IEC TR 63145-1-1

Edition 1.0 2018-09

TECHNICAL REPORT

colour inside

Eyewear display –
Part 1-1: Generic introduction

IEC TR 63145-1-1:2018-09(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.120

ISBN 978-2-8322-6064-7

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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IEC TR 63145-1-1, which is a Technical Report, has been prepared by IEC technical committee 110: Electronic display devices.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
110/966/DTR	110/982A/RVDTR

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 63145 series, published under the general title *Eyewear display*, 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 "http://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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

This document intends to gather technical information on eyewear displays, and to clarify the relationship to normative aspects of the standardization in this technology area.

EYEWEAR DISPLAY –

Part 1-1: Generic introduction

1 Scope

This part of IEC 63145, which is a Technical Report, provides general information for the standardization of eyewear displays. This document includes an overview of the technology, critical performance characteristics, issues of optical measurements, and other information.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
eyewear display
display worn on the user's eye or worn close to the eye in order to provide information to the user

Note 1 to entry: See 4.1.

3.1.2
pupil forming
virtual image optics that are 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

3.1.3
non-pupil forming
virtual image optics where the magnifier does not form a real image of the aperture stop

Note 1 to entry: See 3.1.2.

3.2 Abbreviatied terms

AR	augmented reality
CAVE	cave automatic virtual environment
CRT	cathode ray tube
FOV	field of view
FPD	flat panel display
HMD	head mounted display

HUD	head up display
IPD	interpupillary distance
LMD	light measuring device
MR	mixed reality
QVS	qualified viewing space
VR	virtual reality
WFOV	wide field of view
2-D	two-dimensional

4 Eyewear display technologies

4.1 General

The advancement of display technology has enabled the creation of compact displays that can be placed close to or on a viewer's eye. This miniaturization enables the user to wear the display in a comfortable form factor (such as eye glasses), and allows an individual to render information of interest for their personal use. Some of the benefits of this display technology include:

- good portability, such as hands-free, like eye glasses;
- large perceived image size, despite small structure; and
- link with user's behaviour or external world, for virtual reality/augmented reality/mixed reality.

There have been several designs proposed for wearing the display:

- head mount;
- helmet mount;
- headset;
- glasses mount;
- goggle;
- visor;
- contact lens.

The term "eyewear" is defined as follows in several sources:

a) things worn on the eyes, such as spectacles and contact lenses [1][1]; and
b) devices worn to protect the eyes or improve the vision, such as eyeglasses, sunglasses, safety goggles, etc. [2].

The eyewear includes things to cover the user's eye, and contact lenses are also included.

How the display is mounted near the eye affects the display optics, the performance, and how it is measured. There are other kinds of displays which do not have a mount structure or do not attach to the eye:

- electronic view finder;
- telescope;
- microscope;

[1] Numbers in square brackets refer to the Bibliography.

- binoculars;
- opera glasses; and
- ophthalmic instruments, such as an auto-refractometer.

These cover the user's eye, but are not included in the eyewear display because they are not worn.

The term "near-eye display" is often used because, compared to an ordinary display, such as a TV or PC monitor, the display is positioned closer to the user's eye. In ISO 9241-302:2008 [3], Figure 11, "NTE (near to the eye) display" is used to explain the term "virtual image display". In ISO 9241-305:2008 [4], 6.11.1, the terms "near-to-eye display" and "NED" are used. These four terms are slightly different, but are considered to have the same meaning. For near-eye displays, the proximity of the display to the eye makes it difficult to focus on the display directly. Therefore, it is necessary to include optics between the display and eye for the viewer to focus on the display image. Generally, the optics forming a virtual image are used.

Eyewear displays are typically used in virtual reality (VR) and augmented reality (AR) applications. When the application of displays is considered, "VR" or "AR" is frequently used in academic conferences and even in newspapers to describe them. Mixed reality (MR) is also used when physical and digital (visual) objects co-exist and interact in real time. Some common dictionary definitions of VR are:

- the computer-generated simulation of three-dimensional images of an environment or sequence of events that someone using special electronic equipment may view, as on a video screen, and interact with in a seemingly physical way [2]; and
- a computer-generated environment that, to the person experiencing it, closely resembles reality [5].

It is noted that VR is not limited to eyewear displays. There are other ways to implement VR, such as a multi-screen CAVE (cave automatic virtual environment) [6][7] using image projection. Compared with these VR displays, where the user directly observes the images shown on the display screen, VR eyewear displays are worn and need special optics to see an image. Without the optics, it is difficult for the human eye to focus on the displayed image, or the observed image is too small. The use of eyewear displays for VR has become very popular, with many companies offering non-see-through goggles in the marketplace.

