PD CEN ISO/TS 9241-411:2014

BSI Standards Publication

Ergonomics of human-system interaction

Part 411: Evaluation methods for the design of physical input devices

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National foreword

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

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

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Ergonomie de l'interaction homme-système - Partie 411: Méthodes d'évaluation de la conception des dispositifs d'entrée physiques (ISO/TS 9241-411:2012)

Ergonomie der Mensch-System-Interaktion - Teil 411: Bewertungsverfahren für die Gestaltung von physikalischen Eingabegeräten (ISO/TS 9241-411:2012)

This Technical Specification (CEN/TS) was approved by CEN on 28 June 2014 for provisional application.

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Foreword

The text of ISO/TS 9241-411:2012 has been prepared by Technical Committee ISO/TC 159 “Ergonomics” of the International Organization for Standardization (ISO) and has been taken over as CEN ISO/TS 9241-411:2014 by Technical Committee CEN/TC 122 “Ergonomics” the secretariat of which is held by DIN.

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The text of ISO/TS 9241-411:2012 has been approved by CEN as CEN ISO/TS 9241-411:2014 without any modification.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

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ISO/TS 9241-411 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

This first edition of ISO/TS 9241-411, together with ISO 9241-400, ISO 9241-410 and ISO 9241-420, cancels and 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/TS 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*

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— *Part 5: Workstation layout and postural requirements*

— *Part 6: Guidance on the work environment*

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

— *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 331: Optical characteristics of autosterescopic displays* [Technical Report]

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

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

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— *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 391: Requirements, analysis and compliance test methods for the reduction of photosensitive seizures*

User-interface elements, ergonomic requirements for the reduction of visual fatigue from stereoscopic images, and the evaluation of tactile and haptic interactions are to form the subjects of future parts 161, 392 and 940.

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Introduction

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

This part of ISO 9241 presents methods for the laboratory analysis and comparison of input devices for interactive systems. It does not contain requirements for input devices, but provides the means for evaluating conformance with the requirements of ISO 9241-410 for input devices such as keyboards, mice, pucks, joysticks, trackballs, touch pads, tablets/overlays, touch-sensitive screens, and styli/light pens.

The target users of this part of ISO 9241 are manufacturers, product designers and test organizations concerned with commercial input devices such as the physical input devices listed above.

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Ergonomics of human-system interaction —

Part 411: Evaluation methods for the design of physical input devices

1 Scope

This part of ISO 9241 specifies evaluation methods for the design of physical input devices for interactive systems. It provides guidance for the laboratory assessment of conformance with ISO 9241-410 for keyboards, mice, pucks, joysticks, trackballs, touch pads, tablets/overlays, touch-sensitive screens, and styli/light pens. Its provisions apply only to keyboards identified as “full-size” or “compact” by the manufacturer, but nevertheless could provide useful guidance in the design of other keyboards. It is not applicable to those of the requirements of ISO 9241-410 that relate to gesture- and voice-input systems.

2 Normative references

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

ISO 7000, *Graphical symbols for use on equipment — Index and synopsis*[1)]

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

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

ISO 9241-410:2008, *Ergonomics of human-system interaction — Part 410: Design criteria for physical input devices*

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

IEC 60417, *Graphical symbols for use on equipment*[1)]

1) The database on Graphical Symbols for Use on Equipment contains the complete set of graphical symbols included in ISO 7000 and IEC 60417: http://www.graphical-symbols.info/

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

[SOURCE: ISO 9241-410:2008; 3.2]

3.2
class
category of a property of a product with rank order

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

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

[SOURCE: ISO 9241-410:2008; 3.3]

3.3
compact keyboard
keyboard that features most properties of a full-size keyboard, with the editing section integrated into the alphanumeric section

NOTE 1 A compact keyboard has no numeric section separate from the alpha keys.

