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Ergonomics of human-system interaction —

Part 420:
Selection of physical input devices

Ergonomie de l'interaction homme-système —

Partie 420: Sélection des dispositifs d'entrée physiques

Reference number
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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 9241-420 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

This first edition of ISO 9241-420, together with ISO 9241-400, ISO 9241-410 and ISO/TS 9241-411, partially replaces ISO 9241-4 and ISO 9241-9, technically revised as follows:

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

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

— test methods taken from ISO 9241-4 and ISO 9241-9 have been reviewed and amended and new test methods introduced and collected in annexes for greater convenience.

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 100: Introduction to standards related to software ergonomics* [Technical Report]

— *Part 110: Dialogue principles*

— *Part 129: Guidance on software individualization*

— *Part 143: Forms*

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

— *Part 171: Guidance on software accessibility*

— *Part 210: Human-centred design for interactive systems*

— *Part 300: Introduction to electronic visual display requirements*

— *Part 302: Terminology for electronic visual displays*

— *Part 303: Requirements for electronic visual displays*

— *Part 304: User performance test methods for electronic visual displays*

— *Part 305: Optical laboratory test methods for electronic visual displays*

— *Part 306: Field assessment methods for electronic visual displays*

— *Part 307: Analysis and compliance test methods for electronic visual displays*

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

— *Part 309: Organic light-emitting diode (OLED) displays* [Technical Report]

— *Part 310: Visibility, aesthetics and ergonomics of pixel defects* [Technical Report]

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

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

— *Part 411: Evaluation methods for the design of physical input devices* [Technical Specification]

— *Part 420: Selection of physical input devices*

— *Part 910: Framework for tactile and haptic interaction*

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

The following parts are under preparation:

— *Part 143: Form-based dialogues*

— *Part 154: Interactive voice response (IVR) applications*

Human-centred design and evaluation methods, optical characteristics of autostereoscopic displays, and requirements, analysis and compliance test methods for the reduction of photosensitive seizures are to form the subjects of future parts 230, 330 and 391.

Introduction

Input devices provide the 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 them into signals to be interpreted by the interactive system.

This part of ISO 9241 gives guidance for selecting products on the basis of the relevant properties of the input devices, as outlined in ISO 9241-400, and the design criteria for products, as given in ISO 9241-410. It also includes test and evaluation methods for use at the workplace level. To accelerate the future development of test and evaluation methods, these are treated in separate annexes according to the maturity of the test procedure.

This part of ISO 9241 includes test and evaluation methods for application by user organizations. These methods can also be applied by test houses.

Ergonomics of human-system interaction —

Part 420:
Selection of physical input devices

1 Scope

This part of ISO 9241 provides guidance for the selection of input devices for interactive systems, based on ergonomic factors, considering the limitations and capabilities of users and the specific tasks and context of use. It describes methods for selecting a device or a combination of devices for the task at hand. It can also be used for evaluating the acceptability of trade-offs under the existing conditions.

The target users of this part of ISO 9241 are user organizations and systems integrators who tailor systems for a given context of use.

It is applicable to the following input devices: keyboards, mice, pucks, joysticks, trackballs, trackpads, tablets and overlays, touch-sensitive screens, styli and light pens. It does not specify design requirements or give recommendations for those devices.

NOTE 1 The selection guidance has been developed for the single-finger use of touchpads. Touchpads that allow the use of more fingers do exist; however, this part of ISO 9241 does not offer any guidance on their selection.

NOTE 2 The only physical component of a speech-recognition system is a microphone. Without proper knowledge of the context of use it is not possible to give guidance for selection.

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

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

ISO 9241-410, *Ergonomics of human-system interaction — Part 410: Design criteria for physical input devices*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9241-400 and ISO 9241-410 and the following apply.

3.1
appropriateness
application of the concept of usability on entities that are combined for a specific purpose

EXAMPLE 1 Achieving a certain level of usability for users with special needs or for uses where no single device can achieve the level of usability required for a certain task.

EXAMPLE 2 Achieving a certain level of usability for text input and dragging by a combination of a keyboard and a tablet.

NOTE See also ISO 9241-400 and ISO 9241-410.

3.2
cursor
visual indication of where the user interaction via keyboard (or equivalent input device) will occur

[ISO 9241-400:2007, 5.3.2]

3.3
dragging
dragging and dropping
moving one (or more) objects on a display by translating it along a path determined by a pointer

[ISO 9241-400:2007, 3.9.1]

3.4
accessibility
⟨interactive system⟩ usability of a product, service, environment or facility by people with the widest range of capabilities

NOTE 1 The concept of accessibility addresses the full range of user capabilities and is not limited to users who are formally recognized as having a disability.

NOTE 2 The usability-orientated concept of accessibility aims to achieve levels of effectiveness, efficiency and satisfaction that are as high as possible considering the specified context of use, while paying particular attention to the full range of capabilities within the user population.

[ISO 9241-20:2008, 3.1]

3.5
effectiveness
accuracy and completeness with which users achieve specified goals

[ISO 9241-11:1998, 3.2]

3.6
efficiency
resources expended in relation to the accuracy and completeness with which users achieve goals

[ISO 9241-11:1998, 3.3]

3.7
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.

[ISO 9241-400:2007, 3.6.1]

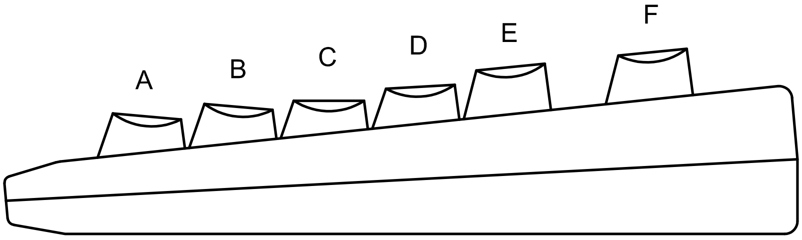


Figure 1 — Typical keyboard — Home row

3.8
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.

[ISO 9241-400:2007, 3.6.2]

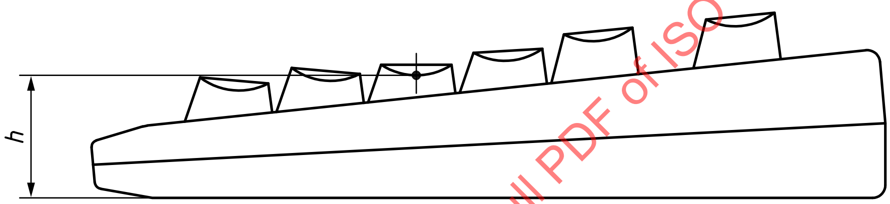


Figure 2 — Typical keyboard — Home row height

3.9
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

$$I_D = \log_2 \frac{d + w}{w} \qquad (1)$$

and for tracing tasks by

$$I_D = \frac{d}{w} \qquad (2)$$

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.

[ISO 9241-410:2008, 3.12]

3.10
input device
user-controlled device that transmits information to a system

[ISO 9241-400:2007, 3.6.3]

3.11
intended user population
group of human beings for which a product or a workstation is designed

EXAMPLE Male and female workers of Southeast Asian origin aged between 45 and 65 years.

[ISO 9241-400:2007, 3.7.7]

3.12
joystick
lever mounted in a fixed base used to control the movement of objects displayed on a screen

NOTE See Figure 3.

[ISO 9241-400:2007, 3.6.4]

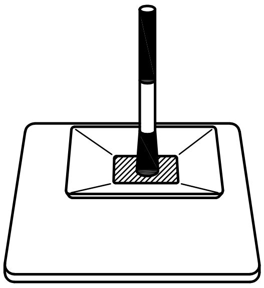


Figure 3 — Side view of example joystick

3.12.1
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

[ISO 9241-400:2007, 3.6.4.1]

3.12.2
isometric joystick
joystick where the input depends on the force exerted rather than the position of the control

[ISO 9241-400:2007, 3.6.4.2]

3.13
keyboard layout
spatial allocation of keys on a keyboard

[ISO 9241-400:2007, 3.6.9]

3.14
keyboard profile
geometric (i.e. flat, stepped, sloped, dished or sculptured) configuration of the top of the keys

[ISO 9241-400:2007, 3.6.5]

3.14.1
dished profile keyboard
keyboard in which the side profile of the keys resembles a continuous concave curve

NOTE See Figure 4.

[ISO 9241-400:2007, 3.6.5.1]

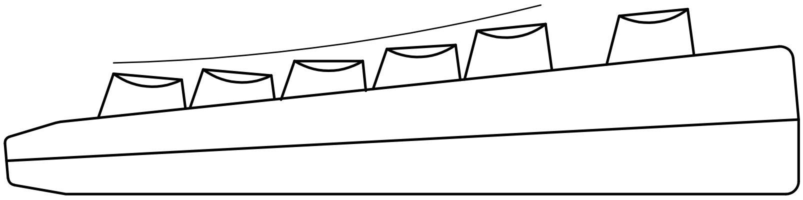


Figure 4 — Example of dished profile keyboard

3.14.2
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

NOTE See Figure 5.

[ISO 9241-400:2007, 3.6.5.2]

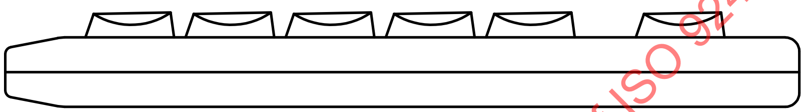


Figure 5 — Example of flat profile keyboard

3.14.3
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

See Figure 6.

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

[ISO 9241-400:2007, 3.6.5.3]

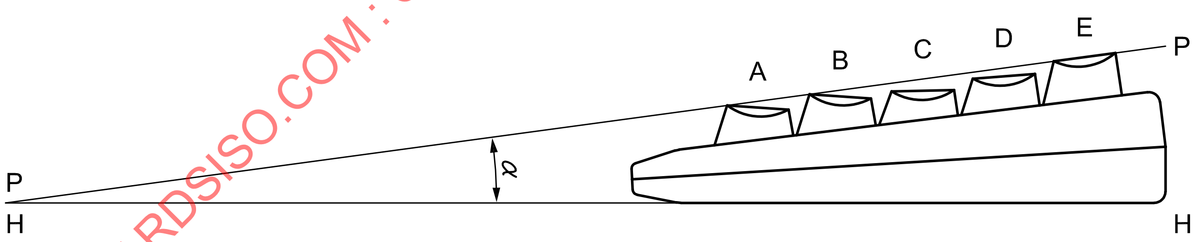


Figure 6 — Keyboard slope

3.14.4
sculptured profile keyboard
keyboard in which the side view of the keytops is shaped in other than a straight line

NOTE See Figure 7.

[ISO 9241-400:2007, 3.6.5.4]

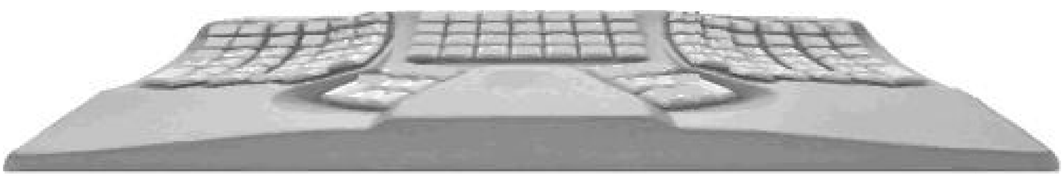


Figure 7 — Example of sculptured profile keyboard

3.14.5
stepped profile keyboard
keyboard in which the top of each row of keys is parallel to the work surface but at a different height from the work surface

NOTE 1 See Figure 8.

NOTE 2 Adapted from ISO 9241-400:2007, definition 3.6.5.5.

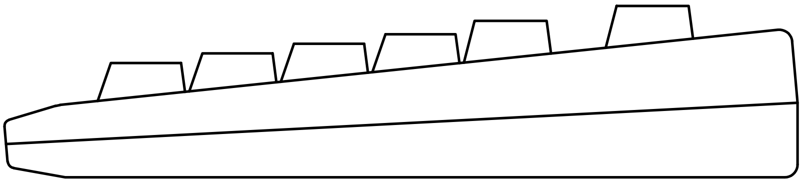


Figure 8 — Example of stepped profile keyboard

3.15
key displacement
key movement from its rest position to its fully depressed position

[ISO 9241-400:2007, 3.6.6]

3.16
key force
force required to displace a key to a specified position

[ISO 9241-400:2007, 3.6.7]

3.17
key roll over
ability of a keyboard to register the correct order of activation of a set of keys

[ISO 9241-400:2007, 3.6.8]

3.18
light pen
light-sensitive input device that, when pointed onto a specific location on a display, identifies its position to the system

NOTE See Figure 9.

[ISO 9241-400:2007, 3.6.10]

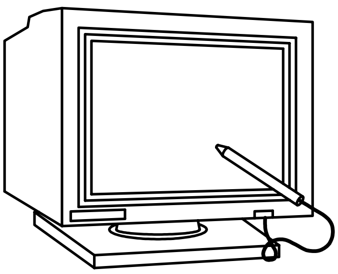


Figure 9 — Example of light pen against display

3.19
mouse
computer input device having one or more buttons and capable of two-dimensional rolling motion which can drive a pointer on the display and performs a variety of selection options or commands

NOTE Adapted from ISO 9241-400:2007, definition 3.6.11.

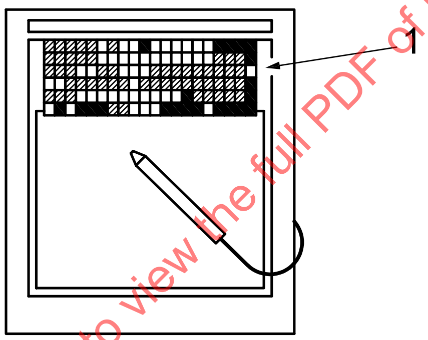
3.20
numeric keypad
array of keys in the numeric section to which are allocated the ten digits 0 to 9 and the decimal separator

[ISO 9241-400:2007, 3.6.12]

3.21
overlay
thin template on the surface of a tablet used to indicate the graphic functions available to the user

NOTE See Figure 10.

[ISO 9241-400:2007, 3.6.13]



Key
1 graphic overlay

Figure 10 — Top view of example table with graphic overlay

3.22
palm rest
surface supporting the palm of the hand (when using an input device) for a keyboard platform placed in front of the keyboard or embedded in the keyboard on which the operator may place the palms of the hands

[ISO 9241-400:2007, 3.6.14]

3.23
pointer
symbol on a display, which indicates input or selection position whose movement is controlled by an input device

[ISO 9241-400:2007, 3.6.15]

3.24
pointing
operation with a graphic user interface in which an input device is used to move a small display image (such as a pointer) to a specific location on the display

[ISO 9241-400:2007, 3.9.2]

3.25
puck
hand-held device similar to a mouse but with a reticle view port and that is typically used with a digitising tablet

NOTE See Figure 11.

[ISO 9241-400:2007, 3.6.16]

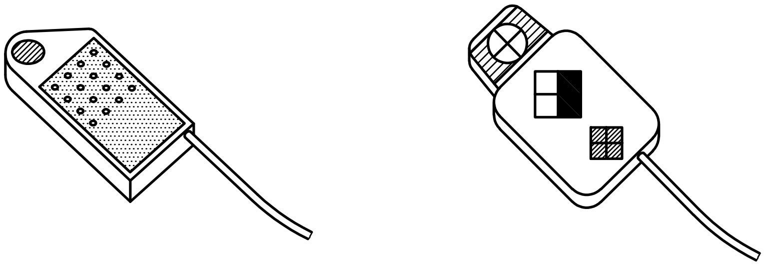


Figure 11 — Top view examples of two types of puck

3.26
quality
degree to which a set of inherent characteristics fulfils requirements

NOTE 1 The term “quality” can be used with adjectives such as poor, good or excellent.

NOTE 2 “Inherent”, as opposed to “assigned”, means existing in something, especially as a permanent characteristic.

[ISO 9000:2005, 3.1.1]

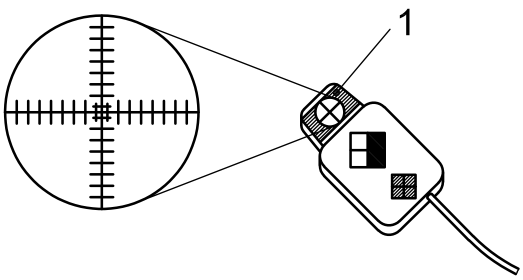
3.27
ramp action
kinaesthetic sensation during key actuation in which the force required to actuate the key increases as the key is displaced

[ISO 9241-400:2007, 3.6.17]

3.28
reticle
orthogonal lines in the lens of a puck used to visually align the puck to an image

NOTE See Figure 12.

[ISO 9241-400:2007, 3.6.18]



Key
1 reticle

Figure 12 — Top view of example puck with reticle

3.29
satisfaction
freedom from discomfort, and positive attitudes towards the use of the product

[ISO 9241-11:1998, 3.4]

3.30
section
⟨keyboard⟩ part of a keyboard

EXAMPLE Alphanumeric section, editing section, function section or numeric section.

[ISO 9241-400:2007, 3.6.19]

3.31
selecting
choosing one or more items on a display

[ISO 9241-400:2007, 3.9.3]

3.32
selector button
actuator located on an input device

[ISO 9241-400:2007, 3.6.20]

3.33
snap action
sudden drop in force required to further displace a key

[ISO 9241-400:2007, 3.6.21]

3.34
strike surface
area on the top surface of the key, which the finger contacts during key actuation

[ISO 9241-400:2007, 3.6.22]

3.35
stylus
pen-shaped pointing device which, when touched to a display or graphics tablet, can be used to draw images on a display or select displayed objects, typically by depressing the stylus tip or actuating a button located along the side of the stylus

NOTE See Figure 13.

