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Varnost strojev - Električno občutljiva zaščitna oprema - 3. del: Posebne zahteve za aktivne optoelektronske zaščitne elemente, ki se odzivajo na difuzni odboj (AOPDDR)

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

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

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

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TITLE:

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY OF MACHINERY –
ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –****Part 3: Particular requirements for active opto-electronic protective
devices responsive to diffuse reflection (AOPDDR)**

FOREWORD

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International Standard IEC 61496-3 has been prepared by subcommittee MT61496-3: Safety of machinery – Electro-sensitive protective equipment – Part 3: Particular requirements for active opto-electronic protective devices responsive to diffuse reflection (AOPDDR), of IEC technical committee 44: Safety of machinery – Electrotechnical aspects.

This fourth edition cancels and replaces the third edition published in 2018. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Some requirement clauses and test procedures have been adapted or removed because they have been consolidated in IEC 61496-1:2020 (e.g. 5.4.6.2 Light sources and Clause A.9);
- b) Change of the minimum probability of detection for Type 2;

55 c) Using the AOPDDR as a trip device is described as an optional function in A.13.

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

FDIS	Report on voting

57 Full information on the voting for the approval of this standard can be found in the report on
58 voting indicated in the above table.

59 The language used for the development of this document is English.

60 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2, and
61 developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC
62 Supplement, available at www.iec.ch/members_experts/refdocs. The main document types
63 developed by IEC are described in greater detail at <https://www.iec.ch/publications>.

64 This document is to be used in conjunction with IEC 61496-1:2020.

65 This document supplements or modifies the corresponding clauses in IEC 61496-1:2020 to
66 specify particular requirements for the design, construction and testing of electro-sensitive
67 protective equipment (ESPE) for the safeguarding of machinery, employing active opto-
68 electronic protective devices responsive to diffuse reflection (AOPDDR) for the sensing function.

69 Where a particular clause or subclause of IEC 61496-1:2020 is not mentioned in this document,
70 that clause or subclause applies as far as is reasonable. Where this document states "*addition*"
71 or "*replacement*", the relevant text of IEC 61496-1:2020 is adapted accordingly.

72 Clauses and subclauses which are additional to those of IEC 61496-1:2020 are numbered
73 sequentially, following on the last available number in IEC 61496-1:2020. Terminological entries
74 (in Clause 3) which are additional to those in IEC 61496-1:2020 are numbered starting from
75 3.301. Additional annexes are lettered from AA onwards.

76 A list of all parts in the IEC 61496 series, published under the general title *Safety of machinery*
77 – *Electro-sensitive protective equipment*, can be found on the IEC website.

78 The committee has decided that the contents of this publication will remain unchanged until the
79 stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to
80 the specific publication. At this date, the publication will be

- 81 • reconfirmed,
- 82 • withdrawn,
- 83 • replaced by a revised edition, or
- 84 • amended.

85

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86

87

88

INTRODUCTION

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

92 This document supplements or modifies the corresponding clauses in IEC 61496-1:2020 to
93 specify particular requirements for the design, construction and testing of electro-sensitive
94 protective equipment (ESPE) for the safeguarding of machinery, employing active opto-
95 electronic protective devices responsive to diffuse reflection (AOPDDRs) for the sensing
96 function.

97 Each type of machine presents its own particular hazards, and it is not the purpose of this
98 document to recommend the manner of application of the ESPE to any particular machine. The
99 application of the ESPE is a matter for agreement between the equipment supplier, the machine
100 user and the enforcing authority. In this context, attention is drawn to the relevant guidance
101 established internationally, for example, IEC 62046 and ISO 12100.

102 The working group responsible for drafting this document was concerned that, due to the
103 complexity of the technology, there are many issues that are highly dependent on analysis and
104 expertise in specific test and measurement techniques. In order to provide a high level of
105 confidence, independent review by relevant expertise is recommended. They considered that if
106 this high level of confidence could not be established these devices would not be suitable for
107 use in safety related applications.

108

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SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –

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

1 Scope

This document specifies additional requirements for the design, construction and testing of non-contact electro-sensitive protective equipment (ESPE) designed specifically to detect persons or parts of persons as part of a safety-related system, employing active opto-electronic protective devices responsive to diffuse reflection (AOPDDRs) for the sensing function. Special attention is directed to requirements which ensure that an appropriate safety-related performance is achieved. An ESPE can include optional safety-related functions, the requirements for which are given both in Annex A of this document and in Annex A of IEC 61496-1:2020.

