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Ergonomics of human-system interaction —

Part 400:
Principles and requirements for physical input devices

Ergonomie de l'interaction homme-système —

Partie 400: Principes et exigences pour les dispositifs d'entrée physiques

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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.

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 9241-400 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

This first edition of ISO 9241-400, together with ISO 9241-410, ISO 9241-411[1], ISO 9241-420[1] and ISO 9241-421[1], partially replaces ISO 9241-4:1998 and ISO 9241-9:2000, technically revised as follows:

— terms and definitions from ISO 9241-4 and ISO 9241-9 have been transferred to ISO 9241-400;

— all guiding principles have been incorporated into ISO 9241-400 and unified so that they correspond to the scope of the new ISO 9241 series;

— these principles are applied in ISO 9241-410 in order to generate provisions for product design.

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 3: Visual display requirements*

— *Part 4: Keyboard requirements*

— *Part 5: Workstation layout and postural requirements*

— *Part 6: Guidance on the work environment*

— *Part 7: Requirements for display with reflections*

— *Part 8: Requirements for displayed colours*

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1) Planned or under preparation. (See Annex A)

— *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 requirements and measurement techniques for electronic visual displays*

— *Part 302: Terminology for electronic visual displays*

— *Part 303: Requirements for electronic visual displays*

— *Part 304: User performance test methods*

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

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

The following parts, under the general title *Ergonomics of human-system interaction*, are under preparation:

— *Part 308: Surface-conduction electron-emitter displays (SED)* [Technical Report]

— *Part 411: Laboratory test and evaluation methods for the design of physical input devices*

— *Part 420: Selection procedures for physical input devices*

— *Part 421: Workplace test and evaluation methods for physical input devices*

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

Introduction

Input devices are means whereby users can enter data into interactive systems. Generally speaking, an input device is a sensor that can detect changes in user behaviour (gestures, moving fingers, etc.) and transform them into signals to be interpreted by the interactive system.

Input devices are utilized for the sole purpose they have been designed for, e.g. a keyboard for entering character codes. Under certain circumstances they may be used also for other purposes. However, in this case, generally their efficiency and/or effectiveness is restricted to a certain degree (e.g. keyboard for pointing). An input device can also be used in combination with others if needed to enhance the capabilities of users. Utilizing a keyboard and a mouse for drawing straight lines is an example of the latter.

Whether or not an input device or a combination of input devices is acceptable from an ergonomic point of view is to be determined following the rationale of the usability concept. This concept postulates that an entity has no inherent usability, but one in a specified context of use, for specified goals and specified users. A product may be designed for an intended user population and for a restricted context of use, e.g. for children in moderately conditioned indoor spaces. Specifying goals for using a device needs additional considerations, however.

Goals that the users of input devices need to achieve may be defined as high-level tasks such as "word processing" or "multimedia". A definition in this level, however, may be too abstract to design, test or select a device on the basis of usability. For this reason, this standard specifies "task primitives" such as "pointing", "dragging" or "code input".

Design and selection equipment requires a fit to be achieved between a range of task requirements and the needs of users. The concept of *fit* as defined in ISO 9241-5:1998 concerns the extent to which equipment (visual display units, input devices, etc.) can accommodate individual users' needs. Good fit is needed for the intended user population, including users with special needs, e.g. people with disabilities, if the use of a certain device is not limited to a specified user population and task. Since a variety of input devices exists that may enable a user to achieve the same usability for the same task by creating input through different bodily abilities (e.g. hand, foot, speech or eye control) the required fit can be achieved by utilizing any device that offers the required level of usability. Depending on the character of the special needs, a combination of different devices may be necessary, e.g. a foot- and an eye-controlled input device instead of a mouse for a person who cannot use his or her hands for whatever reason.

This part of ISO 9241 specifies generic ergonomic principles valid for the design and use of input devices.

To be able to formulate recommendations for groups or types of input devices, a set of typologies is introduced, based on aspects according to which possible designs can be differentiated:

— physical variables carrying the information (relative/absolute position, force, velocity, acceleration, etc.);

— bodily part used for operation;

— dimensionality of control (degrees of freedom);

— multiplicity of control (number of parallel control variables);

— control modality (discrete/continuous);

— control monitoring (one-shot or continuous time, holds last value or returns to nominal value, sequential or skip-out the continuum output, etc.);

— control distance function (monotonic, non-monotonic, uni/bipolar, etc.);

— mapping, straightforwardness;

— psychological nature of control (causality, exploratory or goal-oriented control).

It also specifies properties relevant for the usability of input devices and typologies in consideration of different aspects (e.g. degrees of freedom, property sensed etc.). Guidance on the application of these principles on product design is given in ISO 9241-410. The ergonomic guidance for the design of products is given without including aspects related to a particular context (e.g. using keyboards at CAD workstations). Selecting the intended context of use is part of the design process and not the subject of this part of ISO 9241.

