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**Ergonomic requirements for office work  
with visual display terminals (VDTs) —**

**Part 4:  
Keyboard requirements**

*Exigences ergonomiques pour travail de bureau avec terminaux à écrans  
de visualisation (TEV) —*

*Partie 4: Exigences relatives aux claviers*



**Contents**

Page

1	Scope .....	1
2	Normative references .....	1
3	Definitions .....	2
4	Guiding principles .....	7
5	Performance criterion .....	8
6	Design requirements and recommendations .....	8
7	Measurement .....	13
8	Conformance .....	19

**Annex**

A	Usability test (proposed alternative test) .....	20
B	Bibliography .....	27

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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.

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.

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

ISO 9241 consists of the following parts, under the general title *Ergonomic requirements for office work with visual display terminals (VDTs)*:

- Part 1: General introduction
- Part 2: Guidance on task requirements
- Part 3: Visual display requirements
- Part 4: Keyboard requirements
- Part 5: Workstation layout and postural requirements
- Part 6: Guidance on the work environment
- Part 7: Requirements for display with reflections
- Part 8: Requirements for displayed colours
- Part 9: Requirements for non-keyboard input devices
- Part 10: Dialogue principles
- 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*

Annexes A and B of this part of ISO 9241 are for information only.

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## Introduction

The keyboard is currently the principal input device used by operators to enter information into interactive office computer systems. Keyboard design can have a significant impact on efficiency, effectiveness and satisfaction. The requirements and recommendations are based on ergonomic principles.

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# Ergonomic requirements for office work with visual display terminals (VDTs) —

## Part 4: Keyboard requirements

### 1 Scope

This part of ISO 9241 applies to linear detachable keyboards designed for stationary use. It provides guidance on the design of keyboards used for typical office tasks so that the limitations and capabilities of users are considered. It provides guidance based on ergonomic factors for keyboard layout arrangements, the physical characteristics of the individual keys and the overall design of the housing containing the keys. This part of ISO 9241 specifies methods for testing conformance by measuring the physical attributes of a keyboard. It also includes a proposed alternative test method for keyboards that do not conform to the physical design requirements and recommendations, based on a user performance test and subjective rating scales.

### 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9241. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9241 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2469:1994, *Paper, board and pulps — Measurement of diffuse reflectance factor.*

ISO 7000:1989, *Graphical symbols for use on equipment — Index and synopsis.*

ISO 9241-3:1992, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 3: Visual display requirements.*

ISO 9241-5:—<sup>1)</sup>, *Ergonomic requirements for office work with visual display terminals — Part 5: Workstation layout and postural requirements.*

1) To be published.

ISO/IEC 9995-1:1994, *Information technology — Keyboard layouts for text and office systems — Part 1: General principles governing keyboard layouts.*

ISO/IEC 9995-2:1994, *Information technology — Keyboard layouts for text and office systems — Part 2: Alphanumeric section.*

ISO/IEC 9995-4: 1994, *Information technology — Keyboard layouts for text and office systems — Part 4: Numeric section.*

ISO/IEC 9995-5: 1994, *Information technology — Keyboard layouts for text and office systems — Part 5: Editing section.*

ISO/IEC 9995-6: 1994, *Information technology — Keyboard layouts for text and office systems — Part 6: Function section.*

ISO/IEC 9995-7: 1994, *Information technology — Keyboard layouts for text and office systems — Part 7: Symbols used to represent functions.*

ISO/IEC 9995-8: 1994, *Information technology — Keyboard layouts for text and office systems — Part 8: Allocation of letters to the keys of a numeric keypad.*

IEC 417:1973, *Graphical symbols for use on equipment. Index, survey and compilation of single sheets.*

### 3 Definitions

For the purposes of this part of ISO 9241, the following definitions apply.

#### 3.1 Technical definitions

##### 3.1.1

###### **cursor**

visual indication of the focus for alphanumeric input  
[ISO 9241-12:—<sup>1</sup>]

##### 3.1.2

###### **cursor keys**

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

##### 3.1.3

###### **dished profile keyboard**

keyboard in which the side profile of the keys resembles a continuous concave curve  
(see figure 1)

1) To be published.

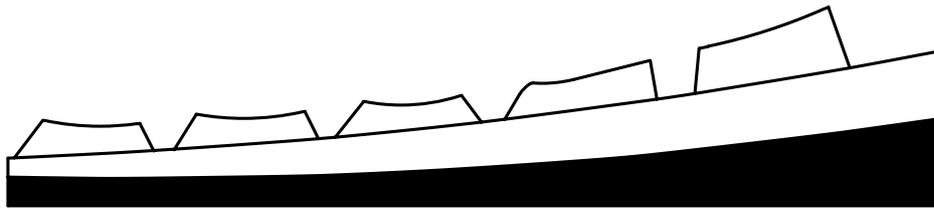


Figure 1 — Example of a dished profile keyboard

### 3.1.4

#### flat profile keyboard

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

(see figure 2)

