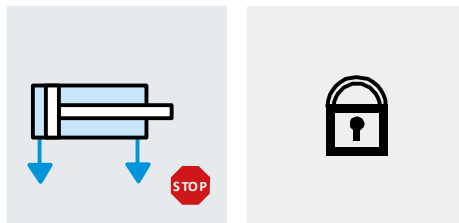


Application Note

FESTO

Safety Sub-functions STO Category 1, up to PL c PUS Category 1, up to PL c



Application Note
STO, PUS, Category
1, up to PL c

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The actual characteristic values that can be obtained (especially PL, PFH_D, category, DC, MTT_D, CCF) 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 EN ISO 12100 and EN ISO 13849. 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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Table of Content

1	Example Circuits	4
1.1	STO and PUS with 5/3 Directional Control Valve, Category 1, up to PL c.....	5
1.1.1	Circuit Diagram	5
1.1.2	Components.....	5
1.1.3	Description.....	6
1.1.4	Safety Considerations	6
1.2	STO and PUS with 3/2 Directional Control Valve, Category 1, up to PL c.....	7
1.2.1	Circuit Diagram	7
1.2.2	Components.....	7
1.2.3	Description.....	8
1.2.4	Safety Considerations	8
1.3	STO and PUS with 2/2 Directional Control Valve, Category 1, up to PL c.....	9
1.3.1	Circuit Diagram	9
1.3.2	Components.....	10
1.3.3	Description.....	10
1.3.4	Safety Considerations	11
2	Literature	11

1 Example Circuits

- The circuits specified in this document are principle circuits which cannot be complete due to their clarity and scope.
- The abbreviations used for the safety sub-functions refer to the definitions in VDMA 24584 [1] for pneumatics:
 - STO: Safe Torque Off
 - PUS: Prevention of unexpected start-up
- Category 1, up to PL c according EN ISO 13849-1 [2]
- The circuits and the procedure described are recommendations which do not exclude other possibilities.
- Due to the wide variety of possible valves, no valve type and part numbers can be given in this document. When selecting valves, make sure that the selected valves have the following characteristics:
 - Type of actuation: electrical
 - Type of reset: mechanical spring
 - Sealing principle: soft
 - Type of piloting: piloted
 - Pilot air supply: internal or external
 - Duty cycle: 100%.
 - Well-trieed components according to EN ISO 13849-1 and the relevant basic and well-trieed safety principles have been observed.
 - B10 value required for the calculation of the $MTTF_D$ value must be available.

