Bernd JAEKEL

Siemens AG, Sector Industry

Current status of standardization related to electromagnetic compatibility and functional safety

***Abstract**: The topic of functional safety of electrical and electronic systems is related to EMC insofar as an adequate immunity against electromagnetic phenomena is required to prevent safety-related systems and equipment used in them from being harmfully affected. Hence there is a need to merge the topics of EMC and functional safety not only from a technical point of view but also in terms of standardization. The paper describes the current situation regarding the standards dealing with both the areas, introducing also the new project IEC 61000-6-7.*

***Streszczenie.** Zagadnienie funkcjonalnego bezpieczeństwa systemów elektrycznych i elektronicznych jest związane z EMC, o ile właściwa odporność przed zjawiskami elektromagnetycznymi jest wymagana, aby zapobiec ich szkodliwemu oddziaływaniu na systemy odpowiedzialne za bezpieczeństwo. Potrzeba połączenia tematów EMC i funkcjonalnego bezpieczeństwa dotyczy nie tylko problemów technicznych, ale również zagadnień normatywnych. W artykule opisano aktualną sytuację w dziedzinie normalizacji w obu obszarach omawiając również projekt normy IEC 61000-6-7 (**Aktualna stan normalizacyjny dotyczący kompatybilności elektromagnetycznej oraz bezpieczeństwa funkcjonalnego**).*

Keywords: EMC, electromagnetic phenomenon; safety, functional safety
Słowa kluczowe: EMC, zjawiska elektromagnetyczne, bezpieczeństwo, bezpieczeństwo funkcjonalne

Introduction

Whenever electrical or electronic equipment is in operation, a situation has generally to be taken into account that the equipment might be exposed to electromagnetic disturbances and consequently it might be affected by them. Electromagnetic disturbances are (basically) present in nearly all types of electromagnetic environments. This situation represents a typical challenge for the achievement of electromagnetic compatibility in so far as appropriate measures have to be designed in order to prevent harmful interference.

In most cases the design of equipment and its proof by corresponding immunity tests have to take into account technical as well as economical boundary conditions. And as a consequence, interference situations are not assumed to be completely avoided in any case. Due to the above stated reasons, EMC (electromagnetic compatibility) measures, immunity requirements and the performance of immunity tests are specified to a certain extent only, namely to such an extent that in a reasonably high number of cases no harmful interference would occur – the consequence of a technical/economical approach.

In some cases, however, items of electrical or electronic equipment are used as components of safety-related systems, i.e. the corresponding items of equipment perform safety functions. Though basically there is the same situation with respect to the exposure to electromagnetic disturbances, the approach to achieve EMC in this case must be much more distinguished compared to the case of non-safety-related systems. Here the function of electrical or electronic equipment must not be affected by external influences, at least not in a way that could lead to an unacceptable risk of harm to users, other persons, animals or property.

Traditionally, safety – including the aspect of functional safety - and EMC have been regarded as two separate disciplines. This is also reflected by the fact that both areas have their own “worlds of standards” and are even partly dealt with by different standardization organizations. In this paper the situation of standardization within the IEC (International Electrotechnical Commission) regarding the topics of EMC and functional safety will be considered.

The area of functional safety itself is treated in great detail in the series of standards IEC 61508 with the 2nd edition of these documents published in 2010. Several parts of this series deal with general requirements and with requirements concerning hardware and software, while some documents within the series give examples and guidelines how the normative parts are to be applied. Since safety of a safety-related system in general is not an issue for special phases of the lifetime only, such as the design or development phase, IEC 61508 regards the whole lifecycle of a safety-related system in terms of functional safety.

The area of EMC is partly described within the series of publications numbered by IEC 61000-X-Y, with the classification into basic standards, generic standards, as well as some further basic documents giving information about fundamentals, measures and installation guidelines with regard to EMC [1].

Systematisation of standards in the areas of EMC and functional safety

Similar to most technical areas, in the area of functional safety there should be a common understanding and a commonly agreed approach with regard to electromagnetic phenomena. Such an approach, however, can deal only with those general procedures and processes, which can be described within standardization documents.