ISO 9241-411[2)] is to specify methods for determining conformance through observation, performance and by measurement of the physical attributes of the various devices.

NOTE   This part of ISO 9421 will be supported by the following methods (ISO 9241-411):

— usability test for text and data input using stationary keyboards (currently given in ISO 9241-4);

— generic usability test for keyboards for non-touch typing tasks;

— input device selection, usability testing and analysis (currently given in ISO 9241-9);

— testing of efficiency and effectiveness of physical input devices (based on the methods specified in ISO 9241-9);

— assessment of comfort (currently given in ISO 9241-4 and ISO 9241-9);

— additional evaluation methods.

Guidance on the application of these principles for selecting appropriate products for a given context of use is described in ISO 9241-420[2)] in the form of ergonomic selection and combination criteria for using single or multiple input devices at the same work-station.

This part of ISO 9241 does not include test and evaluation methods. These will be developed and published in separate documents for the two target groups "manufacturers, designers, and test houses" and "user organizations", since such methods can be subject to frequent change.

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, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*. The revised multipart standard is structured as a 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.

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2)   Planned. (See Annex A)

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Ergonomics of human-system interaction —

Part 400:
Principles and requirements for physical input devices

1 Scope

This part of ISO 9241 gives guidelines for physical input devices for interactive systems. It provides guidance based on ergonomic factors for the following input devices: keyboards, mice, pucks, joysticks, trackballs, trackpads, tablets and overlays, touch sensitive screens, styli, light pens, voice controlled devices, and gesture controlled devices. This part of ISO 9241 defines and formulates ergonomic principles valid for the design and use of input devices. These principles are to be used to generate recommendations for the design of products and for their use. This part of ISO 9241 defines relevant terms for the entire 400 series of ISO 9241. For some applications, e.g. in areas where safety is the major concern, other additional principles may apply and take precedence over the guidance given here.

This part of ISO 9241 also determines properties of input devices relevant for usability including functional, electrical, mechanical, maintainability and safety related properties. Additionally included are aspects of interdependency with the use environment and software.

Any of these properties may be subject to other regulations or standards. These are considered following the example of electrical properties. In this case, this part of ISO 9241 considers the following properties.

— Properties influenced by overriding considerations.

   EXAMPLE   Properties related to electrical safety cannot be influenced by the designer.

— Properties that could impair usability.

   EXAMPLE   The thickness of the cabling for a mouse or the weight of batteries of a hand-held device need to be considered.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9241-5:1998, *Ergonomic requirements for office work visual display terminals (VDTs) — Part 5: Workstation layout and postural requirements*

ISO 9241-11:1998, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 11: Guidance on usability*

ISO/IEC 9995-1:2006, *Information technology — Keyboard layouts for text and office systems — Part 1: General principles governing keyboard layouts*

3   Terms and definitions

For the purposes of this document, the following terms and definitions apply.[3)]

3.1   Actions

3.1.1
click
depression and release of a button or actuation point on an input device

3.1.2
free hand input
input where the input device controls the movement of the cursor without any constraints following the manual input of the user

3.1.3
tracking
moving a pointer or predefined symbol across the surface of a display screen in order to follow a target

3.2   Touch strategies

3.2.1
first contact touch
activation of a function upon touching the display surface

3.2.2
last contact touch
activation of a function upon withdrawing touch from the display surface

3.3   Press/release strategies

3.3.1
on-press activation
activation of a function by pressing a key or button

3.3.2
on-release activation
activation of a function by releasing a key or button

3.4   Feedback

3.4.1
feedback
indicators (such as tactile, auditory or visual) sensed by a user of an action (such as movement or actuation of an input device)

NOTE   Display feedback refers to a change on the display resulting from an input device movement or activation.

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3)   The illustrations of the devices used in this clause do not necessarily represent the design requirements and recommendations of this part of ISO 9241.

3.4.2
kinesthetic feedback
action perceived by the mechanoreceptors in joints, muscles and tendons resulting in awareness of position, movement, weight and resistance of the limbs or other body parts

3.4.3
tactile feedback
indication of the results of a user action transmitted through the sense of touch

3.5 Hardware

3.5.1
button
mechanical object integrated into an input device, which responds to force when depressed and provides input to computer

3.5.2
cursor
visual indication of where the user interaction via keyboard (or equivalent input device) will occur.

