

Ergonomics of human- system interaction

Part 410: Design criteria for physical input devices

ICS 13.180; 35.180

National foreword

This British Standard is the UK implementation of EN ISO 9241-410:2008+A1:2012. It supersedes BS EN ISO 9241-410:2008, which is withdrawn. Together with BS EN ISO 9241-400:2007, PD CEN ISO/TS 9241-411:2014 and BS EN ISO 9241-420:2011, it supersedes BS EN ISO 9241-4:1998 and BS EN ISO 9241-9:2000, which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PH/9, Applied ergonomics.

A list of organizations represented on this committee can be obtained on request to its secretary.

The publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2009

© The British Standards Institution 2014.
Published by BSI Standards Limited 2014

ISBN 978 0 580 88162 6

Amendments/corrigenda issued since publication

Date	Comments
30 November 2012	Implementation of ISO amendment 1:2012 with CEN endorsement A1:2012: Clause 2 has been updated, Clause 10 has been inserted. The identifier has also been aligned with original CEN publication date.
30 September 2014	Correction to supersession information in national foreword

English Version

Ergonomics of human-system interaction - Part 410: Design
criteria for physical input devices (ISO 9241-410:2008)

Ergonomie de l'interaction homme-système - Partie 410:
Critères de conception des dispositifs d'entrée physiques
(ISO 9241-410:2008)

Ergonomie der Mensch-System-Interaktion - Teil 410:
Gestaltungskriterien für physikalische Eingabegeräte (ISO
9241-410:2008)

This European Standard was approved by CEN on 11 February 2008.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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



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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Foreword to amendment A1

This document (EN ISO 9241-410:2008/A1:2012) has been prepared by Technical Committee ISO/TC 159 "Ergonomics" in collaboration with Technical Committee CEN/TC 122 "Ergonomics" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2013, and conflicting national standards shall be withdrawn at the latest by January 2013.

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.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: 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, the United Kingdom and Turkey.

Endorsement notice

The text of ISO 9241-410:2008/AMD 1:2012 has been approved by CEN as a EN ISO 9241-410:2008/A1:2012 without any modification.

Introduction

Input devices are a means for users to 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 it into signals to be interpreted by the interactive system. An *input device* is regarded as the combination of hardware with the software designed to use it (e.g. a driver).

This part of ISO 9241 defines design criteria for products on the basis of relevant properties of physical input devices as laid down in ISO 9241-400:2007. It is intended to cover assessment methods for laboratory use (in order to accelerate future development of test and evaluation methods) and user organizations in future parts of ISO 9241.

Most of the principles presented in this part of ISO 9241 have previously been defined or outlined in International Standards for keyboards and other input devices (ISO 9241-4 and ISO 9241-9). Where necessary, definitions of terms have been reformulated so that they are applicable for all input devices.

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.

Ergonomics of human-system interaction –

Part 410:

Design criteria for physical input devices

1 Scope

This part of ISO 9241 specifies criteria based on ergonomics factors for the design of physical input devices for interactive systems including keyboards, mice, pucks, joysticks, trackballs, trackpads, tablets and overlays, touch-sensitive screens, styli and light pens, and voice- and gesture-controlled devices. It gives guidance on the design of these devices, taking into consideration the capabilities and limitations of users, and specifies generic design criteria for physical input devices, as well as specific criteria for each type of device. Requirements for the design of products are given either as a result of context-free considerations, or else can be determined based on the specified design criteria for the intended use; such specified criteria generally having been subdivided into task-oriented categories, wherever applicable.

EXAMPLE The resolution of a pointing device is given in relation to four levels of index of difficulty for the Fitts test. The required category for the resolution can be determined on the basis of the task characteristics, user population and context of use for the intended application.

This part of ISO 9241 does not specify the categories that are appropriate for devices as, according to the concept of usability, a product has no *inherent* usability. Selecting the category to which a certain property of a device belongs is subject to the design of a product.

This part of ISO 9241 is expected to be used by the manufacturers of physical input devices, including product designers and test organizations, in determining the design characteristics of a device for its intended context of use (user population, task, software or environment, etc.). The data generated by the users of this part of ISO 9241 for the description of the properties of their products can be applied in the selection of a device adequate for the actual context of use on the basis of the task primitives relevant for the task of the specific user population, and for achieving the required level of efficiency and effectiveness for a given system.

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 7000, *Graphical symbols for use on equipment – Index and synopsis*

ISO 9241-400:2007, *Ergonomics of human-system interaction – Part 400: Principles and requirements for physical input devices*

ISO/TS 9241-411, *Ergonomics of human-system interaction — Part 411: Evaluation methods for the design of physical input devices*

ISO/IEC 9995 (all parts), *Information technology – Keyboard layouts for text and office systems*

IEC 60417-DB, *Graphical symbols for use on equipment*²⁾

2) Permanently updated database.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9241-400 and the following apply:

3.1

bounce-free switch

switch that generates a single and definite signal after actuation

3.2

category

part of a system into which properties of entities can be arranged

3.3

class

category of a property of a product with rank order

NOTE 1 Class 1 is the *most*, and class *n* the *least*, favourable category of a specific property of a product, where *n* is the number of classes.

NOTE 2 An example of a property is *durability of the legends* of a key. If a key belongs to the highest class, it will fulfil all requirements for the lower categories.

3.4

compact keyboard

keyboard that features most properties of a full-size keyboard, with the editing section integrated into the alphanumeric section

NOTE A compact keyboard can have a numeric section.

3.5

force feedback

application of physical force in response to user input

EXAMPLE In games, or in car and plane simulators.

3.6

full-size keyboard

keyboard that comprises all sections and zones as described in ISO/IEC 9995-1

3.7

group

category of a property of a product without rank order

NOTE Some properties such as the size of a key do not constitute a virtue without further considerations. For such properties, the categorization may help to differentiate objects without being able to determine a rank in consideration of the specific property.

EXAMPLE A particular size of key on a keyboard that is suited for continuous touch-typing, a smaller key size for hand-held devices or a larger size for use with gloves.

3.8

haptic, adj

of or relating to, or proceeding from, the sense of touch

3.9

haptic display

display presenting information accessible through the sense of touch, mainly by, but not limited to, use of hands and fingers

3.10

haptic interface

user interface based on touch, using the movements of the user as input and the sense of touch as output for tactile and kinaesthetic feedback

EXAMPLE Force feedback joysticks, Braille screen readers.

