
Road vehicles — Functional safety —
Part 5:
Product development at the
hardware level

Véhicules routiers — Sécurité fonctionnelle —

Partie 5: Développement du produit au niveau du matériel



This document is a preview generated by ERS



COPYRIGHT PROTECTED DOCUMENT

© ISO 2018

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword	v
Introduction	vii
1 Scope	1
2 Normative references	2
3 Terms and definitions	2
4 Requirements for compliance	2
4.1 Purpose.....	2
4.2 General requirements.....	2
4.3 Interpretations of tables.....	3
4.4 ASIL-dependent requirements and recommendations.....	3
4.5 Adaptation for motorcycles.....	3
4.6 Adaptation for trucks, buses, trailers and semi-trailers.....	4
5 General topics for the product development at the hardware level	4
5.1 Objectives.....	4
5.2 General.....	4
6 Specification of hardware safety requirements	5
6.1 Objectives.....	5
6.2 General.....	6
6.3 Inputs to this clause.....	6
6.3.1 Prerequisites.....	6
6.3.2 Further supporting information.....	6
6.4 Requirements and recommendations.....	6
6.5 Work products.....	8
7 Hardware design	8
7.1 Objectives.....	8
7.2 General.....	9
7.3 Inputs to this clause.....	9
7.3.1 Prerequisites.....	9
7.3.2 Further supporting information.....	9
7.4 Requirements and recommendations.....	9
7.4.1 Hardware architectural design.....	9
7.4.2 Hardware detailed design.....	10
7.4.3 Safety analyses.....	11
7.4.4 Verification of hardware design.....	13
7.4.5 Production, operation, service and decommissioning.....	14
7.5 Work products.....	14
8 Evaluation of the hardware architectural metrics	14
8.1 Objectives.....	14
8.2 General.....	15
8.3 Inputs of this clause.....	16
8.3.1 Prerequisites.....	16
8.3.2 Further supporting information.....	16
8.4 Requirements and recommendations.....	16
8.5 Work products.....	20
9 Evaluation of safety goal violations due to random hardware failures	20
9.1 Objectives.....	20
9.2 General.....	20
9.3 Inputs to this clause.....	21
9.3.1 Prerequisites.....	21
9.3.2 Further supporting information.....	21
9.4 Requirements and recommendations.....	21

9.4.1	General	21
9.4.2	Evaluation of Probabilistic Metric for random Hardware Failures (PMHF)	22
9.4.3	Evaluation of Each Cause of safety goal violation (EEC)	25
9.4.4	Verification review	29
9.5	Work products	30
10	Hardware integration and verification	30
10.1	Objectives	30
10.2	General	30
10.3	Inputs of this clause	30
10.3.1	Prerequisites	30
10.3.2	Further supporting information	30
10.4	Requirements and recommendations	30
10.5	Work products	32
Annex A (informative) Overview of and workflow of product development at the hardware level		33
Annex B (informative) Failure mode classification of a hardware element		36
Annex C (normative) Hardware architectural metrics		38
Annex D (informative) Evaluation of the diagnostic coverage		44
Annex E (informative) Example calculation of hardware architectural metrics: “single-point fault metric” and “latent-fault metric”		66
Annex F (informative) Example for rationale that objectives of Clause 9 in accordance with 4.2 are met		75
Annex G (informative) Example of a PMHF budget assignment for an item consisting of two systems		82
Annex H (informative) Example of latent fault handling		86
Bibliography		89

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects*.

This edition of ISO 26262 series of standards cancels and replaces the edition ISO 26262:2011 series of standards, which has been technically revised and includes the following main changes:

- requirements for trucks, buses, trailers and semi-trailers;
- extension of the vocabulary;
- more detailed objectives;
- objective oriented confirmation measures;
- management of safety anomalies;
- references to cyber security;
- updated target values for hardware architecture metrics;
- guidance on model based development and software safety analysis;
- evaluation of hardware elements;
- additional guidance on dependent failure analysis;
- guidance on fault tolerance, safety related special characteristics and software tools;
- guidance for semiconductors;
- requirements for motorcycles; and
- general restructuring of all parts for improved clarity.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 26262 series can be found on the ISO website.

This document is a preview generated by EVS

Introduction

The ISO 26262 series of standards is the adaptation of IEC 61508 series of standards to address the sector specific needs of electrical and/or electronic (E/E) systems within road vehicles.

This adaptation applies to all activities during the safety lifecycle of safety-related systems comprised of electrical, electronic and software components.

Safety is one of the key issues in the development of road vehicles. Development and integration of automotive functionalities strengthen the need for functional safety and the need to provide evidence that functional safety objectives are satisfied.

With the trend of increasing technological complexity, software content and mechatronic implementation, there are increasing risks from systematic failures and random hardware failures, these being considered within the scope of functional safety. ISO 26262 series of standards includes guidance to mitigate these risks by providing appropriate requirements and processes.

To achieve functional safety, the ISO 26262 series of standards:

- a) provides a reference for the automotive safety lifecycle and supports the tailoring of the activities to be performed during the lifecycle phases, i.e., development, production, operation, service and decommissioning;
- b) provides an automotive-specific risk-based approach to determine integrity levels [Automotive Safety Integrity Levels (ASILs)];
- c) uses ASILs to specify which of the requirements of ISO 26262 are applicable to avoid unreasonable residual risk;
- d) provides requirements for functional safety management, design, implementation, verification, validation and confirmation measures; and
- e) provides requirements for relations between customers and suppliers.

