TECHNICAL REPORT

ISO/TR 9241-308

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Ergonomics of human-system interaction —

Part 308: Surface-conduction electron-emitter displays (SED)

Ergonomie de l'interaction homme-système —

Partie 308: Écrans à émission d'électrons par conduction de surface (SED)

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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

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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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.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 9241-308 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

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*

— *Part 17: Form filling 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 110: Dialogue principles*

— *Part 151: Guidance on World Wide Web user interfaces*

— *Part 171: Guidance on software accessibility*

— *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 400: Principles and requirements for physical input devices*

— *Part 410: Design criteria for physical input devices*

— *Part 920: Guidance on tactile and haptic interactions*

For the other parts under preparation, see Annex A.

Introduction

This part of ISO 9241 introduces surface-conduction electron-emitter display (SED) technology into the ISO 9241 series and international ergonomics standardization (it is not yet addressed in ISO 9241-307, for instance, or in other ergonomics standards), and has been developed as a set of initial guidelines for the assessment of the ergonomic properties of SED-based products.

Compared with other display technologies, the ergonomic advantages of SED are

— isotropic behaviour of emission of light like that of CRT (cathode ray tube) technology,

— no curvature, unlike CRT technology,

— fast response time, like CRT technology, and

— a uniform and sharp focus on the entire screen as with LCD (liquid crystal display) and PDP (plasma display panel) technologies.

The currently known disadvantages of SED are

— limited display size, from 36 inch upwards (with the potential in the future for smaller display size), and

— fixed resolution compared with CRT technology.

In relation to the ergonomic requirements given in ISO 9241-303 and compared with (for example) CRT, no other specific health aspects or disadvantages of SED technology had been identified at the time of publication of this part of ISO 9241.

Ergonomics of human-system interaction —

Part 308:
Surface-conduction electron-emitter displays (SED)

1 Scope

This part of ISO 9241 gives guidelines for surface-conduction electron-emitter displays (SED).

2 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the following term and definition, symbols and abbreviated terms apply.

2.1
surface-conduction electron-emitter display
SED
emissive visual display for direct view

NOTE See Reference [1].

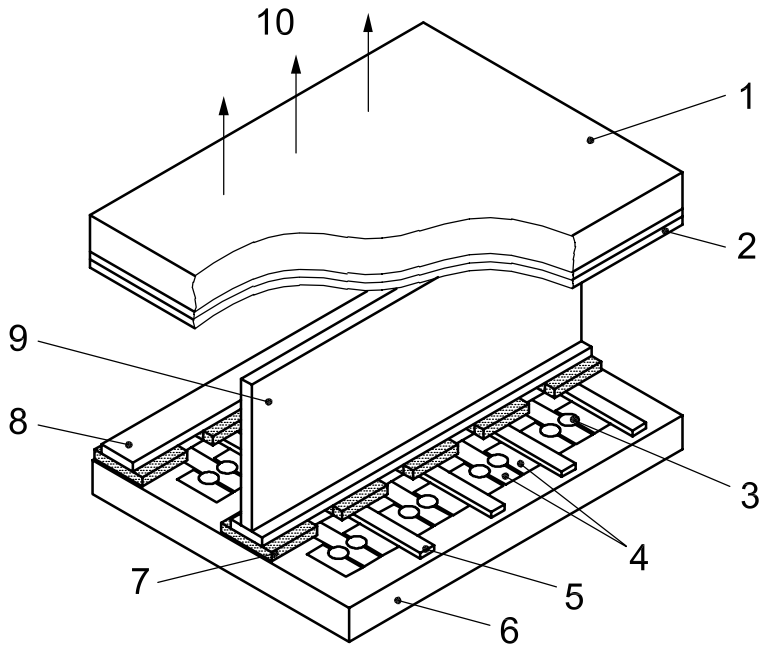
2.2 Symbols and abbreviated terms

A_{scan}	amplitude of scan signal
A_{sig}	amplitude of pulse width modulation signal
$D_{\text{design,view}}$	design viewing distance
d	distance between rear and face plates
W_{view}	horizontal display size (width of active display area)
H_{view}	vertical display size (height of active display area)
I_{e}	emission current
V_{a}	anode voltage
V_{f}	driving voltage
AR	anti-reflective
BM	black matrix
CRT	cathode ray tube
LCD	liquid crystal display
PDP	plasma display panel
RD	residual dispersion
SCE	surface-conduction electron-emitter

