

Safety of machinery — Electro-sensitive protective equipment—

Part 4: Particular requirements for equipment using vision based protective devices (VBPD)

ICS 13.110; 29.260.99

National foreword

This Published Document is the UK implementation of IEC/TR 61496-4:2007. The UK participation in its preparation was entrusted to Technical Committee GEL/44, Safety of machinery — Electrotechnical aspects.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 November 2007

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ISBN 978 0 580 55143 7

Amendments issued since publication

Amd. No.	Date	Comments

TECHNICAL REPORT

IEC TR 61496-4

First edition
2007-07

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

**Part 4:
Particular requirements for equipment using
vision based protective devices (VBPD)**



Reference number
IEC/TR 61496-4:2007

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INTRODUCTION

This technical report provides information related to the design, construction and testing of electro-sensitive protective equipment (ESPE) that employs vision-based protective devices (VBPDs) for the sensing function for the safeguarding of machinery.

At the time of writing this technical report, there were no commercial examples of VBPDs on the market. Therefore, to provide an example of a VBPD for the writing of this technical report, the working group used the results of a Japanese research project. The working group understands that the possibilities for VBPDs are much greater than the limited technologies demonstrated by this example. When real systems do arrive, it is believed that some of the basic concepts put forth in this technical report can be used as a guide for the evaluation and testing of those first systems.

It is anticipated that the characteristics and requirements for VBPDs will vary significantly depending on the underlying technologies and methodologies employed. Therefore, it is planned that this technical report will be divided into subparts which address the unique requirements of the different types of vision-based devices (for example IEC 61496-4-1 would cover general requirements and IEC 61496-4-2 would cover requirements unique to devices using a passive reference pattern).

SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –

Part 4: Particular requirements for equipment using vision based protective devices (VBPD)

1 Scope

NOTE As an example for the development of this technical report, a VBPD is defined as consisting of a single image-sensing device viewing one two-dimensional image against a passive pattern as the background and where the detection principle is blocking the view of the pattern. Information about the thickness, shape and surface characteristics of the object is not required for detection. A passive pattern is not created by a light source.

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) 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 this technical report.

This technical report 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.

- It 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 present in, a detection zone(s).
- Excluded from this part are VBPD employing radiation at wavelengths outside the range 400 nm to 1 500 nm.
- This technical report does not address those aspects required for complex classification or differentiation of the object detected.

This technical report 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 technical report does not deal with EMC emission requirements.

2 Normative references

Additions:

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

ISO 13855:2002, *Safety of machinery – Positioning of protective equipment with respect to the approach speeds of parts of the human body*

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 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.

Additions:

3.401

image

array of pixels

3.402

imaging sensor

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

3.403

passive pattern

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

NOTE Regularity of the pattern refers only to the physical pattern and not to the image of the pattern as seen by the imaging sensor.

3.404

pattern element

unique part of the passive pattern which is defined on the basis of the actual pattern (example used in this technical report: black and white checker board – one black square or one white square)

3.405

physical pixel

for a sensor, smallest element of an imaging sensor array

3.406

pixel

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

3.407

sensing zone

three-dimensional volume (for example in the shape of a pyramid or cone) defined by the field of view of the image sensor and with the apex at the optical window of the sensor device. A zone of limited detection capability and a detection zone 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

3.408

test piece

object used to verify the detection capability of the vision based protective device (VBPD)

3.409**tolerance zone**

zone outside the detection zone which is necessary to achieve the required probability of detection of the specified test piece within the detection zone

3.410**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 For this technical report, the VBPD consists of an image-sensing device viewing a two-dimensional image against a passive pattern as the background.

3.411**zone with limited detection capability**

zone within the sensing zone in which the detection capability is lower than that stated by the supplier. Its dimensions and appropriate information for use are provided by the supplier.

NOTE Limitations can be size, colour, etc.

4 Functional, design and environmental requirements

This clause of Part 1 is applicable except as follows:

4.1 Functional requirements

Replacement:

4.1.2 Sensing function

The detection zone should begin at the border of the zone of limited detection capability and end at the passive pattern (see Figure 1).

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

An object(s) in the zone of limited detection capability should not lead to a failure to danger.

To assure the integrity of the detection capability, the relationship of the minimum detectable object size and the size of the elements of the background pattern should be greater than, or equal to, three (i.e. object size is three or more times the size of the pattern element).

NOTE The restriction for the relationship of the object size to the pattern element size is a result of difficulties in defining a test procedure which adequately verifies integrity of detection capability (see Figure 2).