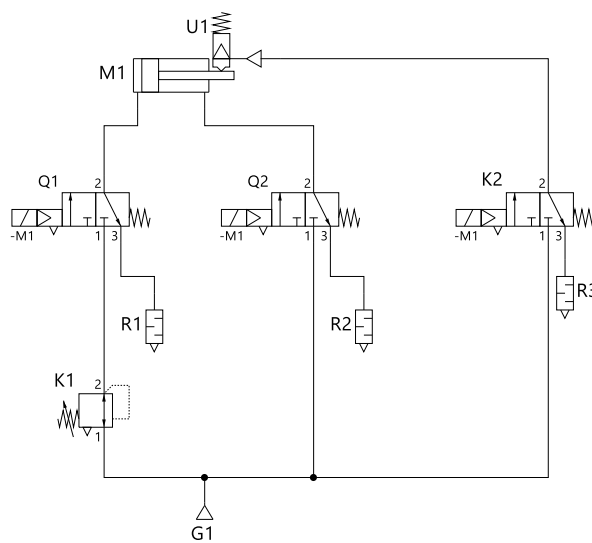
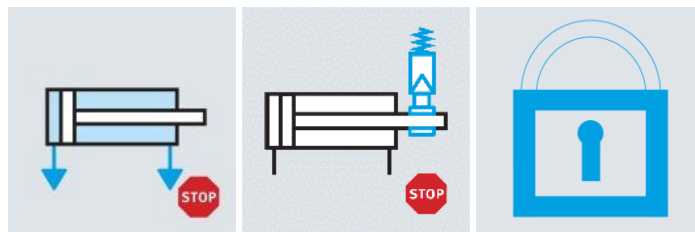


Safety-Subfunctions Pneumatics

SB-f – Safe Blocking, Friction Locking, Cat. 1, PL c

Circuit



Our effort – your advantage

Our effort for the preparation of these documents

and your saved time 6 h

Free of charge for you.

100427

Title Safety Subfunctions Pneumatics - Circuit
Version 1.20
Document number 100427
Original German
Author Festo
Date 2026-09-02

Legal Notice

In the following, the “Festo SE & Co. KG” is designated as “Festo”.

This document is not binding. This document outlines a possible solution for a sample application and makes no claim of completeness, especially with regard to configuration and equipment, as well as any eventualities for your actual application. This document is not a customised solution, it merely offers assistance with typical task assignments.

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_D, category, DC, MTTF_D, CCF, SIL, HFT, PFH, PFD) depend on the components used, as well as their conditions of use in the actual application.

This document does not relieve you of the obligation to carry out a risk assessment and validation for your specific application and to ensure compliance with all requirements yourself, in particular the Machinery Directive 2006/42/EC (to be applied until 20 Jan. 2027) or the Machinery Regulation (EU) 2023/1230 (to be applied from 20 Jan. 2027). As the user, you are solely responsible for your specific use case and for the proper operation of the products described in this context.

Festo does not accept any liability for damages arising from the use of any incorrect or incomplete information contained in this documentation or any information missing therefrom. This equally applies to defects resulting from improper handling of devices and modules. In addition, all liability, with the exception of intent or gross negligence on the part of Festo, for damages arising due to non-adherence of the specifications of the EC Machinery Directive 2006/42/EC (to be applied until 20 Jan. 2027) or the Machinery Regulation (EU) 2023/1230 (to be applied from 20 Jan. 2027) is also rejected.

The information in this document is in no way intended as a substitute for the operating instructions of the respective manufacturers or the design and testing of the application by the user. The operating instructions for products from Festo can be found at www.festo.com. Users of this document must themselves verify that all the functions described herein also work correctly in the application. Even after examining this document and using the specifications contained herein, users are nevertheless solely responsible for their own application.

Otherwise, all stipulations concerning liability included in the terms and conditions of delivery, payment and use of software from Festo, which can be found at www.festo.com and can be supplied on request, apply.

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

Copyright Notice

This documentation is the intellectual property of Festo, which also holds the exclusive copyright. Any modification of the content, duplication or reprinting of this documentation, as well as distribution to third parties, is only permissible with the express consent of Festo.

