IEC 61496-3

Edition 2.0 2008-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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 61496-3:2008

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International Standard IEC 61496-3 has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects, in collaboration with CENELEC technical committee 44X: Safety of machinery – Electrotechnical aspects.

This second edition cancels and replaces the first edition issued in 2001 and constitutes a technical revision.

The most important changes and improvements compared to the first edition of this part of the standard 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 International Standard is to be used in conjunction with IEC 61496-1.

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

FDIS	Report on voting
44/572/FDIS	44/578/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.

A list of all parts of IEC 61496 series, 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 maintenance result 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- withdrawn,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.

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

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 (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 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 62046[1], *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.

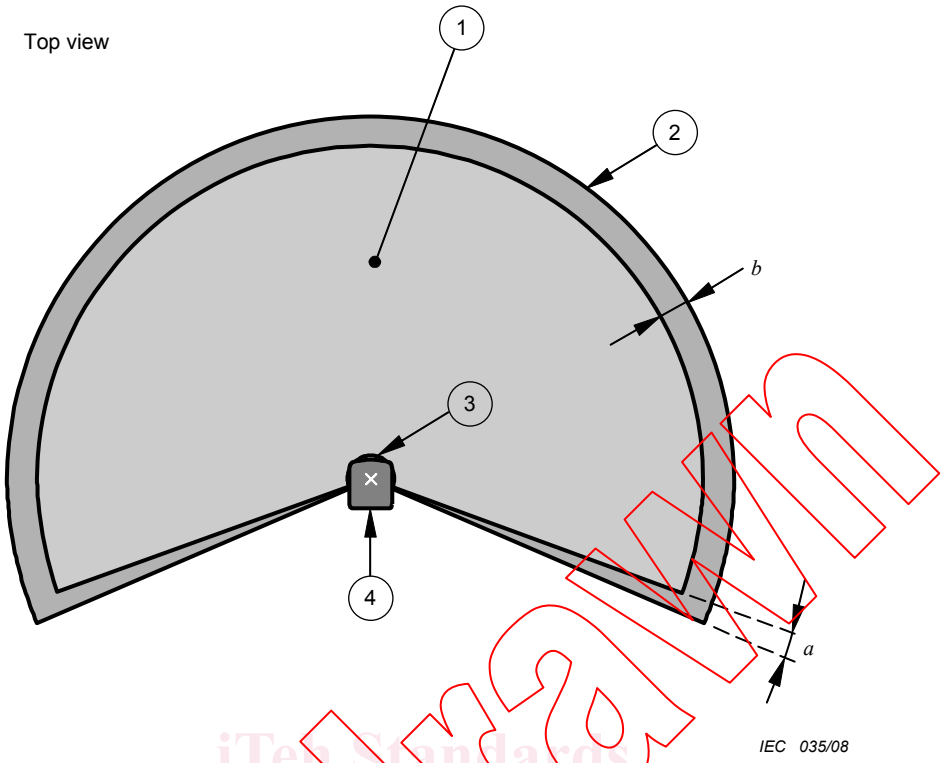
NOTE The technique of scanning on a reference object can satisfy the requirement in respect of ageing of components. Other techniques giving the same level of assurance may be used.

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