3 SED technology

3.1 General

The SED panel has a structure as shown in Figure 1. It consists of three main parts: rear plate, face plate and spacers. The spacers allow a vacuum without change in the confined space and are arranged at an appropriate distance, d, between the rear and face plates, the accuracy of this distance having no effect on the SED's visual ergonomics.

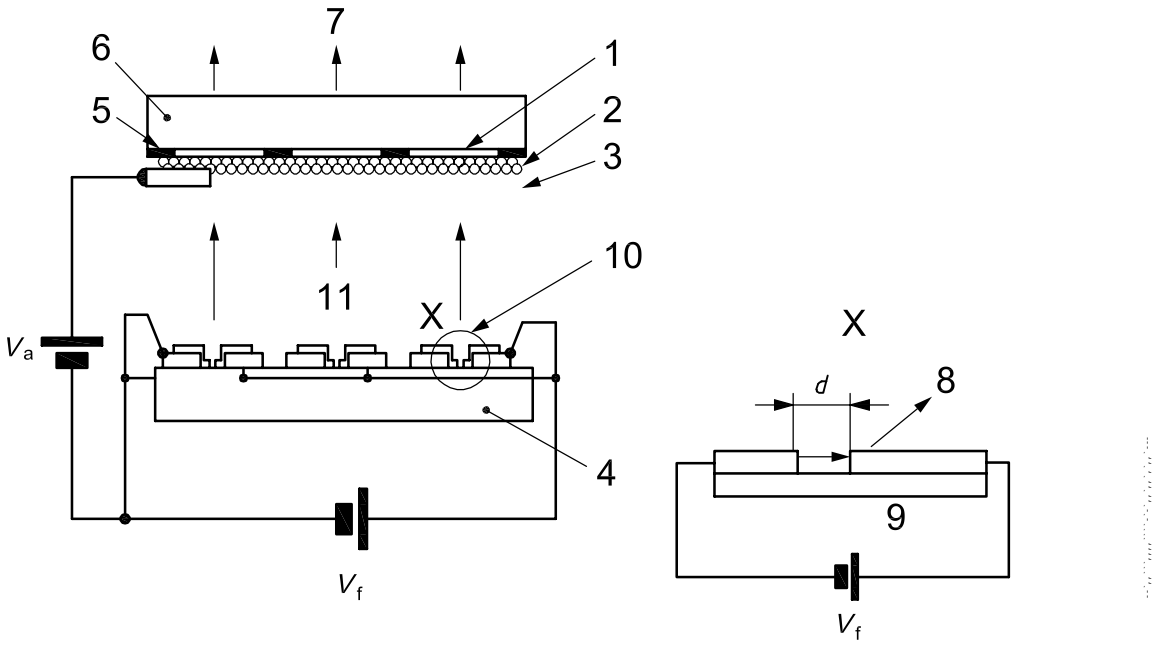


Key

1	face plate	6	rear plate
2	phosphors/metal back film	7	insulator
3	electron emitter	8	scanning wire
4	electrode	9	spacer
5	signal wire	10	luminescence

Figure 1 — SED panel structure

Electrons emitted from surface-conduction electron-emitters (SCE) (see Figures 2 and 3) at a driving voltage, V_f, biased between a pair of electrodes, are accelerated by an anode voltage, V_a. Luminescence from phosphors is extracted through colour filters. The panel operation is summarized in Figure 2.