[ISO 9241-400:2007, 3.6.23]

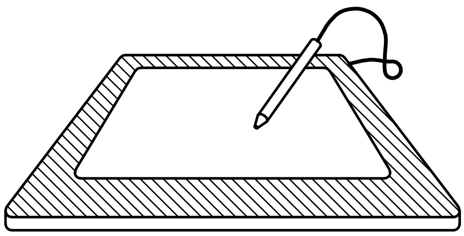


Figure 13 — Side view example of stylus over graphics tablet

3.36
tablet
special flat surface with an input device (such as a stylus or puck) for selection, drawing, or indicating the position, of images to be displayed

[ISO 9241-400:2007, 3.6.24]

3.37
tactile indicator keys
keys in the home row which contain a tactile aid for recentring the hands

[ISO 9241-400:2007, 3.6.25]

3.38
task primitive
fundamental action (such as pointing, selecting and dragging) associated with using a non-keyboard input device

NOTE User tasks contain a mix of task primitives.

[ISO 9241-400:2007, 3.9.4]

3.39
tracing
following the outline of an image by moving the pointer or input device over the lines or shape of an image

[ISO 9241-400:2007, 3.9.5]

3.40
trackball
ball in a fixed housing that can be rolled in any direction by the fingers to control pointer movement and that often has adjacent buttons

NOTE See Figure 14.

[ISO 9241-400:2007, 3.6.26]

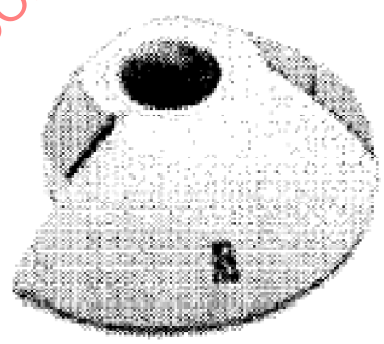


Figure 14 — Example of top view of trackball device with buttons

3.41
touch sensitive screen
TSS
input device that produces a position and selection input signal from a finger touching, lifting off, or moving across a display

[ISO 9241-400:2007, 3.6.27]

3.42
usability
extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use

[ISO 9241-11:1998, 3.1]

3.43
workstation
combination and spatial arrangement of work equipment, surrounded by the work environment under the conditions imposed by the work tasks

[ISO 6385:2004, 2.12]

NOTE This is a general definition of workstation and is different from the definition of the same term given in ISO 9241-5, which is specific to VDT work.

4 Procedures for selecting equipment — General considerations

4.1 Rationale

4.1.1 Concept

Selection procedures can enable a suitable tool or combination of tools for a given task, environment or user to be found. The procedures of this part of ISO 9241 are based on the concept of usability as defined and described in ISO 9241-11. This concept states that a product has no inherent usability, but one in a specified context of use, for specified goals and specified users. Thus, a product may be designed under the assumption of certain conditions for its use (intended context of use) whereas the conditions for the real use may differ from them (actual context of use). For example, laptop computers designed for mobile use may be used in office environments and office equipment may be used in homes. For the actual use, the usability of a device can differ widely from that achievable under the conditions that the designer had assumed.

In order to differentiate the abilities of a device during actual use from its usability, ISO 9241-400 uses the concept of appropriateness, i.e. the usability under the specific conditions of the practical use. For example, the effectiveness of a mouse may suffer severely if utilised together with a keyboard that occupies the space where the mouse should be located for optimum use. Its operation may also be less satisfactory for the user if there is no proper space on the workstation.

4.1.2 Assessing devices under practical conditions

An ergonomic selection procedure differs in principle from the ergonomic design of a device in that the selection considers the actual conditions, whereas the design takes into account the intended context of use. In ideal cases, the designer anticipates the actual conditions by appropriate evaluation of the likely conditions for the use of the product. However, in general, either the actual context of use is different from the anticipated context or a device has to be used for a task outside its intended context of use because of other overriding considerations. There are at least three reasons for applying selection procedures for input devices:

— selection of those input devices that fit best the task(s) of the user and the software that is being used;

— composing a set of devices that make up the best combination of devices for the actual context of use;

— selection of those input devices that are optimal for the physical conditions in the actual context of use.

In general, most devices are designed in consideration of their use in isolation and under reasonable circumstances. For example, a mouse may be designed for manipulating images, for a task for which the services offered by the device will suffice most of the time. The other extreme is using a keyboard for entering text only, similar to the use of a typewriter. Most tasks, however, lie between these extremes and require concurrent use of both devices, but to a different extent. Since types of keyboards differ widely, as pointing devices do to even a greater extent, an optimum pairing of two devices may differ from task to task. In addition, considering relevant characteristics of the environment (e.g. available space, stability, surface colour and texture) can affect the solution considerably.

From the point of view of the concept of usability, the user should first achieve relevant goals required by the task, e.g. accurate pointing of small objects (effectiveness). Combinations of devices that allow achievement of goals may require different amounts of resources, e.g. single-handed input versus two-handed input, or three-finger grip instead of pressing with a single finger (efficiency). And combinations achieving the same level of effectiveness and efficiency may still differ in the workload they cause for the user or distract him or her through their features. This may lead to good acceptance or to rejection, depending on the satisfaction of user needs (satisfaction).

Following the usability concept, the evaluation of an entity, e.g. a keyboard or software, includes three measures: effectiveness, efficiency and satisfaction. Instead of a formal evaluation of the usability of a product, users of this part of ISO 9241 may choose any of these measures, depending on the practical question. For example, in some cases the relevant question can be whether a device under consideration helps achieve the goals of the specific use. In this case, evaluation of the effectiveness, i.e. the accuracy and completeness with which users achieve specified goals, and describing the performance that is achieved using that entity, may suffice.

Since different tools can help achieve the same performance but require a different level of effort for this purpose, the second measure included in the concept, the efficiency, i.e. resources expended in relation to the accuracy and completeness with which users achieve goals, is relevant for identifying an effort/benefit ratio for the use of an entity. The term *resource* can include different items, e.g. time spent on the task, muscular effort by a user, number of users required or cost. Since the entities to be evaluated can be very different, the concept does not specify measures for efficiency. In the case of input devices, efficiency can be measured by the time needed to accomplish the task and the effort for the user (e.g. musculoskeletal load).

Products that can be used effectively and efficiently are not necessarily accepted by the users if they fail to fully satisfy their needs. The last measure of the concept, satisfaction, helps evaluate the degree to which the needs of users are satisfied.

For the utilization of graphical user interfaces, the oldest input device, the keyboard, often is combined with at least one pointing device. Depending on the functionality required for a certain task, different pointing devices may be usable, nevertheless to a different degree depending on the design of the specific device. When used together with a keyboard, the usability of a certain pointing device may be degraded, and, in addition, the use of the pointing device may hamper the operation of the keyboard.

A variety of reasons may exist that reduce the usability of a device under practical conditions, but there are also many instances for improving it. The usability of any device will depend on the conditions of use. In some cases a combination of devices may offer a more usable solution than either device on its own. The most important condition under which the usability of an input device is improved can be the use of a second device that enables other means of input, thereby also improving accessibility for people who may not be able to use the first device because of disability. The additional device can add new functionality, but it also can enhance existing functionality through synergy. This is the case when the additional device can help to refine one or more functions of the device under consideration.

Thus, there are at least three reasons for applying selection procedures for input devices: a concurrent use of different devices by the same user, the use of a device outside its intended context of use, and the use of a device for purposes for which it has not been designed.

4.1.3 Determining usability of devices for specific user populations

Only few technical products are likely to be usable for all human beings to the same extent and function in the same manner under all circumstances. In general, a product is designed to fully satisfy the needs of a certain user population, the target user or the intended user population (see ISO 9241-5). In many cases, users other than the target user may be able to use a well-designed product, but their needs will be satisfied to a lesser extent (e.g. “secondary users” according to ISO 9241-11). The extent to which a given set of needs are met is generally defined as being “fit for purpose”. Versatile products may be fit for a variety of user populations or uses. A general-purpose design intends to be fit for an unlimited user population. But even then, users may experience problems using the device for a number of reasons.

The concept of accessibility in ergonomics takes into account that some users may not be able to use a device as intended, temporarily or permanently. This may happen due either to a permanent disability of the user (e.g. impaired motility of the fingers) or as a result of the momentary situation (e.g. one hand being employed for another task). In such situations, the input device(s) at hand may not suffice for a certain task because it requires a higher degree of effectiveness, or the efficiency achievable with the current tool is lower than that required by the task. Accessibility will depend in many cases on flexibility and adaptability in the selection of appropriate input devices. If this is not practical, then it should be possible to use an assistive technology with the system.

Ergonomic selection methods can help determine whether the user can achieve the required level of effectiveness and efficiency with a given tool or combination of tools in a satisfactory manner or whether another type of equipment is needed.

4.2 Objectives for selection procedures

The simplest objective for applying a selection procedure is to determine whether a device is suitable for the intended use (fit for purpose). In this case, one would check whether the intended context of use matches the actual context of use.

Other objectives for user organizations to apply selection procedures may be, for example:

- comparing devices of the same kind for a given context of use (“Brand A” mouse versus “Brand B” mouse if used together with a standard keyboard);
- testing the acceptability of a given device for a task not covered by the intended context of use (e.g. keyboard as a pointing device);
- determining the minimum quality of an input device (e.g. optimum size of a tablet for a required resolution) for a given task;
- determining the acceptability of a replacement (e.g. replacing a trackball by a trackpad or vice versa);
- determining workplace requirements for a given set of work equipment (e.g. size and shape of support surfaces for working with paper documents and two different input devices);
- determining the correct setup of input devices for a given context of use (e.g. driver settings for a device designed for stationary use inside a vehicle).

5 Performance criterion

An input device or a combination of input devices shall be usable for the task at hand, i.e. the actual user shall achieve a satisfactory level of performance on the given task and maintain an acceptable level of effort and satisfaction.

NOTE A satisfactory level of performance is determined by the user organization.

If completion of the task requires the use of more than one physical device, then all required physical devices should be a common metric or metrics for determining the appropriateness as a single unit, i.e. the usability of the combination.

6 Methods and aids for selection of devices

6.1 Task analysis

A simple analysis of the overall task of the user at a given workstation should precede the selection procedure. The depth to which a task analysis should be performed and the properties considered are dependent on the kind of input device and the task. This analysis should help provide the following information:

— task primitives to be supported by the equipment;

— critical task primitive(s) with overriding importance (e.g. character input);

— rank order of the relevance of task primitives for the given context of use;

— relevant restrictions for available support surfaces (size, quality, arrangement);

— mutual exclusion effects (e.g. if two concurrent devices need to be positioned within the same space in the reach envelope);

— required level of effectiveness (e.g. the minimum size of screen area to be accessed by a pointing device is less than 4 pixels);

— required level of efficiency (e.g. selecting and dragging an object using one finger only).

6.2 Selection based on product description

ISO 9241-410 provides lists of the ergonomic features of input devices. The tables given in Annex H are designed to enable the checking of device features where the product description conforms to ISO 9241-410.

In accordance with ISO 9241-410, the relevant information, except for the properties related to the appropriateness for the specific use, shall be included in the documentation.

6.3 User tests

In cases where the product description does not provide the user organization with sufficient information, user tests may help in the selection of the appropriate device. User testing is generally recommended, especially when considering usability for the wider population of characteristics and capabilities.

Occasions when user tests can be warranted include the following:

— utilizing a given device with others that have not been designed for concurrent use (e.g. in the case of mutual exclusion);

— selecting drivers or settings for a given device under a new context of use (subdividing a tablet into smaller zones to reduce postural problems for smaller persons, selecting mouse settings for unstable support surfaces, etc.);

— testing alternative arrangements of work equipment;

— selecting alternatives of the same type of device;

— testing for a critical task primitive to select a dedicated device.

The user tests introduced in this part of ISO 9241 are not equivalent to the laboratory test methods described in ISO/TS 9241-411. However, they may indicate that a more elaborate analysis could be helpful for a given context of use.

In addition to objective user testing, the level of satisfaction with the available or recommended input devices could also be assessed through interviews or questionnaires (see Annex D).

6.4 Selection based on dominant task primitive(s) with overriding importance

Although any input device can also be utilised for tasks for which it has not been designed (e.g. a keyboard for pointing), each type of input device treated in this part of ISO 9241 has certain strengths and weaknesses in the consideration of task primitives.

The task primitives specifically defined by ISO 9241-400 are code entry (alphanumeric input), pointing, dragging, selecting and tracing.

The task primitive pointing may be considered in two dimensions, speed and accuracy, because, for some real tasks, the accuracy plays the overriding role, e.g. for creating drawings, whereas in other cases the speed or speed and accuracy can be of the highest importance. For the purposes of this part of ISO 9241, "pointing" is considered in two ways: accurate and rapid.

For some tasks, free-hand input may be considered as an aspect although it is a mixture of some task primitives. The same is true for scrolling, i.e. moving the point of focus through an image that is bigger than the display area.

The selection in consideration of the task primitive with overriding importance can be made using Figure 15.

NOTE Figures 15 and 16, and Tables 1 and 2, apply to users without special needs. For other user populations, Figures 15 and 16 may have to be modified in consideration of the capabilities of that user population.

	Rapid pointing	Accurate pointing	Selecting	Dragging	Tracing	Free-hand input	Alphanumeric input
Keyboard	□□□	□□□	■□□	□□□	□□□	□□□	■■■
Mouse	■■■	■■□	■■■	■■■	■□□	■■□	□□□
Tablet with puck	■■□	■■■	■■■	■■■	■■■	■■□	■□□
Joystick	■□□	■■□	■■□	■□□	■□□	■□□	□□□
Trackball	■■□	■■■	■■■	■□□	■□□	■□□	□□□
Touchpad	■■□	■■□	■■□	■□□	■□□	■□□	□□□
Tablet with stylus	■■□	■■■	■■■	■■■	■■■	■■■	■□□
Light pen	■■■	■■□	■■■	■□□	■□□	■■□	■□□
Touch screen	■■■	■□□	■■□	■□□	■□□	■□□	■□□

Usability

□□□	low
■□□	low — medium
■■□	medium
■■■	high

Figure 15 — Overall usability of types of input devices in consideration of task principles and relevant aspects

Table 1 — Overall usability of types of input devices in consideration of task principles and relevant aspects

	Rapid pointing	Accurate pointing	Selecting	Dragging	Tracing	Free-hand input	Alphanumeric input
Keyboard	L	L	LM	L	L	L	H
Mouse	H	M	H	H	LM	M	L
Tablet with puck	H	H	H	H	H	M	M
Joystick	LM	M	M	LM	LM	LM	L
Trackball	M	H	H	LM	LM	LM	L
Touchpad	M	M	M	LM	LM	LM	L
Tablet with stylus	H	H	H	H	H	H	M
Light pen	H	M	H	LM	LM	M	M
Touch screen	H	LM	M	LM	LM	M	M

The structogram shown in Figure 16 for selecting the correct device depicts the decision path for selecting a device. In the case where “tracing“ is the overriding task primitive, the tablet with stylus or puck is shown as the best choice.

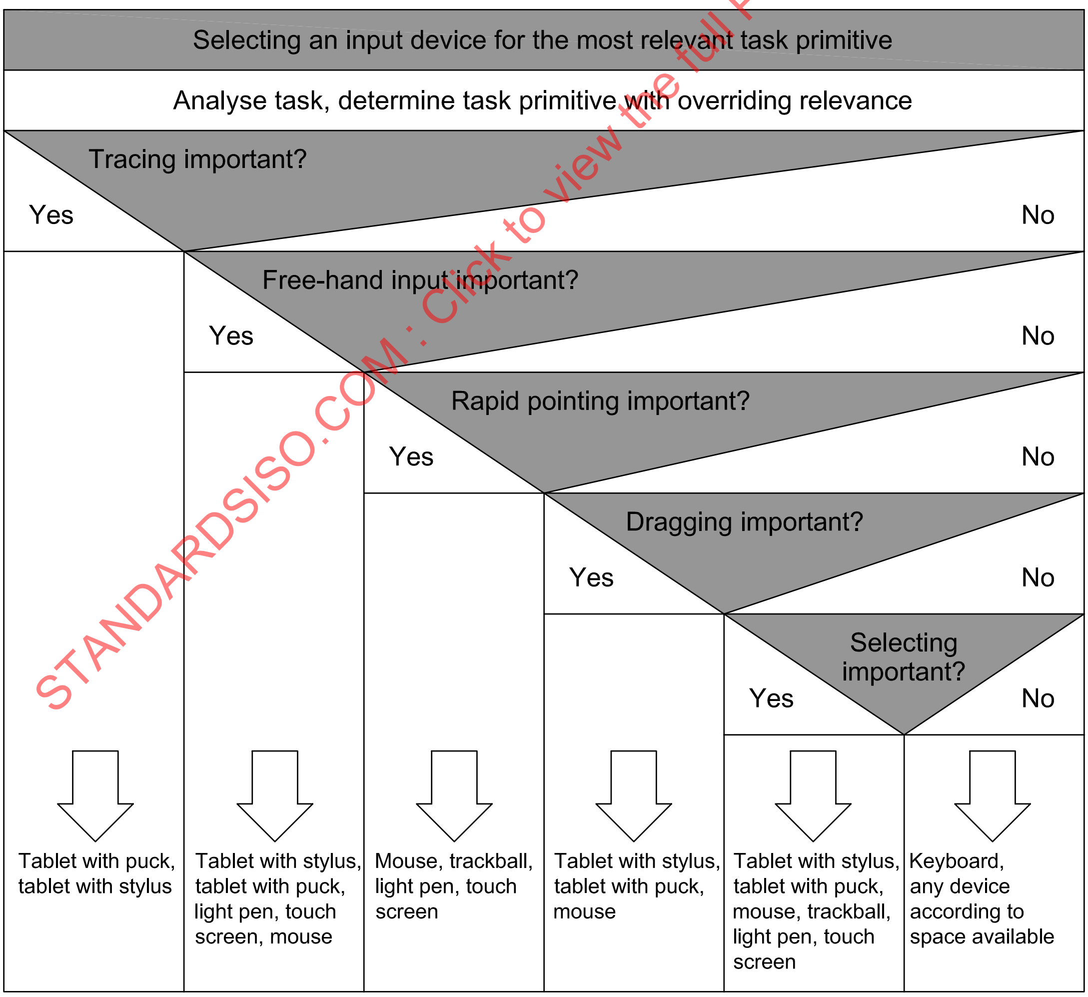


Figure 16 — Structogram for selecting input devices in consideration of most relevant task primitive

Table 2 — Selection based on dominant task primitive(s)

Suitability	Tracing	Free-hand input	Rapid pointing	Dragging	Selecting	Accurate pointing	Alphanumeric input
High	Tablet with puck Tablet with stylus	Tablet with stylus	Mouse Tablet with puck Tablet with stylus Light pen Touch screen	Mouse Tablet with puck Tablet with stylus	Mouse Tablet with puck Trackball Tablet with stylus Light pen	Tablet with puck Trackball Tablet with stylus	Keyboard
Medium		Mouse Tablet with puck Light pen Touch screen	Trackball Touchpad		Joystick Touchpad Touch screen	Mouse Joystick Touchpad Light pen	Tablet with puck Tablet with stylus Light pen Touch screen
Medium to low	Mouse Joystick Trackball Touchpad Light pen Touch screen	Joystick Trackball Touchpad	Joystick	Joystick Trackball Touchpad Light pen Touch screen	Keyboard	Touch screen	
Low	Keyboard	Keyboard	Keyboard	Keyboard		Keyboard	Mouse Joystick Trackball Touchpad

If the device under consideration needs to be supported by one or more devices, e.g. for accessibility reasons or for additional task primitives, another choice yields a more appropriate combination of devices for the support of the overall task.

