

# INTERNATIONAL STANDARD



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

Document Preview

[IEC 61496-3:2018](#)

<https://standards.iteh.ai/catalog/standards/iec/0ef6ebdf-d8b2-47bf-b4e3-399ae35eb504/iec-61496-3-2018>



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2018 IEC, Geneva, Switzerland

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

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

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

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 It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

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

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

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

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

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

IEC 61496-3:2018

<https://standards.iteh.ai/catalog/standards/iec/0ef6ebdf-d8b2-47bf-b4e3-399ac35eb504/iec-61496-3-2018>



IEC 61496-3

Edition 3.0 2018-12  
REDLINE VERSION

# INTERNATIONAL STANDARD



---

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

Document Preview

[IEC 61496-3:2018](https://standards.iteh.ai/catalog/standards/iec/0ef6ebdf-d8b2-47bf-b4e3-399ac35eb504/iec-61496-3-2018)

<https://standards.iteh.ai/catalog/standards/iec/0ef6ebdf-d8b2-47bf-b4e3-399ac35eb504/iec-61496-3-2018>

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 13.110; 31.260

ISBN 978-2-8322-6347-1

**Warning! Make sure that you obtained this publication from an authorized distributor.**

# CONTENTS

FOREWORD..... 5

INTRODUCTION..... 7

1 Scope..... 8

2 Normative references ..... 9

3 Terms and definitions ..... 10

4 Functional, design and environmental requirements ..... 12

    4.1 Functional requirements..... 12

    4.2 Design requirements ..... 13

    4.3 Environmental requirements ..... 26

5 Testing ..... 29

    5.1 General..... 29

    5.2 Functional tests ..... 30

    5.3 Performance testing under fault conditions ..... 49

    5.4 Environmental tests ..... 50

6 Marking for identification and for safe use ..... 75

    6.1 General..... 75

7 Accompanying documents ..... 76

Annex A (normative) Optional functions of the ESPE ..... 78

Annex B (normative) Catalogue of single faults affecting the electrical equipment of the ESPE, to be applied as specified in 5.3..... 90

Annex AA (informative) Examples of the use of an AOPDDR in different applications ..... 91

    AA.1 General..... 91

    AA.2 Example of the use of an AOPDDR-2D on machinery..... 91

    AA.3 Example of the use of an AOPDDR-2D on an automatic guided vehicle (AGV) ..... 93

    AA.4 Positioning of AOPDDR-3D in respect of parts of the human body ..... 95

    AA.5 Examples of the use of an AOPDDR ..... 104

    AA.6 Detection zone angled to the direction of approach – orthogonal approach ..... 107

    AA.7 Example for the calculation of the response time of an AOPDDR-2D..... 109

Annex BB (informative) Relationship between ranging position accuracy and probability of detection..... 110

Bibliography..... 118

~~Figure – Detection zone of an AOPDDR – Example 1 ..... 113~~

~~Figure – Detection zone of an AOPDDR – Example 2 ..... 114~~

~~Figure – Influence on detection capability by stroboscopic light – Example 1 ..... 115~~

~~Figure – Influence on detection capability by stroboscopic light – Example 2 ..... 116~~

~~Figure – Light interference test ..... 117~~

~~Figure – Interference between two AOPDDRs of identical design ..... 118~~


~~Figure – Test of homogeneous pollution – Examples of different designs of AOPDDR housings and optical windows without foil for simulation of homogeneous pollution ..... 119~~

~~Figure – Test of homogeneous pollution – Examples of different designs of AOPDDR housings and optical windows – Examples of correct positions of the foil ..... 120~~