Festo reserves the right to make modifications to this document in whole or in part. All brand and product names are trademarks or registered trademarks of their respective owners.

© Festo SE & Co. KG, D - 73734 Esslingen, 2023, 2026

Internet: <https://www.festo.com>

Table of Contents

1	General	4
1.1	Objectives of this Document	4
1.2	General Notes	4
1.3	Notes on safety-related features of the partial circuit.....	4
2	Circuit	5
3	Suitable Products for Pressure Regulator K1	6
4	Suitable Products for Valve K2	7
5	Suitable Products for Valve Q1, Q2	8
6	Suitable Products for Clamping Unit U1	9
7	Used Literature	10
7.1	Cited Documents from Festo.....	10
7.2	Standards	10
7.3	Legal Regulations	10
8	Information about the Document	11
8.1	General Information.....	11
8.2	Revision History	11
8.3	Approval/Release of the Document	11
8.4	Period of Validity	11

1 General

1.1 Objectives of this Document

- This document shows a possible example circuit for the safety sub-functions STO (Safe Torque Off) with up to category 1, up to PL c, SB-f (Safe Blocking with Friction locking) with up to category 1, up to PL c and PUS (Prevention of Unexpected Startup) with up to category 1, up to PL c.
- For the implementation of the safety sub-function relevant components, the most important features are listed.
- Based on these features, suitable products from Festo are recommended.

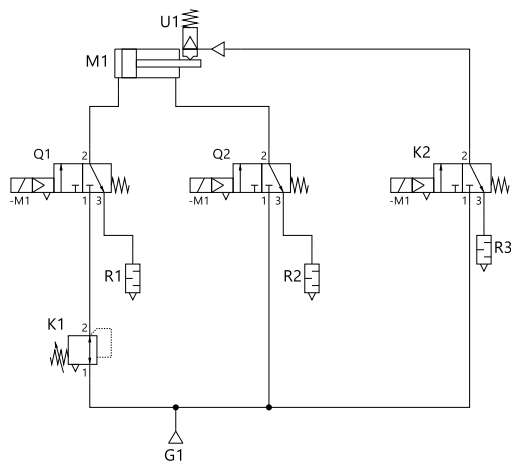
1.2 General Notes

- The given circuit is a principle circuit which cannot be complete due to clarity and scope. It is a recommendation that does not exclude other possibilities.
- The abbreviations used for the safety subfunctions are based on the definitions in VDMA 24584 for pneumatics. The definitions used and important notes are given in the documents ↗ [100380 Safety subfunctions pneumatics – STO, PUS](#) and ↗ [100422 Safety Subfunctions Pneumatic– SB-f, PUS](#).
- The requirements for the valve are only considered in the context of the pneumatic circuit. Suggestions for the electrical wiring of individual valves or valve terminals have not been considered in this document.
 - For single valves, the document ↗ [100393 Safe electrical switch-off of individually controlled valves](#) should be considered.
 - For valve terminals, the document ↗ [100394 Safe electrical switch-off of valve terminals](#) should be considered.
- In the product list included here with recommendations for suitable products, we have checked the specified requirements for the pneumatic circuit. However, if further information is available to us, e.g. through our product observation, this data can be changed on a daily basis. Therefore, these data must be checked in the data sheets available online before final use to see if there has been any change.
- Whether a recommended product is suitable for a particular application must be checked by the user and confirmed in his technical documentation.
- For the Sistema project file of this circuit, the document ↗ [100395 Notes on Sistema project files](#) must be taken into account.

1.3 Notes on safety-related features of the partial circuit

- For safety subfunctions with 1-channel architecture of the safety circuit (here category 1), a fault leads to a failure of the safety subfunction.
- The consideration of measures for failures due to common cause (CCF) are not necessary for category 1.
- The calculation of the MTTF₀ characteristic from the B₁₀ values are included in the Sistema project file. The B₁₀ value and the actuation rate must be adjusted according to the valves used.
- In the safety-related block diagrams of the safety sub-function SB-f, the dimensioning of the clamping unit must be taken into account.
 - If the clamping unit can hold the moving mass, load and force of the drive in the application, the consideration of valve K2 and locking unit U1 may be sufficient. The manufacturer of the clamping unit should provide B₁₀ values for this high load.
 - If the clamping unit can hold the moving mass and load in the application, STO should be executed at the same time with the same category and PL. The manufacturer of the clamping unit should provide B₁₀ values for this load.
 - A clamping unit is always loaded with an external force when the safety sub-function SB-f is requested, so that B_{10D} values without load cannot be used to determine the reliability.

