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BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

Functional safety of electrical/electronic/programmable electronic safety-related systems –

Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems

[IEC 61508-2:2010](#)

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Sécurité fonctionnelle des systèmes électriques/électroniques/électroniques programmables relatifs à la sécurité –

Partie 2: Exigences pour les systèmes électriques/électroniques/électroniques programmables relatifs à la sécurité



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/
PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –****Part 2: Requirements for electrical/electronic/programmable
electronic safety-related systems**

FOREWORD

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International Standard IEC 61508-2 has been prepared by subcommittee 65A: System aspects, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

This edition has been subject to a thorough review and incorporates many comments received at the various revision stages.

It has the status of a basic safety publication according to IEC Guide 104.

The text of this standard is based on the following documents:

FDIS	Report on voting
65A/549/FDIS	65A/573/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2

A list of all parts of the IEC 61508 series, published under the general title *Functional safety of electrical / electronic / programmable electronic safety-related systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
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INTRODUCTION

Systems comprised of electrical and/or electronic elements have been used for many years to perform safety functions in most application sectors. Computer-based systems (generically referred to as programmable electronic systems) are being used in all application sectors to perform non-safety functions and, increasingly, to perform safety functions. If computer system technology is to be effectively and safely exploited, it is essential that those responsible for making decisions have sufficient guidance on the safety aspects on which to make these decisions.

This International Standard sets out a generic approach for all safety lifecycle activities for systems comprised of electrical and/or electronic and/or programmable electronic (E/E/PE) elements that are used to perform safety functions. This unified approach has been adopted in order that a rational and consistent technical policy be developed for all electrically-based safety-related systems. A major objective is to facilitate the development of product and application sector international standards based on the IEC 61508 series.

NOTE 1 Examples of product and application sector international standards based on the IEC 61508 series are given in the Bibliography (see references [1], [2] and [3]).

In most situations, safety is achieved by a number of systems which rely on many technologies (for example mechanical, hydraulic, pneumatic, electrical, electronic, programmable electronic). Any safety strategy must therefore consider not only all the elements within an individual system (for example sensors, controlling devices and actuators) but also all the safety-related systems making up the total combination of safety-related systems. Therefore, while this International Standard is concerned with E/E/PE safety-related systems, it may also provide a framework within which safety-related systems based on other technologies may be considered.

It is recognized that there is a great variety of applications using E/E/PE safety-related systems in a variety of application sectors and covering a wide range of complexity, hazard and risk potentials. In any particular application, the required safety measures will be dependent on many factors specific to the application. This International Standard, by being generic, will enable such measures to be formulated in future product and application sector international standards and in revisions of those that already exist.

This International Standard

- considers all relevant overall, E/E/PE system and software safety lifecycle phases (for example, from initial concept, through design, implementation, operation and maintenance to decommissioning) when E/E/PE systems are used to perform safety functions;
- has been conceived with a rapidly developing technology in mind; the framework is sufficiently robust and comprehensive to cater for future developments;
- enables product and application sector international standards, dealing with E/E/PE safety-related systems, to be developed; the development of product and application sector international standards, within the framework of this standard, should lead to a high level of consistency (for example, of underlying principles, terminology etc.) both within application sectors and across application sectors; this will have both safety and economic benefits;
- provides a method for the development of the safety requirements specification necessary to achieve the required functional safety for E/E/PE safety-related systems;
- adopts a risk-based approach by which the safety integrity requirements can be determined;
- introduces safety integrity levels for specifying the target level of safety integrity for the safety functions to be implemented by the E/E/PE safety-related systems;

NOTE 2 The standard does not specify the safety integrity level requirements for any safety function, nor does it mandate how the safety integrity level is determined. Instead it provides a risk-based conceptual framework and example techniques.