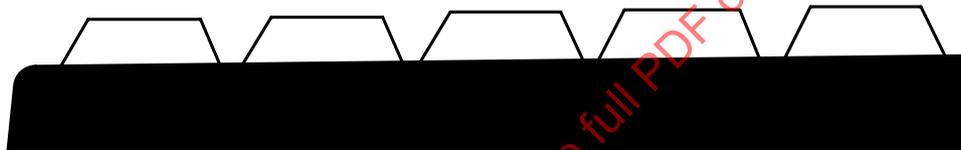


Figure 2 — Example of a flat profile keyboard

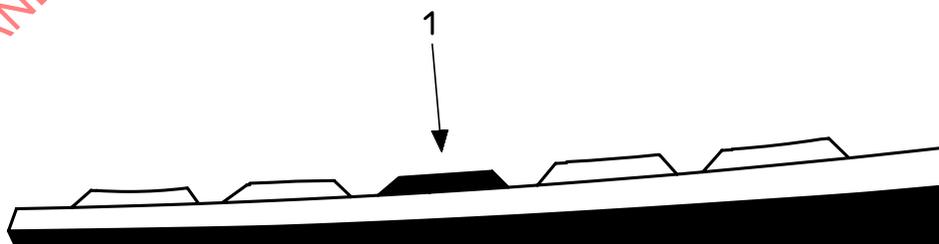
### 3.1.5

#### home row

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

(see figure 3)

NOTE — On a typical keyboard, the home row is row C of ISO/IEC 9995 in the alphanumeric section as well as in the numeric section.



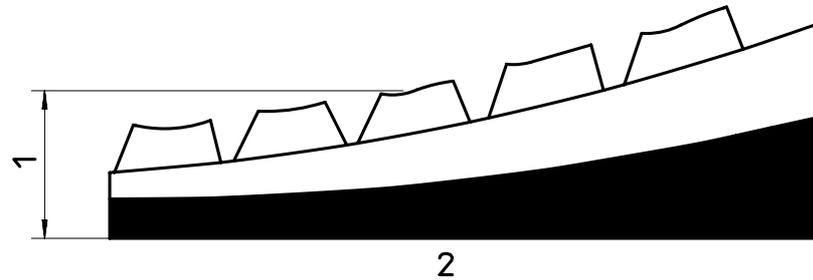
#### Key

1 Home row

Figure 3 — Home row

**3.1.6****home row height**

height from the centre of the strike surface of an unactuated key in the home row to the support surface (see figure 4)

**Key**

- 1 Home row height
- 2 Row C

**Figure 4 — Home row height**

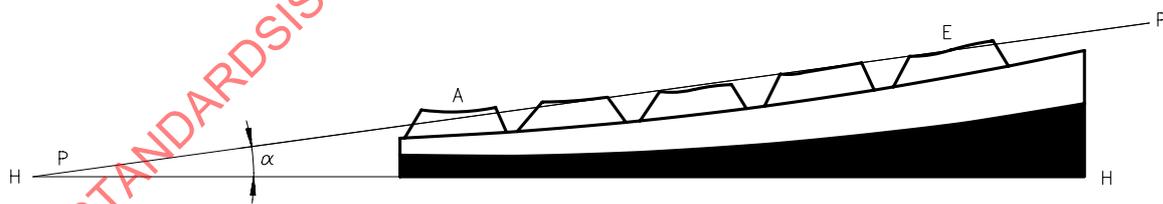
**3.1.7****keyboard profile**

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

**3.1.8****keyboard slope**

angle ( $\alpha$ ) 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 5)

NOTE — For keyboards without an E row, use rows B to D.



**Figure 5 — Keyboard slope**

**3.1.9****key displacement**

key movement from its rest position to its fully depressed position

**3.1.10****key force**

force required to displace a key to a specified position

**3.1.11****key roll over**

ability of a keyboard to register the correct order of activation of a set of keys

**3.1.12****layout**

spatial allocation of keys on a keyboard

**3.1.13****numeric keypad**

array of keys in the numeric section to which are allocated the ten digits 0 to 9 and the decimal separator (see figure 6)

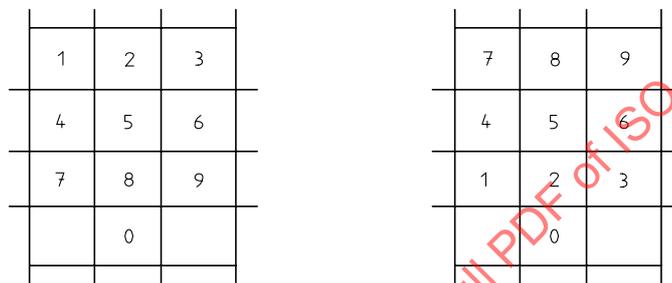


Figure 6 — Numeric keypad [1-2-3 (telephone) layout, left; 7-8-9 (calculator) layout, right]

**3.1.14****palm-rest**

platform placed in front of the keyboard or embedded in the keyboard on which the operator may place the palm of their hands

**3.1.15****principle section**

alphanumeric, editing, function, and numeric sections

**3.1.16****ramp action**

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

**3.1.17****sculptured profile keyboard**

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

**3.1.18****sloped profile keyboard**

keyboard in which the side profiles of the keys are all sloped (pitched) at the same angle with respect to the base

**3.1.19****snap action**

sudden drop in force required to further displace a key

**3.1.20****stepped profile keyboard**

keyboard in which the top of each key is parallel to the work surface but at a different height from the work surface  
(see figure 7)

