

TECHNICAL SPECIFICATION



**Safety of machinery – Electro-sensitive protective equipment –
Part 4-2: Particular requirements for equipment using vision based protective
devices (VBPD) – Additional requirements when using reference pattern
techniques (VBPDP)**

IEC TS 61496-4-2:2022

<https://standards.iteh.ai/catalog/standards/sist/32352a73-6731-4281-b96b-df1e9809baa1/iec-ts-61496-4-2-2022>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

[IEC TS 61496-4-2:2022](https://standards.iteh.ai/catalog/standards/sst/52552a75-6731-4281-b906-dffe9809baa1/iec-ts-61496-4-2-2022)

<https://standards.iteh.ai/catalog/standards/sst/52552a75-6731-4281-b906-dffe9809baa1/iec-ts-61496-4-2-2022>

TECHNICAL SPECIFICATION



**Safety of machinery – Electro-sensitive protective equipment –
Part 4-2: Particular requirements for equipment using vision based protective
devices (VBPD) – Additional requirements when using reference pattern
techniques (VBPDP)**

[IEC TS 61496-4-2:2022](https://standards.iteh.ai/catalog/standards/sist/32352a73-6731-4281-b96b-dffe9809baa1/iec-ts-61496-4-2-2022)

<https://standards.iteh.ai/catalog/standards/sist/32352a73-6731-4281-b96b-dffe9809baa1/iec-ts-61496-4-2-2022>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.110; 29.260.99

ISBN 978-2-8322-5699-2

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	3
INTRODUCTION	5
1 Scope	6
2 Normative references	7
3 Terms and definitions	7
4 Functional, design and environmental requirements	9
5 Testing	17
6 Marking for identification and for safe use	26
7 Accompanying documents	27
Annex A (normative) Optional functions of the ESPE	28
Annex B (normative) Catalogue of single faults affecting the electrical equipment of the ESPE, to be applied as specified in 5.3	30
Annex AA (informative) The positioning of VBPD in respect of parts of the human body	31
Bibliography	38
Figure 1 – Image planes in VBPDPP	9
Figure 2 – Side view of VBPDPP using a passive reference pattern	10
Figure 3 – Light intensity measurement setup for indirect light tests	23
Figure 4 – Light intensity measurement setup for direct light tests	24
Figure AA.1 – Minimum distance S – Example 1	34
Figure AA.2 – Overall minimum distance S_0 without tolerance zone – Example 1	34
Figure AA.3 – Overall minimum distance S_0 including tolerance zone – Example 1	35
Figure AA.4 – Minimum distance S – Example 2	36
Figure AA.5 – Overall minimum distance S_0 without tolerance zone – Example 2	37
Figure AA.6 – Overall minimum distance S_0 including tolerance zone – Example 2	37
Table 421 – Verification of detection capability requirements (see also 4.2.12)	18
Table 422 – Overview of light interference tests	21

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY OF MACHINERY –
ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –****Part 4-2: Particular requirements for equipment
using vision based protective devices (VBPD) –
Additional requirements when using reference
pattern techniques (VBPDP)**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TS 61496-4-2 has been prepared by IEC technical committee TC 44: Safety of machinery – Electrotechnical aspects. It is a Technical Specification.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

This edition includes the following 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 of IEC 61496-1:2020 Light sources or Clause A.9)

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

Draft	Report on voting
44/933/DTS	44/955A/RVDTS

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

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at <http://www.iec.ch/standardsdev/publications>.

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

This document supplements or modifies the corresponding clauses in IEC 61496-1:2020 to specify particular requirements for the design, construction and testing of electro-sensitive protective equipment (ESPE) for the safeguarding of machinery, employing vision based protective devices (VBPD) using reference pattern techniques (VBPDPP) for the sensing function.

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

Clauses and subclauses which are additional to those of IEC 61496-1:2020 are numbered sequentially, following on the last available number in IEC 61496-1:2020. Terminological entries (in Clause 3) which are additional to those in IEC 61496-1:2020 are numbered starting from 3.4201. Additional annexes are lettered from AA onwards and additional tables are numbered with prefix 42

A list of all parts in the IEC 61496 series, published 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.