The ISO 26262 series of standards is concerned with functional safety of E/E systems that is achieved through safety measures including safety mechanisms. It also provides a framework within which safety-related systems based on other technologies (e.g. mechanical, hydraulic and pneumatic) can be considered.

The achievement of functional safety is influenced by the development process (including such activities as requirements specification, design, implementation, integration, verification, validation and configuration), the production and service processes and the management processes.

Safety is intertwined with common function-oriented and quality-oriented activities and work products. The ISO 26262 series of standards addresses the safety-related aspects of these activities and work products.

[Figure 1](#) shows the overall structure of the ISO 26262 series of standards. The ISO 26262 series of standards is based upon a V-model as a reference process model for the different phases of product development. Within the figure:

- the shaded “V”s represent the interconnection among ISO 26262-3, ISO 26262-4, ISO 26262-5, ISO 26262-6 and ISO 26262-7;
- for motorcycles:
 - ISO 26262-12:2018, Clause 8 supports ISO 26262-3;
 - ISO 26262-12:2018, Clauses 9 and 10 support ISO 26262-4;
- the specific clauses are indicated in the following manner: “m-n”, where “m” represents the number of the particular part and “n” indicates the number of the clause within that part.



Road vehicles — Functional safety —

Part 5:

Product development at the hardware level

1 Scope

This document is intended to be applied to safety-related systems that include one or more electrical and/or electronic (E/E) systems and that are installed in series production road vehicles, excluding mopeds. This document does not address unique E/E systems in special vehicles such as E/E systems designed for drivers with disabilities.

NOTE Other dedicated application-specific safety standards exist and can complement the ISO 26262 series of standards or vice versa.

Systems and their components released for production, or systems and their components already under development prior to the publication date of this document, are exempted from the scope of this edition. This document addresses alterations to existing systems and their components released for production prior to the publication of this document by tailoring the safety lifecycle depending on the alteration. This document addresses integration of existing systems not developed according to this document and systems developed according to this document by tailoring the safety lifecycle.

This document addresses possible hazards caused by malfunctioning behaviour of safety-related E/E systems, including interaction of these systems. It does not address hazards related to electric shock, fire, smoke, heat, radiation, toxicity, flammability, reactivity, corrosion, release of energy and similar hazards, unless directly caused by malfunctioning behaviour of safety-related E/E systems.

This document describes a framework for functional safety to assist the development of safety-related E/E systems. This framework is intended to be used to integrate functional safety activities into a company-specific development framework. Some requirements have a clear technical focus to implement functional safety into a product; others address the development process and can therefore be seen as process requirements in order to demonstrate the capability of an organization with respect to functional safety.

This document does not address the nominal performance of E/E systems.

This document specifies the requirements for product development at the hardware level for automotive applications, including the following:

- general topics for the product development at the hardware level;
- specification of hardware safety requirements;
- hardware design;
- evaluation of the hardware architectural metrics;
- evaluation of safety goal violations due to random hardware failures; and
- hardware integration and verification.

The requirements of this document for hardware elements are applicable to both non-programmable and programmable elements, such as ASIC, FPGA and PLD. Further guidelines can be found in ISO 26262-10:2018 and ISO 26262-11:2018.

[Annex A](#) provides an overview on objectives, prerequisites and work products of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 26262-1, *Road vehicles — Functional safety — Part 1: Vocabulary*

ISO 26262-2:2018, *Road vehicles — Functional safety — Part 2: Management of functional safety*

ISO 26262-4:2018, *Road vehicles — Functional safety — Part 4: Product development at the system level*

ISO 26262-6:2018, *Road vehicles — Functional safety — Part 6: Product development at the software level*

ISO 26262-7:2018, *Road vehicles — Functional safety — Part 7: Production and operation*

ISO 26262-8:2018, *Road vehicles — Functional safety — Part 8: Supporting processes*

ISO 26262-9:2018, *Road vehicles — Functional safety — Part 9: Automotive Safety Integrity Level (ASIL)-oriented and safety-oriented analyses*

3 Terms and definitions

For the purposes of this document, the terms, definitions and abbreviated terms given in ISO 26262-1:2018 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

4 Requirements for compliance

4.1 Purpose

This clause describes how:

- a) to achieve compliance with the ISO 26262 series of standards;
- b) to interpret the tables used in the ISO 26262 series of standards; and
- c) to interpret the applicability of each clause, depending on the relevant ASIL(s).

4.2 General requirements

When claiming compliance with the ISO 26262 series of standards, each requirement shall be met, unless one of the following applies:

- a) tailoring of the safety activities in accordance with ISO 26262-2 has been performed that shows that the requirement does not apply; or
- b) a rationale is available that the non-compliance is acceptable and the rationale has been evaluated in accordance with ISO 26262-2.

Informative content, including notes and examples, is only for guidance in understanding, or for clarification of the associated requirement, and shall not be interpreted as a requirement itself or as complete or exhaustive.