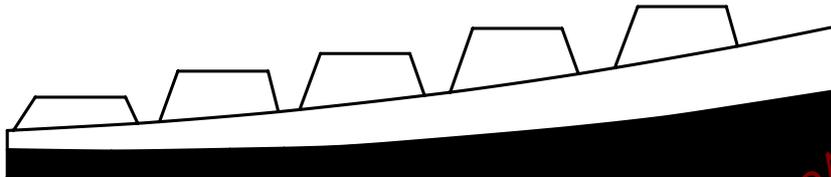


Figure 7 — Example of a stepped profile keyboard

**3.1.21****strike surface**

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

**3.1.22****tactile indicator keys**

keys in the home row which contain a tactile aid for recentering the hands

**3.1.23****visual display terminal (VDT)**

functional unit consisting of at least a visual display and an input device

**3.2 Usability-related definitions****3.2.1****diffuse reflection**

diffusion by reflection in which, on the macroscopic scale, there is no regular reflection  
[CIE Publ. 17.4:1987, IEV 845-04-47]

**3.2.2****efficiency**

resources expended in relation to the accuracy and completeness with which users achieve goals  
[ISO 9241-11]

**3.2.3****effectiveness**

the accuracy and completeness with which users achieve specified goals  
[ISO 9241-11]

**3.2.4****feedback**

information to the user indicating that a key has been actuated

### 3.2.5

#### **kinaesthetic feedback**

sensation based on the cutaneous, joint, and muscle-spindle receptors of the hands, limbs and other body parts

### 3.2.6

#### **neutral hand/arm posture**

hand/arm not deviated (bent or twisted) at a wrist, elbow or shoulder joint

### 3.2.7

#### **reflectance**

ratio of the reflected luminous flux to the incident flux under given conditions  
[CIE Publ. 17.4:1987, IEV 845-04-58]

### 3.2.8

#### **satisfaction**

freedom from discomfort, and positive attitudes to the use of a product

### 3.2.9

#### **specular reflection**

reflection in accordance with the laws of geometrical optics, without diffusion  
[CIE Publ. 17.4:1987, IEV 845-04-45]

### 3.2.10

#### **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]

## 4 Guiding principles

The design of the keyboard can affect efficiency, effectiveness and satisfaction of a user. Design elements interact such that optimizing one feature can degrade another. Trade-offs may be required to achieve an acceptable balance. The objective of an ergonomic design is to ensure that the keyboard allows the user to locate and operate the appropriate keys accurately, quickly and without discomfort. The keyboard characteristics which influence keying performance include the layout arrangement of the alphabetic and numeric keys, linguistic differences (national variants), the physical characteristics of the individual keys and the overall design of the housing containing the keys.

The objective of an ergonomically designed system is to meet the needs of individuals while carrying out specified tasks. To serve this purpose, different methods can be applied, for example, by selecting appropriate tools which have been designed for general purpose use, by application of custom-designed equipment for the specific task and for the specific users, or by providing adequate customization for the components of tools and workstation. In addition, adequate training of the user can contribute substantially to all objectives (efficiency, effectiveness and satisfaction).

Certain characteristics of the keyboard can influence the posture adopted by people working at a VDT (see ISO 9241-5). For example, the height (thickness) of the keyboard combined with the height and thickness of the work surface supporting it can result in users adopting poor postures.

Efficiency, effectiveness and satisfaction of users depend on the selection of the keyboard design adequate to the task of the user and on the use of other additional input devices. For example, provision of a separate numeric pad can help the data input task.

When selecting design criteria for a keyboard for a specified task, the relevant considerations are based on the functionality to be offered by the keyboard and by other input devices. These considerations can suggest selecting the minimum possible size of the keyboard determined by the number and the adequate grouping of the keys.

## 5 Performance criterion

The performance criterion is that the keyboard is usable for its designated purpose. It is considered usable if users can achieve a satisfactory level of keying performance on a given task and maintain a satisfactory level of effort and comfort. This objective can be met by adhering to the design requirements specified in clause 6.

NOTE An alternative method for determining compliance is under development for keyboards that do not have the design characteristics stated in this part of ISO 9241. One proposed test method is included in annex A.

## 6 Design requirements and recommendations

### 6.1 General design of the keyboard

#### 6.1.1 Palm-rests

If the design includes a palm-rest then a depth of 50 mm to 100 mm should be provided in front of row A. Where a palm-rest is not provided, the area in front of row A should be as near as possible to the front edge of the keyboard.

#### 6.1.2 Sections of the keyboard

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

#### 6.1.3 Home row height

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

#### 6.1.4 Slope of the keyboard

The recommended slope is 5° to 12° positive to the horizontal. The slope of the unadjusted keyboard shall be between 0° and 15° positive.

### 6.1.5 Profile of keyboard

The profile of the keyboard may be sloped, dished, stepped, sculptured or flat (see figures 1, 2 and 7).

### 6.1.6 Keyboard surfaces and material properties of keyboards

The visible surfaces of the keytops shall be matt finish.

The diffuse reflectance of the alphanumeric keytops should have values between 0,15 and 0,75 to avoid undue luminance contrast to the equipment and other items within the field of view (see ISO 9241-5:—<sup>1)</sup>, 5.4.4).

The material of the surface with which the user comes into contact frequently should not have unfavourable heat conductivity characteristics.

