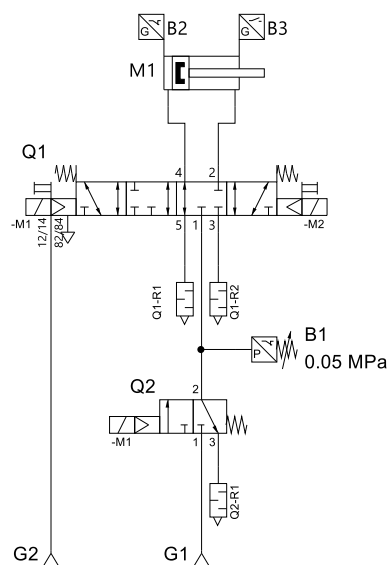
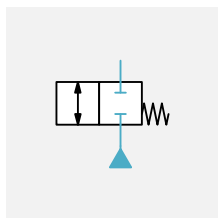


## Circuit

SC – Safe Closing with Cat. 3, PL d

Air Solenoid Valve VUVX-BK10-P54E-...



### Our effort – your advantage

Our effort for the preparation of these documents

and your saved time 8 h

Free of charge for you.

Title ..... Safety Subfunctions Pneumatics - Circuit  
Version ..... 1.10  
Document number ..... 100612  
Original ..... German  
Author ..... Festo  
Date ..... 18.08.2026

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The values stated in this document are partly assumptions and assessments which do not replace a detailed examination based on ISO 13849, IEC 61508, IEC 62061 and/or IEC 61511.

The actual characteristic values that can be obtained (especially PL, PFH<sub>D</sub>, category, DC, MTTF<sub>D</sub>, CCF, SIL, HFT, PFH, PFD) depend on the components used, as well as their conditions of use in the actual application.

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This document is only suitable for persons with sufficient expertise for machine safety based on ISO 12100, ISO 13849, IEC 61508, IEC 62061 and IEC 61511. In addition, the following qualifications are required in the project team:

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

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### Important notes

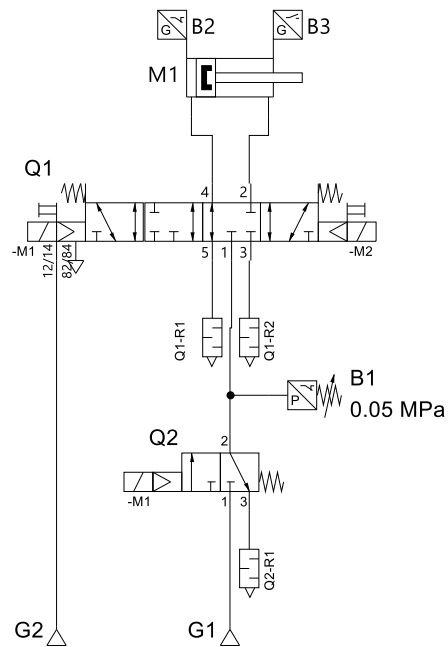
With this type of valve, the valve's switching element can switch between the two middle normal positions during operation even without an input signal. Therefore, it is not possible to assess the safety subfunction "Prevention of unexpected start (PUS)."

Even when switching between the middle normal positions, port 1 remains closed, so no additional compressed air can flow in.

#### 1.4 Notes on safety-related features of the partial circuit

- For safety sub-functions with 2-channel architecture of the safety circuit (here category 3), a fault does not lead to a single failure of the safety sub-function.
- The consideration of measures for failures due to common cause (CCF) are to be evaluated depending on the application. Recommendations on possible measures are contained in the document [100399 Recommendations for the implementation of measures against common cause failures \(CCF\)](#).
- The calculation of the MTTF<sub>0</sub> characteristic value from the B<sub>10</sub> values are included in the Sistema project file. The B<sub>10</sub> value must be adjusted according to the valves used.
- If pneumatic drive M1 is always required to reach its end position, valve Q1 should not be de-energized until the drive has reached an end position monitored by limit switches B2 and B3.
- To estimate the diagnostic coverage of valve Q1, suitable plausibility and positioning-time monitoring of the control signals should be implemented up to the point at which the sensors B2 and B3 change signals. In addition, a test cycle is required to verify whether valve Q1 has closed port 1. The implementation of this test cycle must be assessed based on the specific application. For drives subject to external forces, such as vertical axes, the following test cycle can be used:
  - The drive is driven to its end position by external forces.
  - The control signal for valve Q1 is switched off so that the valve returns to its normal position.
  - Valve Q2 is switched off, interrupting the pressure supply to valve Q1 and exhausting port 1 of valve Q2.
  - If the drive moves out of its end position, valve Q1 has not closed port 1. A fault has therefore occurred, and the application should execute an appropriate fault response; for example, all outputs of the safety controller are switched off.
  - If the drive remains in its end position, the test cycle was successful.
- To estimate the diagnostic coverage of valve Q2, suitable plausibility and switching-time monitoring of the control signal should be implemented up to the point at which sensor B1 changes signal.