3.11

housing

protective cover designed to contain or support a mechanical component

NOTE An input device is either integrated into its own housing or into another unit that comprises other functional units (e.g. control desk, control panel, telephone).

3.12

index of difficulty

I_D

measure of the user precision required in a task

NOTE The index of difficulty, I_D , is measured in bits, and is calculated for selection, pointing, or dragging tasks by

$$I_D = \log_2 \frac{d + w}{w}$$

and for tracing tasks by

$$I_D = \frac{d}{w}$$

where

d is the distance of movement to the target;

w is the target width of the displayed target along the approach axis for selection, pointing or dragging tasks, and perpendicular for tracing tasks.

3.13

key arrangement

spatial organization of keys of a keyboard following certain design rules or conventions

EXAMPLE Typewriter, calculator or telephone layout of keys for generating codes for numerals (numeric keys for digits 0 to 9) on office machines.

3.14

keypad

functional unit that comprises at least a group of keys dedicated and arranged for a given functionality and possibly additional keys supporting related functionality

EXAMPLE Numeric keys, "Enter" key of keypad.

3.15

multi-tap

alphanumeric input requiring several presses per character

3.16

section

<keyboard> functional groups within computer keyboards for which different rules for layouts can apply

NOTE Some sections of existing keyboards are arranged according to more-than-century-old conventions.

3.17

task precision

measure of the accuracy required for a pointing, selecting or dragging task primitive, quantified by the index of difficulty

3.18

touchpad

touch-sensitive pad that senses the position of a finger on its surface

3.19

work surface

surface on which equipment and task materials are used

[ISO 9241-5:1998, definition 3.25]

3.20

zone

(keyboard) smaller unit within a section of a keyboard representing different functionality

EXAMPLE The layout of the alphanumeric keys for entering graphic characters (alphanumeric zone) grouped with function and modifier keys such as “Ctrl”, “Alt”, “Tab” or “Backspace”.

4 Procedure for applying this part of ISO 9241

Generally speaking, the entirety of requirements for the overall design of a product is a result of considerations from a variety of origins, such as engineering, safety, environmental protection, economic efficiency, marketing or the concept of usability (see ISO 9241-400).

This part of ISO 9241 presents requirements related to product properties that are in turn related to usability of physical input devices. Its application requires following steps a) to d), below.

a) Identify properties of the device that are relevant for usability.

First, identify those properties relevant to usability, i.e. relevant for the effectiveness and efficiency of use and for the satisfaction of user needs. Some of the properties are known (e.g. key legends for keyboard) and requirements for them exist for certain areas of use (e.g. minimum size of key legends for full-size keyboards).

b) Apply generic design requirements

Identify other properties by applying the generic design principles on a specific device (e.g. controllability on keyboards or mice). The requirements for these properties can be different for different contexts of use. For these properties, the requirements are subdivided into categories — classes or groups. Specify the category to which a device belongs. The device will need to conform to the requirements that apply to that category.

c) Apply device specific design requirements

For each relevant property, apply the requirements for a specific device (see Annexes B to J). See Figure 1 for a summary of these requirements.

d) Evaluate the performance criterion

Ensure that the device fulfils the requirements derived from the provisions of this part of ISO 9241, while considering the product's designated purpose.

NOTE A *product* is considered as being any combination of hardware and software utilized for a given task.

Relevant Properties			
Property			Class/ Group/ Value
Correspondence with generic design requirement	Appropriateness	Effectiveness	■ ■ ■ □
		Efficiency	■ ■ ■ □
		Dimensioning	■ ■ ■ ■
		Software dependency	✓
		Additional device	○
	Operability	Obviousness	■ ■ ■ ■
		Predictability	■ ■ ■ ■
		Correct order	■ ■ ■ □
		Consistency	■ ■ ■ □
		Compatibility	■ ■ ■ □
	Controllability	Responsiveness	■ ■ ■ ■
		Non-interference	■ ■ ■ ■
		Reliability of device access	■ ■ ■ ■
		Adequacy of device access	■ ■ ■ ■
		Control access	■ ■ ■ ■
	Biomech. Load	Postures	■ ■ □ □
		Effort	■ ■ ■ □
Functional Properties	Keys	Size	○ ○ ● ○
		Roll-over	■ ■ ■ □
		Durability of legends	■ ■ □ □
	Sections and zones	Alphanumeric	✓
		Numeric	○
		Editing	✓
		Function	✓
	Multimedia	--	

Key

- 1 requirement derived from a generic design principle
- 2 not relevant
- 3 property with requirements in four groups
- 4 property with requirements in four classes
- 5 property with requirements
- 6 property without requirements in this document

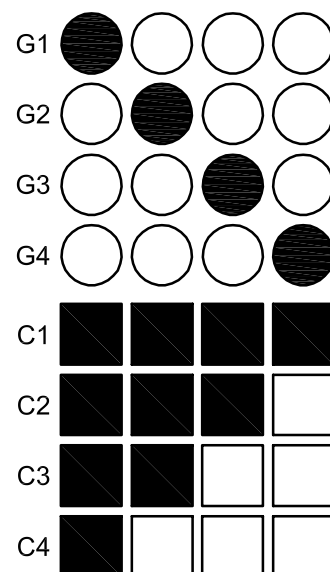


Figure 1 – Sample for a summarizing table

5 Performance criterion

The input device shall be usable for its designated purpose. It is considered *usable* if its user can achieve a satisfactory level of performance on a given task and maintain an acceptable level of effort and satisfaction. This objective is met when the design requirements and recommendations (see Annexes B to J) applicable to the device are satisfied.

If completing the task requires the utilization of more than one physical device, all elements specified shall be treated as a unit for the purposes of determining usability.

6 Properties of physical input devices relevant for usability

Properties of physical input devices with relevance for usability can be broken down into groups of properties. Requirements can either be derived from a generic design principle to which various properties can contribute or the relevant property can be identified without applying a principle. Properties with requirements in groups serve to categorize products without the ability to assign them to classes, whereas other properties can be categorized into classes with rank order:

- functional properties;
- mechanical properties;
- electrical properties;
- maintainability-related properties;
- health- and safety-related properties;
- interdependency with software;
- interdependency with use environment.

For such properties, requirements or recommendations exist based on technical knowledge, scientific evidence or conventions. The relevance of additional (or sometimes the same) properties can be identified or established in consideration of the generic design principles presented in ISO 9241-400. This part of ISO 9241 specifies design requirements for each device derived from those principles. Other properties corresponding to a certain principle equally or even better suited may be used instead.