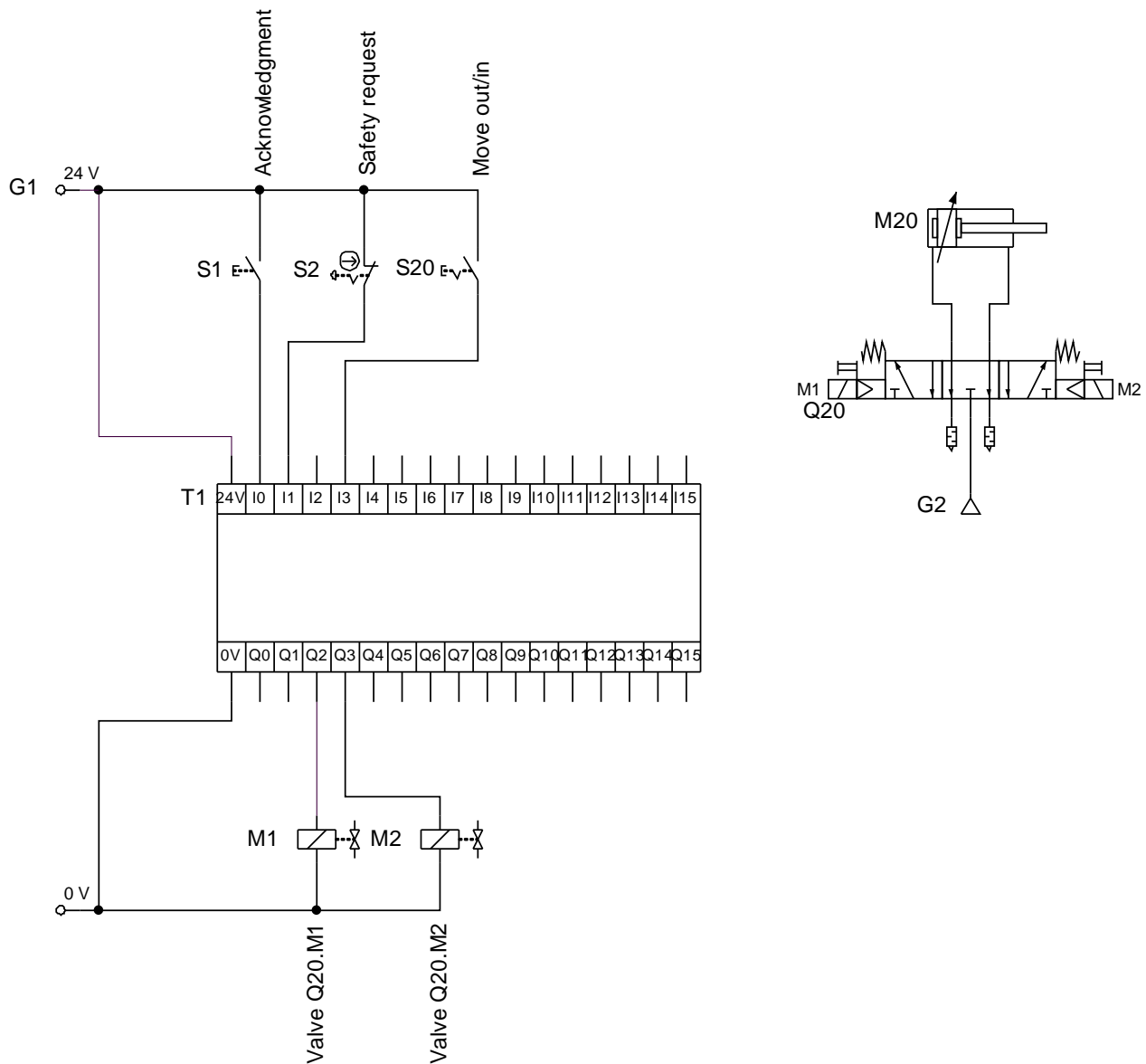
Important note

- In addition, further design features and requirements may exist, which must be determined depending on the application.

1.1 STO and PUS with 5/3 Directional Control Valve, Category 1, up to PL c

STO and PUS according VDMA 24584 [1] and category 1, up to PL c according EN ISO 13849-1 [2].

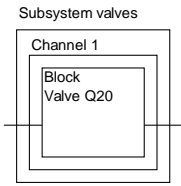
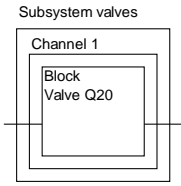
1.1.1 Circuit Diagram



1.1.2 Components

Component	Type	Description / Part Number / Remarks	Qty.	Mssr.
M20		Pneumatic drive	1	Festo
Q20		5/3 directional control valve, monostable	1	Festo
		Silencer, if necessary	2	Festo
S1		Acknowledge push button	1	
S2		Safety commanding device, e.g. emergency stop switch	1	
S20		Switch functional control	1	
T1		Safety switching device	1	

1.1.3 Description

Application	Double acting pneumatic drive, horizontal
Triggering event	Safety request, e.g. by emergency stop switch, safety gate
Reaction (Safety Sub-function)	<p>Safe torque off (STO), category 1, PL c</p>  <p>Prevention of unexpected start-up, category 1, PL c</p> 
Safe state	The pneumatic drive is exhausted and free of energy. It is presumed that the exhausted state of the pneumatic drive is the safe state.
Function	The safety requirement (S2): <ol style="list-style-type: none"> 1. Interrupts the input circuit of the safety switching device (T1). 2. Switch off the safe outputs of the safety switching device (T1). 3. The solenoids of the valve (Q20) are no longer controlled. 4. Valve (Q20) moves to its normal position, separates the compressed air supply and exhaust both chambers of the pneumatic drive (M20). This exhausts the pneumatic drive (M20).
Manual reset function	<ol style="list-style-type: none"> 1. After resetting the safety request (S2), e.g. by mechanically unlocking the emergency stop switch or closing the safety guard, the start or restart can be made possible by pressing the acknowledge push button (S1). 2. The safety switching device (T1) can then allow the solenoids of the valve (Q20) to be controlled so that normal operation is possible.

