8.2.1 Position monitoring of moveable guards by means of a proximity switch – Category B – PL b (Example 1)
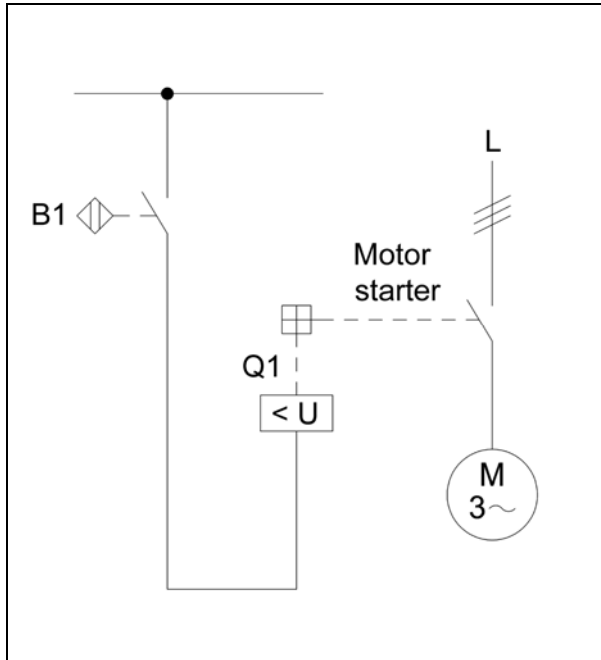

Figure 8.3:
Position monitoring of a moveable guard by means of a proximity switch
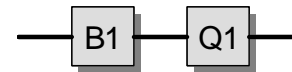
Safety function

- Safety-related stop function, initiated by a protective device: actuation of the proximity switch when the moveable guard (safety guard) is opened initiates the safety function STO (safe torque off).

Functional description

- Opening of the moveable guard (e.g. safety guard) is detected by a proximity switch B1 which acts upon the undervoltage release of a motor starter Q1. The dropping out of Q1 interrupts or prevents hazardous movements or states.

- The safety function cannot be maintained with all component failures, and is dependent upon the reliability of the components.

- Removal of the protective device is detected.

- B1 contains no internal monitoring measures. No further measures for fault detection are implemented.

Design features

- Basic safety principles are observed and the requirements of Category B are met. Protective circuits (e.g. contact protection) as described in the initial paragraphs of Chapter 8 are implemented. The closed-circuit current principle of the undervoltage release is employed as the basic safety principle.

B1 — Q1

- A stable arrangement of the protective device (safety guard) provides assured actuation of the proximity switch.

- Depending upon the design of the proximity switch, safe operation can be bypassed in a reasonably foreseeable manner. Bypassing can be made more difficult, for example by particular conditions for installation, such as mounting in hidden position (see also EN 1088/A1, Annex J).

- The power supply to the entire machine is switched off (stop category 0 to EN 60204-1).

Calculation of the probability of failure

- $MTTF_d$: B1 is a conventional proximity switch on a safety guard with an $MTTF_d$ of 40 years [M]. For the undervoltage release of 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 daily actuation of the proximity switch, an n_{op} of 365 cycles per year for Q1 produces an $MTTF_d$ of 548 years. For the combination of B1 and Q1, the $MTTF_d$ for the channel is 37 years. This value is capped to the arithmetical maximum value for Category B, i.e. 27 years ("medium").

- DC_{avg} and measures against common cause failures are not relevant in Category B.

- The electromechanical control system corresponds to Category B with a medium $MTTF_d$ (27 years). This results in an average probability of dangerous failure of 4.23×10^{-6} per hour. This corresponds to PL b.

More detailed references

- EN 1088/A1: Safety of machinery – Interlocking devices associated with guards – Principles for design and selection (04.07)

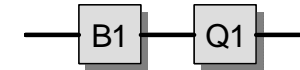- EN 60204-1: Safety of machinery – Electrical equipment of machines. Part 1: General requirements (06.06)

Figure 8.4:
Determining of the PL by means of SISTEMA