

TECHNICAL SPECIFICATION

SPECIFICATION TECHNIQUE



**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 61496-4-2:2014](https://standards.iteh.ai/catalog/standards/sist/fb2ea4f8-a9b9-4a16-a6c2-)

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**Sécurité des machines – Équipements de protection électro-sensibles –
Partie 4-2: Exigences particulières pour les équipements utilisant des dispositifs
protecteurs par vision (VBPD) – Exigences supplémentaires pour l'utilisation de
techniques de motifs de référence (VBPDP)**



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

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC/TS 61496-4-2, which is a technical specification, has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
44/677/DTS	44/689/RVC

Full information on the voting for the approval of this technical specification 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.

This part is to be used in conjunction with IEC 61496-1:2012.

This part supplements or modifies the corresponding clauses in IEC 61496-1:2012 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 passive reference pattern techniques (VBPDP) for the sensing function.

Where a particular clause or subclause of Part 1 is not mentioned in this Part 4-2, 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 adapted accordingly.

Clauses and subclauses which are additional to those of Part 1 are numbered sequentially, following on the last available number in Part 1. Terminological entries (in Clause 3) which are additional to those in Part 1 are numbered starting from 3.4201. Additional annexes are lettered from AA onwards.

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.

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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 technical specification 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 required. 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.

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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 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 vision-based protective devices (VBPDs) using passive reference patterns (VBPDP) 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 61496-1:2012 and this Technical Specification.

This part of IEC 61496 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 part of IEC 61496 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 part of IEC 61496 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 technical specification.

This part of IEC 61496 does not deal with EMC emission requirements.

2 Normative references

Addition:

IEC 60825-1:2007, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 61496-1:2012, *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 20471:2013, *High-visibility clothing – Test methods and requirements*

3 Terms and definitions

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 61496-1:2012, 3.3, modified – text changed to make more relevant to vision based sensors.]

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Additions:

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3.4201

image

snap shot representation of the scene in different planes of the VBPDP 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 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 sensor 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 sensor 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****VBPDP**

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

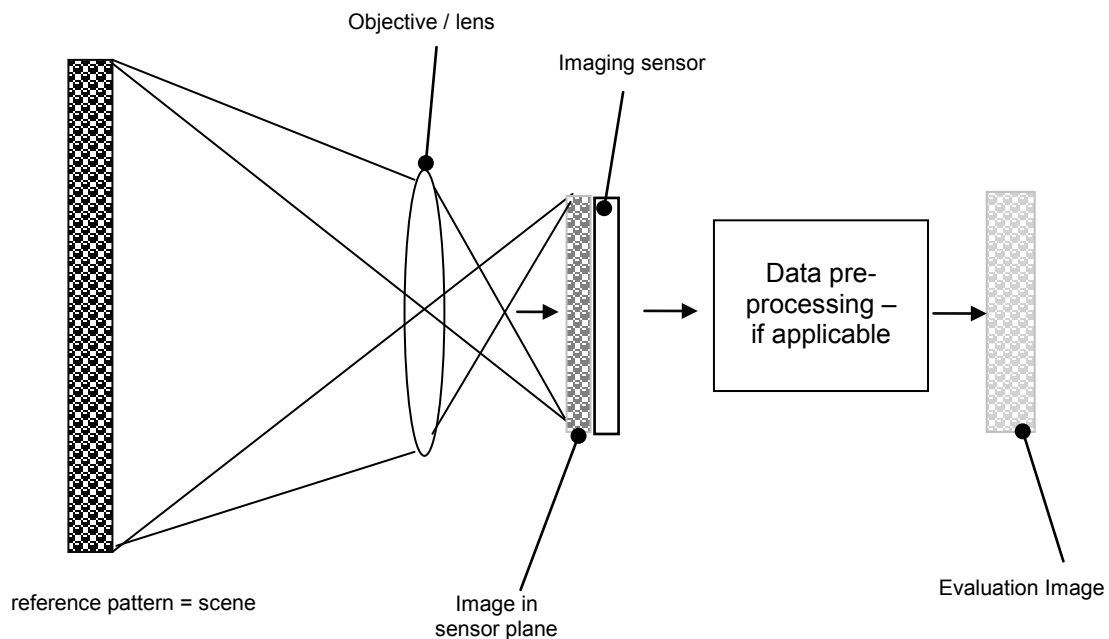
Note 1 to entry: This note applies to the French language only.

3.4210**vision-based protective device passive pattern****VBPDPDP**

VBPDP using a single imaging device viewing on a passive reference pattern as background

Note 1 to entry: The various parts of a VBPDPDP 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 1464/14

Figure 1 – Image planes in VBPDPDP

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

This clause of Part 1 is applicable except as follows:

4.1 Functional requirements

4.1.1 Normal operation

This subclause of Part 1 is applicable.

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 pattern (see Figure 2).

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NOTE It is possible that only parts of the passive 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 VBPDPP shall go to lock-out condition (see 4.2.2.4).

