

Safety of machinery — Electro-sensitive protective equipment —

Part 3: Particular requirements for Active Opto-electronic Protective Devices responsive to Diffuse Reflection (AOPDDR)

ICS 13.110; 31.260

National foreword

This Draft for Development is the UK implementation of CLC/TS 61496-3:2008. It supersedes DD CLC/TS 61496-3:2003 which is withdrawn.

This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature. It should be applied on this provisional basis, so that information and experience of its practical application can be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the European organization responsible for its conversion to a European standard. A review of this publication will be initiated not later than three years after its publication by the European organization so that a decision can be taken on its status. Notification of the start of the review period will be made in an announcement in the appropriate issue of *Update Standards*.

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into a European Standard, to extend the life of the Technical Specification or to withdraw it. Comments should be sent to the Secretary of the responsible BSI Technical Committee at British Standards House, 389 Chiswick High Road, London W4 4AL.

The UK participation in its preparation was entrusted to Technical Committee MCE/3, Safeguarding of machinery.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Date	Comments

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 61496-3:2008)**

Sécurité des machines -
Équipements de protection
électro-sensibles -
Partie 3: Exigences particulières pour les
équipements utilisant des dispositifs
protecteurs optoélectroniques actifs
sensibles aux réflexions diffuses
(AOPDDR)
(CEI 61496-3:2008)

Sicherheit von Maschinen -
Berührungslos wirkende
Schutzeinrichtungen -
Teil 3: Besondere Anforderungen an
aktive optoelektronische diffuse Reflektion
nutzende Schutzeinrichtungen (AOPDDR)
(IEC 61496-3:2008)

This Technical Specification was approved by CENELEC on 2008-03-01.

CENELEC members are required to announce the existence of this TS in the same way as for an EN and to make the TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force.

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CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 44/572/FDIS, future edition 2 of IEC 61496-3, prepared by IEC TC 44, Safety of machinery - Electrotechnical aspects, in collaboration with the Technical Committee CENELEC TC 44X, Safety of machinery: electrotechnical aspects, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as CLC/TS 61496-3 on 2008-03-01.

This Technical Specification supersedes CLC/TS 61496-3:2003.

The most important changes and improvements compared to CLC/TS 61496-3:2003 are:

- extension of the range of detection capability covered by this part of the standard from 50 mm to 100 mm to the range of 30 mm to 200 mm;
- clarification of requirements for the selection of multiple detection zones (Clause A.10);
- more detailed information about the use of an AOPDDR as a whole body trip device by extension of Clause A.12 and a new Clause A.13;
- improved description of the relationship between ranging accuracy and probability of detection (Annex BB).

This Technical Specification is to be used in conjunction with EN 61496-1.

The following date was fixed:

- latest date by which the existence of the CLC/TS
has to be announced at national level (doa) 2008-06-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61496-3:2008 was approved by CENELEC as a Technical Specification without any modification.

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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 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 (AOPDDR) 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 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. In this context, attention is drawn to the relevant guidance established internationally, for example, 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.

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 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 include optional safety-related functions, the requirements for which are given both in Annex A of this part and in Annex A of IEC 61496-1.

This part 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 detection zone specified in two dimensions wherein radiation in the near infrared range is emitted by a transmitter 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.

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.

Excluded from this part are AOPDDRs employing radiation of wavelength outside the range 820 nm to 946 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 part may be used as a guide. This part is relevant for AOPDDRs having a stated detection capability 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 part 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 may be necessary, 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 part does not deal with electromagnetic compatibility (EMC) emission requirements.

Opto-electronic devices that perform only one-dimensional spot-like distance measurements, for example, proximity switches, are not covered by this part.

2 Normative references

Addition:

IEC 60068-2-14:1984, *Basic environmental testing procedures – Part 2: 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 60825-1, *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*

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

IEC 62046¹, *Safety of machinery – Application of protective equipment to detect the presence of persons*

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

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

3 Terms and definitions

Replacement:

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

Addition:

¹ To be published.

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 dimensions

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.

3.303**tolerance zone**

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. The tolerance zone is necessary to achieve the required probability of detection of the specified test piece(s) within the detection zone

NOTE For explanation of the concept of probability of detection and the tolerance zone see Annex BB.

4 Requirements

This clause of part 1 is applicable except as follows:

4.1 Functional requirements**4.1.3 Types of ESPE***Replacement:*

In this part of IEC 61496 only a type 3 ESPE is considered. It is the responsibility of the machine supplier and/or the user to prescribe if this type is suitable for a particular application.