This is also the case for the choice of the suitable keyboard shown in Figure 17.

6.5 Selecting a keyboard

For the task primitive "code entry", i.e. the input of the entire code for a graphical entity (character, graphic primitive, etc.), the keyboard is the most likely candidate. While keyboards of technical equipment and machinery are often custom-made for specific tasks, keyboards used in other areas consist of more or less standardized elements, with the full-size keyboard being the most complex unit and a numeric pad with a stylus to hit very small keys the simplest.

The selection of the most suitable keyboard depends on its intended purpose of use, as shown in Figure 17. This graphic shows that a variety of designs can be appropriate under certain conditions, e.g. space restriction, portability, graphical user interface (GUI), whereas their usability without considering these conditions would suggest another selection.

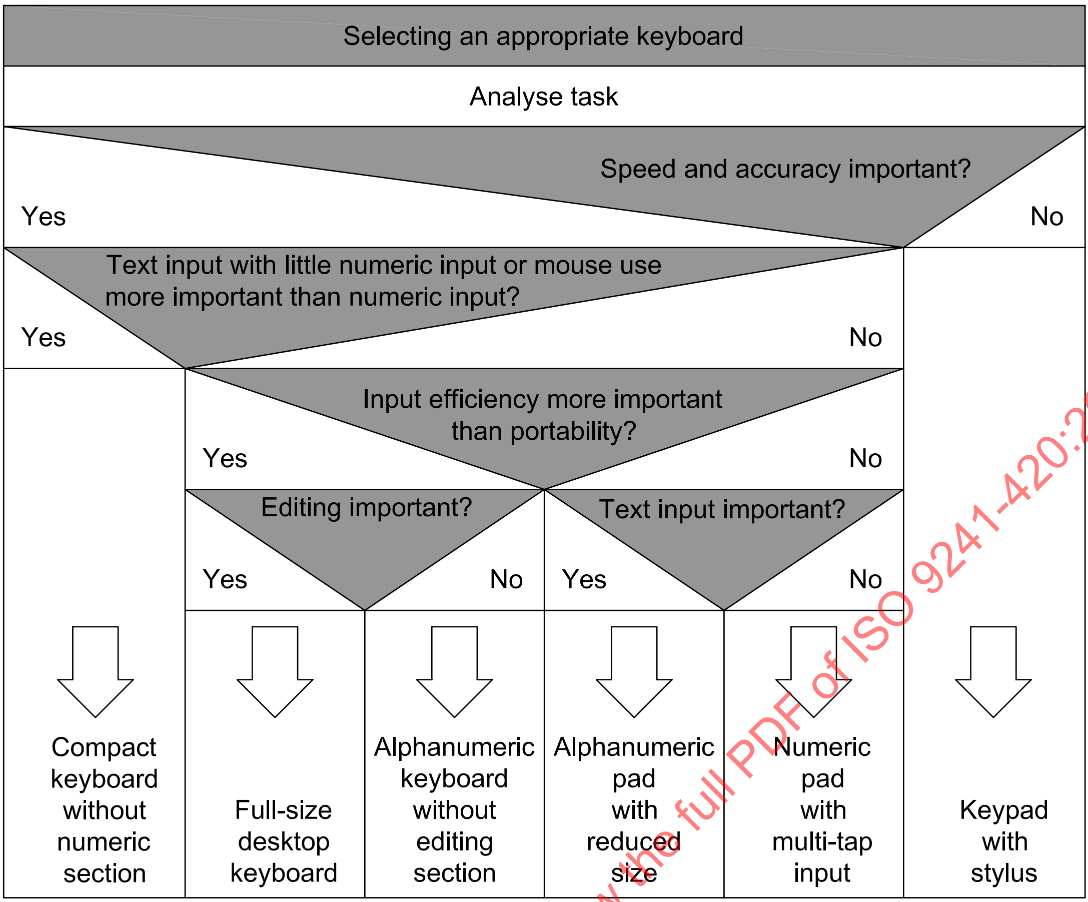


Figure 17 — Selecting keyboard for given task using structogram
(adapted from ISO 9241-410:2008, Figure B.1)

The following conclusions may be drawn from Figure 17.

— For general-purpose use of computers with GUI, the compact keyboard is the appropriate solution.

— The restrictions caused by portability lead to reduced input efficiency. If this aspect is still relevant, however, the restricted abilities of the physical device should be enhanced by software support. As known from the literature, a variety of (mostly language-dependent) methods exists with different effects. Some enhance effectiveness (correct input), while others increase efficiency (e.g. reduced effort for the same amount of input).

— An alphanumeric pad with keys reduced in size to fit the device can be an alternative to the numeric pad with multi-tap input as used by most mobile phones. Since such devices are being used to create billions of text messages [short message service (SMS)], checking the usability of the alternative is advisable.

7 Field assessment of input devices

7.1 Rationale

Testing a device may be necessary for a number of reasons, with missing information relevant to the actual context of use being the most important; therefore, user testing is always advisable. In general, products are designed assuming a certain context of use that may be different from the conditions in the actual environment. Thus, the information given in the product documentation may not be correct or complete for a given situation.

In addition, in many cases, product documentation may not be complete or suffice for a decision. Sometimes, the information can be existent but not suitable for selecting the appropriate device because its meaning for the task at hand is not clear. For example, the unit of measurement of the resolution of both a tablet and a mouse is given in dots per inch (dpi), a measure also used for printers and visual displays. Unfortunately, none of the measures is obvious. Is the quality of a printed image with 4 800 dpi fifty times better than that of an image on a screen with 96 dpi? Using a tablet, the absolute location in space is detected while for using a mouse, the number explains the number of counts the device makes while moving over a distance of one inch. Comparing a tablet and a mouse with the same “dpi” thus does not make much sense, because the user is interested in the speed and accuracy of the task completion rather than in technical numbers that sometimes confuse instead of informing.

These and many other reasons can justify a user test, which is why user testing is always advisable (see Annex D). But it should be kept in mind that ill-designed and poorly performed tests can be misleading.

All methods described in this part of ISO 9241 are simple tests with low requirements on test equipment. The design of the tests takes into account the fact that user organizations usually do not operate sophisticated test units, even if some might.

Annexes B to I of this part of ISO 9241 present the following applicable tests:

- Annex B: tracing test;
- Annex C: dragging test;
- Annex D: assessment of comfort;
- Annex E: one-direction tapping test;
- Annex F: multi-directional tapping test;
- Annex G: test for mobile text entry (hand-held keyboards);
- Annex H: tables for selecting devices in consideration of product description;
- Annex I: usability test for keyboards.

7.2 Methods

7.2.1 Subjects

7.2.1.1 Number of subjects

Selecting the appropriate test population is the most important task before running the test. The number of subjects is crucial for the importance of the outcome. For tests that are planned as a refined inspection method, five subjects can suffice.

For tests where statistics are to be calculated, the number of subjects should be around ten. This number can be found in many publications of the computer industry. Also, university researchers do not employ a considerably higher number of subjects for most experiments. The optimum number for tests is 20 or more if it is intended to achieve a high statistical power for the analyses with the least effort.

7.2.1.2 Qualification and skills of subjects

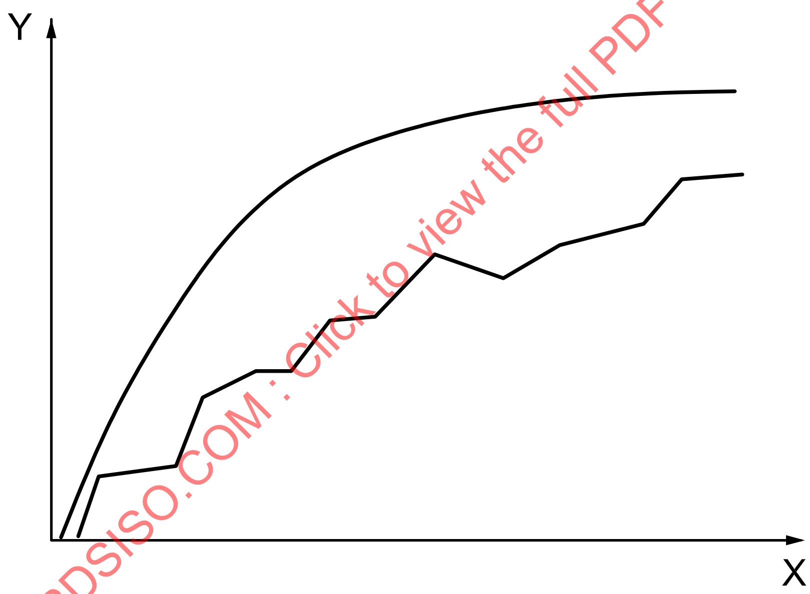
More important for the quality and reliability of the results are the skills of the subjects, if different types of devices or different designs of the same type of device are to be compared. For example, the typing performance of skilled touch typists can differ by a ratio of more than 1:2, while “hunt-and-peck” typists achieve about 20 % of the performance of highly skilled typists. Even larger differences may occur in the use of pointing devices by normal users as opposed to graphic artists or persons using the keyboards of mobile phones for text entry.

Since the subject populations for user testing are relatively small, they cannot represent the actual user population in an organization. Thus, it is advisable to select a homogeneous group with certain abilities, i.e. a group of persons with similar characteristics. These abilities should be suitable for the purpose of the test. For example, if avoiding the interference of software with text input is the most important issue, touch typists with good skills are to be preferred. Whereas, employing the most skilled subjects for the selection of an appropriate pointing device to be used for administrative tasks may turn out to be counterproductive. In this case, subjects with good knowledge of the overall task and average skills in pointing can be more appropriate.

If the consideration of persons with special needs (e.g. elderly users, users with longer reaction times or lower levels of dexterity) is necessary, special attention should be given to the composition of the test population.

A serious problem concerning the skills and the qualifications of the subjects lies in a lack of suitable subjects. For example, by testing novel keyboards with skilled touch typists, the novel design is very likely to fail because the subjects have to unlearn and relearn their typing skills, an impossible mission. Even finding subjects with no keyboard experience may be a serious problem.

In many cases, using the so-called learning curve can help. This curve depicts the development of skills of persons or organizations through learning processes. See Figure 18.



Key

X trials/time

Y competence

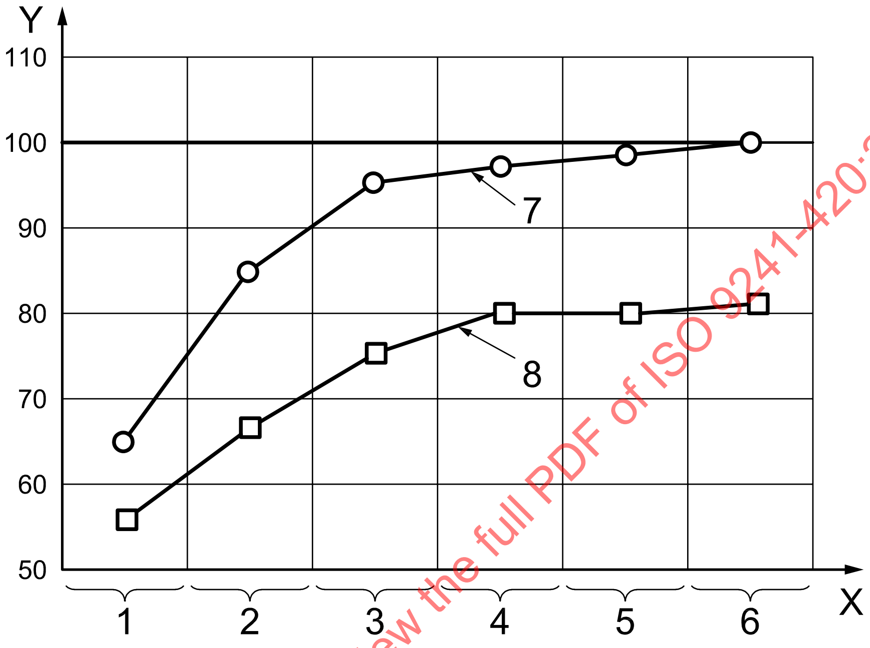
Figure 18 — Progress of skills or competence through learning in theory (thin curve) and in real example

If two devices are to be compared, the likeliest situations are either that both devices are unknown to the subjects or that one of them is unknown. If both are unknown, they can be tested against a known device (e.g. a mouse). Figure 19 shows the outcome of a test where two new devices have been tested against a mouse. The curves reveal that unknown device 1 requires about five trials to achieve the same performance as with the mouse, whereas unknown device 2 shows no more progress.

For performing a test with device 1 in comparison to a mouse (known device), prior training of approximately the length of four sessions is required, with the length of each session depending on the type of device. If two unknown devices are to be compared, the test can be stopped when it can be decided that the learning curves are unlikely to cross.

NOTE Most input devices are unlikely to reach the performance of skilled use of a mouse. In the given example, the tasks were administrative tasks such as pointing for text editing.

Devices designed or intended for use by unskilled persons may be tested without prior training. However, in this case, a comparison with a known device can be meaningless.



Key

1 training

2 session 1

3 session 2

4 session 3

5 session 4

6 session 5

7 device 1

8 device 2

Y percentage of performance with mouse

Figure 19 — Comparison of learning curves for two unknown devices with device used skilfully by subjects

7.2.1.3 Test environment

The test environment should be free of distraction from noise or lighting. Test subjects should be allowed to adapt to the test environment for about 15 min prior to the test. The test subjects should be kept at this level of adaptation throughout the test.

7.2.1.4 Test workstation

If a support surface is necessary, such as a desk, a workstation with similar properties to the intended or likely equipment should be used. It is advisable to use adjustable chairs and tables to avoid any influence of the specific subject population anthropometry.

7.2.1.5 Device assignment

If two or more devices are being compared, each subject should be tested using each device. The input devices should be labelled anonymously (for example, “A” and “B”) and all identifying logos and labels should be covered. The order of presentation should be counterbalanced to eliminate any effects of test order.

7.2.1.6 Length of sessions

Testing input devices is likely to cause fatigue for at least some parts of the body. The maximum length of a session depends on the type of device and task. Always consider the characteristics and capabilities of the user. Sessions should be of sufficient length to obtain statistically valid performance samples.

Tests as described in this part of ISO 9241 do not require lengthy sessions. However, the user of this part of ISO 9241 may repeat them for whatever reasons. In such cases, the following time limits are recommended.

a) The overall test should not exceed 4 h per day including all breaks.

b) The duration of sessions with touch typing or similar activities should not exceed 20 min.

c) Session duration with multi-tap or similar input should not exceed 3 min, followed by breaks of similar length.

d) Sessions with pointing devices should be organised such that parts with tests to be evaluated should be kept short and followed by more relaxed actions using the same device.

7.2.1.7 Confidentiality and ethical conduct

Confidentiality of an individual's performance should be assured. Performance scores which reveal an individual subject's identity should not be released by the testing organiser. Rules governing the ethical conduct of human experimentation should be followed.

NOTE Detailed information in this respect is available from References [8] and [9].

Prior to agreeing to participate, every individual has the right to know and understand what will happen during a test (informed consent). All participants should be informed that they may withdraw from the test at any time.

Annex A
(informative)

Overview of the ISO 9241 series

The annex presents an overview of the structure of ISO 9241. For an up-to-date overview of its structure, subject areas and the current status of both published and projected parts, please refer to:

ISO 9241 series

The structure reflects the numbering of the original ISO 9241 standard; for example, displays were originally Part 3 and are now the 300 series. In each section, the “hundred” is an introduction to the section; for example, Part 100 gives an introduction to the software-ergonomics parts.