Compared to VR, AR is a relatively new term and technology. AR allows for a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data. It is related to a more general concept called mediated reality, in which a view of reality is modified (possibly even diminished rather than augmented) by a computer. As a result, the technology functions by enhancing one's current perception of reality. In contrast, virtual reality replaces the real world with a simulated one. Many AR displays are designed in the form of eye glasses or visors. It is important that the AR/VR term be used with the form factor, such as "VR goggles" and "AR glasses", otherwise AR/VR just identifies the application, not the device type.

The popular use of the term "virtual" has caused some confusion in how it is used for AR/VR applications. In the technical field of optics, the term "virtual", such as "virtual image", has a specific meaning [8]. In optics, the virtual image is defined as an image formed when the outgoing rays from a point on an object always diverge. Therefore, it is more precise to use the term "virtual" in combination with other attributes, such as "virtual reality", "VR", or "virtual image". In ISO 9241-302:2008 [3], 3.4.52, "virtual-image display" is defined as a device that optically or holographically forms a virtual image. Instead of "virtual-image display", "virtual display" is used in ISO 9241-303:2011 [9], Annex E, and "virtual image display" appears in ISO 9241-305:2008 [4], 6.11. These terms are considered to have the same meaning, that is, a display with optics that creates a virtual image. However, the term "virtual display" is confusing, and should be avoided. For example, a projection display with a cave shape screen is often called a "virtual display" because it can produce a virtual reality scene, but it does not use virtual-image optics.

A “head up display (HUD)” is considered as one type of virtual image display, but it is not considered as an eyewear display because it is not worn close to the eye.

To establish the classification of eyewear displays, the above-mentioned points need to be considered.

4.2 Classification

To classify the eyewear displays, as shown in Figure 1, there are some key points to consider as follows:

- virtual image optics, or retina direct projection;
- optical see-through or video see-through (optical non-see-through);
- monocular or binocular;
- near or contact.

AR video see-through is also possible.

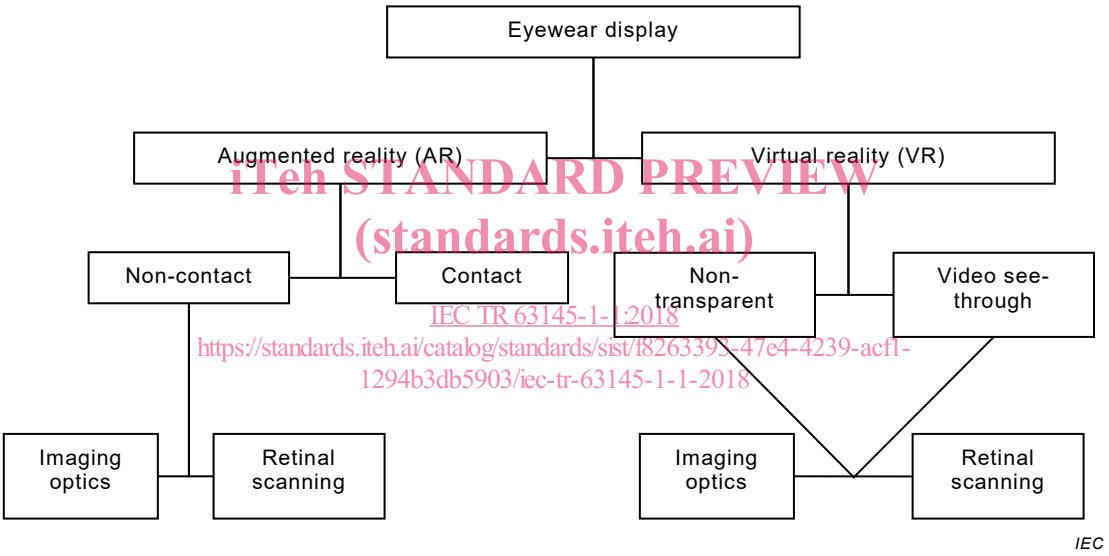

Figure 1 – Eyewear display classification

When application, interface, and design are considered, an alternative classification can be considered as shown in Figure 2. In this classification, the key points are as follows:

– see-through or non-see-through from an application stand point;
– mounting method base by human physical interface;
– monocular, bi-ocular or binocular for human optical interface;
– pupil forming or non-pupil forming from an optical design stand point;
– display source driving method.