However, despite the fact that there are such standardization documents, In many cases there might be a need for an individual safety management which takes into account specific boundary conditions, nonetheless basing on the general procedures described in the standardization documents.

Though safety-related systems in many cases might be individual installations, the items of equipment they are composed of are more or less standardized products, i.e. products intended to be used in safety-related systems. Hence there should be a kind of generally accepted specification of such products taking into account functional safety aspects, as described, for example, in product standards. This, however, does not mean that products specified in such a way can be used in any safety-related system without any restrictions or without any additional mitigation measures.

Typically, the specifications, regarding for example, the immunity to electromagnetic phenomena, are determined in such a way that they cover a relatively large number of cases. But there might be some cases where more severe requirements have to be applied to the products under consideration. Then the immunity properties of the installed products have to be improved, for example, by increasing

the immunity of the products themselves, by applying appropriate mitigation measures, or by performing a combination of these two approaches.

Table 1 lists the currently published standards which cover the combined topic of EMC and functional safety. The interrelationship between the different types of standardization documents is given in Fig. 1.

Table 1. Standardization documents dealing with EMC and functional safety

Document	Title
IEC 61000-1-2 (2008)	Electromagnetic Compatibility (EMC) – General – Methodology for the achievement of functional safety of electrical and electronic equipment with regard to electromagnetic phenomena
IEC 61000-6-7 (new project)	Electromagnetic Compatibility (EMC) – Generic standards – Immunity requirements for safety-related systems and equipment intended to perform functions in a safety-related system (functional safety) in industrial environments
IEC 61326-3-1 (2008)	Electrical equipment for measurement, control and laboratory use – Immunity requirements for safety related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications
IEC 61326-3-2 (2008)	Electrical equipment for measurement, control and laboratory use – Immunity requirements for safety related systems and for equipment intended to perform safety-related functions (functional safety) – Industrial applications with specified electromagnetic environment
IEC 61511-1 (2003)	Functional safety – Safety instrumented system for the process industry sector – Framework, definitions, system, hardware and software requirements
IEC 62061 (2005)	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
IEC 61800-5-2 (2007)	Adjustable speed electrical power drive system – Safety requirements – Functional
IEC 61496-1 (2004)	Safety of machinery – Electro-sensitive protective equipment – General requirements and tests
IEC 61784-3 (2010)	Industrial communication networks – Profiles – Part 3: Functional safety field buses

Generic standard

Non-safety-related equipment and systems operated in industrial environment use the generic standard IEC 61000-6-2 as requirement for EMC testing, if there is no particular sector or product standard. In contrast, the situation for safety-related equipment and systems is not that distinct. There are several documents developed by IEC and national certification or assessment bodies, some of them being the product/product family standards or sector standards listed in Table 1.

Recently some activities have been started to overcome this lack of a generic document with immunity specifications in the area of EMC and functional safety [2]. The purpose of this new work item proposal is to establish an adequate clear situation through a generic standard for safety-related equipment and systems intended to be operated in industrial environments, similar to that one which already exists for non-safety-related equipment within the generic standard IEC 61000-6-2. Three main benefits can be gained from this activity:

- The industry can clearly communicate the installation guidelines for safety-related equipment and systems in an easily understandable manner which always should be the motivation for safety.
- A generic standard “EMC and Functional safety” can be applied to all the types of products or product families for which there is no particular product/product family standard, hence providing a common ground for the safety application area
- Parties involved are able to facilitate their bidding processes by just referencing one "EMC for FS" standard and can put more effort into critical parts of their applications.

This project, intended to become a new generic standard IEC 61000-6-7 “EMC and Functional safety” should serve as the basis for future product and product family standards dealing with both areas, similar to the generic standard IEC 61000-6-2 and based on it product standards. For example, as distributed safety automation is evolving in a fast manner to catch up with the already existing level of non-safety-related distributed automation, it is highly recommended to urge this new standard along/forward. The benefits cannot be quantified easily, as in case of other EMC standards. However, for the sake of safety of personnel, environment and investment it is essential to establish such a generic standard.

