

Personnel safety and machine protection

Risk category according to EN 954-1

Classification of a machine into categories to EN 954-1

Pursuant to the Machinery Directive 89/393/EEC, every machine must comply with the relevant directives and standards. Measures must be taken to keep the risk to persons below a tolerable extent.

In the first step, the project planner performs a risk evaluation to EN 1050 "Risk Assessment". This must take into consideration the machine's ambient conditions for instance. Any overall risk must then be assessed. This risk assessment must be conducted in such a form as to allow documentation of the procedure and the results achieved. The risks, dangers and possible technical measures to reduce risks and dangers must be stipulated in this risk assessment. After stipulating the extent of the risk, the category on the basis of which the safety circuits are to be designed is determined with the aid of EN 954-1 "Safety-Related Components of Controls".

This determined category defines the technical requirements applicable to the design of the safety equipment.

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There are five categories (B, 1, 2, 3 and 4), whereby B (standing for basic category) defines the lowest risk and, thus, also the minimum requirements applicable to the controller.

Possible selection of categories pursuant to EN 954-1

Starting point for the risk assessment of the safety-related component of the controller.

S- Serious injuries

- S1 Slight (normally reversible) injuries,
- S2 Serious (normally irreversible) injuries, including death

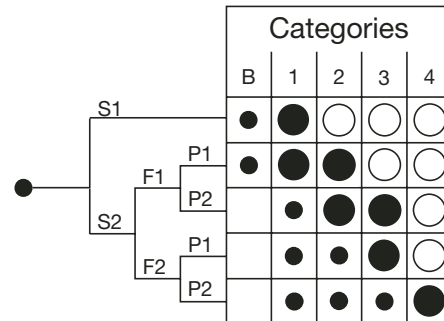
F- Frequency and/or duration of the risk exposure

- F1 Rare to frequent and/or short duration of exposure
- F2 Frequent to sustained and/or longduration of exposure

P- Options for risk avoidance

(Generally referred to the speed and frequency at which the dangerous components moves and to the clearance from the dangerous component).

- P1 Possible under certain conditions
- P2 Hardly possible



B1-4 Categories for safety-related components of controls

- Preferred category
- Possible category requiring additional measures
- Disproportionately extensive measures by comparison with the risk

Safety category ①	Summary of requirements	System behaviour ②	Principles for achieving safety
B	The safety-related components of controls and/or their protection devices and their components must be designed, constructed, selected, assembled and combined in compliance with the applicable standards, such that they can withstand the anticipated influences.	The occurrence of a fault may lead to loss of the safety function.	Predominantly characterised by selection of components!
1	The requirements of B must be complied with. Time-proven components and time-proven safety principles must be applied.	The occurrence of a fault may lead to loss of the safety function but the probability of occurrence is less than in category B.	
2	The requirements of B and the use of the time-proven safety principles must be complied with. The safety function must be checked at appropriate intervals by the machine control.	<ul style="list-style-type: none"> • The occurrence of a fault may lead to loss of the safety function between the inspection intervals. 	Predominantly characterised by the structure
3	The requirements of B and the use of the time-proven safety principles must be complied with. Safety related components must be designed such that: <ul style="list-style-type: none"> • a single fault in any of these components does not lead to loss of the safety function and • the individual fault is detected, wherever feasible in an appropriate manner. 	<ul style="list-style-type: none"> • The loss of the safety function is detected by the check/inspection. • If the single fault occurs, the safety function is always retained. • Certain faults but not all faults are detected. • An accumulation of undetected faults may lead to loss of the safety function. 	
4	The requirements of B and the use of the time-proven safety principles must be complied with. Safety related components must be designed such that: <ul style="list-style-type: none"> • a single fault in any of these components does not lead to loss of the safety function and • the individual fault is detected at or before the next requirement applicable to the safety function or, if this is not possible an accumulation of faults may then not lead to loss of the safety function. 	<ul style="list-style-type: none"> • If the faults occur, the safety function is always retained. • The faults are detected in good time to prevent loss of the safety function 	

This mandatory classification runs like a red thread from selection of the smallest limit switch through to the overall concept of the entire machine, whereby it is necessary to grapple with the permanent conflict between what is technically feasible and what is permitted on the basis of "pure theory".

Thus: Depending on application, not every technically feasible safety category is also permitted. For instance, in the case of contactless protection devices (light barriers etc.) only categories 2 or 4 are permitted. By contrast, in the case of tread mats, categories B to 4 can be used, depending on risk assessment, provided these categories can be reached at all owing to the design.

The 2-hand control C575 would technically also comply with the lower categories but it cannot be connected in categories 1-3.

① The categories are not intended to be applied in any specific order or hierarchical arrangements with respect to the technical-safety requirements.
 ② The risk assessment will indicate whether full or partial loss of the safety function(s) as the result of fault is acceptable.

Selection table

Selection table for ABB safety relays in accordance to risk category (EN 954-1):

Category	C 570	C 571	C 572	C 573	C 574	C 575	C 576	C 577	C 578	C 6700	C 6701	C 6702
B												
1	x	x	x	x	x		x	x		x	x	x
2	x	x	x	x	x		x	x		x	x	x
3	x ^①	x	x	x	x		x	x		x	x	x
4		x ^①	x	x ^①	x ^②	x	x	x	x		x	x

Selection table for ABB safety relays in accordance to device characteristics

Characteristics suitable for device	C 570	C 571	C 572	C 573	C 574	C 575	C 576	C 577	C 578	C 579	C 6700	C 6701	C 6702
7 EMERGENCY STOP	yes	yes	yes	yes	yes	—	yes	yes	—	③	yes	yes	yes
Safety gate monitoring	yes	yes	yes	yes	yes	—	yes	yes	—	③	yes	yes	yes
Tread mats	—	—	—	—	—	—	—	—	—	—	—	—	-
Two-hand control e.g. presses	—	—	—	—	—	yes	—	—	—	—	—	—	-
Feedback loop for monitoring of external contactors	yes	yes	yes	yes	yes	yes	yes	yes	—	—	yes	yes	yes
Single channel	yes	yes	yes	yes	yes	—	—	—	—	—	yes	yes	yes
Two channel	—	yes	yes	yes	—	yes	yes	yes	—	—	yes	yes	yes
Cross-short circuit monitoring	—	—	yes	—	yes	—	yes	yes	—	—	—	yes	yes
24VDC at the EMERGENCY STOP limit switch	—	—	yes	—	—	yes	yes	yes	yes	—	yes	yes	yes
Operating voltage at the EMERG. STOP limit switch	yes	yes	—	yes	yes	—	—	—	—	—	—	—	-
No. of safety outputs	4	2	3	3	2	2	2	2	—	4	2 ^④	2	1
No. of time delayed safety output contacts	—	—	—	—	1	—	—	—	—	—	—	—	1
No. of signalling contacts	2	—	2	1	2	2	—	—	—	—	—	— ^⑤	— ^⑤
Enclosure width in mm	75	22.5	45	22.5	45	45	22.5	22.5	45	22.5	22.5	22.5	22.5
Monitoring overtravel e.g. presses	—	—	—	—	—	—	—	—	yes	—	—	—	—
Auto-start	yes	yes	yes	yes	yes	—	yes	—	—	—	yes	yes	yes
Controlled/monitored start	—	—	yes	—	—	—	—	yes	—	—	yes	yes	yes

① Possible with additional external measures.

② Applies only to undelayed contact. Category 3 applies to delayed contact.

③ Contact extension

④ Solid-state outputs requirements of safety in acc. to 954-1 only in combination with positively guided contactors.

⑤ Solid-state outputs could also be used as safe messaging outputs.