3.5.3
cursor keys
array of keys that control the movement of the cursor on the display screen and that are labelled with arrows indicating the direction of cursor movement caused by the individual keys

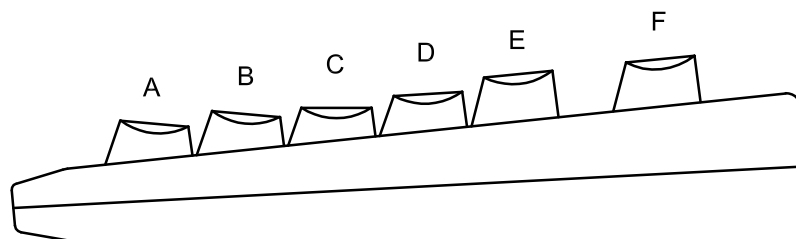## 3.6 Input devices

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3.6.1
home row
row of the keyboard to which the fingers typically return between keystrokes

See Figure 1.

NOTE   On the typical keyboard, the home row is row C as defined by ISO/IEC 9995-1:1994 in the alphanumeric section as well as in the numeric section.

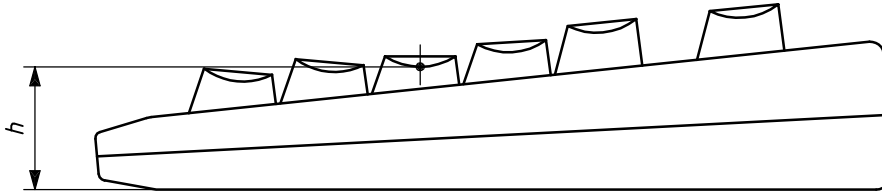**Figure 1 — Typical keyboard — Home row**

3.6.2
home row height
h
height from the centre of the strike surface of an unactuated key in the home row to the support surface

See Figure 2.

Figure 2 — Typical keyboard — Home row height

3.6.3
input device
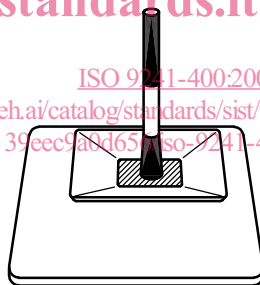user controlled device that transmits information to a system

3.6.4
joystick
lever mounted in a fixed base used to control the movement of objects displayed on a screen

See Figure 3.

Figure 3 — Side view of example joystick

3.6.4.1
displacement joystick
joystick with a lever that tilts in the direction of applied force from a home position moving the display pointer in proportion to the displacement distance

3.6.4.2
isometric joystick
joystick where the input depends on the force exerted rather than the position of the control

3.6.5
keyboard profile
geometric (i.e. flat, stepped, sloped, dished or sculptured) configuration of the top of the keys

3.6.5.1
dished profile keyboard
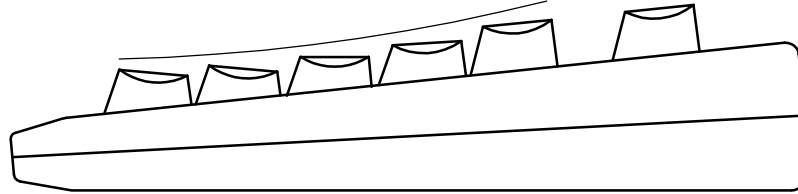keyboard in which the side profile of the keys resembles a continuous concave curve

See Figure 4.

Figure 4 — Example of dished profile keyboard

3.6.5.2
flat profile keyboard
keyboard that has a zero slope with the front at the same height as the back when placed on a flat work surface

See Figure 5.

Figure 5 — Example of flat profile keyboard

3.6.5.3
keyboard slope
α
angle between the plane of the key top surfaces (P-P) and the horizontal surface (H-H) as measured across row A-E using the notation of ISO 9995-1:1994
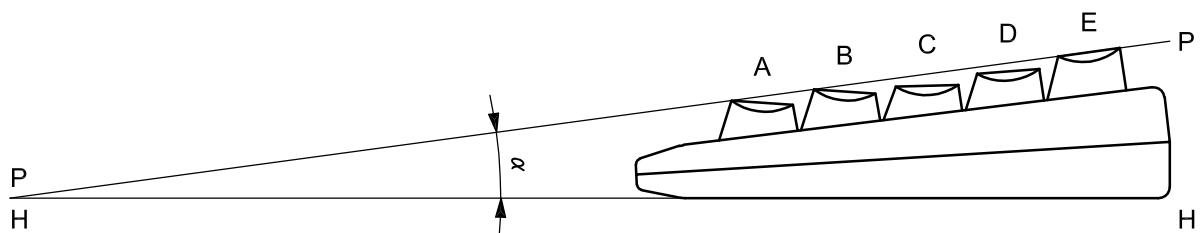
See Figure 6.

NOTE   For keyboards without an E row, rows B to D are used.

Figure 6 — Keyboard slope