NOTE 2 Compact is a term used to describe a keyboard that allows a mouse or other pointing device to be positioned closer to the user as described in 9241-410, B.2.1.1. Some keyboards, for example keyboards with small dimensions as used on portable devices, are neither full-size nor compact keyboards.

[SOURCE: ISO 9241-410:2008, 3.4, modified — Note 1 has been changed and Note 2 added.]

3.4
full-size keyboard
keyboard that comprises all sections and zones as described in ISO/IEC 9995-1

[SOURCE: ISO 9241-410:2008, 3.6]

3.5
housing
protective cover designed to contain or support a mechanical component

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

[SOURCE: ISO 9241-410:2008, 3.11]

3.6
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

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

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and, for tracing tasks, by

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

where

d is the distance of movement to the target;

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

[SOURCE: ISO 9241-410:2008; 3.12]

3.7
input device
user controlled device that transmits information to a system

[SOURCE: ISO 9241-400:2007; 3.6.3]

3.8
joystick
lever mounted in a fixed base used to control the movement of objects displayed on a screen

SEE: Figure 1.

[SOURCE: ISO 9241-400:2007; 3.6.4]

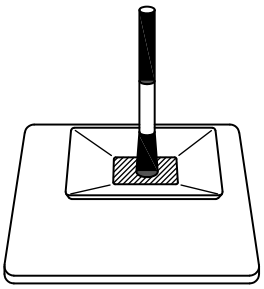

Figure 1 — Side view of example joystick

3.9
keypad
functional unit that comprises at least a group of keys dedicated and arranged for a given functionality and possibly additional keys supporting related functionality

EXAMPLE Numeric keys, “Enter” key of keypad.

[SOURCE: ISO 9241-410:2008; 3.14]

3.10
light-pen
light sensitive input device that, when pointed onto a specific location on a display, identifies its position to the system

SEE: Figure 2.

[SOURCE: ISO 9241-400:2007; 3.6.10]

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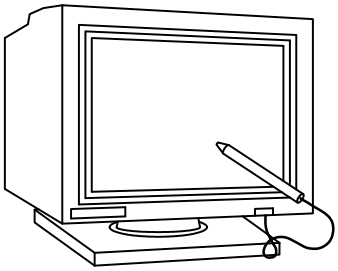


Figure 2 — Example of light-pen against display

3.11
mouse
computer input device having one or more buttons and capable of two dimensional rolling motion which can drive a cursor on the display and performs a variety of selection options or commands

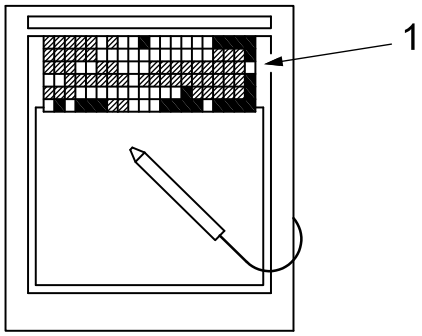
[SOURCE: ISO 9241-400:2007; 3.6.11]

3.12
neutral posture
posture which avoids the extremes of a joint's range of motion or that is not near the end of the range of motion for the particular joint

3.13
overlay
thin template on the surface of a tablet used to indicate the graphic functions available to the user

SEE: Figure 3.

[SOURCE: ISO 9241-400:2007; 3.6.13]



Key
1 graphic overlay

Figure 3 — Top view of example of tablet with graphic overlay

3.14
puck
hand-held device similar to a mouse but with a reticle view port and that is typically used with a digitizing tablet

SEE: Figure 4.

