Safety Application Note ISO 13849

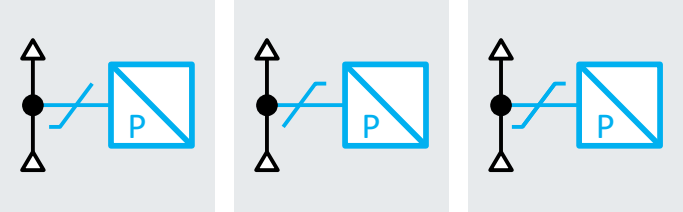
FESTO

Safety Subfunctions Pneumatics

SPM – Safe Pressure Monitoring

SPR – Safe Pressure Range

Definition



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- Specialist in pneumatics
- Specialist in electrical engineering
- Specialist for the programming of control systems and safety switching devices

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1 General

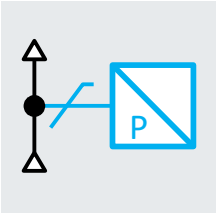
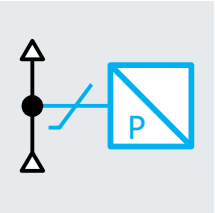
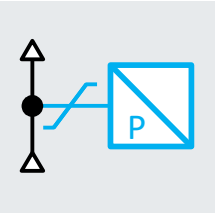
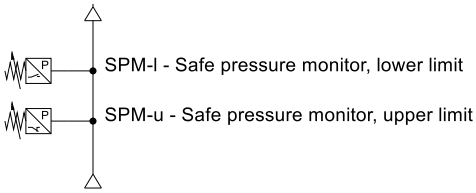
1.1 Objectives of this Document

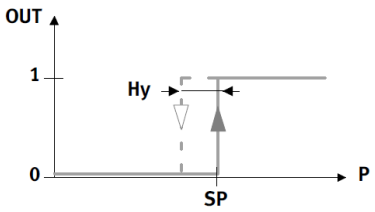
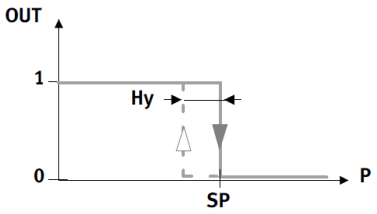
- This document defines the safety subfunctions “Safe Pressure Monitor (SPM)” and the functions derived from them for pneumatic circuits and specifies their safe status. For practical implementation, additional notes are then given which should be observed depending on the application.
- The functions derived from the safety subfunction “safe pressure monitoring (SPM)” are
    - Safe Pressure Monitor, Upper Limit (SPM-u)
    - Safe Pressure Monitor, Lower Limit (SPM-l)
    - Safe Pressure Range (SPR)
- For the possible diagnostic measures in accordance with ISO 13849-1, Table E.1, additional information is provided on how a specific diagnostic coverage can be achieved in one channel of these safety-related subsystems. For information on how these diagnostic coverage levels can be implemented in dual-channel circuits, please refer to the Safety Application Notes in the Support Portal; see also Section ➔ “3 References to Example Circuits.”

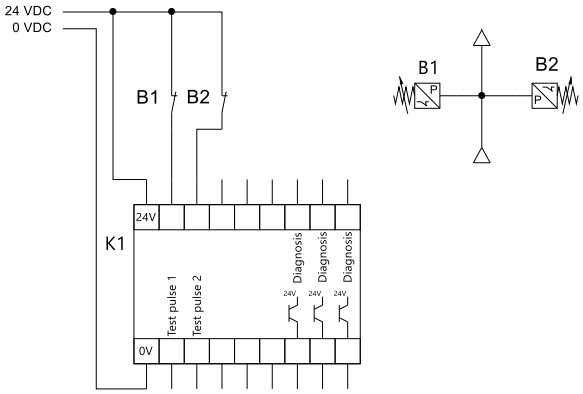
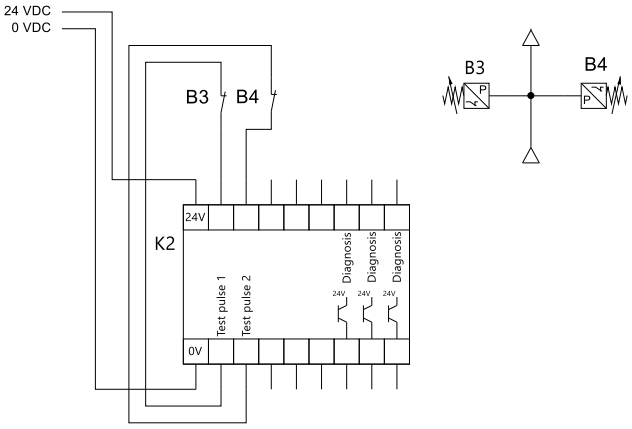
1.2 General Notes

