



BSI British Standards

Safety of machinery — Electro-sensitive protective equipment —

Part 2: Particular requirements for equipment
using active opto-electronic protective devices
(AOPDs)

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National foreword

This Draft for Development is the UK implementation of CLC/TS 61496- 2: 2006. It is identical to IEC/TS 61496-2:2006. It supersedes BS IEC 61496-2:1997 and DD CLC/TS 61496-2:2003, which are withdrawn.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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Compliance with a British Standard cannot confer immunity from legal obligations.

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CLC/TS 61496-2

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English version

**Safety of machinery -
Electro-sensitive protective equipment
Part 2: Particular requirements for equipment using
active opto-electronic protective devices (AOPDs)
(IEC 61496-2:2006)**

Sécurité des machines -
Équipement de protection électrosensible
Partie 2: Exigences particulières à
un équipement utilisant des dispositifs
protecteurs optoélectroniques actifs
(AOPD)
(CEI 61496-2:2006)

Sicherheit von Maschinen -
Berührungslos wirkende
Schutzeinrichtungen
Teil 2: Besondere Anforderungen an
Einrichtungen, welche nach dem aktiven
opto-elektronischen Prinzip arbeiten
(IEC 61496-2:2006)

This Technical Specification was approved by CENELEC on 2006-06-01.

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CENELEC

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

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Foreword

The text of document 44/500/FDIS, future edition 2 of IEC 61496-2, 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 61496-2 on 2006-06-01.

This Technical Specification supersedes CLC/TS 61496-2:2003.

This Technical Specification includes the following technical changes with respect to CLC/TS 61496-2:2003:

- a) Requirements have been corrected and made easier to understand.
- b) Test procedures have been revised to make them easier to perform and to improve repeatability.
- c) Guidance is provided for the evaluation and verification of AOPDs using design techniques for which the test procedures of this part are not appropriate.

This Technical Specification is to be used in conjunction with EN 61496-1:2004.

The following date was fixed:

- latest date by which the existence of the CLC/TS has to be announced at national level (doa) 2006-12-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61496-2:2006 was approved by CENELEC as a Technical Specification without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60825-1	- ¹⁾	Safety of laser products Part 1: Equipment classification, requirements and user's guide	EN 60825-1 + corr. February + A11	1994 ²⁾ 1995 1996
IEC/TS 62046	2004	Safety of machinery - Application of protective equipment to detect the presence of persons	CLC/TS 62046	2005
ISO 13855	2002	Safety of machinery - Positioning of protective - equipment with respect to the approach speeds of parts of the human body		-
-	-	High-visibility warning clothing for professional use - Test methods and requirements	EN 471	2003

¹⁾ Undated reference.

²⁾ Valid edition at date of issue.

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INTRODUCTION

Electro-sensitive protective equipment (ESPE) is applied to machinery that presents a risk of personal injury. It provides protection by causing the machine to revert to a safe condition before a person can be placed in a hazardous situation.

This part of IEC 61496 provides 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 (AOPDs) for the sensing function.

This part supplements or modifies the corresponding clauses in IEC 61496-1.

Where a particular clause or subclause of Part 1 is not mentioned in this Part 2, that clause or subclause applies as far as is reasonable. Where this part states "addition", "modification" or "replacement", the relevant text of Part 1 is to be adapted accordingly.

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 12100.

SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –

Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs)

1 Scope

This clause of Part 1 is replaced by the following:

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

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.

Excluded from this part are AOPDs employing radiation at wavelengths outside the range 400 nm to 1500 nm.

This part may be relevant to applications other than those for the protection of persons, for example, the protection of machinery or products from mechanical damage. In those applications, additional requirements may be necessary, for example, when the materials that are to be recognized by the sensing function have different properties from those of persons.

This part does not deal with EMC emission requirements.

2 Normative references

This clause of Part 1 is applicable except as follows:

Additional references:

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*

IEC 62046:2004, *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, *High-visibility warning clothing for professional use – Test methods and requirements*.