## 2 Circuit



According to ISO 14118 enclosed pressurized air shall be marked and shall be provided with a possibility for manual pressure release. A dangerous movement can occur if the pressure is manually exhausted. Leakage can cause movements that cannot be stopped.

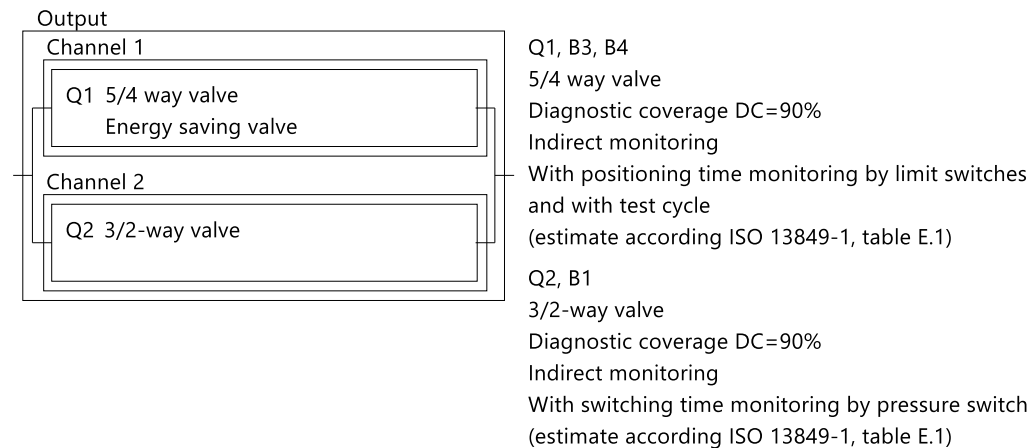
Switching between normal positions may cause motion that cannot be stopped. This motion may constitute a hazard that must be assessed based on the specific application.

### Safety subfunction

SC - Safe Closing

up to category 3, up to PL d can be reached

### Block diagram (single valves)



### Parts list

| Pos... | Identifi... | Description         |
|--------|-------------|---------------------|
| 1      | B1          | Pressure switch     |
| 2      | B2          | Limit switch        |
| 3      | B3          | Limit switch        |
| 4      | G1          | Operation pressure  |
| 5      | G2          | Pilot pressure      |
| 6      | M1          | Double-acting drive |
| 7      | Q1          | 5/4 way valve       |
| 8      | Q1-R1       | Silencer            |
| 9      | Q1-R2       | Silencer            |
| 10     | Q2          | 3/2-way valve       |
| 11     | Q2-R1       | Silencer            |

### 3 Suitable Products for Sensor B1, B2

#### 3.1 Pressure Switch

- Based on the following features, other suitable pressure switches from Festo can also be selected using the features in the data sheets available online.
- Depending on the application, it must be evaluated whether this list of features needs to be added.

| Feature                                                                                                       | Value                                                         |
|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| Product category                                                                                              | Pressure switch                                               |
| Measured variable                                                                                             | Relative pressure                                             |
| Switching element function                                                                                    | Antivalent OR<br>NC contact OR<br>Changeover OR<br>Switchable |
| Operating pressure                                                                                            | 0 – 8 bar OR<br>1 – 10 bar OR<br>1 – 12 bar OR<br>-1 – 10 bar |
| As an alternative to the operating pressure the start and end value for pressure measuring range can be used. |                                                               |
| Start value for pressure measuring range                                                                      | 0 bar                                                         |
| End value for pressure measuring range                                                                        | 10 bar                                                        |

Other values for the features may be possible and must be considered separately.