The type 3 ESPE shall fulfil the fault detection requirements of 4.2.2.4 of this part. 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.

*Additional functional requirements:***4.1.4 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 zone(s) between the optical window and the detection zone, its dimensions and appropriate information for use shall be provided by the supplier.

A zone with limited detection capability shall not extend more than 50 mm from the optical window in the plane of detection.

4.2 Design requirements**4.2.2 Fault detection requirements****4.2.2.2 Particular requirements for a type 1 ESPE**

This subclause of part 1 is not applicable.

4.2.2.3 Particular requirements for a type 2 ESPE

This subclause of part 1 is not applicable.

4.2.2.4 Particular requirements for a type 3 ESPE

Replacement:

A single fault in the sensing device resulting in a complete loss of the stated AOPDDR detection capability shall cause the ESPE to go to a lock-out condition within the specified response time.

NOTE 1 For AOPDDR using rotating mirrors for scanning the detection zone, this requirement can be fulfilled by scanning on a defined reference object located outside the detection zone and the tolerance zone.

A single fault resulting in a deterioration of the stated AOPDDR detection capability shall cause the ESPE to go to a lock-out condition within a time period of 5 s following the occurrence of that fault.

NOTE 2 Examples of deterioration of the AOPDDR detection capability include:

- increase of the minimum detectable object size;
- increase in the minimum detectable reflectance;
- decrease of measurement accuracy.

A single fault resulting in an increase in response time beyond the specified value or preventing at least one OSSD going to the OFF-state shall cause the ESPE to go to a lock-out condition immediately, i.e. within the response time, or immediately upon any of the following demand events where fault detection requires a change in state:

- on actuation of the sensing function;
- on switch off/on;
- on reset of the start interlock or the restart interlock, if available (see Clauses A.5 and A.6 of IEC 61496-1);
- on the application of an external test signal, if available.

NOTE 3 An external test signal may be required if, for example, in a particular application, the frequency of actuation of the sensing function is foreseeably low and the OSSDs are monitored only at the change of state.

It shall not be possible for the ESPE to achieve a reset from a lock-out condition, for example, by interruption and restoration of the mains power supply or by any other means, when the fault which initiated the lock-out condition is still present.

In cases where a single fault which does not cause a failure to danger of the ESPE is not detected, the occurrence of further faults shall not cause a failure to danger. For verification of this requirement, see 5.3.4.

4.2.2.5 Particular requirements for a type 4 ESPE

This subclause of part 1 is not applicable.

Additional design requirements:

4.2.12 Integrity of the AOPDDR detection capability

4.2.12.1 General

The design of the AOPDDR shall ensure that the detection capability is not decreased below the limits specified by the supplier and in this standard by any of, but not limited to, the following:

- ageing of components;
- component tolerances (for example, spectral sensitivity of the receiver element);
- distance-dependent changes of sensitivity related for example to optics;
- limits of adjustment;
- insecure fixing of optical and mechanical components within the AOPDDR;
- environmental interference, especially:
 - a) system noise;
 - b) electrical interference according to 4.3.2 of IEC 61496-1;
 - c) pollution on the surface of the optical window of the housing;
 - d) condensation on the surface of the optical window of the housing;
 - e) ambient temperature;
 - f) ambient light;
 - g) background (for example, contrast between object and background);
 - h) vibration and bump;
 - i) humidity;
 - j) supply voltage variations and interruptions;
 - k) reflections of emitted light(s) from parts of the surrounding especially for devices with more than one transmitting and/or receiving element.

If a single fault (as specified in Annex B of IEC 61496-1), which under normal operating conditions (see 5.1.2.1 of IEC 61496-1) would not result in a loss of the stated AOPDDR detection capability but, when occurring with a combination of the above conditions, would result in such a loss, that fault, together with that combination of conditions, shall be considered as a single fault and the AOPDDR shall respond to such a single fault as required in 4.2.2.4.

