

8.2.7 Undervoltage tripping by means of an emergency stop device – Category 1 – PL c (Example 7)

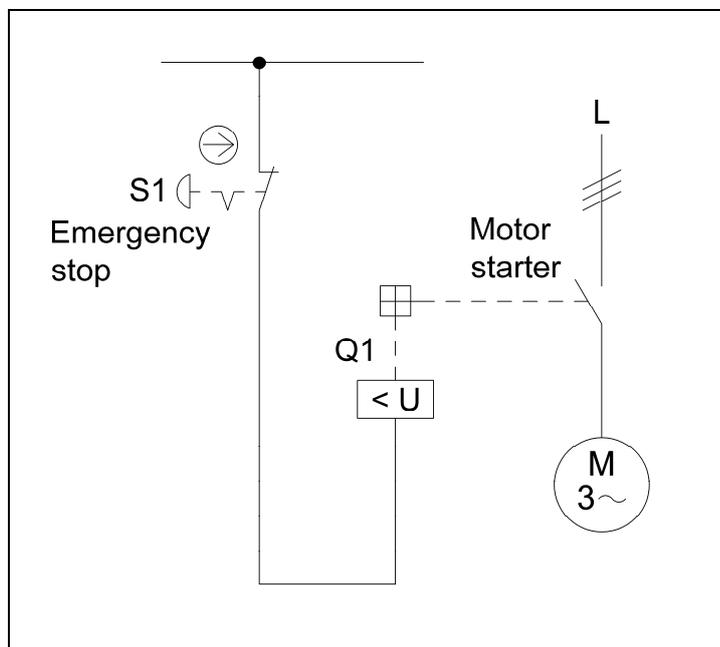


Figure 8.14:
Emergency stop device acting upon the undervoltage release of the supply disconnecting device (motor starter)

Safety function

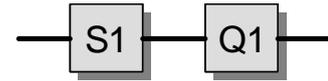
- Emergency stop function, STO (safe torque off) by actuation of the emergency stop device which acts upon the undervoltage release of a motor starter, where appropriate the supply disconnecting device.

Functional description

- Hazardous movements or states are interrupted by actuation of the emergency stop device S1 by undervoltage tripping of the supply disconnecting device, in this case in the form of a motor starter Q1.
- The safety function cannot be maintained with all component failures, and is dependent upon the reliability of the components.
- No measures for fault detection are implemented.

Design features

- Basic and well-tried safety principles are observed and the requirements of Category B are met. Protective circuits (e.g. contact protection) as described in the initial sections of Chapter 8 are implemented. The closed-circuit current principle of the undervoltage release is employed as the basic safety principle.
- The emergency stop device S1 is a switch with direct mode of actuation in accordance with IEC 60947-5-1, Annex K, and is therefore a well-tried component in accordance with Table D.4 of EN ISO13849-2.



- The motor starter Q1 is to be considered equivalent to a circuit-breaker in accordance with Table D.4 of EN ISO 13849-2. Q1 may therefore be regarded as a well-tries component.
- The power supply to the entire machine is switched off (stop category 0 to EN 60204-1).

Remark

- The emergency stop function is a protective measure which supplements the safety functions for the safeguarding of hazardous zones.

Calculation of the probability of failure

- $MTTF_d$: S1 is a standard emergency stop device to EN ISO 13850. Fault exclusion applies for the direct opening contact and the mechanical elements, provided the number of operations indicated in Table D.2 of this report is not exceeded. For the undervoltage release of the motor starter Q1, the B_{10} value approximates to the electrical lifetime of 10,000 switching operations [M]. If 50% of failures are assumed to be dangerous, the B_{10d} value is produced by doubling of the B_{10} value. At actuation of the emergency stop device three times a year and an n_{op} of 3 cycles per year, Q1 has an $MTTF_d$ of 66,666 years. This is also the $MTTF_d$ for the channel, which is capped to 100 years ("high").
- DC_{avg} and measures against common cause failures are not relevant in Category 1.
- The electromechanical control system corresponds to Category 1 with a high $MTTF_d$ (100 years). This results in an average probability of dangerous failure of 1.14×10^{-6} per hour. This corresponds to PL c.

More detailed references

- EN ISO 13850: Safety of machinery – Emergency stop – Principles for design (11.06)
- EN 60204-1: Safety of machinery – Electrical equipment of machines. Part 1: General requirements (06.06)