Key

1 colour filter
2 phosphor
3 metal back film
4 rear plate
5 black matrix
6 face plate
7 luminescence
8 electron beam
9 field emission
10 SCE
11 emission current, I_e

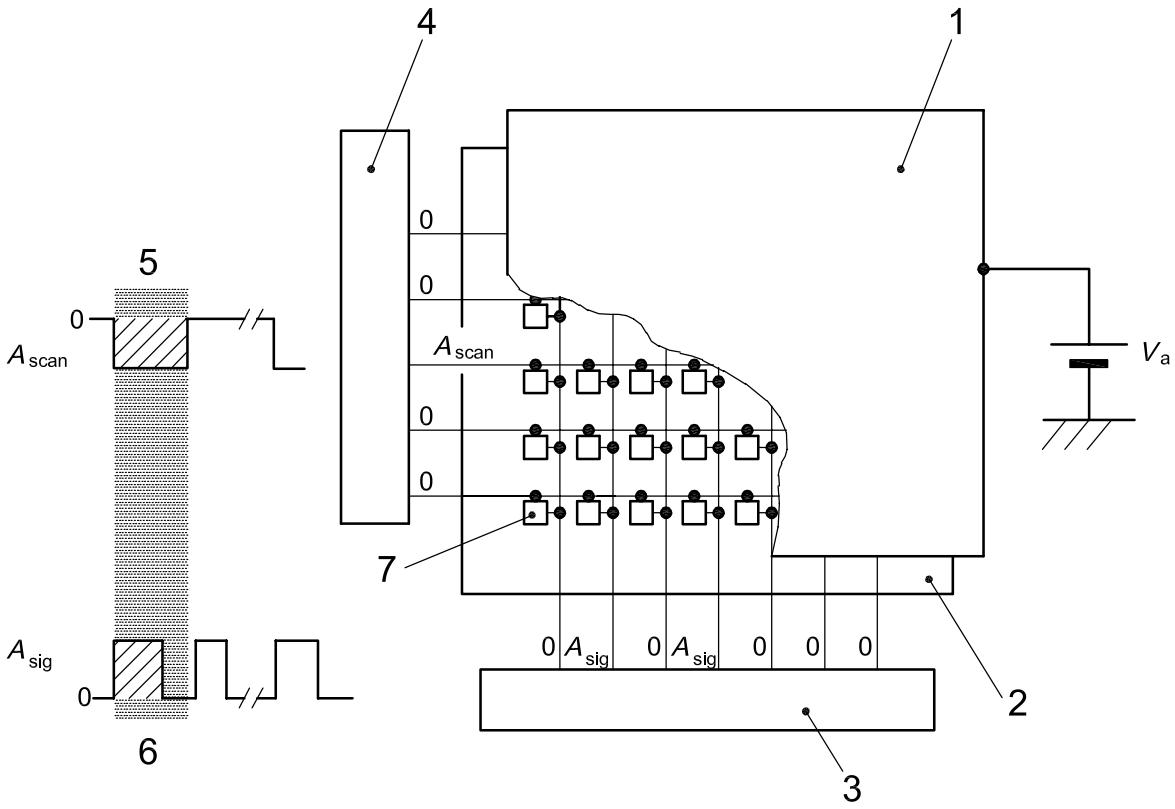
d distance (a few nanometres)
V_a anode voltage
V_f driving voltage

Figure 2 — SED panel operation

3.2 Rear plate

SCE, pairs of electrodes, scanning and signal wires are laid out in a matrix on a glass substrate. The emission current of the SCE is controlled only by V_f at a constant V_a. The diode mechanism of the SCE operation requires only a simple matrix structure for the emitter array.

The SED is driven by line sequential scanning, as shown in Figure 3. The scanning circuit generates the scan signal, the amplitude of which is A_{scan}, and the signal modulation circuit generates a pulse width modulation signal (amplitude, A_{sig}) which is synchronized with the scan signal.



