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INTERNATIONAL STANDARD

colour inside

Eyewear display – Part 21-20: Specific measurement methods for VR image quality – Screen door effect

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CONTENTS

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Part 21-20: Specific measurement methods for VR image quality – Screen door effect

FOREWORD

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The text of this International Standard is based on the following documents:

Draft	Report on voting
110/1433/FDIS	110/1444/RVD

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

The language used for the development of this International Standard 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 www.iec.ch/publications.

A list of all parts in the IEC 63145 series, published under the general title *Eyewear display*, can be found on the IEC website.

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- withdrawn,
- replaced by a revised edition, or
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EYEWEAR DISPLAY –

Part 21-20: Specific measurement methods for VR image quality – Screen door effect

1 Scope

This part of IEC 63145 specifies the standard measurement conditions and measurement methods for determining the screen door effect (SDE), which is one of the image quality aspects of eyewear displays of virtual reality (VR) type.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 63145-1-2, *Eyewear display – Part 1-2: Generic – Terminology*

IEC 63145-20-10:2019, *Eyewear display – Part 20-10: Fundamental measurement methods – Optical properties*

IEC 63145-20-20, *Eyewear display – Part 20-20: Fundamental measurement methods – Image quality*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 63145-1-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
screen door effect
SDE
visibility of inter-pixel areas due to a spatial display resolution lower than that of the human visual system or to an insufficient pixel fill-factor/aperture ratio

3.2 Abbreviated terms

2D two dimensional
CCD charge-coupled device
DUT device under test
LMD light measuring device
MWA moving window average
VR virtual reality

4 Standard measurement conditions

Standard measurement conditions (standard environmental conditions, power supply, warm-up time, dark room conditions) shall comply with IEC 63145-20-10 and IEC 63145-20-20.

5 Measurement systems

5.1 Standard coordinate system

The standard coordinate system shall comply with IEC 63145-20-10 and IEC 63145-20-20.

5.2 Measurement equipment

5.2.1 2D imaging LMD

The 2D imaging light measuring device (LMD) shall comply with IEC 63145-20-10 and IEC 63145-20-20, if not described otherwise in the following paragraphs.

The 2D imaging LMD (using a two-dimensional sensor such as a CCD) is a kind of a filter-type LMD. The performances of the 2D imaging LMD shall comply with the LMD specified in IEC 63145-20-10 and IEC 63145-20-20. A 2D imaging LMD that can capture at least a ±2,5° measurement field shall be used. The measurement field shall be less than 18°. The valid measurement field angle of the 2D imaging LMD shall be confirmed and the peripheral image of the 2D imaging LMD shall confirm the absence of vignetting. The 2D imaging LMD should have a minimum performance of 30 cycles per degree with 50 % Michelson contrast at the entrance pupil of 2 mm to 5 mm. The optical measurement capabilities of the LMD, such as luminance and spectral radiance, should be traceable to national metrology standards under the same conditions (for example entrance pupil size, measurement field angle and focus distance in some structures).

NOTE 1 The measurement field of some 2D imaging LMDs is affected by the smaller entrance aperture. The 2D imaging LMD will have an entrance pupil between 2 mm to 5 mm. (See [1][1], [2] for the effect of aperture size.)

NOTE 2 Moiré effect might occur in the 2D imaging LMD due to factors such as pixel structure, rotational misalignment, etc. If moiré occurs, the measurement cannot be performed. (See [3] for more information about moiré.)

NOTE 3 The peripheral 2D luminance data of the 2D imaging LMD can include vignetting. The valid measurement field angle can include only 2D luminance data without such peripheral 2D luminance data.

5.2.2 Stage conditions

Stage conditions shall comply with IEC 63145-20-10 and IEC 63145-20-20.

5.2.3 Setup conditions

Setup conditions shall comply with IEC 63145-20-10 and IEC 63145-20-20.

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1 Numbers in square brackets refer to the Bibliography.