[SOURCE: ISO 9241-400:2007; 3.6.16]

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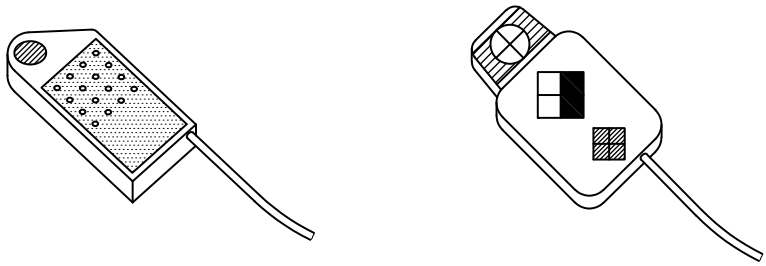

Figure 4 — Top view examples of two types of puck

3.15
section
<keyboard> functional groups within computer keyboards for which different rules for layouts can apply

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

[SOURCE: ISO 9241-410:2008; 3.16]

3.16
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

SEE: See Figure 5.

[SOURCE: ISO 9241-400:2007; 3.6.23]

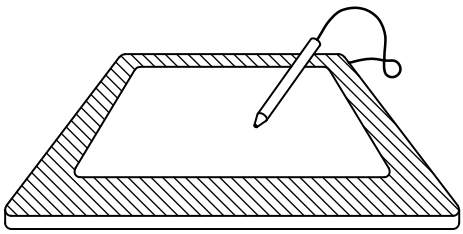

Figure 5 — Side view of example of stylus over graphics tablet

3.17
tablet
graphics 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

[SOURCE: ISO 9241-400:2007; 3.6.24]

3.18
task precision
measure of the accuracy required for a pointing, selecting or dragging task primitive, quantified by the index of difficulty

[SOURCE: ISO 9241-410:2008; 3.17]

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3.19
throughput
<input devices> rate of information transfer when a user is operating an input device to control a pointer on a display

NOTE The throughput is expressed in bits per second.

[SOURCE: ISO 9241-400:2007; 3.7.13]

3.20
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

[SOURCE: ISO 9241-400:2007; 3.6.27]

3.21
touchpad
touch-sensitive pad that senses the position of a finger on its surface

[SOURCE: ISO 9241-410:2008; 3.18]

3.22
trackball
input device consisting of a ball in a fixed housing that can be rolled in any direction by the fingers to control pointer movement

NOTE See Figure 6.

[SOURCE: ISO 9241-400:2007; 3.6.26]

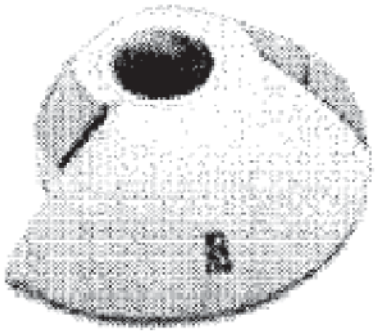

Figure 6 — Example of top view of trackball device with buttons

3.23
zone
<keyboard> smaller unit within a section of a keyboard representing different functionality

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

[SOURCE: ISO 9241-410:2008; 3.20]

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4 Guiding principles

A structure is needed form compliance procedures and evaluation methods for physical input devices. The aim of this structure is to clarify what requirements and classes (specified in ISO 9241-410) are relevant for each intended application.

For this purpose the evaluation methods are outlined in the Tables 1 to 20. Each table addresses different evaluation methods with three columns stating

— the clauses or subclauses referred to in ISO 9241-410, with the specific requirement being addressed,

— the pass/fail criterion based on the requirements reproduced from ISO 9241-410, and

— the recommended measuring methods to verify whether the requirement has been fulfilled.

Reporting should be done using the summarizing table shown in ISO 9241-410: 2008, Figure 1.

5 Evaluation methods

5.1 Physical input devices in general

Table 1 shows the measuring methods for physical input devices in general.