The working group responsible for drafting this document was concerned that, 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. They considered that if this high level of confidence could not be established these devices would not be suitable for use in safety related applications.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[IEC TS 61496-4-2:2022](https://standards.iteh.ai/catalog/standards/sist/32352a73-6731-4281-b96b-df1e9809baa1/iec-ts-61496-4-2-2022)

<https://standards.iteh.ai/catalog/standards/sist/32352a73-6731-4281-b96b-df1e9809baa1/iec-ts-61496-4-2-2022>

SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –

Part 4-2: Particular requirements for equipment using vision based protective devices (VBPD) – Additional requirements when using reference pattern techniques (VBPDP)

1 Scope

Replacement:

This document specifies 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 vision-based protective devices (VBPDs) using reference pattern techniques (VBPDP) for the sensing function. Special attention is directed to features which ensure that an appropriate safety-related performance is achieved. An ESPE can include optional safety-related functions, the requirements for which are given in Annex A of IEC 61496-1:2020 and this document.

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.

A VBPDP is defined as consisting of a single image-sensing device viewing on a passive reference pattern as the background and where the detection principle is based on blocking or partially preventing the view of the pattern. Information about the thickness, shape, surface characteristics or location of the object is not required for detection. For multi-image sensing devices, additional techniques, requirements and test procedures can be necessary.

- This document is limited to automatic vision-based ESPEs that do not require human intervention for detection.
- It is limited to automatic vision-based ESPEs that detect objects entering into, or are present in, a detection zone(s).
- It is limited to ESPEs using active illumination technique.
- Excluded from this technical specification are VBPDPs employing radiation at wavelengths outside the range 400 nm to 1 500 nm.
- This document does not address those aspects required for complex classification or differentiation of the object detected.

This document is relevant for VBPDPs having a stated detection capability up to 200 mm.

NOTE The positioning of VBPD in respect of parts of the human body is presented in Annex AA of this document.

This document does not deal with EMC emission requirements.

2 Normative references

Addition:

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

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

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

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

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

3 Terms and definitions

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

Replacement:

3.3 detection capability

ability to detect the specified test pieces (see 4.2.13) in the specified detection zone

Note 1 to entry: Detection capability is generally measured by the size of object that can be detected. An increase in detection capability means that a smaller object can be detected.

[SOURCE: IEC 61496-1:2020, 3.3, modified – The text has been changed to make it more relevant to vision based sensors and Note 1 has been added]

Additions:

3.4201 image

snap shot representation of the scene in different planes of the VBPDPP in the form of a two dimensional matrix

3.4202 imaging sensor

optoelectronic device which produces electrical signals representing the characteristics of an image

3.4203 passive reference pattern

static (i.e. fixed location and not changing) regular (periodic) combination of pattern elements on a background that covers at least the detection zone and the tolerance zone – blocking the view of part of the pattern causes detection

Note 1 to entry: Regularity of the pattern refers only to the physical pattern and not to the image of the pattern as seen by the imaging sensor.

3.4204 pattern element

local part of the passive reference pattern

EXAMPLE Black and white checker board – one black square or one white square.

3.4205**pixel**, <of a sensor>

smallest light sensitive element of an imaging sensor array

3.4206**pixel**, <of an image>

area of the smallest element that can be distinguished from its neighbouring elements

3.4207**sensing zone**

three-dimensional volume defined by the field of view of the image sensor and with the apex at the optical window of the sensing device

Note 1 to entry: The volume could be in the shape of a pyramid or cone.

Note 2 to entry: A zone of limited detection capability, a detection zone and tolerance zone(s) are contained within the sensing zone. The zone of limited detection capability is located between the optical window of the sensing device and the detection zone.

3.4208**tolerance zone**

zone outside of and adjacent to the (configured) detection zone within which the specified test piece may not be detected

3.4209**vision-based protective device****VBPD**

ESPE using an imaging sensor, operating in the visible and near infrared light spectrum to detect an object in a defined field of view