- The given circuits are principle circuits which cannot be complete due to clarity and scope. They are recommendations that do not exclude other possibilities.
- The abbreviations used for the safety subfunctions are based on the definition SPM in VDMA 24584 for pneumatics. The safety subfunctions SPM-u, SPM-l and SPR are not defined in VDMA 24584.
- The safety subfunctions SPM or SPR monitor a pressure limit or pressure range. If the pressure limit is exceeded or falls below the specified value, or if the pressure range is left, an appropriate safety subfunction – such as a stop function or prevention of unexpected start-up (PUS) – is activated to bring the application into a safe state. This stop function or PUS is not part of the safety subfunctions SPM or SPR.
- Pressure switches suitable for safety-related circuits (confirmation of the relevant safety principles or confirmation as well-tried component according ISO 13849-1) are used to implement the safety subfunction.
- Safety pressure switches certified in accordance with ISO 13849, IEC 62061, or IEC 61508 may also be used. However, these are not considered in this document.

2 SPM – Safe Pressure Monitor

Abbreviations	SPM-u	SPM-l	SPR
Designation	Safe Pressure Monitor, Upper Limit	Safe Pressure Monitor, Lower Limit	Safe Pressure Range
Symbol	 SPM-u	 SPM-l	 SPR
Principle circuit			
Monitoring function	• The safety subfunction SPM-u outputs a safe signal when the pressure is below the specified limit. • The safety subfunction SPM-l outputs a safe signal when the pressure is above the specified limit. • The safety subfunction SPR outputs a safe signal when the pressure is between the specified limits.		
Output	• If the pressure is within the specified pressure range, a signal (24 VDC) is output. • If the pressure is outside the specified pressure range, no signal (0 VDC) is output. • The output signal can be processed by a safety switching device.		
Warnings 	**ATTENTION** • Electromechanical pressure switches with microswitches contain an elastomer diaphragm. If these pressure switches are used in a safety subfunction involving trapped compressed air, such as SSC, these safety subfunction may fail suddenly due to the diaphragm rupturing. • If pressure switches are used to monitor a safety subfunction that involves trapped compressed air, the fault exclusion “bursting” is required for the pressure switch or pressure sensor. • The monitoring functions SPM and SPR detect a hazardous condition. An appropriate response of the safety circuit must therefore be defined; for example, all pneumatic functions are brought to a standstill using STO or SDE. • For dual-channel monitoring, diversity through different technologies is recommended, such as PEV-1/4-B (electromechanical pressure switch) and SPBA (metal thin-film pressure sensor). • These safety subfunctions correspond to SPM in accordance with VDMA 24584 for pneumatics.		

Notes	• To monitor a depressurized state, a pressure that is not dangerous for the application should be monitored. This must always be assessed in relation to the application. Monitoring to 0.05 MPa is usual. If a lower pressure is selected, pressure sensors with a high resolution should be used, which significantly increase the costs for monitoring functions. • When defining a limit value, the accuracy and hysteresis of the sensors must be taken into account. • The lower limit value of pressure monitoring (SPM-l) is also referred to as minimum pressure monitoring. • The upper limit value of the pressure monitoring (SPM-u) is also referred to as maximum pressure monitoring. • The setting function of the limit value must be protected against manipulation. • If two electronic pressure sensors are used in a dual-channel system, the manufacturer must confirm that the software has also been developed using diversity (see ISO 13849-1, Section 7.3.2) or in accordance with IEC 61508. This has been verified for the SPAU-... (8001231) and SPBA- (8000210) pressure sensors. The confirmation is provided in document FAQ-200138 (attached). • In the case of two-channel monitoring with pressure switches, it must be ensured that the hysteresis of the mechanical pressure switches must be set for the electronic pressure switch. This is possible with the SDE 3 pressure sensor, for example. If this setting is not made, the pressure switches will switch with too large time discrepancy at different pressures, and a safety reaction may not be requested. Switching element function normally open  Switching element function normally closed  • This safety subfunction corresponds to SPM in accordance with VDMA 24584.