Key

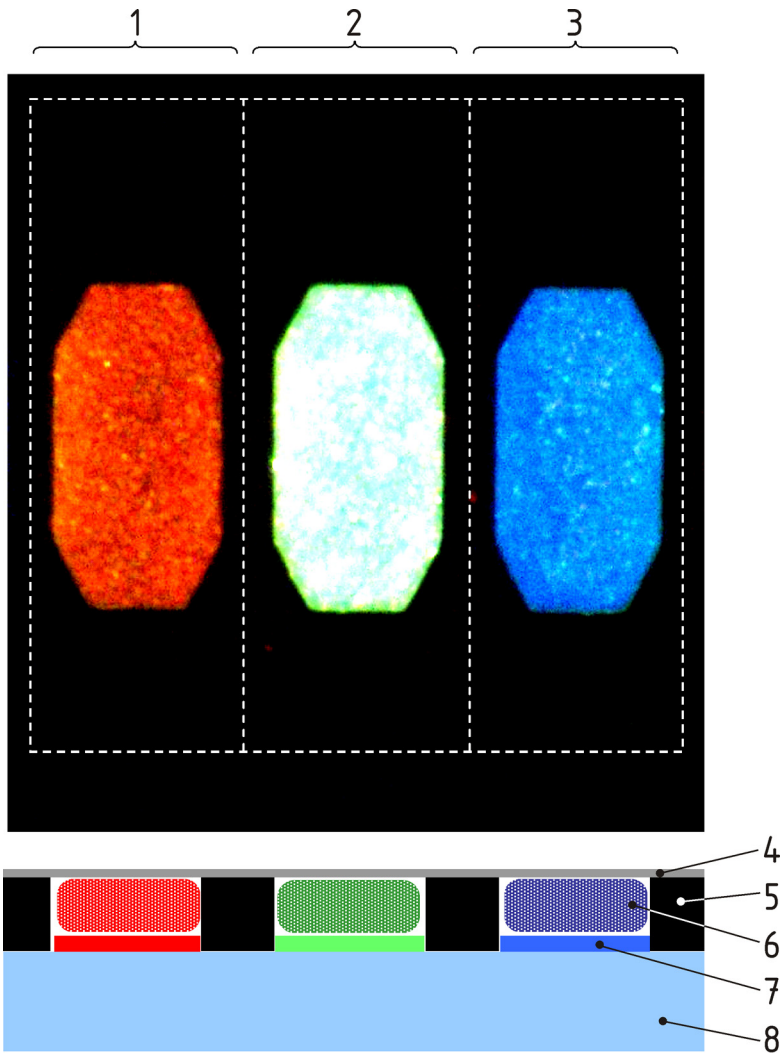
1 face plate
2 rear plate
3 signal modulation driver
4 scanning driver
5 scan signal
6 modulation signal
7 SCE

A_{scan} amplitude of scan signal
A_{sig} amplitude of pulse width modulation signal
V_a anode voltage

Figure 3 — SED driving method

3.3 Face plate

The face plate consists of black matrix (BM), colour filters, phosphors and a metal (aluminium) back. P22 phosphors are adopted to realize a CRT grade colour gamut. Colour filters play the roles of reducing diffuse reflectance and improving colour purity, with the effect of widening the gamut. The BM opening pattern as shown in Figure 4 is designed from the viewpoints of reducing the diffuse reflectance and matching with the electron beam shape.



Key

1	red	5	BM
2	green	6	phosphor
3	blue	7	colour filter
4	metal back	8	face plate

Figure 4 — BM opening pattern

4 SED product information

The following are the typical physical and design data for a plot-type SED product.

— Pixel pitch horizontal/vertical: (H) 0,615 mm × (V) 0,615 mm.

— Number of pixels horizontal/vertical: (H) 1 280 × 3 × (V) 768.

— Horizontal display size, W_{view}: 787,2 mm.

— Vertical display size, H_{view}: 472,3 mm.

— Active diagonal: 918 mm (36,1 inch).

— Front: glass panel with AR treatment.

Table 1 presents the basic differences between an SED and other VDT devices.