EXAMPLE 1 The form of the housing of a mouse is relevant if the user has no equivalent or better means to sense the orientation of the device (principle: controllability, reliability of device access).

EXAMPLE 2 The orientation of a button for minimizing finger extension is relevant if the button is located on a mouse where the button will be actuated without losing overall control of the device (principle: controllability, control access). For other buttons, the orientation might not be relevant.

7 Generic design requirements for physical input devices

7.1 General

The intended use of a physical input device shall be specified unless it is obvious or the product is designed for general-purpose use. The specification shall include technical conditions for the context of use to be realized for satisfactory use of the device (e.g. operating system, driver, support surface).

Each physical entity possesses a number of properties, of which only some are relevant for its usability. Since a device cannot have intrinsic usability, for each relevant property subject to a design requirement, wherever

possible four categories are given. If sufficient knowledge exists to recommend a certain category, this is indicated.

NOTE The category required for a given task, intended user population and/or context of use (e.g. stationary, portable, hand-held and in different environments) will be able to be determined using procedures given in a future part of ISO 9241.

7.2 Generic design requirements

7.2.1 General

This clause derives generic design requirements from the ergonomic principles that apply to all input devices as defined in ISO 9241-400:2007, 4.2. These are

- appropriateness,
- operability,
- controllability, and
- biomechanical load.

7.2.2 Appropriateness

The design of a device shall be appropriate for the intended tasks being performed and the intended use environment, including additional devices if required by the task. An appropriate input device enables the user to achieve the required effectiveness for the task and is efficient and satisfactory for the intended user population.

The dimensioning of an input device and its parts shall be compatible with the relevant anthropometric dimensions of the part of the body for the intended user population so that relevant design objectives can be met (intended level of effectiveness, intended level of efficiency).

If the design objectives cannot be met without the use of additional tools (e.g. stylus for input via small size keys) or if, in order to achieve the intended level of appropriateness, the design requires enhancement by software or the additional use of a device other than is delivered with the device under consideration, then this shall be specified.

7.2.3 Operability

7.2.3.1 General

An input device shall be operable, i.e. its intended use is obvious, predictable and consistent and the user receives adequate feedback.

7.2.3.2 Obviousness

The obviousness of the intended use can be categorized into four classes:

- C1 known or visible without additional instructions and information;
- C2 detectable by the user by trial and error;
- C3 learnable by simple instructions;
- C4 learnable by special training.

7.2.3.3 Predictability

The predictability of the input is achieved if the movement or other activation of the input device consistently produces a directly corresponding movement of the display or desired action by the system, e.g. movement of an input device in one of the cardinal directions (up, down, left, right), or if a voice command to the same effect consistently produces movement of the pointer in the same direction on the screen.

7.2.3.4 Consistency of operation

Consistency of operation is provided if the device operates and responds in the same manner in the specified context of use.

Operating in the same manner means that the same level of effectiveness is maintained under the intended context of use.

Responding in the same manner means that the user receives the same feedback through the same channels (e.g. tactile, visual or auditory).

7.2.3.5 User compatibility

7.2.3.5.1 General requirement

Physical input devices shall be user-compatible, i.e. their design accommodates the intended user anthropometric characteristics and biomechanical capabilities.

7.2.3.5.2 Throughput

The anthropometric characteristics of the intended user population can be accommodated in four classes:

- C1 fully compatible, enables maximum throughput and accuracy;
- C2 restricted (level 1), maximum achievable level for effectiveness 90 %, efficiency 90 %;
- C3 restricted (level 2), maximum achievable level for effectiveness 80 %, efficiency 80 %;
- C4 use requires additional aids.

7.2.3.5.3 Force and posture

The compatibility with biomechanical capabilities of the intended user population can be categorized by the degree to which a fraction of the maximum capability (e.g. angle of joint, contracting force of a muscle) is needed for the operation of the device.

NOTE Current scientific knowledge does not allow a setting up of such categories valid for all input devices. Therefore, this part of ISO 9241 does not include categories for the angle of joints and the contracting force of muscle.

7.2.3.6 Feedback

An input device shall provide effective feedback, i.e. the user is given immediately perceptible and understandable indication that the device is responding to user actuation (see ISO 9241-400). The feedback generated by the operation of an input device is only partly transmitted by that device to the users, e.g. by tactile feedback while actuating a button. Some input devices such as gesture-sensitive cameras do not provide any feedback except that generated by the system. Thus, the adequacy of feedback is highly software-dependent.

An input device shall either give adequate feedback by its own functionality or generate a signal enabling the system to provide feedback. The feedback is adequate if the user can detect the following without taking further action:

- current state of the device;
- outcome of the latest action (e.g. input accepted, required action initiated);
- any action required as consequence of the latest action.

Users with special needs or use conditions may require certain types of feedback. For example, feedback through the same channel (tactile feedback by the button that is being actuated) could be needed if visual or acoustic feedback are likely to fail. In other cases, feedback through a diverse channel may be beneficial if the channel that is being used for an action does not accept the response, e.g. the acceptance of a text that is being dictated cannot be confirmed continuously by sound, but by visual or tactile feedback.

7.2.4 Controllability

7.2.4.1 General

The operation of an input device shall be controllable. This means that

- the device shall be responsive, and its use shall not interfere with its functionality,
- the design of the device shall give the user adequate and reliable access, and
- the design shall prevent unintended loss of control during intended use, e.g. slipping by hand-operated devices.

NOTE See ISO 9241-110 for details concerning controllability in dialogue design in general.

7.2.4.2 Responsiveness

Responsiveness of an input device occurs if the feedback following its actuation is consistent and sufficient.

EXAMPLE Activating a graphic key on a keyboard is always accompanied by a generated character on the screen and by a tactile feedback that is the same for all keys on that keyboard.

7.2.4.3 Non-interference

An input device shall not interfere with its own use. This means that all functional elements belonging to that device can be accessed and operated without degrading the usability of the device. Functional elements needed to transport data from the device to the system and vice-versa (cables, infrared beams) shall not influence throughput and accuracy.

EXAMPLE 1 The user's hand or arm does not block an infrared beam.

EXAMPLE 2 A computer mouse is not pulled by its own stiffness and weight during intended use.

7.2.4.4 Reliability of device access

Adequate control of an input device is given when its design prevents unintended loss of control during intended use.

