

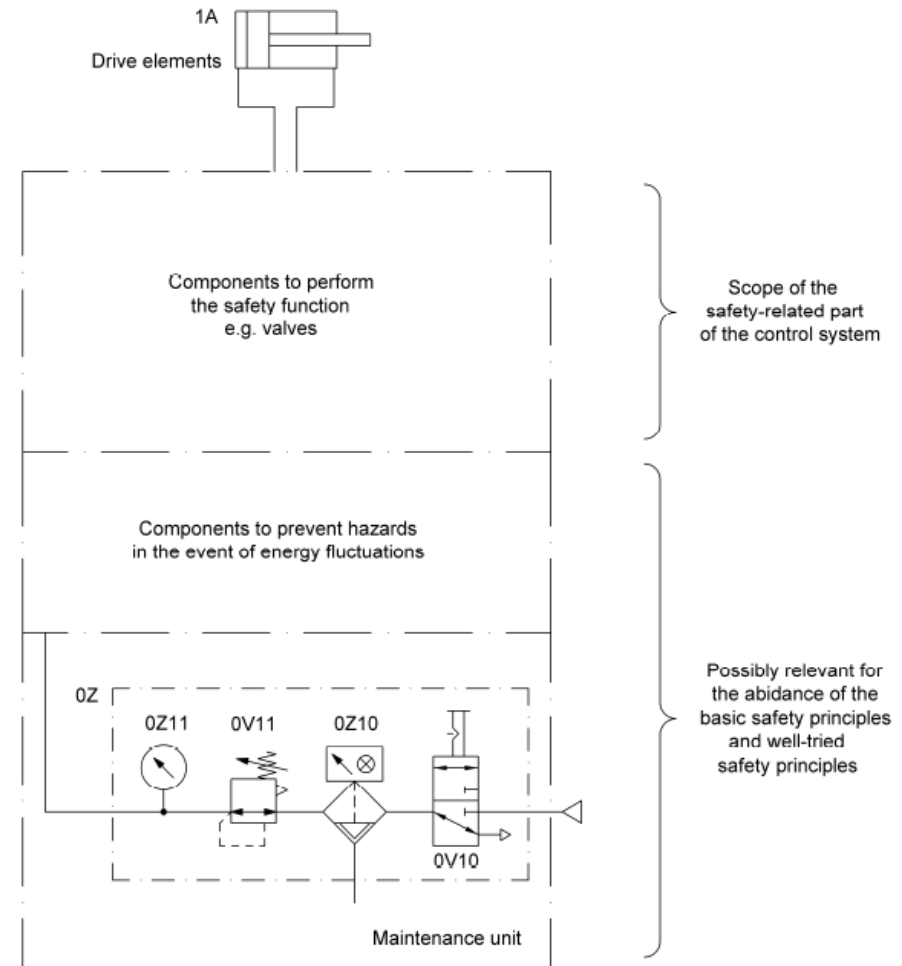
„Application of EN ISO 13849-1 in electro-pneumatic control systems“

Hazards and measures against hazards by implementation of safe pneumatic circuits

These examples of switching circuits are offered free of charge. For this reason, we do not assume any liability or responsibility for whatever legal reason, especially not for correctness of contents, faultlessness, completeness or technical or commercial usability of this guideline.

Scope of EN ISO 13849 for pneumatic systems

- The area of valves in particular should be considered as „safety-related part of the control system“, and specifically the valves which control hazardous movements or states.
- The drive elements and components for energy conversion and transmission generally lie outside the scope of the standard.
- Maintenance units for conditioning of compressed air must be considered from a safety perspective in conjunction with the valve area.
- For possible energy conversions to be controlled with consideration for safety aspects, an exhaust valve is frequently used in conjunction with a pressure switch.



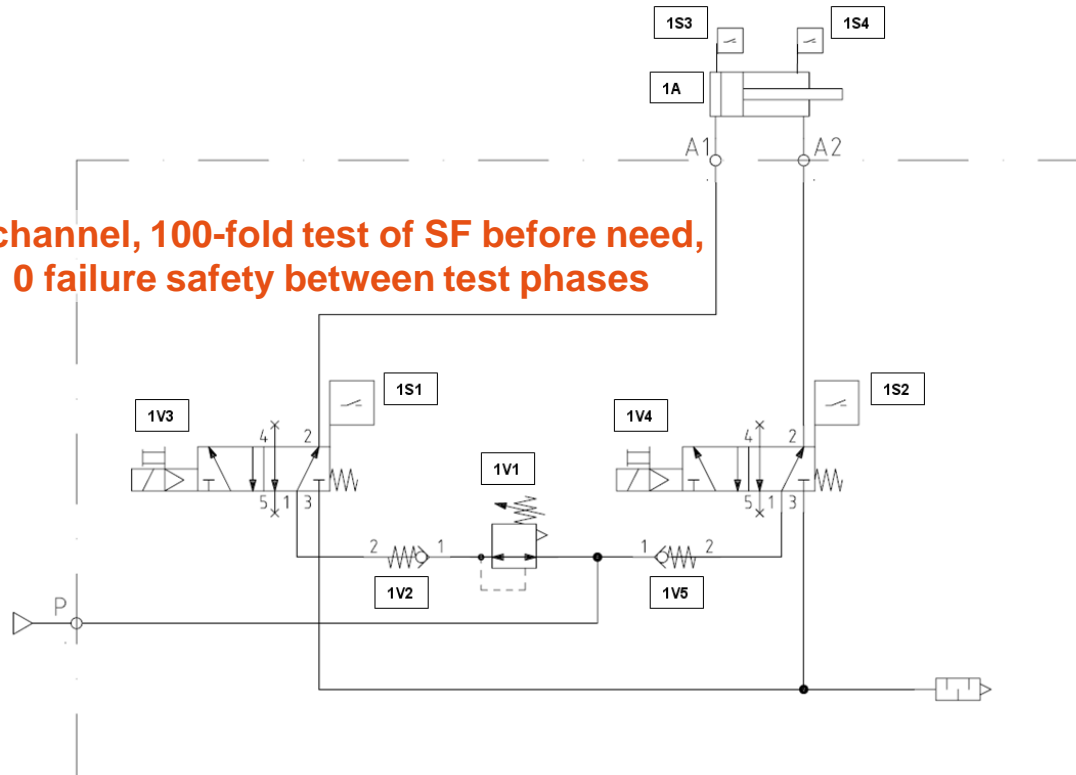
Source: BGIA Report 2/2008e Functional safety of machine controls

