

Safety of machinery — Electro-sensitive protective equipment —

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

ICS 13.110; 31.260

National foreword

This British Standard (BS IEC 61496-2:1997, published September 1999) reproduces verbatim IEC 61496-2:1997 and implements it as the UK national standard. Together with BS EN 61496-1:1998 it superseded BS 6491-1:1984 and BS 6491-2:1987, which were withdrawn in September 1999.

The UK participation in its preparation was entrusted to Technical Committee GEL/44, Safety of machinery — Electrotechnical aspects, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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Summary of pages

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**Safety of machinery –
Electro-sensitive protective equipment –**

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



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –

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

FOREWORD

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International Standard IEC 61496-2 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

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

FDIS	Report on voting
44/208/FDIS	44/212/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.

INTRODUCTION

An 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 International Standard IEC 61496 provides general design and performance requirements of ESPEs for use over a broad range of applications. Essential features of equipment meeting the requirements of this standard are the appropriate level of safety-related performance provided and the built-in periodic functional checks/self-checks that are specified to ensure that this level of performance is maintained.

This part supplements or modifies the corresponding clause 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.

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

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.

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) for the safeguarding of machinery, employing active opto-electronic protective devices (AOPDs) for the sensing function. Special attention is directed to features that ensure 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 part 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.

Excluded from this part are AOPDs employing radiation at wavelengths outside the range 400 nm to 1 500 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 reference:

IEC 60825-1: 1993, *Safety of laser products – Part 1 – Equipment classification, requirements and user's guide*

3 Definitions

NOTE – The index at the end of this standard 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): A 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.

NOTE – AOPDs operate either on a through beam principle, where the light beam traverses the detection zone once, or on a retro-reflective principle, where the light beam traverses the detection zone twice.

3.202 AOPD detection capability: In an active opto-electronic protective device (AOPD), the dimension representing the diameter of the opaque cylinder which

- for a light curtain, will actuate the sensing device when placed in the detection zone,
- for a light beam device, will actuate the sensing device when placed in the beam on the axis of the beam.

3.203 beam centre-line: In an active opto-electronic protective device (AOPD), the optical path joining the optical centre of an emitting element to the optical centre of the receiving element, that is intended to respond to light from that emitting element during normal operation.

NOTES

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

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).

3.204 effective aperture angle (EAA): The maximum angle of deviation from the optical alignment of the emitting element(s) and the receiving element(s) within which the active opto-electronic protective device (AOPD) continues in normal operation.

3.205 light beam device: An active opto-electronic protective device (AOPD) comprising one emitting element and one receiving element, where a detection zone is not specified by the supplier.

NOTE – An AOPD can comprise an arrangement of more than one light beam device.

3.206 light curtain: An active opto-electronic protective device (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, both specified by the supplier.

3.207 test piece: An opaque cylindrical element used to verify the detection capability of the active opto-electronic device (AOPD).

3.208 trip device: A device which causes a machine or machine elements to stop (or ensures an otherwise non-hazardous condition) when a person or a part of a person is detected by the sensing function.

3.209 trip device test piece: A test piece used to verify the detection capability of an active opto-electronic protective device (AOPD) used as a trip device.

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 or the defined signal range specified by the supplier. No adjustment of the detection zone or defined signal range shall be possible without the use of a key, key-word or tool.

The sensing device of a light curtain shall be actuated when a test piece in accordance with 4.2.13 is placed anywhere within the detection zone at any angle, either static or moving, at any speed between:

- 0 m/s and 2,5 m/s for an AOPD detection capability less than or equal to 40 mm,
- 0 m/s and 1,6 m/s for an AOPD detection capability greater than 40 mm.

Where the supplier states that a light curtain can be used as a trip device, the sensing device shall be actuated, and the OSSDs shall go to the OFF-state for at least 100 ms, when a trip device test piece, with a diameter equal to the stated AOPD detection capability and with a length of 150 mm, moves through the detection zone at a speed of 1,6 m/s, such that the direction of motion is along the axis of the cylinder and is normal to the detection zone, anywhere within the detection zone.