Product-family and product standards

Safety-related systems in general could be very large installations which cannot be tested by means of standardized immunity tests. However, In many cases such systems are compact, hence allowing such testing. This applies particularly to items of equipment which safety-related systems are built of.

Product manufacturers have to prove that the products fulfil a requirement specification, whereas evidence has to be provided by application of appropriate methods. They normally do not need to consider aspects of the application. The objective is that all the products (and the equipment) in a safety-related system comply with particular performance criteria, taking into account functional safety aspects up to the levels specified in the safety requirements specification independent of the required safety integrity level [3].

Examples of product standards with the emphasis on electrical equipment for measurement, control and laboratory use are IEC 61326-3-1 and IEC 61326-3-2. They consider two approaches, how to deal with the electromagnetic environments and how to conclude on appropriate immunity requirements:

- To consider a general electromagnetic environment – general for a type of locations, for example, a typical industrial environment - and to take into account all the phenomena relevant for that type of locations. This approach requires modified immunity levels for some electromagnetic phenomena, modified compared to immunity standards without any relation to safety aspects.
- To control the electromagnetic environment where an item of equipment of a safety-related system is intended to be operated, for example, by the application of particular installation and mitigation practices. This means - to control it in such a way that electromagnetic phenomena and their amplitudes can occur to a certain extent only.

Beside these product standards which have been published in 2008 there are currently some further standards in progress which consider EMC requirements in terms of functional safety. There is for example a project related to equipment within the area of low-voltage switchgear and