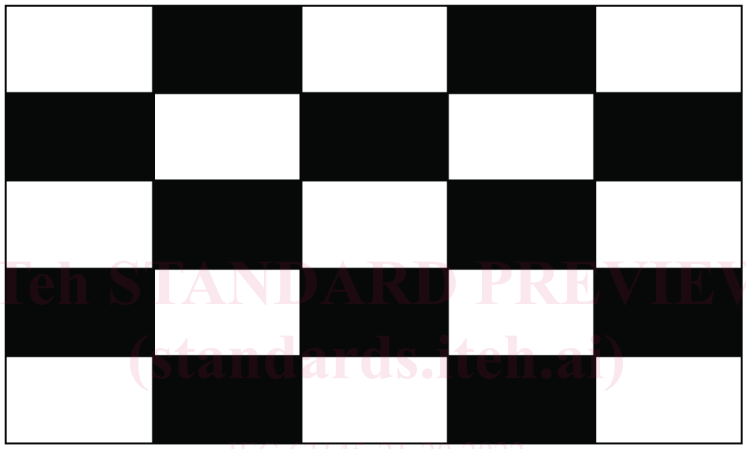
5.3 Test patterns

5.3.1 General

The following test patterns shall be specified, and the applied test pattern shall be noted in the report. When other test patterns are applied, they shall be noted in the report.

5.3.2 Checkerboard pattern

The checkerboard pattern as shown in Figure 1 should be used to measure the applicable properties and can be used for alignment of the DUT and LMD optics. The checkerboard pattern with crosses, whose example is specified in ISO 9241-305 [4], should also be used for alignment of the DUT and LMD optics. Both patterns of white and black at the centre can be used. Usually, a white and black checkerboard pattern is used, but a checkerboard pattern of another colour (red, green, blue and so on) and black can be used if necessary.



NOTE The 5 × 5 checkerboard pattern is helpful in navigating across the virtual image and focusing the LMD.

Figure 1 – Example of 5 × 5 checkerboard pattern

5.3.3 4 % colour window signal patterns

4 % colour window patterns can be used to measure the optical qualities. The colours should be defined in terms of the display primaries as white, black, red, green and blue. The 4% window is filled with a single colour. Figure 2 shows an example of a 4 % white window signal pattern that is surrounded by black background.

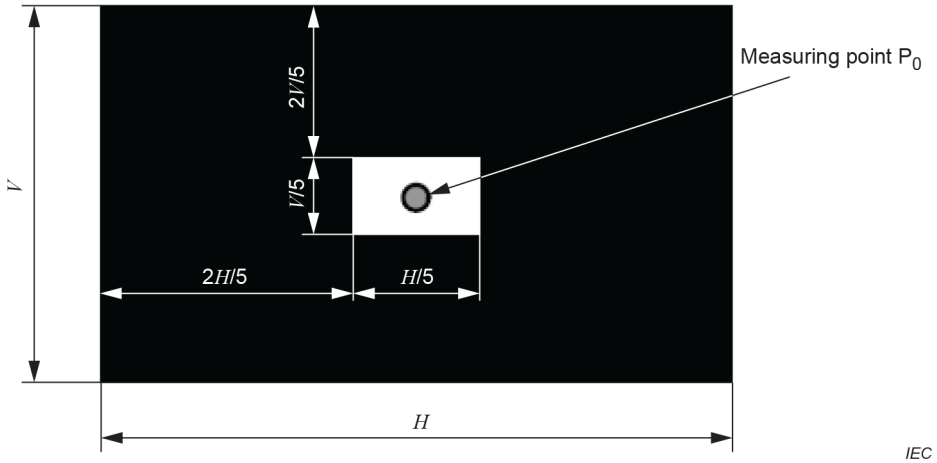
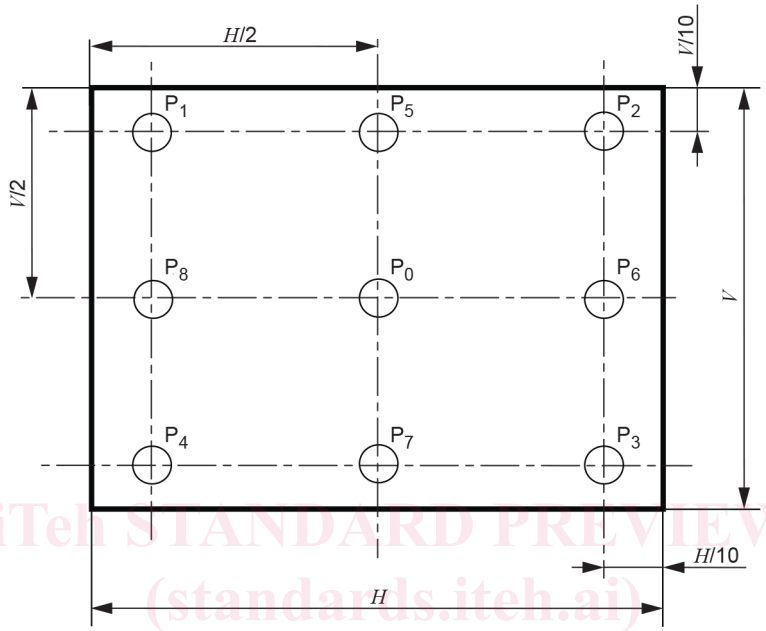


Figure 2 – Example of 4 % white window signal pattern

5.4 Measuring points

The centre point (one point) or the multi-point (five points or nine points) measurements shall be applied. An example of measuring point(s) of one-point, five-point, and nine-point measurements is P_0, P_0 to P_4, and P_0 to P_8, respectively, as shown in Figure 3, where H and V are used to define the positions of these points.