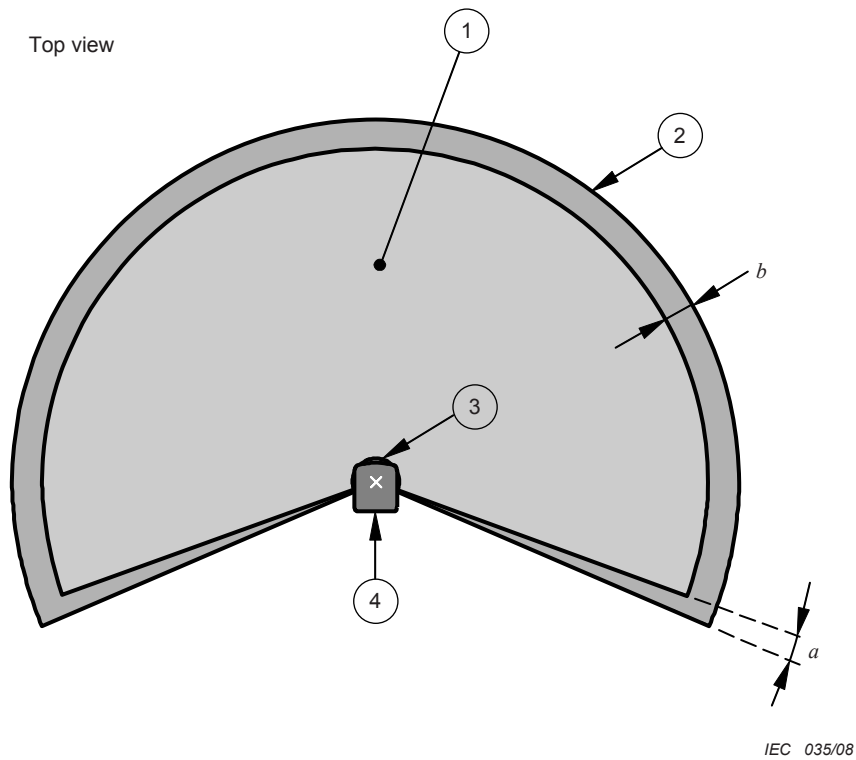
NOTE The technique of scanning on a reference object can satisfy the requirement in respect of ageing of components. Other techniques giving the same level of assurance may be used.

4.2.12.2 Detection zone(s) and tolerance zone(s)

The supplier shall specify the tolerance zone(s).

The supplier shall take into account worst-case conditions including, for example, signal-to-noise ratio S/N and standard deviation σ considering all influences listed in this standard and any additional influences specified by the supplier (environmental influence, component faults, etc.).

The tolerance zone depends on systematic interferences, measurement faults, resolution of the measurement values, etc. and is necessary to ensure the required detection probability within the detection zone. Figures 1 and 2 show examples of tolerance zones.



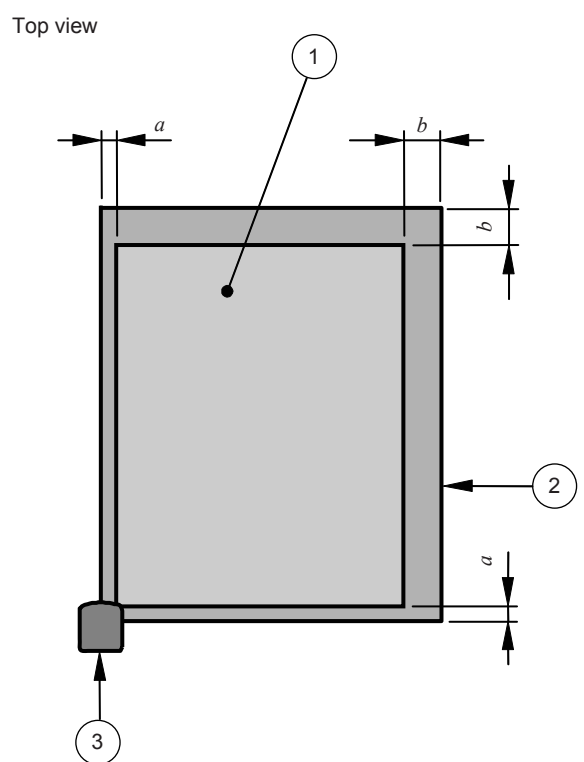
Key

- 1 Detection zone within which the specified test piece(s) is detected by the AOPDDR with a minimum required probability of detection.
- 2 Tolerance zone (detection not assured).
- 3 Zone with limited detection capability (detection not assured).
- 4 AOPDDR

NOTE 1 For an application of the AOPDDR, it may be necessary to take into account that the size of parts of the tolerance zone can be related for example to the diameter of the test piece and the beam position (see value of "a"). The value of "b" corresponds for example to the distance measurement accuracy.

NOTE 2 The detection zone origin is marked by a cross.

Figure 1 – Detection zone of an AOPDDR – Example 1



IEC 036/08

Key

- 1 Detection zone
- 2 Tolerance zone
- 3 AOPDDR

NOTE The value of "a" corresponds for example to the diameter of the test piece and the beam position. The value of "b" corresponds for example to the distance measurement accuracy.