Note: These pressure switches were selected as examples from different series and sizes.

| No. | Material | Designation/Type (Sorting ↑)              | Link<br>Data Sheet |
|-----|----------|-------------------------------------------|--------------------|
| 1.  | 10773    | Pressure switch PEV-1/4-B                 | <a href="#">↗</a>  |
| 2.  | 8000210  | Pressure switch SPBA-P2R-G18-2P-M12-0,25X | <a href="#">↗</a>  |

### 3.2 Pressure sensors

- Based on the following features, other suitable pressure sensors from Festo can also be selected using the features in the data sheets available online.
- Depending on the application, it must be evaluated whether this list of features needs to be added.

| Feature                                                                                                       | Value                                                      |
|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| Product category                                                                                              | Pressure sensors                                           |
| Measured variable                                                                                             | Contains "Relative pressure"                               |
| Switching element function                                                                                    | NC/NO contact switchable OR<br>Switchable OR<br>NC contact |
| Switching output                                                                                              | Contains "PNP"                                             |
| Operating pressure                                                                                            | 0 – 8 bar OR<br>1 – 12 bar OR<br>-1 – 10 bar               |
| As an alternative to the operating pressure the start and end value for pressure measuring range can be used. |                                                            |
| Start value for pressure measuring range                                                                      | -1 bar OR<br>0 bar                                         |
| End value for pressure measuring range                                                                        | The end value should be $\geq 6$ bar.                      |

Other values for the features may be possible and must be considered separately.

Note: These pressure sensors were selected as examples from different series and sizes.

| No. | Material | ★ | Designation/Type (Sorting ↑)                       | Link<br>Data Sheet |
|-----|----------|---|----------------------------------------------------|--------------------|
| 1.  | 540209   |   | Pressure sensor SDE3-D10D-B-HQ4-2P-M8              | <a href="#">↗</a>  |
| 2.  | 542889   | ★ | Pressure sensor SDE5-D10-C-Q4E-P-M8                | <a href="#">↗</a>  |
| 3.  | 8001448  |   | Pressure sensor SPAE-P10R-Q4-PNLK-2.5K             | <a href="#">↗</a>  |
| 4.  | 609149   | ★ | Pressure sensor SPAN-B11R-G18M-PNLK-PNVBA-L1       | <a href="#">↗</a>  |
| 5.  | 8001221  |   | Pressure sensor SPAU-P10R-H-G18FD-L-PNLK-PNVBA-M8U | <a href="#">↗</a>  |

★ Core product range

#### 4 Suitable Products for Limit Switches B2, B3

- Based on the following features, other suitable proximity or position sensors from Festo can also be selected using the features in the data sheets available online.
- Depending on the application, it must be evaluated whether this list of features needs to be added.

| Feature                      | Value                                                         |
|------------------------------|---------------------------------------------------------------|
| Product category             | Proximity sensor                                              |
| Measured variable            | Position                                                      |
| Switching output             | Contact OR<br>Contactless OR<br>PNP OR<br>NPN/PNP switchable  |
| Switching element function   | NO OR<br>NC/NO switchable                                     |
| Operational voltage range DC | The maximum permissible operating voltage must be $\geq 30$ V |

Other values for the features may be possible and must be considered separately.

Note: These proximity sensors were selected as examples from different series and sizes.

| No. | Material | ★ | Designation/Type (Sorting ↑)              | Link<br>Data Sheet |
|-----|----------|---|-------------------------------------------|--------------------|
| 1.  | 8059122  | ★ | Proximity sensor SDBT-MSX-1L-PU-E-5-N-LE  | <a href="#">↗</a>  |
| 2.  | 543863   |   | Proximity sensor SME-8M-DS-24V-K-5,0-OE   | <a href="#">↗</a>  |
| 3.  | 543872   |   | Proximity sensor SME-8M-ZS-24V-K-2,5-OE   | <a href="#">↗</a>  |
| 4.  | 574336   | ★ | Proximity sensor SMT-8M-A-PS-24V-E-5,0-OE | <a href="#">↗</a>  |
| 5.  | 8165237  | ★ | Proximity sensor SMT-8M-A-ZS-24V-E-5,0-OE | <a href="#">↗</a>  |

