

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 61496-1:2004

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

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International Standard IEC 61496-1 has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects, in collaboration with CENELEC technical committee 44X: Safety of machinery – Electrotechnical aspects.

This edition constitutes a technical revision. In this edition of this part of IEC 61496, general requirements for a Type 3 ESPE have been added. In addition, several small changes and corrections have been made to clarify the requirements and to align this standard with current practice.

This standard has the status of a product family standard and may be used as a normative reference in a dedicated product standard for the safety of machinery.

This standard has been prepared as a specification of general requirements for electro-sensitive protective equipment (ESPE) specifically related to machinery safety and has been developed to meet the needs of manufacturers, industrial users and safety enforcement authorities.

This consolidated version of IEC 61496-1 consists of the second edition (2004) [documents 44/444/FDIS and 44/445/RVD], its amendment 1 (2007) [documents 44/560/FDIS and 44/568/RVD] and its corrigendum of July 2008.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

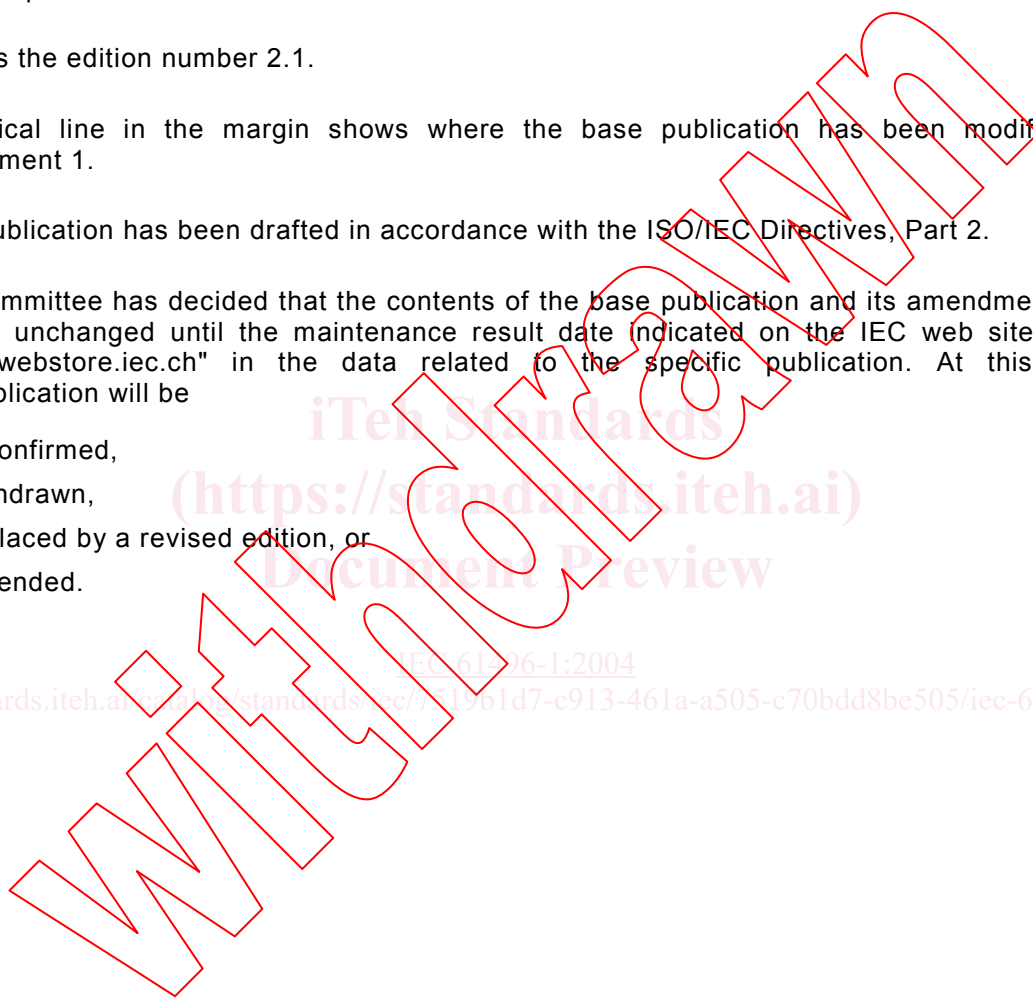
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INTRODUCTION

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 TR 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.

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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 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 60050-191:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-29:1987, *Basic environmental testing procedures – Part 2: Tests – Test Eb and guidance: Bump*

IEC 60204-1:1997, *Safety of machinery – Electrical equipment of industrial machines – Part 1: General requirements*

IEC 60249-2, *Base materials for printed circuits – Part 2: Specifications*

IEC 60439-1:1999, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*

IEC 60445:1999, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system*

IEC 60447:1993, *Man-machine interface (MMI) – Actuating principles*

IEC 60529:2001, *Degrees of protection provided by enclosures (IP code)*

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60947-5-1:1997, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 60950 (all parts), *Information technology equipment – Safety*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test – Basic EMC publication*

IEC 61000-4-3:2002, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test – Basic EMC publication*

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test – Basic EMC publication*

IEC 61000-4-5:2001, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity tests – Basic EMC publication*

IEC 61000-4-6:2001, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields – Basic EMC publication*

IEC 61000-6-2:1999, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61131-2:1992, *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*

ISO 9001:2000, *Quality management systems – Requirements*

ISO/TR 12100-1:1992, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology*

ISO/TR 12100-2:1992, *Safety of machinery – Basic concepts, general principles for design – Part 2: Technical principles and specifications*

ISO 13849-1:1999, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

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 this Clause and indicates where they are used in the text of this part.

3.1

blinking

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 Fixed blinking is a technique wherein the locations of the blinked areas of the detection zone do not change during operation. The detection capability of the other parts of the detection zone remain unchanged.

NOTE 2 Floating blinking is a technique wherein the blinked 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 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 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
[IEV 191-04-01, modified]

NOTE 1 After failure the item has a fault.

NOTE 2 'Failure' is an event, as distinguished from 'fault', which is a state.

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

NOTE 4 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
[IEV 191-05-01]

NOTE 1 A fault is often the result of a failure of the item itself, but may exist without prior failure.

NOTE 2 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 Examples include ASICs, ROMs, PROMs, EPROMs, PALs, CPUs, PLAs, and PLDs.

NOTE 2 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 Examples are SSI or MSI logic ICs, comparators.

NOTE 2 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 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 When fitted, the MSCE is normally controlled by the secondary switching device (SSD).

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

**3.16
muting**

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

NOTE 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 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 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 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 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 This also includes monitoring systems.

NOTE 2 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/TR 12100-1, 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 preset limit(s)

3.28**supplier**

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

NOTE 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 A data interface will not have addressing capability.

NOTE 2 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

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 requirements of 4.2.4.4. In this case, a single safety-related data interface can substitute for two OSSDs in a type 3 or type 4 ESPE.