Figure 2 – Detection zone of an AOPDDR – Example 2

The test pieces (see 4.2.13) shall be detected with a minimum probability of detection of $1 - 2,9 \times 10^{-7}$ throughout the detection zone(s). To achieve this minimum probability of detection, the tolerance zone is added to the detection zone (see Figure BB.2). Even if a measured distance value of a test piece falls into the tolerance zone this test piece will be determined as detected and the OSSDs shall go to the OFF-state or remain in the OFF-state.

NOTE 1 The tolerance zone is not included in the detection zone.

NOTE 2 Probability of detection as used in this part is not related to the probability of faults.

NOTE 3 Special attention may be required when the detection zone of AOPDDR is made up by more than one transmitting and/or receiving unit to ensure that the AOPDDR detection capability is not affected between the fields of view of these units.

When a test piece is placed on the boundary between the detection zone and the tolerance zone (i.e. on the border of the detection zone) the measured distance values of this test piece shall be the median point of the distribution of measurement values determined using a test piece with a reflectivity of any value from that of the "black" test piece to that of the "white" test piece. The supplier shall document the reflectivity of the test piece and the calculations used. This requirement may be verified by inspection of the supplier's documentation.

NOTE 4 The value for the ranging accuracy and the tolerance zone is not necessarily a constant. It can, for example, be a function of the measurement distance.

NOTE 5 If the AOPDDR has a facility to automatically set its detection zone(s), the ranging error of the set values is taken into account when determining the tolerance zone (see Clause A.11).

NOTE 6 Annex BB gives additional information about the relationship between ranging accuracy and probability of detection.

4.2.12.3 Scanning geometry, scanning frequency and response time

The supplier shall specify the relevant parameters of the detection zone(s), including range and scanning angle. The scanning geometry and/or scanning frequency shall be sufficient to ensure that a test piece with a diameter of the specified minimum detectable object size is detected at the maximum range of the detection zone(s). The supplier shall define values in the range of 30 mm to 200 mm as the minimum detectable object size of the AOPDDR. The minimum detectable object size may be distance dependent.

NOTE 1 The restriction of the minimum detectable object size to the range of 30 mm to 200 mm is based on current applications. Additional requirements may be necessary for AOPDDRs having detection capabilities outside this range.

Objects of the minimum detectable size that are either stationary or moving within the detection zone at any speed up to 1,6 m/s shall be detected by the ESPE within the specified response time. The response time shall be determined by the supplier taking into account worst-case conditions, especially for the scanning frequency and the movement of objects. Where the supplier states that an AOPDDR can be used to detect objects moving at speeds greater than 1,6 m/s, the requirements shall be met at any speed up to and including the stated maximum speed(s).

NOTE 2 The detection capability may be determined by the optical geometry of the AOPDDR so that one complete beam will impinge on the specified test pieces in the maximum range of detection zone and tolerance zone for a special design. In this case, the distance between the centre of two adjacent transmitter beams (except the first and the last one) will not exceed half the diameter of the test pieces. For other designs, it can be more difficult to carry out the verification according to 5.2.1.2 and 5.2.11, especially when movement of objects is taken into account, as required above.

NOTE 3 An example for the calculation of the response time is given in Clause AA.5.

All points on a path projected from any point on the border of the detection zone to the receiving element(s) of the AOPDDR shall be within the detection zone (see 4.2.12.2) or the zone with limited detection capability (see 4.1.4).

4.2.13 Test pieces for type testing

4.2.13.1 General

The test pieces are part of the AOPDDR and shall therefore be provided by the supplier for use in the type tests of Clause 5. They shall be marked with a type reference and identification of the AOPDDR with which they are intended to be used.