★ Core product range

## 5 Suitable Products for Valve Q1

- Based on the following features, suitable valves from Festo can be selected using the features in the data sheets available online.
- Depending on the application, it must be evaluated whether this list of features needs to be extended.
- Additional information on these features can be found in the document “[100396 Notes on features of directional control valves](#)”

| Feature                            | Value                                                                                                             |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Product category                   | electrically actuated valves                                                                                      |
| Valve function                     | 5/4 exhausted                                                                                                     |
| Type of actuation                  | electric                                                                                                          |
| Type of piloting                   | pilot actuated                                                                                                    |
| Pilot air supply                   | external                                                                                                          |
| Type of reset                      | mechanical spring                                                                                                 |
| Duty cycle                         | 100 %                                                                                                             |
| Service-life value B <sub>10</sub> | specified                                                                                                         |
| Basic safety principles            | Yes                                                                                                               |
| Well-tried safety principles       | Yes<br>Note: the well-tried safety principle of a “safe position” for the two normal positions is not maintained. |
| Well-tried component               | Yes                                                                                                               |

Other values for the features may be possible and must be considered separately.

| No. | Material                         | Designation/Type (Sorting ↑)                 | Code <sup>1</sup> | Link Data Sheet   | Link Data Sheet Product Reliability |
|-----|----------------------------------|----------------------------------------------|-------------------|-------------------|-------------------------------------|
|     | <i>Valve for valve terminals</i> |                                              |                   |                   |                                     |
| 1.  | 8187067                          | Air solenoid valve VUVX-BK10-P54E-MZH-F-1T1L | ND                | <a href="#">↗</a> | <a href="#">↗</a>                   |

<sup>1</sup> Code of the valve for the configurator or in the order code of the valve terminal.

### Important notes

- The safety subfunction “Prevention of unexpected start (PUS)” cannot be evaluated. The reasons are:
  - According to the product reliability datasheet, an excessive back pressure (simultaneous exhausting of 18 pilot valves on the same valve terminal) can cause switching between the two normal positions of the valve's main stage.
  - There is no fault exclusion for “spontaneous change of the main stage without an input signal” for the two normal positions.

## 6 Suitable Products for Valve Q2

### 6.1 Soft-Start/Quick Exhaust Valve in Service Unit

- Based on the following features, other suitable soft-start/quick exhaust valves from Festo can also be selected using the features in the data sheets available online.
- Depending on the application, it must be evaluated whether this list of features needs to be added.
- Additional information on these features can be found in the document [100396 Notes on features of directional control valves](#).

| Feature                            | Value                                            |
|------------------------------------|--------------------------------------------------|
| Product category                   | Soft-Start/Quick Exhaust Valve                   |
| Valve function                     | 3/2-way, closed, monostable, soft-start function |
| Type of actuation                  | electric                                         |
| Type of piloting                   | pilot actuated                                   |
| Type of reset                      | mechanical spring                                |
| Duty cycle                         | 100 %                                            |
| Service-life value B <sub>10</sub> | specified                                        |
| Performance Level (PL)             | PL c                                             |

Other values for the features may be possible and must be considered separately.

Note: These soft-start and quick exhaust valves were selected as examples from different series and sizes.

| No. | Material | Designation/Type (Sorting ↑)                        | Link<br>Data Sheet | Link Data Sheet<br>Product Reliability |
|-----|----------|-----------------------------------------------------|--------------------|----------------------------------------|
| 1.  | 8001469  | Soft-start/quick exhaust valve MS6-SV-1/2-C-10V24-S | <a href="#">↗</a>  | <a href="#">↗</a>                      |
| 2.  | 570737   | Soft-start/quick exhaust valve MS9-SV-G-C-V24-S-VS  | <a href="#">↗</a>  | <a href="#">↗</a>                      |

Note

- Soft-start and quick exhaust valves with category 3, PL d and category 4, PL e can also be used in the service unit if this is required in the application.

## 6.2 On-Off Valves in Service Unit

- Based on the following features, other suitable valves from Festo can also be selected using the features in the data sheets available online.
- Depending on the application, it must be evaluated whether this list of features needs to be added.
- Additional information on these features can be found in the document ➔ [100396 Notes on features of directional control valves](#).

| Feature                               | Value                       |
|---------------------------------------|-----------------------------|
| Product category                      | On-off Valves               |
| Valve function                        | 3/2-way, closed, monostable |
| Type of actuation                     | electric                    |
| Type of piloting                      | pilot actuated              |
| Type of reset                         | mechanical spring           |
| Duty cycle                            | 100 %                       |
| Service-life value B <sub>10</sub>    | specified                   |
| Relevant basic safety principles      | yes                         |
| Relevant well-tried safety principles | yes                         |

Other values for the features may be possible and must be considered separately.