Table A.1 — Structure of ISO 9241 — Ergonomics of human–system interaction

Part	Title
1	Introduction
2	Job design
11	Hardware and software usability
20	Accessibility and human–system interaction
21-99	Reserved numbers
100	Software ergonomics
200	Human–system interaction processes
300	Displays and display-related hardware
400	Physical input devices — Ergonomics principles
500	Workplace ergonomics
600	Environment ergonomics
700	Control rooms
900	Tactile and haptic interactions

Annex B
(informative)

Tracing test

B.1 Application

Evaluating the tracing of an object, free-hand input.

B.2 Test procedure

The test object consists of four circles, each with a diameter of 100 mm. The subjects attempt to draw a free-hand line around each of the circles (see Figure B.1) — in the clockwise direction for the top left and bottom right circles and anticlockwise for the other two circles.

Task completion time: less than 1 min with the fastest input devices.

For this test, an application is necessary that enables freeform paths. If the application works with magnetic grids or similar, disable them.

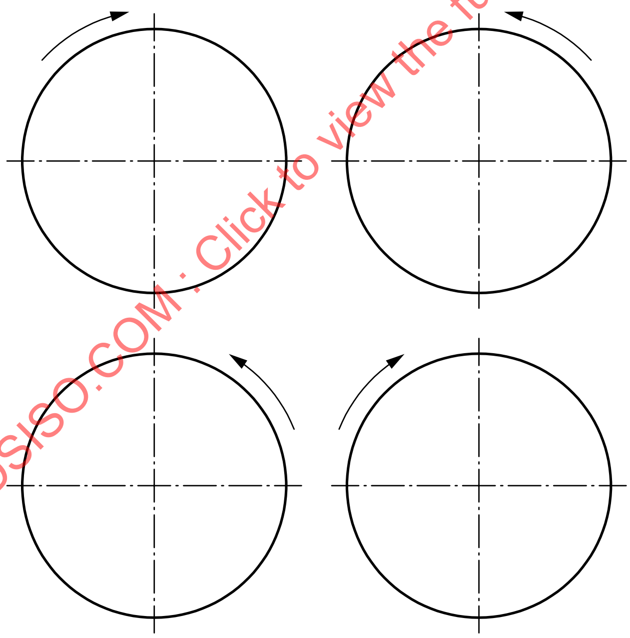


Figure B.1 — Test object and direction of movement

B.3 Data

Measure the distance between the test object (each of the circles) and the free-hand-drawn line, in full millimetres, at 36 locations. Set all deviations below 1 mm to 0 (see Figure B.2).

Measure the task completion time using a means for time measurement with a temporal resolution of 0,1 s.

EXAMPLE Microsoft Excel[1)] works with a resolution of one millisecond (= 0,001 s).

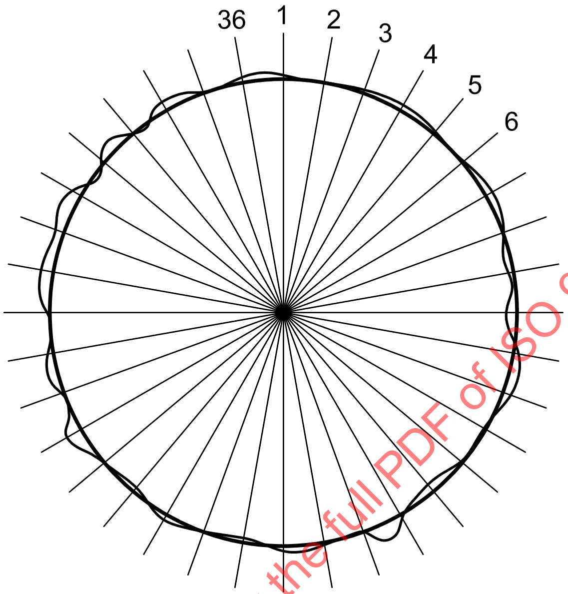


Figure B.2 — Test object and points of measurement for deviations

B.4 Evaluation

Calculate the means and standard deviations for each device and circle separately, as the deviations may be direction-dependent.

Compare completion time and accuracy.

1) Excel is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Annex C
(informative)

Dragging test

C.1 Application

Evaluating clicking and dragging objects to specific locations, e.g.

a) clicking and dragging the pointer down a pull-down menu, and

b) selecting and dragging an object from one window to another.

C.2 Test procedure

Drag the test object — circles with a diameter of 8 mm — over a distance of 100 mm and place them in circles with a diameter of 10 mm (see Figure C.1).

Perform the task in all four cardinal directions (left-to-right, right-to-left, down, up), ten times in each direction.

Measure the task completion time for each direction.

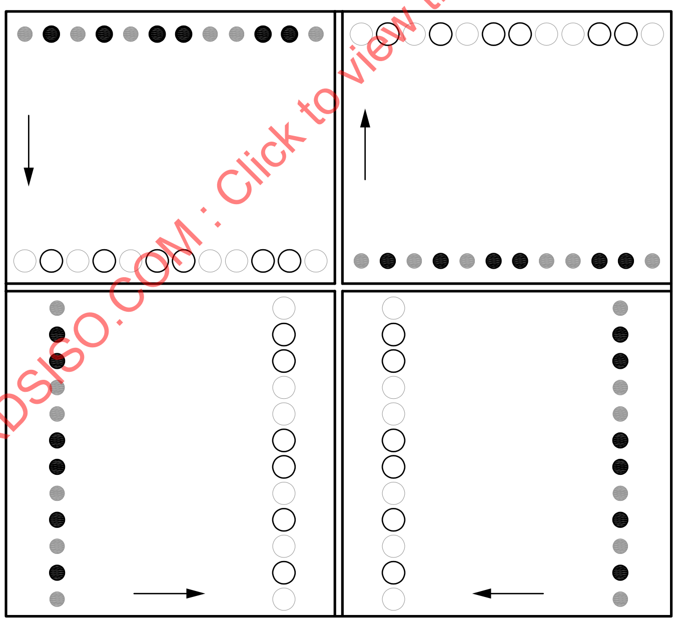


Figure C.1 — Arrangement of the objects for the dragging task for the cardinal directions

C.3 Data

Assess the accuracy as follows (see Figure C.2): score “3” for a perfect hit (object well within target), “2” for a near-miss (object at a distance of less than 1 mm from outline of target) and “1” for a miss (object lies beyond outline of target).

Measure the task completion time for each direction using a means for time measurement with a temporal resolution of 0,1 s.

EXAMPLE Microsoft Excel[2] works with a resolution of one millisecond (= 0,001 s).

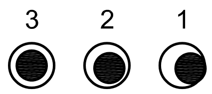


Figure C.2 — Accuracy for the dragging test

Figure C.2 shows a perfect hit at left with the object placed in the centre of the target or very near to it. A near miss (middle) is when the object lies less than 1 mm from the outline of the target and a miss (right) is when part of the object lies outside of the target.

C.4 Evaluation

Calculate the overall score and standard deviation for each device and direction separately, as the deviations may be direction-dependent.

Compare completion time and accuracy.

2) Excel is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Annex D
(informative)

Assessment of comfort

IMPORTANT — Tables D.1 to D.4 of this annex do not fall within the copyright of this part of ISO 9241 and may be reproduced freely.

D.1 General

Use the comfort-rating scales described in this annex to assess comfort. Providing such information on potential methods for testing input devices is aimed at encouraging institutions or individuals to conduct research on these methods such that further validation can be supplied.

This annex includes rating scales that assess comfort and usability by asking subjects to rate input devices independently and comparatively. These scales are designed so that the devices with the highest scores represent those preferred. Whichever scales are chosen for use, they should be formatted in a positive direction, with the highest values being associated with the most positive impressions.

D.2 Independent ratings

The independent rating scales (see Table D.1) can be used to assess impressions of each input device being tested. This is done after the subject completes a series of tasks with an input device. The subject draws a circle around the number that best describes his or her impression of each characteristic for the input device used. Comparative evaluations are made by comparing significant differences between devices for each item rated.

D.3 Comparative ratings

The comparative scales (see Tables D.2 and D.3) are used to determine which input device is preferred. Although designed to comparatively assess two devices, they can be expanded to be used for more than two input devices.

The response sheet is given to each subject after completing the tasks on one device (for example, device A) and again after completing the tasks on the other device (for example, device B). Subjects complete the Phase 1 rating after using the first input device. Subjects check the letter associated with the input device they are rating (“A” or “B”) and then place a mark under the column that best represents their feeling about the input device.

Subjects complete the Phase 2 rating after using the second input device, checking the letter associated with the input device being rated (“A” or “B”) and then placing a mark under the column that best represents their feelings about the second input device in comparison with the first.

Table D.1 — Independent rating scale

1. Force required for actuation:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very uncomfortable | Very comfortable

2. Smoothness during operation:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very rough | Very smooth

3. Effort required for operation:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very high | Very low

4. Accuracy:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very inaccurate | Very accurate

5. Operation speed:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Unacceptable | Acceptable

6. General comfort:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very uncomfortable | Very comfortable

7. Overall operation of input device:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very difficult (to use) | Very easy (to use)

8. Finger fatigue:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very high | None

9. Wrist fatigue

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very high | None

10. Arm fatigue:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very high | None

11. Shoulder fatigue

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very high | None

12. Neck fatigue:

1 .... 2 .... 3.................... 4 .... 5 .... 6.................... 7

Very high | None

Table D.2 — Dependent rating scale

General indices	**Phase 1: First input device ☐ A or ☐ B**					**Phase 2: Second input device ☐ A or ☐ B**		
	Most negative			Most positive		Worse	Same	Better
	1	2	3	4	5	–1	0	+1
1. Actuation force								
2. Operation smoothness								
3. Operation effort								
4. Accuracy								
5. Operation speed								
6. General comfort								
7. Overall operation								
Fatigue indices	**First input device ☐ A or ☐ B**					**Second input device ☐ A or ☐ B**		
	Extreme				None	Worse	Same	Better
	1	2	3	4	5	–1	0	+1
8. Finger fatigue								
9. Wrist fatigue								
10. Arm fatigue								
11. Shoulder fatigue								
12. Neck fatigue								

D.4 Assessment of effort

Rating scales of perceived effort can be used to quantify subjective opinions about the level of effort a given input device (or task) requires. One example is the Borg scale, which was designed for use in collecting opinion data about the level of whole-body effort and effort in large muscle groups such as the arm, shoulder and neck and which thus may not be appropriate for small muscles used in fine precision movements.

The Borg scale has 12 points (see Table D.3). The points represent the percentage of maximum muscular strength — the maximum voluntary muscle contraction (MVC) as a percentage — that a given effort requires. The descriptors in the scale relate to muscle work; whole-body-effort descriptors are included in parentheses.

Table D.3 — Borg scale

Points	Effort representation
( ) 10	Very, very strong (almost max.)
( ) 9	
( ) 8	
( ) 7	Very strong
( ) 6	
( ) 5	Strong (heavy)
( ) 4	Somewhat strong
( ) 3	Moderate
( ) 2	Weak (light)
( ) 1	Very weak
( ) 0,5	Very, very weak (just noticeable)
( ) 0	Nothing at all

For the purposes of this annex, the Borg scale can be formatted as in Table D.4.

Table D.4 — Borg scale for arm, shoulder, and neck effort

Effort			Effort
Arm	Shoulder	Neck	
( ) 10	( ) 10	( ) 10	Very, very strong (almost max.)
( ) 9	( ) 9	( ) 9	
( ) 8	( ) 8	( ) 8	
( ) 7	( ) 7	( ) 7	Very strong
( ) 6	( ) 6	( ) 6	
( ) 5	( ) 5	( ) 5	Strong (heavy)
( ) 4	( ) 4	( ) 4	Somewhat strong
( ) 3	( ) 3	( ) 3	Moderate
( ) 2	( ) 2	( ) 2	Weak (light)
( ) 1	( ) 1	( ) 1	Very weak
( ) 0,5	( ) 0,5	( ) 0,5	Very, very weak (just noticeable)
( ) 0	( ) 0	( ) 0	Nothing at all

D.5 Statistical analysis

The rating assessments described in D.1 and D.2 employ rating scales that yield interval-scale data. Given that the proper underlying assumptions are met, standard analysis of variance statistical techniques can be used to analyse this data. However, in instances where the necessary assumptions are not met (i.e. with small sample sizes or non-normal distributions), non-parametric techniques of hypothesis testing should be used and tend to be computationally less complex.

Annex E
(informative)

One-direction tapping test

E.1 Application

Evaluating pointing movement along one axis, e.g.

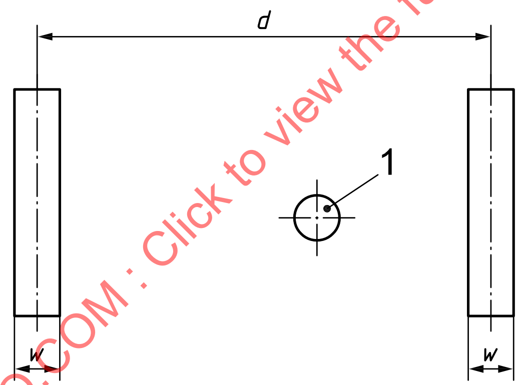
a) a horizontal or vertical rubber-banding,

b) an insert cursor at points along a character string,

c) selecting information in columns or rows.

E.2 Test procedure

The test object consists of two rectangles with a defined width in the direction perpendicular to the direction of the movement (see Figure E.1). The task consists of alternately tapping between the two rectangles.



Key

1 pointer object

d target distance

w target width

Figure E.1 — One direction tapping task

The target width, w, depends on the precision for the pointing task. Task precision is the measure of accuracy for a pointing task primitive. Expressed in bits, it is quantified by the index of difficulty, I_D, as follows:

a) low: an index of difficulty less than or equal to 4;

b) medium: an index of difficulty greater than 4 and less than or equal to 6;

c) high: an index of difficulty greater than 6.

The target width for pointing tasks is obtained using Equation (1) (see 3.9).

The resulting widths for a distance of 100 mm are shown in Table E.1.

Table E.1 — Index of difficulty and target width for a distance of 100 mm

I_D bits	w mm
3	14
4	6,5
5	3,1
6	1,5

A sensitive area with a width of at least 10 mm should be arranged around the target for counting missed targets.

For this test, an application with a temporal resolution of better than 0,1 s is required.

EXAMPLE Microsoft Excel[3)] works with a resolution of one millisecond (= 0,001 s).

The task is to point and click, along one axis, within each rectangle 25 times. Each test session starts when the user first moves the pointer into a rectangle and actuates a button. Target acquisition may be either manual (for example, depression of a button) or automatic (for example, the system sensing the presence of the pointer within the target area).

E.3 Data

The result of the test is a table displaying the time used to accomplish the task against the index of difficulty of the task and the number of targets missed.

E.4 Evaluation

For field assessments for comparisons of devices, an evaluation of the time and errors is sufficient.

A good illustration of the performance of the device is given by a graph displaying the time, T_M, needed for task completion and the index of difficulty, I_D (see Figure E.2). The ratio of I_D to T_M is called *throughput*.

NOTE If it is the intention to apply more refined methods for data analyses, refer to ISO/TR 9241-411 and the literature (see Bibliography).

3) Excel is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

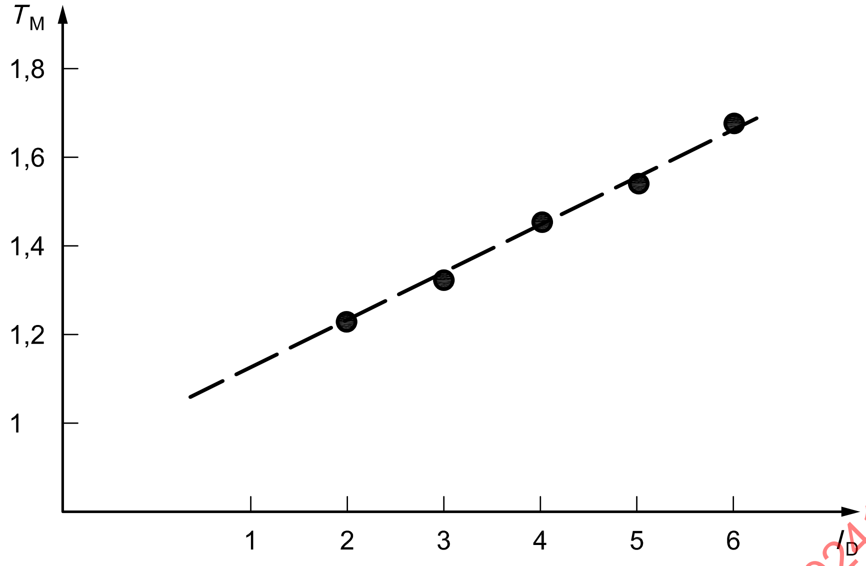


Figure E.2 — Graphic display of throughput

Annex F
(informative)

Multi-directional tapping test

F.1 Application

Evaluating pointing movements in many different directions, e.g.

a) repositioning a pointer at different areas on the screen,

b) cell selection in a spreadsheet,

c) selecting randomly located icons.

F.2 Test procedure

The test object consists of targets positioned around the circumference of a circle. Arrange the targets so that the movements are nearly equal to the diameter of the circle (see Figure F.1). Highlight the targets to which the subject should advance. Each test session starts after the subject points to the topmost target and ends when the sequence is completed (at the topmost target).

Conduct the test with a range of difficulties, i.e. the size of the circle and thus the distance between the target squares should be varied between trials, provided all subjects have the same test conditions.

