TECHNICAL REPORT

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Ergonomics of human-system interaction —

Part 309: Organic light-emitting diode (OLED) displays

Ergonomie de l'interaction homme-système —

Partie 309: Écrans à diodes électroluminescentes organiques (OLED)

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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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.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 9241-309 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 products 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 the OLED (organic light-emitting diode) display technology, and provides guidance for the assessment of OLED-based products. OLED technology is not addressed by ISO 9241-307 (which establishes test methods for the analysis of a variety of visual display technologies, tasks and environments) or other parts of the “300” subseries.

ISO 9241 was originally developed as a seventeen-part International Standard on the ergonomics requirements for office work with visual display terminals. As part of the standards review process, a major restructuring of ISO 9241 was agreed to broaden its scope, to incorporate other relevant standards and to make it more usable. The general title of the revised ISO 9241, “Ergonomics of human-system interaction”, reflects these changes and aligns the standard with the overall title and scope of Technical Committee ISO/TC 159, Subcommittee SC 4. The revised multipart standard is structured as series of standards numbered in the “hundreds”: the 100 series deals with software interfaces, the 200 series with human centred design, the 300 series with visual displays, the 400 series with physical input devices, and so on.

See Annex A for an overview of the entire ISO 9241 series.

Ergonomics of human-system interaction —

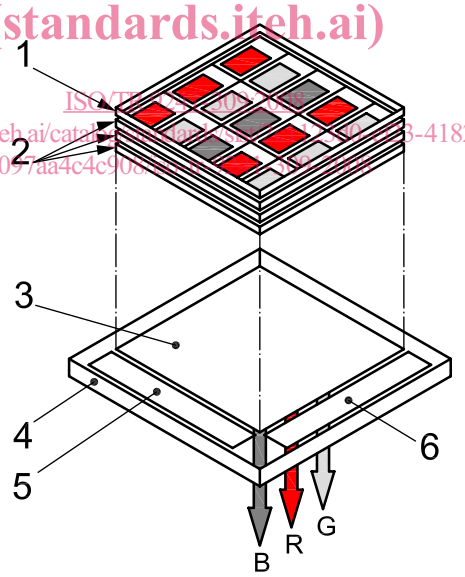
Part 309:
Organic light-emitting diode (OLED) displays

1 Scope

This part of ISO 9241 gives guidelines for organic light-emitting diode (OLED) displays.

2 OLED technology

OLED is an emissive device used in visual displays for direct view [3]. A typical active matrix OLED (AM-OLED) display panel is shown in Figure 1. It consists of three parts: substrate, organic layers and reflective electrode. A pixel contains three or more primary-colour sub-pixels in full-colour OLED displays.



Key

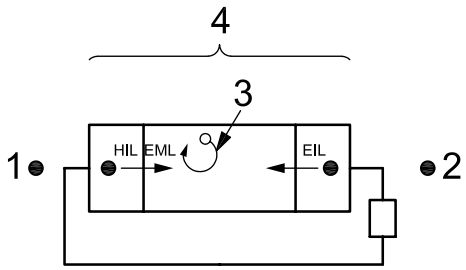
1 cathode
2 organic layer (electron transport layer, emitting layer, hole transport layer)
3 anode
4 low temperature poly-Si TFT substrate
5 driver, horizontal
6 driver, vertical

Figure 1 — Typical OLED display panel structure (bottom emission type)

The substrate of an AM-OLED display panel is usually a low temperature poly-Si TFT (thin film transistor) substrate.

The organic layers consist of more than two layers. These layers are chosen from the electron injection layer (EIL), electron transport layer, emitting layer, hole transport layer, hole injection layer (HIL) and so on. The cathode is usually made of aluminium. It reflects light from the emitting layer (EML) in the viewing direction.

The OLED operation is summarized in Figure 2.