Example 1

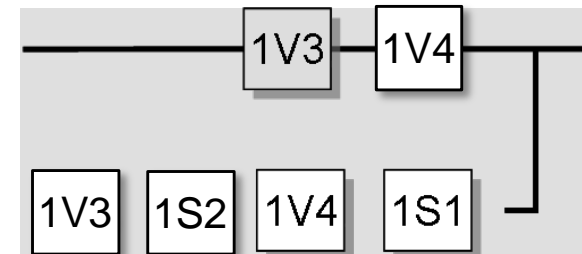
Stop of cylinder movement by pressurizing both sides (Category 2), possible PL a-d

- **In case of pressure drop**, the non-return valves 1V2 and 1V5 avoid exhausting -> cylinder is kept in position.
- The pressure regulator 1V1 reduces supply pressure so that there is a balance of forces → cylinder movement is stopped

1 channel, 100-fold test of SF before need, 0 failure safety between test phases



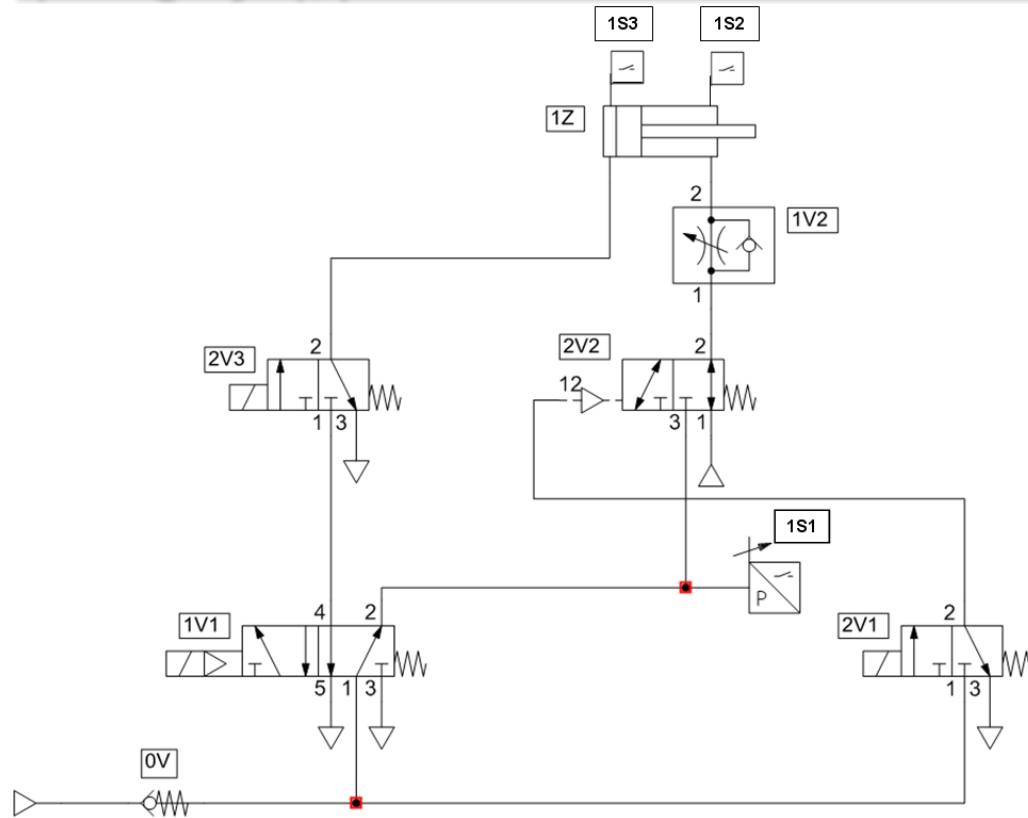
▪ Block diagram



Positive assessment by IFA

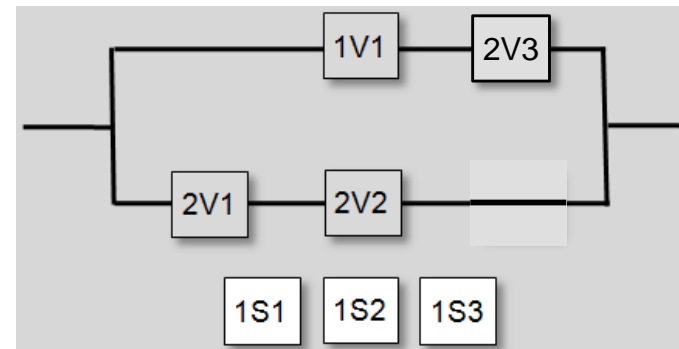
Example 2a

Safe retraction of a cylinder (Category 3), possible PL a-e



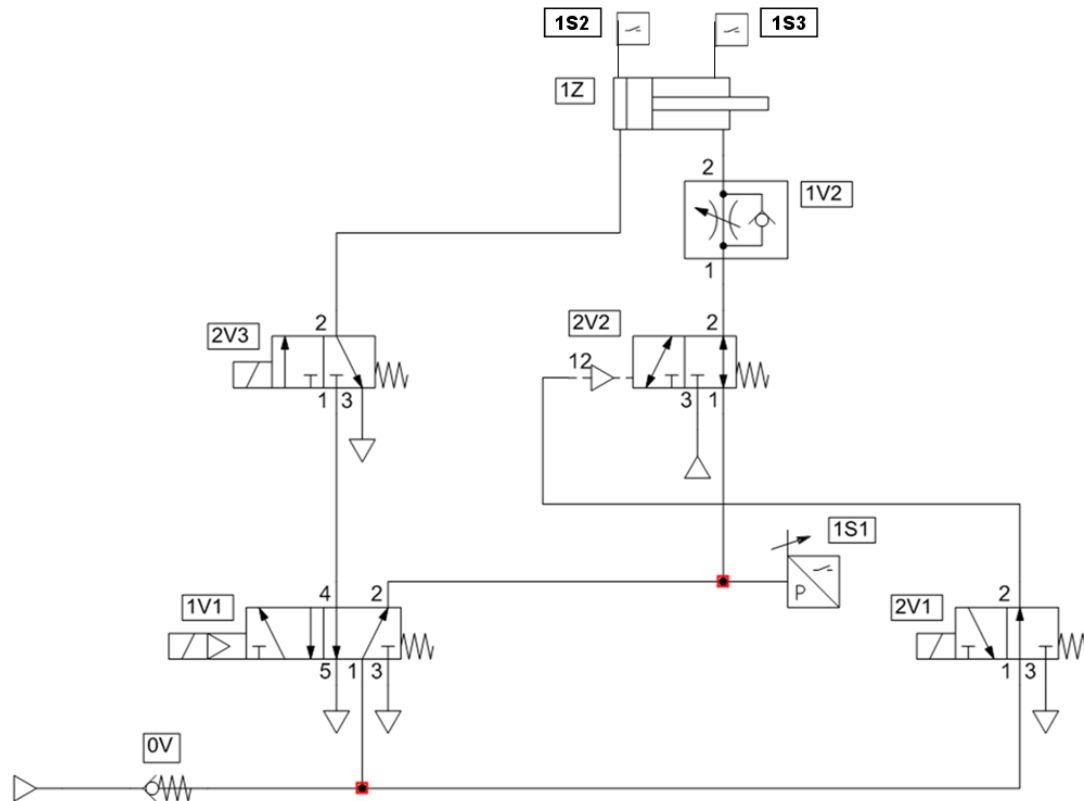
- The cylinder 1Z can be retracted by non-operating of valve 1V1 or non-operating of valves 2V3 and 2V1.
- On permanent operation of valves 2V3 and 2V1, the cylinder 1Z can be driven by valve 1V1.