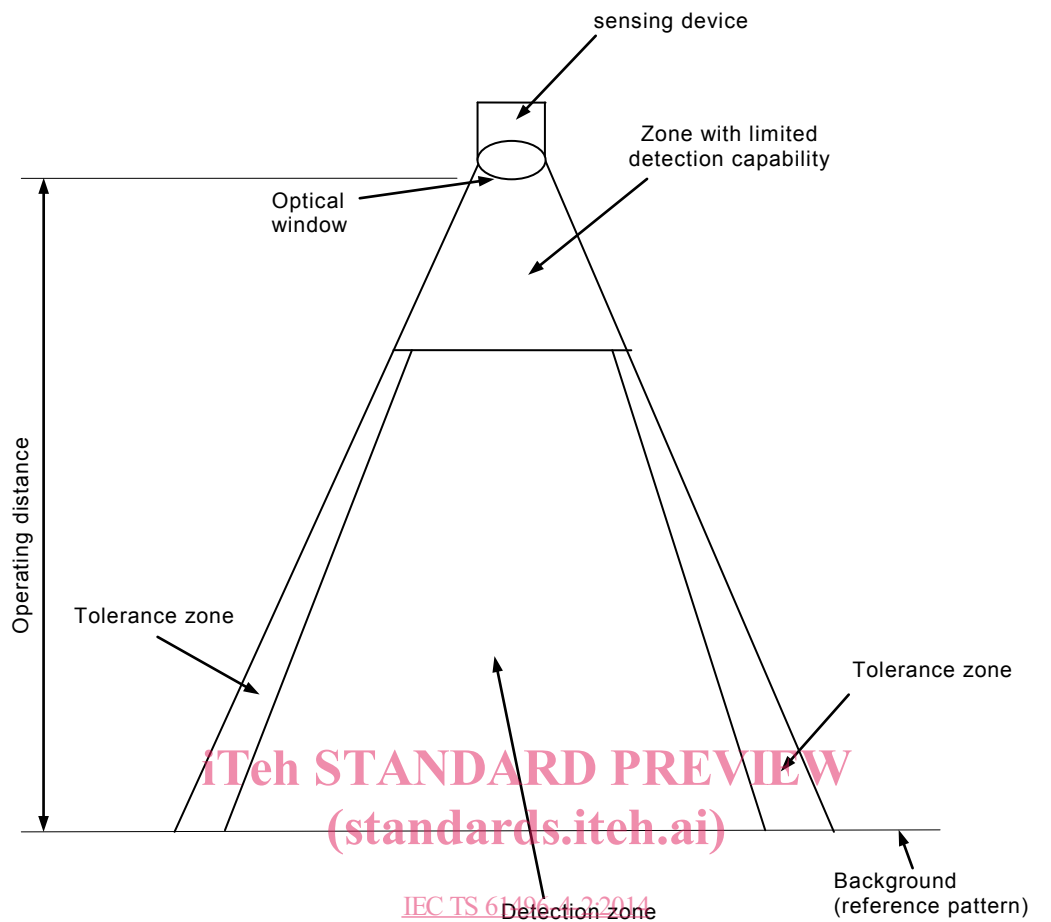


Figure 2 – Side view of VBPDP using a passive reference pattern

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 part of IEC 61496.

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 1500 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 technical specification, only a type 3 ESPE is considered. It is the responsibility of the machine supplier and/or the user to determine if this type is suitable for a particular application.

The type 3 ESPE shall fulfill the fault detection requirements of 4.2.2.4 of this part of IEC 61496. 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 device.

4.1.4 Types and required safety performance

This subclause of Part 1 is applicable.

4.1.5 Required PL_r or SIL and corresponding ESPE type

This subclause of Part 1 is applicable.

New functional requirement:

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

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4.2.2 Fault detection requirements

[b6dae9/iec-ts-61496-4-2-2014](#)

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 VBDPP detection capability shall cause the ESPE to go to a lock-out condition within the specified response time.

A single fault resulting in a deterioration of the stated VBDPP detection capability shall cause the ESPE to go to a lock-out condition within a time period of 5 seconds following the occurrence of that fault.

NOTE Examples of deterioration of the VBDPP detection capability include:

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

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 lockout 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 61496-1:2012).

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 one additional fault 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.

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

Additional design requirements:

4.2.12 Integrity of the VBPDPP detection capability

4.2.12.1 General

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The design of the VBPDPP shall ensure that the detection capability is not degraded below the limits specified by the supplier and in this technical specification by any of, but not limited to, the following:

- a) at the minimum contrast between an object and reference pattern on the evaluation images;
NOTE Minimum contrast on the evaluation image can be achieved by low or high contrast in the scene.
- b) the position of the object within the detection zone
- c) the number of objects;
- d) the size of objects;
- e) auto-adjustment, for example the following:
 - 1) auto-focus
 - 2) gain control
 - 3) orientation
 - 4) sample rate
 - 5) shutter time
 - 6) aperture stops
 - 7) focal length
- f) properties/limitations of imaging sensor, for example the following:
 - 1) signal noise (e.g. fixed pattern noise; dark noise)
 - 2) dynamic range
 - 3) sensitivity
 - 4) micro lenses
 - 5) gain settings