~~Figure – Test of homogeneous pollution – Examples of different designs of AOPDDR housings and optical windows – Examples of incorrect positions of the foil ..... 121~~

|  |                  |
|--|------------------|
| <del>Figure – Use of an AOPDDR as a whole-body trip device – Example 1 .....</del>                             | <del>.....</del> |
| <del>Figure – Use of an AOPDDR as a whole-body trip device – Example 2 .....</del>                             | <del>.....</del> |
| <del>Figure – Use of an AOPDDR as parts of a body trip device – Example 1 .....</del>                          | <del>.....</del> |
| <del>Figure – Use of an AOPDDR as parts of a body trip device – Example 2 .....</del>                          | <del>.....</del> |
| <del>Figure – Reference boundary monitoring – Distribution of measurement values – Example 1 .....</del>       | <del>.....</del> |
| <del>Figure – Reference boundary monitoring – Distribution of measurement values – Example 2 .....</del>       | <del>.....</del> |
| Figure 1 – Detection zone of an AOPDDR-2D .....  | 19               |
| Figure 2 – Detection zone of an AOPDDR-3D .....  | 20               |
| Figure 3 – AOPDDR used as a trip device with orthogonal approach (200 mm minimum detectable object size) ..... | 22               |
| Figure 4 – AOPDDR used as a trip device with orthogonal approach (150 mm minimum detectable object size) ..... | 23               |
| Figure 5 – Minimum diffuse reflectivity of materials .....   | 25               |
| Figure 6 – Test piece intrusion into the detection zone for test .....   | 32               |
| Figure 7 – Influence on detection capability by incandescent light – Example 1 .....                           | 38               |
| Figure 8 – Influence on detection capability by incandescent light – Example 2 .....                           | 40               |
| Figure 9 – Influence on detection capability by light reflected by the background .....                        | 42               |
| Figure 10 – Configuration for the endurance test – Example 1 .....   | 46               |
| Figure 11 – Configuration for the endurance test – Example 2 .....   | 48               |
| Figure 12 – Interference between two AOPDDR-3D of identical design (opposite arrangement) .....                | 64               |
| Figure 13 – Interference between two AOPDDR-3D of identical design (parallel arrangement) .....                | 65               |
| Figure 14 – Example of an emitting element of an AOPDDR .....  | 67               |
| Figure 15 – Example of a receiver of an AOPDDR .....   | 67               |
| Figure 16 – Influence on detection capability by background .....  | 71               |
| Figure 17 – Multi-path reflection test (top view) .....  | 72               |
| Figure 18 – Multi-path reflection test (side view) .....   | 72               |
| Figure A.1 – Reference boundary monitoring – Distribution of measurement values .....                          | 87               |
| Figure A.2 – Use of an AOPDDR with reference boundary monitoring .....   | 88               |
| Figure A.3 – Use of an AOPDDR as parts of a body trip device .....   | 88               |
| Figure AA.1 – Example of the use of an AOPDDR-2D on machinery .....  | 92               |
| Figure AA.2 – Example of the use of an AOPDDR-2D on an AGV .....   | 94               |
| Figure AA.3 – Minimum distance $S$ – Example 1 .....   | 97               |
| Figure AA.4 – Overall minimum distance $S_0$ without tolerance zone – Example 1 .....                          | 98               |
| Figure AA.5 – Overall minimum distance $S_0$ including tolerance zone – Example 1 .....                        | 99               |
| Figure AA.6 – Minimum distance $S$ – Example 2 .....   | 100              |
| Figure AA.7 – Overall minimum distance $S_0$ without tolerance zone – Example 2 .....                          | 101              |
| Figure AA.8 – Overall minimum distance $S_0$ including tolerance zone – Example 2 .....                        | 101              |
| Figure AA.9 – Application example for body detection of an AOPDDR-3D .....                                     | 103              |
| Figure AA.10 – Limited distance .....  | 105              |
| Figure AA.11 – Overlap .....   | 106              |
| Figure AA.12 – Reference boundary monitoring – Distribution of measurement values .....                        | 107              |