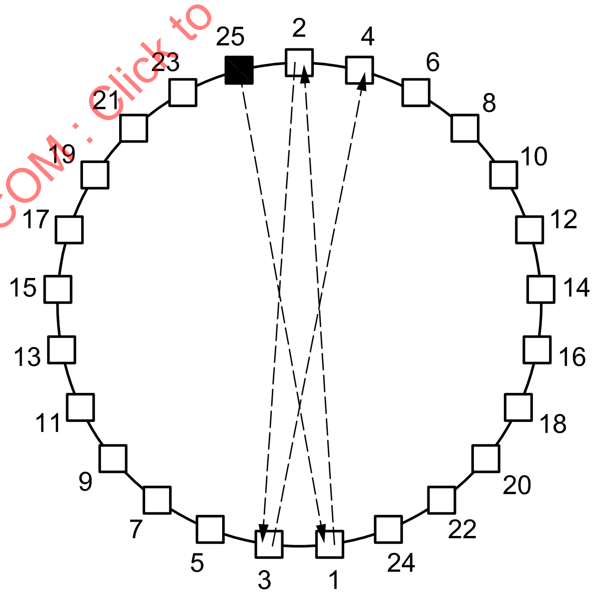


Figure F.1 — Multi-directional tapping test

F.3 Data

The data obtained by this test is the same as with the one-direction tapping test.

F.4 Evaluation

The evaluation is the same as with the one-direction tapping test.

Annex G
(informative)

Test for mobile text entry (hand-held keyboards)

G.1 Application

Speed and accuracy of text, data and numeric input.

G.2 Test procedure

G.2.1 General

The test is a text copy test. The subjects are asked to enter a predefined number of character strings or perform an entry for a fixed time period.

Although the task is different from the typical usage, which could be better mimicked by a text-creation task (e.g. comparable to writing a short message), text copy tasks yield more reliable results in simple settings.

NOTE Random alphanumeric character entry is suitable for direct comparisons of two or more devices tested under these procedures because of its reliability. However, for estimation of usability metrics (e.g. effectiveness, efficiency, and satisfaction), natural-language text strings would be more appropriate.

G.2.2 Test material

Test material for text entry should have double-spaced lines of continuous text. The text should not contain indentations or special representation of the characters such as italicized, bold or underlined. The level of difficulty of the vocabulary should not be beyond the reading ability of the subjects. A good “rule of thumb” is to use material written for 12 year olds. The text should be neutral in content (not political or religious) and should not be too technical or scientific. The text should be free of spelling and grammatical errors and should be correctly punctuated.

The text should be in the usual language of the target user population.

Data should consist of sets of randomly chosen letters or digits. (see Table G.1)

There should be sufficient test material, so that test subjects do not repeat the entry of any text or data throughout the entire test.

G.2.3 Instructions

A standard set of instructions should be given to each subject prior to starting the test. The instructions should tell subjects to work as quickly and accurately as possible and to leave errors uncorrected.

G.2.4 Software dependency

Software features or settings can substantially affect the performance of keying. If entire devices are to be compared, this does not cause a problem. However, if just the keyboard or keypad is to be compared, software is likely to bias the results. Therefore, the setting should be adjusted to yield equal opportunities for each device.

Table G.1 — Samples of data to be used in the test

Data	Numbers
SOEN FIL	2017947
OAP ICAI	9329450
TOZ NBHT	1623337
MTOD SRI	1361489
EIFR ESG	2756490
TESB LTO	4905087
KYOR SWT	2586728
RSW ETOE	0104652
FRB GECE	7498501
OSQE TYH	6417180
USIP ROZ	7925381
TSNK LXE	0891273
TYA PAUR	4209317
DTIA OMI	1876504
ECV RNBT	7580893
GHW QANT	2735018
DSG BEFR	5873642
BHIF RWN	6098971
CSA YLUS	1240354
ADH TCNI	4769016
LEUR MNM	5187638
TICN OWL	1754520
XBI AJDM	9357216
HSN CIEV	6489571
POAS CRT	2758096

G.2.5 Duration

The duration of the sessions should be adequate for the task at hand. Mobile devices such as phones or PDAs are unlikely to be used for typing continuous text over 200 characters. For example, SMS (short message service) transports a maximum of 160 characters. Assuming a slow entry rate of 5 words per minute (wpm) or 25 characters per minute, typing a full text would require about 8 min whereas 20 wpm (100 characters per minute) for expert users would take about 2 min. Thus, a duration of 120 s per session seems reasonable if the duration is fixed and the number of entries is evaluated.

If the number of entries is given and the task completion time is evaluated, a session should not last longer than 3 min.

G.3 Data

Text entry tasks yield two different results as evaluation metrics: speed (throughput) and accuracy (errors).

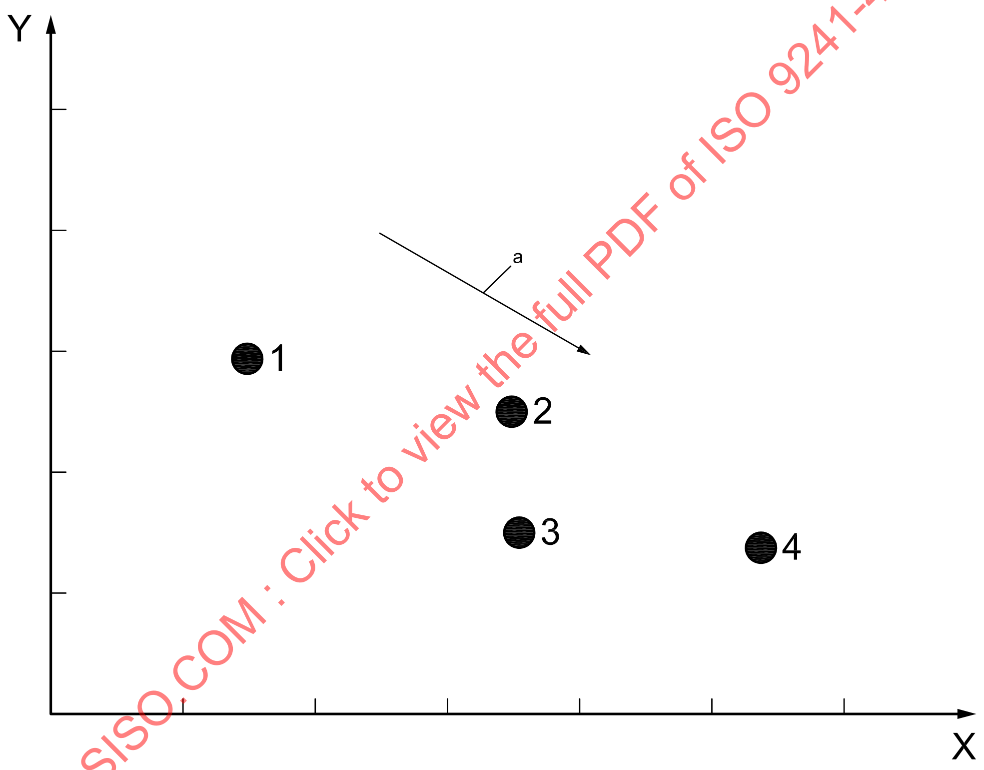
If the subjects are asked to correct errors, the speed is lower and the test situation similar to real-world tasks where a user corrects detected errors from time to time. However, correcting errors can be accomplished through different strategies, and the test may turn into a test of personal abilities instead of a method for the assessment of devices. Therefore, it is better to measure throughput, i.e. uncorrected input, and to evaluate errors separately.

Typing speed is usually registered in characters per second (cps), characters per minute (cpm) or in words per minute (wpm). Since users of mobile devices do not enter only readable sentences, cpm should be used.

Analysing accuracy is not easy, since there can be four types of errors: entering an incorrect character (substitution); omitting a character (omission); adding an extra character (insertion) or swapping neighbouring characters (transposition). For field assessments, it is sufficient to count correct entries and calculate a ratio of incorrect to correct entries.

G.4 Evaluation

Compare throughput and error ratio separately or in a graph combining both (see Figure G.1).



Key

X throughput, cps

Y error ratio, %

1 device 1

2 device 2

3 device 3

4 device 4

[a] Performance gets better.

Figure G.1 — Evaluation of text entry by, for example, four devices

Annex H
(normative)

Tables for selecting devices in consideration of product description

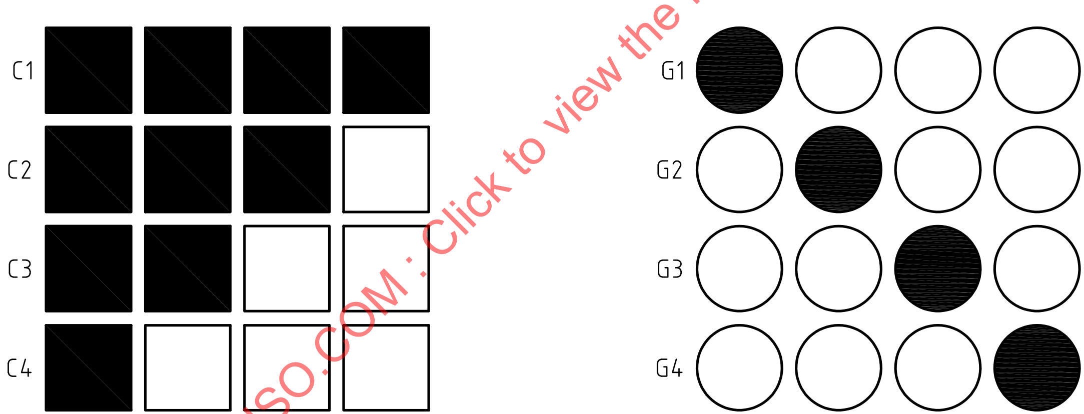
H.1 General

This annex presents five tables for each of the physical input devices treated in ISO 9241-410, and gives the related requirements specified in ISO 9241-410, if existent, or recommendations on how to evaluate a specific feature.

H.2 Representation of information

The information in the product description based on ISO 9241-410 follows the rationale of this part of ISO 9241, i.e. instead of requiring certain values for a property, ISO 9241-410 defines categories (classes or groups) for that property. The manufacturer may decide on the intended class or group and fulfil the requirements for that category. Whether or not a device is usable for the task at hand depends on the characteristics of that task and the use environment.

The classes and groups are represented as shown in Figure H.1.



a) Classes **b) Groups**

Figure H.1 — Classes and groups for properties

Classes (C1 to C4) are categories with rank order, i.e. a product of a higher class fulfils the requirements of all lower classes, whereas groups (G1 to G4) have no rank order. Products belonging to G1 are different from those belonging to G4, but the difference does not constitute a rank.

The tables contain an expected value for each property, if possible.

If a property is relevant but not measurable under the conditions of a field assessment, the property is included in the table with a remark such as “not measurable” or “measurable only with laboratory equipment”.

H.3 Categories (classes and groups) and their meaning

H.3.1 General

For various properties, classes or groups are defined in ISO 9241-410. The information below is cited from ISO 9241-410 for ease of use of the tables.

H.3.2 Operability

An input device shall be operable, i.e. its intended use is obvious, predictable and consistent and the user receives adequate feedback, according to ISO 9241-400.

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.

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).

H.3.3 Classes for obviousness

The obviousness of the intended use is categorised by the following 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.

H.3.4 Classes for predictability (keyboards)

The predictability of the intended use is categorised by the following four classes:

C1 unlimited (exceeds maximum throughput for two-hand operation), n-key rollover or equivalent;

C2 maximum throughput for 90 % of two-hand operation, two-key rollover or equivalent;

C3 no rollover, i.e. first activated key shall be released before the subsequent activated key can be detected;

C4 delayed input necessary, i.e. after releasing the first activated key, a defined time period needs to pass before the subsequent activated key can be detected.

No predictability classes are defined for other devices.

H.3.5 Classes for consistency of operation

H.3.5.1 Keyboards

The consistency of the intended use of a keyboard is categorised by the following four classes:

C1 unlimited (exceeds maximum throughput for two-hand operation), n-key rollover or equivalent;

C2 maximum throughput for 90 % of two-handed input, two-key rollover or equivalent;

C3 no rollover, i.e. first activated key must be released before the subsequent activated key can be detected;

C4 delayed input required, i.e. after releasing the first activated key, a defined time period needs to pass before the subsequent activated key can be detected.

H.3.5.2 Mice

The consistency of the intended use of a mouse is categorised by the following four classes:

C1 independent of the characteristics of the support surface;

C2 operable on any smooth surface;

C3 operation requires a mousepad;

C4 operation requires a mousepad with specific characteristics.

These classes apply to users without special needs. For other user populations, the classes may be modified in consideration of the capabilities of that user population.

H.3.6 Classes for electrical properties

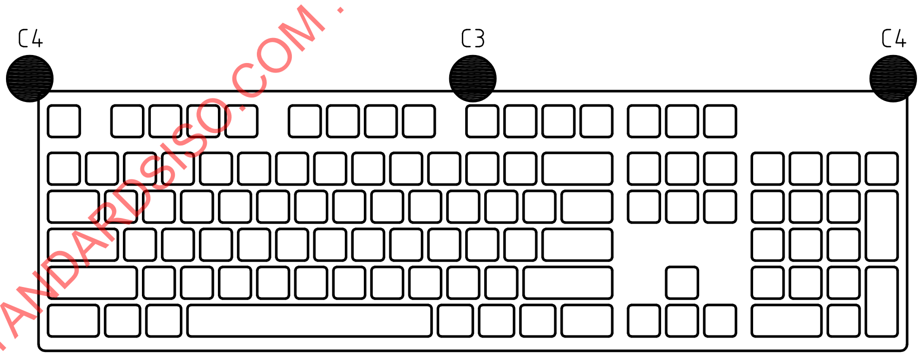
The four classes for the design of the device are (see Figure H.2)

C1 no cable needed,

C2 cable can be plugged in at different locations on the keyboard as needed at a particular workplace,

C3 cable connected at the middle of the device, and

C4 cable connected at one end of the device.



Key

C3 cable connection in middle of device

C4 cable connection at one end of device

NOTE While C2 allows the connection of the cable for minimum interference with space, in C3 the connection is at the middle of the keyboard and in C4 only one of the connections at either end of the keyboard is used.

Figure H.2 — Possible cable connections of a keyboard (from ISO 9241-410)

The design of the cable can interfere with the space if the cable is, for example, too thick, too stiff or too long (see Figure H.3).

The four classes for the design of the cable are

- C1 no cable needed,
- C2 thin, flexible cable,
- C3 spiral cable with the spiral end at the keyboard, and
- C4 cable thick or inflexible due to other considerations.

C2 **C3** **C4**

Figure H.3 — Cables categorised for possible interference with other devices on the desktop

H.3.7 Further property names used in the tables

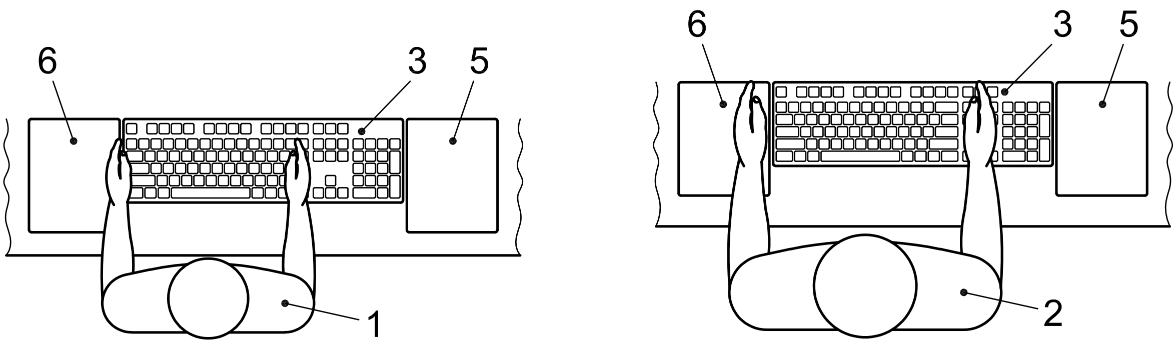
H.3.7.1 User compatibility

Physical input devices shall be user-compatible, i.e. their design shall accommodate the intended user anthropometric characteristics and biomechanical capabilities, in accordance with ISO 9241-410.

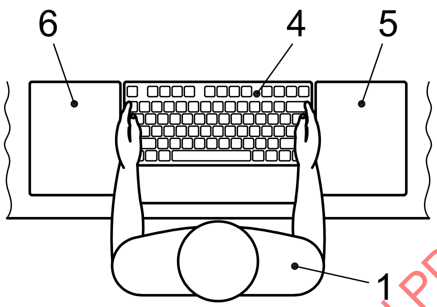
Since user compatibility is difficult to evaluate directly, one can evaluate whether or not the performance of the body part used for the operation of the device is impaired due to the properties of the object under consideration. For example, keyboards with smaller keys are likely to reduce throughput and increase errors. Thus, keyboards with a spacing of 19 mm are considered “fully compatible”, whereas keyboards with much smaller keys are less compatible.

H.3.7.2 Posture

The evaluation of the posture considers arm and hand posture only. “Neutral” posture here means that muscles involved in the activity are not deliberately contracted (see Figure H.4).



