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INTERNATIONAL STANDARD

Eyewear display – Part 1-2: Generic – Terminology

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EYEWEAR DISPLAY –

Part 1-2: Generic – Terminology

FOREWORD

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IEC 63145-1-2 has been prepared by IEC technical committee TC 110: Electronic displays. It is an International Standard.

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

Draft	Report on voting
110/1432/FDIS	110/1443/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/standardsdev/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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- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

EYEWEAR DISPLAY –

Part 1-2: Generic – Terminology

1 Scope

This part of IEC 63145 provides terms that are used in the field of eyewear displays for augmented reality, virtual-reality, mixed reality, and the image or video rendering on these displays.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

3.1 General

For the purposes of this document, the following terms and definitions apply.

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

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

3.2 Classification of terms

Terms for eyewear displays, their optical systems, and image rendering are classified as follows:

- display types (3.3)
- computer-generated visual environment (3.4)
- display optical system and related terms (3.5)
- optical performance related terms (3.6)
- performance characteristics (3.7)
- visual ergonomics (3.8)
- display electronics and related terms (3.9)
- terms related to image rendering (3.10)

3.3 Display types

3.3.1
eyewear display
EWD
display that is worn on the user's eye or worn close to the eye in order to provide dynamically addressable visual information to the user

Note 1 to entry: Detailed explanations are given in IEC TR 63145-1-1:2018, 4.1 [1]1.

Note 2 to entry: Eyewear displays include spectacle-mounted, head-mounted and contact lens displays.

Note 3 to entry: The head-mounted display is usually referred to as a headwear. In a few cases, HMD is used for "helmet-mounted display" or "head-mounted device".

Note 4 to entry: There are several mount types: head mount, helmet mount, headset, goggle, visor and devices with similar applications, etc. See IEC TR 63145-1-1:2018, Clause 4 [1].

3.3.2
contact lens display
eyewear display that is worn on the user's cornea in the same way as a contact lens

3.3.3
virtual-image display
device that optically or holographically forms a virtual-image

Note 1 to entry: In ISO 9241-302:2008 [4], 3.4.52, "virtual-image display" is defined as "device that optically or holographically forms a virtual-image"; however in this definition "a virtual-image" is ambiguous (see 3.5.1 "virtual-image optical system").

[SOURCE: ISO 9241-302:2008 [4], 3.4.52, modified – a note has been added.]

3.3.4
head-mounted display
HMD
eyewear display that is mounted on the user's head, using a mechanical support other than a spectacle frame

3.3.5
see-through
superimposition of an image(s) or a video onto the whole or part of the user's real-world field of view

Note 1 to entry: The superposition is achieved by means of a partially transmissive or reflective optical element.

[SOURCE: ISO 9241-302:2008 [4], 3.5.45, modified – "or a video", "the whole or part of" and "real-world" have been added to the definition and a note has been added.]

3.3.6
optical see-through display
transmission or projection virtual-image display that the user can see through in at least part of the user's real-world field of view

1 Numbers in square brackets refer to the Bibliography.

3.3.7
video see-through display
immersive HMD that provides a display that combines a video camera view of the real-world with overlaid computer-generated visual information

Note 1 to entry: See 3.4.7 for the meaning of “immersive”.

3.3.8
monocular display device
device in which the virtual-image is visible to a single eye

[SOURCE: ISO 9241-302:2008 [4], 3.5.38, modified – in the definition, the term “virtual” has been added and “one eye” has been replaced with “a single eye”.]

3.3.9
binocular display device
device in which different displays or parts of the display are presented to the left and right eyes via different optical axes

Note 1 to entry: In the context of eyewear displays, the term relates to virtual-image creation due to the close proximity of the source from the eye.

Note 2 to entry: The binocular display device is sometimes called a dual-view display device.

Note 3 to entry: The images displayed can be the same (as in a single-view binocular display device) or slightly different, e.g., to provide a stereoscopic view

[SOURCE: ISO 9241-302:2008 [4], 3.5.5, modified – the sentence "a slightly different image of the same target is " is changed to "different displays or parts of the display are”, and the phrase "via different optical axes" and the notes have been added.]