- sets target failure measures for safety functions carried out by E/E/PE safety-related systems, which are linked to the safety integrity levels;
- a low demand mode of operation, the lower limit is set at an average probability of a dangerous failure on demand of 10^{-5} ;
- a high demand or a continuous mode of operation, the lower limit is set at an average frequency of a dangerous failure of 10^{-9} [h^{-1}];

NOTE 3 A single E/E/PE safety-related system does not necessarily mean a single-channel architecture.

NOTE 4 It may be possible to achieve designs of safety-related systems with lower values for the target safety integrity for non-complex systems, but these limits are considered to represent what can be achieved for relatively complex systems (for example programmable electronic safety-related systems) at the present time.

- sets requirements for the avoidance and control of systematic faults, which are based on experience and judgement from practical experience gained in industry. Even though the probability of occurrence of systematic failures cannot in general be quantified the standard does, however, allow a claim to be made, for a specified safety function, that the target failure measure associated with the safety function can be considered to be achieved if all the requirements in the standard have been met;
- introduces systematic capability which applies to an element with respect to its confidence that the systematic safety integrity meets the requirements of the specified safety integrity level;
- adopts a broad range of principles, techniques and measures to achieve functional safety for E/E/PE safety-related systems, but does not explicitly use the concept of fail safe. However, the concepts of “fail safe” and “inherently safe” principles may be applicable and adoption of such concepts is acceptable providing the requirements of the relevant clauses in the standard are met.

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FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems

1 Scope

1.1 This part of the IEC 61508 series

- a) is intended to be used only after a thorough understanding of IEC 61508-1, which provides the overall framework for the achievement of functional safety;
- b) applies to any safety-related system, as defined by IEC 61508-1, that contains at least one electrical, electronic or programmable electronic element;
- c) applies to all elements within an E/E/PE safety-related system (including sensors, actuators and the operator interface);
- d) specifies how to refine the E/E/PE system safety requirements specification, developed in accordance with IEC 61508-1 (comprising the E/E/PE system safety functions requirements specification and the E/E/PE system safety integrity requirements specification), into the E/E/PE system design requirements specification;
- e) specifies the requirements for activities that are to be applied during the design and manufacture of the E/E/PE safety-related systems (i.e. establishes the E/E/PE system safety lifecycle model) except software, which is dealt with in IEC 61508-3 (see Figures 2 to 4). These requirements include the application of techniques and measures that are graded against the safety integrity level for the avoidance of, and control of, faults and failures;
- f) specifies the information necessary for carrying out the installation, commissioning and final safety validation of the E/E/PE safety-related systems;
- g) does not apply to the operation and maintenance phase of the E/E/PE safety-related systems – this is dealt with in IEC 61508-1 – however, IEC 61508-2 does provide requirements for the preparation of information and procedures needed by the user for the operation and maintenance of the E/E/PE safety-related systems;
- h) specifies requirements to be met by the organisation carrying out any modification of the E/E/PE safety-related systems;

NOTE 1 This part of IEC 61508 is mainly directed at suppliers and/or in-company engineering departments, hence the inclusion of requirements for modification.

NOTE 2 The relationship between IEC 61508-2 and IEC 61508-3 is illustrated in Figure 4.

- i) does not apply for medical equipment in compliance with the IEC 60601 series.

1.2 IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are basic safety publications, although this status does not apply in the context of low complexity E/E/PE safety-related systems (see 3.4.3 of IEC 61508-4). As basic safety publications, they are intended for use by technical committees in the preparation of standards in accordance with the principles contained in IEC Guide 104 and ISO/IEC Guide 51. IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are also intended for use as stand-alone standards. The horizontal safety function of this international standard does not apply to medical equipment in compliance with the IEC 60601 series.

1.3 One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. In this context, the requirements, test methods or test conditions of this basic safety publication will not apply

unless specifically referred to or included in the publications prepared by those technical committees.

NOTE The functional safety of an E/E/PE safety-related system can only be achieved when all related requirements are met. Therefore, it is important that all related requirements are carefully considered and adequately referenced.

