



UL 61496-1:2021 (R2025)

(IEC 61496-1:2012, MOD)

STANDARD FOR SAFETY

**Safety of Machinery – Electro-Sensitive
Protective Equipment – Part 1: General
Requirements and Tests**

UL Standard for Safety of Machinery – Electro-Sensitive Protective Equipment – Part 1: General Requirements and Tests, UL 61496-1

Third Edition, Dated February 9, 2021

Summary of Topics

This reaffirmation of ANSI/UL 61496-1 dated July 16, 2025 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

UL 61496-1 is an adoption of IEC 61496-1, third edition issued by the IEC April 2012, as an IEC-based UL standard, with US National Differences.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated May 30, 2025.

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ANSI/UL 61496-1-2021 (R2025)

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UL 61496-1:2021 (R2025)
(IEC 61496-1:2012, MOD)

**Standard for Safety of Machinery – Electro-Sensitive Protective Equipment –
Part 1: General Requirements and Tests**

First Edition – January, 2002

Third Edition

February 9, 2021

This ANSI/UL Standard for Safety consists of the Third Edition including revisions through July 16, 2025.

The most recent designation of ANSI/UL 61496-1 as a Reaffirmed American National Standard (ANS) occurred on July 16, 2025. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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Preface (UL)

This ULSE standard is based on IEC Publication 61496-1: Third Edition, Safety of Machinery – Electro-Sensitive Protective Equipment – Part 1: General Requirements and Tests. IEC Publication 61496-1 is copyrighted by the IEC.

Efforts have been made to synchronize the UL edition number with that of the corresponding IEC standard with which this standard is harmonized. As a result, one or more UL edition numbers have been skipped to match that of the IEC edition number.

This is the UL Standard for Safety for Electro-Sensitive Protective Equipment – Part 1: General Requirements and Tests. This UL Part 1 is to be used in conjunction with the appropriate UL Part 2, which contains clauses to supplement or modify the corresponding clauses in Part 1, to provide relevant requirements for each type of product.

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Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

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NATIONAL DIFFERENCES

National Differences from the text of International Electrotechnical Commission (IEC) Publication 61496-1, Safety of machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests, copyright 2012 are indicated by notations (differences) and are presented in bold text.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

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.

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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.

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.

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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 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*

2DV.1 DC Modification to Clause 2, Normative References, by deleting the following:

**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 60947-1:2011,

Low-voltage switchgear and controlgear – Part 1: General rules

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

2DV.2 DC Modification of Clause 2, Normative References, by adding the following:

UL 840
Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment

UL 60947-1
Low-Voltage Switchgear and Controlgear – Part 1: general Rules

UL 61131-2
Programmable Controllers – Part 2: Equipment Requirements and Tests

NFPA 79:2015,
Electrical Standard for Industrial Machinery

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 IEC 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.