

Safety of machinery - Electro-sensitive protective equipment - Part 3: Particular requirements for Active Opto-electronic Protective Devices responsive to Diffuse Reflection (AOPDDR)

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

| | |
|---|--|
| See Eesti standard EVS-EN IEC 61496-3:2019 sisaldab Euroopa standardi EN IEC 61496-3:2019 ingliskeelset teksti. | This Estonian standard EVS-EN IEC 61496-3:2019 consists of the English text of the European standard EN IEC 61496-3:2019. |
| Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas. | This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation. |
| Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 15.02.2019. | Date of Availability of the European standard is 15.02.2019. |
| Standard on kättesaadav Eesti Standardikeskusest. | The standard is available from the Estonian Centre for Standardisation. |

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 13.110, 31.260

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:
Koduleht www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:

Homepage www.evs.ee; phone +372 605 5050; e-mail info@evs.ee

English Version

**Safety of machinery - Electro-sensitive protective equipment -
Part 3: Particular requirements for active opto-electronic
protective devices responsive to diffuse Reflection (AOPDDR)
(IEC 61496-3:2018)**

Sécurité des machines - Equipements de protection électro-sensibles - Partie 3: Exigences particulières pour les équipements utilisant des dispositifs protecteurs optoélectroniques actifs sensibles aux réflexions diffuses (AOPDDR)
(IEC 61496-3:2018)

Sicherheit von Maschinen - Berührungslos wirkende Schutzeinrichtungen - Teil 3: Besondere Anforderungen an aktive optoelektronische diffuse Reflexion nutzende Schutzeinrichtungen (AOPDDR)
(IEC 61496-3:2018)

This European Standard was approved by CENELEC on 2019-01-11. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 44/831/FDIS, future edition 3 of IEC 61496-3, prepared by IEC/TC 44 "Safety of machinery - Electrotechnical aspects" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61496-3:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2019-10-11
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-01-11

This document supersedes CLC/TS 61496-3:2008.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61496-3:2018 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

The bibliography of IEC 61496-1:2012 applies, except as follows:

Addition:

| | | |
|---------------------|------|---|
| IEC 60068-2-64:2008 | NOTE | Harmonized as EN 60068-2-64:2008 (not modified) |
| IEC 60721-3-5:1997 | NOTE | Harmonized as EN 60721-3-5:1997 (not modified) |
| IEC 61508-1:2010 | NOTE | Harmonized as EN 61508-1:2010 (not modified) |

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Clause 2 of IEC 61496-1:2012 applies, except as follows.

Addition:

| <u>Publication</u> | <u>Year</u> | <u>Title</u> | <u>EN/HD</u> | <u>Year</u> |
|--------------------|-------------|---|--------------------------------|-------------|
| IEC 60068-2-14 | - | Environmental testing - Part 2-14: Tests - Test N: Change of temperature | EN 60068-2-14 | - |
| IEC 60068-2-75 | - | Environmental testing - Part 2-75: Tests - Test Eh: Hammer tests | EN 60068-2-75 | - |
| IEC TR 60721-4-5 | - | Classification of environmental conditions - Part 4-5: Guidance for the correlation and transformation of environmental condition classes of IEC 60721-3 to the environmental tests of IEC 60068 - Ground vehicle installations | - | - |
| IEC 60825-1 | 2014 | Safety of laser products - Part 1: Equipment classification and requirements | EN 60825-1 | 2014 |
| - | - | | EN 60825-1:2014/ AC:2017-06 | |
| IEC 61496-1 | 2012 | Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests | EN 61496-1 | 2013 |
| IEC 62471 | - | Photobiological safety of lamps and lamp systems | EN 62471 | - |
| ISO 13855 | 2010 | Safety of machinery - Positioning of safeguards with respect to the approach speeds of parts of the human body | EN ISO 13855 | 2010 |
| ISO 20471 | 2013 | High-visibility clothing - Test methods and requirements | EN ISO 20471 | 2013 |