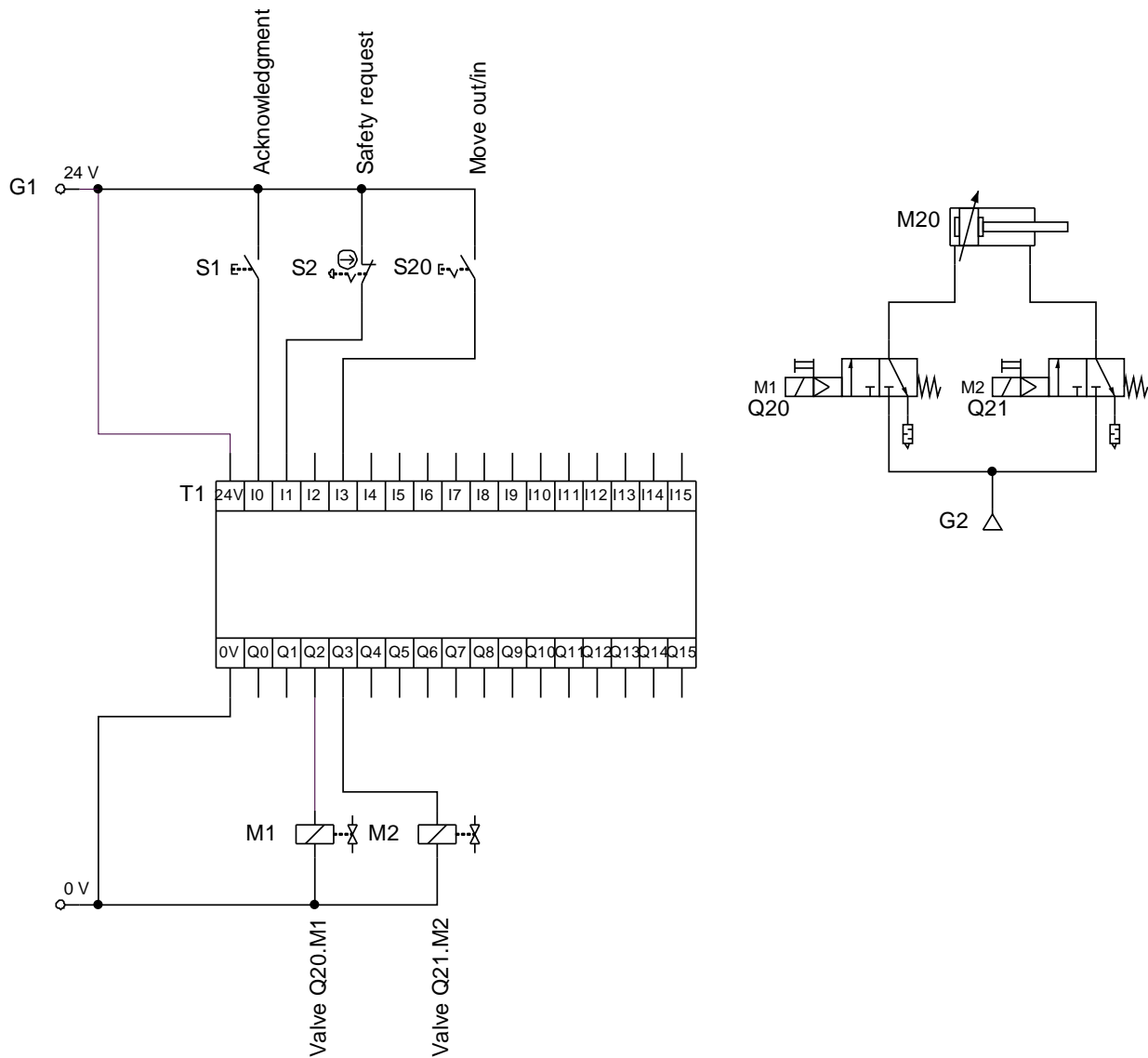
1.1.4 Safety Considerations

Input	Safety considerations must be carried out in accordance with the selected safety commanding device (S2).
Logic	Safety considerations must be carried out in accordance with the selected safety switching device (T1).
Output	The valve (Q20) is a well-tried component according to EN ISO 13849-1 and the relevant basic and well-tried safety principles have been observed. B10 value required for the calculation of the $MTTF_D$ must be available.

1.2 STO and PUS with 3/2 Directional Control Valve, Category 1, up to PL c

STO and PUS according VDMA 24584 [1] and category 1, up to PL c according EN ISO 13849-1 [2].