- The retraction of the cylinder is redundant.
- Further safety function: redundant „avoidance of unexpected start-up“, (category 3).

▪ Block diagram



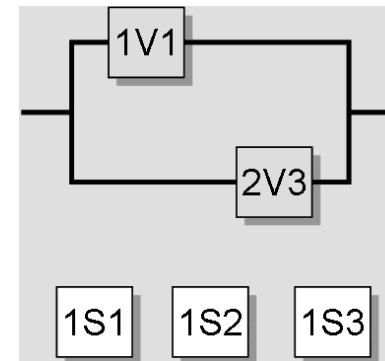
Example 2b

**Protection against unexpected start-up
(Category 3), possible PL a-e**



- The cylinder can be kept in initial position with both switching positions of valve 2V2.
- The cylinder can only be extracted with full power by operating the valves 1V1, 2V3 and 2V1.

▪ Block diagram

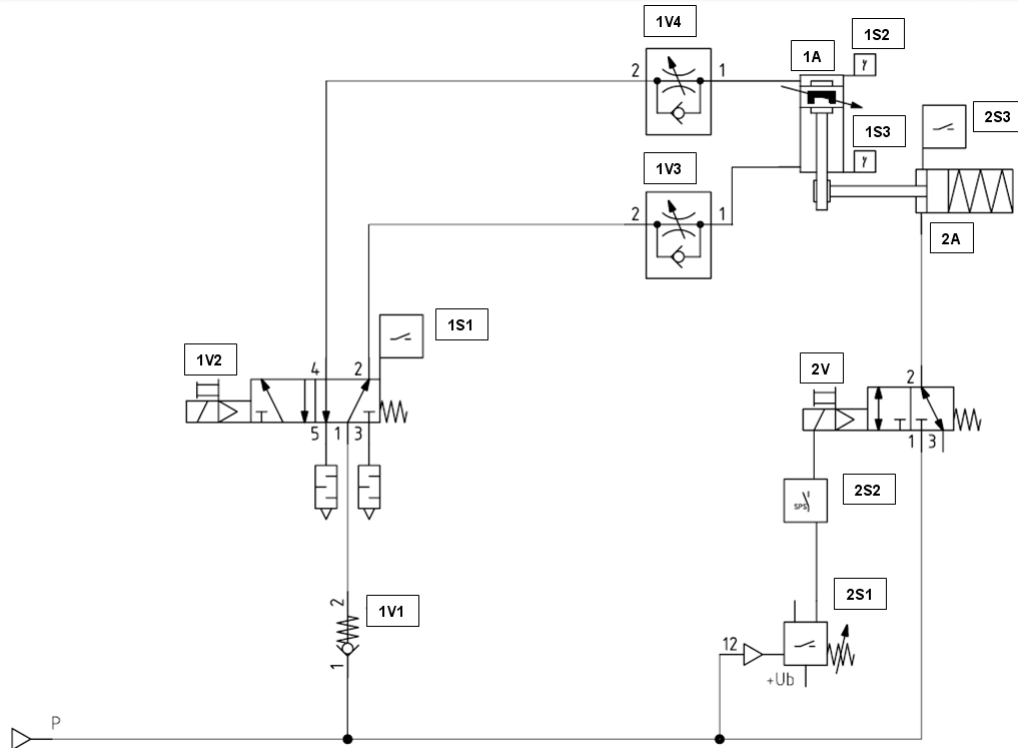


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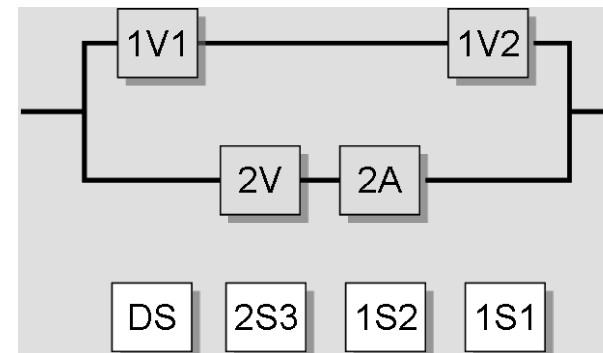
Example 3

Safe stop in upper position by clamping and one-sided pressurizing (Category 3, Category 4 attainable), possible PL a-e

- Clamping unit 2A can be released by valve 2V with supply pressure at pressure switch 2S1 and a control system 2S2.
- Non-return valve 1V1 avoids exhausting on pressure drop.