Possible diagnoses	**Diagnostic coverage DC = 90%** To achieve a diagnostic coverage of DC = 90% for the SPM or SPR safety subfunction, the diagnostic measure “cross monitoring of input signals with dynamic test if short circuits are not detectable (for multiple I/O)” can be applied.  Pressure switches B1 and B2 monitor the pressure in the pneumatic system. Since short circuits and cross-circuits cannot be detected directly, the diagnostic coverage is limited to 90%. **Diagnostic coverage DC=99%** To achieve a diagnostic coverage of DC = 99%, the diagnostic measure “cross monitoring of input signals and intermediate results within the logic (L), and temporal and logical software monitor of the program flow and detection of static faults and short circuits (for multiple I/O)” is used. 

3 References to Example Circuits

Safety Application Notes with a possible evaluation based on ISO 13849 for basic circuits with different valve functions are available in the Support Portal.

SPM-l, SPM-u, SPR	Channel 1: Valve function diagnosis	Channel 2: Valve function diagnosis	Link
Up to category 1, up to PL c	Pressure switch	–	↗ 100569
Up to category 3, up to PL e	Pressure switch Cross monitoring, short / cross circuits are not detected	Pressure sensor Cross monitoring, short / cross circuits are not detected	↗ 100570
Up to category 4, up to PL e	Pressure switch Cross monitoring, short / cross circuits are detected	Pressure sensor Cross monitoring, short / cross circuits are not detected	↗ 100627

4 Used Literature

4.1 Cited documents from Festo

[1] 100569 Safety subfunction SPM with up to category 1, up to PL c
[2] 100570 Safety subfunction SPM with up to category 3, up to PL e
[3] 100627 Safety subfunction SPM with up to category 4, up to PL e

4.2 Standards

[4] DIN EN ISO 4414:2011-04 – Pneumatic fluid power - General rules and safety requirements for systems and their components (ISO 4414:2010); German version EN ISO 4414:2010
[5] ISO 5598:2020-01 – Fluid power systems and components - Vocabulary
[6] DIN EN ISO 12100:2011-03 - Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010); German version EN ISO 12100:2010
[7] DIN EN ISO 13849-1:2023-12 – Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2023); German version EN ISO 13849-1:2023
[8] DIN EN ISO 13849-2:2013-02 – Safety of machinery - Safety-related parts of control systems - Part 2: Validation (ISO 13849-2:2012); German version EN ISO 13849-2:2012
[9] VDMA 24584:2022-06 – Safety functions of regulated and unregulated (fluid) mechanical systems; German Version
[10] DIN EN 61508:2011-02 - Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508:2010); German version EN 61508:2010
[11] DIN EN 61508-4:2011-02 - Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations (IEC 61508-4:2010); German version EN 61508-4:2010
[12] DIN EN 61511:2019-02 - Functional safety - Safety instrumented systems for the process industry sector - (IEC 61511:2016); German version EN 61511:2017
[13] DIN EN IEC 62061:2023-02 - Safety of machinery - Functional safety of safety-related control systems (IEC 62061:2021); German version EN IEC 62061:2021

4.3 Legal Regulations

[14] Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)
[15] Machinery Regulation: Regulation (EU) 2023/1230 of the European Parliament and of the Council of 14 June 2023 on machinery and repealing Directive 2006/42/EC of the European Parliament and of the Council and Council Directive 73/361/EEC

5 Information about the Document

5.1 General Information

Document Number	100519
Definition	SPM – Safe Pressure Monitoring SPR – Safe Pressure Range

5.2 Revision History

Ver.	Date	Ed.	Chapter	Description of Change/Impact
1.10	19.11.2026	JKHL	All	Creation of document

5.3 Approval/Release of the Document

Role	Signature
Release	 Digital signiert von Jürgen Kühnle DN: cn=Jürgen Kühnle gn=Jürgen Kühnle c=DE Germany l=DE Germany o=Festo SE & Co. KG ou=SC-OTP e=juergen.kuehnle@festo.com Grund: Freigabe dieses Dokuments Ort: Esslingen Datum: 2026-11-19 08:49+01:00

5.4 Period of Validity

Document is valid until 2031-11-19 or until one of the documents used or the required relevant base are changed.











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