NOTE "Non-contact" means that physical contact is not required for sensing.

Where this document does not contain all necessary provisions, then IEC TS 62998-1 applies. It is also possible, for those aspects not considered in this document, to use provisions from IEC TS 62998-1 additionally.

This document does not specify the dimensions or configurations of the detection zone and its disposition in relation to hazardous parts for any particular application, nor what constitutes a hazardous state of any machine. It is restricted to the functioning of the ESPE and how it interfaces with the machine.

AOPDDRs are devices that have either

- one or more detection zone(s) specified in two dimensions (AOPDDR-2D), or
- one or more detection zone(s) specified in three dimensions (AOPDDR-3D)

wherein radiation in the near infrared range is emitted by an emitting element(s). When the emitted radiation impinges on an object (for example, a person or part of a person), a portion of the emitted radiation is reflected to a receiving element(s) by diffuse reflection. This reflection is used to determine the position of the object.

Opto-electronic devices that perform only a single one-dimensional spot-like distance measurement, for example, optical proximity switches, are not covered by this document.

This document is limited to ESPE that do not require human intervention for detection. It is limited to ESPE that detect objects entering into or being present in a detection zone(s).

This document does not address those aspects required for complex classification or differentiation of the object detected.

This document does not address requirements and tests for outdoor application.

Excluded from this document are AOPDDRs employing radiation with the peak of wavelength outside the range 820 nm to 1 100 nm, and those employing radiation other than that generated by the AOPDDR itself. For sensing devices that employ radiation of wavelengths outside this range, this document can be used as a guide. This document is relevant for AOPDDRs having a minimum detectable object size in the range from 30 mm to 200 mm.

153 This document can be relevant to applications other than those for the protection of persons,
154 for example, for the protection of machinery or products from mechanical damage. In those
155 applications, different requirements can be appropriate, for example when the materials that
156 have to be recognized by the sensing function have different properties from those of persons
157 and their clothing.

158 This document does not deal with electromagnetic compatibility (EMC) emission requirements.

159 **2 Normative references**

160 *Addition:*

161 IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of*
162 *temperature*

163 IEC 60068-2-75:2014, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

164 IEC 60825-1:2014, *Safety of laser products – Part 1: Equipment classification and requirements*

165 IEC 61496-1:2020, *Safety of machinery – Electro-sensitive protective equipment – Part 1:*
166 *General requirements and tests*

167 IEC 62471:2006, *Photobiological safety of lamps and lamp systems*

168 IEC TS 62998-3:2023, *Safety of machinery – Safety-related sensors used for the protection of*
169 *persons – Part 3: Sensor technologies and algorithms*

170 ISO 13855:2010, *Safety of machinery – Positioning of safeguards with respect to the approach*
171 *speeds of parts of the human body*

172 ISO 20471:2013, *High-visibility clothing – Test methods and requirements*

173 **3 Terms and definitions**

174 This clause of IEC 61496-1:2020 is applicable except as follows.

175 Definition 3.1 is not applicable.

176 *Replacement:*

177 **3.3**

178 **detection capability**

179 ability to detect the specified test pieces in the specified detection zone

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

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

185 Note 3 to entry: A decrease of detection capability does not mean that a smaller object can be detected.

186 [SOURCE: IEC 61496-1:2020, 3.3, modified – The text has been changed to make it more
187 relevant to AOPDDR and Notes 1 to 3 have been added.]

188 **3.4**
 189 **detection zone**, <of an AOPDDR>
 190 zone within which the specified test piece(s) is detected by the AOPDDR with a minimum
 191 required probability of detection

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

194 *Addition:*

195 **3.301**
 196 **active opto-electronic protective device responsive to diffuse reflection**
 197 **AOPDDR**
 198 device using active optical radiation to detect the diffuse reflection of an object present in a
 199 detection zone specified in two or three dimensions

200 Note 1 to entry: This note applies to the French language only.

201 **3.302**
 202 **AOPDDR-2D**
 203 AOPDDR that has one or more detection zone(s) specified in two dimensions

204 Note 1 to entry: When the third dimension of each detection zone is not greater than the minimum detectable object
 205 size, the AOPDDR is regarded as 2D.

