart sensitivity	Normal, High, Very High		Normal
			Disabled
Settings > Advanced > Multi-analysing unit synchronization			
Analysing unit channel	0	3	0
Settings > Anti-tampering			
Anti-masking sensitivity (for each sensor)	Disabled, Low, Medium, High		High
Anti-rotation around axes (for each sensor)	Disabled, Enabled		Disabled
Settings > Digital Input-Output			
Digital input (for each input)	Not configured, Stop signal, Restart signal, Muting group “N”, Dynamic configuration switch, Fieldbus controlled, System recondition, Restart signal + System recondition, Single channel (Category 2), Acquisition Trigger		Not configured
Digital input channel (for each channel of each input)	Not configured, Restart signal, Fieldbus controlled, System recondition		Digital input channel (for each channel of each input)
Redundancy mode	Coherent, Inverted		Coherent
Encoded channel	Enabled, Disabled ***Note**: available only when both the digital inputs are configured as Dynamic configuration switch*		Disabled
Digital output (for each output)	Not configured, System diagnostic signal, Muting enable feedback signal, Fieldbus controlled, Restart feedback signal, Detection signal 1, Detection signal 2, Acquisition Trigger		Not configured
OSSD Pulse width	Short (300 µs), Long (2 ms)		Short (300 µs)
Short-circuit/Open circuit diagnostics	Enabled, Disabled	Disabled	Short-circuit/Open circuit diagnostics
Settings > Muting			
Group for muting (for each sensor)	None, Group 1, Group 2, both		Group 1

Parameter	Min	Max	Default value
Pulse width (for each Input TYPE)	0 µs (= Period and Phase shift disabled) 200 µs	2000 µs	0 µs
Period (for each Input TYPE)	200 ms	2000 ms	200 ms
Phase shift (for each Input TYPE)	0.4 ms	1000 ms	0.4 ms
Settings > Restart function			
Detection field 1, 2, 3, 4	Automatic, Manual, Safe manual		Automatic
Settings > Activity History			
Log verbosity level	0	5	0
Admin > Network Parameters			
IP Address	-		192.168.0.20
Netmask	-		255.255.255.0
Gateway	-		192.168.0.1
TCP port	1	65534	80
Admin > Fieldbus Parameters			
PROFINET/PROFIsafe			
System configuration and status PS2v6	1	65535	145
Sensors information PS2v6	1	65535	147
Sensor 1 detection status PS2v6	1	65535	149
Sensor 2 detection status PS2v6	1	65535	151
Sensor 3 detection status PS2v6	1	65535	153
Sensor 4 detection status PS2v6	1	65535	155
Sensor 5 detection status PS2v6	1	65535	157
Sensor 6 detection status PS2v6	1	65535	159
System configuration and status PS2v4	1	65535	146
Sensors information PS2v4	1	65535	148
Sensor 1 detection status PS2v4	1	65535	150
Sensor 2 detection status PS2v4	1	65535	152
Sensor 3 detection status PS2v4	1	65535	154
Sensor 4 detection status PS2v4	1	65535	156
Sensor 5 detection status PS2v4	1	65535	158
Sensor 6 detection status PS2v4	1	65535	160
Fieldbus endianness	Big Endian, Little Endian		Big Endian
FSoE			
FSoE Safe Address	1	65535	145
Admin > MODBUS Parameters			
MODBUS Enable	Enabled, Disabled		Enabled
Listening port	1	65534	502
Admin > Modbus labels			
Analysing unit	-		-
Sensor 1	-		-
Sensor 2	-		-
Sensor 3	-		-
Sensor 4	-		-
Sensor 5	-		-
Sensor 6	-		-
Admin > Users management			
User name	-		-

Parameter	Min	Max	Default value
Role	Administator, Engineer, Limited service, Viewer, Service		Viewer
Admin > SD Card			
Automatic backup creation	Enabled, Disabled		Disabled
Users data included	Enabled, Disabled		Disabled
Enable restore by button	Enabled, Disabled		Enabled

12.5 Digital input signals

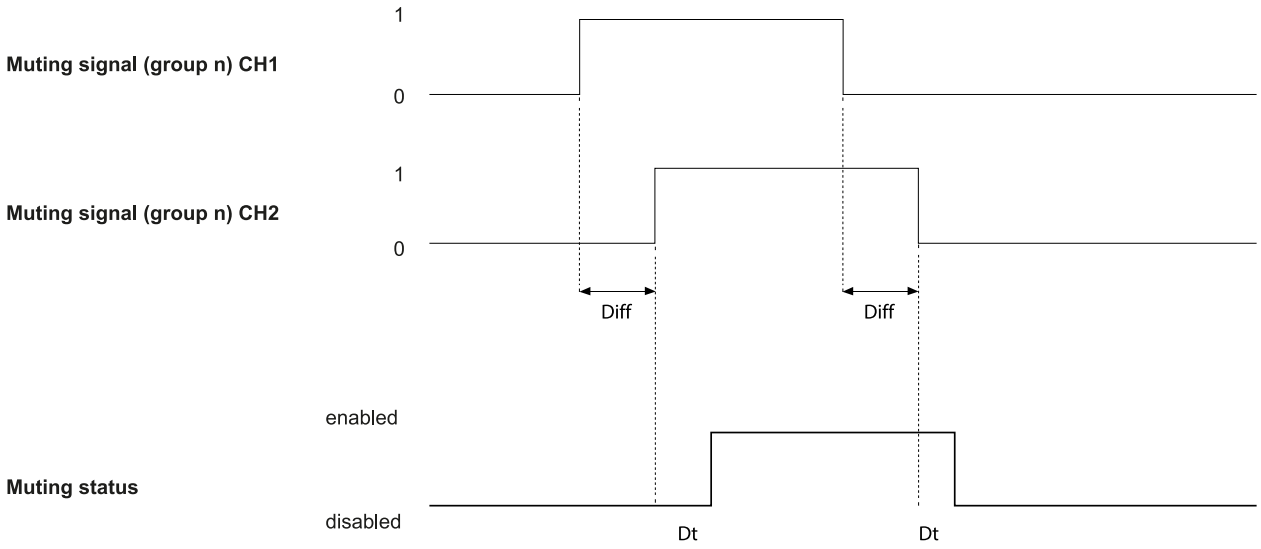
12.5.1 Stop signal



Part	Description
OSSDx: **Detection signal "N"/Detection signal group "N"**	Detection signal outputs deactivate on the falling edge of at least one of the two input channels of the input signal. They remain in OFF-state as long as one of the two input channels remains to the low logic status (0).
Stop signal CH1 **Stop signal CH2**	Interchangeable channel. As soon as one channel goes to the low logic level (0), Detection signal 1 and Detection signal 2 are set to OFF-state.
Diff	Less than 50 ms. If the value is greater than 50 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Dt	Activation delay. If the Stop signal debounce filter is disabled, less than 5 ms. If the Stop signal debounce filter is enabled, less than 50 ms.