|  |     |
|--|-----|
| Figure AA.13 – AOPDDR-2D detection zone angled to the direction of approach – Orthogonal approach .....  | 108 |
| Figure AA.14 – AOPDDR-3D detection zone angled to the direction of approach – Orthogonal approach .....  | 108 |
| Figure BB.1 – Relationship between-ranging position accuracy and detection zone .....  | 110 |
| Figure BB.2 – Relationship between-ranging position accuracy, detection zone and the probabilistic part of the tolerance zone – Example 1 .....            | 111 |
| Figure BB.3 – Relationship between-ranging position accuracy, detection zone and the probabilistic part of the tolerance zone – Example 2 .....            | 112 |
| Figure BB.4 – Relationship between-ranging position accuracy, detection zone and tolerance zone – Example 1 .....  | 113 |
| Figure BB.5 – Relationship between-ranging position accuracy, detection zone and tolerance zone – Example 2 .....  | 114 |
| Figure BB.6 – POD of a single measurement (logarithmic) for a MooM-evaluation with $1 \leq M \leq 50$ .....  | 116 |
| Figure BB.7 – POD of a single measurement for a MooM-evaluation with $1 \leq M \leq 50$ in relation to $\sigma$ in the case of a normal distribution ..... | 117 |
| Table 1 – Minimum tests required for the verification of detection capability requirements (see also 4.2.12.1) .....                                       | 34  |
| Table 2 – Overview of light interference tests .....   | 55  |

  
 (https://standards.iteh.ai)  
 Document Preview

[IEC 61496-3:2018](https://standards.iteh.ai/catalog/standards/iec/0ef6ebdf-d8b2-47bf-b4e3-399ac35eb504/iec-61496-3-2018)

<https://standards.iteh.ai/catalog/standards/iec/0ef6ebdf-d8b2-47bf-b4e3-399ac35eb504/iec-61496-3-2018>

## 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.

**This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.**

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.

~~Where a particular clause or subclause of part 1 is not mentioned in this part 3, that clause or subclause applies as far as is reasonable. Where this part states "addition", "modification" or "replacement", the relevant text of part 1 should be adapted accordingly.~~

~~Supplementary Annexes are entitled AA, BB, etc.~~

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 ~~should be~~ 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 ~~TR~~ 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.

## Document Preview

[IEC 61496-3:2018](https://standards.iteh.ai/catalog/standards/iec/0ef6ebdf-d8b2-47bf-b4e3-399ac35eb504/iec-61496-3-2018)

<https://standards.iteh.ai/catalog/standards/iec/0ef6ebdf-d8b2-47bf-b4e3-399ac35eb504/iec-61496-3-2018>

## SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –

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

#### 1 Scope

##### *Replacement:*

This part of IEC 61496 specifies additional requirements for the design, construction and testing of ~~non-contact~~ 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 ~~may~~ 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 ~~a~~ 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 ~~a transmitter~~ 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 ~~whereby the presence of the object can be detected~~. This reflection is used to determine the position of the object.

~~NOTE 1—Under certain circumstances, limitations of the sensor in relation to its use need to be considered. For example:~~

- ~~—Objects that generate mirror-like (specular) reflections may not be detected if the diffuse reflectance value is less than that specified for the "black" test piece.~~
- ~~—The determination of the minimal reflection factors for the detection of obstacles is based on the clothing of a person. Objects having a reflectivity lower than that considered in this part may not be detected.~~

Opto-electronic devices that perform only a single one-dimensional spot-like distance measurements, 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 ~~946~~ 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 ~~may~~ can be used as a guide. This document is relevant for AOPDDRs having a ~~stated detection capability~~ minimum detectable object size in the range

from 30 mm to 200 mm. ~~AOPDDRs intended for use as trip device using whole-body detection with normal approach to the detection zone and having a stated detection capability not exceeding 200 mm shall meet the requirements of Clause A.12. AOPDDRs intended for a direction of approach normal to the detection zone and having a stated detection capability in the range from 30 mm to 70 mm shall meet the requirements of Clause A.13.~~

~~NOTE 2 According to ISO 13855 (EN 999), 6.3 foreseeable angles of approach greater than 30° should be considered normal approach and foreseeable angles of approach less than 30° should be considered parallel approach.~~

~~NOTE 3 According to ISO 13855 (EN 999), 6.2 when electro-sensitive protective equipment employing active opto-electronic protective devices is used for direction of approach parallel to the detection zone the device should have a detection capability in the range from 50 mm to 117 mm.~~

This document ~~may~~ 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 ~~may~~ can be ~~necessary~~ 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.

