

Logic Units to ensure safety functions

Application of the Machinery Directive 2006/42/EC [1] has been mandatory since 29 December 2009. The directive lists products that are described as "logic units to ensure safety functions". These products are stated in Annex IV of the Machinery Directive. This appendix lists products which owing to their function are a source of particularly high hazards in the event of a fault. Accordingly, stricter requirements apply to the conformity assessment method. The affected components and the possible assessment methods are stated below.

1 What products are described as "logic units to ensure safety functions"?

Products are affected by this provision when:

- a) they are safety components (see below) and are therefore governed by the Machinery Directive;

and

- b) they are "logic units to ensure safety functions" in accordance with Annex IV, No. 21 (see below).

Concerning a): safety component in accordance with the Machinery Directive

Article 1 of the Machinery Directive states its scope. The products considered here fall under c) safety components. In Sub-point c), Article 2 contains the definition of a safety component:

- c) "safety component" means a component
- which serves to fulfil a safety function
 - which is independently placed on the market,
 - the failure and/or malfunction of which endangers the safety of persons, and
 - which is not necessary in order for the machinery to function, or for which normal components may be substituted in order for the machinery to function.

If the above definition is applied for example to a safety PLC (Programmable Logic Controller), the following conclusion is reached: a safety PLC

- serves to fulfil a safety function
- is placed independently on the market, i.e. it is not supplied solely fitted to a machine
- endangers the safety of persons in the event of its failure and/or malfunction
- is not necessary for the machinery to function when used solely for the implementation of safety functions, or can be substituted by a conventional PLC for the purpose of the functioning of the machine, if non safety related functions are also performed.

Under the provisions of the Machinery Directive, a safety PLC is therefore classified as a safety component. As this example shows, the definition applies both to products which are employed solely for safety functions and to products which at the same time fulfil both safety functions and machine functions.

An additional aid for determining whether a component is a safety component can be found in Annex V of the Machinery Directive. This contains a non-exhaustive list of safety components.

Concerning b): logic units to ensure safety functions

The background to the inclusion of these components in Annex IV is the growing use of functional safety products in machine controls. The Machinery Directive also lists the "logic units to ensure safety functions" in Annex V, but does not define these components. Clarification is provided by the "Guide to application of the Machinery Directive 2006/42/EG" [2]:

Item 21

The logic units to ensure safety functions referred to in item 21 are complex components which:

- correspond to the definition of safety components – see §42: comments on Article 2 (c) and
- analyse one or several input signals and generate, by a given algorithm, one or more output signals and
- are intended to operate in connection with, or as part of, the control system of machinery in order to perform one or more safety functions.

However, the control system as a whole is not to be considered as a logic unit.

Simple devices like electromechanical sensors or switching devices which just transform an input signal into an output signal are not to be considered as logic units.

Logic units to ensure safety functions include, for example:

- logic units for two-hand control devices,
- safety PLCs,
- components for the logical processing of safety-related signals of Safety Bus Systems.

If these explanations are applied to products that are typically employed for the implementation of safety functions on machines, the result is the list (not exhaustive) shown in **Table 1** in which products are classified according to whether they are logic units. This list, proposed by the IFA as early as 2009, has since been adopted by the European Commission and published as "recommendations for use" for mandatory application by the notified bodies [3]. Notified bodies are authorized to perform EC type examinations.

2 What conformity assessment procedures are relevant?

Article 12 of the Machinery Directive, "Procedures for assessing the conformity of machinery", lists the various ways by which a product's conformity with the provisions of the directive can be demonstrated. For the "logic units to ensure safety functions" listed in Annex IV, Paragraph 3 and Paragraph 4 are relevant¹. The following conformity assessment procedures are possible:

- a) Conformity assessment by the manufacturer in accordance with Annex VIII (only where manufacture is fully in compliance with the listed standards²)
- b) EC type examination in accordance with Annex IX by a notified body and internal checks on the manufacture in accordance with Annex VIII, No. 3
- c) Full quality assurance in accordance with Annex X

Conformity assessment by the manufacturer under his own responsibility in accordance with (a) is possible only when manufacturing fully complies with the listed standards, i.e.:

- The product is manufactured in accordance with standards giving rise to a presumption of conformity.
- **All** health and safety requirements relevant to the product set out in the above standards are observed.