3 Terms and definitions

NOTE At the end of this standard there is an index which lists, in alphabetical order, the terms and acronyms defined in Clause 3 and indicates where they are used in the text.

This clause of Part 1 is applicable except as follows:

Additional definitions:

3.201

active opto-electronic protective device (AOPD)

device whose sensing function is performed by opto-electronic emitting and receiving elements detecting the interruption of optical radiations generated, within the device, by an opaque object present in the specified detection zone (or for a light beam device, on the axis of the light beam)

3.202

beam centre-line

optical path joining the optical centre of an emitting element to the optical centre of the corresponding receiving element that is intended to respond to light from that emitting element during normal operation

NOTE 1 The optical axis of a light beam is not always on the beam centre-line.

NOTE 2 Physical displacement of the beam centre-line may occur as a consequence of normal operation (for example, by the use of a motor-driven mirror).

NOTE 3 For an AOPD that operates on a retro-reflective technique, the optical path is defined by the retro-reflector target together with the emitting and receiving elements.

3.203

effective aperture angle (EAA)

maximum angle of deviation from the optical alignment of the emitting element(s) and the receiving element(s) within which the AOPD continues in normal operation

3.204

light beam device

single light beam device or a multiple light beam device

- **single light beam device:** AOPD comprising one emitting element and one receiving element, where a detection zone is not specified by the supplier;
- **multiple light beam device:** AOPD comprising multiple emitting elements and corresponding receiving elements, and where a detection zone is not specified by the supplier

3.205

light curtain

AOPD comprising an integrated assembly of one or more emitting element(s) and one or more receiving element(s) forming a detection zone with a detection capability specified by the supplier

NOTE A light curtain with a large detection capability is sometimes referred to as a light grid.

3.206

test piece

opaque cylindrical element used to verify the detection capability of the AOPD

3.207

monitored blanking

configuration of the detection capability and/or detection zone in such a way that the presence of an object(s) within a defined part of the detection zone will not cause an OFF-state of the OSSD(s) but the absence (or, in some cases, a change in size or location) of the object will cause the OSSD(s) to go to the OFF-state

Replacement:

3.3

detection capability

dimension representing the diameter of the test piece which:

- for a light curtain, will actuate the sensing device when placed in the detection zone;
- for a single light beam device, will actuate the sensing device when placed in the beam centre-line;
- for a multiple light beam device, will actuate the sensing device when placed in any beam centre-line

NOTE Can also be used to mean the ability to detect a test piece of the specified diameter.

4 Functional, design and environmental requirements

This clause of Part 1 is applicable except as follows:

4.1 Functional requirements

4.1.2 Sensing function

Replacement:

4.1.2.1 General

The sensing function shall be effective over the detection zone specified by the supplier. No adjustment of the detection zone, detection capability or blanking function shall be possible without the use of a key, key-word or tool.

The sensing device of a light curtain shall be actuated and the OSSD(s) shall go to the OFF-state when a test piece in accordance with 4.2.13 is placed anywhere within the detection zone either static (at any angle) or moving (with the axis of the cylinder normal to the plane of the detection zone), at any speed between 0 m/s and 1,6 m/s.

The sensing device of a light beam device shall be actuated and the OSSD(s) shall go to the OFF-state when a test piece in accordance with 4.2.13 is present in the beam centre-line, at any point throughout the operating distance, with the axis of the cylinder normal to the axis of the beam.

NOTE The purpose of this requirement is to ensure that the OSSD(s) go to the OFF-state when a person or part of a person passes through the detection zone or light beam. Based on a dimension of 150 mm and a walking speed of 1,6 m/s, a minimum OFF time of 80 ms was determined to be adequate.

When the OSSD(s) go to the OFF-state, they shall remain in the OFF-state while the test piece is present in the detection zone (or light beam) or for at least 80 ms, whichever is greater.

Where the supplier states that an AOPD can be used to detect objects moving at speeds greater than those specified above, the above requirements shall be met at any speed up to and including the stated maximum speed(s).