CONTENTS

| | |
|---|----|
| FOREWORD..... | 5 |
| INTRODUCTION..... | 7 |
| 1 Scope..... | 8 |
| 2 Normative references | 9 |
| 3 Terms and definitions | 9 |
| 4 Functional, design and environmental requirements | 11 |
| 4.1 Functional requirements..... | 11 |
| 4.2 Design requirements..... | 12 |
| 4.3 Environmental requirements | 22 |
| 5 Testing | 25 |
| 5.1 General..... | 25 |
| 5.2 Functional tests | 26 |
| 5.3 Performance testing under fault conditions | 36 |
| 5.4 Environmental tests | 37 |
| 6 Marking for identification and for safe use | 56 |
| 6.1 General..... | 56 |
| 7 Accompanying documents | 57 |
| Annex A (normative) Optional functions of the ESPE | 59 |
| Annex B (normative) Catalogue of single faults affecting the electrical equipment of the ESPE, to be applied as specified in 5.3..... | 65 |
| Annex AA (informative) Examples of the use of an AOPDDR in different applications | 66 |
| AA.1 General..... | 66 |
| AA.2 Example of the use of an AOPDDR-2D on machinery..... | 66 |
| AA.3 Example of the use of an AOPDDR-2D on an automatic guided vehicle (AGV) | 67 |
| AA.4 Positioning of AOPDDR-3D in respect of parts of the human body | 69 |
| AA.5 Examples of the use of an AOPDDR | 78 |
| AA.6 Detection zone angled to the direction of approach – orthogonal approach | 81 |
| AA.7 Example for the calculation of the response time of an AOPDDR-2D..... | 83 |
| Annex BB (informative) Relationship between position accuracy and probability of detection..... | 84 |
| Bibliography..... | 90 |
| Figure 1 – Detection zone of an AOPDDR-2D | 16 |
| Figure 2 – Detection zone of an AOPDDR-3D | 17 |
| Figure 3 – AOPDDR used as a trip device with orthogonal approach (200 mm minimum detectable object size) | 18 |
| Figure 4 – AOPDDR used as a trip device with orthogonal approach (150 mm minimum detectable object size) | 19 |
| Figure 5 – Minimum diffuse reflectivity of materials | 21 |
| Figure 6 – Test piece intrusion into the detection zone for test..... | 27 |
| Figure 7 – Influence on detection capability by incandescent light – Example 1 | 31 |
| Figure 8 – Influence on detection capability by incandescent light – Example 2 | 32 |
| Figure 9 – Influence on detection capability by light reflected by the background | 33 |

| | |
|---|----|
| Figure 10 – Configuration for the endurance test – Example 1 | 34 |
| Figure 11 – Configuration for the endurance test – Example 2 | 35 |
| Figure 12 – Interference between two AOPDDR-3D of identical design (opposite arrangement) | 47 |
| Figure 13 – Interference between two AOPDDR-3D of identical design (parallel arrangement) | 48 |
| Figure 14 – Example of an emitting element of an AOPDDR | 50 |
| Figure 15 – Example of a receiver of an AOPDDR | 50 |
| Figure 16 – Influence on detection capability by background..... | 52 |
| Figure 17 – Multi-path reflection test (top view)..... | 53 |
| Figure 18 – Multi-path reflection test (side view) | 53 |
| Figure A.1 – Reference boundary monitoring – Distribution of measurement values..... | 62 |
| Figure A.2 – Use of an AOPDDR with reference boundary monitoring..... | 63 |
| Figure A.3 – Use of an AOPDDR as parts of a body trip device..... | 63 |
| Figure AA.1 – Example of the use of an AOPDDR-2D on machinery | 66 |
| Figure AA.2 – Example of the use of an AOPDDR-2D on an AGV | 68 |
| Figure AA.3 – Minimum distance S – Example 1..... | 71 |
| Figure AA.4 – Overall minimum distance S_0 without tolerance zone – Example 1 | 72 |
| Figure AA.5 – Overall minimum distance S_0 including tolerance zone – Example 1 | 73 |
| Figure AA.6 – Minimum distance S – Example 2..... | 74 |
| Figure AA.7 – Overall minimum distance S_0 without tolerance zone – Example 2..... | 75 |
| Figure AA.8 – Overall minimum distance S_0 including tolerance zone – Example 2 | 75 |
| Figure AA.9 – Application example for body detection of an AOPDDR-3D..... | 77 |
| Figure AA.10 – Limited distance | 79 |
| Figure AA.11 – Overlap..... | 80 |
| Figure AA.12 – Reference boundary monitoring – Distribution of measurement values | 81 |
| Figure AA.13 – AOPDDR-2D detection zone angled to the direction of approach – Orthogonal approach | 82 |
| Figure AA.14 – AOPDDR-3D detection zone angled to the direction of approach – Orthogonal approach | 82 |
| Figure BB.1 – Relationship between position accuracy and detection zone | 84 |
| Figure BB.2 – Relationship between position accuracy, detection zone and the probabilistic part of the tolerance zone – Example 1 | 85 |
| Figure BB.3 – Relationship between position accuracy, detection zone and the probabilistic part of the tolerance zone – Example 2 | 86 |
| Figure BB.4 – Relationship between position accuracy, detection zone and tolerance zone – Example 1 | 87 |
| Figure BB.5 – Relationship between position accuracy, detection zone and tolerance zone – Example 2 | 88 |
| Figure BB.6 – POD of a single measurement (logarithmic) for a MooM-evaluation with $1 \leq M \leq 50$ | 89 |
| Figure BB.7 – POD of a single measurement for a MooM-evaluation with $1 \leq M \leq 50$ in relation to σ in the case of a normal distribution..... | 89 |