Annex I of the Machinery Directive describes the essential health and safety requirements. Almost all listed standards state, in their Annex ZB, the requirements of Annex I of the Machinery Directive which are covered by the standard concerned. Therefore, in order to determine whether the standards being applied cover all requirements, follow the following procedure:

- 1) Identify the requirements of Annex I relevant to your product. Assistance in this task is available from the IFA in the form of **Table 2**, "Machinery Directive 2006/42/EC – Annex I".
- 2) Indicate which harmonized and listed standards³ cover these relevant requirements, give rise to a presumption of conformity for your product. **Table 3⁴** contains an example for frequency converters/servo controllers with integrated safety functions.

¹ The Machinery Directive employs the term "machinery" as a generic term for a range of products (see Article 2). These also include the safety components.

² When a standard is harmonised (Article 21) and has been published in the Official Journal of the EU (http://ec.europa.eu/enterprise/sectors/mechanical/documents/legislation/machinery/notified-bodies/index_en.html), it is described as a listed standard. Where the standard concerned is applied in full, a product is presumed to comply with the relevant "essential health and safety requirements relating to the design and construction of machinery".

³ The Guide [2] sets out the provisions of the Machinery Directive more precisely and requires the application of Type C standards, i.e. machine safety standards for certain machines or groups of machines. The standards applicable to logic units to ensure safety functions are Type B2 standards, i.e. standards for protective equipment (for example: EN 61800-5-2, Adjustable speed electrical power drive systems – Part 5-2: Safety Requirements – Functional). A list of harmonized standards for each directive is available on the Internet [5].

⁴ DIN EN 61800-5-1, Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy, is used for electrical hazards. This standard is not listed for the Machinery Directive; however it is a listed standard for the Low Voltage Directive. The safety objectives of the Low Voltage Directive are also part of the Machinery Directive and therefore the presumption of conformity regarding electrical hazards of the Machinery Directive is covered by the harmonised standards of the Low Voltage Directive.

Note: In principle, Annex ZB of a standard should list the sections of Annex I of the Machinery Directive that are covered by the standard. These standards are not all found to contain a complete list in Annex ZB, however. You may have to draw up such a list yourself.

- 3) If all relevant requirements are covered by listed standards and these standards are applied in full, the conformity assessment procedure stated under a) applies.
- 4) If not all relevant requirements are covered by listed standards or these standards are not applied in full, only the procedures stated in b) and c) are possible.

EC type examination by a notified body and with internal checks on the manufacture

In this case, an independent body confirms that a submitted type satisfies the requirements of Annex I of the Machinery Directive. For products listed in Annex IV, and thus also the logic units to ensure safety functions, only the "notified bodies" are authorized to perform this task, however. These bodies are subject to special monitoring and are notified to the European Commission by the Member States. A list of all notified bodies is available on the Internet [4].

Full quality assurance

The conformity assessment procedure of full quality assurance is a new addition to the Machinery Directive. In contrast to a type examination, the objective is not that of evaluating individual products, but of demonstrating the competence of a manufacturer to develop and manufacture products stated in Annex IV. The demands placed upon the manufacturer are not inconsiderable, since the directive equates the result with an EC type examination by an independent, notified body. As a notified test body, the IFA has long offered product tests, and now also offers audits of the "full quality assurance" QA system.

3 Safety technology components

Table 1 contains a list of products typically employed in safety functions of machine controls. The table describes and reasons whether and on what basis a product must be regarded as being a logic unit to ensure safety functions.

Several component descriptions in Table 1 include the extension "... for safety functions". In these cases it is necessary to distinguish them from product versions intended to be applied only in conventional machine controls. Components are strictly intended to be applied in safety functions if the manufacturer describes this application in the documentation and/or confirms at least one of the following product characteristics:

- The Performance Level (PL) to EN ISO 13849-1
- The Safety Integrity Level (SIL)

These parameters are required only when the component is used for the implementation of safety functions.

The product documentation may include phrases such as "applicable up to category .../PL ...". This neither confirms that a product fulfils a category or a PL, nor that it is a safety component according to the Machinery Directive. The product can nevertheless be applied in safety functions; in this case which safety relevant requirements are actually met (in combination with other components) depend upon the specific application concerned.

