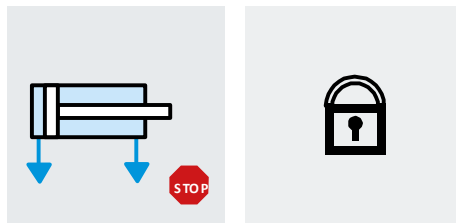


## Application Note

# FESTO

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



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

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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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# 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:
  - SET: Safe Equilibrium of Torque
  - 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: external
  - Duty cycle: 100%.
  - 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  $MTTF_0$  value must be available.

## Important note

- In addition, further design features and requirements may exist, which must be determined depending on the application.
- Due to the wide variety of possible pressure regulators, no pressure regulator type and part numbers can be given in this document. When selecting pressure regulators, make sure that the selected pressure regulators have the following characteristics:
  - Controller function: output pressure constant with secondary exhaust
  - 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  $MTTF_0$  value must be available.

## Important note

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

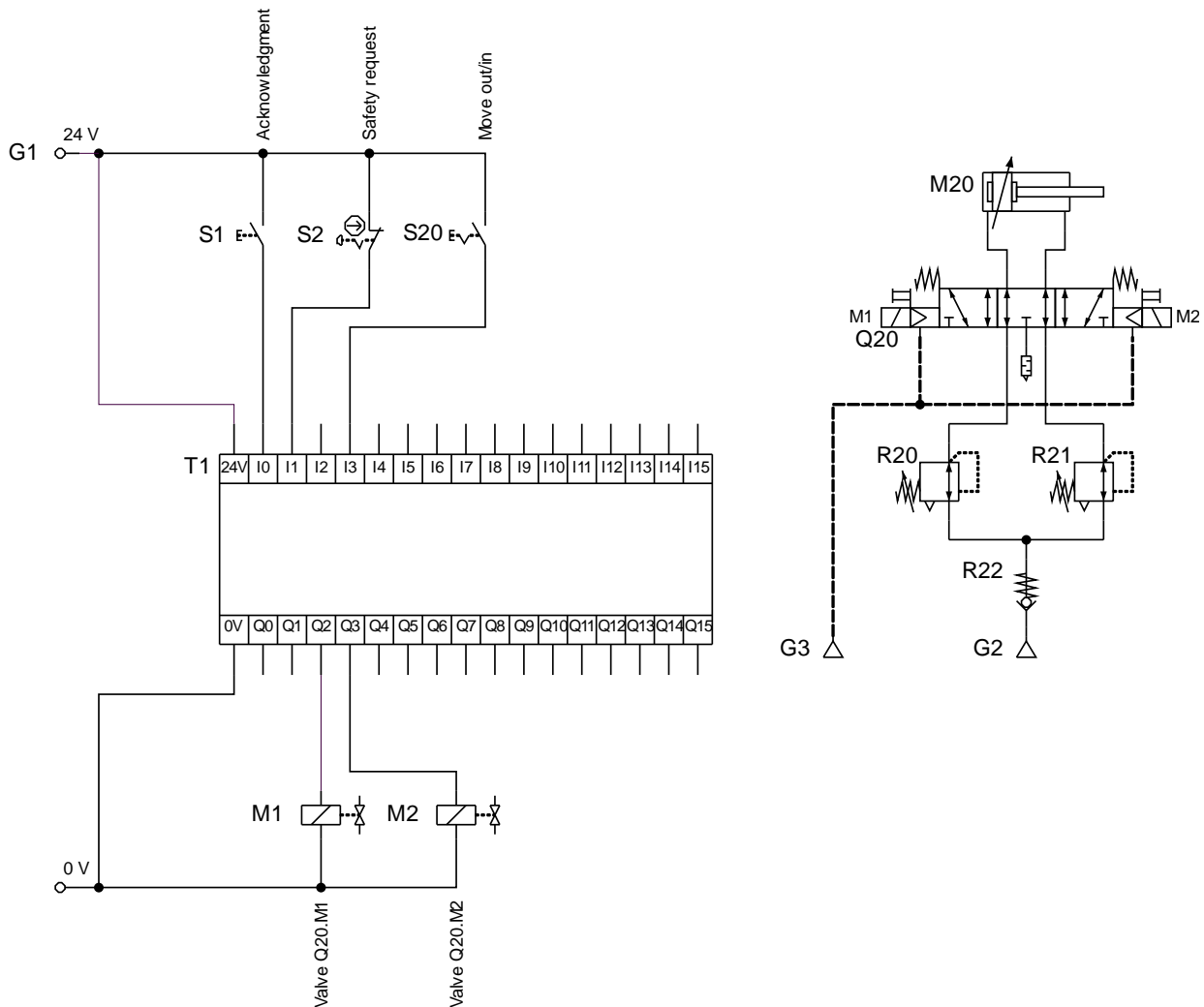
## 1.1 SET and PUS with 5/3 Directional Control Valve, Category 1, up to PL c