7.2.4.5 Adequacy of device access

The design of an input device shall enable the user to quickly and easily access it (e.g. grasp, position, manipulate) during intended use without adversely affecting performance.

NOTE Positioning of a device depends on its design and the design and adjustment of the workstation and position of the user.

7.2.4.6 Control access

The controls of an input device shall be able to be located and actuated quickly and easily without interference with the overall use of the device.

EXAMPLE Actuating a mouse button does not move the focus of the pointer.

7.2.5 Biomechanical load

7.2.5.1 General

The design of a physical input device shall minimize the biomechanical load of the user. For the purposes of this part of ISO 9241, only postures and muscular effort are considered.

NOTE Some input devices incorporate functionality that helps to reduce static muscle load. This can include a mechanism that measures duration of holding without user actions and gives feedback that reminds the user to adopt a more neutral posture, e.g. with a tactile signal.

7.2.5.2 Postures

An input device shall be operable without undue deviation from a neutral posture during intended use.

NOTE Proper setup of the device as a component of the full workstation is important relative to encouraging neutral postures in the workplace (workstation height, keyboard placement, etc.).

7.2.5.3 Effort

An input device designed for efficient use shall be operable without excessive effort during intended use.

NOTE Proper setup of the device as a component of the full workstation is important relative to encouraging efficient use without excessive effort in the workplace (workstation height, keyboard placement, etc.).

8 Device-specific design requirements

While generic design requirements of this part of ISO 9241 cover aspects applicable to any physical unit that could be used as an input device, some requirements are highly device-specific. Different requirements may apply to the same object if it is designed to be used in another context. For example, while keyboards, mice, trackballs or joysticks can all incorporate buttons in their design, the buttons can serve different purposes. While those on an alphanumeric keyboard are designed for fast typing with ten fingers, a button on a joystick is designed to be pressed by the thumb. Thus requirements can be different depending on the specific device.

The following are treated as device-specific design requirements in this part of ISO 9241:

- functional properties;
- mechanical properties;
- electrical properties;
- maintainability-related properties;
- health- and safety-related properties;
- interdependency with software;
- interdependency with use environment.

9 Documentation

The documentation of a product shall comprise the product description and the operating instructions. The product description shall specify all relevant and usability-related information for selection of the appropriate device.

Since all input devices are operated through some changes in at least one part of the body, relevant information for using them can require dynamic representations (e.g. video clips, animations). Designers are encouraged to select the type of information adequate for the specific information.

Using most devices requires initial learning, but also long-term training in skills. Some devices with potential benefits are not accepted by the user because of information missing on the amount of training needed to achieve a certain level of effectiveness and efficiency. Therefore, the documentation should include information on the timescale for achieving a high level of proficiency.

10 Conformance

The test methods specified in ISO/TS 9241-411 shall be used to assess conformance with the requirements of this part of ISO 9241.

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	International Standard (intended to be 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	International Standard (intended to be replaced by the ISO 9241-300 subseries)
8	Requirements for displayed colours	International Standard (intended to be 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)

Part no.	Subject/title	Current status
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
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 control 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

Part no.	Subject/title	Current status
Domain-specific guidance		
151	Guidance on World Wide Web user interfaces	International Standard
152	Interpersonal communication	Planned
153	Virtual reality	Planned
Accessibility		
171	Guidance on software accessibility	Under preparation
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	To be published
302	Terminology for electronic visual displays	To be published
303	Requirements for electronic visual displays	To be published
304	User performance test methods	To be published
305	Optical laboratory test methods for electronic visual displays	To be published
306	Field assessment methods for electronic visual displays	To be published
307	Analysis and compliance test methods for electronic visual displays	To be published
308	Surface conduction electron-emitter displays (SED)	To be published (Technical Report)
309	Organic light-emitting diode displays (OLED)	Planned
310	Pixel defects (visibility, aesthetics and ergonomics)	Planned
Physical input devices		
400	Principles and requirements for physical input devices	International Standard
410	Design criteria for physical input devices	International Standard
411	Laboratory test and evaluation methods for the design of physical input devices	Planned
420	Selection procedures for physical input devices	Under preparation

Part no.	Subject/title	Current status
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
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

Annex B (normative)

Keyboards

B.1 Properties of the keyboard

B.1.1 Functional properties

B.1.1.1 Design of the keys

The functional properties of keys within keyboards (not single buttons) relevant for the usability of a keyboard are

- size (overall),
- keytop shape,
- strike surface,
- displacement,
- force,
- force/displacement characteristic,
- feedback,
- bounce,
- roll-over,
- legend, and
- durability of legends.

B.1.1.2 Sections and zones

A keyboard comprises at least one keypad. More complex arrangements can consist of different keypads, which should be organized in meaningful sections. The following sections are defined in ISO/IEC 9995 (all parts):

- alphanumeric section;
- numeric section;
- editing section;
- function section.

A keyboard may comprise any of these sections, combinations thereof and additional sections and zones. The minimum required number of sections for a keyboard and zones within these sections is determined by the intended use of the keyboard. A maximum arrangement can also be determined by the task, but realization could be restricted by space constraints or other overriding considerations such as portability or fitting into the human hand.

B.1.2 Mechanical properties

Those mechanical properties of a keyboard relevant for usability are

- centreline spacing,
- height,
- width,
- slope,
- profile,
- surface finish,
- weight,
- material,
- thermal conductivity,
- adjustability, and
- palmrest.

B.1.3 Electrical properties

For keyboards that do not require separate power supply, the electrical properties of keyboards are unrelated to usability.

For keyboards with their own power supply, the following usability-related aspects need to be considered:

- influence of cabling (keyboards with external power supply);
- influence of provisions for electrical safety;
- electromagnetic influences on other equipment;
- weight (battery-operated keyboards).

B.1.4 Maintainability-related properties

Maintainability-related properties of keyboards to be considered for usability reasons are the following:

- surface of keytops (cleaning);
- surface of covers required for certain environments (cleaning or keeping free of bacteria in areas with high hygienic requirements).

For keyboards with their own power supply, the following usability related aspects need to be considered:

- dependence of operational characteristics from power supply (voltage and current);
- durability of batteries (battery-operated keyboards);
- indicators for insufficient power supply (e.g. low voltage).