Table 1 — Measuring methods for physical input devices in general

Attribute in ISO 9241-410: 2008	Pass/Fail criterion based on requirements and intended context of use	Measuring method
Clause 5 Usable for designated purpose	The input device shall be usable for its designated purpose.	Verify the conformance with the normative design requirements in the relevant annex (ISO 9241-410:2008, Annexes B to J).
Clause 5 Satisfactory level of performance	The input device shall be usable for its designated purpose. It is considered usable if users can achieve a satisfactory level of performance on a given task and maintain an acceptable level of effort and satisfaction.	Verify the level of effort and satisfaction by measuring and demonstrating comfort using the methods in Annex C.
7.1 Specification of intended use	The intended use for a physical input device shall be specified unless it is obvious or the device is designed for general purpose use. [Modified from ISO 9241-410]	State: — that the intended use is specified; or — that the intended use is for general purposes; or — that the intended use is obvious.
7.1 Technical conditions for use	The specification shall include technical conditions for the context of use to be realized for a satisfactory use of the device (e.g. operating system, driver, support surface, etc.).	Verify that the specification of the intended use of the device states the required technical conditions for the context of use.

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Table 1 (*continued*)

Attribute in ISO 9241-410: 2008	Pass/Fail criterion based on requirements and intended context of use	Measuring method
7.1 Specification of category	The user of this standard shall specify to which category a device belongs to.	Verify that a declaration has been made as to which category or categories (ISO 9241-410:2008, Annexes A to I) the device belongs.
7.1 Specification of category	The user of this standard shall specify to which category a device belongs to.	Verify that a declaration has been made as to which category or categories (ISO 9241-410:2008, Annexes A to I) the device belongs.
7.2.2 Anthropometric dimensions	The dimensioning of an input device and its parts shall be compatible with the relevant anthropometric dimensions of the part of the body for the intended user population to a degree that relevant design objectives can be met (intended level of effectiveness, intended level of efficiency). [Modified from ISO 9241-410]	Verify the dimensions of the device are appropriate for the intended user population. Verify the intended level of effectiveness, efficiency and satisfaction using the test methods described in Annexes B, C or D, as appropriate.
7.2.2 Appropriate-ness	If achieving the intended level of appropriateness requires enhancing by software or by additional use of another device other than delivered with the device under consideration the additional equipment shall be specified.	Specify if additional software or additional equipment is necessary.
7.2.3.6 Feedback	An input device shall provide effective feedback, i.e. the user is given immediately perceptible and understandable indication that the device is responding to the user's actuation.	Verify that the user: — can determine the current state of the device; — can determine the outcome of the latest action; — can determine any action that is required as a consequence of the previous action(s).
7.2.4.1 Adequate and reliable access	The design of the device shall give the user adequate and reliable access;	Verify that: — the input device provides adequate and reliable access can be used without undue biomechanical loading; — the input device can be used without inadvertent activation.
7.2.4.2 Device responsive-ness	The device shall be responsive, and its use shall not interfere with its functionality; [Modified from ISO 9241-410]	Verify that: — every operation performed with the input device generates the appropriate feedback; — the use of the input device does not necessarily interfere with its own function, e.g., a mouse that is entangled by its own tail.
7.2.4.1 Loss of control	The design shall prevent unintended loss of control during intended use, e.g. slipping by hand operated devices.	Verify that the input device can be used without unintended slipping when being held, pushed or activated.
7.2.4.3 Self-interference	An input device shall not interfere with its own use.	Verify that the user can access all functional elements of the input device without degrading the usability of the device.

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Table 1 (*continued*)

