

SLOVENSKI STANDARD
SIST-TP CEN ISO/TR 9241-331:2013
01-november-2013

Ergonomija medsebojnega vpliva človek-sistem - 331. del: Optične značilnosti avtostereoskopičnih zaslonov (ISO/TR 9241-331:2012)

Ergonomics of human-system interaction - Part 331: Optical characteristics of autostereoscopic displays (ISO/TR 9241-331:2012)

Ergonomie der Mensch-System-Interaktion - Teil 331: Optische Besonderheiten autostereoskopischer Displays (ISO/TR 9241-331:2012)

Ergonomie de l'interaction homme-système - Partie 331: Caractéristiques optiques des écrans autostéréoscopiques (ISO/TR 9241-331:2012)

<https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013>

Ta slovenski standard je istoveten z: CEN ISO/TR 9241-331:2013

ICS:

13.180	Ergonomija	Ergonomics
31.120	Elektronske prikazovalne naprave	Electronic display devices

SIST-TP CEN ISO/TR 9241-331:2013 **en**

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST-TP CEN ISO/TR 9241-331:2013](https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013)

<https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013>

TECHNICAL REPORT
RAPPORT TECHNIQUE
TECHNISCHER BERICHT

CEN ISO/TR 9241-331

September 2013

ICS 35.180; 13.180

English Version

Ergonomics of human-system interaction - Part 331: Optical characteristics of autostereoscopic displays (ISO/TR 9241-331:2012)

Ergonomie de l'interaction homme-système - Partie 331:
Caractéristiques optiques des écrans autostéréoscopiques
(ISO/TR 9241-331:2012)

Ergonomie der Mensch-System-Interaktion - Teil 331:
Optische Besonderheiten autostereoskopischer Displays
(ISO/TR 9241-331:2012)

This Technical Report was approved by CEN on 19 August 2013. It has been drawn up by the Technical Committee CEN/TC 122.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST-TP CEN ISO/TR 9241-331:2013](https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013)
<https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013>



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

	Page
Foreword.....	3

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST-TP CEN ISO/TR 9241-331:2013](https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013)
<https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013>

Foreword

The text of ISO/TR 9241-331:2012 has been prepared by Technical Committee ISO/TC 159 “Ergonomics” of the International Organization for Standardization (ISO) and has been taken over as CEN ISO/TR 9241-331:2013 by Technical Committee CEN/TC 122 “Ergonomics” the secretariat of which is held by DIN.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of ISO/TR 9241-331:2012 has been approved by CEN as CEN ISO/TR 9241-331:2013 without any modification.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST-TP CEN ISO/TR 9241-331:2013](https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013)

<https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST-TP CEN ISO/TR 9241-331:2013](https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013)

<https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013>

TECHNICAL REPORT

ISO/TR 9241-331

First edition
2012-04-01

Ergonomics of human-system interaction —

Part 331: Optical characteristics of autostereoscopic displays

iTeh STANDARD PREVIEW
(standards.iteh.ai)
*Ergonomie de l'interaction homme-système —
Partie 331: Caractéristiques optiques des écrans autostéréoscopiques*

[SIST-TP CEN ISO/TR 9241-331:2013](https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013)
<https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013>



Reference number
ISO/TR 9241-331:2012(E)

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST-TP CEN ISO/TR 9241-331:2013
<https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2012