B.1.5 Health- and safety-related properties

The following properties of keyboards need to be considered for safety and health:

- electrical safety (devices with external power supply);
- weight (hand-held devices for continuous operation);
- chemical safety (e.g. fumigation);
- mechanical safety (e.g. sharp edges).

B.1.6 Interdependency with software

Some relevant characteristics of keyboards may be adversely influenced by software.

EXAMPLE 1 Certain application software can slow down the transfer of data from the physical device to the system.

In some cases, using the “generic” driver may degrade the usability of the keyboard.

Like any other control, the functionality of a physical keyboard may be enhanced by adequate software support.

EXAMPLE 2 If the task requires a certain key to be protected against unintended use (e.g. “fat finger error”) the intended protection may be realized

- a) by adequate physical properties of the key and its location within the layout, with the key possibly requiring a higher force to actuate than the adjacent keys and/or being located in a position where it is unlikely to be hit unintended,
- b) by adequate physical properties and software, where the execution of the command initiated by the key is deliberately slowed down and requires holding for a certain time period, and
- c) by software alone, where the execution of the commands initiated by the activation of a key requires confirmation.

Optimizing interdependencies between physical properties of a keyboard and software requires knowledge of the context of use, the task and the user population.

B.1.7 Interdependency with use environment

The operation of a keyboard should be independent from the use environment. The operation of a keyboard can influence the use environment to a certain degree (e.g. through noise) and can be influenced by environmental conditions such as the stability of the support surface and its size or mechanical vibrations affecting the support surface or the user. Both influences can have undesirable effects.

The use of a keyboard can influence the environment through

- noise,
- reflections on the screen,
- occupying free space.

The use of a keyboard can be affected by the following environmental conditions:

- vibrations;
- instability of the support surface;
- lighting (gloss, modelling by multiple shadows etc.).

Both sets of influences can have undesirable effects.

B.2 Design requirements and recommendations

B.2.1 Correspondence with generic design requirements

B.2.1.1 Appropriateness of keyboards

A product may offer different levels of appropriateness. In the case of keyboards, systems integrators or users shall be given information to enable them to select the appropriate device for the task at hand (see Figure B.1).

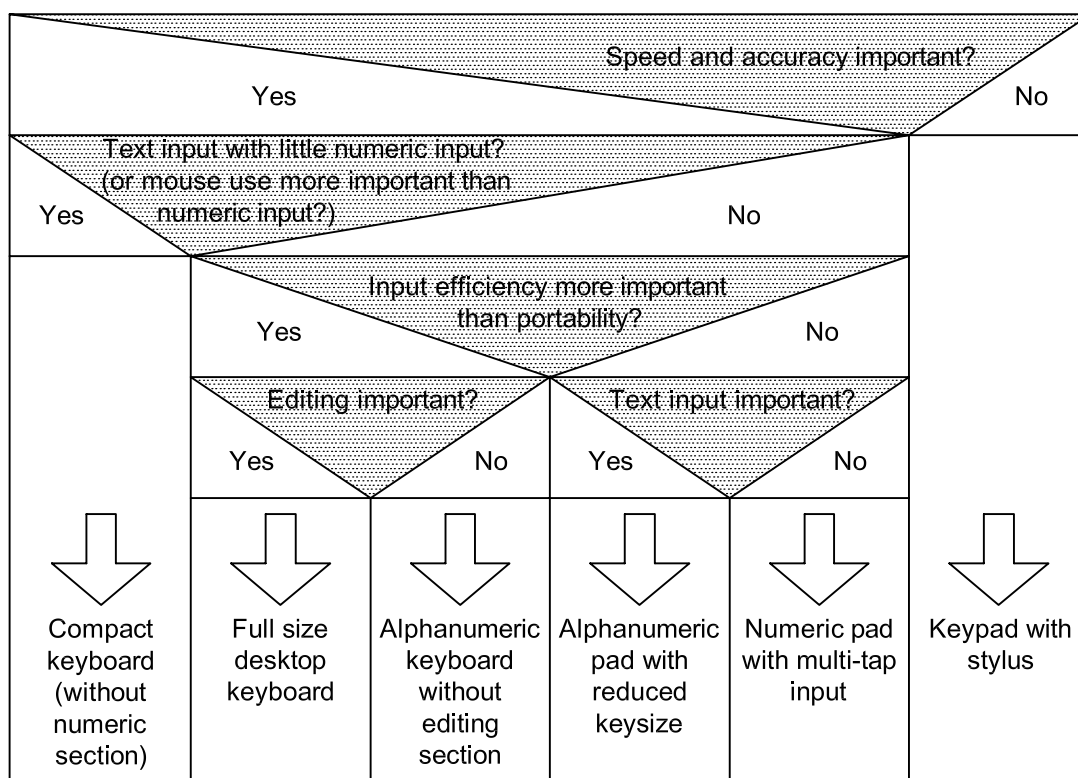


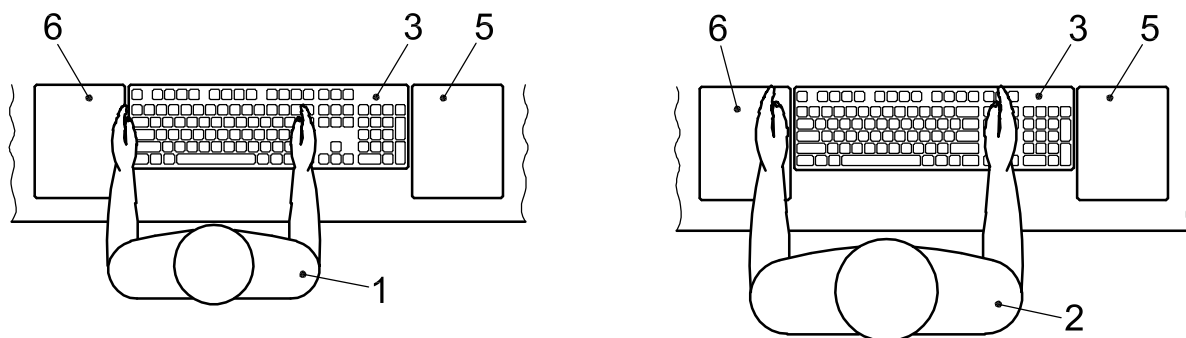
Figure B.1 – Guidance for selecting the appropriate keyboard

If speed and accuracy of the input are not important a keypad with stylus may be appropriate for various reasons (size, weight, space requirement).