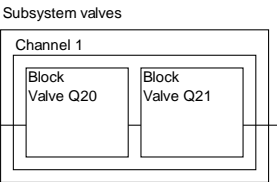
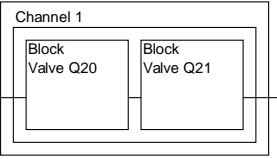
1.2.1 Circuit Diagram



1.2.2 Components

Component	Type	Description / Part Number / Remarks	Qty.	Mssr.
M20		Pneumatic drive	1	Festo
Q20, Q21		3/2 directional control valve	2	Festo
		Silencer, if necessary	2	Festo
S1		Acknowledge push button	1	
S2		Safety commanding device, e.g. emergency stop switch	1	
S20		Switch functional control	1	
T1		Safety switching device	1	

1.2.3 Description

Application	Double acting drive, horizontal
Triggering event	Safety request, e.g. by emergency stop switch, safety gate
Reaction (Element safety function)	<p>Safe torque off (STO), category 1, PL c</p>  <p>Prevention of unexpected start-up (PUS), category 1, PL c</p> 
Safe state	The pneumatic drive is exhausted and free of energy. It is presumed that the exhausted state of the drive is the safe state.
Function	<p>The safety requirement (S2):</p> <ol style="list-style-type: none"> 1. Interrupts the input circuit of the safety switching device (T1). 2. The safe outputs of the safety switching device (T1) are then switched off. 3. The solenoid of the valves (Q20, Q21) are no longer controlled. 4. Valves (Q20, Q21) move to their normal position, separate the supply of the operating pressure and exhausts both chambers of the pneumatic drive (M20). This exhausts the pneumatic drive (M20).
Manual reset function	<ol style="list-style-type: none"> 1. After resetting the safety request (S2), e.g. by mechanically unlocking the emergency stop switch or closing the safety gate, the start or restart can be made possible by actuating the acknowledgement button (S1). 2. Then the safety switching device (T1) can allow the solenoids of the valves (Q20, Q21) to be controlled so that normal operation is possible.