Block diagram

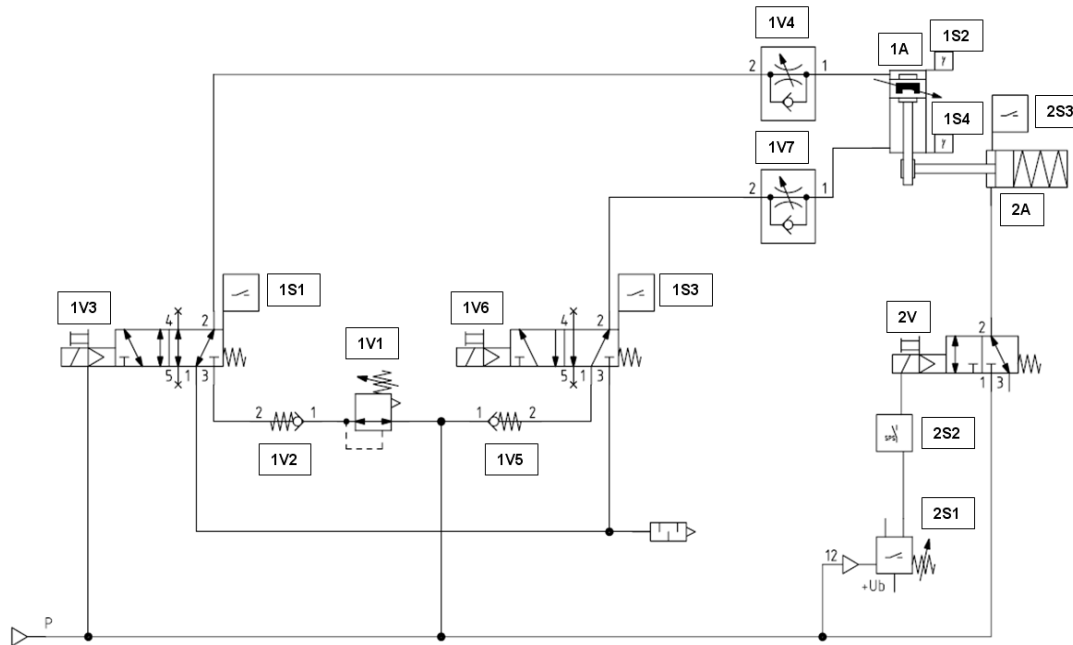


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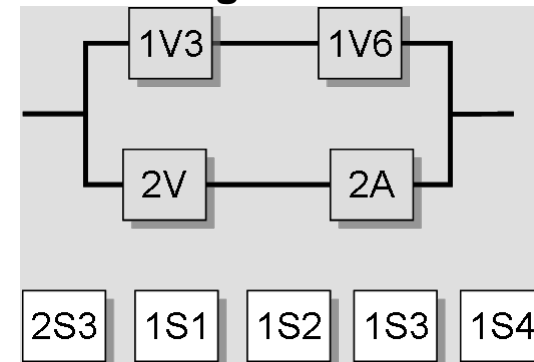
Example 4

Safe stop of a cylinder in upper position by clamping and one-sided pressurizing (Category 3, Category 4 attainable), possible PL a-e

- Approaching the upper end-position in basic switching position of valves 1V3 and 1V6.
- Clamping unit 2A which can be released by valve 2V with supply pressure at pressure switch 2S1 and a control system 2S2.