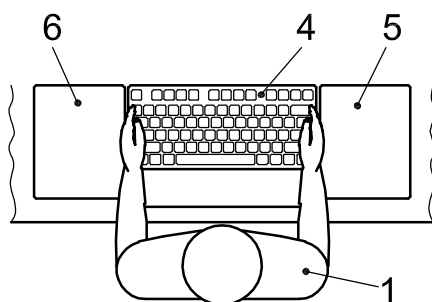
For text input with only little numeric input a keyboard with full-size alphanumeric section but without a numeric section is appropriate because it facilitates a more relaxed and neutral mousing position.

A full-size desktop keyboard with all sections according to ISO/IEC 9995 is needed if text and numeric input and the editing of existing data are important. In this case, however, no user will be able to take a position that allows the use of the keyboard and of a mouse while maintaining a neutral posture (see Figure B.2)

If portability is more important than input efficiency the key size may be reduced. If text input is of minor importance a multi-tap numeric pad may be used also for text input.



a) Position of full-size keyboard for 5th percentile (female top percentile) and 95th percentile (male bottom percentile) user of European origin



b) Position of compact keyboard for 5th percentile (female bottom percentile) user of European origin with easier access to mouse area

Key

- 1 user of European origin, 5th percentile (female)
- 2 user of European origin, 95th percentile (male)
- 3 full-size keyboard
- 4 compact keyboard
- 5 mouse area for right-hand use
- 6 mouse area for left-hand use

Figure B.2 – Position of a keyboard (optimum for typing)

B.2.1.2 Operability of keyboards

B.2.1.2.1 Obviousness

A keyboard shall either belong to class C1 for obviousness (known or visible without additional instructions and information) or else the required level of instructions shall be specified.

B.2.1.2.2 Predictability

The predictability of key input is achieved if an unintended multiple event, signalled from a single key actuation, is prevented, and if the keyboard detects each key activation in the correct order.

Prevention of the signalling of an unintended multiple event is achieved if the keyboard is provided with either bounce-free switches or a means to ensure that bounce will not cause unintended activation.

Detecting each key activation in correct order is achievable by adequate key roll-over. The required roll-over characteristics depend on the speed of input. Keyboards can be assigned to the following classes characterizing their roll-over abilities:

- C1 unlimited (exceeds maximum throughput for two-hand operation), n -key roll-over or equivalent;
- C2 maximum throughput for 90 % of two-handed input, two-key roll-over or equivalent;
- C3 no roll-over, i.e. first activated key must be released before the subsequent key can be detected;
- C4 delayed input required, i.e. after release of the first activated key, a defined waiting period is needed before the subsequent key can be detected.

Keyboards shall either belong to class C1 or else the class to which they belong shall be specified.

B.2.1.2.3 Consistency of operation of keyboards

There is consistency of operation if the effectiveness does not change under different situations belonging to the intended context of use. The feedback given shall be the same for the intended context of use. This means that the effectiveness and the feedback will not be changed under conditions for which a certain variation is allowed (e.g. a temperature range).

As for compatibility, a keyboard shall either belong to class C1 (enables maximum throughput and accuracy for two-handed operation) or else the restricted level shall be specified.

B.2.1.2.4 Compatibility of keyboards with biomechanical capabilities

The most important property of keyboards for accommodating the anthropometric characteristics of a user population is the centreline spacing, i.e. the distance of adjacent keys measured from centre to centre. For fast touch typing, which needs prior training and long-term experience, it is important to have the same spacing for all systems that accept fast and continuous input from keyboards. This spacing is set to 19 mm by convention.

NOTE Certain keys can occupy more than one position in the grid and thus the 19 mm centre-to-centre restriction might not be applicable vertically or horizontally, nor in either direction (see ISO/IEC 9995-1).

Certain user populations with special needs can require a greater distance, while 19 mm could be too wide for others such as children). A distance greater than 19 mm can also be required for certain environments (e.g. cold environments where users need protective equipment or unstable environments such as cars, aeroplanes or trains).

There are a variety of reasons for using smaller centreline distances for keys, thus also for using smaller keys. Portability of a device with an integrated keyboard is one such reason; fitting a device into the human hand is another. Currently, there are no established ergonomic rules for establishing an acceptable compromise between them.

For the spacing of the keys, the following group categories apply for the adult user population:

- G1 fully compatible for adult user population, 19 mm;
- G2 restricted maximum achievable level for effectiveness 90 % and efficiency 90 %, 14 mm;
- G3 restricted maximum achievable level for effectiveness 80 %, efficiency 80 %, 12 mm;
- G4 use requires additional aids (e.g. stylus) and or special forms for keys, less than 10 mm.

For users with small hands (e.g. children, women with hand-size below the 5th percentile), keys with smaller spacing (pitch) can be beneficial. Such keyboards have a spacing between G2 and G3.

With very young children who have less precise motor control, larger keys (more than 19 mm) can be better suited. Such keyboards are also beneficial for other users who have lost some precision of their motor control, such as elderly users. Where it is not possible to use key spacing other than 19 mm, the use of an additional mechanical guide for the fingers can help to compensate for some loss of motor control. Such guides may also be beneficial in environments where typing is affected by vibration.

B.2.1.2.5 Feedback

Feedback from a keyboard can be visual, kinaesthetic, auditory or a combination of these. The feedback can be given partly by other components of the system using the signal generated by the keyboard.

The characteristics of feedback required for usability depend on the specific task. The fastest detectable feedback for keying is kinaesthetic feedback, while visual feedback on a secondary device can be the slowest and least effective. Kinaesthetic feedback is also the most effective and efficient because it gives continuous information on the actuation and activation of a key, whereas auditory and visual feedback indicate activation only.

Feedback can be categorized into four classes:

- C1 continuous kinaesthetic feedback sufficient for two-handed touch typing;
- C2 ramp action and auditory feedback;
- C3 auditory feedback;
- C4 delayed visual feedback.

B.2.1.3 Controllability of keyboards

The responsiveness of a keyboard is given if the feedback following its actuation is consistent and accurate to the same degree.

EXAMPLE Activating a graphic key is always accompanied by a generated character on the screen and by a tactile feedback which is the same for all keys on that keyboard.

The responsiveness of a keyboard can be changed by software. Reliable access to a keyboard designed to be used while resting on a support surface is given if user actions during intended use cannot cause it to slip or rock. For the adequacy of device access, detachable keyboards shall be designed so as to be easily repositioned on the support surface.