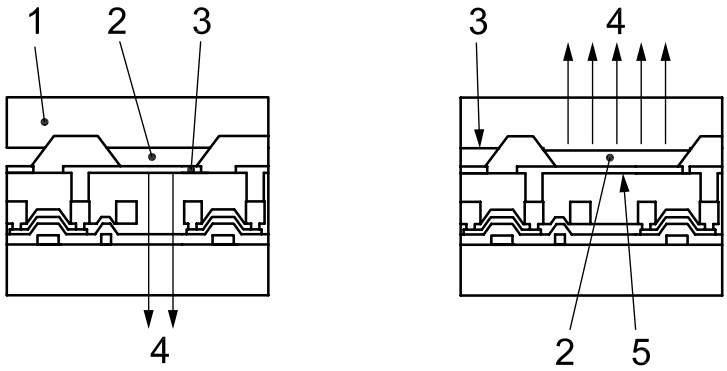
Key

1 hole, h^+
2 electron, e^-
3 exiton
4 emission

Figure 2 — OLED operation

Electrons and holes are injected through the cathode and the anode, respectively. Then electrons and holes are recombined in the emission layer and the light is emitted.

There are two types of OLED, depending on the direction of the emissive light: the bottom emission type and the top emission type. These are shown in Figure 3.



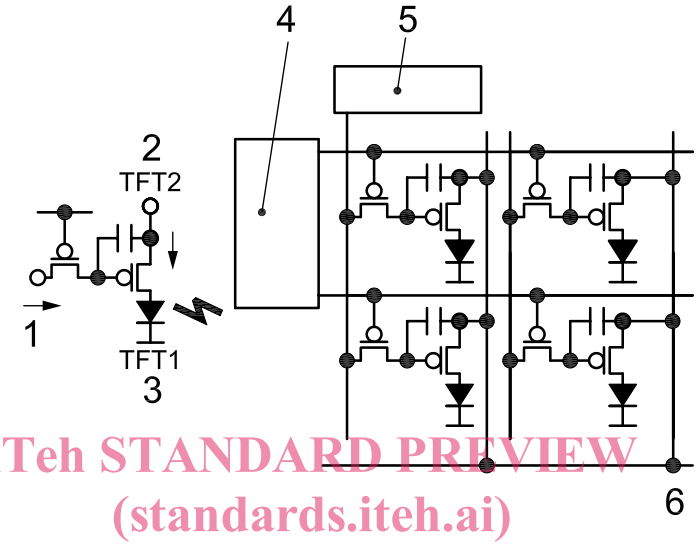
Bottom emission **Top emission**

Key

1 cathode, metal electrode
2 organic layer
3 cathode, semi-transparent
4 light
5 anode, metal electrode

Figure 3 — Ways of emission

OLED displays are driven by line scanning or TFT switching elements, as shown in Figure 4 [3]. A sub-pixel consists of at least an OLED, two TFTs and a memory capacitor which memorizes signal voltage in a full-colour OLED display. Each signal line is driven by a data drive circuit and simultaneously selecting TFT (TFT2) for writing is driven by a scan drive circuit. Signal voltage is applied to the gate of the driving TFT (TFT1) when the pixel is selected for writing. The voltage is held by the memory capacitor during off-selected term (TFT2 off). Current flow through the OLED continues, controlled by TFT1 corresponding to the signal voltage. The memorized signal is applied to the LED through the scanning period by the driving TFT. The pixel emits light according to the signal level. The response time of the OLED is so fast that moving picture quality is excellent.