1.4 Figure 1 shows the overall framework of the IEC 61508 series and indicates the role that IEC 61508-2 plays in the achievement of functional safety for E/E/PE safety-related systems. Annex A of IEC 61508-6 describes the application of IEC 61508-2 and IEC 61508-3.

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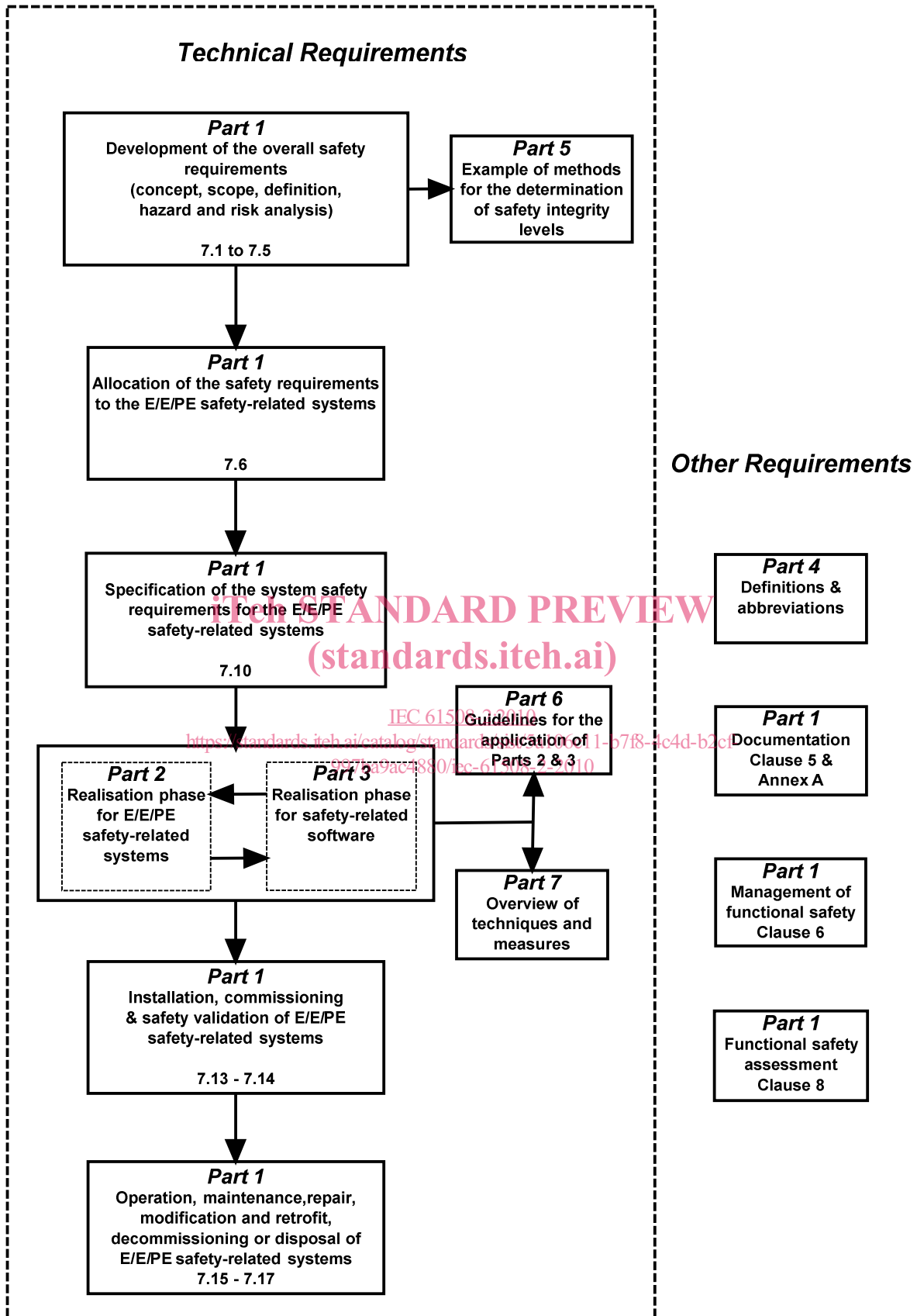


