Fault exclusion on interlocking device with guard locking PSEN me1

Product
Type: Guard Locking
Name: PSEN me1, PSEN b5
Manufacturer: Pilz GmbH & Co. KG, Safe Automation

Document
Release Number: 03
Release Date: 25 March 2014

Document Revision History

Release	Date	Changes	Chapter
01	2014-03-25	Creation	all
02	2014-03-25	New draft version 13	all
03	2014-03-25	Change of translation	4.1.3

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March 2014

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1. Useful documentation

Reading the documentation listed below is necessary for understanding this application note. The availability of the indicated tools and safe handling are also presupposed with the user.

1.1. Documentation from Pilz GmbH & Co. KG

No.	Description	Item No.
1	Pilz international homepage, download section	www.pilz.com
2	Installation and Operating Instructions PSEN me1	0800000624-3FR-xx
3	Operating instructions PSEN b5	1002471-3FR-xx
4		
5		
6		

1.2. Documentation from other sources of information

No.	Description	Item No.
1	DIN EN ISO 13849-1	European Standard
2	DIN EN ISO 13849-2	European Standard
3	IEC 62061	European Standard
4	DIN EN ISO 14119	European Standard
5	DIN EN 60947-5-1	European Standard
6	DIN EN 1088	European Standard
7	Functional safety of machine controls	BGIA- Report 2/2008
8	Auswahl und Anbringung von Verriegelungseinrichtungen	BGI
9		

2. Hardware configuration

2.1. Pilz products

No.	Description	Order number	Version	Number
1	PSEN me1S/1AS	570 000	-	1
2	PSEN b5	540 015	-	1
3				
4				

3. Category considerations PSEN me1 in accordance with ISO 13849-1 and -2

- As a general rule, when considered individually these products are mechanically single-channel and technically may only be used up to Category 1, in other words up to a maximum of PL c.
- For higher categories or PLs, technically two mechanical channels must be provided, i.e. two switches.
- If necessary, information about the category of a position switch can be taken from the C standards!
- When position switches have two N/C contacts, a dual-channel design can be assumed for the electrical system. However, as the actuator area has a single-channel mechanical design, technically we are back to Category 1.
- Under certain conditions it is possible to use a mechanical safety switch up to Category 3, max. PL d. However, this requires fault exclusion in the switch actuation system. Fault exclusion is achieved by controlling a variety of error sources, such as:
  - Wear / corrosion
  - Fracture
  - Loosening
  - Deformation
  - Sticking
- The following points should therefore be considered in any practical application:
  - Environmental influences such as temperature, chemically aggressive materials, air pressure, dust, etc.
  - The actuating mechanism should be protected so that it can't be blocked by foreign particles or be manipulated.
  - The actuating travel, forces and tolerances must be maintained over the whole of the application's life.
- The way in which these are controlled must be documented appropriately. Fault exclusion must also be validated in accordance with ISO 13849-2:2008.
- The fault exclusion procedure is based on ISO 13849-1:2008, 7.3 and ISO 13849-2:2013, Annex A Table A.4. Fault exclusion for an interlock with guard locking is described on the following pages by way of example.
- PL e can only ever be achieved through mechanical and electrical redundancy. In other words, two physical switches are required.

4. Application description

4.1. Description

This document describes an example of how fault exclusion for an interlocking device with guard locking can be used to achieve **PL d with one safety switch PSEN me1**.
The example assumes that all requirements for PL d (MTTFd, Category, DC, CCF) are met for the whole interlocking device. Performance Level d generally requires a universal dual-channel structure. In this example, dispensing with a second position switch on the safety gate means that the mechanical operation of the guard locking device has only a single-channel structure from the actuator to the positive-opening contacts. To justify its use for PL d, fault exclusions regarding an unsafe failure of the mechanical parts of the guard locking device are accepted under certain conditions.

The following assessment focuses on the safety switch and the measures needed for fault exclusion, from the machine designer's perspective. This document does not consider or describe the required safety-related evaluation of the interlocking switch and guard locking device in accordance with PL d.

For further information regarding the safety-related evaluation please refer to ISO 13849-1 or IEC 62061, ISO 14119, the BGIA Report 2/2008 entitled "Functional safety of machine control systems", or the BGI's "Selection and positioning of interlocking devices", for example.