Note: These on-off valves were selected as examples from different series and sizes.

| No. | Material | ★ | Designation/Type (Sorting ↑)    | Link Data Sheet   | Link Data Sheet Product Reliability |
|-----|----------|---|---------------------------------|-------------------|-------------------------------------|
| 1.  | 542602   | ★ | On-off valve MS6-EE-1/2-10V24-S | <a href="#">↗</a> | <a href="#">↗</a>                   |

★ Core product range

### 6.3 Single Valves

- Based on the following features, suitable valves from Festo can be selected using the features in the data sheets available online.
- Depending on the application, it must be evaluated whether this list of features needs to be extended.
- Additional information on these features can be found in the document [↗ 100396 Notes on features of directional control valves](#).

| Feature                               | Value                                            |
|---------------------------------------|--------------------------------------------------|
| Product category                      | Electrically actuated valves                     |
| Valve function                        | 3/2 closed monostable                            |
| Type of actuation                     | Electric                                         |
| Type of piloting                      | Pilot actuated                                   |
| Pilot air supply                      | Internal or external                             |
| Type of reset                         | Mechanical spring                                |
| Duty cycle                            | 100 % OR<br>100 % with holding current reduction |
| Service-life value B10                | Specified                                        |
| Relevant basic safety principles      | Yes                                              |
| Relevant well-tried safety principles | Yes                                              |

Other values for the features may be possible and must be considered separately.

Note: These valves were selected as examples from different series and sizes.

| No. | Material             |   | Designation/Type (Sorting ↑)                | Link<br>Data Sheet | Link Data Sheet<br>Product Reliability |
|-----|----------------------|---|---------------------------------------------|--------------------|----------------------------------------|
|     | <i>Single valves</i> |   |                                             |                    |                                        |
| 1.  | 574348               |   | Solenoid valve VUUG-L10-T32C-MT-M5-1P3      | <a href="#">↗</a>  | <a href="#">↗</a>                      |
| 2.  | 574352               |   | Solenoid valve VUUG-L10-T32C-MZT-M5-1P3     | <a href="#">↗</a>  | <a href="#">↗</a>                      |
| 3.  | 575274               | ★ | Solenoid valve VUVS-L20-M32C-MD-G18-F7-1C1  | <a href="#">↗</a>  | <a href="#">↗</a>                      |
| 4.  | 575273               | ★ | Solenoid valve VUVS-L20-M32C-MZD-G18-F7-1C1 | <a href="#">↗</a>  | <a href="#">↗</a>                      |

★ Core product range

## 7 Used Literature

### 7.1 Cited Documents from Festo

- [1] [100394 Safe electrical switch-off of valve terminals](#)
- [2] [100395 Notes on Sistema project files](#)
- [3] [100396 Notes on features of directional control valves](#)
- [4] [100399 Recommendations for the implementation of measures against common cause failures \(CCF\)](#)
- [5] [100607 Safety Subfunctions Pneumatics – SC](#)

### 7.2 Standards

- [6] 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
- [7] ISO 5598:2020-01 – Fluid power systems and components - Vocabulary
- [8] 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
- [9] 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
- [10] 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
- [11] ISO 19973-1:2015-08 - Pneumatic fluid power - Assessment of component reliability by testing - Part 1: General procedures
- [12] VDMA 24584:2022-06 – Safety functions of regulated and unregulated (fluid) mechanical systems; German Version
- [13] DIN EN 61508:2011-02 - Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508:2010); German version EN 61508:2010
- [14] 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
- [15] DIN EN 61511:2019-02 - Functional safety - Safety instrumented systems for the process industry sector - (IEC 61511:2016); German version EN 61511:2017
- [16] 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

### 7.3 Legal Regulations

- [17] 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)
- [18] 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

## 8 Information about the Document

### 8.1 General Information

|                        |                   |
|------------------------|-------------------|
| <b>Document Number</b> | <b>100612</b>     |
| Safety Subfunction     | Safe Closing (SC) |
| Category               | Up to Category 3  |
| PL                     | Up to PL d        |

### 8.2 Revision History

| Ver. | Date       | Ed.  | Chapter | Description of Change/Impact |
|------|------------|------|---------|------------------------------|
| 1.10 | 18.08.2026 | JKHL | All     | Creation of document         |

### 8.3 Approval/Release of the Document

| Role    | Signature |
|---------|-----------|
| Release |           |

### 8.4 Period of Validity

Document is valid until 2032-08-18 or until one of the documents used or the required relevant base are changed.



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