3.3.10
single-view binocular display device
device in which the same or slightly different virtual-images are presented to the left and right eyes via different optical systems

3.3.11
bi-ocular display device
device in which the same image is presented to the left and right eyes via optical axes split from a common one

3.3.12
waveguide display device
device that uses a transparent or semi-transparent substrate to observe the real-world and fully or partially guide the light by total internal reflection from the image display to the eyes of the viewer

3.3.13
image display
display device that outputs images or video information to the eyewear system

Note 1 to entry: The term “imager” is sometimes used for “image display”. However, that term is ambiguous as it is also used to mean “image sensors”, and therefore is to be avoided.

Note 2 to entry: The term “image source” is sometimes used for “image display”.

Note 3 to entry: Image displays include emissive type displays, such as OLED or micro-OLED, micro-LED and non-emissive types such as LCD, DLP and LCOS.

3.4 Computer-generated visual environment

3.4.1
virtual-reality
VR
3D computer-generated environment in which viewers are immersed and giving the sense of being in another space different from their real-world

Note 1 to entry: Only computer-generated visual environments similar to the real-world are considered here, though further sensations such as sound, touch, perception of odour or scent or similar can be involved.

Note 2 to entry: See 3.4.7.

3.4.2
augmented reality
AR
direct view of the real-world supplemented or modified by overlaying computer-generated visual graphics/video and/or other information or sensation

Note 1 to entry: Augmented reality comes with or without spatial registration of the virtual objects onto the real-world environment [2],[3]. In the case where there is no spatial registration, AR is referred to as "assisted reality" instead.

3.4.3
augmented virtuality
AV
environment in which images of real objects are inserted into a predominantly virtual computer-generated environment by means of real sensory inputs for implementing the virtual environment

3.4.4
mixed reality
MR
continuum that encompasses virtual-reality (VR), augmented reality (AR), and augmented virtuality (AV)

3.4.5
extended reality
XR
extension of human experiences related to various senses (e.g., existence, cognition) and interaction between machine and human in real and computer-generated virtual environments

Note 1 to entry: The 'X' in XR is simply a variable that can stand for A of the AR, the V of the VR, and the M of the MR.

3.4.6
hyper reality
XR with computer-modified vision, audio or other sensations of the real-world that provide information beyond the capability of the human senses, for example, x-ray vision or ultra-auditory sensing

3.4.7
immersive, adj.
state produced by a computer-generated image and/or sound that appears to surround the user in three-dimensions

Note 1 to entry: The state may include audio/hearing, haptics, smell, etc.

3.5 Display optical system and related terms

3.5.1
virtual-image optical system
optical system that collects focus points made by extensions of diverging rays from an object where the image is magnified

Note 1 to entry: For head-mounted and eyewear displays, an image display is applied instead of a real object.

Note 2 to entry: The word ”virtual” is frequently used when viewing by means of digital media, and in this case the meaning refers to EWD. See 3.4.1.

3.5.2
field of view
FOV
angular region as observed from the viewer’s eye point, subtended by the visible area of the displayed virtual-image (in AR, VR, and MR devices) and of the perceived real-world view in case of an optical see-through display

3.5.3
eye point
location where the centre of an eyewear device or the centre of the exit pupil of the EWD is positioned

Note 1 to entry: The eye point is generally located within the exit pupil of the eyewear display.

Note 2 to entry: The design eye point is often located at the centre of the device's exit pupil.

Note 3 to entry: In some designs, the apex of the cornea of the user is taken as reference instead of the eye pupil of the user.

3.5.4
eye relief
distance from the cornea of the eye to the closest optical element of the virtual-image display

Note 1 to entry: Refer to Note 2 and Note 3 in 3.5.3.

Note 2 to entry: In some designs the apex of the cornea of the user is taken as reference.

[SOURCE: ISO 9241-302:2008 [4], 3.5.21, modified – the notes have been added.]

3.5.5
eye rotation
<physiology> rotation of the eye by a coordinated action of the extra-ocular muscles to view the virtual-image displayed by the AR, VR or MR device

Note 1 to entry: For measurement purposes, the centre of rotation is considered to be about 13 mm behind the corneal apex, and about 10 mm behind the pupil.

3.5.6
eye rotation
<metrology> angular scanning method that simulates the natural rotation of the human eyeball about its centre when gazing over the visual field

Note 1 to entry: For measurement purposes, the centre of rotation is considered to be about 13 mm behind the corneal apex, and about 10 mm behind the pupil.