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 H.4 — Neutral posture for arms and hands (from ISO 9241-410)

H.3.7.3 Feedback for keyboard use

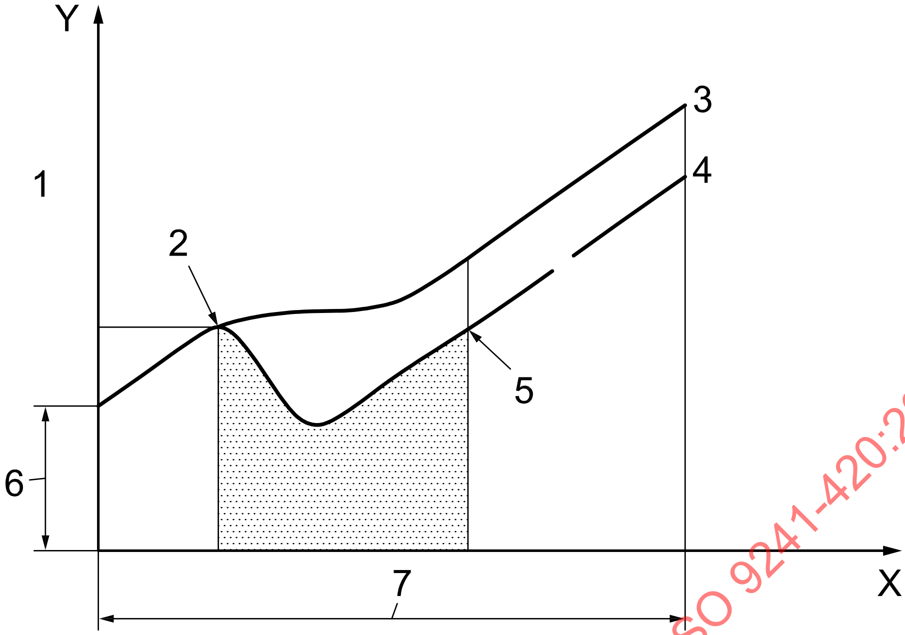
The optimum feedback for touch-typing is the kinaesthetic feedback that necessitates a certain characteristic for force and displacement (see Figure H.5). Since not all keyboard are designed for touch-typing, other types of feedback can be appropriate; therefore, feedback is categorised by the following 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.



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 by ISO 9241-410)

2 snap point

3 ramp action

4 snap action

5 switch-make point occurs — after snap point, at force ≤ snap point

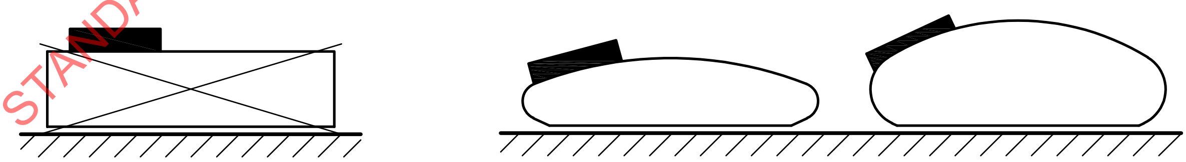
6 initial resistance — between 25 % and 75 % of force at snap point

7 full travel — 2 mm to 4 mm (preferred), 1,5 mm to 6 mm (permitted by ISO 9241-410)

Figure H.5 — Relationship between key displacement and key force for optimum kinaesthetic feedback (from ISO 9241-410)

H.3.7.4 Control access

While using a device, one or more controls can be needed to accomplish an action. For example, for pointing and selecting an object, the mouse is moved and a button activated. The main requirement for control access is that actuating any button or combination of buttons does not move the focus of the pointer. The design of a device should aim at minimising finger extension and optimising finger movements (see Figure H.6).



a) Initial design enforcing extension

b) Forward inclination to change finger starting position into flexion

Figure H.6 — Example of design aimed at minimising finger extension (from ISO 9241-410)

H.3.7.5 Interdependency with use environment (acoustic)

The use of an input device can be affected by environmental conditions, e.g. voice input by ambient noise. The environment can also be affected by the use of a device, e.g. the noise emission of keyboards. To address this aspect, ISO 9241-410 defines three classes of noise level for the environment, depending on which noise emitted by the keyboard can be evaluated:

C1 suitable for meeting rooms or tasks involving concentration [35 dB(A) to 45 dB(A)];

C2 suitable for routine office work [45 dB(A) to 55 dB(A)];

C3 suitable for industrial workplaces [75 dB(A) to 80 dB(A)].

The data in square brackets in the list is the recommended maximum noise exposure range.

H.3.8 Using the tables

Tables H.1 to H.141 each comprise four main columns, with the first of these naming the relevant property. All properties treated in ISO 9241-410 are included. The second column gives the assessment, divided in two further columns to give the answer. The first answer is “Yes”, because an appropriate device is expected to fulfil all requirements. The second answer can be “No” or something different, depending on the nature of the requirement, recommendation or comment given in the fourth column. The third column gives an expected value, i.e. what can be considered state-of-the-art technology.

For example, the requirement for cabling a device is that it shall not interfere with the use of that device. In this case, a device without a cable will always fulfil this requirement (C1). This value is indicated in column 3. However, there can be many good reasons for using a cable in a use environment, hence three other classes for cabling with growing possibility of affecting the work. But it can still be possible to fulfil the requirement, e.g. through adequate arrangement of the workplace.

For most items, the user should either mark “Yes” if the evaluation yields a *satisfactory* result under the specific conditions, or “No” or another option if the answer is not clearly “Yes”.

For example, the requirement for a number of features is that the device shall either belong to class 1 (best class) or the class shall be specified. The response for such a requirement is

❍ **Yes** ❍ Class adequate?

If the product description states that the product conforms to the requirements for class 1, the product passes. If another class is given, the user needs to assess whether the class of the product is adequate for the task at hand.

For example, for the operation of a mouse, the classes are those given in H.3.5.2. A C1 product would function on any support surface in the same way. However, requiring such abilities from any mouse cannot be justified since most use environments include either a smooth surface or would allow placing a mousepad. Thus C2 and C3 products may be adequate for most professional or private use environments.

In certain cases, the use of a device may require certain features for the mousepad. If the required characteristics can be realized in the use environment, a C4 device can be adequate.

H.4 Tables for selecting devices in consideration of product description

H.4.1 Tables for selection of compact keyboards

Table H.1 — Correspondence with generic requirements on compact keyboards — Appropriateness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Effectiveness Efficiency Dimensioning	**❍Yes**	❍No	—	Determine using Figure 17.
Software dependency	❍Yes	**❍No**	—	Application software should not limit the throughput and accuracy of the device.
Additional device	❍Yes	**❍No**	—	Device should be fully functional without any additional aid. If an additional device is required (e.g. stylus), the documentation shall indicate this.

Table H.2 — Correspondence with generic requirements on compact keyboards — Operability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Obviousness	**❍Yes**	❍Instructions?	■■■■	If the functions cannot be detected by trial and error by the user, relevant information shall be included in the documentation.
Predictability	**❍Yes**	❍Class?	■■■■	Device shall not limit input speed and accuracy (keys with n-key rollover, testable by touch typist); if not, the class shall be specified.
Consistency	**❍Yes**	❍Group?	■■■■	Accuracy of input (typing errors) shall remain the same under all conditions of use, as specified in the documentation. To be evaluated if the actual use differs from optimum two-hand keying operation.
Compatibility	**❍Yes**	❍Class?	○○○●	Spacing of the keys shall be either 19 mm ± 1 mm or the group shall be specified (Group 2: 14 mm; Group 3: 12 mm; Group 4: less than 10 mm).
Feedback	**❍Yes**	❍Class?	■■■■	Device shall provide continuous kinaesthetic feedback sufficient for two-handed touch-typing (see Figure H.5) or the class shall be specified (Class 2: ramp action and auditory; Class 3: auditory; Class 4: delayed visual feedback).

Table H.3 — Correspondence with generic requirements on compact keyboards — Controllability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Responsiveness	—	—	—	See Functional properties.
Non-interference	—	—	—	See Functional properties.
Reliability of device access	—	—	—	See Functional properties.
Control access	—	—	—	See Functional properties.

Table H.4 — Correspondence with generic requirements on compact keyboards — Biomechanical load

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Posture	❍**Yes**	❍No	—	Access and use of the device shall not require undue deviation from neutral posture (see Figure H.4) for the arm and the hand.
Effort	—	—	—	see Functional properties.

Table H.5 — Functional properties of compact keyboards — Design of keys of compact keyboards — Design of keys

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Keytop shape	❍**Yes**	❍No	—	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.
Strike surface	❍**Yes**	❍No	—	Strike surface of normal-size keys: ≥ 110 mm^2 in the alphanumeric and numeric zones, outside this area: ≥ 64 mm^2.
Tactile indicators	❍**Yes**	❍No	—	Tactile indicators should be provided on the appropriate keys on the home rows of the alphanumeric zones.
Force	Not measurable	Not measurable	—	Key force at the snap point between 0,5 N to 0,8 N; measurable only with laboratory equipment.
Force/displacement	Not measurable	Not measurable	—	Optimum characteristics as shown in Figure H.5; measurable only with laboratory equipment.
Feedback	❍**Yes** ❍**Yes** ❍**Visible**	❍No ❍No ❍No	— — —	Best feedback kinaesthetic (“snap” action). Auditory feedback shall be suppressible. Long-term status (e.g. caps lock activated) visible (e.g. indicator lamp, mechanical displacement).

Table H.6 — Functional properties of compact keyboards — Design of keys — Key legends

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Readability	❍**Yes**	❍No	—	Height of primary legends: ≥ 2,6 mm.
Graphic symbols	[a]	[a]	—	—
Durability of legends	❍**Yes**	❍No	—	The legends shall be legible throughout the intended life of the product. The legends shall be robust and durable so that they are able to withstand normal wear and tear, including regular cleaning. Currently, the intended life of a desktop keyboard is calculated for continuous keying on “E” over the workday during the full life span of the product, assuming the approximate occurrence of the character “e” in European languages. Keyboards designed for portable use may offer a shorter intended life than devices intended for stationary use.

[a] For graphic symbols, consult ISO 7000 and, if necessary, the IEC 60417 data base.

Table H.7 — Functional properties of compact keyboards — Design of keyboard — Sections and zones

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Alphanumeric	❍Yes	❍No	●	Required
Numeric	❍Yes	❍No	○	Not required
Editing	❍Yes	❍No	●	Required; may be integrated in the alphanumeric zone.
Function	❍Yes	❍No	●	Required
Multimedia	❍Yes	❍No	○	Not required; assess functionality if present.

Table H.8 — Functional properties of compact keyboards — Design of keyboard — Mechanical design

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Centre-line spacing	❍Yes	❍No	—	Numeric and alphanumeric zones: 19 mm ± 1 mm; elsewhere ≥ 16 mm.
Home-row height	❍Yes	❍No	—	Less than 30 mm in the row with the symbol “A”; lower profile preferred.
Width and depth	❍Yes	❍No	—	The width and depth of the device should not considerably exceed the space required for proper layout of the keys.
Slope	❍Yes	❍No	—	Slope of the keyboard 0° to 12° (0° preferred; for touch typists a negative slope may be beneficial).
Surface gloss	❍Yes	❍No	—	Matt (for use in environments with high hygienic requirements, keyboard may be glossy).
Surface reflectance	❍Yes	❍No	—	Not too dark, not too light (correct figure: diffuse reflectance between 0,15 and 0,75).
Weight	❍Yes	❍No	—	Sufficient to avoid slipping during use; no value given because different designs can avoid slipping with different aids.
Thermal conductivity	❍Yes	❍No	—	Low (relevant for cold and warm use environments).
Adjustability	❍Yes	❍No	—	If present: any adjustment mechanism shall not compromise the requirements for stability and placement. Adjustments shall not change unintentionally. Tools shall be required for adjustment purposes.
Palm rest	❍Yes	❍No	—	If present: depth at least 50 mm to 100 mm.

Table H.9 — Other considerations for compact keyboards — Electrical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Cable connection	❍Yes	❍No	■■■■	No interference with use; no cable if possible (C1) (for other classes, see Figure H.2).
Cable design	❍Yes	❍No	■■■■	Interference with space as small as possible (for appropriate design of keyboard and cable, see Figure H.3).
Weight of batteries	—	—	—	Relevant for non-stationary use; no requirement.

Table H.10 — Other considerations for compact keyboards — Maintainability-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Easy cleaning	❍Yes	❍No	—	If easy cleaning required for hygienic reasons, keyboard may be glossy, but consider glare if the device is used in bright environments.
Battery status	❍Yes	❍No	—	Easily detectable indication of the battery power status (e.g. indicator lamp, alarm sound or mechanical indicator).
Low-power indicator	❍Yes	❍No	—	Low-battery alarm more than 5 min before failure, not relevant if integrated into portable computers.

Table H.11 — Other considerations for compact keyboards — Interdependencies

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
With software	❍Yes	❍No	—	Input speed not affected by application; testable through input in different applications.
With acoustic environment	❍Yes	❍Class adequate?	■■■■	Suitable for meeting rooms [(35 dB(A) to 45 dB(A)]; other classes, C1: for routine office work, C2: for industrial workplaces.
With limited space	❍Yes	❍No	—	Select appropriate size (see Figure H.4) if insufficient space available in the use environment.
With lighting	❍Yes	❍No	—	Some lighting can cause glare; remedy either through better lighting or less glossy device or other place for the keyboard.
With visual environment	❍Yes	❍No	—	If colour recognition important, no visible reflection on the screen.

Table H.12 — Other considerations for compact keyboards — Documentation

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Special training	❍Yes	❍No	—	To be specified if necessary.
Additional physical tools	❍Yes	❍No	—	To be specified if necessary (e.g. stylus for small buttons).
Specific software support	❍Yes	❍No	—	To be specified if necessary.

H.4.2 Tables for selection of full-size keyboards

Table H.13 — Correspondence with generic requirements on full-size keyboards — Appropriateness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Effectiveness Efficiency Dimensioning	❍**Yes**	❍No	—	Determine using Figure 17.
Software dependency	❍Yes	❍**No**	—	Application software should not limit the throughput and accuracy of the device.
Additional device	❍Yes	❍**No**	—	Device should be fully functional without any additional aid. If an additional device is required (e.g. stylus), the documentation shall indicate this.

Table H.14 — Correspondence with generic requirements on full-size keyboards — Operability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Obviousness	❍**Yes**	❍Instructions?	■■■■	If the functions cannot be detected by trial and error by the user, relevant information shall be included in the documentation.
Predictability	❍**Yes**	❍Class?	■■■■	Device shall not limit input speed and accuracy (keys with n-key rollover, testable by a touch typist); if not, the class shall be specified.
Consistency	❍**Yes**	❍Class?	■■■■	Accuracy of input (typing errors) shall remain the same under all conditions of use, as specified in the documentation. To be evaluated if the actual use differs from optimum two-hand keying operation.
Compatibility	❍**Yes**	❍Group?	○○○●	Spacing of the keys shall be either 19 mm ± 1 mm or the group shall be specified (Group 2: 14 mm; Group 3: 12 mm; Group 4: less than 10 mm.)
Feedback	❍**Yes**	❍Class?	■■■■	Device shall provide continuous kinaesthetic feedback sufficient for two-handed touch-typing (see Figure H.5) or the class shall be specified (Class 2: ramp action and auditory; Class 3: auditory; Class 4: delayed visual feedback).

Table H.15 — Correspondence with generic requirements on full-size keyboards — Controllability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Responsiveness	—	—	—	see Functional properties
Non-interference	—	—	—	see Functional properties
Reliability of device access	—	—	—	see Functional properties
Control access	—	—	—	see Functional properties

Table H.16 — Correspondence with generic requirements on full-size keyboards — Biomechanical load

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Posture	❍**Yes**	❍No	—	Access and use of the device shall not require undue deviation from neutral posture (see Figure H.4) for arm and hand.
Effort	—	—	—	see Functional properties.

Table H.17 — Functional properties of full-size keyboards — Design of keys — Design of keys

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Keytop shape	❍**Yes**	❍No	—	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.
Strike surface	❍**Yes**	❍No	—	Strike surface of normal-size keys: $\geq$ 110 mm^2 in the alphanumeric and numeric zones; outside this area: $\geq$ 64 mm^2.
Tactile indicators	❍**Yes**	❍No	—	Tactile indicators should be provided on the appropriate keys on the home rows of the alphanumeric zones.
Force	Not measurable	Not measurable	—	Key force at the snap point between 0,5 N to 0,8 N; measurable only with laboratory equipment.
Force/displacement	Not measurable	Not measurable	—	Optimum characteristics as shown in Figure H.5; measurable only with laboratory equipment.
Feedback	❍**Yes** ❍**Yes** ❍**Visible**	❍No ❍No ❍No	— — —	Best feedback kinaesthetic (“snap” action). Auditory feedback shall be suppressible. Long-term status (e.g. caps lock activated) visible (e.g. indicator lamp, mechanical displacement).

Table H.18 — Functional properties of full-size keyboards — Design of keys — Key legends

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Readability	❍**Yes** ❍**Yes**	❍No ❍No	— —	Height of primary legends: $\geq$ 2,6 mm. Height of abbreviations: $\geq$ 2,2 mm.
Graphic symbols	a	a	—	—
Durability of legends	❍**Yes**	❍No	—	The legends shall be legible throughout the intended life of the product. The legends shall be robust and durable so that they are able to withstand normal wear and tear, including regular cleaning. Currently, the intended life of desktop keyboards is calculated for continuous keying on “E” over the workday during the full life span of the product, assuming the approximate occurrence of the character “e” in European languages.

[a] For graphic symbols, consult ISO 7000 and, if necessary, the IEC 60417 data base.

Table H.19 — Functional properties of full-size keyboards — Design of keyboard — Sections and zones

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Alphanumeric	❍**Yes**	❍No	●	Required
Numeric	❍**Yes**	❍No	●	Required
Editing	❍**Yes**	❍No	●	Required
Function	❍**Yes**	❍No	●	Required
Multimedia	❍**Yes**	❍No	❍	Not required; assess functionality if present.

