

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Safety of machinery – Electro-sensitive protective equipment –
Part 1: General requirements and tests**

**Sécurité des machines – Équipements de protection électrosensibles –
Partie 1: Exigences générales et essais**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Safety of machinery – Electro-sensitive protective equipment –
Part 1: General requirements and tests**

**Sécurité des machines – Équipements de protection électrosensibles –
Partie 1: Exigences générales et essais**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 13.110; 29.260.99

ISBN 978-2-8322-8435-3

Warning! Make sure that you obtained this publication from an authorized distributor. Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.
--

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	9
3 Terms and definitions	10
4 Functional, design and environmental requirements	14
4.1 Functional requirements.....	14
4.1.1 Normal operation	14
4.1.2 Sensing function	15
4.1.3 Types of ESPE	15
4.1.4 Types and required safety performance	15
4.1.5 Required PL _r or SIL and corresponding ESPE type	16
4.2 Design requirements	16
4.2.1 Electrical supply	16
4.2.2 Fault detection requirements.....	17
4.2.3 Electrical equipment of the ESPE.....	18
4.2.4 Output signal switching devices (OSSDs)	19
4.2.5 Indicator lights and displays.....	21
4.2.6 Adjustment means	22
4.2.7 Disconnection of electrical assemblies.....	22
4.2.8 Non-electrical components.....	22
4.2.9 Common cause failures	22
4.2.10 Programmable or complex integrated circuits.....	22
4.2.11 Software, programming, functional design of integrated circuits	22
4.2.12 Integrity of the ESPE detection capability.....	23
4.2.13 Test piece.....	23
4.3 Environmental requirements	23
4.3.1 Ambient air temperature range and humidity.....	23
4.3.2 Electrical disturbances.....	23
4.3.3 Mechanical environment	26
4.3.4 Enclosures.....	27
4.3.5 Light interference.....	27
5 Testing	28
5.1 General.....	28
5.1.1 Type tests.....	28
5.1.2 Test conditions	29
5.1.3 Test results.....	30
5.2 Functional tests	30
5.2.1 Sensing function	30
5.2.2 Response time.....	30
5.2.3 Limited functional tests	31
5.2.4 Periodic test.....	31
5.2.5 Indicator lights and displays.....	32
5.2.6 Means of adjustment.....	32
5.2.7 Rating of components	32
5.2.8 Output signal switching devices (OSSD)	32

5.3	Performance testing under fault conditions	33
5.3.1	General.....	33
5.3.2	Type 1 ESPE	33
5.3.3	Type 2 ESPE	33
5.3.4	Type 3 ESPE	33
5.3.5	Type 4 ESPE	33
5.4	Environmental tests	34
5.4.1	Rated supply voltage	34
5.4.2	Ambient temperature variation and humidity	34
5.4.3	Effects of electrical disturbances	35
5.4.4	Mechanical influences.....	40
5.4.5	Enclosures.....	42
5.4.6	Light interference.....	42
5.5	Validation of programmable or complex integrated circuits.....	44
5.5.1	General.....	44
5.5.2	Complex or programmable integrated circuits	44
5.5.3	Software, programming, functional design of integrated circuits	44
5.5.4	Test results analysis statement.....	44
6	Marking for identification and for safe use	44
6.1	General.....	44
6.2	ESPE supplied from a dedicated power supply	45
6.3	ESPE supplied from an internal electrical power source.....	45
6.4	Adjustment.....	45
6.5	Enclosures	45
6.6	Control devices	46
6.7	Terminal markings	46
6.8	Marking durability	46
7	Accompanying documents	46
Annex A (normative)	Optional functions of the ESPE	49
A.1	General.....	49
A.2	External device monitoring (EDM).....	49
A.2.1	Functional requirements	49
A.2.2	Fault condition requirements.....	49
A.2.3	Verification	49
A.2.4	Information for use.....	50
A.3	Stopping performance monitor (SPM)	50
A.3.1	Functional requirements	50
A.3.2	Fault condition requirements.....	50
A.3.3	Verification	50
A.3.4	Marking.....	51
A.4	Secondary switching device (SSD).....	51
A.4.1	Functional requirements	51
A.4.2	Fault condition requirements.....	51
A.4.3	Verification	51
A.5	Start interlock	51
A.5.1	Functional requirements	51
A.5.2	Fault condition requirements.....	52
A.5.3	Verification	52
A.5.4	Indication	52