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

### 1.1.1 Circuit Diagram



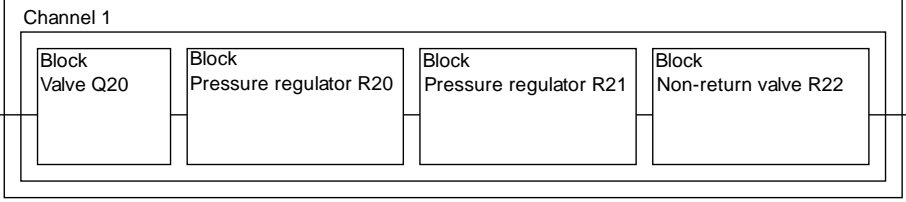
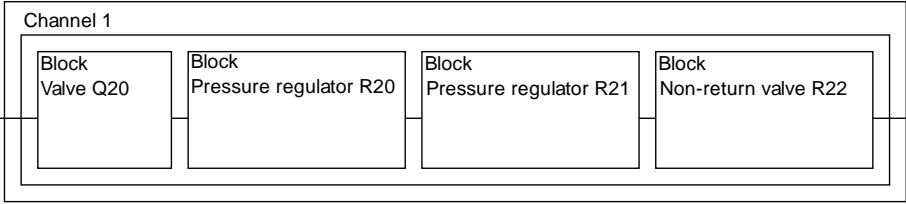
According to EN ISO 14118 enclosed pressurized air shall be marked and shall be provided with a possibility for manual pressure release.



### 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	1	Festo
R20, R21		Pressure regulator	2	Festo
R22		Non-return valve	1	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
Triggering event	Safety request, e.g. by emergency stop switch, safety gate
Reaction (Safety Sub-function)	<p><b>Safe equilibrium of torque (SET), category 1, PL c</b></p> <p>Subsystem valves</p>  <p><b>Prevention of unexpected start-up, category 1, PL c</b></p> <p>Subsystem valves</p> 
Safe state	<p>The chambers of the pneumatic drive are supplied with compressed air. The pressures in the chambers are adjusted with pressure regulators so that all forces on the pneumatic drive are balanced, i.e. the external forces are compensated by the force of the pneumatic drive and the pneumatic drive can thus maintain its current position.</p> <p>It is presumed that this condition of the pneumatic drive can be a safe condition.</p> <p>Notes:</p> <ul style="list-style-type: none"> <li>• The safe state presumes that the external forces and the force generated by the drive remain constant. If there are different load conditions in the application, it is recommended to adjust the moment equilibrium for the largest load so that for smaller loads there is movement in the direction where the risk is lower. Depending on the risk, it may be necessary to evaluate the safety sub-function SLT for smaller loads or to use clamping units.</li> <li>• Depending on the settings of the pressure regulators (R20, R21) and the application, the SET safety sub-function can perform a stop function. If there are different load conditions in the application, the stop function can only be executed for one load condition. With the other load conditions, the pneumatic drive will normally come to a standstill in its end position.</li> <li>• If the operating pressure supply (G2) is exhausted, the exhausted state of the pneumatic drive (M20) can be brought about by actuating the valve (Q20) in both switching states.</li> <li>• The non-return valve (R22) is used to maintain the operating pressure when the compressed air supply is switched off or fails. After switching off or after failure of the operating pressure, a movement may occur due to the leakage which cannot be stopped.</li> <li>• The settings of the pressure regulators (R20, R21) must be protected against manipulation, e.g. by lockable pressure regulators.</li> <li>• If the load changes or additional external forces act, a movement can take place. Whether this can lead to a risk depends on the application. Additional measures may be required if the movement represents a risk, e.g. a clamping unit.</li> <li>• For vertically mounted pneumatic drives, a stationary known load can be held at any intermediate position.</li> <li>• In the safe state, the pneumatic drive is usually easy to move by hand.</li> <li>• According to EN ISO 13736 [3], the movement possible due to leakage or changes in the tribological system must not exceed a value of 5 mm/s. This must be checked at regular intervals, e.g. in the maintenance interval of the machine.</li> </ul>
Function	<p>The safety requirement (S2):</p> <ol style="list-style-type: none"> <li>1. Interrupts the input circuit of the safety switching device (T1).</li> </ol>

	<ol style="list-style-type: none"> <li>2. Switch off the safe outputs of the safety switching device (T1).</li> <li>3. The solenoids of the valve (Q20) are no longer controlled.</li> <li>4. The valve (Q20) switches to its normal position and connects the chambers of the pneumatic drive (M20) with the pressure regulators (R20, R21). The pressure regulators are set so that the known load is held in position at standstill.</li> </ol>
Manual reset function	<ol style="list-style-type: none"> <li>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).</li> <li>2. The safety switching device (T1) can then allow the solenoids of the valve (Q20) to be controlled so that normal operation is possible.</li> </ol>

#### 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), the pressure regulators (R20, R21) and the non-return valve (R22) 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.

## 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
- [3] DIN EN 13736:2009-11 - Safety of machine tools - Pneumatic presses; German version EN 13736:2003+A1:2009