Table H.20 — Functional properties of full-size keyboards — Design of keyboard — Mechanical design

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Centre-line spacing	❍**Yes**	❍No	—	Numeric and alphanumeric zones: 19 mm ± 1 mm; elsewhere ≥ 16 mm.
Home-row height	❍**Yes**	❍No	—	Less than 30 mm in the row with the symbol “A”; lower profile preferred.
Width and depth	❍**Yes**	❍No	—	The width and depth of the device should not considerably exceed the space required for proper layout of the keys.
Slope	❍**Yes**	❍No	—	Slope of the keyboard 0° to 12° (0° preferred; for touch typists a negative slope may be beneficial).
Surface gloss	❍**Yes**	❍No	—	Matt (for use in environments with high hygienic requirements, keyboard may be glossy).
Surface reflectance	❍**Yes**	❍No	—	Not too dark, not too light (correct figure: diffuse reflectance between 0,15 and 0,75).
Weight	❍**Yes**	❍No	—	Sufficient to avoid slipping during use; no value given because different designs can avoid slipping with different aids.
Thermal conductivity	❍**Yes**	❍No	—	Low (relevant for cold and warm use environments).
Adjustability	❍**Yes**	❍No	—	If present: any adjustment mechanism shall not compromise the requirements for stability and placement. Adjustments shall not change unintentionally. Tools shall be required for adjustment purposes.
Palm-rest	❍**Yes**	❍No	—	If present: depth at least 50 mm to 100 mm.

Table H.21 — Other considerations for full-size keyboards — Electrical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Cable connection	❍**Yes**	❍No	■■■■	No interference with use; no cable if possible (C1) (other classes, see Figure H.2).
Cable design	❍**Yes**	❍No	■■■■	Interference with space as small as possible (for appropriate design of keyboard and cable, see Figure H.3).
Weight of batteries	—	—	—	Not relevant for stationary use.

Table H.22 — Other considerations for full-size keyboards — Maintainability-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Easy cleaning	❍**Yes**	❍No	—	If easy cleaning required for hygienic reasons, keyboard may be glossy.
Battery status	❍**Yes**	❍No	—	Easily detectable indication of the battery power status (e.g. indicator lamp, alarm sound or mechanical indicator).
Low-power indicator	❍**Yes**	❍No	—	Low-battery alarm more than 5 min before failure.

Table H.23 — Other considerations for full-size keyboards — Interdependencies

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
With software	❍**Yes**	❍No	—	Input speed not affected by application; testable through input in different applications.
With acoustic environment	❍**Yes**	❍Class adequate?	■■■■	Suitable for meeting rooms [(35 db(A) to 45 dB(A)]; other classes, C1: for routine office work, C2: for industrial workplaces.
With limited space	❍**Yes**	❍No	—	Select appropriate size (see Figure 17) if insufficient space available in the use environment.
With lighting	❍**Yes**	❍No	—	Some lighting can cause gloss; remedy either through better lighting or less glossy device or other place for the keyboard.
With visual environment	❍**Yes**	❍No	—	If colour recognition important, no visible reflection on the screen.

Table H.24 — Other considerations for full-size keyboards — Documentation

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Special training	❍**Yes**	❍No	—	To be specified if necessary.
Additional physical tools	❍**Yes**	❍No	—	To be specified if necessary (e.g. stylus for small buttons).
Specific software support	❍**Yes**	❍No	—	To be specified if necessary.

H.4.3 Tables for selection of mice

Table H.25 — Correspondence with generic requirements on mice — Appropriateness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Effectiveness	**❍Yes**	❍No	■■■■	Device should enable the highest throughput for the human hand.
Efficiency	**❍Yes**	❍No	■■■■	Device should enable the highest throughput for the human hand.
Dimensioning	—	—	—	For the dimensioning of a mouse, no reliable data exists for achieving high appropriateness.
Software dependency	❍Yes	**❍No**	—	Application software should not limit the throughput and accuracy of the device.
Additional device	❍Yes	**❍No**	—	Device should be fully functional without any additional aid. If an additional device such as a keyboard is to be used the same time, it should not interfere with the functionality.

Table H.26 — Correspondence with generic requirements on mice — Operability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Obviousness	**❍Yes**	❍Instructions?	■■■□	If the functions cannot be detected by trial and error by the user, relevant information shall be included in the documentation.
Predictability	**❍Yes**	❍No?	■■■■	The user should be able to sense the direction of the movement of the pointer without visual contact with the device.
Consistency	**❍Yes**	❍Class?	■■■■	Device should be operable on any support (C2: any smooth surface; C3: mousepad; C4: specific mousepad).
Compatibility	**❍Yes**	❍Limited performance?	■■■■	Device should be suitable for pointing tasks with the highest speed and accuracy or the limitation of the performance shall be indicated.
Feedback	**❍Yes**	❍No?	—	Feedback shall occur in less than 20 ms. Since the time can only be measured in a laboratory, assess whether a delay is visible.

Table H.27 — Correspondence with generic requirements on mice — Controllability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Responsiveness	**❍Yes**	❍No?	—	Device shall give continuous and consistent feedback under the conditions of intended use.
Non-interference	**❍Yes**	❍No?	—	Operating the device shall not interfere with its use, e.g. the stiffness of the cable moves the mouse.
Reliability of device access	**❍Yes**	❍No?	—	Design of the device shall enable the user to sense the orientation of the device without visual access to it.
Control access	**❍Yes**	❍No?	—	Access to buttons shall be easy and without undue effort for access (see Figure H.6).

Table H.28 — Correspondence with generic requirements on mice — Biomechanical load

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Posture	❍**Yes**	❍No	—	Access and use of the device shall not require undue deviation from neutral posture (see Figure H.4) for arm and hand.
Effort	—	—	—	Not relevant for mouse use.

Table H.29 — Functional properties of mice — Functional properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Anchoring	❍**Yes**	❍No	—	It shall be possible to anchor some part of the fingers, hand or arm on either the input device or the work surface to create a stable relationship between the hand and the point of action.
Resolution	❍**Yes**	❍Class adequate[a]	—	Device shall either offer sufficient resolution for difficult pointing tasks or for the task at hand.
Sensor location	❍**Yes**	❍No	—	Sensor of the device should be under the fingers rather than under the palm of the hand.

[a] Device classes 2 to 4.

Table H.30 — Functional properties of mice — Button design

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Button motion	❍**Yes**	❍No	—	Fingers should be able to make contact with and press the buttons without undue movement.
Button actuation	❍**Yes**	❍No	—	It should be possible to press the buttons on the mouse without reducing control of the device.
Button activation	❍**Yes**	❍No	—	It should be possible to activate the buttons on the mouse without reducing control of the device.
Button shape	❍**Yes**	❍No	—	Device should be designed to be resistant to inadvertent button activation (click) during use.
Button force	❍**Yes**	❍No	—	Buttons should not feel too easy or too hard to press (required force range between 0,5 N and 1,5 N, measurable with suitable equipment only).
Button displacement	❍**Yes**	❍No	—	Buttons should move slightly when pressed (required travel of 0,5 mm, measurable with suitable equipment only).
Inadvertent pointer movement	❍**Yes**	❍No	—	Button actuation shall not cause unintended movement of the pointer.
Button lock	❍**Yes**	❍No	—	Device design or software should enable the user to lock buttons which need to be pressed continuously, e.g. during dragging or tracing.

Table H.31 — Functional properties of mice — Considerations of handedness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Ambidextrous use	❍Yes	❍No	—	Devices should be operable using either hand; or right- and left-handed devices should be available. The shape and location of the controls (buttons, wheel) should be selected to support ambidextrous use of the device.

Table H.32 — Functional properties of mice — Resolution consistency

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Resolution consistency	❍Yes	❍No	—	Resolution of the device shall be independent of both the position of the device and the position of the pointer on the screen.

Table H.33 — Other properties of mice — Mechanical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Mechanical properties	—	—		No separate consideration necessary.

Table H.34 — Other properties of mice — Electrical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Interference of cable with use	❍Yes	❍No	■■■■	No cable or interference under work conditions (Class 2: cable does not interfere with use; Class 3: additional aids necessary to stop interference).
Electromagnetic influences	Not relevant	Not relevant	—	Devices conforming to standards for electromagnetic compatibility are unlikely to cause problems.
Weight of batteries	Not relevant	Not relevant	—	Weight of batteries is unlikely to reduce usability of device through increased friction.

Table H.35 — Other properties of mice — Maintainability-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Cleaning	❍Yes	❍No	—	All parts to be cleaned by the user shall be accessible without tools.
Dependence from power supply	❍Yes	❍No	—	Operational characteristics should be independent from the current state of power supply.
Power indicator	❍Yes	❍No	—	Insufficient power supply (batteries) should be indicated in a timely and proper manner before functionality can be impaired.

Table H.36 — Other properties of mice — Health- and safety-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Edges and corners	❍Yes	❍No	—	Sharp edges or corners shall be avoided. (Exact measurement for edges ≥ 2 mm and for corners ≥ 3 mm.)
Static muscle load avoided	❍Yes	❍No	—	Cabling can turn or pull the device if the grip is loosened. Loading to static muscle load to be prevented by adequate measures.
Material	❍Yes	❍No	Not measurable under practical conditions	Device should not contain or be made of materials known to cause health and safety problems through skin contact or emissions. Normally considered by health and safety regulations.

Table H.37 — Interdependencies and documentation of mice — Interdependency with software

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
No dedicated software	❍Yes	❍No	—	Documentation shall specify how the device is to be properly operated if no dedicated software is delivered with the device.
Documentation of setup	❍Yes	❍No	—	Documentation shall specify the setting up of the device for its intended use.
Testing settings	❍Yes	❍No	—	There should be the possibility of testing the settings.

Table H.38 — Interdependencies and documentation of mice — Interdependency with use environment

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Sufficient space	❍Yes	❍No	—	Proper mouse use necessitates sufficient space (about the size of A4/letter sheet of paper, portrait) if used right or left of the keyboard.
Remedy for insufficient space	❍Yes	❍No	—	Variable gain may help if not sufficient space available. There are also equivalent devices with lower space requirements.
Remedy for vibrations	❍Yes	❍No	—	Effects of vibrations of the user or the support surface can be avoided by software to a certain degree.

Table H.39 — Interdependencies and documentation of mice — Documentation

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Optimum location of device	❍**Yes**	❍No	—	Optimum location of the mouse for best effectiveness, efficiency and postural comfort shall be described.
Location for keyboard use	❍**Yes**	❍No	—	Best location of the device for concurrent use with a keyboard shall be specified.
Adjustment of gain	❍**Yes**	❍No	—	Adjustment of gain for limited space for the operation shall be specified.
Support surface	❍**Yes**	❍No	—	If reaching the maximum level of effectiveness and efficiency for a given device requires certain characteristics, the relevant requirements shall be specified.
Dust, sand, dirt, etc.	❍**Yes**	❍No	—	Not relevant for living areas and office workspaces. Elsewhere, cleaning and testing proper functioning of the device may be warranted.

H.4.4 Tables for selection of pucks

Table H.40 — Correspondence with generic requirements on pucks — Appropriateness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Effectiveness	❍**Yes**	❍No	■■■■	Device should enable the highest throughput for the human hand.
Efficiency	❍**Yes**	❍No	■■■■	Device should enable the highest accuracy for pointing for the human hand.
Dimensioning	—	—	—	For the dimensioning of a puck, no reliable data exists for achieving a high level of appropriateness.
Software dependency	❍Yes	❍**No**	—	Application software should not limit the throughput and accuracy of the device.
Additional device	❍Yes	❍**No**	—	Device should be fully functional without any additional aid. Other devices such as keyboards to be used at the same time should not interfere with the functionality.

Table H.41 — Correspondence with generic requirements on pucks — Operability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Obviousness	❍Yes	❍Instructions?	■■■□	If the functions cannot be detected by trial and error by the user, relevant information shall be included in the documentation.
Predictability	❍Yes	❍No?[a]	■■■■	The user should be able to sense the direction of the movement of the pointer without visual contact with the device.
Consistency	❍Yes	❍Class?	■■■■	Device is usually operated on a tablet designed for this purpose. Thus, its use is consistent per se. The resolution can be different for the same device used on tablets of different size; relevant if used with different tablets.
Compatibility	❍Yes	❍Limited performance?	■■■■	Device should be suitable for pointing tasks with highest speed and accuracy or the limitation of the performance shall be indicated.
Feedback	❍Yes	❍No?[a]	—	Visual feedback on the screen is less critical than with the mouse and is appropriate if it occurs within 50 ms after stopping the movement.

[a] Since pucks indicate the absolute position of the target, tactile feedback is always given through the position of the limbs.

Table H.42 — Correspondence with generic requirements on pucks — Controllability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Responsiveness	❍Yes	❍ No?	—	High in general because device gives continuous and consistent feedback on its absolute position. Buttons should have a minimum travel of 0,5 mm if their feedback is kinaesthetic only.
Non-interference	❍Yes	❍No?	—	Operating the device shall not interfere with its use, e.g. the reticle window obscures the object under it.
Reliability of device access	❍Yes	❍No?	—	Design of the device shall enable the user to sense the orientation of the device without visual access to it.
Control access	❍Yes	❍No?	—	Access to buttons shall be easy and without undue effort for access (see Figure H.6).

Table H.43 — Correspondence with generic requirements on pucks — Biomechanical load

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Posture	❍Yes	❍No	—	Access and use of the device shall not require undue deviation from neutral posture (see Figure H.4) for arm and hand.
Effort	—	—	—	Not relevant for puck use.

Table H.44 — Functional properties of pucks — Functional properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Anchoring	❍**Yes**	❍No	—	It shall be possible to anchor some part of the fingers, hand or arm on either the input device or the work surface to create a stable relationship between the hand and the point of action.
Resolution	❍**Yes**	❍Class adequate[a]	—	Device shall either offer sufficient resolution for difficult pointing tasks or for the task at hand. It can be assumed that a puck is designed for highest possible resolution.
Sensor location	❍**Yes**	❍No	—	Sensor of the device is located in the centre of the reticle window. Thus, it should be considered that the usable sensitive space of the tablet is limited by the size of the device.
[a] Device classes 2 to 4.				

Table H.45 — Functional properties of pucks — Button design

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Button motion	❍**Yes**	❍No	—	Fingers should be able to make contact with and press the buttons without undue movement.
Button actuation	❍**Yes**	❍No	—	It should be possible to press the buttons on the puck without reducing control of the device.
Button activation	❍**Yes**	❍No	—	It should be possible to activate the buttons on the puck without reducing control of the device.
Button shape	❍**Yes**	❍No	—	Device should be designed to be resistant to inadvertent button activation (click) during use.
Button force	❍**Yes**	❍No	—	Buttons should not feel too easy or too hard to press (required force range between 0,5 N and 1,5 N, measurable with suitable equipment only).
Button displacement	❍**Yes**	❍No	—	Buttons should move slightly when pressed (required travel of 0,5 mm, measurable with suitable equipment only).
Inadvertent pointer movement	❍**Yes**	❍No	—	Button actuation shall not cause unintended movement of the pointer.
Button lock	❍**Yes**	❍No	—	Device design or software should enable the user to lock buttons which need to be pressed continuously.

Table H.46 — Functional properties of pucks — Consideration of handedness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Ambidextrous use	❍**Yes**	❍No	—	Devices should be operable using either hand; or right- and left-handed devices should be available.

Table H.47 — Functional properties of pucks — Resolution consistency

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Resolution consistency	❍Yes	❍No	—	Resolution of a puck shall be independent of the position of both device and tablet.

Table H.48 — Other properties of pucks — Mechanical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Unintended slippage	❍Yes	❍No	—	The puck should be resistant to unintended slippage if it is used on an inclined surface.
Reticle location	❍Yes	❍No	—	The reticle window should be located on the puck to allow it to be operated without causing the user's head to deviate excessively (by more than 15°).
Reticle window	❍Yes	❍No	—	The reticle window should be sufficiently transparent and free of aberrations to allow appropriate visibility of the target.

Table H.49 — Other properties of pucks — Electrical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Interference of cable with use	❍Yes	❍No	■■■■	No cable or interference under work conditions (Class 2: cable does not interfere with use; Class 3: additional aids necessary to stop interference).
Electromagnetic influences	Not relevant	Not relevant	—	Devices conforming to standards for electromagnetic compatibility are unlikely to cause problems.
Weight of batteries	Not relevant	Not relevant	—	Weight of batteries is unlikely to reduce usability of device, e.g. through increased friction.

Table H.50 — Other properties of pucks — Maintainability-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Cleaning	❍Yes	❍No	—	The reticle window should be formed to facilitate cleaning. Any precautions necessary during cleaning shall be indicated in the documentation.
Dependence from power supply	❍Yes	❍No	—	The puck should function properly for about a minute after the warning.
Power indicator	❍Yes	❍No	—	Insufficient power supply (batteries) should be indicated in a timely and proper manner before functionality is impaired.

Table H.51 — Other properties of pucks — Health- and safety-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Edges or corners	❍**Yes**	❍No	—	Sharp edges or corners shall be avoided. (Exact measurement for edges ≥ 2 mm and for corners ≥ 3 mm.)
Material	❍**Yes**	❍No	Not measurable under practical conditions	Device should not contain or be made of materials known to cause health and safety problems through skin contact or emissions. Normally considered by health and safety regulations.

Table H.52 — Interdependencies and documentation of pucks — Interdependency with software

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
No dedicated software	❍**Yes**	❍No	—	Documentation shall specify how the device is to be properly operated if no dedicated software is delivered with the device.
Documentation of setup	❍**Yes**	❍No	—	Documentation shall specify the setting up of the device for its intended use.
Testing settings	❍**Yes**	❍No	—	There should be the possibility of testing the settings.

Table H.53 — Interdependencies and documentation of pucks — Interdependency with use environment

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Sufficient space	❍**Yes**	❍No	—	Proper puck use necessitates sufficient space on the tablet so that it can be positioned and function properly.
Remedy for insufficient space	❍**Yes**	❍No	—	Usable space on the tablet should match the needs of the intended use.
Remedy for vibrations	❍**Yes**	❍No	—	Pucks are unlikely to be used in use environments where vibrations can be expected to interfere with the operation of the device.