3.5.7
pupil rotation
<physiology> pivot motion about the eye's pupil for viewing the virtual-image display by the AR, VR, and MR

3.5.8
pupil rotation
<metrology> angular scanning method where the optical axis of the light measuring device rotates about its entrance pupil

3.5.9
eye rotation centre
assumed pivot point of the eye rotation lying about 13 mm behind the apex of the cornea, or about 10 mm behind the pupil

3.5.10
eye pupil rotation centre
<design> centre of the entrance pupil placed at a given location that serves as the pivot point for eye pupil rotation to achieve the optimum performance when using an eyewear display and that serves as the origin for measurement

Note 1 to entry: See pupil rotation in 3.5.7 and 3.5.8.

3.5.11
pupil forming
virtual-image optical system that is equipped with a magnifier and the optical elements which act as an aperture stop, and where the magnifier forms a real image of the aperture stop

[SOURCE: IEC TR 63145-1-1:2018 [1], 3.1.2, modified – "virtual image optics" has been replaced with "virtual-image optical system".]

3.5.12
non-pupil forming
virtual-image optical system where the magnifier does not form a real image of the aperture stop

Note 1 to entry: The system does not form a real intermediate image of the display, only a virtual one.

[SOURCE: IEC TR 63145-1-1:2018 [1], 3.1.3, modified – "virtual image optics" has been replaced with "virtual-image optical system" and the note has been added.]

3.5.13
vision convergence point
point in space at which the visual axes of the eyes cross

Note 1 to entry: In ISO 9241-302:2008 [4], 3.5.10, "convergence" is defined as "turning inward of the lines of sight towards each other as the object of fixation moves toward the observer".

Note 2 to entry: The system does not form a real image of the display, only a virtual-image.

[SOURCE: ISO 9241-302:2008 [4], 3.5.12, modified, – "in which" has been replaced by "at which" and the notes have been added.]

3.5.14
eye-box
three-dimensional region of the space or volume where the users place their eyes for seeing properly the entire virtual-image without moving their heads or making any other adjustment other than the natural rotation of the eye

Note 1 to entry: "Seeing properly" means that the display image has to fulfil all the requirements indicated in the product specification.

Note 2 to entry: In ISO 9241-302:2008 [4], 3.5.42, "qualified viewing space (QVS)" is defined as "space (volume) from where the image is perceived at an acceptance level". See ISO 9241-302:2008 [4], 3.5.20 for "exit pupil" which is defined as "vertical/horizontal dimension of the QVS".

3.5.15
accommodation distance
focal distance from the pupil to a real or virtual object

Note 1 to entry: Accommodation distance is not the same as the focal length of the eyewear's display optical system.

3.5.16
gesture
non-verbal communication through the hands, eyes, head or whole body that is tracked by scanning sensors and is taken into the virtual environment

3.5.17
spatial display resolution
minimum separation of two discrete points or lines in a display image that can be discerned

Note 1 to entry: Spatial display resolution in eyewear displays is closely related to the angular display resolution.

3.6 Optical performance related terms

3.6.1
image quality
assessment or subjective measure of how accurately an image of a subject represents that subject

EXAMPLE The brightness and evenness of illumination, contrast, geometry, colour reproduction (rendering or signal fidelity), modulation transfer function (MTF) and colour discrimination of the observed image.

Note 1 to entry: An image can be affected by lens aberrations, diffraction and reflection effects, pollutants such as dust in the atmosphere, scratches on the lens, effects of heat on detectors, motion of subject, or the optical noise of the system (measured using optical signal-to-noise ratio, environment optical noise).

3.6.2
virtual-image luminance
luminance of the virtual-image leaving a virtual-image optical system

Note 1 to entry: The term “front luminance” is sometimes used for “virtual-image luminance”.

Note 2 to entry: The “front luminance” is not necessarily the luminance of the display.

3.6.3
virtual-image luminance uniformity
luminance uniformity of a virtual-image with distinct primary colours leaving a virtual-image optical system

3.6.4
virtual-image contrast
contrast of the virtual-image leaving a virtual-image optical system

3.6.5
display latency
time delay between the start of the data input of a single intended image scene via the electrical interface until the actual image is visually displayed

3.6.6
motion-to-image latency
time delay between the movement of the viewer’s head and the change in the eyewear’s virtual-image caused by the movement

Note 1 to entry: Latency can also depend on sensors, not just the display.

3.6.7
dioptre
unit of focusing power of a lens or surface, or of vergence of a wave front, when distances are expressed in metres

Note 1 to entry: The unit of dioptre is the reciprocal of the distance when distances are expressed in metre, m^{-1}. Commonly used abbreviations are D and dpt.