For hand-held devices, controllability is given if the required level of effectiveness and efficiency can be achieved without the aid of a support surface for the device and/or upper extremities.

Adequate control access for a keyboard designed to be used while resting on a support surface is given if it is detachable and fulfils the requirements for the mechanical design of keyboards (see B.2.3).

Adequate control access for a keyboard designed for hand-held operation is given if the required effectiveness can be achieved under consideration of the compatibility with the biomechanical capabilities of the intended user population and the user can operate the keyboard without losing contact to the display.

B.2.2 Requirements for functional properties

B.2.2.1 Requirements for the design of keys

B.2.2.1.1 Requirements for full-size keyboards

The requirements a) to m), below, apply for full-size keyboards for which (see also Figure B.1)

- speed and accuracy are important,
- mouse use is less important than numeric input,
- input efficiency is more important than portability,
- editing is important,
- there is C1 operability (exceeds maximum throughput for two-hand operation), and
- there is C1 user compatibility (adult user population).

a) Keytop shape

The keytops of normal-size keys in the alphanumeric, cursor and numeric zones shall have either concave or flat strike surfaces. The space bar may be flat or convex.

b) Strike surface

The strike surface of the keytops of alphanumeric keys shall be at least 110 mm² in area, and between 12 mm and 15 mm in width. The minimum strike surfaces apply to the keys in the alphanumeric and numeric zones. Outside these sections, strike surfaces may be smaller, but not less than 64 mm².

NOTE The appropriate dimensions of the keytop (keycap) depend on the key width and key centre spacing, as well as the strike surface and the key displacement.

Tactile indicators should be provided on the appropriate keys on the home rows of the alphanumeric zones (i.e. position C04 and C07 according to ISO/IEC 9995-1) and numeric zones (i.e. C52 according to ISO/IEC 9995-1).

c) Displacement

The key displacement shall be between 1,5 mm and 6,0 mm. The preferred key displacement is between 2,0 mm and 4,0 mm.

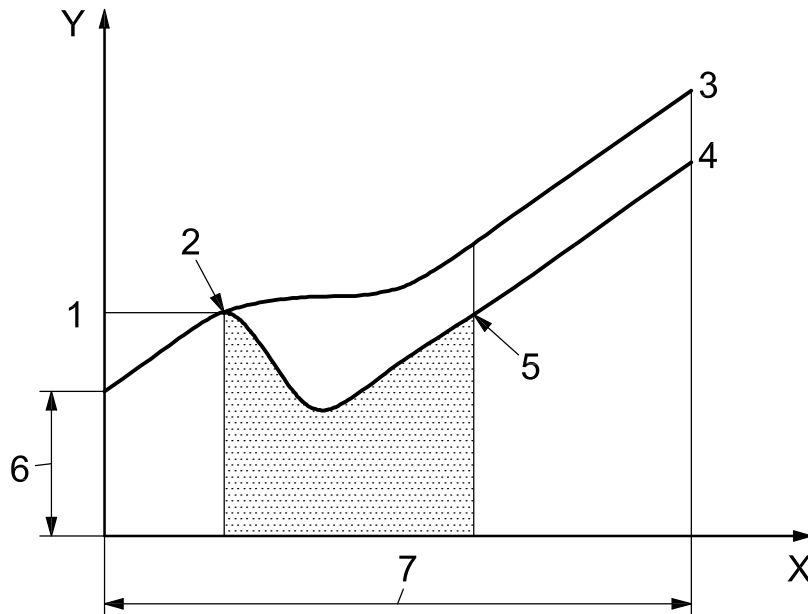
d) Force

The force at the character generation point or at the snap point should be between 0,5 N and 0,8 N and shall be between 0,25 N and 1,5 N.

e) Force/displacement characteristics

For displacement keyboards (see Figure B.3), the initial resistance (starting force or preload) shall be between 25 % and 75 % of the force at the character generation point (for ramp action) or snap point (for snap action). The switch-make action in the snap action shall occur after the snap point but before the key force has returned to the snap point. The activation should occur around the minimum force point after the snap point.

The force/displacement characteristics across the alphanumeric keys should be consistent. The force/displacement characteristics of a key should not depend on the part of the strike surface hit while actuating.



Key

- X travel, mm
- Y force, N
- 1 force at snap point — between 0,5 N and 0,8 N (preferred), 0,25 N and 1,5 N (permitted)
- 2 snap point
- 3 ramp action
- 4 snap action
- 5 switch-make point occurs — after snap point, at force $\leq$ snap point
- 6 initial resistance — between 25 % and 75 % of force at snap point
- 7 full travel — 2 mm to 4 mm (preferred), 1,5 mm to 6 mm (permitted)

Figure B.3 – Relationship between key displacement and key force

f) Feedback

Actuation of a key shall be accompanied by feedback. Feedback can be kinaesthetic, auditory or some combination of the two. If the design allows for only one means of feedback, then kinaesthetic feedback is preferred.

Ramp action displacement alone does not provide sufficient tactile feedback and should be accompanied by auditory feedback.

Auditory feedback should be provided whenever tactile feedback is not provided. If the principal means is auditory, the auditory signal shall be perceptible in the use environment. The auditory signal should be an impulse sound (e.g. click of a relay switch) or tone (e.g. bell or beep sound). Supplementary auditory feedback shall be suppressible (i.e. a volume control position that represents “off”). The feedback shall occur within 100 ms after the key activation.

Visual feedback should be used to indicate the long-term status of a particular key or keys (e.g. shift, mode state). Such feedback should be clearly visible to the user. Visual feedback may be given by the key itself or the keyboard, in which case it should be adjacent to or in close proximity to the key. In the case of feedback appearing on the screen (e.g. in an operator information area) it should clearly indicate which state the key or keys are in.

g) Bounce

In order to prevent unintended multiple event signalling from a single key actuation, the keyboard shall be provided with either bounce-free switches or a means of ensuring that bounce will not cause unintended activation.

h) Key repeat function

Where a repeat function is provided, the fixed repeat rate shall be 10 activations per second to 20 activations per second after an initial delay of between 500 ms and 750 ms after the key is actuated. If the repeat function is activated by a higher pressure force upon the key, the delay may be reduced.

NOTE Initial delays of greater than 750 ms are likely to be perceived as too long.

A user-adjustable repeat rate is preferred.