4.1.2.2 Optical performance

The AOPD shall be designed and constructed to:

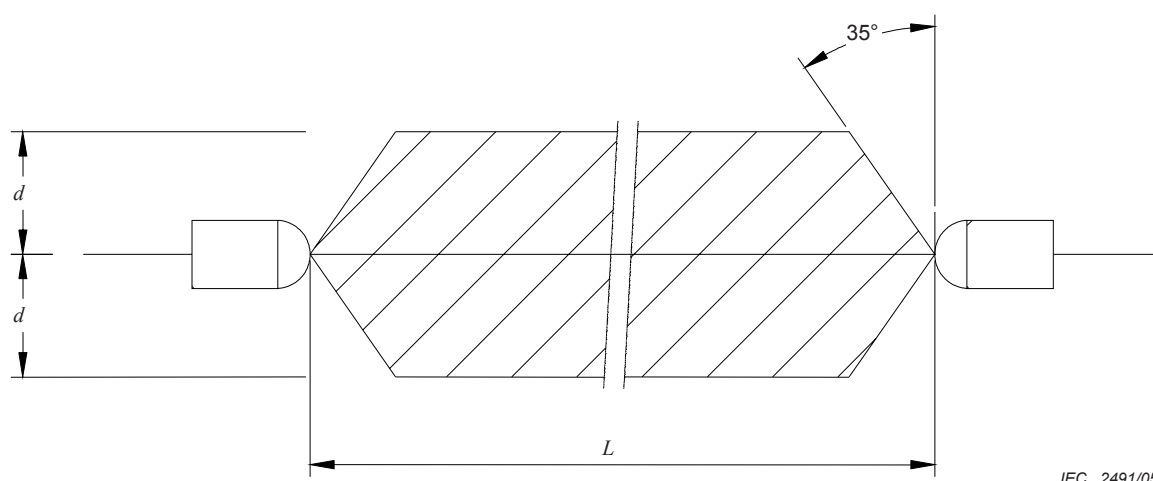
- limit the possibility of failure to danger resulting from extraneous reflections (for example, for operating range up to 3 m, see Figure 1);
- limit the misalignment at which normal operation is possible;
- limit the possibility of malfunction during exposure to extraneous light in the range of 400 nm to 1 500 nm;
- control the size of the emitted beam to minimize the effects on other equipment.

One method of achieving these requirements is by ensuring that the effective aperture angle (EAA) of each emitting and each receiving element does not exceed the values given in Figure 2. When this method is used, the requirements are met when the AOPD conforms to the tests in 5.2.9.2 and Annex D.

There are other technical means alternative to the restriction of the EAA to achieve equivalent performance for the characteristics in items a), b), c) and d) above. In such cases, the requirements are met when the AOPD conforms to the tests in 5.2.9.2 and Annex E.

Acceptable optical performance shall be verified by passing the appropriate tests of 5.2.9 and 5.4.

If the AOPD is intended to provide protection when mounted very close to a reflective surface (i.e. inside the shaded area of Figure 1), the AOPD shall be designed in such a manner that no optical bypassing can occur on the reflective surfaces. For such a device, an EAA much less than $2,5^\circ$ (for example, less than $0,1^\circ$) can be necessary. In this case, Figures 1 and 2 do not apply and the limits of protection against optical bypassing shall be as specified by the manufacturer.