Attribute in ISO 9241-410: 2008	Pass/Fail criterion based on requirements and intended context of use	Measuring method
7.2.4.3 Cable interference	Functional elements needed to transport data from the device to the system and vice versa (cables, infrared beams) shall not influence throughput and accuracy.	Verify that functional elements do not necessarily inhibit input actuation, thereby negatively influencing throughput and accuracy.
7.2.4.5 Readily usable design	The design of an input device shall enable the user to quickly and easily access it (e.g. grasp, position and manipulate) during intended use without adversely affecting performance.	Verify that the user can access the device without adversely affecting performance.
7.2.4.6 Readily usable controls	Controls of an input device shall be located and actuated quickly and easily without interfering with the overall use of the device.	Verify that accessing and activating an input device does not change the intended consequence, e.g. inadvertent movement of the hot spot resultant from pressing a button on a mouse.
7.2.5.2 Avoidance of extreme postures	An input device shall be operable without undue deviation from a neutral posture.	Verify that the design of the input device does not constrain the user's joints in positions at the extremes of the joint's range of motion while using the input device in the intended operation.
7.2.5.3 Avoidance of excessive effort	An input device designed for efficient use shall be operable without excessive effort.	Verify that the design of the input device does not force the user to make excessive exertions for the intended operation. Acceptable levels of effort may be documented by use of a survey similar to the example shown in Table C.1.
9 Description and operating instructions	The documentation of a product shall comprise the product description and the operating instructions.	Verify that the product documentation includes the product description and operating instructions.
9 Information for selection of appropriate device	The product description shall specify all relevant and usability related information for selecting the appropriate device.	Verify that the product documentation provides the information necessary for selecting the appropriate device.

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5.2 Keyboards

Tables 2 to 12 give the requirements common to all keyboards, as well as those specific to a particular type of keyboard — for example, full-size or compact keyboards.

Table 2 — Requirements on the generic operability of keyboards

Attribute in ISO 9241-410: 2008	Pass/Fail criterion based on requirements and intended context of use	Conformance method
B.2.1.2.1 Obviousness of use	A keyboard shall either belong to class C1 for obviousness (known or visible without additional instructions and information) or the required level of instructions shall be specified.	Verify either: — that the keyboard is identified as C1; or — that the required level of instructions is provided in the documentation.

Table 3 — Requirements for functional properties of full-size keyboards

Attribute in ISO 9241-410: 2008	Pass/Fail criterion based on requirements and intended context of use	Measuring method
B.2.2.1.1 a) Keytop shape	The keytops of normal-size keys in the alphanumeric, cursor and numeric zones shall have either concave or flat strike surfaces.	Determine if the keytops in the alphanumeric, numeric and cursor zones are flat or concave (see Figure 7).
B.2.2.1.1 b) Strike surface	The strike surface of the keytops of alphanumeric keys shall be at least 110 mm2 in area, the width of the strike surface shall be between 12 mm and 15 mm.	Evaluate the area of the strike surface by measuring the width and depth of the top surface of the key and calculating the area (see Figure 8).
B.2.2.1.1 c) Displacement	The key displacement shall be between 1,5 mm and 6,0 mm.	The key displacement is measured by activating the key at its centre, in the direction of key motion, with an applied force of 1,5 N. The distance between height of the non-actuated key (before it is depressed) and the completely depressed key is the key displacement (see Figure 9). NOTE The force and displacement characteristics described herein do not apply to virtual keyboards, for example, those formed on a display or projected onto a surface.
B.2.1.2.2 Predictability of operation of keyboards	The class to which a keyboard belongs with regard to predictability shall be specified.	Verify either that: the keyboard is identified as C1 (i.e. capable of n-key roll-over where $n > 2$); or the restricted level of predictability C2 to C4 and is specified in the documentation. The following classes are categorized: — C1: n-key roll-over where $n > 2$; or equivalent — C2: two-key roll-over or equivalent; — C3: no roll-over, i.e. first activated key must be released before the subsequent key can be detected; — C4: delayed input required, i.e. after release of the first activated key, a defined waiting period is needed before a subsequent key can be detected.