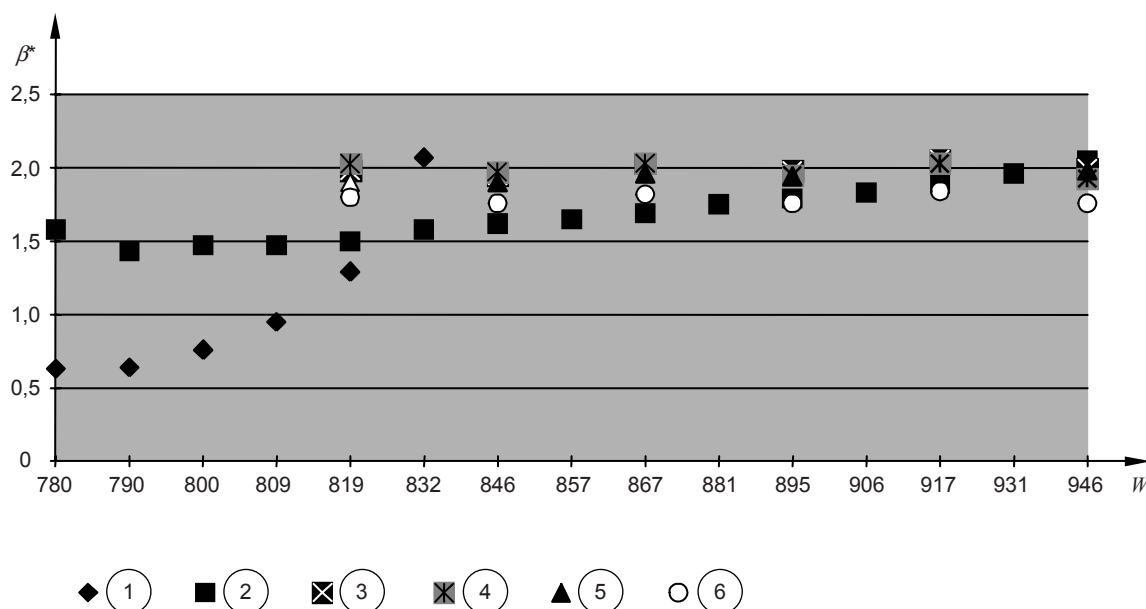
The test pieces shall have a diameter equal to the maximum specified detection capability (minimum diameter). Other diameters within the range of 30 mm to 200 mm may be required for testing depending on the detection capability of the AOPDDR.

NOTE The minimum effective length of the test pieces has been selected for ease of use.

4.2.13.2 Black test piece

The black test piece shall be a cylinder with a minimum effective length of 0,3 m. The surface of the test piece shall have a diffuse reflectance value in the range of 1,6 % to 2,0 % including measurement accuracy, at the wavelength of the transmitter and under normal conditions. This value shall be verified by measurement. Where this reflectance value is used for calculation, the nominal value of 1,8 % shall be used.

NOTE Figure 3 shows the results of an investigation to determine the reflectance of the black test piece (performed by Berufsgenossenschaftliches Institut für Arbeitsschutz, 53754 Sankt Augustin, Germany).



IEC 037/08

Key

- 1 Black velvet MG 20/5
- 2 Black broad corduroy MG 0/5
- 3 Black plastic foam MG 0/5
- 4 Black gumboot MG 20/5
- 5 Black synthetic material MG 20/5
- 6 Black shoe leather MG 20/5
- W Wavelength [nm]
- β^* Coefficient of diffuse reflection [%]

NOTE A measurement geometry (MG) of, for example, 0/5 is represented by an entrance angle of 0° and an observation angle of 5°. The entrance angle characterizes the angular position of the tested material with respect to the direction of the incident light. The observation angle is the angle by which the direction of the observation of the tested material differs from the direction of the incident light.

Figure 3 – Minimum diffuse reflectivity of materials

4.2.13.3 White test piece

The white test piece shall be a cylinder with a minimum effective length of 0,3 m. The surface of the test piece shall have a diffuse reflectance value in the range of 80 % to 90 % at the wavelength of the transmitter.

4.2.13.4 Retro-reflective test piece

The retro-reflective test piece shall be a cylinder with a minimum effective length of 0,3 m. The surface of the test piece shall be of retro-reflecting material. The material shall comply with the requirements for retro-reflection of EN 471 class 2 or equivalent.

NOTE Table 5 of EN 471 defines the minimum coefficient of retro-reflection for class 2 material as $330 \text{ cd} \cdot \text{lx}^{-1} \cdot \text{m}^{-2}$ with an entrance angle of 5° and an observation angle of $0,2^\circ$ ($12'$).

4.2.14 Wavelength

AOPDDRs shall operate at a wavelength within the range of 820 nm to 946 nm.

NOTE This range of wavelengths is based on the present availability of components together with research which shows it to be suitable for materials used as clothing.

4.2.15 Radiation intensity

The radiation intensity generated and emitted by the AOPDDR shall at no time, even in the presence of a component failure, exceed the maximum power or energy levels for a class 1M laser in accordance with IEC 60825-1. The marking as a class 1 laser shall be carried out as required in 5.2 of IEC 60825-1.

4.2.16 Mechanical construction

When the detection capability can be decreased below the limit stated by the supplier, as a result of a change of position of components, the fixing of those components shall not rely solely on friction.