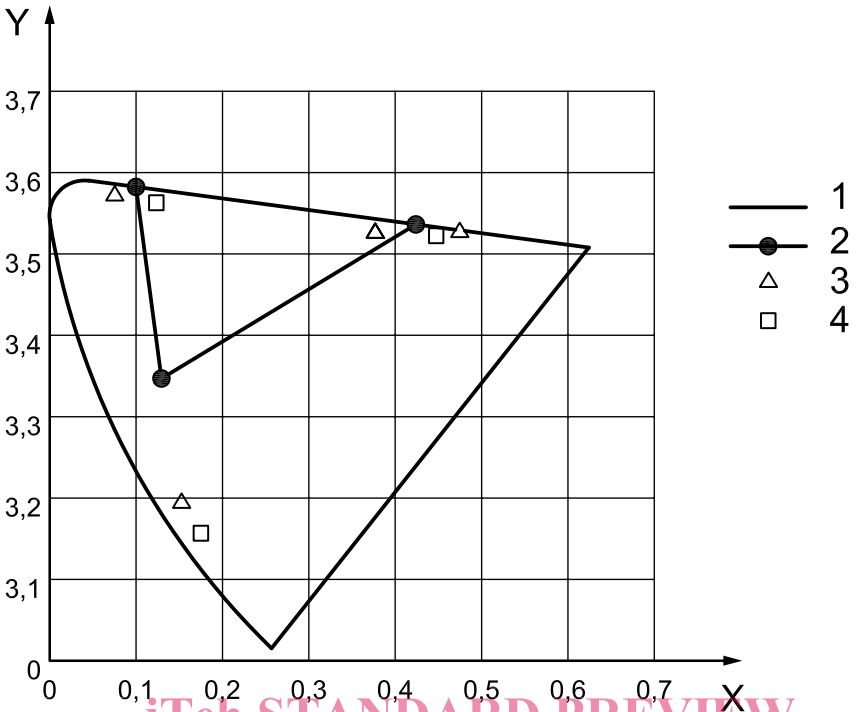


Key

1 signal
2 current
3 light emission
4 scan drive
5 data drive
6 power source

Figure 4 — Primitive circuit for driving AM-OLED

A typical colour reproduction range of OLED displays is shown in Figure 5.



Key

u', v'	chromaticity coordinates
1	spectrum focus
2	OLED (typical)
3	ITU-R BT 470
4	ITU-BT 709

Figure 5 — Chromaticity diagram of an OLED display

The picture of a 3,5 in QVGA 116 ppi OLED panel is shown in Figure 6.

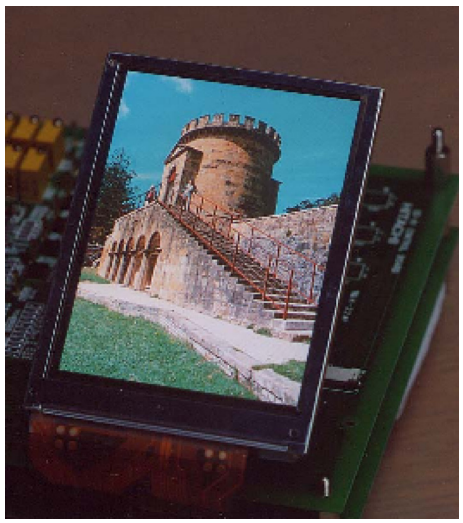


Figure 6 — OLED display of 3,5 in QVGA panel

The pixel image of an OLED panel is shown in Figure 7. The electroluminescence material of each colour is deposited by using an appropriate mask for that colour.

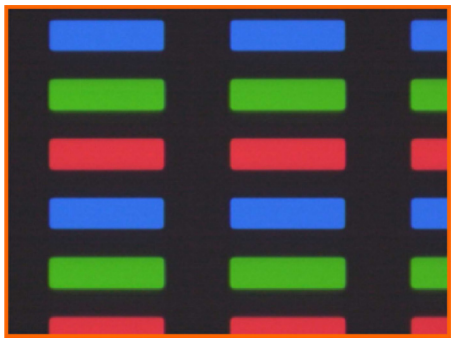


Figure 7 — Electroluminescence image of pixels in a display panel

3 Information about OLED displays

Examples of dimensional specifications are given in Table 1.

Table 1 — Example dimensional specifications

Pixel pitch horizontal/vertical	(H) 0,056 mm × (V) 0,168 mm
Number of pixels horizontal/vertical	(H) 480 × 3 × (V) 320
Horizontal display size, W_{view}	77 mm
Vertical display size, H_{view}	58 mm
Active diagonal millimetre/inch	97 mm/3,8 in
Front	glass panel with antireflective treatment

Table 2 compares OLED and other VDT devices in terms of their basic features.

Table 2 — Comparison of OLED typical basic features with those of other VDT devices

Feature	VDT device			
	OLED	CRT (cathode ray tube)	LCD (liquid crystal display)	PDP (plasma display panel)
Emitting principle	Electroluminescence	Hot-cathode luminescence	Back light	Photo-luminescence
Optical performance	Isotropy	Isotropy	Anisotropic	Isotropy
Thickness of face plate	Very thin	Thick glass	Thin	Thin
Pixel type	Fixed type	Not fixed type	Fixed type	Fixed type
Displaying method	Hold and duty	Scanning	Hold	Subframe