Table H.54 — Interdependencies and documentation of pucks — Documentation

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Optimum location of device	❍Yes	❍No	—	Optimum location of the tablet and puck for best effectiveness, efficiency and postural comfort shall be described.
Location for keyboard use	❍Yes	❍No	—	Best location of the tablet for concurrent use with a keyboard shall be specified.
Improving posture	❍Yes	❍No	—	Features of the hardware/software that may improve postural comfort or reduce biomechanical load (e.g. subdivision of the tablet into smaller areas with different resolutions) shall be included in the documentation.
Surface of tablet	❍Yes	❍No	—	If reaching the maximum level of effectiveness and efficiency for a given device requires certain characteristics for the surface of the tablet, the relevant requirements shall be specified in the documentation.
Dust, sand, dirt, etc.	❍Yes	❍No	—	Not relevant for living areas and office workspaces. Elsewhere, cleaning and testing the proper functioning of the device may be warranted.

H.4.5 Tables for selection of joysticks

Table H.55 — Correspondence with generic requirements on joysticks — Appropriateness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Effectiveness Efficiency Dimensioning Software dependency Additional device	—	—	—	Since a variety of joysticks with extremely different designs and functionalities exists, no provisions can be given in a normative sense. It can be stated, however, that joysticks are not affected considerably by the use of other devices or by the use environment. Thus, if a joystick is usable it can be assumed that it is appropriate, too.

Table H.56 — Correspondence with generic requirements on joysticks — Operability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Obviousness	❍**Yes**	❍Instructions?	■■□□	If the functions cannot be detected by trial and error by the user, relevant information shall be included in the documentation. This will be the case for many designs with complex functionality.
Predictability	❍**Yes**	❍No?[a]	(■■■■)	—
Consistency	❍**Yes**	❍Class?[b]	■■■■	—
Compatibility	❍**Yes**	❍Limited performance?	■■□□	Device less compatible than mouse, trackball and touchpad. Throughput and accuracy lower.
Feedback	❍**Yes**	❍No?[a]	—	Visual feedback shall occur in less than 20 ms. Since the time can only be measured in a laboratory, assess whether a delay is visible. The pointer should follow the movements of the device without detectable delay.

a The movement of the pointer is predictable only in 2D applications. There are no provisions for 3D applications.

b Joysticks operate and respond in the same manner under different environmental conditions. In general, this will represent the best available solution for consistent operation.

Table H.57 — Correspondence with generic requirements on joysticks — Controllability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Responsiveness	❍**Yes**	❍No?	—	Device shall give continuous and consistent feedback under the conditions of intended use.
Non-interference	❍**Yes**	❍No?	—	Operating the device shall not interfere with its use, e.g. moving the joystick does not move the display.
Reliability of device access	❍**Yes**	❍No?	—	Unintended loss of grip (lever) is unlikely. Thus, device access is normally very reliable.
Control access	❍**Yes**	❍No?	—	Accessing and pressing the buttons shall not move the focus of the pointer. Access to buttons shall be easy and without undue effort for access (see Figure H.6 for an example).

Table H.58 — Correspondence with generic requirements on joysticks — Biomechanical load

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Posture	❍**Yes**	❍No	—	Access and use of the device shall not require undue deviation from neutral posture (see Figure H.4) for arm, wrist and hand.
Effort	—	—	—	No provisions can be given.

Table H.59 — Functional properties of joysticks — Functional properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Anchoring	❍Yes	❍No	—	It shall be possible to anchor some part of the fingers, hand or arm on either the input device or the work surface to create a stable relationship between the hand and the point of action.
Resolution	❍Yes	❍Class adequate[a]	—	Device shall either offer sufficient resolution for difficult pointing tasks or for the task at hand.
[a] Device classes 2 to 4.				

Table H.60 — Functional properties of joysticks — Button design

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Button motion	❍Yes	❍No	—	Fingers should be able to make contact with and press the buttons without undue movement.
Button actuation	❍Yes	❍No	—	It should be possible to press the buttons on the device without reducing control of the device.
Button activation	❍Yes	❍No	—	It should be possible to activate the buttons on the device without reducing control of the device.
Button shape	❍Yes	❍No	—	Device should be designed to be resistant to inadvertent button activation (click) during use.
Button force	❍Yes	❍No	—	Buttons should not feel too easy or too hard to press (required force range between 0,5 N and 1,5 N, measurable with suitable equipment only).
Button displacement	❍Yes	❍No	—	Buttons should move slightly when pressed (required travel of 0,5 mm, measurable with suitable equipment only).
Inadvertent pointer movement	❍Yes	❍No	—	Button actuation (pressing and moving) shall not cause unintended movement of the pointer.
Button lock	❍Yes	❍No	—	Device design or software should enable the user to lock buttons which need to be pressed continuously, e.g. during dragging or tracing.

Table H.61 — Functional properties of joysticks — Consideration of handedness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Ambidextrous use	❍Yes	❍No	—	Devices should be operable using either hand; or right- and left-handed devices should be available. The shape and location of the controls (buttons, wheel) should be selected to support ambidextrous use of the device.

Table H.62 — Functional properties of joysticks — Resolution consistency

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Resolution consistency	❍Yes	❍No	—	Resolution of the device shall be independent of both the position of the device and the position of the pointer on the screen, if not deliberately designed to achieve a higher degree of usability.

Table H.63 — Other properties of joysticks — Mechanical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Unintended slippage	❍Yes	❍No	—	The base of the device shall not move unintentionally during use.
Actuation force	❍Yes	❍No	—	The force to displace finger-operated joysticks should be between 0,05 N and 1,1 N. For other devices, no advice can be given.
Displacement	❍Yes	❍No	—	For hand-operated joysticks, the displacement should not exceed 45° in the left and right directions, 30° in the forward direction (away from user), and 15° in the backward direction (towards the user).
Button location	❍Yes	❍No	—	The function buttons of a finger-operated joystick should be located on top of the handle so that the buttons can be actuated by the index finger.

Table H.64 — Other properties of joysticks — Electrical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Interference of cable with use	Not relevant	Not relevant	—	The influence of cabling on the operation of a joystick does not affect the usability of the device.
Electromagnetic influences	Not relevant	Not relevant	—	Devices conforming to standards for electromagnetic compatibility are unlikely to cause problems.
Weight of batteries	Not relevant	Not relevant	—	Weight of batteries (hand-held devices) is unlikely to reduce usability of device.

Table H.65 — Other properties of joysticks — Maintainability-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
—	—	—	—	No known issues.

Table H.66 — Other properties of joysticks — Health- and safety-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Edges and corners	❍Yes	❍No	—	Sharp edges and corners shall be avoided. (Exact measurement for edges ≥ 2 mm and for corners ≥ 3 mm.)
Thermal conductance	❍Yes	❍No	—	The parts of the joysticks that are grasped during use should have low thermal conductance (feel warm).
Material	❍Yes	❍No	Not measurable under practical conditions	Device should not contain or be made of materials known to cause health and safety problems through skin contact or emissions. Normally considered by health and safety regulations.

Table H.67 — Interdependencies and documentation of joysticks — Interdependency with software

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
No dedicated software	❍Yes	❍No	—	Documentation shall specify how the device is to be properly operated if no dedicated software is delivered with the device.
Documentation of setup	❍Yes	❍No	—	Documentation shall specify the setting up of the device for its intended use.
Testing settings	❍Yes	❍No	—	There should be the possibility of testing the settings.

Table H.68 — Interdependencies and documentation of joysticks — Interdependency with use environment

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
—	—	—	—	Interdependency with use environment low. Device may be best choice under unfavourable conditions.

Table H.69 — Interdependencies and documentation of joysticks — Documentation

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Optimum location of device	❍Yes	❍No	—	Optimum location of the joystick for best effectiveness, efficiency and postural comfort shall be described.
Location for keyboard use	❍Yes	❍No	—	Best location of the device for concurrent use with a keyboard shall be specified.
Adjustment of gain	❍Yes	❍No	—	Adjustment of gain for limited space for the operation shall be specified.
Setup	❍Yes	❍No	—	Features of the hardware/software that may improve postural comfort or reduce biomechanical load (setup for different buttons, changes in the setup to relieve fingers and thumb, etc.) shall be included in the documentation.

H.4.6 Tables for selection of trackballs

Table H.70 — Correspondence with generic requirements on trackballs — Appropriateness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Effectiveness	❍**Yes**	❍No	■■■□	Device should enable the highest throughput for the human hand.
Efficiency	❍**Yes**	❍No	■■■□	Device should enable the highest accuracy for pointing for the human hand.
Dimensioning	❍**Yes**	❍No	—	Due to its dimensions and mode of operation, a trackball may be the most appropriate device for concurrent use with keyboards.
Software dependency	❍ Yes	❍**No**	—	Application software should not limit the throughput and accuracy of the device.
Additional device	❍ Yes	❍**No**	—	Other devices such as keyboards to be used at the same time should not interfere with the functionality. The influence of additional devices is low.

Table H.71 — Correspondence with generic requirements on trackballs — Operability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Obviousness	❍**Yes**	❍Instructions?	■■■□	If the functions cannot be detected by trial and error by the user, relevant information shall be included in the documentation.
Predictability	❍**Yes**	❍No?	■■■■	The user should be able to sense the direction of the movement of the pointer without visual contact with the device. Device predictable in 2D applications.
Consistency	❍**Yes**	❍Class?	■■□□	Device should be operable on any support surface. Trackballs do not belong to the best available devices in this respect.
Compatibility	❍**Yes**	❍Limited performance?	■■■□	Device should be suitable for pointing tasks with highest speed and accuracy or the limitation of the performance shall be indicated. Normally, compatibility is lower than with mice and trackpads.
Feedback	❍**Yes**	❍No?	—	Trackballs can be designed to give different types of feedback, e.g. force (active), haptic (force, vibration, acceleration) and kinaesthetic. No advice can be given because of the complex nature of the possible modes of feedback.

Table H.72 — Correspondence with generic requirements on trackballs — Controllability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Responsiveness	❍**Yes**	❍No?	—	Device shall give continuous and consistent feedback under the conditions of intended use.
Non-interference	❍**Yes**	❍No?	—	Operating the device shall not interfere with its use, e.g. pressing a button does not move the pointer.
Reliability of device access	❍**Yes**	❍No?	—	Design shall prevent unintended loss of control during use, e.g. slipping. Unintended loss of control of the ball may occur under unfavourable conditions.
Control access	❍**Yes**	❍No?	—	Access to buttons shall be easy and without undue effort for access (see Figure H.6).

Table H.73 — Correspondence with generic requirements on trackballs — Biomechanical load

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Posture	❍**Yes**	❍No	—	Access and use of the device shall not require undue deviation from neutral posture (see Figure H.4) for arm and hand. In concurrent use with keyboards, the trackball affects the posture less than a number of other devices.
Effort	—	—	—	Not relevant for trackball use.

Table H.74 — Functional properties of trackballs — Functional properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Anchoring	❍**Yes**	❍No	—	It shall be possible to anchor some part of the fingers, hand or arm on either the input device or the work surface to create a stable relationship between the hand and the point of action.
Resolution	❍**Yes**	❍Class adequate[a]	■■■■	Device shall offer sufficient resolution for difficult pointing tasks or for the task at hand.

[a] Device classes 2 to 4.

Table H.75 — Functional properties of trackballs — Button design

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Button motion	❍Yes	❍No	—	Fingers should be able to make contact with and press the buttons without undue movement.
Button actuation	❍Yes	❍No	—	It should be possible to press the buttons on the device without reducing control of the device.
Button activation	❍Yes	❍No	—	It should be possible to activate the buttons on the device without reducing control of the device.
Button shape	❍Yes	❍No	—	Device should be designed to be resistant to inadvertent button activation (click) during use.
Button force	❍Yes	❍No	—	Buttons should not feel too easy or too hard to press (required force range between 0,5 N and 1,5 N, measurable with suitable equipment only).
Button displacement	❍Yes	❍No	—	Buttons should move slightly when pressed (required travel of 0,5 mm, measurable with suitable equipment only).
Inadvertent pointer movement	❍Yes	❍No	—	Button actuation shall not cause unintended movement of the pointer.
Button lock	❍Yes	❍No	—	Device design or software should enable the user to lock buttons which need to be pressed continuously, e.g. during dragging or tracing.

Table H.76 — Functional properties of trackballs — Consideration of handedness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Ambidextrous use	❍Yes	❍No	—	Devices should be operable using either hand; or right- and left-handed devices should be available. The shape and location of the controls (buttons, wheel) should be selected to support ambidextrous use of the device.

Table H.77 — Functional properties of trackballs — Resolution consistency

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Resolution consistency	❍Yes	❍No	—	Resolution of the device shall be independent of both the position of the ball and the position of the pointer on the screen.

Table H.78 — Other properties of trackballs — Mechanical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Size of the ball	❍Yes	❍No	—	The exposed area of the ball should have a cord length of more than 25 mm.
Exposed arc	❍Yes	❍No	—	Exposed arc, measured from the centre of ball of not less than 100° and not more than 140°.
Unintended slippage	❍Yes	❍No	—	The base of the device shall not move during use.
Rolling force	❍Yes	❍No	—	There should be a small amount of resistance (correct value: starting resistance 0,2 N to 0,4 N).
Button location	❍Yes	❍No	—	The buttons shall be located such that their use does not interfere with the operation of the ball. The shape and location of the controls (buttons, wheel) should be selected to support ambidextrous use of the device.

Table H.79 — Other properties of trackballs — Electrical properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Interference of cable with use	❍Yes	❍No	■■■■	No interference under work conditions. Normally, the cabling of trackballs does not interfere with use.
Electromagnetic influences	Not relevant	Not relevant	—	Devices conforming to standards for electromagnetic compatibility are unlikely to cause problems.
Weight of batteries	Not relevant	Not relevant	—	Weight of batteries is unlikely to reduce usability of device.

Table H.80 — Other properties of trackballs — Maintainability-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Cleaning	❍Yes	❍No	—	The ball shall be easily removable for cleaning.
Rugged design	❍Yes	❍No	—	For environments where dust or spills may affect the operation of the device, trackballs with rugged design features (e.g. sealed, spill-proof, dust-proof, beverage-immune) can be utilised.
Power indicator	❍Yes	❍No	—	Insufficient power supply (batteries) should be indicated in a timely and proper manner before functionality is impaired.

Table H.81 — Other properties of trackballs — Health- and safety-related properties

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Edges and corners	❍Yes	❍No	—	Sharp edges and corners shall be avoided. (Exact measurement for edges ≥ 2 mm and for corners ≥ 3 mm.)
Material	❍Yes	❍No	Not measurable under practical conditions	Device should not contain or be made of materials known to cause health and safety problems through skin contact or emissions. Normally considered by health and safety regulations.

Table H.82 — Interdependencies and documentation of trackballs — Interdependency with software

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
No dedicated software	❍**Yes**	❍No	—	Documentation shall specify how the device is to be properly operated if no dedicated software is delivered with the device.
Documentation of setup	❍**Yes**	❍No	—	Documentation shall specify the setting up of the device for its intended use.
Testing settings	❍**Yes**	❍No	—	There should be the possibility of testing the settings.

Table H.83 — Interdependencies and documentation of trackballs — Interdependency with use environment

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Space	❍**Yes**	❍No	—	Trackballs need little space for proper operation and can be a good choice where space is restricted.
Remedy for vibrations	❍**Yes**	❍No	—	Effects of vibrations from the user or the support surface can be avoided to a certain degree by suitable software. Adequate design of the parts that can be used to anchor parts of the hand and fingers can also be beneficial.

Table H.84 — Interdependencies and documentation of trackballs — Documentation

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Optimum location of device	❍**Yes**	❍No	—	Optimum location of the device for best effectiveness, efficiency and postural comfort shall be described.
Location for keyboard use	❍**Yes**	❍No	—	Best location of the device for concurrent use with a keyboard shall be specified.
Adjustment of gain	❍**Yes**	❍No	—	Adjustment of gain for limited space for the operation shall be specified.
Setup	❍**Yes**	❍No	—	Features of the hardware/software that may improve postural comfort or reduce biomechanical load (setup for different buttons, changes in the setup to relieve fingers and thumb, etc.) shall be included in the documentation.

H.4.7 Tables for the selection of touchpads

Table H.85 — Correspondence with generic requirements on touchpads — Appropriateness

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Effectiveness	❍**Yes**	❍No	■■■□	Device should enable the highest throughput for the human hand.
Efficiency	❍**Yes**	❍No	■■■□	Device should enable the highest accuracy for pointing for the human hand.
Dimensioning	❍**Yes**	❍No	—	For the dimensioning of a touchpad no reliable data exists for achieving good appropriateness. However, since the device occupies little space, it may be appropriate in concurrent use with many other devices.
Software dependency	❍ Yes	❍**No**	—	Application software should not limit the throughput and accuracy of the device.
Additional device	❍ Yes	❍**No**	—	Device should be fully functional without any additional aid. Other devices such as keyboards to be used at the same time should not interfere with the functionality. Since touchpads can be operated without any additional control, they may be more appropriate than a mouse, despite lower effectiveness.

Table H.86 — Correspondence with generic requirements on touchpads — Operability

Relevant property	Assessment		Expected value	Requirement/recommendation/comment
Obviousness	❍**Yes**	❍Instructions?	■■■■	If the functions cannot be detected by trial and error by the user, relevant information shall be included in the documentation.
Predictability	❍**Yes**	❍No?	■■■■	The user should be able to sense the direction of the movement of the pointer without visual contact with the device.
Consistency	❍**Yes**	❍Class?	■■■■	Device belongs to the best available input tools because of its low dependency on the environment.
Compatibility	❍**Yes**	❍Limited performance?	■■■□	Device is less compatible with user characteristics and is inferior to the mouse in terms of performance and accuracy.
Feedback	❍**Yes**	❍No?	—	Feedback shall occur in less than 20 ms. Since the time can only be measured in a laboratory, assess whether a delay is visible.