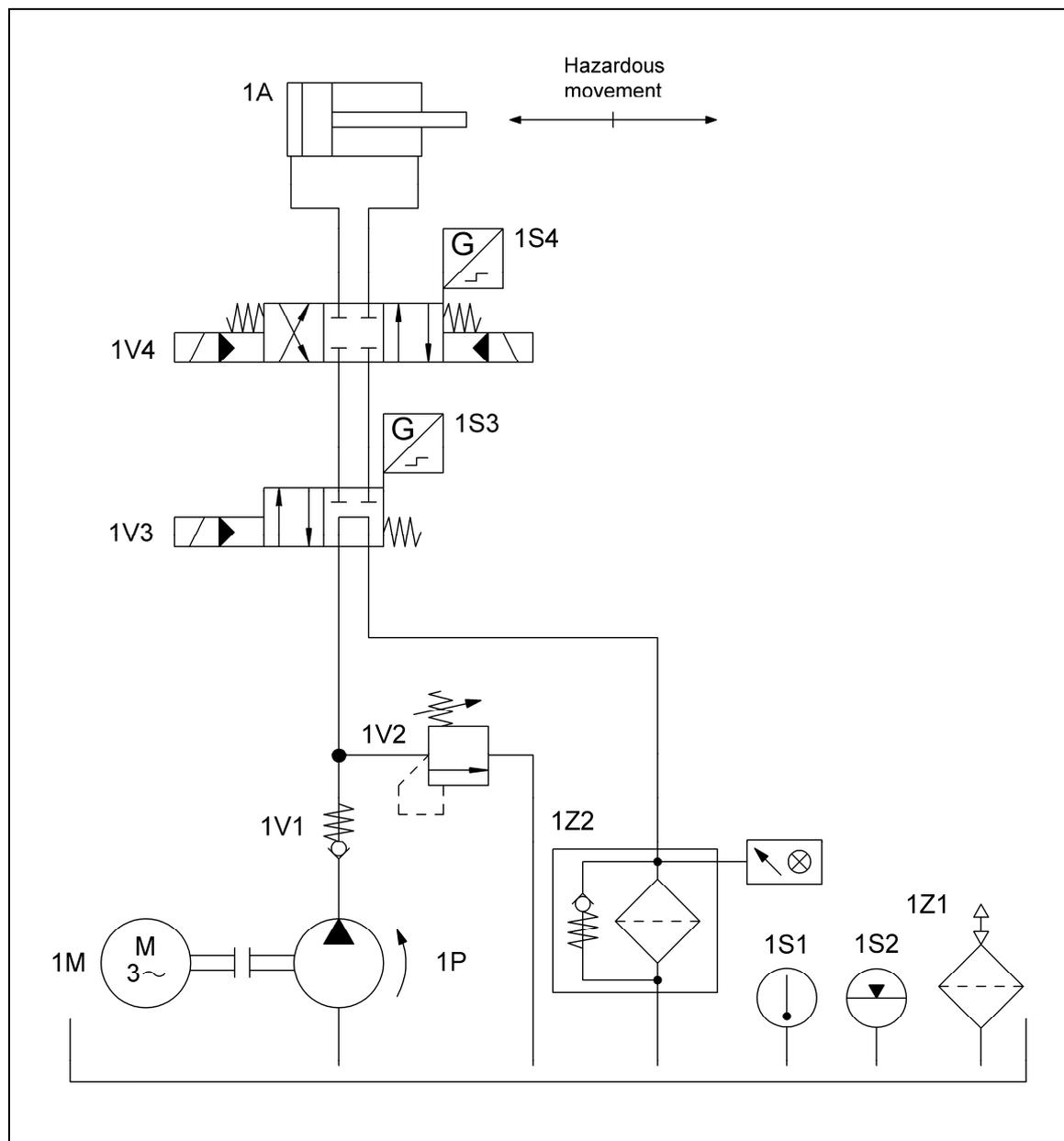




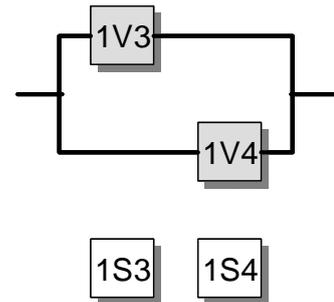
8.2.32 Hydraulic valve control (subsystem) – Category 4 – PL e (Example 32)

Figure 8.54:
Tested hydraulic valves for redundant control of hazardous movements



Safety functions

- Safety-related stop function: stopping of the hazardous movement and prevention of unexpected start-up from the rest position
- Only the hydraulic part of the control is shown here, in the form of a subsystem. Further safety-related control components (e.g. protective devices and electrical logic elements) must be added in the form of subsystems for completion of the safety function.



Functional description

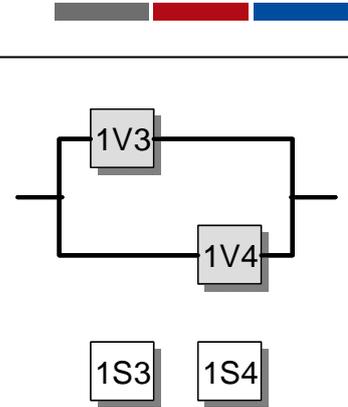
- Hazardous movements are controlled by two directional control valves (1V3 and 1V4).
- Failure of one of the two valves alone does not result in loss of the safety function.
- The two directional control valves are actuated cyclically.
- Both directional control valves are equipped with direct position monitors (1S3 and 1S4). Failure of either of the two directional control valves is detected; following a fault, initiation of the next hazardous movement is prevented.

Design features

- Basic and well-tried safety principles are observed and the requirements of Category B are met.
- Directional control valves 1V3 and 1V4 possess a closed centre position with sufficient overlap, spring-centering/return, and electrical position monitoring.
- The safety-oriented switching position is assumed from any position by removal of the control signal.
- Signal processing by the electrical position monitor satisfies the relevant requirements for the control of failures.

Calculation of the probability of failure

- $MTTF_d$: an $MTTF_d$ of 150 years is assumed for the directional control valves 1V3 and 1V4 [S]. This is also the $MTTF_d$ value per channel, which is capped to 100 years (“high”).
- DC_{avg} : the DC of 99% for the directional control valves 1V3 and 1V4 is based upon direct monitoring of the switching states. Averaging thus also produces a DC_{avg} of 99% (“high”).
- Adequate measures against common cause failure (65 points): separation (15), overvoltage protection etc. (15) and environmental conditions (25 + 10)
- The combination of the hydraulic control elements corresponds to Category 4 with a high $MTTF_d$ (100 years) and high DC_{avg} (99%). This results in an average



probability of dangerous failure of 2.47×10^{-8} per hour. This corresponds to PL e. The addition of further safety-related control parts as subsystems for completion of the safety function generally results in a lower PL.

Figure 8.55:
Determining of the PL by means of SISTEMA