A.6	Restart interlock.....	52
A.6.1	Functional requirements	52
A.6.2	Fault condition requirements.....	52
A.6.3	Verification	52
A.6.4	Indication	53
A.7	Muting.....	53
A.7.1	General.....	53
A.7.2	Functional requirements	53
A.7.3	Fault condition requirements.....	53
A.7.4	Verification	53
A.7.5	Indication	54
A.8	Reinitiation of machine operation facility	54
A.8.1	General.....	54
A.8.2	Functional requirements	54
A.8.3	Fault condition requirements.....	54
A.8.4	Verification	54
A.9	Setting the detection zone and/or other safety-related parameters	55
A.9.1	Functional requirements	55
A.9.2	Verification	55
Annex B (normative)	Catalogue of single faults affecting the electrical equipment of the ESPE, to be applied as specified in 5.3.....	56
B.1	General.....	56
B.2	Conductors and connectors	56
B.3	Switches	56
B.4	Discrete electrical components	56
B.5	Solid-state electrical components.....	56
B.6	Motors	56
Annex C (informative)	Design review	57
Bibliography		58
Figure 1	– Examples of ESPEs using safety-related communication interfaces	21
Figure 2	– Test setup for the EMC test of ESPEs with safety-related communication interfaces.....	30
Table 1	– Types and required safety performance.....	15
Table 2	– Required PL_r or SIL and corresponding ESPE type	16
Table 3	– Supply voltage dips and interruptions for AC power ports	24
Table 4	– Supply voltage dips and interruptions for DC power ports.....	24
Table 5	– Vibration test for stationary use	40
Table 6	– Sinusoidal vibration test for ground vehicle installations	40
Table 7	– Broadband vibration test for ground vehicle installations	41
Table 8	– Shock test for stationary use	41
Table 9	– Shock test for ground vehicle installation.....	42

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY OF MACHINERY –
ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –****Part 1: General requirements and tests****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61496-1 has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects.

This fourth edition cancels and replaces the third edition published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) It has been clarified that some requirements for ESPEs that are dependent on sensing technology are not included in IEC 61496-1. They are provided in a subsequent part of IEC 61496.
- b) Requirements for protection against environmental influences from subsequent parts of IEC 61496 that are common to all ESPEs have been consolidated into IEC 61496-1.

- c) Some test procedures in IEC 61496-1 were incomplete. They have been expanded with more detail and step by step procedures.
- d) Some requirements and procedures in IEC 61496-1 are now covered by new generic machine safety standards. The requirements in IEC 61496-1 have been harmonized with references to the new generic standards.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
44/874/FDIS	44/877/RVD

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

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

A list of all the parts in the IEC 61496 series, published under the general title *Safety of machinery – Electro-sensitive protective equipment*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

An electro-sensitive protective equipment (ESPE) is applied to machinery presenting a risk of personal injury. It provides protection by causing the machine to revert to a safe condition before a person can be placed in a hazardous situation.

This document provides general design and performance requirements of ESPEs for use over a broad range of applications. Essential features of equipment meeting the requirements of this document are the appropriate level of safety-related performance provided and the built-in periodic functional checks/self-checks that are specified to ensure that this level of performance is maintained.

Each type of machine presents its own particular hazards and it is not the purpose of this document to recommend the manner of application of the ESPE to any particular machine. The application of the ESPE is a matter for agreement between the equipment supplier, the machine user and the enforcing authority, and in this context attention is drawn to the relevant guidance established internationally, for example ISO 12100.

This document specifies technical requirements of electro-sensitive protective equipment. The application of this document may require the use of substances and/or test procedures that could be injurious to health unless adequate precautions are taken. Conformance with this document in no way absolves either the supplier or the user from statutory obligations relating to the safety and health of persons during the use of the equipment covered by this document.