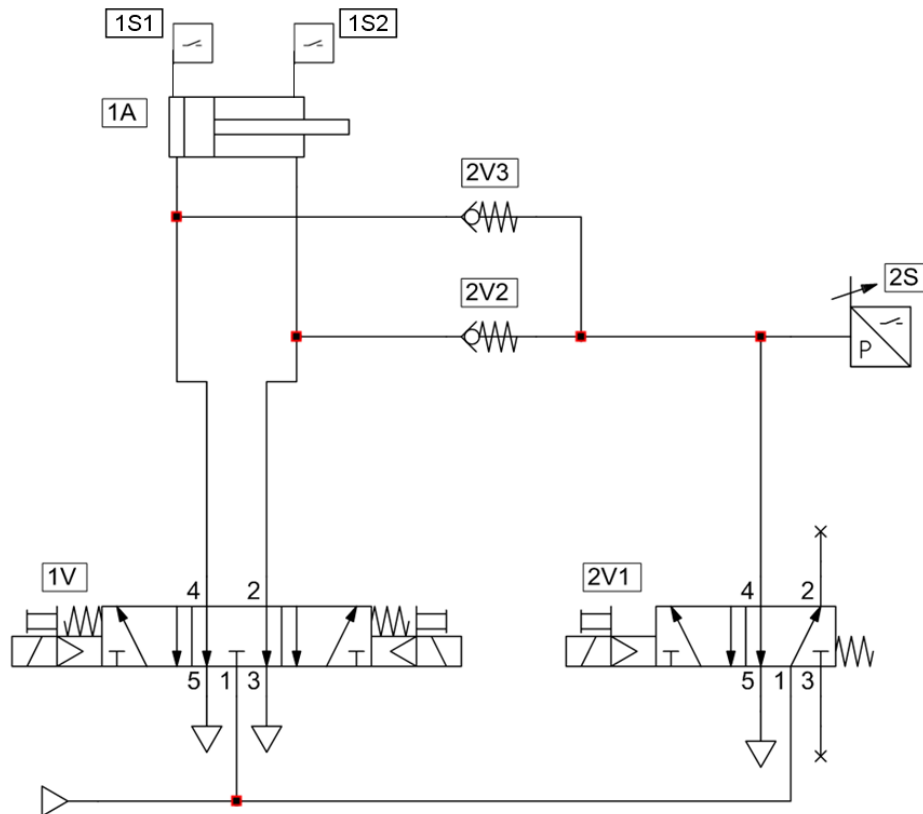
Block diagram



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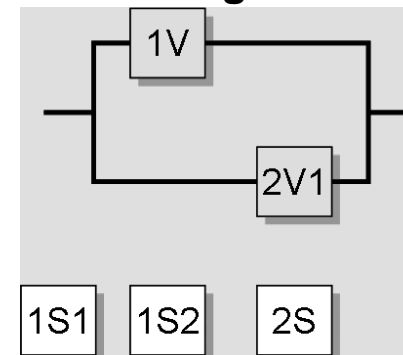
Example 5

Safe exhausting (Category 3), possible PL a-e



- The system is exhausted in the basic switching position of the valves, → **2 paths for exhausting**:
 1. Via non-return valves 2V2 and 2V3 and valve 2V1 (the minimum opening pressure of the non-return valves is to be respected).
 2. Via valve 1V.
- Retraction and extraction of the cylinder is only possible with combined operation of 2V1.

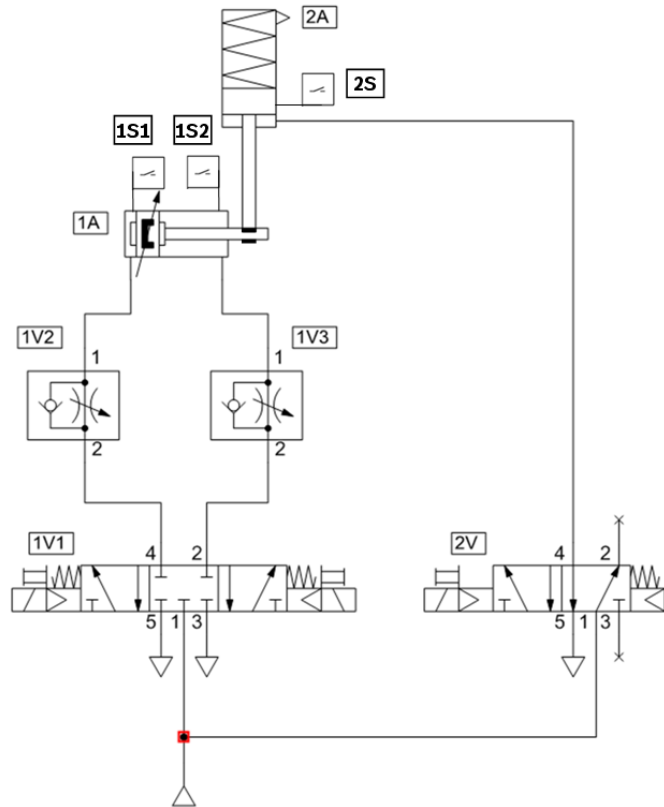
▪ Block diagram



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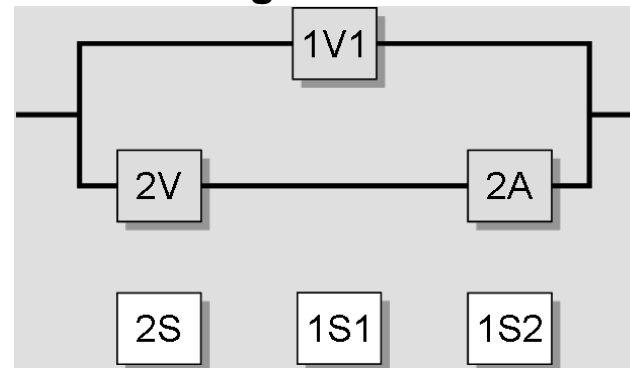
Example 6 (BGIA Example 8.2.14)

Protection against unexpected start-up of the cylinder (Category 3), possible PL a-e



- 2 possibilities to stop / hold the cylinder:
 1. On pressure drop and in the basic switching position of valve 2V, the cylinder is held by clamping unit 2A.
 2. In closed (middle) position of the valve 1V1, the cylinder is stopped by blocking up the air.
- The cylinder can only be extracted or retracted by combined operation of 1V1 and 2V.
- At re-starting, check the pressure balance of the cyl. piston.

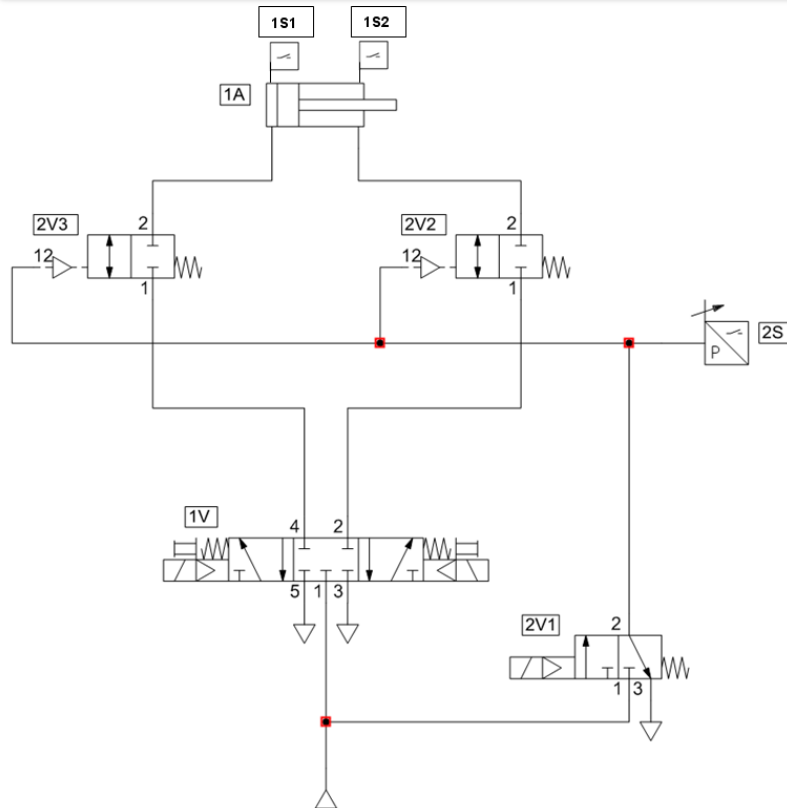
▪ Block diagram



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Example 7 (BGIA Example 8.2.25)