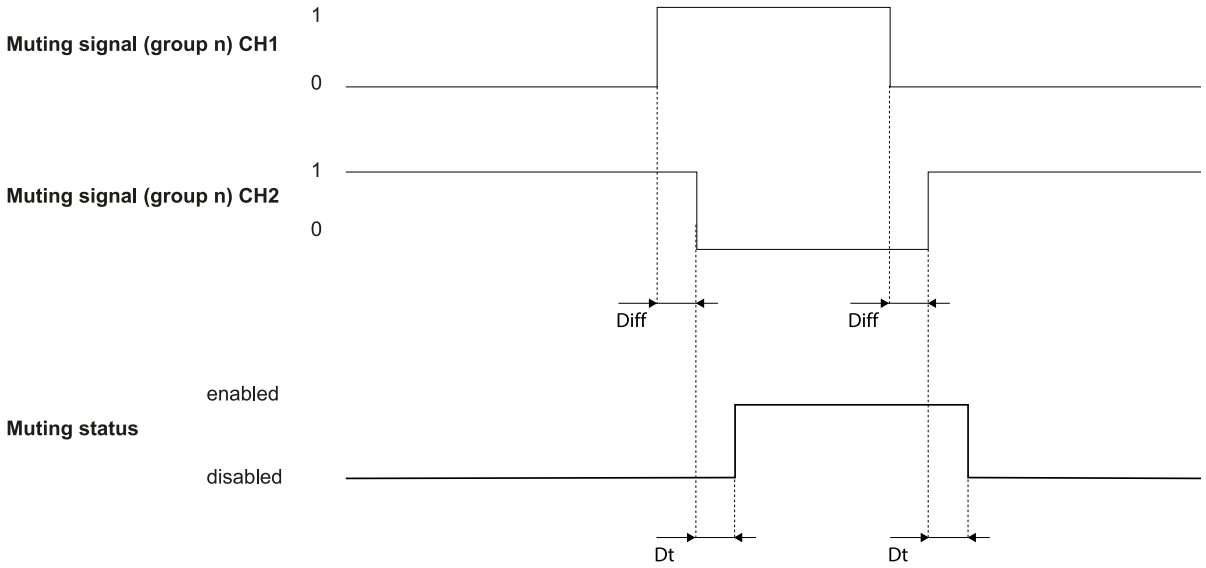
12.5.2 Muting (with/without pulse)

Without pulse (redundancy mode coherent)



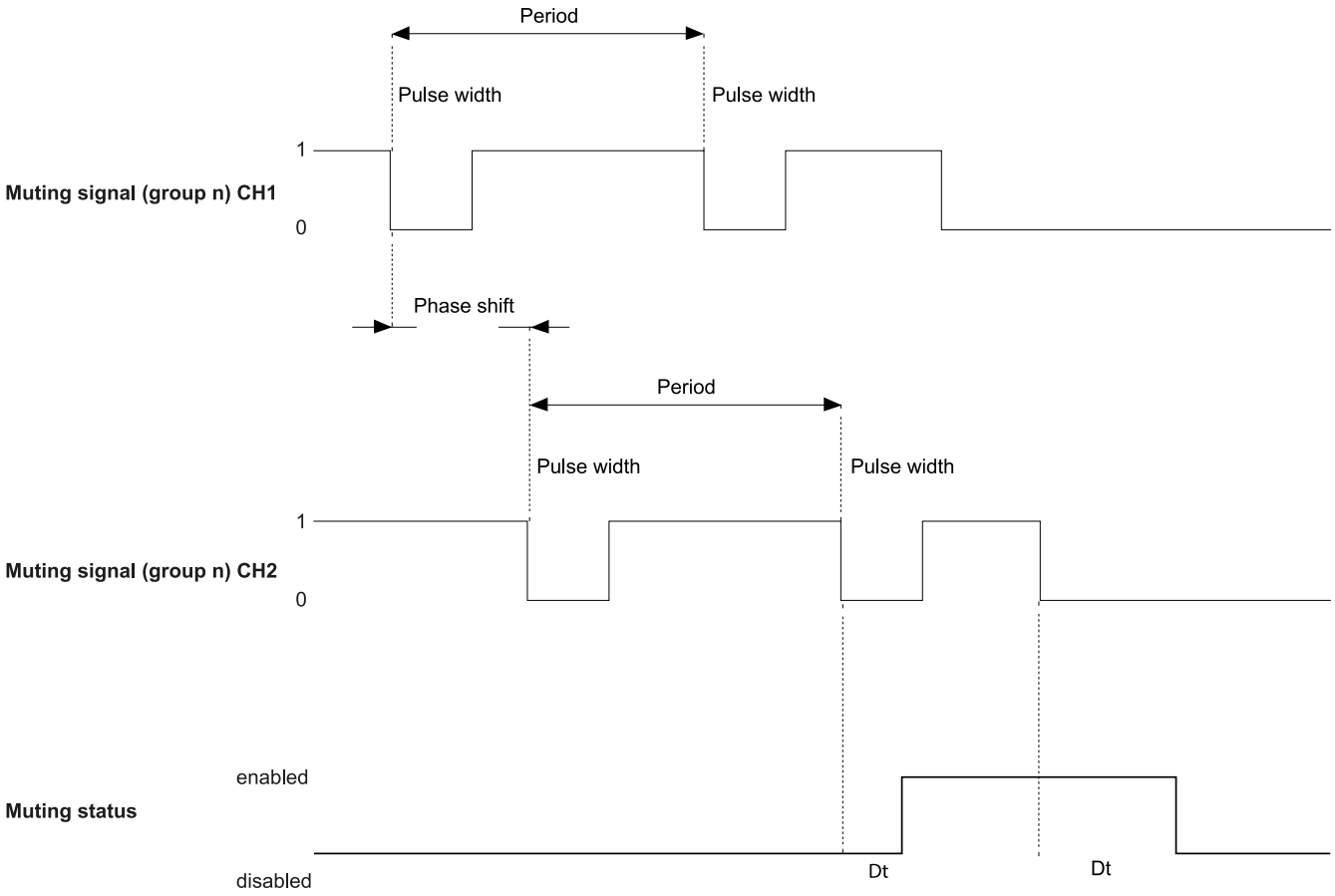
Part	Description
Diff	Less than 100 ms. If the value is greater than 100 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Muting signal (group *n*) CH 1 **Muting signal (group *n*) CH 2**	Interchangeable channel.
Muting status	They are enabled as long as both channels are at a high logic level (1) and deactivated when both channels go to a low logic level (0).
Dt	Activation/deactivation delay. Less than 50 ms.