The sensing device of a light beam device shall be actuated when a test piece in accordance with 4.2.13 is in the beam, at any point throughout the operating distance, such that the axis of the cylinder is normal to the axis of the beam.

Where the supplier states that a light beam device can be used as a trip device, the sensing device shall be actuated, and the OSSDs shall go to the OFF-state for at least 100 ms, when a trip device test piece, with a diameter equal to the stated AOPD detection capability and with a length of 150 mm, moves through the beam at a speed of 1,6 m/s, such that the direction of movement is along the axis of the cylinder and is normal to the axis of the beam, at any point throughout the operating distance.

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 Additional requirements for an AOPD using retro-reflective techniques

A light beam device using retro-reflective techniques shall monitor the operating distance between the emitting/receiving element(s) and the reflective element(s) to an accuracy of $\pm 0,5$ m. When the prescribed operating distance is changed by more than $\pm 0,5$ m the OSSDs shall go to and remain in the OFF-state.

The sensing device of the light beam device shall be actuated when a retro-reflective plane object of a size equal to the diameter and length of the test piece (see 4.2.13) is placed in the beam at any position greater than 0,5 m from the reflective element.

Under normal operating conditions the OSSDs of a type 4 ESPE employing an AOPD using retro-reflective techniques shall go to and remain in the OFF-state when an identical reflector is placed in contact with the sensing surface of the emitting/receiving element(s).

The sensing device of the AOPD shall be actuated

- when a highly reflective cylindrical object of a size and shape equal to those of the test piece is placed anywhere within the detection zone, and
- when a highly reflective plane object of a size equal to the diameter and length of the test piece is placed normal to the optical axis(es) anywhere within the detection zone.

The highly reflective surfaces considered shall consist of 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.

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 signal shall simulate the actuation of the sensing device, and the duration of the periodic test shall not exceed 150 ms. 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;
- environmental conditions specified in 4.3 (parts 1 and 2);
- at the limits of alignment and/or adjustment.

If a single fault (as specified in annex B of part 1), which under normal operating conditions (see 5.1.2.1 of part 1) 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.

4.2.13 Test piece

The test piece shall be cylindrical and opaque, with a minimum effective length of 200 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.

Verification shall be by inspection.

4.2.14 Extraneous reflections and misalignment

4.2.14.1 Extraneous reflections

With the ESPE aligned in accordance with the supplier's specification, the ESPE shall not fail to danger when a reflective surface(s) is placed in any of the positions detailed in figure 1. This requirement shall apply for each beam, under all other conditions within the supplier's specification.

NOTE – This requirement is intended to prevent systems failing to danger in the presence of reflective surfaces adjacent to the detection zone or due to misalignment during installation.

4.2.14.2 Misalignment

The OSSD(s) shall be in the OFF-state for misalignments that are in excess of the angles shown in figure 2 and given in table 1 for a type 2 ESPE and in table 2 for a type 4 ESPE.

Table 1 – Maximum permissible angle of misalignment (in degrees) for a type 2 ESPE depending on the dimensions of the light curtain

Operating range of the light curtain (longitudinal dimension) m	Distance between beam centre-lines of outermost beams (lateral dimension) mm									
	300	450	600	750	900	1 050	1 200	1 350	1 500	1 800
	Maximum permissible angle of misalignment degrees									
Up to 3,0	51,8	33,8	25,2	20,1	16,7	14,3	12,5	11,1	10,0	8,3
4,0	71,4	45,8	33,9	27,0	22,4	19,2	16,8	14,9	13,4	11,2
5,0	93,6	58,2	42,8	33,9	28,1	24,0	21,0	18,6	16,8	14,0
6,0	122,1	71,4	51,9	41,0	33,9	29,0	25,3	22,4	20,2	16,8