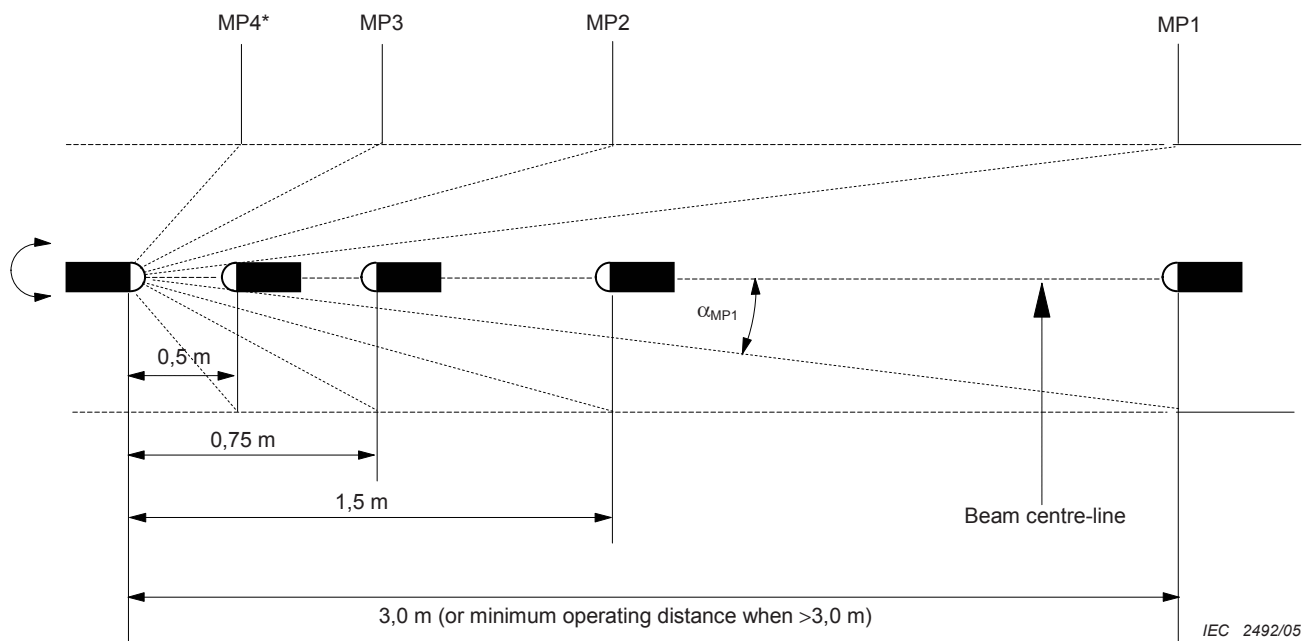


IEC 2491/05

For Type 4: $d = 131\text{mm}$, $L = 250$ to $3\,000\text{ mm}$

For Type 2: $d = 262\text{ mm}$, $L = 500$ to $3\,000\text{ mm}$

Figure 1 – Limit area for the protection against the risk of beam bypass



Type 2 AOPD	MP1	MP2	MP3	MP4		Type 4 AOPD	MP1	MP2	MP3	MP4
α Limit values degrees	5	10	19,3	27,7		α Limit values degrees	2,5	5	10	14,7
* MP measuring point										

NOTE 1 The effective aperture angle should be determined according to 5.2.9.2.

NOTE 2 Measurements should be carried out at each of the measuring points MP1 to MP4 (or if minimum distance is greater than 3,0 m, at MP1 only).

NOTE 3 The limit values for other distances can be calculated using the formula:

$$\alpha = \tan^{-1}(d/L) \quad \text{where} \quad d = 262 \text{ (for Type 2)}$$

$$\text{or} \quad d = 131 \text{ (for Type 4)}$$

and L is the distance between emitter and receiver (or DUT and retro-reflector target).

NOTE 4 For retro-reflector systems, the value of α is one-half of the value shown in the table above.

Figure 2 – Measurement of the effective aperture angle (EAA)

4.1.2.3 Additional requirements for an AOPD using retro-reflective techniques

An AOPD using retro-reflective techniques where the light beam traverses the detection zone more than once (over the same path) shall not fail to danger if a reflective object (for example, reflective clothes) is placed at any position in the detection zone and shall not be bypassed by an easily available reflector (for example, mirror).

NOTE The use of mirrors to return the light beam is not considered to be a retro-reflective technique.

The OSSD(s) of a single light beam device shall go to, and remain in, the OFF-state when a reflective object of a size greater than, or equal to, the diameter and length of the test piece (see 4.2.13) is placed in the beam at any position as specified in 5.2.1.1.