Fault exclusion should be performed on the mechanical parts of an interlocking device with guard locking in accordance with ISO 13849-1:2008, 7.3 and ISO 13849-2:2013, Annex A Table A.4.

This example assumes that PLr = d is required for the safety function of the interlocking device as well as the guard locking device.

Caution
The requirements in relevant standards (e.g. C standards) may be different to those described in this document. What's fundamental is that the described fault exclusion is always produced for the respective application and justified with reference to that application. The whole application must be validated in accordance with ISO 13849-2.

4.1.1. Safety functions

Interlocking device
Prevention of unexpected start-up when a safety gate is open.

Guard locking device
Access to the danger zone while the danger is present is prevented by a safety gate with guard locking device.

Releasing the guard locking device
The safeguard can only be opened once the hazard is no longer present.

4.1.2. Description of the mode of operation

A movable guard (safety gate) and interlocking device with guard locking (guard locking switch PSEN me1) is used to prevent access to a hazardous movement until the hazard has passed.

Guard locking on the safety gate is based on positive mechanical blocking of the actuator by a spring-force operated solenoid bolt.

The hazardous movement can only be switched on when the safety gate is closed and the actuator is bolted.

Integrated position switches monitor the position of the locking bolt as well as the position of the safety gate.

The solenoid bolt acts positively on the contacts of the interlocking and guard locking device.

The integrated failsafe locking device prevents an unexpected start-up while the gate is open. Due to the failsafe locking device, the solenoid bolt can only reach the locked position when the gate is closed, i.e. the actuator is engaged.

4.1.3. Design features

The interlocking device with guard locking PSEN me1 is tested and certified by DGUV in accordance with GS-ET-19 and meets Category B of ISO 13849-1 as a minimum. The two integrated positive-opening N/C contacts for monitoring the guard locking function comply with EN 60947-5-1 Annex K

Fundamental safety principles are met, as are the requirements of Category B in accordance with ISO 13849-1.

The evaluation and logic used to release the guard locking device comply with the required PL as a minimum.

The evaluation device that monitors the contacts of the guard locking switch complies with Category 3, PL d as a minimum. The interlocking switch with guard locking device is mounted on a "locking bar" (consisting of a gate mounting plate with bolt and handle, e.g. bolt PSEN b5) in accordance with the instructions for the bolt and guard locking device (particularly the standard stated in the instructions for the guard locking device, EN 1088 / ISO 14119). The mechanical stress of the gate system is absorbed by the locking bar system.



Fig. 1: PSEN me1 with bolt PSEN b5

All the data stated in the documentation for the guard locking switch (e.g. max. permitted holding force, temperature range, protection type, tightening torques, mechanical service life beyond the mission time of 20 years, etc.) is maintained.

Fault exclusion is carried out on the external mechanical parts of the interlocking device with guard locking and is justified as follows:

- Damage to the guard locking device and actuator can be excluded.
  - The actuator of the guard locking device is designed in such a way that the actuator or switch cannot be damaged even if the gate position drops. Also, the mechanical stop is integrated within the locking bar system, so that an actuator overrun is impossible.