Table 1 — Basic differences between SED and other VDT devices

Item	SED	CRT	LCD	PDP
Emitting principle	Cold-cathode luminance	Hot-cathode luminance	Back light	Photo-luminance
Anode voltage	10 kV	30 kV	—	—
Optical performance	Isotropic	Isotropic	Anisotropic	Isotropic
Face plate thickness	Thin	Thick glass	Thin	Thin
Pixel type	Fixed type	No fixed type	Fixed type	Fixed type
Display method	Line by line scan (impulse drive)	Scan (beam impulse)	Line by line scan (hold drive) [a]	Sub-frame tiling

[a] Typical active matrix LCD.

5 Intended context of use

See Table 2.

Table 2 — Typical intended context of use for an SED product

Design screen illuminance	At indoor locations up to 600 lx
Illuminant	CIE illuminant A and D65
Content and perception	Reality information: imaging of objects and scenes that do have existing originals in our world (e.g. faces, people, landscapes, etc.) in full-colour presentation [a]
Design viewing distance	$3 \times H_{view}$
Design viewing direction	Perpendicular
Design viewing direction range	Maximum angle of inclination, Θ: 40°; azimuth angle, Φ: 0° to 360°

[a] At the time of publication of this part of ISO 9241, SED products were being used mainly for “reality information”, but this can also apply to “artificial information”.

6 Guidelines for assessment

These guidelines are based on initial optical measurements of a SED product in an accredited optical lab, and the measurements discussed at the TÜV Rheinland Product Safety, Display Measurement Lab of Cologne, Germany.

a) Isotropy

The isotropy of the SED was determined. The luminance at any inclination angle, Θ, less than or equal to 40° does not deviate by more than 12 % from the luminance measured perpendicularly. The SED therefore has optically isotropic behaviour.

As a result of this measurement, the assessment methods given in the compliance procedure for CRT display for indoor use [2] may serve as a good basis for the assessment of the SED product.

b) Distortion on the entire screen

While flat CRT has geometrical distortion caused by the thickness difference between the face plate centre and the face plate corner, SED is a fixed pixel type display and thus has has no geometrical distortion.

c) Focusing on the display corner

Whereas flat CRT has defocus on the display corners (caused by deflection defocus), the SED is a fixed pixel type display and thus has a uniform and sharp focus over the entire screen.

d) Motion picture

The response time of the SED is determined by the phosphor decay time. SED provides a rapid response time below 1 ms by using the same phosphor attribute as CRT and displays the picture image line by line. Therefore, the SED realizes moving images without blur.

e) Specific items

Additional specific items to be considered for SED products are given in Table 3, related to the assessment methods specified in ISO 9241-307.

Table 3 — Additional items to be considered for SED

Item	Consideration
Design viewing distance, $D_{\text{design,view}}$	For aspect ratio 16:9, consider ITU-R BT.710[5]: $D_{\text{design,view}} = 3H_{\text{view}}$
Measurement locations	The standard measurement locations, 1, 3, 7 and 9 (see Figure 5), are at the locations on the diagonals that are 10 % of the diagonal length in from the corners of the addressable area of the display as defined in ISO 9241-3.
The picture elements (pixels) of SED are arranged in a matrix.	Geometric distortions are not applicable. Pixel faults have to be considered.
SED do not require electronic beam deflection.	Colour misconvergence is not applicable.

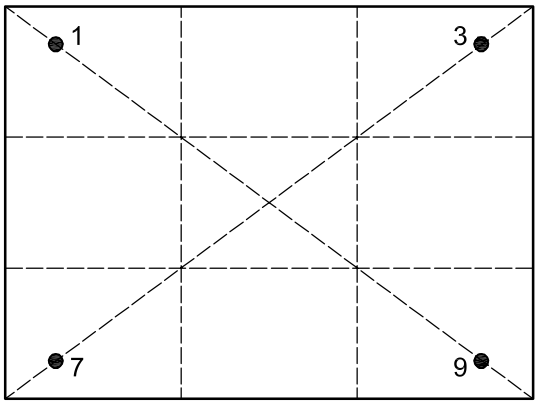


Figure 5 — Measurement locations for SED

f) Other items

For all other items, such as luminance, contrast and luminance non-uniformity, it can be shown that the measurement methodology specified in ISO 9241-307 for CRT displays for indoor use can also be used for SED products [4]. See Table 4.