The reflective objects considered shall consist of:

- the retro-reflector target;
- a retro-reflecting material conforming to the requirements for retro-reflection of EN 471:2003 class 2 or equivalent;
NOTE Table 5 in EN 471:2003 defines the minimum coefficient of retro-reflection for class 2 material as 330 cd lx⁻¹ m⁻² with an entrance angle of 5° and an observation angle of 0,2° (12').
- a mirror-type reflective surface having a reflection factor greater than, or equal to, 90 % at the operating wavelength, for example polished chrome plating or polished aluminium;
- a diffuse reflective surface, for example, white paper.

Under normal operating conditions the OSSD(s) of a light curtain and of a multiple light beam device using retro-reflective techniques shall go to and remain in the OFF-state when an identical reflector is placed as close as practicable in front of the sensing surface of the emitting/receiving element(s).

4.1.2.4 Additional requirements for an AOPD using emitters and receivers in the same assembly

Under normal operating conditions the OSSD(s) of an AOPD shall go to, and remain in, OFF-state when a reflective object whose size is greater than, or equal to, the diameter and length of the test piece is placed normal to the optical axes anywhere within the detection zone.

NOTE This subclause does not apply to an AOPD using retro-reflective techniques.

The reflective objects considered shall consist of

- a retro-reflecting material conforming to the requirements for retro-reflection of EN 471:2003 class 2 or equivalent;
NOTE Table 5 in EN 471:2003 defines the minimum coefficient of retro-reflection for class 2 material as 330 cd lx⁻¹ m⁻² with an entrance angle of 5° and an observation angle of 0,2° (12').
- a mirror-type reflective surface having a reflection factor greater than or equal to 90 % at the operating wavelength, for example, polished chrome plating or polished aluminium;
- a diffuse reflective surface, for example, white paper.

4.2 Design requirements

4.2.2 Fault detection requirements

4.2.2.3 Particular requirements for a type 2 ESPE

Replacement of first paragraph:

A type 2 ESPE shall have a means of periodic test to reveal a failure to danger (for example, loss of sensing unit detection capability, response time exceeding that specified). The test shall verify that each light beam operates in the manner specified by the supplier. Where the periodic test is intended to be initiated by an external (for example, machine) safety-related control system, the ESPE shall be provided with suitable input facilities (for example, terminals).

Additional design requirements:

4.2.12 Integrity of the AOPD detection capability

The design of the AOPD shall be such that the AOPD detection capability remains less than, or equal to, the value stated by the supplier when the AOPD is operated under any and all combinations of the following:

- any condition within the specification of the supplier;
- the environmental conditions specified in 4.3 (of IEC 61496-1:2004 and IEC 61496-2:2005);
- at the limits of alignment and/or adjustment.

If a single fault (as specified in Annex B of IEC 61496-1:2004), which under normal operating conditions (see 5.1.2.1 of IEC 61496-1:2004) would not result in a loss of AOPD detection capability but, when occurring with a combination of the conditions specified above, would result in such a loss, that fault together with that combination of conditions shall be considered as a single fault, and the AOPD shall respond to such a single fault as required in 4.2.2. An example of a method for determining detection capability is shown in Annex E.

4.2.13 Test piece

The test piece shall be cylindrical and opaque, with a minimum effective length of 150 mm. The diameter of the test piece shall not exceed the AOPD detection capability stated by the supplier.

For an AOPD detection capability of not more than 40 mm, the test piece for a light curtain shall be provided by the supplier and shall be marked with the following:

- diameter in millimetres;
- type reference and an indication of the AOPD with which the test piece is intended to be used.

When more than one detection capability can be configured on the AOPD, the supplier shall provide a test piece for each detection capability.

Verification shall be by inspection.

4.2.14 Wavelength

AOPDs shall operate at a wavelength within the range 400 nm to 1 500 nm.

4.2.15 Radiation intensity

The radiation intensity generated and emitted by the AOPD shall at no time exceed the maximum power or energy levels for a class 1M device in accordance with 8.2 of IEC 60825-1.

NOTE The use of class 2M devices is under consideration.