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Table 3 (*continued*)

Attribute in ISO 9241-410: 2008	Pass/Fail criterion based on requirements and intended context of use	Measuring method
B.2.7.1 Documentation	The documentation of a keyboard shall indicate whether: — special training; — additional physical tools; — specific software is needed to achieve the intended level of usability (effectiveness, efficiency and satisfaction).	If special training, tools or software is necessary to provide the intended level of usability of the keyboard, verify that this information is provided in the keyboard documentation. NOTE Some examples of special training might include one-hand-keyboards, chording keyboards, special design keyboards. Normal training for typing on keyboards is not regarded as special training.
B.2.2.1.1 d) Force	The force at the character generation point or at the snap point should be between 0,5 N and 0,8 N and shall be between 0,25 N and 1,5 N.	Measure the key force and displacement relationship as illustrated in Figure 10. Determine the force (resistance) at the snap point (illustrated at 2 in Figure 10). NOTE The force and displacement characteristics described herein do not apply to virtual keyboards, for example, those formed on a display or projected onto a surface.
B.2.2.1.1 e) Force/ displacement characteristics	For displacement keyboards (see ISO 9241-410:2008, Figure B.3), the initial resistance (starting force or preload) shall be between 25 % and 75 % of the force at the character generation point (for ramp activation) or at the snap point (for snap action).	Measure the key force and displacement relationship as illustrated in Figure 10. Determine the force at which initial displacement of the key occurs (before the snap point, as illustrated at 6 in Figure 10). NOTE The force and displacement characteristics described herein do not apply to virtual keyboards, for example, those formed on a display or projected onto a surface.
B.2.2.1.1 e) Force/ displacement characteristics	The switch-make action in the snap action shall occur after the snap point but before the key force has returned to the snap point.	Verify (e.g. via a description of the key force and displacement as shown in Figure 10) that the switch make action occurs after the snap point but before the key force returns to the same level as at the snap point.
B.2.2.1.1 f) Feedback	Actuation of a key shall be accompanied by feedback. If the principle means (of feedback) is auditory, the auditory signal shall be perceptible in the use environment.	If auditory feedback is the principal means of feedback, verify that auditory feedback from the operation of the key(s) is perceptible from a background sound level of the intended use environment, generally 10 dB A-weighted above.
B.2.2.1.1 f) Feedback	Supplementary auditory feed-back shall be suppressible (i.e. a volume control position that represents “off”).	Verify that the auditory feedback from the key(s) can be suppressed or turned off.
B.2.2.1.1 f) Feedback	The feedback shall occur within 100 ms after the key activation.	Verify that auditory feedback occurs within 100 ms of key activation.

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Table 3 (*continued*)

Attribute in ISO 9241-410: 2008	Pass/Fail criterion based on requirements and intended context of use	Measuring method
B.2.2.1.1 g) Bounce	In order to prevent unintended multiple event signalling from a single key actuation, the keyboard shall be provided with either bounce-free switches or a means of ensuring that bounce will not cause unintended activation.	Take a random sample of five alphanumeric or numeric keys, and, with a mechanical device, actuate each key at a rate of 5 times per second using a force of 1,5 N for 60 s. Count the number of characters produced and determine if it is the same as the number of inputs (1 500 total, or 300 per key).
B.2.2.1.1 h) Key repeat function	Where a repeat function is provided, the fixed repeat rate shall be 10 activations per second to 20 activations per second after an initial delay between 500 ms and 750 ms after the key is actuated.	Actuate an alphanumeric key by holding it down for 15 s. Note the delay until the second character appears; this is the initial delay period. Determine the number of characters produced after the initial delay, and then divide this by the time that the key remains activated after the initial delay period to obtain the characters per second.
B.2.2.1.1 i) Key roll-over	C1 keyboards shall be equipped with n-key roll-over according to C1 (B.2.1.2.2). [Modified from ISO 9241-410] NOTE n-key roll-over is defined as follows: When a keyboard has n-key roll-over, if some number (n) of keys is pressed at the same time, then the input from each key is interpreted correctly. Keyboards where $n > 2$ are classed as C1. Touch-typing generally requires 3-key roll-over. For some limited keyboard uses, such as music, gaming and Braille input, n-key roll-over where $n > 3$ is utilized. In order to avoid confusion, it is recommended that a manufacturer of a C1 keyboard choose to specify the value of n for n-key roll-over when the value of $n > 3$.	Simultaneously press and hold three alphanumeric or numeric keys. If the keyboard is equipped with 3-key roll-over, the appropriate characters corresponding to the combination of the 3 keys will be produced. For C1 keyboards where $n > 3$, the appropriate characters corresponding to the combination of the n keys is produced when the n keys are pressed at the same time. NOTE n-key roll-over is defined as follows: When a keyboard has n-key roll-over, if some number (n) of keys is pressed at the same time, then the input from each key is interpreted correctly. Keyboards where $n > 2$ are classed as C1. Touch-typing generally requires 3-key roll-over. For some limited keyboard uses, such as music, gaming and Braille input, n-key roll-over where $n > 3$ is utilized. In order to avoid confusion, it is recommended that a manufacturer of a C1 keyboard choose to specify the value of n for n-key roll-over when the value of $n > 3$.
B.2.2.1.1 j) Geometric design of key legends	All legends on keys shall be legible from the design reference posture (see ISO 9241-5).	Measure the height of the characters in the key legends; the height of a capital letter such as “H” or “M” divided by the viewing distance shall be at least 0,006 (sine of 21’ of arc).
B.2.2.1.1 j) Geometric design of key legends	The height of primary legends on an alphanumeric key shall not be < 2,6 mm. NOTE Assumes a viewing distance of 40 cm. [Modified from ISO 9241-410]	Character height is measured from the top line to the bottom edge of the bottom line of capitals “H” and “M” (see Figure 11).