Without pulse (redundancy mode inverted)



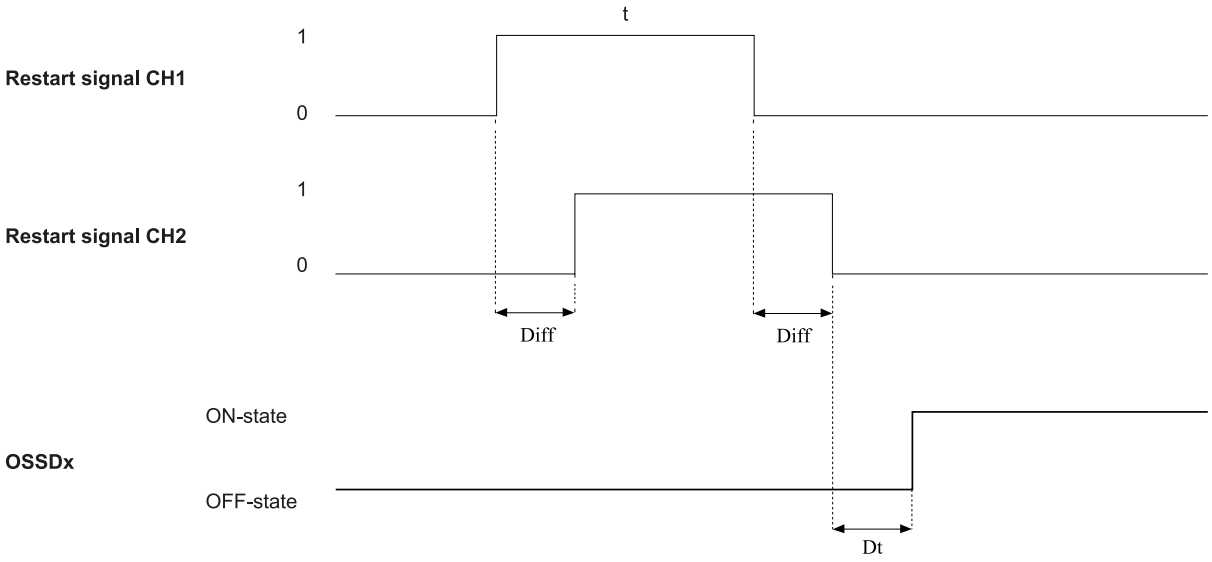
Part	Description
Diff	Less than 100 ms. If the value is greater than 100 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Muting status	They are enabled as long as channel 1 of the Muting signal is at a high logic level (1) and channel 2 is at a low logic level (0). Disabled as long as channel 1 is at a low logic level (0) and channel 2 is at a high logic level (1).
Dt	Activation/deactivation delay. Less than 50 ms.

With pulse



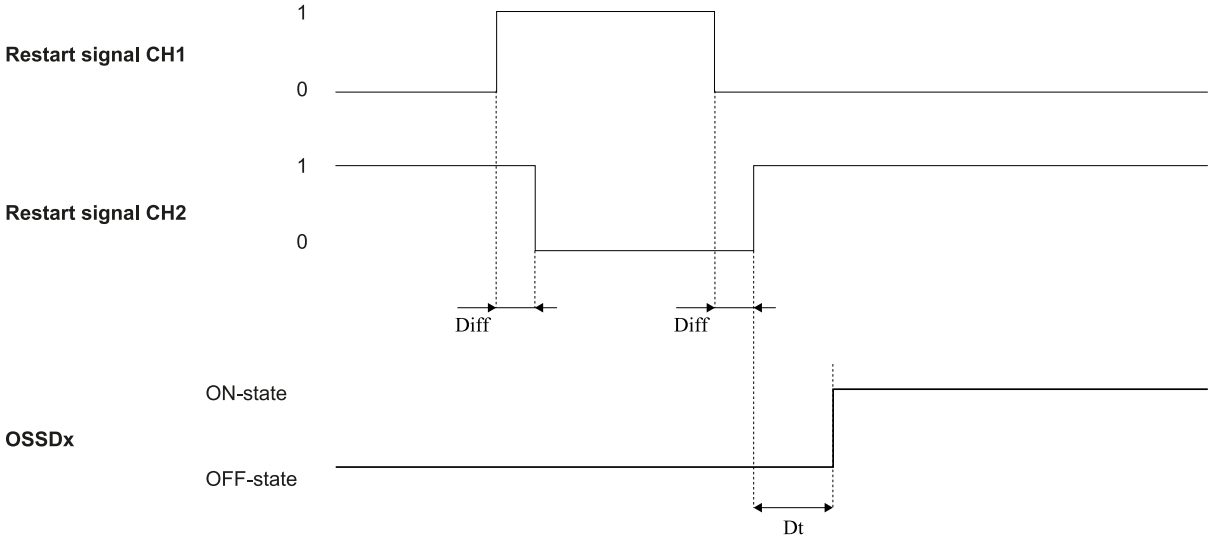
Part	Description
Diff	Less than 100 ms. If the value is greater than 100 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Muting signal (group *n*) CH 1 **Muting signal (group *n*) CH 2**	Interchangeable channel.
Muting status	They are enabled as long as both the input signals follow the configured muting parameters (pulse width, period, and phase shift).
Dt	Activation/deactivation delay. Less than three times the period.