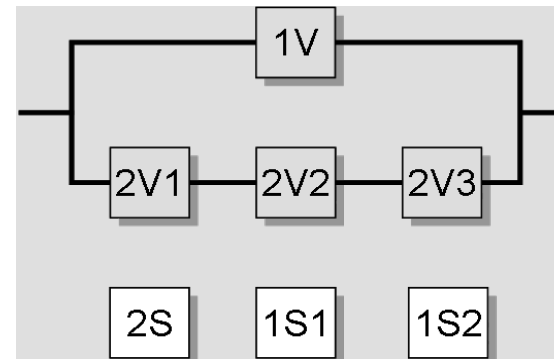
Safe stop / holding by two-channel block-up of air (Category 3), possible PL a-e



- 2 possibilities for stopping / holding the cylinder

 1. For non-operation of 2V1, the valves 2V2 and 2V3 are in closed position.
 2. For non-operation of 1V, the valve is closed in mid-position.

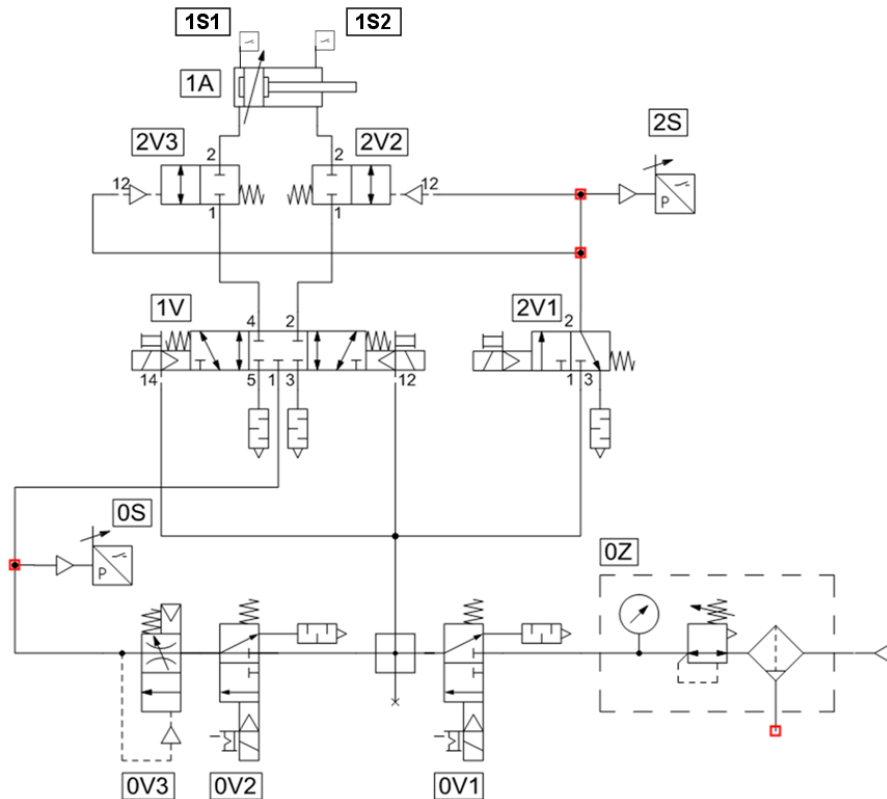
▪ Block diagram



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Example 8 (BGIA Example 8.2.25)

Safe stop / holding by 2-channel block-up of air + extension (Category 3), possible PL a-e

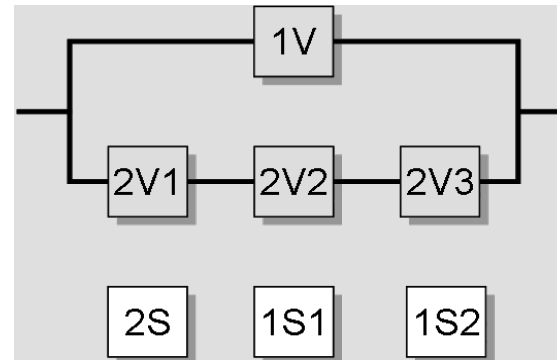


- 2 possibilities for stopping / holding the cylinder
- 1. On non-operating of 2V1, the valves 2V2 and 2V3 are in closed position.
- 2. On non-operation of 1V, the valves is closed in mid- position.

Extended options:

- Release of pilot air for 1V and compressed air supply for 2V1 by operating 0V1.
- Controlled start-up by filling unit 0V3.