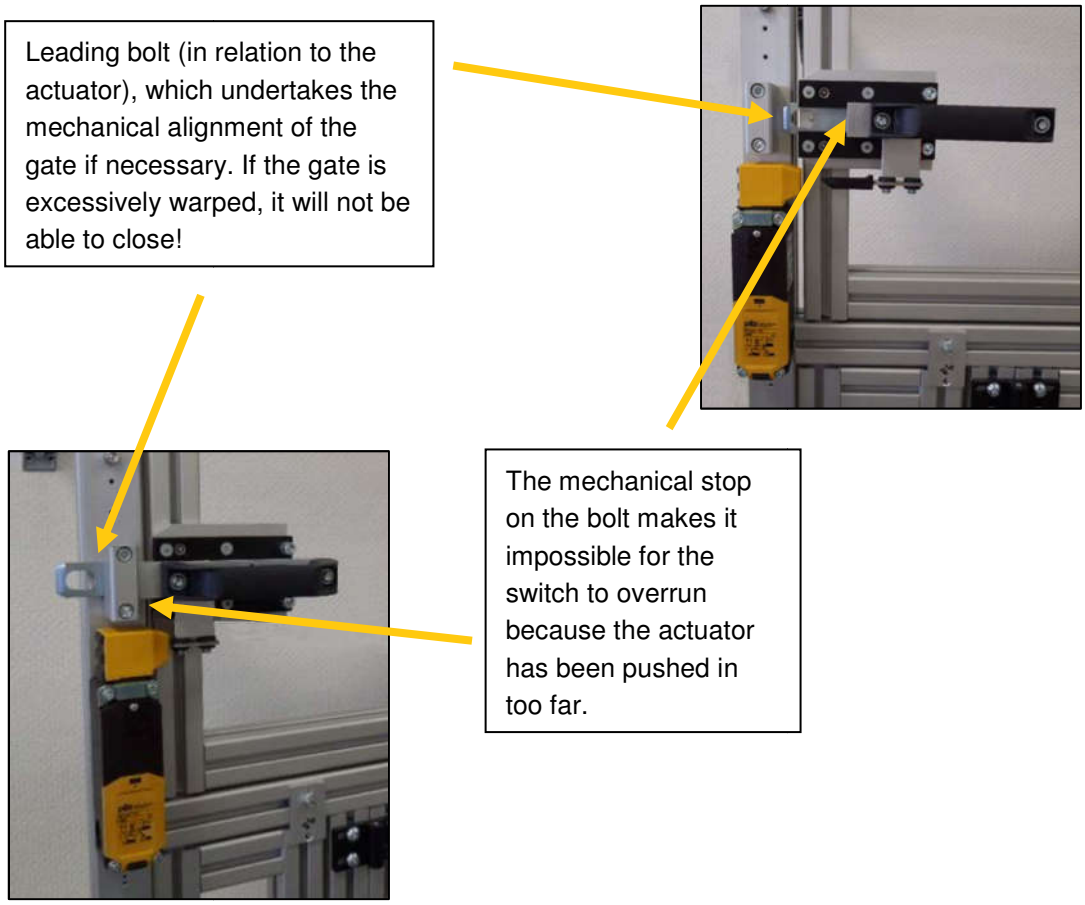


Fig. 2: Positioning of bolt

- Due to this mechanical assembly, all forces exerted on the gate from all directions are absorbed by the locking bar and in this case specifically by the locking bolt. So there is no mechanical stress on the guard locking switch and actuator.

- Nor is it possible to damage the guard locking device when the gate is closed with the bolt extended.

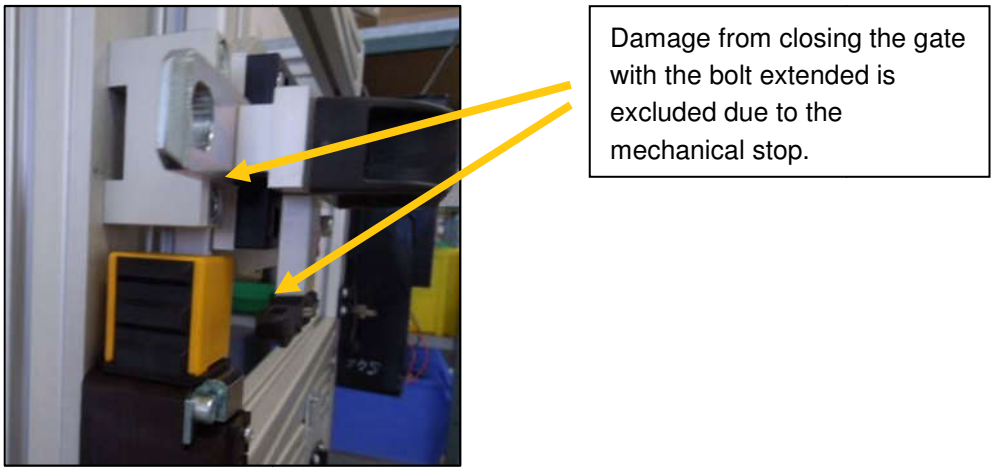


Fig. 3: Mechanical stop PSEN b5

- The ability of the safety gate to move is restricted in the closed position through a separate mechanical stop, so that the actuator cannot access the area "behind" the frame of the gate and be damaged during the reverse movement.

The forces exerted statically on the guard locking device, by the user for example, are lower than the holding forces F_{ZH} in accordance with GS-ET-19.

- The holding force F_{ZH} for the interlocking switch is 1500 N in accordance with the operating instructions.