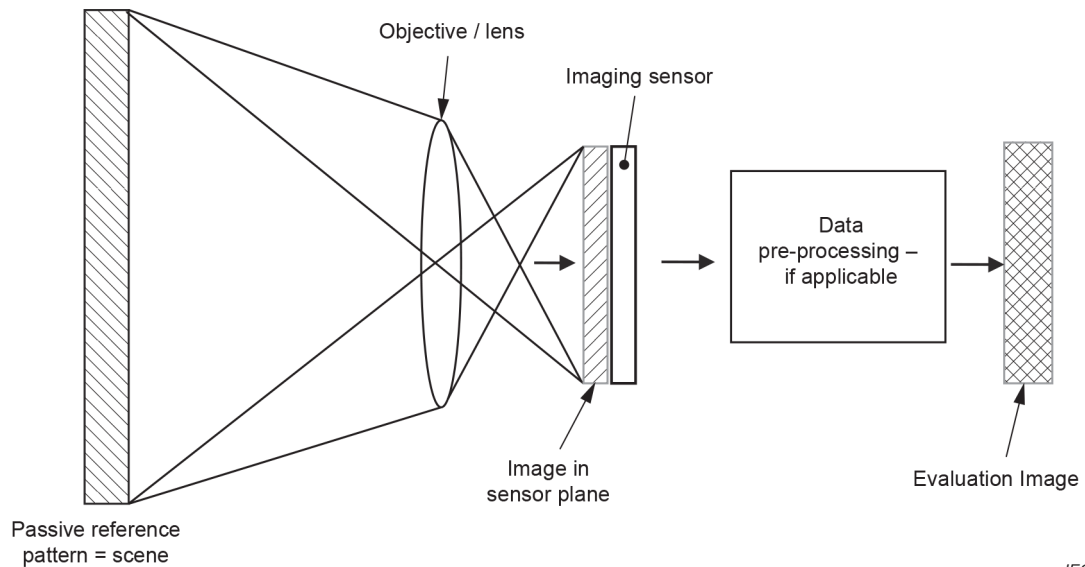
Note 1 to entry: This note applies to the French language only.

3.4210**vision-based protective device using passive reference pattern techniques****VBPDPP**

VBPD using a single imaging device and active illumination viewing on a passive reference pattern as background

Note 1 to entry: The various parts of a VBPDPP and their relationship to the viewed scene is shown in Figure 1.

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



IEC

Figure 1 – Image planes in VBDPP

3.4211

zone with limited detection capability

volume between the detection zone and the optical window(s) of the sensing device which does not achieve the stated detection capability

Note 1 to entry: The dimensions and appropriate information for use of the zone with limited detection capability are provided by the supplier.

4 Functional, design and environmental requirements

<https://standards.iteh.ai/catalog/standards/sist/32352a73-6731-4281-b96b-dffe9809baa1/iec-ts-61496-4-2:2022>
This clause of IEC 61496-1:2020 is applicable except as follows:

4.1 Functional requirements

4.1.2 Sensing function

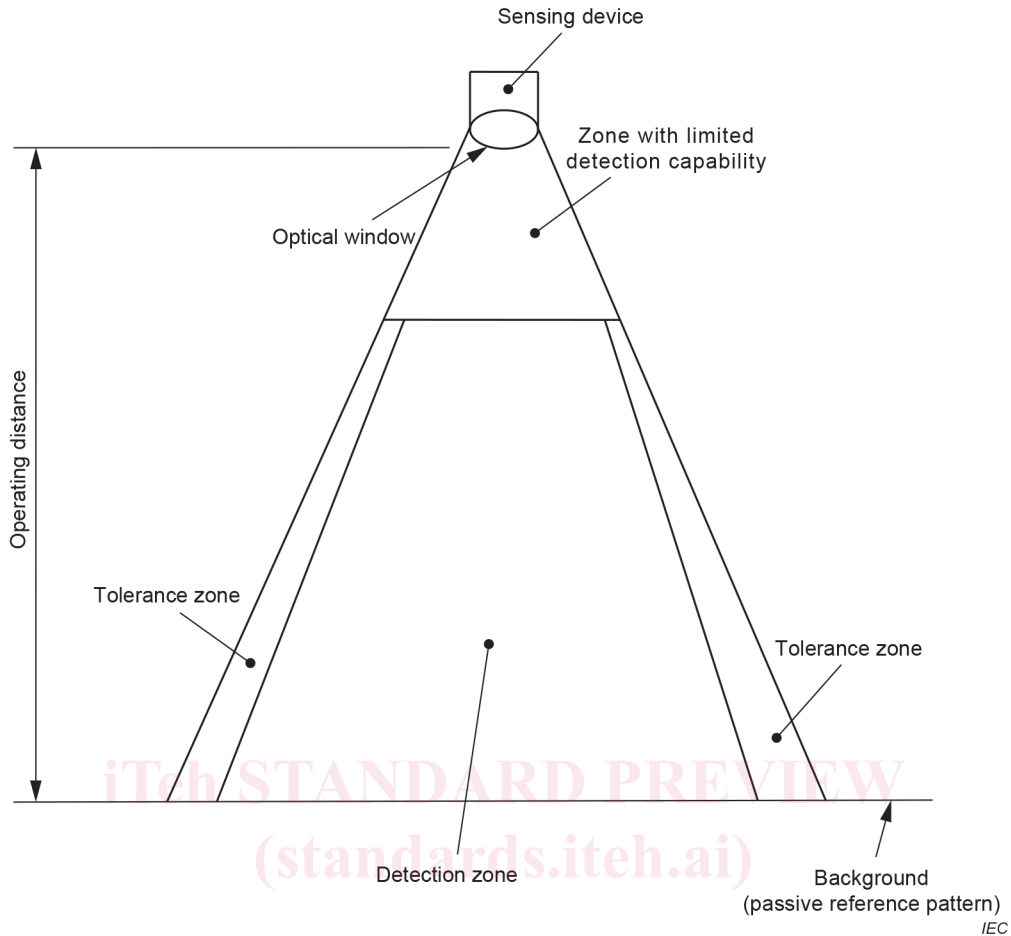
Replacement:

