IEC 61496-1

Edition 3.0 2012-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Sécurité des machines – Equipements de protection électro-sensibles –
Partie 1: Prescriptions générales et essais

IEC 61496-1:2012

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

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
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 corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you 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It also gives information on projects, replaced and withdrawn publications.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 on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

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: csc@iec.ch.

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

Liens utiles:

Recherche de publications CEI - www.iec.ch/searchpub

La recherche avancée vous permet de trouver des publications CEI 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.

Just Published CEI - webstore.iec.ch/justpublished

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

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - webstore.iec.ch/csc

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

IEC 61496-1

Edition 3.0 2012-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Sécurité des machines – Equipements de protection électro-sensibles – Partie 1: Prescriptions générales et essais

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE XA
CODE PRIX

ICS 13.110; 29.260.99

ISBN 978-2-8322-0061-2

CONTENTS

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 third edition cancels and replaces the second edition published in 2004 and its amendment 1 (2007). The document 44/615/CDV, circulated to the National Committees as amendment 2, led to the publication of this new edition.

The main changes with respect to the previous edition are as follows: The design, test and verification requirements have been updated to make them consistent with the latest standards for functional safety and EMC.

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

CDV	Report on voting
44/615/CDV	44/641/RVC

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 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.

A vertical line in the margin shows where the base publication has been modified by amendment 2.

The committee has decided that the contents of this publication will remain unchanged until the stability 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,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of April 2015 have been included in this copy.

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 part of IEC 61496 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 standard 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 standard to recommend the manner of application of the ESPE to any particular machine. The application of the ESPE should be 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 part of IEC 61496 specifies technical requirements of electro-sensitive protective equipment. The application of this standard may require the use of substances and/or test procedures that could be injurious to health unless adequate precautions are taken. Conformance with this standard 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 standard.

Due to the complexity of the technology used to implement ESPEs, there are many issues that are highly dependent on analysis and expertise in specific test and measurement techniques. In order to provide a high level of confidence, independent review by relevant experts 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 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 may include optional safety-related functions, the requirements for which are given in Annex A.

The particular requirements for specific types of sensing function are given in other parts of this standard.

This standard 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 standard does not provide specific requirements. Requirements for these safety-related functions can be determined by consulting other standards (for example, IEC 61508, IEC/TS 62046, IEC 62061, and ISO13849-1).

This standard may 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 necessary, for example when the materials that have to be recognized by the sensing function have different properties from those of persons.

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

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 60204-1:2009, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

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

IEC 60447, *Basic and safety principles for man-machine interface, marking and identification – Actuating principles*

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

IEC 60947-1:2011, *Low-voltage switchgear and controlgear – Part 1: General rules*

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

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

IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test*

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

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

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61131-2:2007, *Programmable controllers – Part 2: Equipment requirements and 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*

IEC/TS 62046, *Safety of machinery – Application of protective equipment to detect the presence of persons*

ISO 9001, *Quality management systems – Requirements*

ISO 12100:2010, *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 13849-2:2003, *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.

NOTE The index lists, in alphabetical order, the terms and acronyms defined in Clause 3 and indicates where they are used in the text of this part.

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)

3.5
electro-sensitive protective equipment
ESPE
assembly of devices and/or components working together for protective tripping or presence-sensing purposes and comprising as a minimum

– a sensing device;
– controlling/monitoring devices;
– output signal switching devices and/or a safety-related data interface

Note 1 to the entry: The safety-related control system associated with the ESPE, or the ESPE itself, may further include a secondary switching device, muting functions, stopping performance monitor, etc. (see Annex A).

Note 2 to entry: A safety-related communication interface can be integrated in the same enclosure as the ESPE.

3.6
external device monitoring
EDM
means by which the electro-sensitive protective equipment (ESPE) monitors the state of control devices which are external to the ESPE

3.7
failure
termination of the ability of an item to perform a required function

[SOURCE: IEC 60050-191:1990, 191-04-01, modified]

Note 1 to entry: After failure the item has a fault.

Note 2 to entry: 'Failure' is an event, as distinguished from 'fault', which is a state.