Figure 1 – Overall framework of the IEC 61508 series

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60947-5-1, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC/TS 61000-1-2, *Electromagnetic compatibility (EMC) – Part 1-2: General – Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena*

IEC 61326-3-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications*

IEC 61508-1: 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61508-3: 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

IEC 61508-4: 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

IEC 61508-7: 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 7: Overview of techniques and measures*

IEC 61784-3, *Industrial communication networks – Profiles – Part 3: Functional safety fieldbuses – General rules and profile definitions*

IEC 62280-1, *Railway applications – Communication, signalling and processing systems – Part 1: Safety-related communication in closed transmission systems*

IEC 62280-2, *Railway applications – Communication, signalling and processing systems – Part 2: Safety-related communication in open transmission systems*

IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:1999, *Safety aspects – Guidelines for their inclusion in standards*

EN 50205, *Relays with forcibly guided (mechanically linked) contacts*

3 Definitions and abbreviations

For the purposes of this document, the definitions and abbreviations given in IEC 61508-4 apply.

4 Conformance to this standard

The requirements for conformance to this standard are as detailed in Clause 4 of IEC 61508-1.

5 Documentation

The requirements for documentation are as detailed in Clause 5 of IEC 61508-1.

6 Management of functional safety

The requirements for management of functional safety are as detailed in Clause 6 of IEC 61508-1.

7 E/E/PE system safety lifecycle requirements

7.1 General

7.1.1 Objectives and requirements – general

7.1.1.1 This subclause sets out the objectives and requirements for the E/E/PE system safety lifecycle phases.

NOTE The objectives and requirements for the overall safety lifecycle, together with a general introduction to the structure of the standard, are given in IEC 61508-1.

7.1.1.2 For all phases of the E/E/PE system safety lifecycle, Table 1 indicates

- the objectives to be achieved;
- the scope of the phase;
- a reference to the subclause containing the requirements;
- the required inputs to the phase;
- the outputs required to comply with the subclause.

7.1.2 Objectives

7.1.2.1 The first objective of the requirements of this subclause is to structure, in a systematic manner, the phases in the E/E/PE system safety lifecycle that shall be considered in order to achieve the required functional safety of the E/E/PE safety-related systems.

7.1.2.2 The second objective of the requirements of this subclause is to document all information relevant to the functional safety of the E/E/PE safety-related systems throughout the E/E/PE system safety lifecycle.

7.1.3 Requirements

7.1.3.1 The E/E/PE system safety lifecycle that shall be used in claiming conformance with this standard is that specified in Figure 2. A detailed V-model of the ASIC development lifecycle for the design of ASICs (see IEC 61508-4, 3.2.15) is shown in Figure 3. If another E/E/PE system safety lifecycle or ASIC development lifecycle is used, it shall be specified as part of the management of functional safety activities (see Clause 6 of IEC 61508-1), and all the objectives and requirements of each subclause of IEC 61508-2 shall be met.

NOTE 1 The relationship between and scope for IEC 61508-2 and IEC 61508-3 are shown in Figure 4.

NOTE 2 There are significant similarities between the ASIC and the software design processes. IEC 61508-3 recommends the V-model for designing safety-related software. The V-model requires a clearly structured design process and a modular software structure for avoiding and controlling systematic faults. The ASIC development lifecycle for the design of ASICs in Figure 3 follows this model. At first the requirements for the ASIC specification are derived from the system requirements. ASIC architecture, ASIC design and module design follow. The results of each step on the left-hand side of the V become the input to the next step, and are also fed back to the preceding step for iteration where appropriate, until the final code is created. This code is verified against the corresponding design through post-layout simulation, module testing, module integration testing and verification of the complete ASIC. The results of any step may necessitate a revision to any of the preceding steps. Finally, the ASIC is validated after its integration into the E/E/PE safety-related system.