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction.....	vi
1 Scope	1
2 Terms and definitions	1
2.1 General terms	1
2.2 Human factors	3
2.3 Performance characteristics	3
3 Autostereoscopic display technologies	5
3.1 General	5
3.2 Cues for depth perception.....	5
3.3 Stereoscopic display classification.....	7
3.4 Two-view (autostereoscopic) display.....	9
3.5 Multi-view (autostereoscopic) display	14
3.6 Integral (autostereoscopic) display.....	22
3.7 Discussion	29
3.8 Future work	36
4 Performance characteristics	36
4.1 General	36
4.2 Crosstalk	38
4.3 Visual artefacts	42
4.4 3D fidelity	45
4.5 Future work	46
5 Optical measurement methods.....	46
5.1 General	46
5.2 Measurement conditions	47
5.3 Measurement methods	52
5.4 Future work	68
6 Viewing spaces and their analysis	68
6.1 General	68
6.2 Qualified viewing spaces.....	69
6.3 Related performance characteristics	73
6.4 Analysis methods.....	75
6.5 Future work	77
7 Further work.....	78
Annex A (informative) Overview of the ISO 9241 series	79
Annex B (informative) Head tracking technology.....	80
Bibliography.....	81

ISO/TR 9241-331:2012(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 9241-331 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*. [SIST-TP CEN ISO/TR 9241-331:2013](https://standards.iteh.ai/catalog/standards/sist/94d77502-10d7-45f9-b336-5b1ef0526e20/sist-tp-cen-iso-tr-9241-331-2013)

ISO 9241 consists of the following parts, under the general title *Ergonomic requirements for office work with visual display terminals (VDTs)*:

- *Part 1: General introduction*
- *Part 2: Guidance on task requirements*
- *Part 4: Keyboard requirements*
- *Part 5: Workstation layout and postural requirements*
- *Part 6: Guidance on the work environment*
- *Part 9: Requirements for non-keyboard input devices*
- *Part 11: Guidance on usability*
- *Part 12: Presentation of information*
- *Part 13: User guidance*
- *Part 14: Menu dialogues*
- *Part 15: Command dialogues*
- *Part 16: Direct manipulation dialogues*

ISO 9241 also consists of the following parts, under the general title *Ergonomics of human-system interaction*:

- *Part 20: Accessibility guidelines for information/communication technology (ICT) equipment and services*
- *Part 100: Introduction to standards related to software ergonomics* [Technical Report]
- *Part 110: Dialogue principles*
- *Part 129: Guidance on software individualization*
- *Part 143: Forms*
- *Part 151: Guidance on World Wide Web user interfaces*
- *Part 154: Interactive voice response (IVR) applications*
- *Part 171: Guidance on software accessibility*
- *Part 210: Human-centred design for interactive systems*
- *Part 300: Introduction to electronic visual display requirements*
- *Part 302: Terminology for electronic visual displays*
- *Part 303: Requirements for electronic visual displays*
- *Part 304: User performance test methods for electronic visual displays*
- *Part 305: Optical laboratory test methods for electronic visual displays*
- *Part 306: Field assessment methods for electronic visual displays*
- *Part 307: Analysis and compliance test methods for electronic visual displays*
- *Part 308: Surface-conduction electron-emitter displays (SED)* [Technical Report]
- *Part 309: Organic light-emitting diode (OLED) displays* [Technical Report]
- *Part 310: Visibility, aesthetics and ergonomics of pixel defects* [Technical Report]
- *Part 331: Optical characteristics of autostereoscopic displays* [Technical Report]
- *Part 400: Principles and requirements for physical input devices*
- *Part 410: Design criteria for physical input devices*
- *Part 411: Evaluation methods for the design of physical input devices* [Technical Specification]
- *Part 420: Selection of physical input devices*
- *Part 910: Framework for tactile and haptic interaction*
- *Part 920: Guidance on tactile and haptic interactions*

User-interface elements, requirements, analysis and compliance test methods for the reduction of photosensitive seizures, ergonomic requirements for the reduction of visual fatigue from stereoscopic images, and the evaluation of tactile and haptic interactions are to form the subjects of future Parts 161, 391, 392 and 940.

Introduction

Recent developments in display technologies have made it possible to render highly realistic content on high-resolution colour displays. The developments include advanced 3D display technologies such as autostereoscopic displays. The new 3D displays extend the capabilities of applications by giving the user more-realistic-than-ever perception in various application fields. This is valid not only in the field of leisure but also in the fields of business and education, and in medical applications.