[SOURCE: ISO 4007:2018 [5], 3.7.1, modified – in the term, “D” has been deleted, and the notes have been replaced with Note 1.]

3.6.8
inter-pupil distance
IPD
distance between the centres of the pupils when the eyes are fixating an object at an infinite distance in the straight ahead position

Note 1 to entry: The term “interpupillary distance” is sometimes used for “inter-pupil distance”.

Note 2 to entry: The abbreviation PD is often used for the interpupillary distance in ophthalmology, optometry and spectacle dispensing

[SOURCE: ISO 13666:2019 [6], 3.2.28, modified – in the term “interpupillary distance” has been replaced by “inter-pupil distance” and “PD” with “IPD”, and the notes have been added.]

3.6.9
motion blur
visual artefact with still or moving images due to delays in display processing or human eye movement

Note 1 to entry: As given in IEC 61747-30-3 [7], measuring methods for LCD-motion artefacts, “the human eye movement” is also another cause for motion blur.

3.7 Performance characteristics

3.7.1
geometrical distortion
geometrical artefact in the virtual-image and/or a real object in a see-through display

3.7.2
chromatic dispersion
change in the refractive index of monochromatic radiation in a medium as a function of the frequency of the radiation

[SOURCE: ISO 13666:2019 [6], 3.1.6, modified – the note has been deleted.]

3.7.3
chromatic aberration
unequal refraction of light rays of different wavelengths passing through the optical elements of eyewear displays producing a blurred image

3.7.4
screen door effect
SDE
visibility of inter-pixel areas due to a spatial display resolution lower than that of the human visual system or an insufficient pixel fill-factor/aperture ratio

3.7.5
stray light
unwanted light that forms part of the measurement

[SOURCE: IEC 60050-845:2020 [8], 845-25-116, modified – the example has been deleted.]

3.7.6
blocking artefacts
distortion that appears in compressed video material as abnormally large pixel blocks occurring when the encoder cannot keep up with the allocated bandwidth

3.7.7
optical disturbance
stray light or any view blocking artefact in the optical system

3.7.8
optical noise
stray light or external light observed in the eyewear display

Note 1 to entry: See IEC 62595-1-2:2016 [9].

3.7.9
inside out tracking
integrated camera located on an eyewear display for determining the user's position

3.7.10
outside in tracking
external camera that determines the user's position and reports it to the eyewear display

3.7.11
eye tracking
tracking the eye movements of an experiencer to feed back the information into the display's data processor

3.7.12
head tracking
means of determining the head position by sensors in order to render images in the corresponding directions in the virtual space

3.7.13
haptics
creation of non-visual stimuli by applying force, vibration, or motion for providing feedback to the user when manipulating virtual or remote objects

3.7.14
hologram
reconstruction of the wave fronts of light reflected off an object

3.8 Visual ergonomics

3.8.1
eyestrain
uncomfortable or symptomatic physiological response in the eye or its surroundings

Note 1 to entry: Eyestrain can be caused by, for example, mismatch of the interpupillary distance (IPD), accommodation convergence conflict, user's focal point, or right/left image differences.

3.8.2
sickness
physiological discomfort

EXAMPLE Upset stomach, nausea, and headache

3.8.3
VR sickness
simulation sickness
feeling of dizziness and nauseousness due to visually induced perception of movement that does not correspond to the physical movement

3.8.4
binocular fusion
fusing of the images of the left and right eyes into a single image by means of motor and sensory fusion

[SOURCE: ISO 9241-302:2008 [4], 3.5.6, modified – "that consists" has been changed to "by means".]

3.9 Display electronics and related terms

3.9.1
frame rate
frame per second
FPS
number of frames per second rendered by and transferred from the video graphics source

3.9.2
refresh rate
number of frames per second written to the display from the frame buffer

3.9.3
gaze
direction that an eyewear display experiencer is viewing

Note 1 to entry: See XR experiencer in 3.10.11.