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

### 6.1.7 Keyboard placement

The design of the keyboard shall permit it to be easily repositioned on the work surface, except for special applications with clearly defined tasks. The keyboard shall be detachable. The keyboard should be stable during use (i.e. it should not slip or rock) on a horizontal plane surface.

### 6.1.8 Keyboard slope adjustment mechanism

The keyboard slope should be adjustable. Any adjustment mechanism shall not compromise the requirements for stability and placement. Adjustments shall not change unintentionally. Tools shall not be required for adjustment purposes.

NOTE Support surfaces or other mechanisms designed for the purpose of placing or holding keyboards (e.g. keyboard trays that provide *x*, *y* and *z* and slope adjustments are subject to design provisions given in ISO 9241-5.

## 6.2 Design of keys

### 6.2.1 Key layout and centre-line spacing

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

NOTE Certain keys can occupy more than one position in the grid and therefore the 19 mm centre to centre restriction may not be applicable either vertically or horizontally or both (see ISO/IEC 9995-1).

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1) To be published.

**6.2.2 Keytop design**

The strike surface of the keytops of alphanumeric keys shall be at least 110 mm<sup>2</sup> in area, the width of the strike surface shall be between 12 mm and 15 mm. The minimum strike surfaces apply to the keys in the alphanumeric and numeric zones. Outside these sections, strike surfaces may be smaller, but not less than 64 mm<sup>2</sup>.

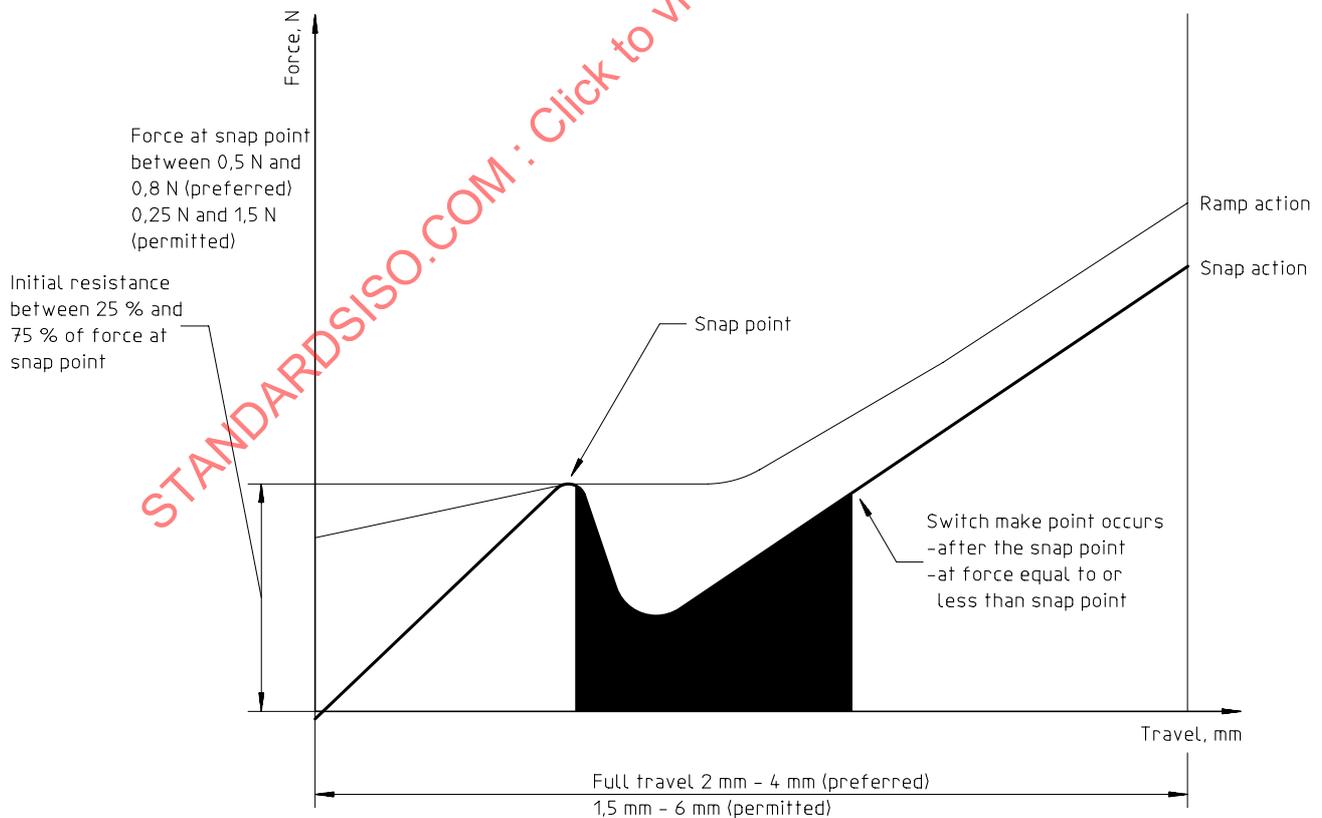
NOTE The appropriate dimensions of the keytop (keycap) depend on the key width, the key centre spacing, as well as the strike surface and the key displacement.