12.5.3 Restart signal (dual channel, redundancy mode coherent)



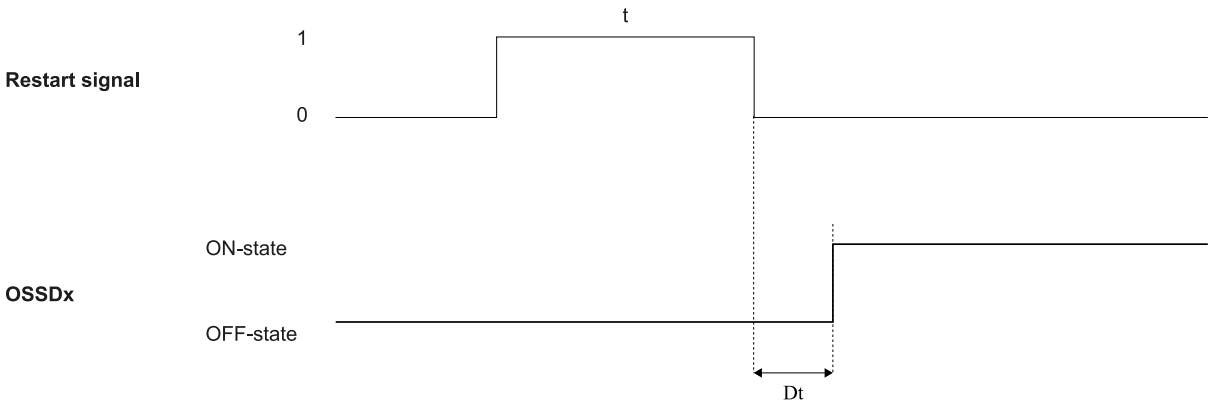
Part	Description
OSSDx: **Detection signal "N"/Detection signal group "N"**	Detection signal outputs go to ON-state as soon as the last channel has correctly completed the transition 0 -> 1 -> 0.
Restart signal CH1 **Restart signal CH2**	Interchangeable channel. Both channels of Restart signal must have a transition of logical level 0 -> 1 ->0. The time they stay at a high logical level (t) must be at least 200 ms and less than 5 s.
Dt	Activation delay. Less than 50 ms.
Diff	Less than 100 ms. If the value is greater than 100 ms, the system maintains the outputs deactivated.

12.5.4 Restart signal (dual channel, redundancy mode inverted)



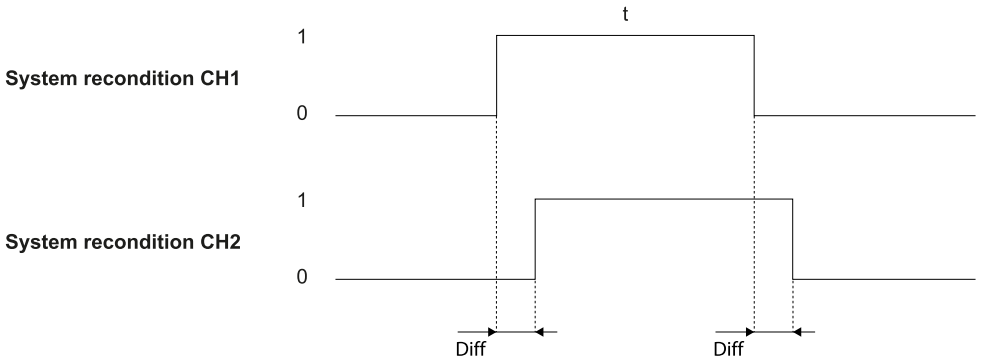
Part	Description
OSSDx: **Detection signal "N"/Detection signal group "N"**	Detection signal outputs go to ON-state as soon as the last channel has correctly completed the transition.
Restart signal CH1 **Restart signal CH2**	Channel 1 of the Restart signal must have a transition of logical level 0 -> 1 -> 0. Channel 2 of Restart signal must have a transition of logical level 1 -> 0 -> 1. The time Channel 1 stays at a high logical level and the time Channel 2 stays at a low logical level (t) must be at least 200 ms and less than 5 s.
Dt	Activation delay. Less than 50 ms.
Diff	Less than 100 ms. If the value is greater than 100 ms, the system maintains the outputs deactivated.

12.5.5 Restart signal (single channel)



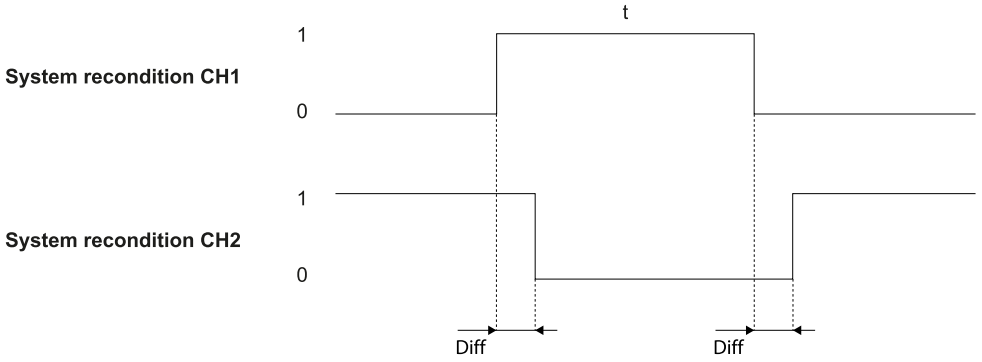
Part	Description
OSSDx: **Detection signal "N"/Detection signal group "N"**	Detection signal outputs go to ON-state as soon as the Restart signal has correctly completed the transition 0 -> 1 -> 0.
Restart signal	The channel must have a transition of logical level 0 -> 1 ->0. The time they stay at a high logical level (t) must be at least 200 ms and less than 5 s.
Dt	Activation delay. Less than 50 ms.