Note 3 to entry: This concept, as defined, does not apply to items consisting of software only.

Note 4 to entry: In practice, the terms fault and failure are often used synonymously.

3.8
failure to danger
failure which prevents or delays all output signal switching devices going to, and/or remaining in the OFF-state in response to a condition which, in normal operation, would result in their so doing

3.9
fault
state of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources

[SOURCE: IEC 60050-191:1990, 191-05-01]

Note 1 to entry: A fault is often the result of a failure of the item itself, but may exist without prior failure.

Note 2 to entry: In English the term "fault" and its definition are identical with those given in IEV 191-05-01. In the field of machinery, the French term "défaut" and the German term "Fehler" are used rather than the terms "panne" and "Fehlzustand" that appear with this definition.

3.10
final switching device
FSD
component of the machine's safety-related control system that interrupts the circuit to the machine primary control element (MPCE) when the output signal switching device (OSSD) goes to the OFF-state

3.11
integrated circuit – complex or programmable
monolithic, hybrid or module circuit which satisfies one or more of the criteria below:

a) more than 1 000 gates are used in the digital mode;
b) more than 24 functionally different external electrical connections are available for use;
c) the functions can be programmed.

Note 1 to entry: Examples include ASICs, ROMs, PROMs, EPROMs, PALs, CPUs, PLAs, and PLDs.

Note 2 to entry: The circuits may function in the analogue mode, the digital mode, or a combination of the two modes.

3.12
integrated circuit – simple
monolithic, hybrid or module circuit which satisfies none of the criteria in 3.11

Note 1 to entry: Examples are SSI or MSI logic ICs, comparators.

Note 2 to entry: The circuits may function in the analogue mode, in the digital mode, or in a combination of the two modes.

3.13
lock-out condition
condition, initiated by a fault, preventing normal operation of the electro-sensitive protective equipment (ESPE). All output signal switching devices (OSSDs) and, where applicable, all secondary switching devices (SSDs) are signalled to go to the OFF-state

3.14
machine primary control element
MPCE
electrically powered element that directly controls the normal operation of a machine in such a way that it is the last element (in time) to function when machine operation is to be initiated or arrested

Note 1 to entry: This element can be, for example, a mains contactor, a magnetic clutch or an electrically operated hydraulic valve.

3.15
machine secondary control element
MSCE
machine control element, independent of the machine primary control element(s), that is capable of removing the source of power from the prime mover of the relevant hazardous parts

Note 1 to entry: When fitted, the MSCE is normally controlled by the secondary switching device (SSD).

Note 2 to entry: This element can be, for example, a mains contactor, a magnetic clutch or an electrically operated hydraulic valve.

3.16
muting
a temporary automatic suspension of a safety function(s) by safety-related parts of the control system

Note 1 to entry: For ESPE-muting see Clause A.7

3.17
OFF-state
state of the output(s) of the ESPE in which the machine under control is caused to stop running and is prevented from starting (for example, the output circuit is interrupted and disables the flow of current)

3.18
ON-state

state of the output(s) of the ESPE in which the machine under control is allowed to run (for example, the output circuit is complete and enables the flow of current)

3.19
output signal switching device
OSSD
component of the electro-sensitive protective equipment (ESPE) connected to the machine control system which, when the sensing device is actuated during normal operation, responds by going to the OFF-state

3.20
overall system stopping performance
time interval resulting from the sum of the electro-sensitive protective equipment (ESPE) response time and the time to the cessation of hazardous machine operation

3.21
response time
maximum time between the occurrence of the event leading to the actuation of the sensing device and the output signal switching devices (OSSD) achieving the OFF-state

Note 1 to entry: When an ESPE includes a safety-related data interface, the response time is defined at the output of the safety-related data interface.

Note 2 to entry: When a safety-related communication interface is included in the ESPE enclosure, then the response time is defined at the output of the safety-related communication interface. In this case, the response time is also dependent on the protocol and architecture of the communication network.

Note 3 to entry: If an ESPE has both a safety-related data interface and OSSDs, the ESPE can have a different response time for the safety-related data interface and for the OSSDs.