## 2 Normative references

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

Addition:

IEC 60068-2-14:~~1984~~, ~~Basic Environmental testing procedures – Part 2-14: Tests – Test N: Change of temperature Amendment 1 (1986)~~

IEC 60068-2-75:~~1997-08~~, ~~Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests~~

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 ~~and user's guide~~*

IEC 61496-1:~~2004~~ 2012, *Safety of machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests*

~~IEC 62046<sup>1</sup>, Safety of machinery – Application of protective equipment to detect the presence of persons~~

IEC 62471, *Photobiological safety of lamps and lamp systems*

ISO 13855:~~2002~~ 2010, *Safety of machinery – Positioning of ~~protective equipment~~ safeguards with respect to the approach speeds of parts of the human body*

~~EN 471:2003-09~~ ISO 20471:2013, *High-visibility ~~warning~~ clothing ~~for professional use~~ – Test methods and requirements*

<sup>1</sup> ~~To be published.~~

### 3 Terms and definitions

Clause 3 of IEC 61496-1:2012 applies, except as follows.

*Replacement of 3.3 and 3.4:*

#### 3.3

##### **detection capability**

ability to detect the specified test pieces (see 4.2.13) in the specified detection zone

Note 1 to entry: A list of influences which can affect the AOPDDR detection capability is given in 4.2.12.1.

Note 2 to entry: Detection capability is often described by the minimum detectable object size and the object reflectivity. The supplier can state more than one value as the minimum detectable object size, for example depending on distances or mounting conditions. For an AOPDDR-2D the minimum detectable object size is the diameter of the cylindrical test piece.

#### 3.4

##### **detection zone**

zone within which the specified test piece(s) (see 4.2.13) is detected by the AOPDDR with a minimum required probability of detection (see 4.2.12.2)

Note 1 to entry: A tolerance zone is necessary to achieve the required probability of detection of the specified test piece(s) within the detection zone.

*Addition:*

#### 3.301

##### **active opto-electronic protective device responsive to diffuse reflection AOPDDR**

device, whose sensing function is performed by opto-electronic emitting and receiving elements, that detects the diffuse reflection of optical radiations generated within the device by an object present in a detection zone specified in two or three dimensions

Note 1 to entry: A receiving element can be composed by optics/optic-arrays and a single sensor element(s) or a sensor array(s).

Note 2 to entry: This note applies to the French language only.

#### ~~3.302~~

##### ~~**AOPDDR detection capability**~~

~~ability to detect the specified test pieces (see 4.2.13) in the detection zone~~

~~NOTE—A list of influences which can affect the AOPDDR detection capability is given in 4.2.12.1.~~

#### 3.302

##### **AOPDDR-2D**

AOPDDR that has one or more detection zone(s) specified in two dimensions

Note 1 to entry: For example, a third dimension is not greater than the minimum detectable object size, then the AOPDDR is regarded as 2D (see Figures 1 and 2).

Note 2 to entry: A typical example of an AOPDDR-2D is a laser scanner that performs distance measurement by measuring the time a pulse needs for travelling from the sensing device to an object and back to the sensing device. An AOPDDR-2D that has more than one detection zone may carry out distance measurements in different planes.

Note 3 to entry: This note applies to the French language only.

#### 3.303

##### **AOPDDR-3D**

AOPDDR that has one or more detection zone(s) specified in three dimensions

Note 1 to entry: For example, a third dimension as specified by the supplier is greater than the minimum detectable object size, the AOPDDR is regarded as 3D (see Figures 1 and 2). The detection zone(s) can be set-up for example as a volume in the shape of a pyramid or a cone.