Nevertheless, 3D displays have display-specific characteristics originating from the basic principles of the image formation applied for the different 3D display designs. Among negative characteristics are imperfections that affect the visual quality of the displayed content and the visual experience of the users. These imperfections can induce visual fatigue for the users, which is one of the image safety issues described in IWA 3:2005. Nevertheless, it is important for the end user to be able to enjoy of the benefits of the 3D display without suffering any undesirable biomedical effects. It is therefore necessary that a standardized methodology be established which characterizes and validates technologies in order to ensure the visual quality of the displays and the rendered content. The development of such a methodology has to be based on the human perception and performance in the context of stereoscopic viewing.

The negative characteristics, by nature, originate from both 3D displays and 3D image content. In this part of ISO 9241, however, attention is focussed only on 3D display, for simplicity of discussion and as a first step.

In ISO 9241-303, performance objectives are described for virtual head-mounted displays (HMDs). This is closely related to autostereoscopic displays, but not directly applicable to them.

Considering the growing use of autostereoscopic displays, and the need for a methodology for their characterization in order to reduce visual fatigue caused by them, this Technical Report presents basic principles for related technologies, as well as optical measurement methods required for the characterization of the current technologies and for a future International Standard on the subject.

Since this Technical Report deals with display technologies that are in continual development, its content will be updated if and as necessary. It includes no content intended for regulatory use.

Ergonomics of human-system interaction —

Part 331:

Optical characteristics of autostereoscopic displays

1 Scope

This part of ISO 9241 establishes an ergonomic point of view for the optical properties of autostereoscopic displays (ASDs), with the aim of reducing visual fatigue caused by stereoscopic images on those displays. It gives terminology, performance characteristics and optical measurement methods for ASDs.

It is applicable to spatially interlaced autostereoscopic displays (two-view, multi-view and integral displays) of the transmissive and emissive types. These can be implemented by flat-panel displays, projection displays, etc.

2 Terms and definitions

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

2.1 General terms

2.1.1

3D display

display device or system including a special functionality for enabling depth perception

2.1.2

stereoscopic display

3D display where depth perception is induced by binocular parallax

NOTE 1 People perceive depth from the retinal disparity provided by binocular parallax.

NOTE 2 Stereoscopic displays include stereoscopic displays requiring glasses, stereoscopic HMDs and autostereoscopic displays.

NOTE 3 See ISO 9241-302:2008, 3.5.5, *binocular display device*.

2.1.3

autostereoscopic display

ASD

stereoscopic display that requires neither viewing aids such as special glasses nor head-mounted apparatus

NOTE Autostereoscopic displays includes two-view displays, multi-view displays and integral displays, as well as other types of display not discussed in this part of ISO 9241, such as holographic displays and volumetric displays.

2.1.4

two-view display

two-view autostereoscopic display

autostereoscopic display that creates two monocular views with which the left and right stereoscopic images are coupled

ISO/TR 9241-331:2012(E)

2.1.5

multi-view display**multi-view autostereoscopic display**

autostereoscopic display that creates more than two monocular views with which the stereoscopic images are coupled

NOTE 1 It becomes an autostereoscopic display when the number of stereoscopic images is increased from two to more than two.

NOTE 2 Principally, one of multiple stereoscopic images corresponds to one of multiple stereoscopic views, yet not necessarily excluding one-to-multi correspondence.

2.1.6

integral display**integral autostereoscopic display**

autostereoscopic display that is intended to optically reproduce three-dimensional objects in space

NOTE Since, at present, it is not easy to make the optical reproduction perfect, integral displays are not necessarily free from such factors of undesirable biomedical effect as accommodation-vergence inconsistency (see 3.7, 4.1).