12.5.6 System recondition (dual channel, redundancy mode coherent)



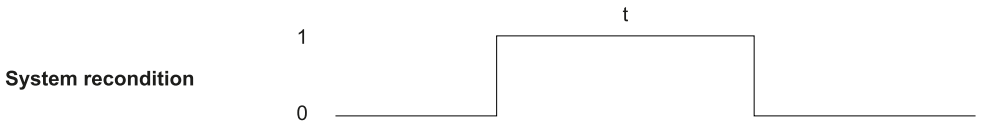
Part	Description
System recondition CH1 **System recondition CH2**	Interchangeable channel. Both channels of System recondition must have a transition of logical level 0 -> 1 ->0. They must stay at a high logical level (t) for at least 10 s and less than 30 s.
Diff	Less than 100 ms. If the value is greater than 100 ms, the system maintains the outputs deactivated.

12.5.7 System recondition (dual channel, redundancy mode inverted)



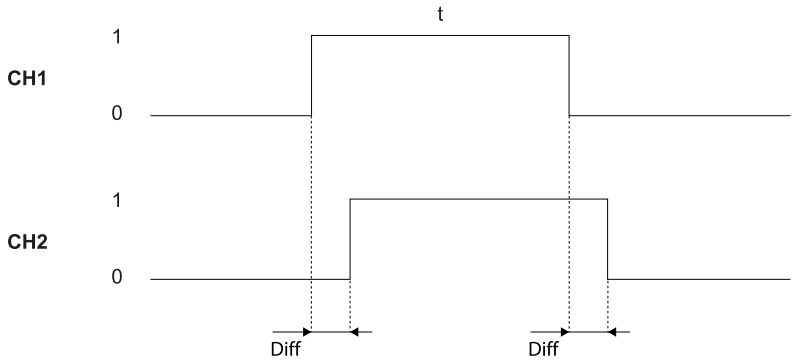
Part	Description
System recondition CH1 **System recondition CH2**	Channel 1 of System recondition must have a transition of logical level 0 -> 1 -> 0. Channel 2 of System recondition must have a transition of logical level 1 -> 0 -> 1. The time Channel 1 stays at a high logical level and the time Channel 2 stays at a low logical level (t) for at least 10 s and less than 30 s.
Diff	Less than 100 ms. If the value is greater than 100 ms, the system maintains the outputs deactivated.

12.5.8 System recondition (single channel)



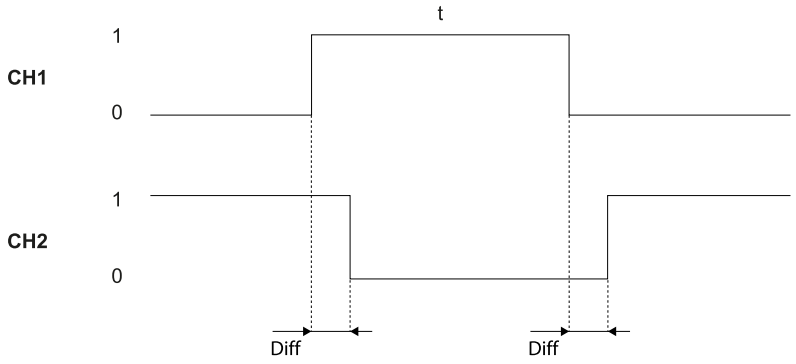
Part	Description
System recondition	The channel must have a transition of logical level 0 -> 1 ->0. The time it stays at a high logical level (t) must be at least 10 s and less than 30 s.

12.5.9 Restart signal + System recondition (dual channel, redundancy mode coherent)



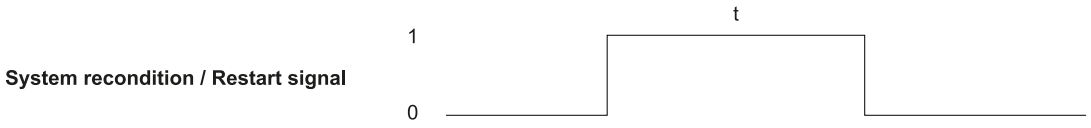
Part	Description
CH1 **CH2** **(Restart signal)**	Interchangeable channel. Both channels must have a transition of logical level 0 -> 1 ->0. The time they stay at a high logical level (t) must be at least 200 ms and less than 5 s. For details about the behavior of Detection signal 1 and 2 outputs and the deactivation delay, see "Restart signal (dual channel, redundancy mode coherent)" on page 117.
CH1 **CH2** **(System recondition)**	Interchangeable channel. Both channels must have a transition of logical level 0 -> 1 ->0. They must stay at a high logical level (t) for at least 10 s and less than 30 s.
Diff	Less than 100 ms. If the value is greater than 100 ms, the system maintains the outputs deactivated.

12.5.10 Restart signal + System recondition (dual channel, redundancy mode inverted)



Part	Description
CH1 **CH2** **(Restart signal)**	Channel 1 of the Restart signal must have a transition of logical level 0 -> 1 -> 0. Channel 2 of Restart signal must have a transition of logical level 1 -> 0 -> 1. The time Channel 1 stays at a high logical level and the time Channel 2 stays at a low logical level (t) must be at least 200 ms and less than 5 s. For details about the behavior of Detection signal 1 and 2 outputs and the deactivation delay, see "Restart signal (dual channel, redundancy mode inverted)" on page 118.
CH1 **CH2** **(System recondition)**	Channel 1 of System recondition must have a transition of logical level 0 -> 1 -> 0. Channel 2 of System recondition must have a transition of logical level 1 -> 0 -> 1. The time Channel 1 stays at a high logical level and the time Channel 2 stays at a low logical level (t) for at least 10 s and less than 30 s.
Diff	Less than 100 ms. If the value is greater than 100 ms, the system maintains the outputs deactivated.