Note 2 to entry: Typical examples of AOPDDR-3D are laser scanners with two perpendicular positioned moving mirrors or time-of-flight-cameras (TOF) that perform distance measurement on several pixels. An AOPDDR-3D that has more than one detection zone may carry out distance measurements in different volumes.

Note 3 to entry: This note applies to the French language only.

### **3.304** **basic test distance** **BTD**

Radius, respectively width and length (or equivalent values), of the detection zone used for test set-up

Note 1 to entry: For dimension of BTD, see 5.1.1.2.

Note 2 to entry: This note applies to the French language only.

### **3.305** **centre axis**

line through the origin of distance measurement and the centre of the maximum detection zone stated by the supplier

Note 1 to entry: See Figure 1 and Figure 2.

### **3.306** **corner axis**

line through the origin of distance measurement and defined by the bounding line of the detection zone

Note 1 to entry: See Figure 1 and Figure 2.

### **3.307** **minimum detection zone**

lowest dimension of the detection zone which is necessary to ensure the integrity of the detection capability

### **3.308** **position accuracy**

accuracy in two or three dimensions of the position of an object as measured by the AOPDDR

### ~~3.303~~**309** **tolerance zone** **TZ**

zone outside of and adjacent to the detection zone within which the specified test piece(s) (see 4.2.13) is detected with a probability of detection lower than the required probability within the detection zone

Note 1 to entry: The tolerance zone is necessary to achieve the required probability of detection of the specified test piece(s) within the detection zone

Note 2 to entry: For explanation of the concept of probability of detection and the tolerance zone, see Annex BB.

Note 3 to entry: This note applies to the French language only.

### **3.310** **zone with limited detection capability**

zone, between the optical window and the beginning of the detection zone, where the detection capability is not achieved

Note 1 to entry: The dimensions and appropriate information for use of the zone with limited detection capability are provided by the supplier.

*Addition:*

### 3.101 Abbreviated terms

**AGV** automated guided vehicle

**BTD** basic test distance

**POD** probability of detection

**TZ** tolerance zone

## 4 Functional, design and environmental requirements

~~This clause of part 1 is applicable except as follows:~~

### 4.1 Functional requirements

#### 4.1.3 Types of ESPE

*Replacement:*

In this document, only type 2 and type 3 ESPE ~~is~~ are considered. The types differ in their performance in the presence of faults and under influences from environmental conditions. It is the responsibility of the machine supplier and/or the user to prescribe ~~if this~~ which type is suitable for a particular application.

The type 2 ESPE shall fulfil the fault detection requirements of 4.2.2.3 of this document. In normal operation, the output circuit of each of at least two output signal switching devices (OSSDs) or of one output signal switching device (OSSD) and one secondary switching device (SSD) of the type 2 ESPE shall go to the OFF-state when the sensing device is actuated, or when the power is removed from the device.

The type 3 ESPE shall fulfil the fault detection requirements of 4.2.2.4 of this document. In normal operation, the output circuit of each of at least two output signal switching devices (OSSDs) of the type 3 ESPE shall go to the OFF-state when the sensing device is actuated, or when the power is removed from the device.

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 ESPE.

*Addition:*

#### 4.1.46 Zone(s) with limited detection capability

~~A zone between the optical window and the beginning of the detection zone is referred to as a zone with limited detection capability.~~ In order to ensure no hazard can arise in a particular application due to the presence of ~~this~~ one or more zone(s) with limited detection capability between the optical window and the detection zone, its dimensions and appropriate information for use shall be provided by the supplier.

**A** If the zone with limited detection capability ~~shall not~~ extends more than 50 mm from the optical window in direction to the ~~plane of~~ detection zone(s), then additional and effective technical measures shall be applied to prevent undetected presence of objects or persons or parts of persons in the zone with limited detection capability.