2 Circuit



Parts list

Pos...	Identif...	Description
1	G1	Operation pressure
2	K1	Pressure regulator
3	K2	3/2-way valve
4	M1	Double-acting drive
5	Q1	3/2-way valve
6	Q2	3/2-way valve
7	R1	Silencer
8	R2	Silencer
9	R3	Silencer
10	U1	Clamping unit



Before releasing the clamping unit,
balance the forces on the piston of the drive.

Safety subfunction

STO - safe torque off

up to category 1, up to PL c can be reached

SB-f - Safe blocking with friction locking

up to category 1, up to PL c can be reached

PUS - Prevention unexpected start-up

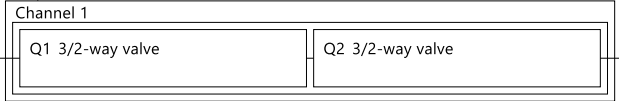
up to category 1, up to PL c can be reached

Block diagram

STO - safe torque off

PUS - Prevention unexpected start-up

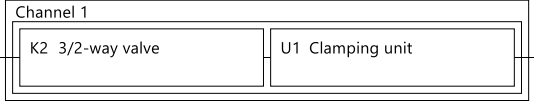
Output



SB-f - Safe blocking with friction locking

PUS - Prevention unexpected start-up

Output



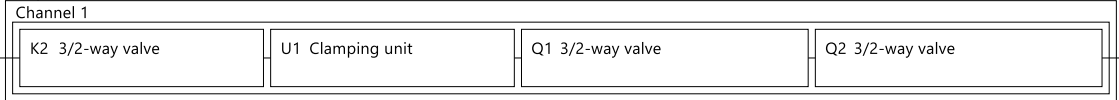
Remarks

Dimensioning of the clamping unit: Can hold moving mass, load and force of the drive.

SB-f - Safe blocking with friction locking

PUS - Prevention unexpected start-up

Output



Remarks

Dimensioning of the clamping unit: Can hold moving mass and load,
i.e. STO is executed simultaneously

3 Suitable Products for Pressure Regulator K1

- Based on the following features, suitable pressure regulators 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.

Feature	Value
Product category	Standard regulators
Operating pressure	Depends on the supply pressure of the application. Pressure regulator should withstand the possible pressures, e.g. ...14 bar
Pressure regulation range	According to the requirements of the application

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 Data Sheet	Link Data Sheet Product Reliability
1.	529417	★	Pressure regulator MS4-LR-1/4-D6-AS	↗	↗
2.	529991	★	Pressure regulator MS6-LR-1/2-D6-AS	↗	↗

★ Core product range

4 Suitable Products for Valve K2

- 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 2 x 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 100 % with holding current reduction
Service-life value B ₁₀	Specified
Relevant basic safety principles	Yes
Relevant well-tried safety principles	Yes
Well-tried component	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 ↑)	Code ¹	Link Data Sheet	Link Data Sheet Product Reliability
<i>Single valves</i>						
1.	574348		Solenoid valve VUVG-L10-T32C-MT-M5-1P3		↗	↗
2.	574352		Solenoid valve VUVG-L10-T32C-MZT-M5-1P3		↗	↗
3.	575274	★	Solenoid valve VUVS-L20-M32C-MD-G18-F7-1C1		↗	↗
4.	575273	★	Solenoid valve VUVS-L20-M32C-MZD-G18-F7-1C1		↗	↗
<i>Valve for valve terminals</i>						
5.	556838		Solenoid valve VMPA1-M1H-KS-PI	KS	↗	↗
6.	573413		Solenoid valve VUVG-B10-T32C-MZT-F-1T1L	VK	↗	↗

★ Core product range

¹ Code of the valve for the configurator or in the order code of the valve terminal.