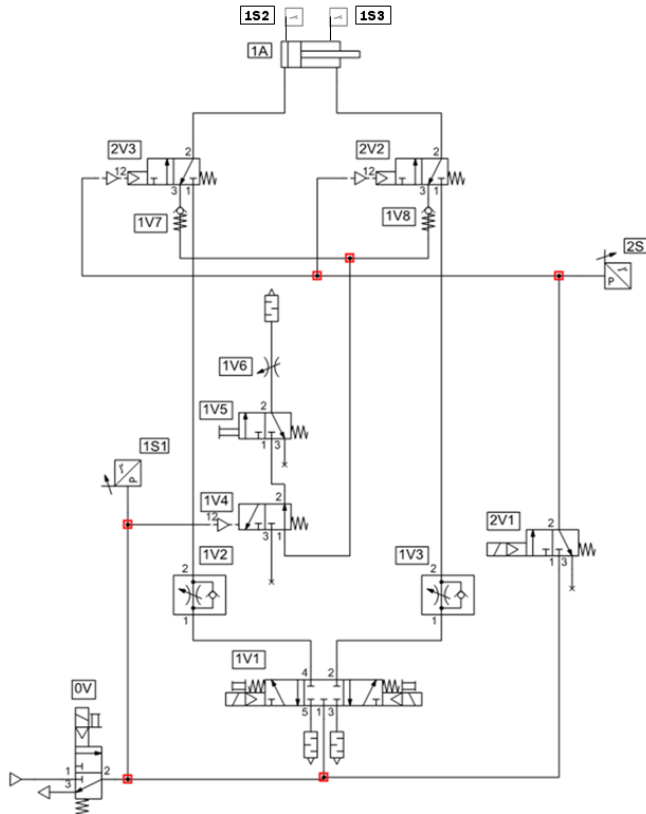
▪ Block diagram



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Example 9

Safe stop / holding by 2-channel block-up of air (Category 3), possible PL a-e + extension

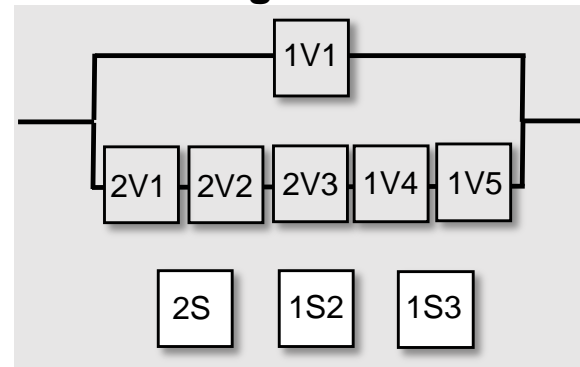


Stop / Hold the cylinder

- On non-operation of 1V5, the valve is in closed mid-position.
- If 2V2 and 2V3 are operated, the valve 1V1 closes up in mid-position.

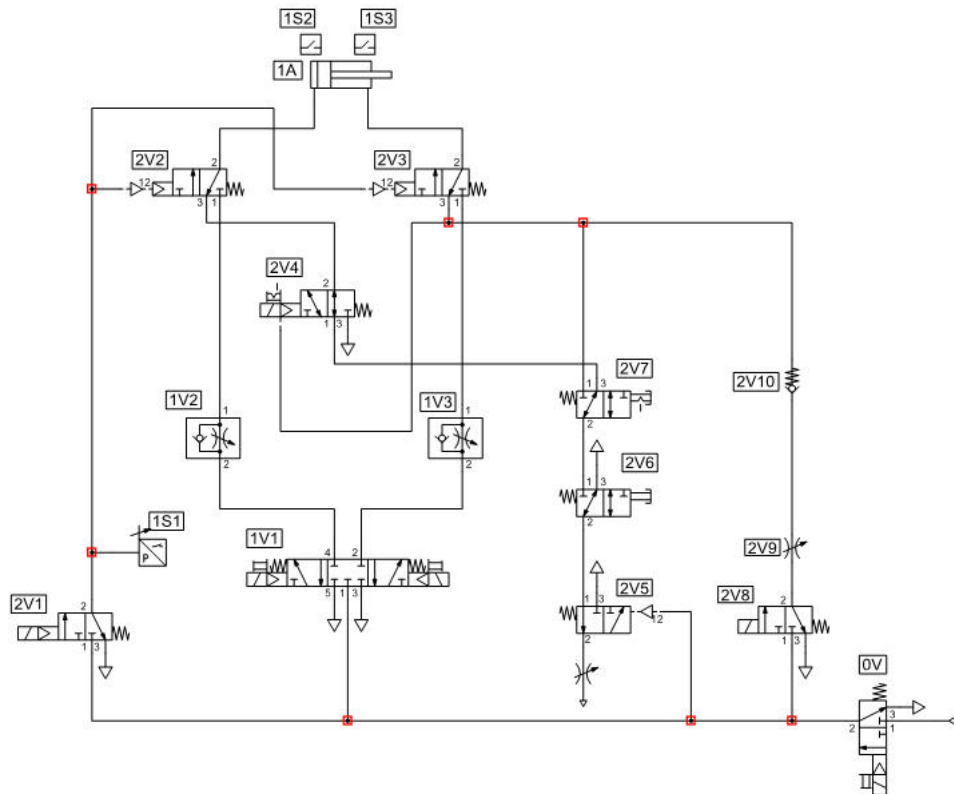
Extended option: targeted exhausting on pressure drop during setting mode, e.g. for rescue of persons by switching 1V5.

Block diagram



Example 10

Safe stop / holding by 2-channel block-up of air (Category 3), possible PL a-e + extension

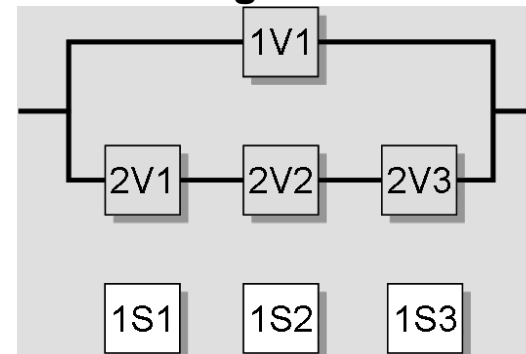


Stop / Hold the cylinder

- Close up via valve 2V6 and non-return valve 2V10.
- On non-operation of 1V1, the valve is closed in mid-position.

Extended option: Targeted exhausting on pressure drop by switching 2V6 and controlled movement of the cylinder into start-up position by one-sided throttled pressurizing via 2V8.