4 Literature

- [1] Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery and amending Directive 95/16/EC (recast) with Corrigendum to Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery and amending Directive 95/16/EC of 9 June 2006. OJ EU L 157
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:157:0024:0086:en:PDF>
- [2] Guide to application of the Machinery Directive 2006/42/EC, 2nd Edition, June 2010, European Commission, Enterprise and Industry
- [3] Recommendation for Use CNB/M/11.045/R/E Rev 06, Logic units to ensure safety functions, European co-ordination of Notified Bodies Machinery Directive 2006/42/EC + Amendment, 4.7.2012
- [4] Bodies, Germany, Machinery, European Commission Enterprise and Industry
http://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=country.notifiedbody&cou_id=276
- [5] Harmonised Standard, European Commission Enterprise and Industry
<http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/>

Components for safety functions			
			Rev I 29.03.2017
Criteria/information for application of this table:			
a	A condition is that the component serves the purpose of assuring a safety function, is placed separately on the market, and that its failure or malfunction presents a hazard to persons.		
b	The classification of a component as a "logic unit to ensure safety functions" constitutes an estimation on the part of the IFA which has been agreed with further European test bodies. Liability is excluded.		
c	Components are suitable for use in safety functions when the manufacturer confirms at least one of the following product characteristics: Performance Level (PL), Safety Integrity Level (SIL). Where only the MTTf/MTTFd or B10/B10d are stated for a component, the use for which it suitable is not clearly defined.		
No	Component ^a	Logic unit to ensure safety functions ^b in accordance with the Machinery Directive; Annex	Article 12/(3)(4) applicable?
1	Position switch with positive opening operation acc. to EN 60947-5-1, Annex K	No Does not perform logic operations for the control of safety functions.	No
2	Proximity switch for safety functions ^c ; also termed PDF-X in accordance with EN 60947-5-3	Yes Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
3	Mechanical guard locking acc. to EN 14119 (for personnel protection)	No Does not perform logic operations for the control of safety functions.	No
4	Electromagnetic guard locking for safety functions ^c acc. to EN 14119 (for personnel protection)	Yes Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
5	Trapped-key interlocking system for safety functions ^c ; in the form of a complete system only, not of discrete components	Yes Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
6	Position measurement system for safety functions ^c , e.g. rotary encoder, length measuring device	Yes Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
7	Protective equipment designed to detect the present of persons – e.g. electro-sensitive protective equipment, laser scanner, pressure-sensitive mat, pressure-sensitive bumper, camera system	No Is listed separately in Annex IV.	Yes
8	Protective equipment for indirect detection of the presence of persons, for example by the use of RFID transponders	Yes Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
9	Protective equipment for the detection and disconnection of possible hazards (not purely warning systems), for example for the detection by an active laser barrier of hazardous laser radiation	Yes Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
10	Emergency-stop control device	No Does not perform logic operations for the control of safety functions.	No
11	Control device for enabling devices (enabling control)	No Does not perform logic operations for the control of safety functions.	No

Table 1

No	Component ^a	Logic unit to ensure safety functions ^b in accordance with the Machinery Directive; Annex	Article 12/(3)(4) applicable?	
12	Safety switchgear ^c , for example for the monitoring of speed, vibration, torque, temperature, pressure, force, protective doors, emergency stop, two-hand control, enabling device; note: may be part of a portable control station	Yes	Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
13	Safety PLC ^c	Yes	Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
14	Relay/contactor relay with mechanically linked contacts	No	Does not perform logic operations for the control of safety functions.	No
15	Contactors with mirror contacts	No	Does not perform logic operations for the control of safety functions.	No
16	Contactors monitoring module	Yes	Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
17	Drive control with integral safety functions ^c , e.g. frequency converter, servo controller	Yes	Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
18	Time delay for safety functions ^c	Yes	Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
19	Undervoltage release for a supply disconnecting device, intended for use in safety functions (for example to provide protection against restarting following power restoration)	No	Does not perform logic operations for the control of safety functions.	No
20	Brake servo, for example for woodworking machines	Yes	Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
21	Component for the logical processing of safety-related signals on safety bus systems ^c ; components for use on the "black channel" in accordance with IEC 61784-3 are excluded (black channel: communication channel without available evidence of design or validation according to the IEC 61508 series)	Yes	Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
22	Brake for protection of persons, for example for holding axes against gravity	No	Does not perform logic operations for the control of safety functions.	No
23	Valve combination with independent logic operations on the safety-related signals, e.g. safety valve block for presses	Yes	Performs logic operations for generation of the output signal, and is intended for use within safety functions.	Yes
24	Valves with additional means for failure detection intended for the control of dangerous movements on machinery	No	Does not perform logic operations for the control of safety functions.	No
25	Equipment for protection against excess pressure, e.g. pressure valve	No	Does not perform logic operations for the control of safety functions.	No
26	Equipment for interruption of a movement, for example unlockable check valve	No	Does not perform logic operations for the control of safety functions.	No