3.9.4
gaze point
point on the display that is being intersected by the line of sight

3.9.5
antialiasing
spatial low-pass filtering that smoothens jagged edges

3.10 Terms related to image rendering

3.10.1
avatar
object in computer-generated content that is the so-called humanoid character, representing a human or an animal in a virtual world

3.10.2
webVR
technology that presents virtual-reality in existing websites using current protocols and devices

3.10.3
foveated rendering
rendering of images by a graphics processing unit (GPU) at a spatial resolution that is higher at the gazing point than in the periphery

3.10.4
foveal display
display hardware with a spatial resolution that is higher at the central gazing point than in the periphery

3.10.5
virtual presence
being present in the virtual environment

3.10.6
room scale
room size space in the real-world for performing an XR experience or a space designed for an XR experiencer who can move freely in the virtual world

3.10.7
binocular disparity
XR device that renders different images for the right and left eyes to reproduce the natural parallax between the two eyes

Note 1 to entry: Binocular disparity is the difference between images for the left and right eyes that occurs in viewing the actual object or that is rendered in the XR device to reproduce the natural parallax between the two eyes.

3.10.8
360° video
video taken by an omnidirectional camera that can be viewed in every direction

Note 1 to entry: 360° video is sometimes referred to as “spherical video” or "immersive video".

3.10.9
beacon
device positioned in a real environment that emits electromagnetic waves which can be detected by the users to determine their positions

Note 1 to entry: In some cases, the word “base station” is used instead of beacon.

3.10.10
cinematic VR
VR having real images and real sounds taken by an omnidirectional camera and ambisonic microphone

3.10.11
XR experiencer
XR user
XR wearer
person wearing an eyewear display and experiencing interactive real and virtual worlds

3.10.12
gaze tracking
direction vector for each eye by pupillometry or monitoring of gaze (see 3.9.3) in an eyewear display experience [10]

3.10.13
immersion
artificial awareness of an XR experiencer through a virtual environment composed of visual sensations (“viewing”), possibly extended by further sensations (e.g., audio/hearing, haptics, smell, etc.)

3.10.14
light field display
display emitting or reflecting light fields in varying focal planes to approximate the wave fronts of the light reflected off an object, thus resulting in an illusion of depth

3.10.15
social virtual-reality
experience that allows the viewer to feel physically right next to another person or group of people, despite a long distance between the participants

Note 1 to entry: A virtual-reality meeting or social event is a hyper space in which each avatar represents a single participant in a real-world meeting or shared VR.

3.10.16
stitching
seamless concatenation of multiple cameras and/or display images to create an image with a field of view larger than that of the original individual cameras and/or displays

3.10.17
simultaneous localization and mapping
SLAM
head-worn camera system that scans the environment and creates a digital map to be used in a computer to create a virtual world that combines with the real-world

3.10.18
marker-based tracking
two-dimensional image or code recognized by computers using SLAM to present the contents

3.10.19
virtual world
3D environment created by a computer with which the user can interact

3.10.20
roll
rotation about the horizontal axis of the direction of travel, that is, x-axis

3.10.21
pitch
rotation about a horizontal axis perpendicular to the direction of travel, that is, y-axis

3.10.22
yaw
rotation about a vertical axis, that is, z-axis

3.10.23
AR overlay
image or graphic superimposed over the view of the physical environment of the real-world

Note 1 to entry: Augmented reality without spatial registration is sometimes referred to as “assisted reality” (refer to augmented reality in 3.4.2).

3.10.24
chroma key video
part of a video that is made transparent for a specific colour and superimposing another video onto the original video

3.10.25
extended tracking
preserving tracking by images that are not the tracked ones in the 3D virtual environment

3.10.26
hotspot
point in the AR experience at which the experiencer acquires more information by patting it

3.10.27
AR marker
scene recognition via images that are recognizable by the application producing the AR experience

Note 1 to entry: AR marker sometimes is referred to as AR trackable, AR trigger, AR target, and image target.

3.10.28
interactive video
video that includes (a) hotspot(s) with a special feature where the video content requires the user to interact with the video

3.10.29
markerless AR
scene recognition for AR mapping in a physical environment in real-time without the need for image targets to position virtual objects in space

3.10.30
ambisonic audio
full-sphere surround sound format in which the sound field can be rotated based on the orientation of the user's head in VR, AR or MR

3.10.31
application programming interface
API
programming software for developing VR and AR, in which the software connects the operating systems through interfaces

3.10.32
AR light estimation
feed of information on the ambient illumination in an AR scene causing highlights or shadows in order to increase the feeling of immersion

3.10.33
three-dimensional audio
sound associated with a VR image having manipulated and controlled volume and direction

3.10.34
face analysis
one of the computer functions for tracking facial features in real time by using still images or videos

3.10.35
moving vision
users' vision that is acquired by moving their heads by rolling, pitching, and/or yawing and/or by moving the eyes