4.1.2.1 General

The detection zone shall begin at the border of the zone of limited detection capability and end at the passive reference pattern (see Figure 2).

NOTE It is possible that only parts of the passive reference pattern are used to define the detection zone.

Object(s) in the zone of limited detection capability shall not reduce the detection capability within the detection zone. Any reduction of the detection capability shall be detected and the VBDPP shall go to lock-out condition (see 4.2.2.4).



IEC TS 61496-4-2:2022
<https://standards.iteh.ai/iec-ts-61496-4-2-2022>
Figure 2 – Side view of VBPDP using a passive reference pattern

4.1.2.2 Additional functional requirements

The sensing function shall be effective over the specified detection zone. No adjustment of the detection zone or detection capability shall be possible without the use of a security measure (e.g. key, key-word or tool).

The sensing device of a VBPDP shall respond by giving (an) appropriate output signal(s) when a test piece is placed anywhere within the detection zone either static or moving.

The supplier shall specify the limits of detection capability. The supplier shall take into account worst case scenario including, for example, signal-to-noise ratio, light intensity in the image on the sensor plane, contrast in the image on the sensor plane, position of the image on the sensor, considering all influences listed in this document.

4.1.2.3 Optical performance

The VBPDP shall be designed and constructed to

- limit the possibility of malfunction during exposure to extraneous radiation in the range of 400 nm to 1 500 nm;
- limit the effects of environmental influences (temperature, vibration and bumps, dust, moisture, ambient light, extraneous reflections, changing illumination, shadows, background reflectivity);
- limit the misalignment at which normal operation is possible.

4.1.3 Types of ESPE

Replacement:

In this document, only a type 3 ESPE is considered. It is the responsibility of the machine supplier and/or the user to specify which type is required for a particular application.

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

When a single safety-related data interface is used to perform the functions of the OSSD(s), then the data interface and associated safety-related communication interface shall meet the requirements of 4.2.4.4 of IEC 61496-1:2020. In this case, a single safety-related data interface can substitute for two OSSDs in a type 3 ESPE.

Addition:

4.1.6 Zone 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 between the optical window and the detection zone, its dimensions and appropriate information for use shall be provided by the supplier.

4.2 Design requirements

4.2.2 Fault detection requirements

4.2.2.2 Particular requirements for a type 1 ESPE

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

4.2.2.3 Particular requirements for a type 2 ESPE

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

4.2.2.4 Particular requirements for a type 3 ESPE

Addition:

NOTE Examples of deterioration of the VBDPP detection capability include:

- increase of the minimum detectable object size;
- Increase in the minimum detectable contrast.

4.2.2.5 Particular requirements for a type 4 ESPE

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

NOTE Type 4 is not considered in this document. Additional definitions, requirements and test procedures would be necessary.