Table 1

No	Component ^a	Logic unit to ensure safety functions ^b in accordance with the Machinery Directive; Annex		Article 12/(3)(4) applicable?
27	Contact extension module; extension of a safety switching device (see No 12); if with time delay, see No 18	No	Does not perform logic operations for the control of safety functions.	No
28	Safety clamping units for piston rods of hydraulic or pneumatic cylinders	No	Does not perform logic operations for the control of safety functions.	No

Table 2

Machine directive 2006/42/EC - Annex I		relevant?	listed standard
1.	ESSENTIAL HEALTH AND SAFETY REQUIREMENTS		
1.1.	GENERAL REMARKS		
1.1.1.	Definitions		
1.1.2.	Principles of safety integration		
1.1.3.	Materials and products		
1.1.4.	Lighting		
1.1.5.	Design of machinery to facilitate its handling		
1.1.6.	Ergonomics		
1.1.7.	Operating positions		
1.1.8.	Seating		
1.2.	CONTROL SYSTEMS		
1.2.1.	Safety and reliability of control systems		
1.2.2.	Control devices		
1.2.3.	Starting		
1.2.4.	Stopping		
1.2.4.1.	Normal stop		
1.2.4.2.	Operational stop		
1.2.4.3.	Emergency stop		
1.2.4.4.	Assembly of machinery		
1.2.5.	Selection of control or operating modes		
1.2.6.	Failure of the power supply		
1.3	PROTECTION AGAINST MECHANICAL HAZARDS		
1.3.1.	Risk of loss of stability		
1.3.2.	Risk of break-up during operation		
1.3.3.	Risks due to falling or ejected objects		
1.3.4.	Risks due to surfaces, edges or angles		
1.3.5.	Risks related to combined machinery		
1.3.6.	Risks related to variations in operating conditions		
1.3.7.	Risks related to moving parts		
1.3.8.	Choice of protection against risks arising from moving parts		
1.3.8.1.	Moving transmission parts		
1.3.8.2.	Moving parts involved in the process		
1.3.9.	Risks of uncontrolled movements		

Table 2

Machine directive 2006/42/EC - Annex I		relevant?	listed standard
1.4.	REQUIRED CHARACTERISTICS OF GUARDS AND PROTECTIVE DEVICES		
1.4.1.	General requirements		
1.4.2.	Special requirements for guards		
1.4.2.1.	Fixed guards		
1.4.2.2.	Interlocking movable guards		
1.4.2.3.	Adjustable guards restricting access		
1.4.3.	Special requirements for protective devices		
1.5.	RISKS DUE TO OTHER HAZARDS		
1.5.1.	Electricity supply		
1.5.2.	Static electricity		
1.5.3.	Energy supply other than electricity		
1.5.4.	Errors of fitting		
1.5.5.	Extreme temperatures		
1.5.6.	Fire		
1.5.7.	Explosion		
1.5.8.	Noise		
1.5.9.	Vibrations		
1.5.10.	Radiation		
1.5.11.	External radiation		
1.5.12.	Laser radiation		
1.5.13.	Emissions of hazardous materials and substances		
1.5.14.	Risk of being trapped in a machine		
1.5.15.	Risk of slipping, tripping or falling		
1.5.16.	Lightning		
1.6.	MAINTENANCE		
1.6.1.	Machinery maintenance		
1.6.2.	Access to operating positions and servicing points		
1.6.3.	Isolation of energy sources		
1.6.4.	Operator intervention		
1.6.5.	Cleaning of internal parts		

Table 2

Machine directive 2006/42/EC - Annex I		relevant?	listed standard
1.7.	INFORMATION		
1.7.1.	Information and warnings on the machinery		
1.7.1.1.	Information and information devices		
1.7.1.2.	Warning devices		
1.7.2.	Warning of residual risks		
1.7.3.	Marking of machinery		
1.7.4.	Instructions		
1.7.4.1.	General principles for the drafting of instructions		
1.7.4.2.	Contents of the instructions		
1.7.4.3.	Sales literature		