Table 4 — Measured values for sample SED prototype

Item	Value measured for sample SED prototype
Luminance	Typically 430 cd/m^2
Luminance non-uniformity	Typically < 1,3:1
Colour non-uniformity	Typically < 0,02
Darkroom contrast	Typically > 100 000:1
Contrast under 600 lx	Typically > 50:1
Reflectometer value RD	Approx. 0,014
Chromaticity diagram area under darkroom conditions [a]	Typically 38,5 %
[a] The total area of the CIE 1976 UCS chromaticity diagram, i.e. the complete area inside the spectrum locus as shown in a chromaticity diagram, is set to 100 %.	

7 Conclusion

Given that there are no specific assessment methods currently available for SED products, the assessment methods specified in ISO 9241-307 for CRT displays for indoor use provide a reasonable assessment for application to SED products as well, considering the above-mentioned characteristics and items.

Annex A
(informative)

Overview of the ISO 9241 series

This annex presents an overview of ISO 9241: its structure, subject areas and the current status of both published and projected parts, at the time of publication of this part of ISO 9241. For the latest information on the series, see: http://isotc.iso.org/livelink/livelink?func=ll&objId=651393&objAction=browse&sort=name.

Part no.	Subject/title	Current status
1	General introduction	International Standard (intended to be replaced by ISO/TR 9241-1 and ISO 9241-130)
2	Guidance on task requirements	International Standard
3	Visual display requirements	Replaced by the ISO 9241 “300” subseries
4	Keyboard requirements	International Standard (intended to be replaced by the ISO 9241 “400” subseries)
5	Workstation layout and postural requirements	International Standard (intended to be replaced by ISO 9241-500)
6	Guidance on the work environment	International Standard (intended to be replaced by ISO 9241-600)
7	Requirements for display with reflections	Replaced by the ISO 9241 “300” subseries
8	Requirements for displayed colours	Replaced by the ISO 9241 “300” subseries
9	Requirements for non-keyboard input devices	International Standard (intended to be replaced by the ISO 9241 “400” subseries)
11	Guidance on usability	International Standard
12	Presentation of information	International Standard (intended to be replaced by ISO 9241-111 and ISO 9241-141)
13	User guidance	International Standard (intended to be replaced by ISO 9241-124)
14	Menu dialogues	International Standard (intended to be replaced by ISO 9241-131)
15	Command dialogues	International Standard (intended to be replaced by ISO 9241-132)
16	Direct-manipulation dialogues	International Standard (intended to be replaced by ISO 9241-133)
17	Form filling dialogues	International Standard (intended to be replaced by ISO 9241-134)
20	Accessibility guidelines for information/communication technology (ICT) equipment and services	International Standard

Part no.	Subject/title	Current status
Introduction		
100	Introduction to software ergonomics	Planned
General principles and framework		
110	Dialogue principles	International Standard
111	Presentation principles	Planned to partially revise and replace ISO 9241-12
112	Multimedia principles	Planned to revise and replace ISO 14915-1
113	GUI and controls principles	Planned
Presentation and support to users		
121	Presentation of information	Planned
122	Media selection and combination	Planned to revise and replace ISO 14915-3
123	Navigation	Planned to partially revise and replace ISO 14915-2
124	User guidance	Planned to revise and replace ISO 9241-13
129	Individualization	Planned
Dialogue techniques		
130	Selection and combination of dialogue techniques	Planned to incorporate and replace ISO 9241-1:1997/Amd 1:2001
131	Menu dialogues	Planned to replace ISO 9241-14
132	Command dialogues	Planned to replace ISO 9241-15
133	Direct-manipulation dialogues	Planned to replace ISO 9241-16
134	Form-based dialogues	Planned to replace ISO 9241-17
135	Natural language dialogues	Planned
Interface control components		
141	Controlling groups of information (including windows)	Planned to partially replace 9241-12
142	Lists	Planned
143	Media controls	Planned to partially revise and replace ISO 14915-2
Domain-specific guidance		
151	Guidance on World Wide Web user interfaces	International Standard
152	Interpersonal communication	Planned
153	Virtual reality	Planned