- Should anyone attempt to open the gate by force (irrespective of whether or not the gate is guard locked), the force is exerted exclusively on the locking bar mechanics and not on the guard locking switch or actuator.



Fig. 4: Bolt force action

- The bolt opening direction is at a right angle to the door opening direction, so that the forces that arise when attempting to open the gate with the actuator bolted produce a maximum force of 1300 N (< F_{ZH}), in accordance with ISO 14119, Table I1.

- Higher dynamic forces cannot arise because the safeguard is moved manually and the guard lock function is not activated until the gate position is detected as closed.

- Due to the failsafe locking device, the guard locking device cannot be activated until after the gate is closed.

4.2. Summary

It is assumed that all the necessary measures and requirements for achieving a PL d in accordance with ISO 13849-1 are met for the integration of the guard locking switch and for all other parts of the safety function. These include achieving the required MTTFd (consisting of B10d and Nop), DC, CCF and Category.

The safety-related characteristic values of the PSEN me1 can be found in the operating and assembly instructions.

The safety function must be validated in accordance with ISO 13849-2.

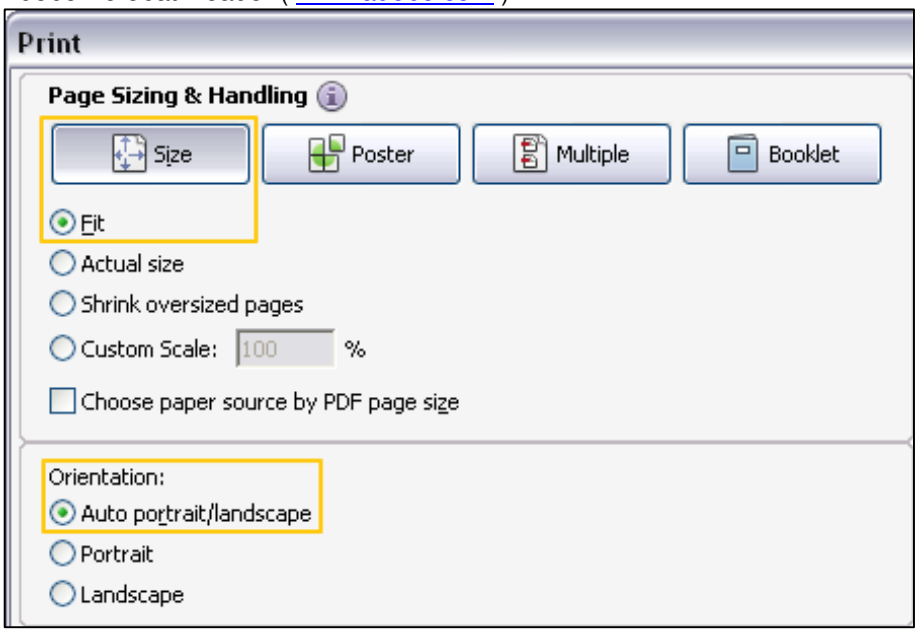
The implementations of the interlocking device with guard locking on a safety gate, as described in this document, plus the correct implementation of the overall safety function in accordance with normative requirements, mean that PL d can be achieved for the safety gate's interlocking device and guard locking device.

5. Table of figures

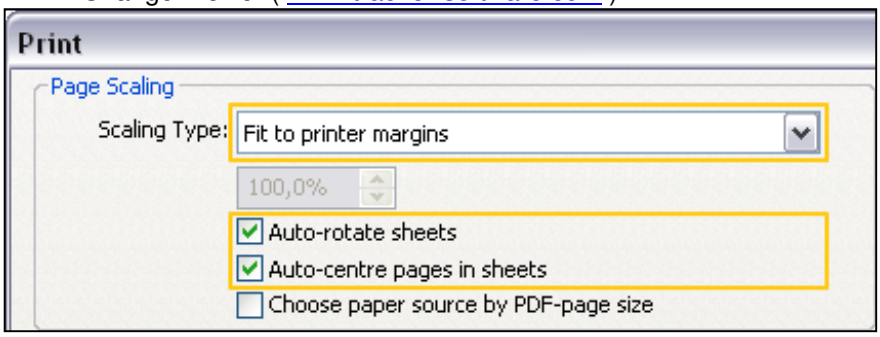
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