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

**6.2.3 Key displacement and force**

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

For displacement keyboards (see figure 8), the initial resistance (starting force or preload) shall be between 25 % and 75 % of the force at the character generation point (for ramp action) or at the snap point (for snap action). 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. The switch make action in the snap action shall occur after the snap point but before the key force has returned to the snap point. The activation should occur around the minimum force point after the snap point.



**Figure 8 — Relationship between key displacement and key force**

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

## **6.2.4 Keying feedback**

### **6.2.4.1 General**

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

### **6.2.4.2 Kinaesthetic feedback**

Ramp action displacement alone does not provide sufficient tactile feedback and should be accompanied by auditory feedback (see 6.2.4.3).

### **6.2.4.3 Auditory feedback**

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

### **6.2.4.4 Visual feedback**

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

## **6.2.5 Rebound action (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.

## **6.2.6 Key roll-over**

The keyboard shall correctly detect each key activation in correct order. This is achievable by adequate key roll-over.

## **6.2.7 Key repeat function**

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

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

A user-adjustable repeat rate is preferred.

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

### 6.2.8 Key legends

Key legends are used to indicate to the user which graphic characters or functions are allocated to the keys. The legends consist of either graphical symbols representing the allocated graphic characters, text or functions.

The provisions of this subclause only apply to Latin and Cyrillic based alphabets.

#### 6.2.8.1 Graphical symbols

Graphical symbols, if used, shall be in accordance with ISO/IEC 9995 and with ISO 7000 and IEC 417 where applicable.

#### 6.2.8.2 Geometric design of key legends

All legends on keys shall be legible from the design reference posture (see ISO 9241-5:—<sup>1</sup>), 3.6).

The height of primary legends on an alphanumeric key shall not be less than 2,6 mm. When a graphical symbol, a full word or a well established abbreviation is used, the height shall not be less than 2,2 mm. The width of the capital letters (except I and W) shall be between 50 % and 100 % of the height. The ratio between the height and stroke width should be between 5:1 and 14:1.

For primary legends on all keys, the luminance contrast between luminance level of the background and legends shall be a minimum of 3:1. Secondary legends should be perceptually different from the primary legends on the same key. Legends should appear to have a sharp outline.

Dark characters on a light background are recommended.

#### 6.2.8.3 Number and positioning of legends

The number of legends on any key should be kept to a minimum.

The positioning of the legends shall be in accordance with ISO/IEC 9995-1.

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

#### 6.2.8.4 Durability of legends

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.

<sup>1</sup>) To be published.

### 6.2.9 Cursor keys and keys in the editing section

Keys for the control of cursor movement shall be provided.

They shall be positioned as specified in ISO/IEC 9995-5.

Keys which activate erase or delete functions should be positioned in order to prevent inadvertent activation.

### 6.2.10 Numeric keypad

The ten digits zero to nine shall be allocated to keys in the numeric zone ZNO in one of two ways, either in the form of the 1-2-3 (telephone) layout or the 7-8-9 (calculator) layout. The telephone layout is recommended. Layout and allocation of the numeric section is specified in ISO/IEC 9995-4.

### 6.2.11 Keytop shape

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

## 7 Measurement

### 7.1 General

The keyboard is measured on a flat horizontal surface.

According to ISO/IEC 9995-1, references to keyboard "row" are described by the codes "A", "B", "C", "D" and "E".

"A" is the row closest to the user; "C" is the centre or "home" row.

### 7.2 General design of the keyboard

#### 7.2.1 Palm-rests

Where a palm rest is provided, the depth is measured from the rear edge of the rest to the front.

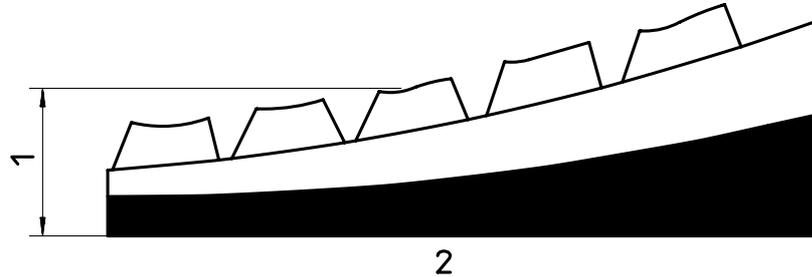
#### 7.2.2 Sections of the keyboard

If the principal sections of the keyboard are to be distinguished by spatial separation, the distance between the closest edges of the bottom of the keys of the sections is measured.

If the principal sections of the keyboard are to be distinguished by other means than spatial separation, use direct observation.

**7.2.3 Home row height**

The home row height of the keyboard is measured from the centre of the keytop of the undepressed C row to the supporting surface (see figure 9).

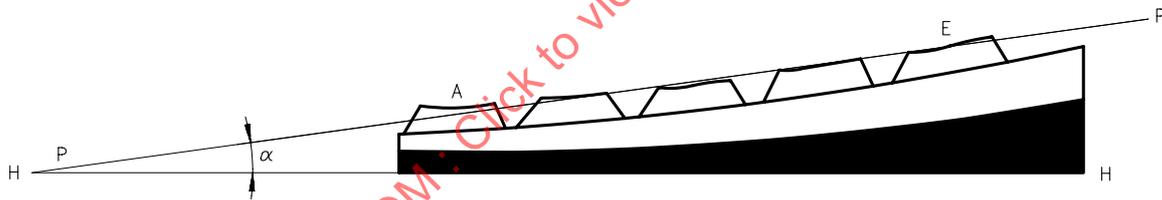


- Key**  
 1 Home row height  
 2 Row C

**Figure 9 — Measuring the height of the keyboard at row C (home row)**

**7.2.4 Slope of the keyboard**

The slope ( $\alpha$ ) is calculated from the difference in height between rows A and E (B and D in the case of keyboards with no row E), measured at the top surface of the key (excluding convex keys), (see figure 10).