| | |
|---|----|
| Table 1 – Minimum tests required for the verification of detection capability requirements (see also 4.2.12.1)..... | 28 |
|---|----|

| | |
|---|----|
| Table 2 – Overview of light interference tests..... | 41 |
|---|----|

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY OF MACHINERY –
ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –****Part 3: Particular requirements for active opto-electronic protective
devices responsive to diffuse reflection (AOPDDR)**

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 61496-3 has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision.

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

- a) extension of the scope from AOPDDR-2D to AOPDDR-3D;
- b) extension of the scope from Type 3 ESPE to Type 2 ESPE;
- c) implementation of requirements and test procedures for AOPDDR-3D and Type 2 ESPE;
- d) listing of reference boundary monitoring as an optional function of the ESPE;

- e) implementation of instructions for positioning of AOPDDR-3D in respect of parts of the human body;
- f) revised requirement for combinations of single faults with conditions for no failure to danger, see for example 4.2.2.4, last paragraph.

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

| | |
|-------------|------------------|
| FDIS | Report on voting |
| 44/831/FDIS | 44/837/RVD |

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.

This document is to be used in conjunction with IEC 61496-1:2012.

Where a particular clause or subclause of IEC 61496-1:2012 is not mentioned in this document, that clause or subclause applies as far as is reasonable. Where this document states "addition" or "replacement", the relevant text of IEC 61496-1:2012 is adapted accordingly. Clauses and subclauses which are additional to those of IEC 61496-1:2012 are numbered sequentially, following on the last available number in IEC 61496-1:2012. Where no available number exist, the additional subclauses are numbered starting from 101. Supplementary Annexes are entitled AA and BB.

A list of all 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 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 supplements or modifies the corresponding clauses in IEC 61496-1 to specify particular requirements for the design, construction and testing of electro-sensitive protective equipment (ESPE) for the safeguarding of machinery, employing active opto-electronic protective devices responsive to diffuse reflection (AOPDDRs) for the sensing function.

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. In this context, attention is drawn to the relevant guidance established internationally, for example, IEC 62046 and ISO 12100.

Due to the complexity of the technology, 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 expertise is recommended.

SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –

Part 3: Particular requirements for active opto-electronic protective devices responsive to diffuse reflection (AOPDDR)

1 Scope

This part of IEC 61496 specifies additional requirements for the design, construction and testing of electro-sensitive protective equipment (ESPE) designed specifically to detect persons or parts of persons as part of a safety-related system, employing active opto-electronic protective devices responsive to diffuse reflection (AOPDDRs) for the sensing function. Special attention is directed to requirements which ensure that an appropriate safety-related performance is achieved. An ESPE can include optional safety-related functions, the requirements for which are given both in Annex A of this document and in Annex A of IEC 61496-1:2012.

This document does not specify the dimensions or configurations of the detection zone and its disposition in relation to hazardous parts for 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.

AOPDDRs are devices that have either

- one or more detection zone(s) specified in two dimensions (AOPDDR-2D), or
- one or more detection zone(s) specified in three dimensions (AOPDDR-3D)

wherein radiation in the near infrared range is emitted by an emitting element(s). When the emitted radiation impinges on an object (for example, a person or part of a person), a portion of the emitted radiation is reflected to a receiving element(s) by diffuse reflection. This reflection is used to determine the position of the object.

Opto-electronic devices that perform only a single one-dimensional spot-like distance measurement, for example, optical proximity switches, are not covered by this document.

This document does not address those aspects required for complex classification or differentiation of the object detected.

This document does not address requirements and tests for outdoor application.

Excluded from this document are AOPDDRs employing radiation with the peak of wavelength outside the range 820 nm to 950 nm, and those employing radiation other than that generated by the AOPDDR itself. For sensing devices that employ radiation of wavelengths outside this range, this document can be used as a guide. This document is relevant for AOPDDRs having a minimum detectable object size in the range from 30 mm to 200 mm.

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 and their clothing.

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