NOTE The use of oblong mounting holes without additional means could lead for example to a change of the position of the detection zone under mechanical interference such as bump.

4.3 Environmental requirements

Addition:

NOTE These requirements may not fulfil the needs of certain applications (for example: use on vehicles, including automatic guided vehicles (AGVs), forklifts, mobile machinery, etc.).

4.3.1 Ambient air temperature range and humidity

Addition:

The ESPE shall not fail to danger when subjected to a rapid change of temperature and humidity leading to condensation on the optical window.

This requirement is verified by the condensing test of 5.4.2.

4.3.3 Mechanical environment

Additional mechanical requirements:

4.3.3.3 Change of temperature

The ESPE shall be free of damage, including displacement and/or cracks of the optical window, after the tests of 5.4.4.3 and it shall be capable of continuing in normal operation.

4.3.3.4 Impact resistance

4.3.3.4.1 Normal operation

The ESPE shall be free of damage, including displacement and/or cracks of the optical window, after the tests of 5.4.4.4.2 and it shall be capable of continuing in normal operation.

4.3.3.4.2 Fail to danger

The ESPE shall not fail to danger after the tests of 5.4.4.4.3.

4.3.4 Enclosures

Addition:

Means shall be provided for the secure fixing of the enclosure(s).

Enclosures of the AOPDDR containing optical components shall provide a degree of protection of at least IP65 (see IEC 60529) when mounted as specified by the supplier.

Additional environmental requirements:

4.3.5 Light interference on AOPDDR receiving elements and other optical components

The ESPE shall continue in normal operation when subjected to the following:

- incandescent light;
- fluorescent light operated with high-frequency electronic power supply;
- radiation from an AOPDDR of identical design if no mounting restrictions related to possible interference are given by the supplier of the AOPDDR.

The ESPE shall not fail to danger when subjected to the following:

- high-intensity incandescent light (simulated daylight using a quartz lamp);
- fluorescent light operated with its rated power supply and with a high-frequency electronic power supply;
- stroboscopic light;
- radiation from an AOPDDR of identical design;
- flashing beacon.

These requirements are verified by the tests of 5.2.1.2 and 5.4.6.

4.3.6 Pollution interference

The supplier shall specify the maximum level of homogeneous pollution in percentage of transmission which will not result in a decrease of the stated detection capability.

The AOPDDR shall continue in normal operation when the received signal energy of the detection system itself is attenuated by up to 30 % by homogeneous pollution.

Pollution between the transmitting and/or receiving element(s) and the beginning of the detection zone(s) (including optical components) of the AOPDDR resulting in a loss of the stated detection capability shall cause the OSSDs to go to the OFF-state.

These requirements are verified by the tests of 5.4.7.

NOTE The tests listed in 5.4.7 may not cover all possible forms of pollution, for example, oil, grease and process materials.

Any pollution monitoring means for detecting a loss of the stated detection capability shall comply with all the relevant requirements of this standard.

4.3.7 Background interference

The stated tolerance zone shall not be increased by background interference. This requirement is verified by the tests of 5.4.8.

NOTE 1 The supplier may specify the AOPDDR for a maximum reflectance value that is monitored by the AOPDDR itself and which leads to the OFF-state of the OSSDs if the specified maximum reflectance value is exceeded. Background interference by materials with higher values of reflectance can thereby be excluded.

NOTE 2 Backgrounds that may interfere with the measurement results include corner cube reflectors, tiles, sheet metal, white paper, etc.

NOTE 3 Retro-reflectors are considered as a background within the tests of detection capability and measurement accuracy (see 5.4.8). If retro-reflectors in the background lead to measurement faults, it may be possible in specific applications to use other measures instead of an addition to the tolerance zone.

4.3.8 Manual interference

It shall not be possible to reduce the stated detection capability by covering the optical window of the housing of the AOPDDR or other parts (if applicable) or by placing objects within a zone with limited detection capability (see 4.1.4). In such cases the OSSDs shall go to the OFF-state within a time period of 5 s and the OSSDs shall remain in the OFF-state until the manual interference is removed.

AOPDDR for use as trip device using whole-body detection with normal approach (Clause A.12) and AOPDDR used for the detection of parts of a body with normal approach (Clause A.13) shall be designed such that the OSSDs shall go to the OFF-state within the stated response time when manual interference is performed and the OSSDs shall remain in the OFF-state until the manual interference is removed. These requirements are verified by the tests of 5.4.9.