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Table 3 (*continued*)

Attribute in ISO 9241-410: 2008	Pass/Fail criterion based on requirements and intended context of use	Measuring method
B.2.2.1.1 j) Geometric design of key legends	The width of the capital letters (except I and W) shall be between 50 % and 100 % of the height.	Character width is measured from the left edge of the leftmost line to the right edge of the rightmost line without serifs. Divide the character width by the character height; acceptable values for the character width to height ratio are decimal fractions ≥ 0,5 and ≤ 1,0.
B.2.2.1.1 j) Luminance contrast	For primary legends on all keys, the luminance contrast between luminance level of the background and legends shall be a minimum of 3:1.	Use a microphotometer to measure the luminance level of the background and the legend. The ratio of the higher luminance level to the lower should be at least 3:1.
B.2.2.1.1 k) Graphical symbols	Where graphical symbols are used, these shall be in accordance with ISO/IEC 9995-7 and with ISO 7000 and IEC 60417 as applicable.	Verify that graphical symbols are designed according to ISO/IEC 9995-7, ISO 7000 and IEC 60417.
B.2.2.1.1 l) Placement of legends	The positioning of the legends shall be in accordance with ISO/IEC 9995-1.	Verify conformance with ISO/IEC 9995-1.
B.2.2.1.1 l) Overlays	If reference cards or overlays are used to provide legends, the overlays and reference cards shall have a matt finish. [Modified from ISO 9241-410]	Measure the gloss level of the reference cards or overlays using a glossmeter (60º). Acceptable results are 45 gloss units or less.
B.2.2.1.1 m) Durability of legends	The legends shall be legible throughout the intended life of the product.	Determine the total number of keystrokes expected during the life of the keyboard. Multiply the total number of keystrokes by the expected percentage of keystrokes that are expected to be “E”, e.g. approximately 12 % in English. Verify that the legend remains legible after a number of actuations corresponding to the expected number of “E” keystrokes.
B.2.2.1.1 m) Durability of legends	The legends shall be robust and durable so that they are able to withstand normal wear and tear including regular cleaning. NOTE Currently the intended life of desktop keyboards is calculated for continuous typing on the type “E” over the workday during the full life-span of the product assuming the approximate occurrence of the character “E” in European languages.	Determine the total number of keystrokes expected during the life of the keyboard. Multiply the total number of keystrokes by the expected percentage of keystrokes that are expected to be “E”, e.g. approximately 12 % in English. Verify that the legend remains legible after a number of actuations corresponding to the expected number of “E” keystrokes.

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