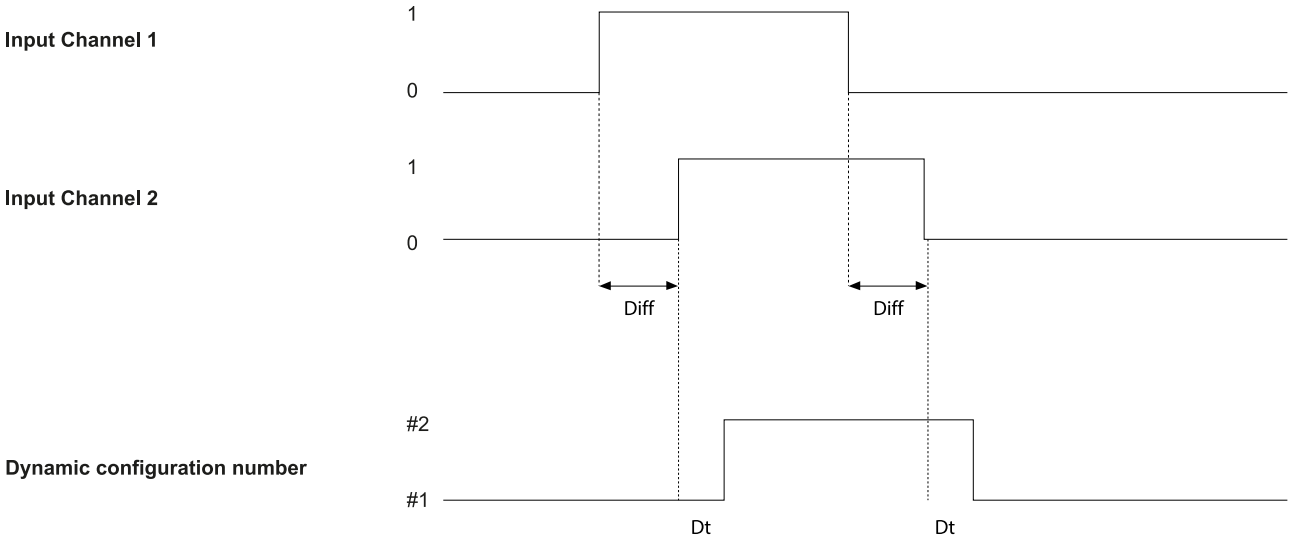
12.5.11 Restart signal + System recondition (single channel)



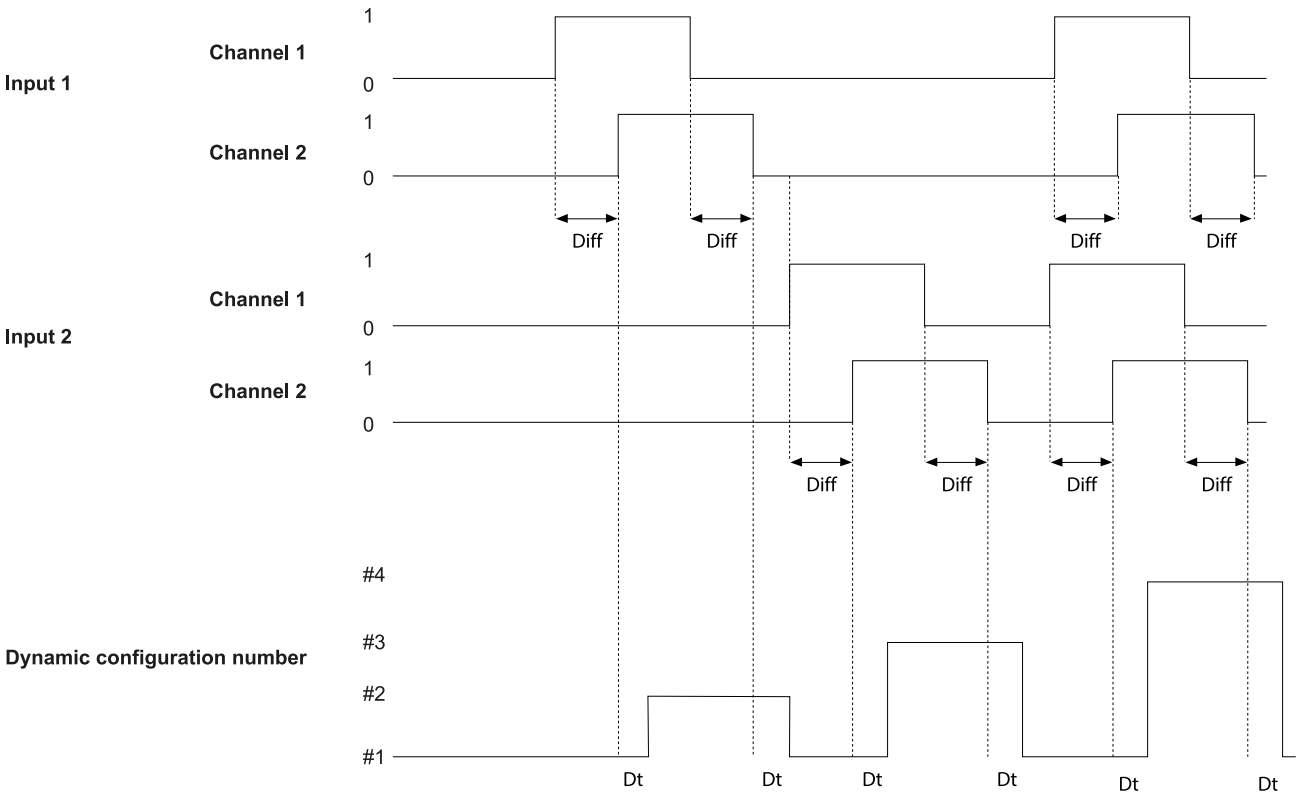
Part	Description
Restart signal	The channel must have a transition of logical level 0 -> 1 ->0. The time it stays at a high logical level (t) must be at least 200 ms and less than 5 s. For details about the behavior of Detection signal 1 and 2 outputs and the deactivation delay, see "Restart signal (single channel)" on page 118.
System recondition	The channel must have a transition of logical level 0 -> 1 ->0. The time it stays at a high logical level (t) must be at least 10 s and less than 30 s.