2.1.7

stereoscopic images

set of images with parallax shown on a stereoscopic display

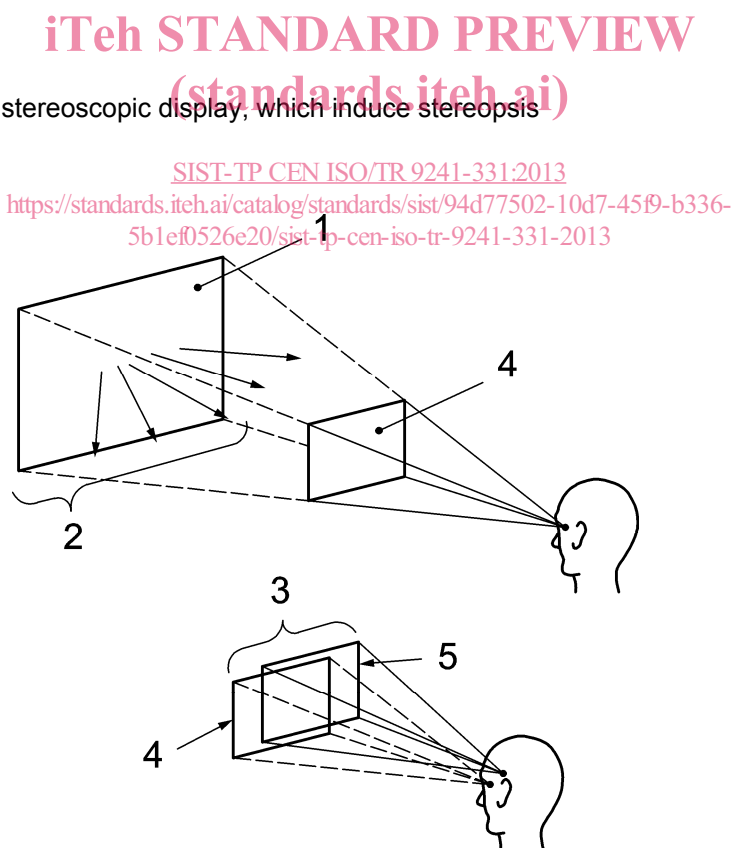
NOTE See 2.1.8.

2.1.8

stereoscopic views

pair of sights provided by a stereoscopic display, which induce stereopsis

NOTE See Figure 1.

**Key**

- | | | | | | |
|---|--------------------------|---|---------------------------|---|----------------------------|
| 1 | autostereoscopic display | 3 | stereoscopic views | 5 | monocular view (right eye) |
| 2 | stereoscopic images | 4 | monocular view (left eye) | | |

Figure 1 — Relation between stereoscopic images, stereoscopic views and monocular view

2.1.9**monocular view**

one stereoscopic view

NOTE See 2.1.8.

2.1.10**number of views**

number of monocular views with which stereoscopic images are coupled

2.2 Human factors**2.2.1****binocular parallax**

apparent difference in the direction of a point as seen separately by one eye and by the other, while the head remains in a fixed position

NOTE 1 See IWA 3:2005, 2.15.

NOTE 2 Binocular parallax is equivalent to the optic angle between the visual axes of both eyes, when they are fixated to a single point.

2.2.2**visual fatigue**

eyestrain or asthenopia, which shows a wide range of visual symptoms, including tiredness, headache and soreness of the eyes, caused by watching images in a visual display

NOTE 1 Adapted from IWA 3:2005 (2.13).

NOTE 2 See also ISO 9241-302:2008, 3.5.3.

2.2.3**accommodation**

adjustment of the optics of an eye to keep an object in focus on the retina as its distance from the eye varies

[SOURCE: ISO 9241-302:2008, 3.5.1, modified — the Note to the definition has not been included.]

NOTE Adapted from IWA 3:2005, 2.18.

2.2.4**convergence**

turning inward of the lines of sight toward each other as the object of fixation moves toward the observer

[SOURCE: ISO 9241-302:2008, 3.5.10]

NOTE See also IWA 3:2005, 2.19.

2.3 Performance characteristics**2.3.1****3D crosstalk**

leakage of an unwanted image data to each eye

2.3.2**interocular crosstalk**

leakage of the stereoscopic image(s) from one eye to the other