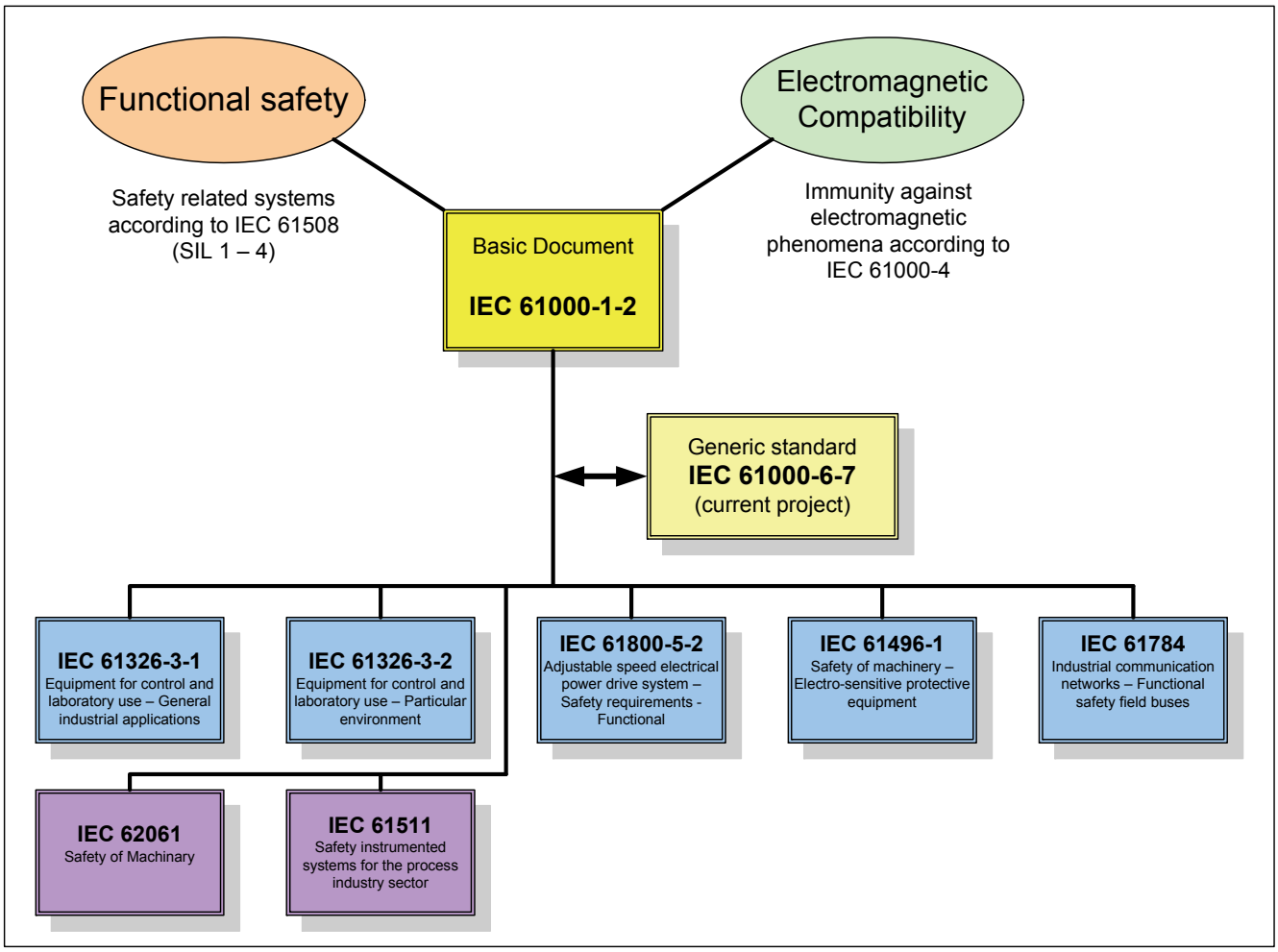

Fig. 1. Interrelationship between standardization documents dealing with EMC and functional safety

Application standards

A system designer should follow a commonly agreed and standardized approach when dealing with functional safety aspects related to applications, for example, using safety-related systems in the areas of machinery or the process industry. Such approaches are described in application standards, such as IEC 62061 or IEC 61511-2. Since they deal with the approach in a general sense, they have to cover all relevant aspects which might affect functional safety, with EMC being one of them.

Conclusions

EMC and functional safety can no longer be treated as two separate disciplines, when electrical or electronic systems for safety applications are considered. This separation cannot be further maintained both on the technical and on the standardization level. The achievement of functional safety with regard to electromagnetic phenomena requires a systematic, well-structured and standardized process. Hence standards or technical specifications merging these areas have to be worked out in order to ensure a mutual consideration. Such standards should take into account the description of a fundamental methodology for the achievement of functional safety which is more or less a description on the level of a safety-related system. They should further take into account the equipment level where the achievement of functional safety results partly in the specification of immunity levels in connection with appropriate performance criteria.

REFERENCES

[1] IEC Guide 107, "Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications", Geneva, Switzerland, 1998

[2] IEC 77/389/CD (Project IEC 61000-6-7), "Electromagnetic Compatibility (EMC) – Generic standards – Immunity requirements for safety-related systems and equipment intended to perform functions in a safety-related system (functional safety) in industrial environments", IEC, Geneva, Switzerland, 2009

[3] B. Jaekel, A. Kohling and H. Krosigk, "EMC and Functional Safety – Performance Criterion FS", XV International Conference on Electromagnetic Disturbances EMD, Sep 2005, Bialystok, Poland, pp. 8.3-1 – 8.3-6, ISBN 83-88229-97-4

[4] IEC 17B/1729/CD2 (Project IEC 60947-5-3), "Low-voltage switchgear and controlgear – Part 5-3: Control circuit devices and switching elements – Requirements for proximity devices with defined behaviour under fault conditions (PDF), IEC, Geneva, Switzerland, 2011

[5] IEC 65B/797/CDV (Project IEC 61131-6), "Programmable controllers – Part 6: Functional safety", IEC, Geneva, Switzerland, 2011

***Author**: Dr. rer. nat. Bernd Jaekel, Siemens AG, Sector Industry, EMC-Center, Guenther-Scharowsky-Str. 21, 91058 Erlangen, Germany, E-mail: bernd.jaekel@siemens.com .*