12.5.12 Dynamic configuration switch (redundancy mode coherent)

With one input



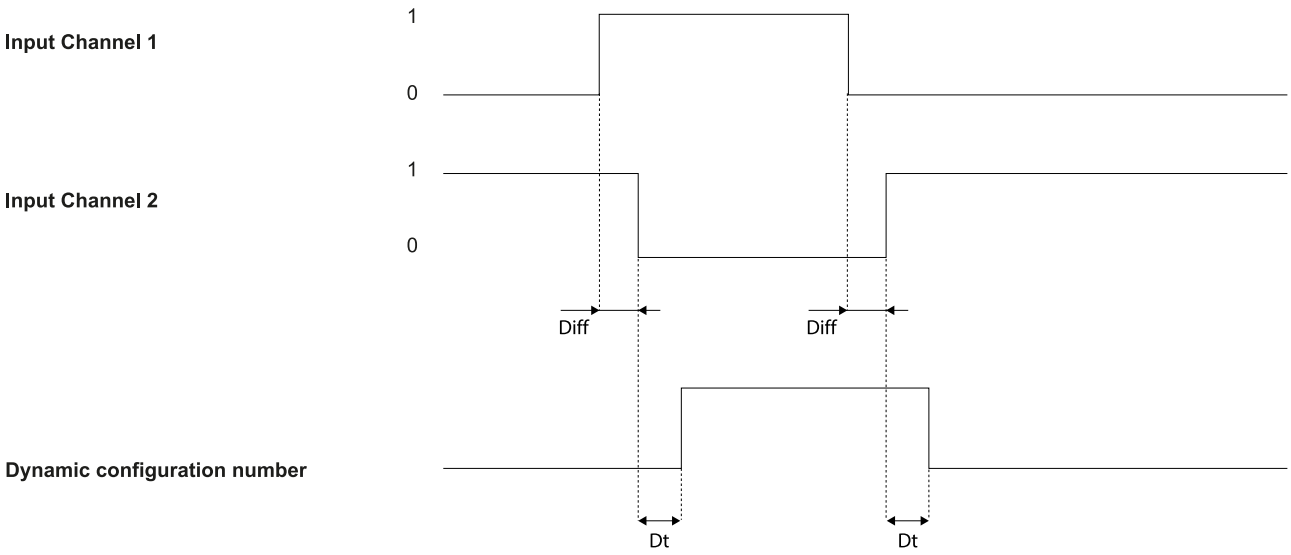
With two inputs (encoded channels disabled)



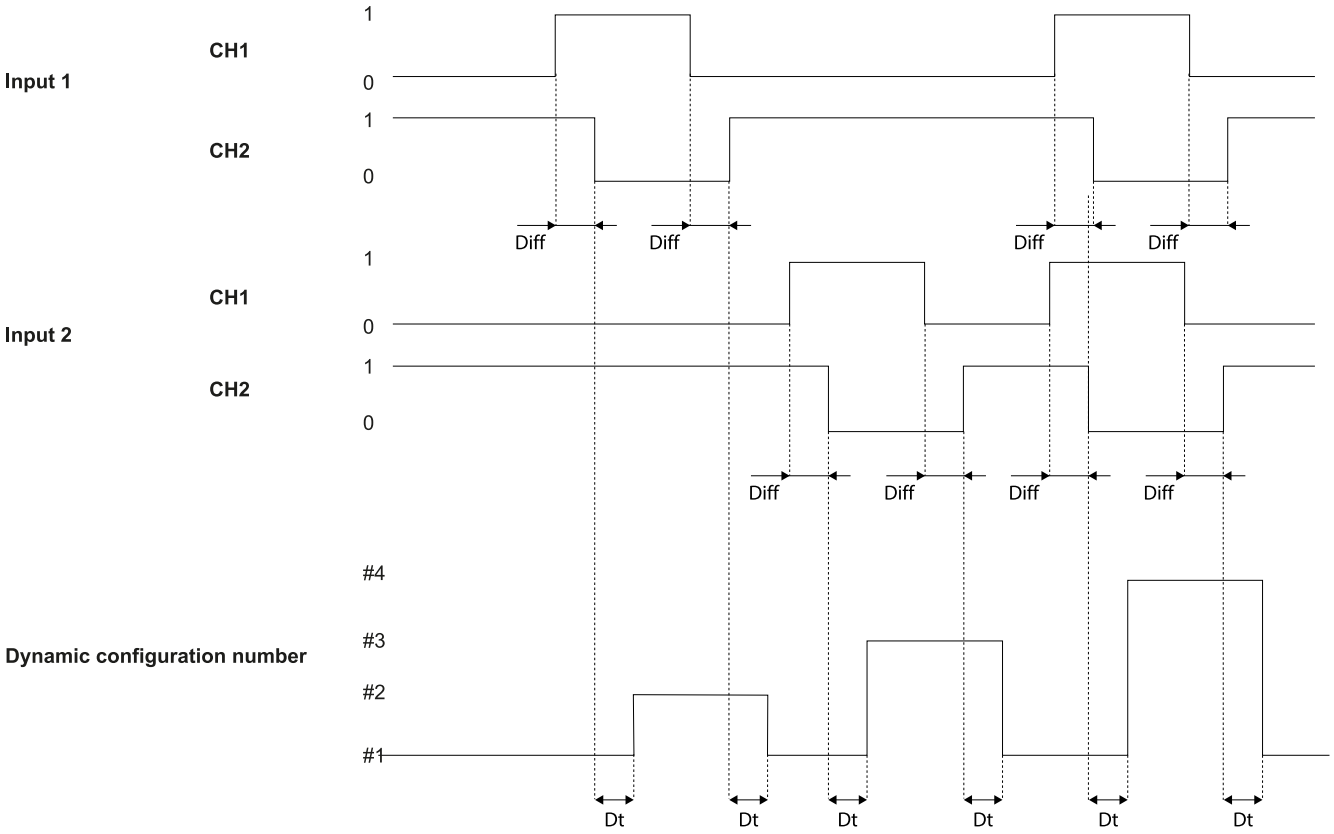
Part	Description
Diff	Less than 100 ms. If the value is greater than 100 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Dynamic configuration number	For details about the dynamic configuration number and the encoded channel option, see "Dynamic configuration through the digital inputs" on page 27.
Dt	Activation/deactivation delay. Less than 50 ms.