3.22
restart interlock
means of preventing automatic restarting of a machine after actuation of the sensing device during a hazardous part of the machine operating cycle, after a change in mode of operation of the machine, and after a change in the means of start control of the machine

Note 1 to entry: Modes of operation include inch, single stroke, automatic. Means of start control include foot switch, two-hand control, and single or double actuation of the electro-sensitive protection equipment (ESPE) sensing device.

3.23
safety-related part of a control system
part or subpart(s) of a control system which respond(s) to input signals and generate(s) safety-related output signals

Note 1 to entry: This also includes monitoring systems.

Note 2 to entry: The combined safety-related parts of a control system start at the points where the safety-related signals are initiated and end at the output of the power control elements (see also ISO 12100, Annex A)

3.24
secondary switching device
SSD
device which, in a lock-out condition goes to the OFF-state. It may be used to initiate an appropriate machine control action, for example de-energizing the machine secondary control element (MSCE)

3.25
sensing device
part of the electro-sensitive protective equipment (ESPE) which uses electro-sensitive means to determine the event or state that the ESPE is intended to detect

EXAMPLE An opto-electronic sensing device would detect an opaque object entering the detection zone.

3.26
start interlock
means which prevents an automatic machine start when the electrical supply to the electro-sensitive protection equipment (ESPE) is switched on, or is interrupted and restored

3.27
stopping performance monitor
SPM
monitoring means to determine whether or not the overall system stopping performance is within the pre-set limit(s)

3.28
supplier
entity (for example manufacturer, contractor, installer, integrator) that provides equipment or services associated with the machine

Note 1 to entry: The user may act in the capacity of a supplier to himself.

3.29
safety-related data interface
direct connection (peer-to-peer) interface between the output of the ESPE and the safety-related communication interface that is used to represent the status of the OSSD(s)

NOTE 1 to entry: A data interface will not have addressing capability.

NOTE 2 to entry: The safety-related data interface can be bi-directional.

3.30
safety-related communication interface
safety-related connection to a standardized communication network intended for safety-related control functions

4 Functional, design and environmental requirements

4.1 Functional requirements

4.1.1 Normal operation

Normal operation is the state of an ESPE where no faults are detected and where the OSSD(s) are allowed to be in the ON-state or the OFF-state depending on the state of the sensing function and operating mode.

In normal operation, the ESPE shall respond by giving (an) appropriate output signal(s) when part of a person greater than or equal to the detection capability (as specified in the relevant part of IEC 61496) enters or is in the detection zone.

The ESPE response time shall not exceed that stated by the supplier. No means of adjustment of the response time shall be possible without the use of a key, key-word or tool.

4.1.2 Sensing function

The detection capability shall be effective over the detection zone specified by the supplier. No adjustment of the detection zone, detection capability or blanking function (monitored, unmonitored, fixed or floating) shall be possible without the use of a key, key-word or tool.

4.1.3 Types of ESPE

In this standard, three types of ESPEs are considered. The types differ in their performance in the presence of faults and under influences from environmental conditions. In this part, the effects of electrical and electromechanical faults are considered (such faults are listed in Annex B). Additional requirements are provided in the other parts where faults generated by the particular sensing technology employed are considered. It is the responsibility of the machine manufacturer and/or the user to prescribe which type is required for a particular application.

NOTE Requirements for a type 1 ESPE are not being considered at this time.

A type 2 ESPE shall fulfil the fault detection requirements of 4.2.2.3.

For a type 2 ESPE, in normal operation the output circuit of at least one output signal switching device shall go to the OFF-state when the sensing function is actuated, or when power is removed from the ESPE.

A type 2 ESPE shall have a means of periodic test.

A type 3 ESPE shall fulfil the fault detection requirements of 4.2.2.4.

A type 4 ESPE shall fulfil the fault detection requirements of 4.2.2.5.

For a type 3 ESPE and for a type 4 ESPE, in normal operation the output circuit of at least two output signal switching devices shall go to the OFF-state when the sensing function is actuated, or when power is removed from the ESPE.

When a single safety-related data interface is used to perform the functions of the OSSD(s), then the data interface and associated safety-related communication interface shall meet the