Machine directive 2006/42/EC - Annex I				
product:	frequency converter / servo-controller with integrated safety function			
Annex I		relevant?	listed standards	explanation
1.	ESSENTIAL HEALTH AND SAFETY REQUIREMENTS	no		
1.1	GENERAL REMARKS	no		
1.1.1	Definitions	no		
1.1.2	Principles of safety integration	yes	61800-5-2	fulfilled implicitly because of the structure of the standard and the predetermined development process
1.1.3	Materials and products	no		
1.1.4	Lighting	no		
1.1.5	Design of machinery to facilitate its handling	no		
1.1.6.	Ergonomics	yes	12100-2, 4.8 13849-1, 4.8	
1.1.7	Operating positions	no		
1.1.8	Seating	no		
1.2	CONTROL SYSTEMS			
1.2.1	Safety and reliability of control systems	yes	61800-5-2	SIL-classification
1.2.2	Control devices	no		
1.2.3	Starting	no		not relevant, the function is not enclosed completely in the product

Annex I		relevant?	listed standards	explanation
1.2.4	Stopping	no		not relevant, the function is not enclosed completely in the product
1.2.4.1	Normal stop	no		not relevant, the function is not enclosed completely in the product
1.2.4.2	Operational stop	no		not relevant, the function is not enclosed completely in the product
1.2.4.3	Emergency stop	no		not relevant, the function is not enclosed completely in the product
1.2.4.4	Assembly of machinery	no		not relevant, the function is not enclosed completely in the product
1.2.5	Selection of control or operating modes	no		not relevant, the function is not enclosed completely in the product
1.2.6	Failure of the power supply	yes	DIN EN 61800-5-2	a disturbance of the power supply is exposed by error detection (depending on SIL level) and the safe condition is initiated.
1.3	PROTECTION AGAINST MECHANICAL HAZARDS			
1.3.1	Risk of loss of stability	no		
1.3.2	Risk of break-up during operation	no		
1.3.3	Risks due to falling or ejected objects	no		
1.3.4	Risks due to surfaces, edges or angles	no		
1.3.5	Risks related to combined machinery	no		
1.3.6	Risks related to variations in operating conditions	no		

Annex I		relevant?	listed standards	explanation
1.3.7	Risks related to moving parts	no		
1.3.8	Choice of protection against risks arising from moving parts	no		
1.3.8.1	Moving transmission parts	no		
1.3.8.2	Moving parts involved in the process	no		
1.3.9	Risks of uncontrolled movements	no		
1.4	REQUIRED CHARACTERISTICS OF GUARDS AND PROTECTIVE DEVICES	no		
1.4.1	General requirements	no		
1.4.2	Special requirements for guards	no		
1.4.2.1	Fixed guards	no		
1.4.2.2	Interlocking movable guards	no		
1.4.2.3	Adjustable guards restricting access	no		
1.4.3	Special requirements for protective devices	no		
1.5	RISKS DUE TO OTHER HAZARDS	no		
1.5.1	Electricity supply	yes	61800-5-1	
1.5.2	Static electricity	no		
1.5.3	Energy supply other than electricity	no		
1.5.4	Errors of fitting	no		
1.5.5	Extreme temperatures	yes	61800-5-1	
1.5.6	Fire	yes	61800-5-1	
1.5.7	Explosion	no		
1.5.8	Noise	no		
1.5.9	Vibrations	no		
1.5.10	Radiation	no		
1.5.11	External radiation	yes	61800-361800-5-2	only EMC is relevant
1.5.12	Laser radiation	no		
1.5.13	Emissions of hazardous materials and substances	no		
1.5.14	Risk of being trapped in a machine	no		
1.5.15	Risk of slipping, tripping or falling	no		

Annex I		relevant?	listed standards	explanation
1.5.16	Lightning	no		
1.6	MAINTENANCE	no		
1.6.1	Machinery maintenance	no		
1.6.2	Access to operating positions and servicing points	no		
1.6.3	Isolation of energy sources	no		
1.6.4	Operator intervention	no		
1.6.5	Cleaning of internal parts	no		
1.7	INFORMATION	no		
1.7.1	Information and warnings on the machinery	no		
1.7.1.1	Information and information devices	no		
1.7.1.2	Warning devices	no		
1.7.2	Warning of residual risks	yes	61800-5-1	
1.7.3	Marking of machinery	yes	61800-5-1	
1.7.4	Instructions	yes	61800-5-1	
1.7.4.1	General principles for the drafting of instructions	yes	61800-5-1	
1.7.4.2	Contents of the instructions	yes	61800-5-1	
1.7.4.3	Sales literature	yes	-	this section does not contain additional requirements