12.5.13 Dynamic configuration switch (redundancy mode inverted)

With one input



With two inputs



Part	Description
Diff	Less than 100 ms. If the value is greater than 100 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Dynamic configuration number	For details about the dynamic configuration number and the encoded channels option, see "Dynamic configuration through the digital inputs" on page 27.
Dt	Activation/deactivation delay. Less than 50 ms.

13. Appendix

Contents

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13.3 Service and warranty **126**
13.4 Checklist for installing ESPE **126**
13.5 Intellectual property **127**

13.1 System software

13.1.1 Introduction

The aim of this appendix is to provide and clarify the information related to the system software. It includes the information necessary for the integrator during the installation and integration in accordance with IEC 61508-3 Annex D.

Considering that PSEN rd1.1 systems is an embedded system provided with a firmware already deployed on board, no software integration is required by the system installer or by the end user. The following paragraphs analyzes all the information required in IEC 61508-3 Annex D.

13.1.2 Configuration

The system configuration can be performed by means of a PC-based configuration tool, called the PSEN rd1 configurator.

The system configuration is described in "Installation and use procedures" on page 67.

13.1.3 Competence

Although no competence is required for software integration, a skilled person is required for system installation and configuration, as described in "Installation and use procedures" on page 67.

13.1.4 Installation instructions

The firmware is already deployed on the hardware, the PC-based configuration tool includes a self-explanatory setup installer.

13.1.5 Outstanding anomalies

At the moment of the issue of this document, no software/firmware anomalies or bugs are known.

13.1.6 Backward compatibility

Backward compatibility is guaranteed.

13.1.7 Change control

Any change proposal suggested by the integrator or the end user should be forwarded to Pilz and evaluated by the Product Owner.

13.1.8 Implemented security measures

Firmware upgrade packages are managed by Pilz and are signed to prevent the use of unverified binary files.

13.2 Disposal

PSEN rd1.1 systems contains electrical parts. As set forth in European Directive 2012/19/EU, do not dispose of the product with unsorted urban waste materials.

It is the responsibility of the owner/distributor to dispose of these products, as well as other electrical and electronic equipment, through specific waste collection facilities indicated by the waste disposal services.

Correct disposal and recycling will contribute to the prevention of potentially harmful consequences to the environment and human health.

For more detailed information about disposal, contact the waste disposal services or the representative from whom you purchased the product.

13.3 Service and warranty

13.3.1 Customer service

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13.4 Checklist for installing ESPE

13.4.1 Introduction

Collecting the details relating to the following items is mandatory no later than when the system is commissioned for the first time.

This checklist should be kept with the machine documentation to serve as a reference during periodic tests.

This checklist does not replace the initial commissioning or regular inspection by qualified safety personnel.

13.4.2 Checklist

Question	Yes	No
Have the safety rules and regulations been observed in compliance with the directives and standards applicable to the machine?		
Are the applied directives and standards listed in the declaration of conformity?		
Does the ESPE comply with the required PL/SIL claim limit and PFHd in accordance with EN ISO 13849-1/EN 62061 and the required type in accordance with EN 61496-1?		
Is access to the dangerous area only possible through the detection field of the ESPE?		
Have appropriate measures been taken to detect any persons in the dangerous area?		
Have the safety devices been secured or locked to prevent their removal?		
Are additional mechanical protective measures fitted and secured against manipulation which prevent reaching below, above, or around the ESPE?		
Has the maximum stopping time of the machine been measured, specified, and documented?		
Has the ESPE been mounted such that the required minimum distance from the nearest hazardous point has been achieved?		
Are the ESPE devices properly mounted and secured against manipulation after adjustment?		
Are the required protective measures against electric shock in effect (protection class)?		
Is the control switch for resetting the protective devices (ESPE) or restarting the machine present and correctly installed?		
Are the outputs of the ESPE integrated according to the required PL/SIL in accordance with EN ISO 13849-1/EN 62061, and does the integration correspond to the circuit diagrams?		
Has the protective function been checked in compliance with the test notes of this documentation?		
Are the specified protective functions effective at every operating mode that can be set?		
Does the ESPE activate the switching elements?		
Is the ESPE effective over the entire period of the dangerous state?		
Once initiated, will a dangerous state be stopped when switching the ESPE on or off, when changing the operating mode, or when switching to another protective device?		

13.5 Intellectual property

13.5.1 Trademarks

EtherCAT® and Safety over EtherCAT® are registered trademarks and patented technologies licensed by Beckhoff Automation GmbH, Germany.

13.5.2 US patents

Pilz GmbH & Co. KG products are protected by the following US patents:

- US Patent #10761205
- US Patent #11402481
- US Patent #11282372
- US Patent #11422227
- US Patent #11579249
- US Patent #11835616
- US Patent #11982983
- US Patent #11846724
- US Patent #11988739
- US Patent #11041937

Other US patents are peding.

Support

Technical support is available from Pilz round the clock.

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Partner of the Engineering Industry Sustainability Initiative

German Standards
BRAND OF THE CENTURY 2022

Quality Management ISO 9001:2015 REG. NO. 2462
Environmental Management ISO 14001 REG. NO. 2462
Energy Management ISO 50001 REG. NO. 2462

We are represented internationally. Please refer to our homepage www.pilz.com for further details or contact our headquarters.

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PILZ
THE SPIRIT OF SAFETY

1005737-EN-08, 2025-07 Printed in Germany
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