For certain irreversible functions (e.g. "erase" command) the repeat action facility should be suppressible.

i) Key rollover

Keyboards designed for stationary use shall be equipped with *n*-key rollover according to C1 (see B.2.1.2.2). Alternatively, any means ensuring that each key activation is detected in correct timely order may be used.

j) Geometric design of key legends

All legends on keys shall be legible from the design reference posture (see ISO 9241-5). The height of primary legends on an alphanumeric key shall not be less than 2,6 mm. When a graphical symbol, a full word or a well-established abbreviation is used, the height shall not be less than 2,2 mm. The width of the capital letters (excepting I and W) shall be between 50 % and 100 % of the height. The ratio between the height and stroke width should be between 5:1 and 14:1. For primary legends on all keys, the luminance contrast between the luminance level of the background and the legends shall be a minimum of 3:1. Secondary legends should be perceptually different from the primary legends on the same key. Legends should appear to have a sharp outline. Dark characters on a light background are recommended for bright environments.

k) Graphical symbols

Where graphical symbols are used, these shall be in accordance with ISO/IEC 9995, and with ISO 7000 and IEC 60417-DB, as applicable.

l) Number and positioning of legends

The number of legends on any key should be kept to a minimum. The positioning of the legends shall be in accordance with ISO/IEC 9995-1, as applicable.

Where legends are too long for the keytop or where the function of the keys can change (e.g. emulation), key legends may be provided on an overlay. Where legends are provided on overlays or the keyboard housing, they should be adjacent, or in close proximity, to the keys to which they refer. If space does not allow for the implementation of this recommendation, a reference card should be provided. Overlays and reference cards shall have a matt finish.

Some keyboards incorporate individual displays for each key. In this case, it shall be possible to label the re-legendable key with appropriate information about the content programmed into the key.

m) Durability of legends

Legends shall be legible throughout the intended life of the product. They shall be robust and durable so that they are able to withstand normal wear and usage, including regular cleaning.

NOTE Currently, the intended life of desktop keyboards is calculated for continuous keying of the E key over the workday during the full life-span of the product, assuming the approximate occurrence of this character in European languages.

B.2.2.1.2 Requirements for compact keyboards

The requirements for the design of the keys for compact keyboards shall be the same as those specified for full-size keyboards in B.2.2.1.1, a) to l). The requirements related to the durability of legends are as follows.

Legends shall be legible throughout the intended life of the product. They shall be robust and durable so that they are able to withstand normal wear and usage, including regular cleaning.

If the device is designed to be used as an equivalent replacement for a full-size keyboard, the intended life of the product shall be the same as that for the full-size keyboard. For devices designed to be integrated in portable units (e.g. laptop computers), a less intensive use for keying may be assumed.

NOTE Currently, the intended life of desktop keyboards is calculated for continuous keying of the E key over the workday during the full life-span of the product, assuming the approximate occurrence of this character in European languages.

B.2.2.2 Sections and zones

B.2.2.2.1 Requirements for full-size keyboards

A full-size desktop keyboard shall comprise all the sections and zones defined in ISO/IEC 9995:

- alphanumeric section;
- numeric section;
- editing section;
- function section.

The principal sections of a keyboard as defined in ISO/IEC 9995-1 shall be perceptually differentiated. This may be accomplished by a spatial vertical and horizontal separation by at least half a key pitch or by visual differentiation.

B.2.2.2.2 Requirements for compact keyboards

A compact keyboard shall comprise the following sections and zones as defined in ISO/IEC 9995-1:

- alphanumeric section;
- editing section;
- function section.

The principal sections of a keyboard as defined in ISO/IEC 9995-1 shall be perceptually differentiated. This may be accomplished by a spatial vertical and horizontal separation by at least half a key pitch or by visual differentiation. Spatial grouping of the keys of the function section is not required.

B.2.3 Requirements for the mechanical design of keyboards

B.2.3.1 Requirements for full-size keyboards

The requirements a) to m), below, apply for keyboards for which (see also Figure B.1)

- speed and accuracy are important,
- mouse use is less important than numeric input,

- input efficiency is more important than portability,
- editing is important,
- there is C1 operability (exceeds maximum throughput for two-hand operation), and
- there is C1 user compatibility (adult user population).

a) Centreline spacing

The layout of the keys shall conform to ISO/IEC 9995. The horizontal and vertical distances between two adjacent keys in the alphanumeric and the numeric zones measured centre to centre shall be $19 \text{ mm} \pm 1 \text{ mm}$. Outside the alphanumeric and numeric zones, other centreline spacings are permitted, but should not be smaller than 15 mm.

NOTE Certain keys can occupy more than one position in the grid and thus the 19 mm centre-to-centre restriction might not be applicable vertically or horizontally, nor in either direction (see ISO/IEC 9995-1).

b) Home row height

The preferred home row height is as low as possible and not greater than 30 mm. However, the home row height of the keyboard shall not exceed 35 mm. If an adjustment mechanism is provided, there shall be at least one adjustment that allows it to comply with the height specification.

c) Width and depth

For the purpose of achieving efficient use of the keyboard, the overall size of a device shall be determined in consideration of the number of keys needed and their adequate grouping in sections and zones. Following the concept of minimum footprint, the size of a keyboard should be limited to the space required to achieve the intended functionality.

Since most keyboards are likely to be used together with a mouse by right-handed persons, the keyboard housing should not extend further to the right than is required by mechanical considerations.

The overall depth of a keyboard is less critical than the width, given that flat monitors offer more freedom to positioning the keyboard. However, on workplaces with restricted space, the depth can be critical for usability and it is therefore beneficial to keep the depth of the keyboard as small as possible.

d) Slope of keyboard

The recommended slope is 0° to 12° positive to the horizontal. The slope of the unadjusted keyboard shall be between 0° and 15° positive.

e) Profile of keyboard

The profile of the keyboard may be sloped, dished, stepped, sculptured or flat.

f) Keyboard surfaces and material properties

The visible surfaces of the keyboard shall be matt-finished. The finish of the surfaces should not exceed silky matt (corresponding to 45 gloss units or to a 60° reflectometer value of less than 20), in order to minimize specular reflections.

For lighted environments, the diffuse reflectance of the keyboard should have values of between 0,15 and 0,75, in order to avoid undue luminance contrast to the equipment and other items within the field of view (see ISO 9241-5:1998, 5.4.4).

There should be no sharp edges or corners on the keyboard that could cause injury or discomfort to users. The minimum radius at edges and corners on the keyboard housing should be 2 mm with a larger radius at the corners.