H: Horizontal size of virtual image
V: Vertical size of virtual image

Figure 3 – Example of measuring points for the centre and multi-point measurements

Another example of nine points is shown in Figure 4, where azimuth and elevation angles are used to define the positions. Azimuth and elevation angles are defined in IEC 63145-20-10:2019, Figure 1.

If other measuring points are applied, this shall be defined in the relevant specification.

NOTE The centre point measurement is carried out to measure the screen door effect. The five-point and nine-point measurements are carried out to measure the deviations, averages, and uniformities.

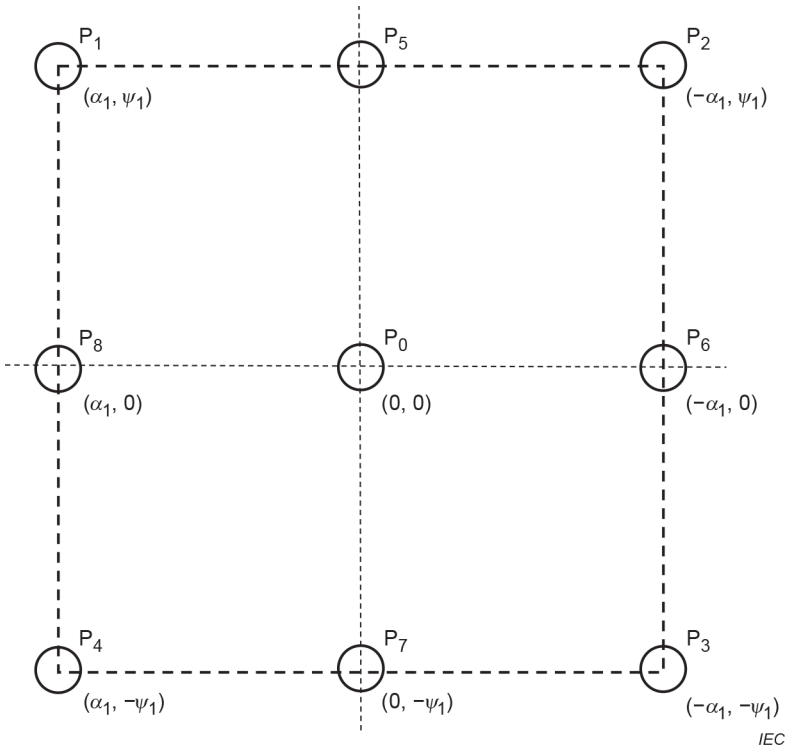


Figure 4 – Example of measuring points in azimuth and elevation angles

6 Measurement methods for screen door effect

6.1 General

The screen door effect (SDE) is one of the items for evaluating the image quality of the eyewear display to be measured (DUT). SDE is observed as the spatial repetition of the bright and dark region. The purpose of this method is to measure the screen door effect at the centre or the other measuring points (see Annex B).

The standard measurement conditions (Clause 4), the standard coordinate system (5.1), setup conditions (5.2.3) and 4 % window pattern (5.3.3) shall be applied.

6.2 Preparations

The DUT should be placed in the measurement arrangement specified in 5.2.3 using the checkerboard pattern specified in 5.3.2. The entrance pupil of the LMD and the eye point of the DUT shall match the origin position of the five-axis system (x = 0, y = 0, z = 0, α = 0, Ψ = 0).

NOTE In case the pivoting point of the LMD is 10 mm behind the entrance pupil, this pivoting point can be used, instead of the entrance pupil, to match the origin position of the measurement.

The DUT-adjustable conditions which are related to the optical properties shall be reported. Some DUTs use image processing, and if a setting for the image processing is also adjustable, the default setting specified by the manufacturer or the supplier shall be applied and reported.

The focus of the LMD shall be adjusted through the image finder or by a supplier-specified autofocus procedure to achieve the clear virtual image. A grille pattern with a high resolution (the highest resolution is a one-by-one line pair) which is appropriate for the DUT and provided by the manufacturer or the supplier, can be applied for adjustment of the virtual image focus.