Part no.	Subject/title	Current status
Accessibility		
171	Guidance on software accessibility	International Standard
Human-centred design		
200	Introduction to human-centred design standards	Planned
210	Human-centred design of interactive systems	Planned to revise and replace ISO 13407
Process reference models		
220	Human-centred lifecycle processes	Planned to revise and replace ISO/PAS 18152
Methods		
230	Human-centred design methods	Planned to revise and replace ISO/TR 16982
Ergonomic requirements and measurement techniques for electronic visual displays		
300	Introduction to electronic visual display requirements	International Standard
302	Terminology for electronic visual displays	International Standard
303	Requirements for electronic visual displays	International Standard
304	User performance test methods	International Standard
305	Optical laboratory test methods for electronic visual displays	International Standard
306	Field assessment methods for electronic visual displays	International Standard
307	Analysis and compliance test methods for electronic visual displays	International Standard
308	Surface conduction electron-emitter displays (SED)	Technical Report
309	Organic light-emitting diode (OLED) displays	Technical Report
Physical input devices		
400	Principles and requirements for physical input devices	International Standard
410	Design criteria for physical input devices	Under preparation
411	Laboratory test and evaluation methods for the design of physical input devices	Planned
420	Selection procedures for physical input devices	Under preparation
421	Workplace test and evaluation methods for the use of physical input devices	Planned
Workstation		
500	Workstation layout and postural requirements	Planned to revise and replace ISO 9241-5
Work environment		
600	Guidance on the work environment	Planned to revise and replace ISO 9241-6

Part no.	Subject/title	Current status
Application domains		
710	Introduction to ergonomic design of control centres	Planned
711	Principles for the design of control centres	Planned to revise and replace ISO 11064-1
712	Principles for the arrangement of control suites	Planned to revise and replace ISO 11064-2
713	Control room layout	Planned to revise and replace ISO 11064-3
714	Layout and dimensions of control centre workstations	Planned to revise and replace ISO 11064-4
715	Control centre displays and controls	Planned to revise and replace ISO 11064-5
716	Control room environmental requirements	Planned to revise and replace ISO 11064-6
717	Principles for the evaluation of control centres	Planned to revise and replace ISO 11064-7
Tactile and haptic interactions		
900	Introduction to tactile and haptic interactions	Planned
910	Framework for tactile and haptic interactions	Planned
920	Guidance on tactile and haptic interactions	Under preparation
930	Haptic and tactile interactions in multimodal environments	Planned
940	Evaluation of tactile and haptic Interactions	Planned
971	Haptic and tactile interfaces to publicly available devices	Planned

Bibliography

[1] *High-brightness, High-resolution, High-contrast, and Wide-gamut Features of Surface-conduction Electron-emitter Displays*. IDW, Japan. December, 2005

[2] ISO 9241-307, *Ergonomics of human-system interaction — Part 307: Analysis and compliance test methods for electronic visual displays* [1)]

[3] ISO 9241-3, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 3: Visual display requirements*

[4] *A 36-inch WXGA Surface-conduction Electron-emitter Display (SED)*, Microoptical Group, Optical Society of Japan, JSAP

[5] ITU-R BT.710-2, *Subjective assessment methods for image quality in high-definition television* [2)]

1) To be published.

2) International Telecommunication Union (ITU) Recommendation.

ICS 13.180; 35.180

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