4.3.9 Optical shadowing in the detection zone

The AOPDDR detection capability shall be maintained when small objects are present in the detection zone. This shall be verified by analysis and by a test according to 5.4.10. The analysis shall include examination of any software filtering algorithms provided.

NOTE Software filtering algorithms may be provided to disregard small objects, for example, to increase reliability of operation.

4.3.10 Ageing of components

Drift or ageing of components that would reduce the detection capability below the value stated shall not cause a failure to danger of the ESPE, shall be detected within a time period of 5 s and shall lead to a lock-out condition.

If a reference object is used for monitoring ageing and drift of components, variations in its properties (for example, reflectance) shall not cause a failure to danger of the ESPE. If a reference object is used to monitor ageing and drift of components, it shall be considered to be part of the AOPDDR and shall be provided by the supplier of the AOPDDR.

5 Testing

This clause of part 1 is applicable except as follows:

5.1 General

5.1.1.2 Operating condition

Addition:

Unless otherwise stated in this part, and if the facility is provided to set the detection zone, the zone used for the tests shall be set up as follows:

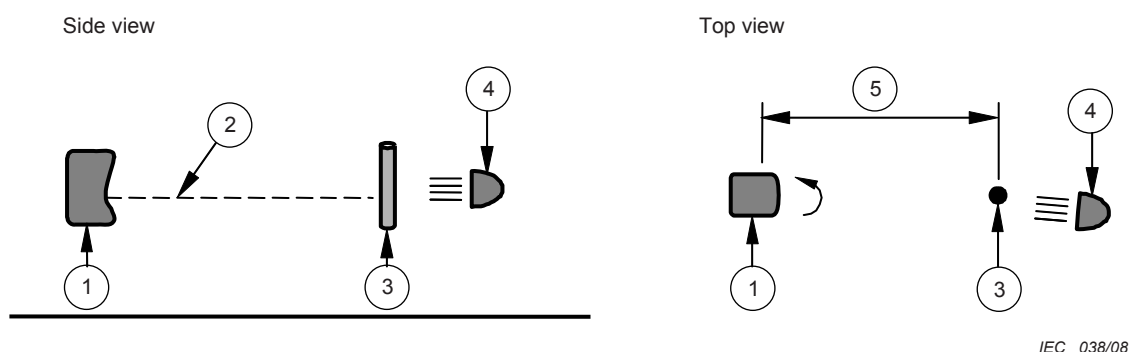
- radius respectively width and length (or equivalent values) of the detection zone of 1,0 m;
- add the value of the specified tolerance zone.

NOTE For example, a detection zone of 1,0 m and a tolerance zone of 0,2 m results in a zone used for the tests of 1,2 m.

For an AOPDDR with a stated maximum detection distance of less than 1,0 m, this distance shall be used where 1,0 m is specified in Clause 5.

For an AOPDDR without the facility to set the detection zone, the fixed detection zone shall be used for all tests.

During these tests the test piece(s) shall be used normal to the plane of the AOPDDR detection zone. Figures 4, 5, 6, 7, 8, 9 and 10 show possible configurations for individual tests on the integrity of the detection capability and light interference.