The requirements of this document are highly dependent on analysis and expertise in specific test and measurement techniques. In order to provide a high level of confidence, independent review is recommended.

SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –

Part 1: General requirements and tests

1 Scope

This part of IEC 61496 specifies general requirements for the design, construction and testing of non-contact electro-sensitive protective equipment (ESPE) designed specifically to detect persons or part of a person as part of a safety-related system. Special attention is directed to functional and design requirements that ensure an appropriate safety-related performance is achieved. An ESPE can include optional safety-related functions, the requirements for which are given in Annex A.

NOTE "Non-contact" means that physical contact is not required for sensing.

This document is intended to be used with a subsequent part of IEC 61496 that provides particular requirements based on the sensing technology.

EXAMPLE This document and IEC 61496-2 are used for AOPDs; this document and IEC 61496-3 are used for AOPDDRs.

Where a part covering the sensing technology does not exist, IEC TS 62998-1 is used.

Where the IEC 61496 series does not contain all necessary provisions, IEC TS 62998-1 is used.

It is an additional possibility to combine those aspects covered by the IEC 61496 series in addition to IEC TS 62998-1.

This document does not specify the dimensions or configuration of the detection zone and its disposition in relation to hazards in any particular application, nor what constitutes a hazardous state of any machine. It is restricted to the functioning of the ESPE and how it interfaces with the machine.

While a data interface can be used to control optional safety-related ESPE functions (Annex A), this document does not provide specific requirements. Requirements for these safety-related functions can be determined by consulting other standards (for example, IEC 61508 (all parts), IEC 62046, IEC 62061, and ISO 13849-1).

This document can be relevant to applications other than those for the protection of persons, for example for the protection of machinery or products from mechanical damage. In those applications, different requirements can be appropriate, for example when the materials that have to be recognized by the sensing function have different properties from those of persons.

This document does not deal with requirements for ESPE functions not related to the protection of persons (e.g. using sensing unit data for navigation).

This document does not deal with electromagnetic compatibility (EMC) emission requirements.

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.

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60204-1:2016, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60417, *Graphical symbols for use on equipment* (Available from: <http://www.graphical-symbols.info/equipment>)

IEC 60445, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

IEC 60721-3-5, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 5: Ground vehicle installations*

IEC TR 60721-4-3, *Classification of environmental conditions – Part 4-3: Guidance for the correlation and transformation of environmental condition classes of IEC 60721-3 to the environmental tests of IEC 60068 – Stationary use at weatherprotected locations*

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*
IEC 60947-1:2007/AMD2:2014

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*
IEC 61000-4-5:2014/AMD1:2017

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-11:2020, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase*

IEC 61000-4-29:2000, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 62061, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

ISO 12100, *Safety of machinery – General principles for design – Risk assessment and risk reduction*

ISO 13849-1, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

ISO 13849-2:2012, *Safety of machinery – Safety-related parts of control systems – Part 2: Validation*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 <http://www.iso.org/obp>

3.1

blanking

optional function that permits an object of a size greater than the detection capability of the ESPE to be located within the detection zone without causing an OFF-state of the OSSD(s)

Note 1 to entry: Fixed blanking is a technique wherein the locations of the blanked areas of the detection zone do not change during operation. The detection capability of the other parts of the detection zone remains unchanged.

Note 2 to entry: Floating blanking is a technique wherein the blanked area of the detection zone follows the location of a moving object(s) during operation. The detection capability of the other areas remains unchanged.

3.2

controlling/monitoring device

part of the electro-sensitive protective equipment (ESPE) that:

- receives and processes information from the sensing device and provides signals to the output signal switching devices (OSSD),
- monitors the sensing device and the OSSD

3.3

detection capability

sensing function parameter limit specified by the supplier that will cause actuation of the electro-sensitive protective equipment (ESPE)

3.4

detection zone

zone within which a specified test piece will be detected by the electro-sensitive protective equipment (ESPE)