206 Example: A laser scanner that performs distance measurement by measuring the time a pulse needs for travelling
 207 from the sensing device to an object and back to the sensing device. An AOPDDR-2D that has more than one
 208 detection zone can carry out distance measurements in different planes.

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

210 **3.303**
 211 **AOPDDR-3D**
 212 AOPDDR that has one or more detection zone(s) specified in three dimensions

213 Note 1 to entry: When the third dimension of each detection zone is greater than the minimum detectable object
 214 size, the AOPDDR is regarded as 3D. The detection zone(s) can be set-up for example as a volume in the shape of
 215 a pyramid or a cone.

216 Example: A laser scanner with two perpendicular positioned moving mirrors or time-of-flight-cameras (TOF) that
 217 perform distance measurement on several pixels. An AOPDDR-3D that has more than one detection zone can carry
 218 out distance measurements in different volumes.

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

220 **3.304**
 221 **centre axis**
 222 line through the origin of distance measurement and the centre of the maximum detection zone

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

224 **3.305**
 225 **corner axis**
 226 line through the origin of distance measurement and defined by the bounding line of the
 227 detection zone

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

229 **3.306**
 230 **maximum detection zone**
 231 largest dimension of the detection zone specified by the supplier

232 **3.307**
 233 **minimum detection zone**
 234 smallest dimension of the detection zone which is necessary to ensure the integrity of the
 235 detection capability

236 **3.308**
 237 **position accuracy**
 238 accuracy in one or more dimension(s) of the position of an object as measured by the ESPE

239 **3.309**
 240 **tolerance zone**
 241 **TZ**
 242 zone outside of and adjacent to the detection zone within which the specified test piece(s) is
 243 detected with a probability of detection lower than the required probability within the detection
 244 zone

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

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

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

249 **3.310**
 250 **zone with limited detection capability**
 251 zone, between the optical window and the beginning of the detection zone, where the detection
 252 capability is not achieved

253

254 *Addition:*

255 **Abbreviated terms**

256 **AGV** automated guided vehicle

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

258 **BTD** basic test distance <https://standards.iteh.ai/sist/1c59c900-35cd-4fcc-88cb-5a8a4bf51e62/osist-pren-iec-61496-3-2024>

259 **ESPE** electro-sensitive protective equipment

260 **lx** Lux

261 **OSSD** output signal switching device

262 **POD** probability of detection

263 **TZ** tolerance zone

264 **4 Functional, design and environmental requirements**

265 This clause of IEC 61496-1:2020 is applicable except as follows.

266 **4.1 Functional requirements**

267 **4.1.2 Sensing function**

268 *Addition:*

269 The detection zone shall begin at the border of the zone with limited detection capability and
 270 end within the maximum operating distance.

271 Object(s) in the zone with limited detection capability shall not reduce the detection capability
272 within the detection zone. Any reduction of the detection capability shall be detected and the
273 AOPDDR shall go to lock-out condition.

274 The AOPDDR shall respond by giving appropriate output signal(s) when a test piece is present
275 anywhere within the detection zone whether static or moving with respect to the AOPDDR.

276 The supplier shall specify the limits of the detection capability. The supplier shall take into
277 account all influences listed in this document.

278 **4.1.3 Types of ESPE**

279 *Replacement:*

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

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

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

293 When a single safety-related data interface is used to perform the functions of the OSSD(s),
294 then the data interface and associated safety-related communication interface shall meet the
295 requirements of 4.2.4.4. In this case, a single safety-related data interface can substitute for
296 two OSSDs in a type 3 ESPE.

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297

298 *Addition:*

299 **4.1.6 Zone(s) with limited detection capability**

300 In order to ensure no hazard can arise in a particular application due to the presence of one or
301 more zone(s) with limited detection capability, its dimensions and appropriate information for
302 use shall be provided by the supplier.

303 If the zone with limited detection capability extends more than 50 mm from the optical window
304 in direction to the detection zone(s), then additional and effective technical measures shall be
305 applied to prevent undetected presence of objects or persons or parts of persons in the zone
306 with limited detection capability.

307 **4.2 Design requirements**

308 **4.2.2 Fault detection requirements**

309 **4.2.2.2 Particular requirements for a type 1 ESPE**

310 This subclause of IEC 61496-1:2020 is not applicable.