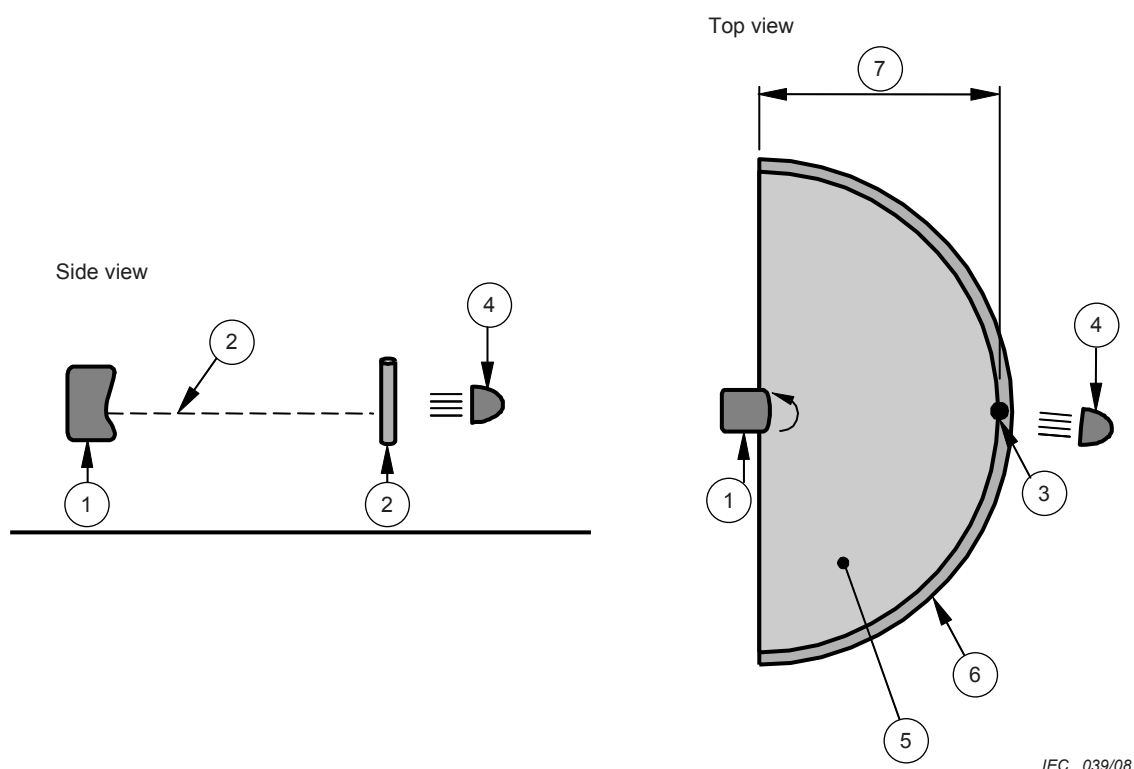


Key

- 1 AOPDDR
- 2 Detection plane
- 3 Test piece
- 4 Light source
- 5 1,0 m and maximum distance

NOTE Figure 4 shows a possible configuration for a test according to 5.2.1.2.2.

Figure 4 – Influence on detection capability by incandescent light – Example 1

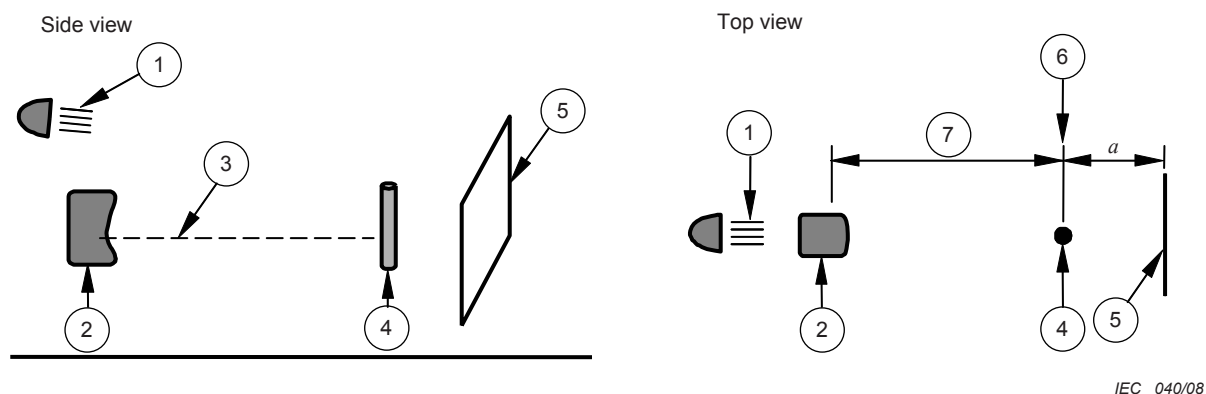


Key

- 1 AOPDDR
- 2 Detection plane
- 3 Test piece
- 4 Light source
- 5 Detection zone
- 6 Tolerance zone in relation to light interference
- 7 1,0 m and maximum distance

NOTE Figure 5 shows a possible configuration for a test according to 5.2.1.2.2.

Figure 5 – Influence on detection capability by incandescent light – Example 2



Key

- 1 Light source
- 2 AOPDDR
- 3 Detection plane
- 4 Test piece
- 5 Background (diffuse reflective surface 0,5 m x 0,5 m)
- 6 Measurement of intensity of reflected light in the detection plane without test piece
- 7 1,0 m and maximum distance

NOTE 1 Figure 6 shows a possible configuration for a test according to 5.2.1.2.3.

NOTE 2 "a" = 0,4 m, but at least so large that the background is not detected as an object.

NOTE 3 Figure 6 shows no detection zone because in this example it is the influence on the measurement accuracy that is being tested.

NOTE 4 The coefficient of reflection of the background used for this test shall not vary in the range of wavelengths used by the AOPDDR itself and used for the measurement of intensity.

Figure 6 – Influence on detection capability by light reflected by the background