If an E row is not provided, use rows B to D.

**Figure 10 — Measuring the slope of the keyboard**

**7.2.5 Profile of keyboard rows**

Use direct observation.

**7.2.6 Keyboard surfaces and material properties of keyboards**

Use direct observation for matt finish.

The diffuse reflection is the ratio of the diffuse reflected part of the reflected flux to the incident flux. Use a reflectometer that has the geometric spectral and photometric characteristics described in ISO 2469. The recommended test area is approximately 50 mm by 50 mm, therefore, it may be necessary to use a representative sample of the top surface of the keyboard.

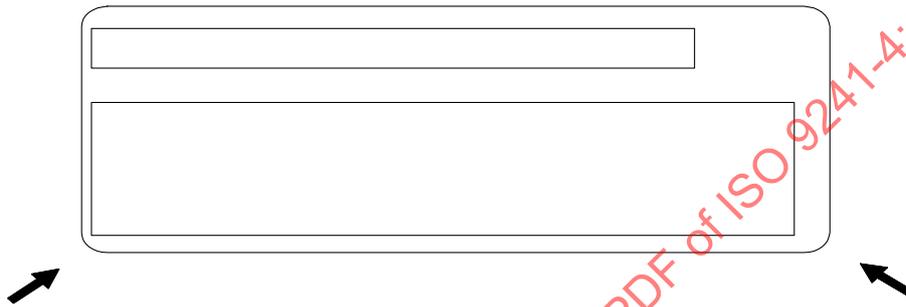
Measurement of thermal conductivity is not required.

### 7.2.7 Keyboard placement

Determine whether the keyboard can be repositioned without the use of a tool. Verify that the keyboard is detachable.

To determine keyboard slippage, use a suitable force gauge and push on the keyboard at the front corners in the horizontal plane (see figure 11). Note the force required to initiate keyboard movement. Ensure that the force applied is greater than 0,75 N and less than 13,0 N.

Measure on a horizontal smooth flat surface representative of an office worksurface.



**Figure 11 — Measuring the force required to move the keyboard**

To measure stability, measure the largest gap, if any, at one of the contact points between the keyboard and the work surface. The gap should be less than 0,25 mm.

### 7.2.8 Keyboard slope adjustment mechanism

To determine stability and repositioning ease with the slope adjustment mechanism, measure placement and stability using the metrics described in 7.2.8 with the slope adjustment mechanism in all positions. Determine if the slope adjustment mechanism can be manually adjusted.

## 7.3 Design of keys

### 7.3.1 Key layout and centre-line spacing

Refer to ISO/IEC 9995 for assessment of key position.

Evaluate the horizontal and vertical distance between two adjacent keys by measuring the distance between the centre of the keytops. Alternatively, the measurement can be done from edge to edge.

### 7.3.2 Keytop design

Evaluate the size of the strike surface by measuring the area of the top surface of the key from the width and depth of the key (see figure 12).

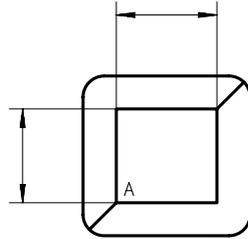


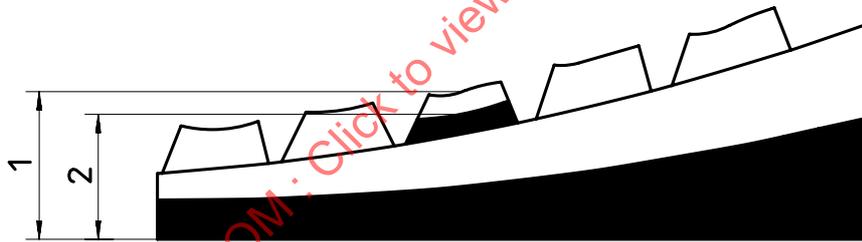
Figure 12 — Measuring keytop design

### 7.3.3 Key displacement and force

Key displacement is measured by actuating the key at its centre, in the direction of key motion, with an applied force of 1,5 N. The distance between the non-actuated key and the completely depressed key is the key displacement (see figure 13). Use an acceptable method to produce a force-displacement curve and compare with figure 8. Include a description of the procedure.

The measured resistance at the snap point represents the key force.

Verify that the character generation point in the snap action occurs after the snap point but before the key force has returned to the snap point.



**Key**

- 1 Undepressed key
- 2 Depressed key

Figure 13 — Measuring the key displacement

### 7.3.4 Keying feedback

#### 7.3.4.1 General

Determine if a perceptible sensation of kinaesthetic or auditory feedback is present.

#### 7.3.4.2 Kinaesthetic feedback

Determine the presence of a drop in resistance while actuating a key.