5 Suitable Products for Valve Q1, Q2

- 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 100 % with holding current reduction
Service-life value B ₁₀	Specified
Relevant basic safety principles	Yes
Relevant well-tried safety principles	Yes
Well-tried component	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 Data Sheet	Link Data Sheet Product Reliability
	<i>Single valves</i>				
1.	575274	↺	Solenoid valve VUVS-L20-M32C-MD-G18-F7-1C1	↗	↗
2.	575273	↺	Solenoid valve VUVS-L20-M32C-MZD-G18-F7-1C1	↗	↗

★ Core product range

6 Suitable Products for Clamping Unit U1

- Based on the following features, other suitable clamping units 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	Clamping elements
Type of clamping with direction of action	On both sides Clamping via spring force, pressurized air to release
Safety function	Clamping OR Blocking of a movement
Service-life value B ₁₀₀ (in operating instructions)	specified
Relevant basic safety principles	Yes
Relevant well-tried safety principles	Yes
Well-tried component	Yes

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

Note: This holding brake was selected as examples from different series and sizes.

No.	Material	Designation/Type (Sorting ↑)	Link Data Sheet	Link Data Sheet Product Reliability
1.	8072770	Holding brake DACS-16-A-S	↗	↗

7 Used Literature

7.1 Cited Documents from Festo

- [1] [100380 Safety subfunctions pneumatics – STO, PUS](#)
- [2] [100393 Safe electrical switch-off of individually controlled valves](#)
- [3] [100394 Safe electrical switch-off of valve terminals](#)
- [4] [100395 Notes on Sistema project files](#)
- [5] [100396 Notes on features of directional control valves](#)
- [6] [100422 Safety subfunctions pneumatics – SB-f, PUS](#)

7.2 Standards

- [7] 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
- [8] ISO 5598:2020-01 – Fluid power systems and components - Vocabulary
- [9] 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
- [10] DIN EN ISO 13849-1:2016-06 – Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015); German version EN ISO 13849-1:2015
- [11] 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
- [12] ISO 19973-1:2015-08 - Pneumatic fluid power - Assessment of component reliability by testing - Part 1: General procedures
- [13] VDMA 24584:2022-06 – Safety functions of regulated and unregulated (fluid) mechanical systems; German Version
- [14] DIN EN 61508:2011-02 - Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508:2010); German version EN 61508:2010
- [15] 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
- [16] DIN EN 61511:2019-02 - Functional safety - Safety instrumented systems for the process industry sector - (IEC 61511:2016); German version EN 61511:2017
- [17] 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

- [18] 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)
- [19] 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

Document Number	100427		
Safety Subfunction	STO	SB-f	PUS
Category	up to cat. 1 reachable	up to cat. 1 reachable	up to cat. 1 reachable
PL	up to PL c reachable	up to PL c reachable	up to PL c reachable

8.2 Revision History

Ver.	Date	Ed.	Chapter	Description of Change/Impact
1.10	2023-03-10	JKHL	All	Creation of the document
1.20	2026-09-02	JKHL	Last page	Addition contact possibilities
			Title page, 2	Circuit adapted
			3, 4, 6	Product lists updated
			4, 5	Section for Q1, Q2 and pressure regulators K1 added
			2, 4, 5, 6, 7	Updating the links to the Support Portal and standards
			7	Machinery regulation added

8.3 Approval/Release of the Document

Role	Signature
Release	

8.4 Period of Validity

Document is valid until 2029-09-02 or until one of the documents used or the required relevant base are changed.



Do you have any questions about this Application Note?

You are welcome to send us your questions via the contact form.



Are you looking for Safety Application Notes with solution examples for the most important safety sub-functions in pneumatics?

We regularly expand our collection of documents in the Support Portal.



Do you want to get a general overview of machine and system safety?

We have compiled information on machine and functional safety in our guide.

Download the guide.



Do you need further support?

We also offer services for machine safety

- Risk assessment
- Safety concept
- Circuit design
- Verification / validation



You can request a quotation via the contact form.

Do you need training or further education?

At Festo Didactic you will find training courses on machine safety, functional safety and CE marking.



Request a quote for training or workshop.