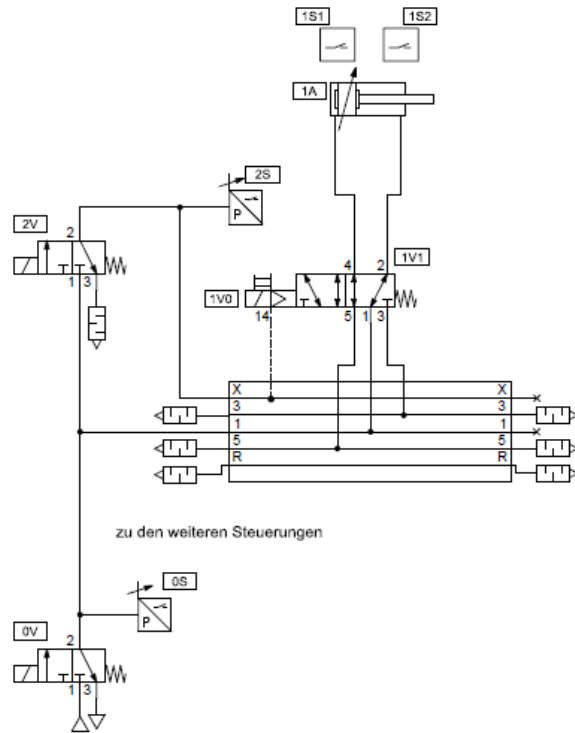
Block diagram



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Example 12

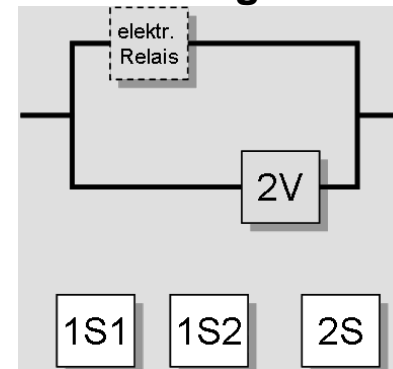
Avoid unexpected operation by blocking up pilot air (Category 3), possible PL a-e



Block-up of pilot air

- The pilot air is blocked through 2V in basic switching position, the valve 1V1 cannot be operated.

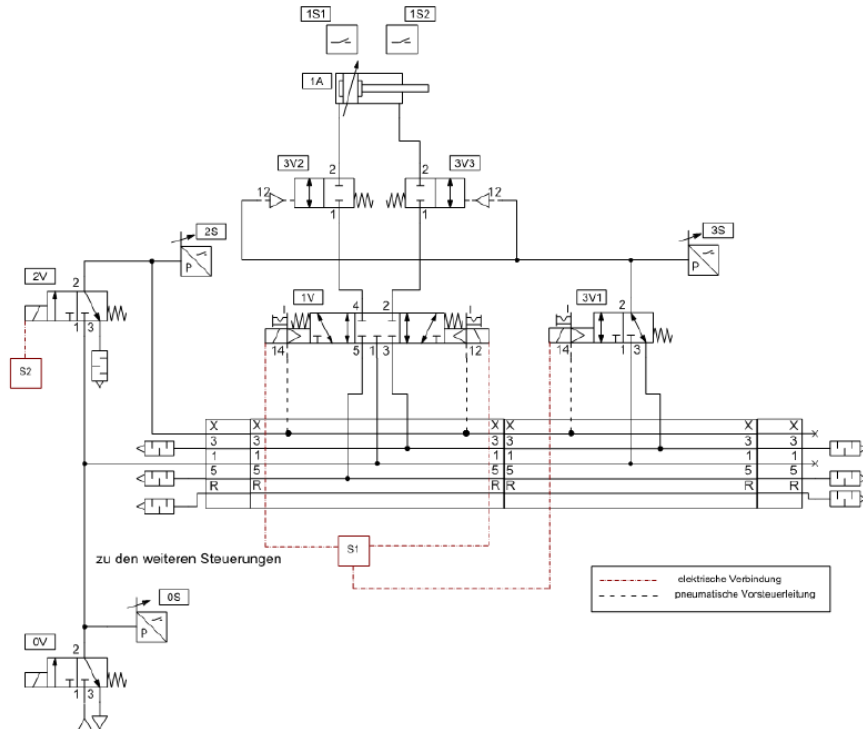
Block diagram



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Example 13

Avoid unexpected operation by blocking up pilot air + safe stop/holding by two-channel block-up of air (Category 3), possible PL a-e



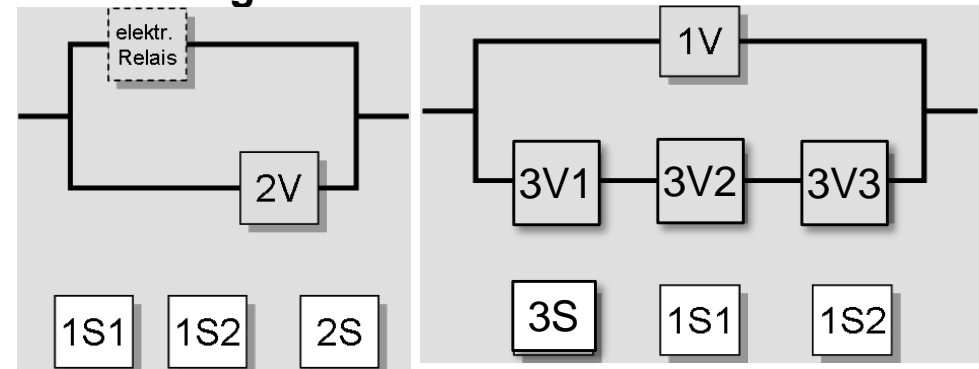
Block-up of pilot air

1. In the basic position, the pilot air is blocked through 2V, the valves 1V and 3V1 cannot be operated.

Block-up of air

2. On non-operating of 3V1, the valves 3V2 and 3V3 are in closed position.
3. On non-operating of 1V, the valve is closed in mid-position.

Block diagram



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