### 7.3.4.3 Auditory feedback

Determine if the volume level of acoustic feedback can be turned off.

When the auditory feedback is generated directly under the control of the keyboard, the occurrence of the auditory feedback after the key activation can be measured. In this case, determine the time span between the character generation point and the occurrence of the acoustic signal. In all other cases, this feature cannot be assessed.

### 7.3.5 Rebound action (bounce)

Determine if key switches are bounce free, or have a system to prevent unintended signal generation. With a mechanical device, actuate any alphabetic or numeric key 5 times per second with a force of 1,5 N. Take a random selection of 5 keys and operate for 60 s. Compare the number of key strokes with the number of characters generated to determine if intended characters and the same number of characters per key stroke were generated.

### 7.3.6 Key roll-over

Determine if three keys held down in consecutive order are correctly recorded. Test three keys in each row of alphanumeric and numeric zones.

The keyboard under test shall also be able to correctly report the activation of any non-modifier key, when pressed while one of each type of modifier key are simultaneously actuated. For example: — right control + right alt + left shift + “A” but not: — right control + left control + right alt + left shift + “A”.

### 7.3.7 Key repeat function

To determine the number of characters that can be repeated per second when the key is held down, actuate an alphanumeric key and hold it down for 15 s.

Note the delay until the second character appears. This is the “initial delay”. Count the number of characters which have appeared after the initial delay and divide that number by (15 minus the initial delay). This will be the “characters per second” of the repeat function.

Determine if the repeat action is suppressible.

### 7.3.8 Key legends

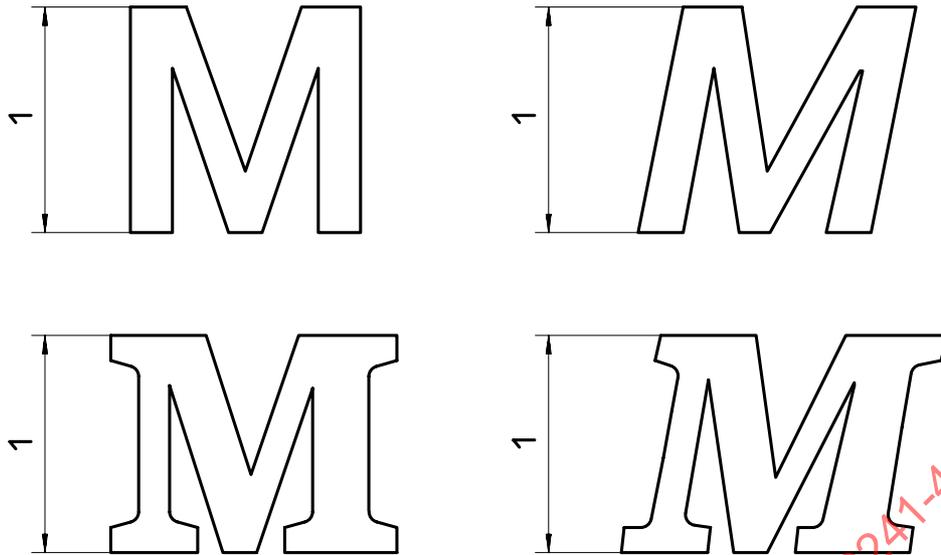
#### 7.3.8.1 Graphical symbols

Verify compliance using ISO/IEC 9995-7.

#### 7.3.8.2 Geometric design of key legends

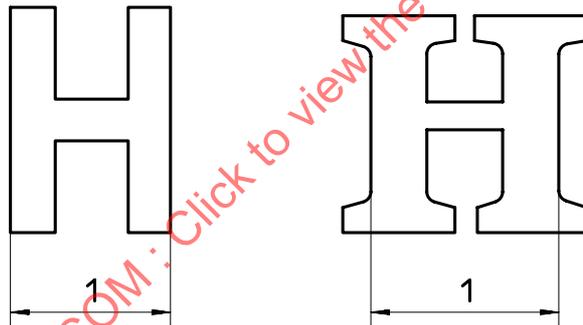
Character height is measured from the top edge of the top line to the bottom edge of the bottom line of capitals like H and M (see figure 14).

Character width of a capital letter (except I) is measured from the left edge of the leftmost line to the right edge of the rightmost line without serifs. Calculate the ratio of height to width if the width is between 50 % and 100 % of the height (see figure 15).



**Key**  
 1 Character height

**Figure 14 — Measuring character height**



**Key**  
 1 Character width

**Figure 15 — Measuring character width**

Measure the stroke width using a calibrated line-width comparator foil.

One method of measuring contrast is to calculate the average luminance of at least 4 different spots on the symbol and at least 4 different spots on its background. Specify the standard deviation of both averages and the estimated uncertainty of the contrast values calculated by the partial deviation method.

**7.3.8.3 Number and positioning of legends**

Refer to ISO/IEC 9995-1 to determine positioning compliance.  
 Determine if function keys and editing keys can be activated without entering a shift key.  
 For measurement of finish see 7.2.6.

#### 7.3.8.4 Durability of legends

To determine if legends are durable with normal use, review appropriateness and procedures of the manufacturer's durability test.

NOTE 1 This test is only required for non-permanent markings.

NOTE 2 Robustness and durability of legends are determined by the intended use with regard to intensity, frequency and force. Durability is demonstrated when the legends are legible for the duration of the product, as specified by the manufacturer.