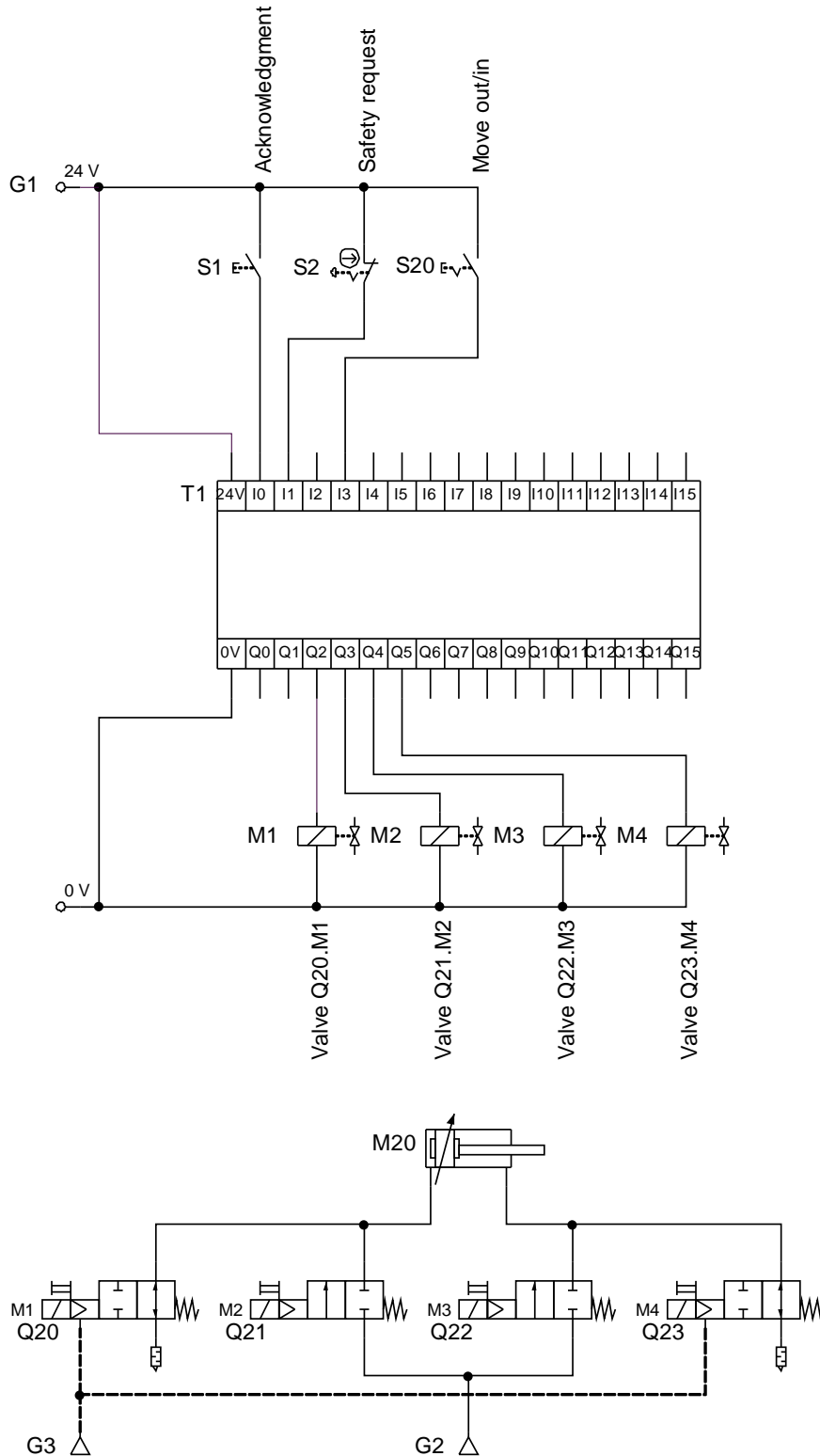
1.2.4 Safety Considerations

Input	Safety considerations must be carried out in accordance with the selected safety commanding device (S2).
Logic	Safety considerations must be carried out in accordance with the selected safety switching device (T1).
Output	The valves (Q20, Q21) are well-tried components according to EN ISO 13849-1 and the relevant basic and well-tried safety principles have been observed. B10 value required for the calculation of the $MTTF_0$ must be available.

1.3 STO and PUS with 2/2 Directional Control Valve, Category 1, up to PL c

STO and PUS according VDMA 24584 [1] and category 1, up to PL c according EN ISO 13849-1 [2].

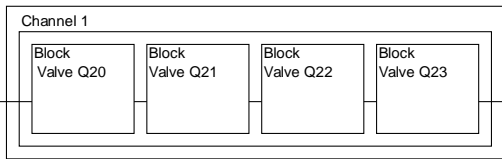
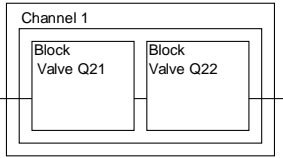
1.3.1 Circuit Diagram



1.3.2 Components

Component	Type	Description / Part Number / Remarks	Qty.	Mssr.
M20		Pneumatic drive	1	Festo
Q20, Q23		2/2 directional control valve, open, external pilot air supply	2	Festo
Q21, Q22		2/2 directional control valve, closed	2	Festo
		Silencer, if necessary	2	Festo
S1		Acknowledge push button	1	
S2		Safety commanding device, e.g. emergency stop switch	1	
S20		Switch functional control	1	
T1		Safety switching device	1	

1.3.3 Description

Application	Double acting drive, horizontal
Triggering event	Safety request, e.g. by emergency stop switch, safety gate
Reaction (Element safety function)	<p>Safe torque off (STO), category 1, PL c</p> <p>Subsystem valves</p>  <p>Prevention of unexpected start-up (PUS), category 1, PL c</p> <p>Subsystem valves</p> 
Safe state	The pneumatic drive is exhausted and free of energy. It is presumed that the exhausted state of the drive is the safe state.
Function	<p>The safety requirement (S1):</p> <ol style="list-style-type: none"> 1. Interrupts the input circuit of the safety switching device (T1). 2. The safe outputs of the safety switching device (T1) are then switched off. 3. The solenoid of the valves (Q20, Q21, Q22, Q23) are no longer controlled. 4. Valves (Q21, Q22) move to their normal position, separate the supply of the working pressure to the pneumatic drive (M20). Valves (Q20, Q23) move to their normal position and exhausts both chambers of the pneumatic drive (M20). This exhausts the pneumatic drive (M20).
Manual reset function	<ol style="list-style-type: none"> 1. After resetting the safety request (S2), e.g. by mechanically unlocking the emergency stop switch or closing the safety gate, the start or restart can be made possible by actuating the acknowledgement button (S1). 2. Then the safety switching device (T1) can allow the solenoids of the valves (Q20, Q21, Q22, Q23) to be controlled so that normal operation is possible.

1.3.4 Safety Considerations

Input	Safety considerations must be carried out in accordance with the selected safety commanding device (S2).
Logic	Safety considerations must be carried out in accordance with the selected safety switching device (T1).
Output	The valves (Q20, Q21, Q22, Q23) are well-tried components according to EN ISO 13849-1 and the relevant basic and well-tried safety principles have been observed. B10 value required for the calculation of the $MTTF_D$ must be available.

2 Literature

- [1] VDMA 24584:2016-08 - Safety functions of regulated and unregulated (fluid) mechanical systems (German edition)
- [2] 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