#### 7.3.9 Cursor keys and keys in the editing section

Determine if cursor keys are provided.

See ISO/IEC 9995 to determine if cursor keys are correctly positioned.

Evaluate which layout the cursor keys have according to ISO/IEC 9995-5.

#### 7.3.10 Numeric keypad

See ISO/IEC 9995-4 to determine compliance.

#### 7.3.11 Keytop shape

Determine if keytops in alphanumeric, cursor and numeric zones are flat or concave (see figure 16). Determine if the spacebar is flat or convex.

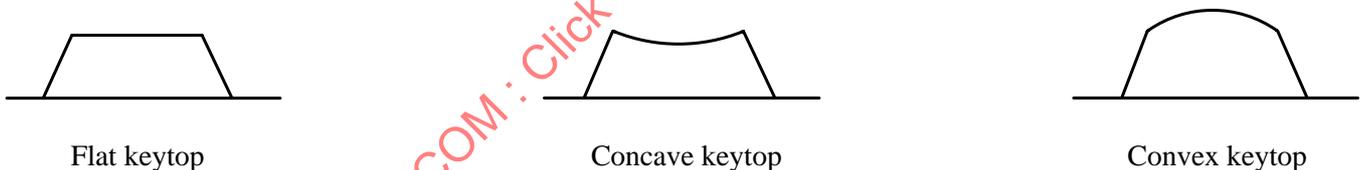


Figure 16 — Flat, concave and convex keytops

## 8 Conformance

Conformance with this part of ISO 9241 shall be demonstrated by meeting the requirements in clause 6 (measurements described in clause 7).

NOTE If an alternative route to conformance through use of a performance test is approved (such as that proposed in annex A), then meeting the performance criterion stated in clause 5 using such a test method can constitute conformance.

## Annex A (informative)

### Usability test (proposed alternative test)

*This test method is under consideration for its applicability as an alternative method of testing conformance for this part of ISO 9241. Testing organizations are requested to indicate their experience with this technique together with supporting documentation, in particular the statistical methods employed.*

#### A.1 Test method for determining alternative compliance

This clause describes a methodology for evaluating the performance and comfort of keyboards which do not meet all of the requirements in clause 6. This clause is primarily intended to help designers and/or manufacturers of innovative keyboards to assess the usability of their designs, thus encouraging the exploration of new keyboard concepts. The test methodology described in this clause may also be used by test agencies and user organizations who need to determine whether a particular keyboard meets the performance criterion of this part of ISO 9241.

##### A.1.1 Statement of usability

Usability is a consideration in the design of keyboards concerned with the extent to which users of keyboards are able to work effectively, efficiently and with satisfaction. For the purpose of this part of ISO 9241, effectiveness and efficiency are addressed by the performance measures (keying rate respectively error rate), satisfaction by the assessment of comfort.

##### A.1.2 Overview of the test procedure

The test procedure includes two tasks: text entry and data entry. The keyboard should be tested with the task which represents its intended use. It is not necessary for a keyboard to be tested on both tasks; however, a general purpose keyboard that will be used for both text and data entry is required to pass both tests.

In addition to the keyboard being tested (hereafter referred to as the “test keyboard”), a “reference keyboard” that meets all of the requirements in clause 6, using the direct measurement approach, should be used for comparison.

For both text and data entry, the test procedure involves setting up the keyboard and a monitor so that typed characters are displayed on the monitor. Test subjects perform specified text or data entry tasks while performance measures are obtained. Upon completion of the text or data entry task, subjects complete a questionnaire designed to assess subjective measures of comfort. This basic procedure is performed twice, once for the test keyboard and once for the reference keyboard.

The test keyboard meets the performance criterion of this part of ISO 9241 if performance and subjective measures of comfort are not significantly worse than those obtained from the reference keyboard using accepted statistical analysis procedures.

### A.1.3 Subjects

Test subjects should be representative of the anticipated user population(s). User variables such as gender, age range, visual characteristics (use of corrective lenses), handedness, should be considered when selecting the subject sample. In addition, the keying proficiency of the sample should match that of intended users. The subjects should be fluent in the language for which the keyboard is intended.

Perform a strength of association test to determine the appropriate subject sample size.

### A.1.4 Apparatus

The test system should be capable of

- a) displaying typed characters on a monitor,
- b) displaying typed information consecutively (no page breaks),
- c) capturing and storing keystrokes,
- d) timing sessions,
- e) printing or displaying typed information so that keystrokes and errors can be counted.

The monitor(s) used for the test should meet all of the requirements in ISO 9241-3. Preferably, the same monitor should be used for displaying the keyed characters for both the test and reference keyboards. If different monitors are used, both should have the same polarity. The appearance of the fonts should match.

Any software used in the test should not interfere with the subjects' performance. For example, if the system is connected to a network, notification of incoming mail should be disabled.

### A.1.5 Test materials

All test materials should be presented as dark text or numbers on white paper. The format of the test materials should match the capabilities of the monitor as closely as possible, i.e., printed text or data should match displayed text or data in terms of font, spacing, line width, line justification, etc.

#### A.1.5.1 Text entry

##### A.1.5.1.1 Content

Text should consist of continuous complete sentences. 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.