
**Ergonomics — Accessible design —
Controls of consumer products**

*Ergonomie — Conception accessible — Commandes d'entrée des
produits de consommation courante*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document deals with the accessibility requirements and recommendations for controls of consumer products based on ergonomic principles and practices.

This document serves the following user groups:

- a) the consumer product designers, who apply specifications of this document during the development process when designing particular consumer products;
- b) the buyers, who reference this document during the product procurement process, and whose end users gain from the potential benefits provided by this document; and
- c) the customer care service staffs who give consultancy to the end users.

The ultimate beneficiaries of this document are the end users, i.e. the consumers with age or disabilities. Its application by designers, buyers, and evaluators should provide controls that are more accessible, usable, and satisfactory. Furthermore, this document widens the range of consumers as far as possible and is not limited to the ergonomic capabilities of any particular working populations. It constitutes a starting point from which to offer requirements and recommendations for accessible design of controls of most consumer products.

This document is based on current understandings of the characteristics and capabilities of individuals who have particular physical, sensory, or cognitive impairments. The intended users are consumers of everyday products with a wide range of human characteristics and capabilities engaging in the activities of daily living. People with age or disabilities do not need to be considered separately when using this document for design processes.

This document consists of general recommendations based on extended ergonomic principles as explained above concerning the operation of various controls. The recommendations were developed primarily by reviewing the existing relevant literature and empirical evidence, then generalizing and formulating the derived or gathered knowledge into recommendations for use by designers and consumers.

This document adopts the concepts of accessibility given in ISO/IEC Guide 71. Designers can obtain general concept of accessibility needs and design requirements in ISO/IEC Guide 71. Together with the ISO 9241-400 series, this document provides principles and requirements when designing controls regardless of their types and forms, for a wider spectrum of users, including persons with disabilities and older persons. This document also presents accessibility specifications for particular types of controls covered by other documents, for example IEC 63008.

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Ergonomics — Accessible design — Controls of consumer products

1 Scope

This document defines design principles of accessibility for controls of consumer products, so that users from a population with the widest range of user needs, characteristics and capabilities are able to use controls to operate and control consumer products in the same manner and ease as users without disabilities.

This document is applicable to all kinds and types of consumer products. This document is applicable to the controls for common main operations of consumer products such as initiation, termination, and cancellation of operation, as well as for specified functions necessary for more detailed operations and fine adjustment.

This document does not deal with controls for some specialized devices intended only for specified user populations and tasks, e.g. assistive and medical devices. Each design consideration in this document is based on ergonomic principles that are necessary for making the controls of consumer products accessible to a wider range of users.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

accessible design

design focused on diverse users to maximize the number of potential users who can readily use a system in various contexts

[SOURCE: ISO/IEC Guide 71:2014, 2.19]

3.2

main operation

major fundamental function commonly needed to control a consumer product without detailed configuration

Note 1 to entry: Controls are differentiated in type for main operation and for function selection and value adjustment. The main functions of consumer products include start, stop, pause, and cancel operations as well as power control.

3.3

consumer product

product that is intended to be acquired and used by an individual for personal rather than professional use

[SOURCE: ISO/TS 20282-1:2006, 3.2]

3.4

control

part of a device that is used by a user to operate or control the functions as prescribed by the usage of *consumer products* (3.3) or to adjust and select detailed operations of a function

Note 1 to entry: Typical controls of consumer products include various types of push buttons, dials, or switches.

EXAMPLE Controls of consumer products and products to which this document is applied include, but are not limited to:

- on/off button(s): turn on or off a TV, computer, fan or water purifier;
- start button: start the operation of a microwave oven;
- start/stop button(s): start or stop the operation of a rice cooker;
- start/stop/cancel button(s): start or stop or cancel of a selected program of a washing machine;
- mute button (remote control of a multimedia player): mute sound;
- key pad or dial: setting temperature of a refrigerator or air condition;
- cue/review button(s): listen to the previous or next recordings.

3.5

control-response ratio

ratio of the movement of the control device to the movement or the result of the system response^[Z]

4 Guiding principles for controls

4.1 General considerations for accessible design

Guiding principles given in this clause are generic design rules for a control or combinations of controls. For a specific control, design requirements can be derived from the principles in consideration of the relative importance for each principle, the use and the intended user population.

The guiding principles of this clause are based on the concept of accessibility as defined in ISO/IEC Guide 71. Following the rationale of this concept, a control has no intrinsic accessibility, but can only be used in a particular context.

The concept of universal design and accessible design (as defined in ISO/IEC Guide 71) concerns the extent to which equipment and products can accommodate diverse users' needs as much as possible. The ergonomic consideration for universal design and accessible design in consumer products ensures the accommodation of a wide range of users for intended use. The designer should consider a wide range of users including older persons and persons with disabilities. The required accommodation can be achieved by using any product that provides a design and functionality that meets the user's accessibility needs in various contexts. For example, there are a variety of controls which enable users to achieve the same results by using different parts of their body (e.g. hand, foot, speech or eye control). Designers need to understand that depending on their specific needs, some users can even use a combination of different controls to achieve the same result.

Designer should pay attention to ensuring the following so that consumers with a wide range of characteristics and capabilities can achieve a specified and intended goal for the use of the product with effectiveness, efficiency, and satisfaction.

- a) Controls should be arranged in a way that can facilitate user manipulation regardless of their characteristics and physical limitations. In particular, controls for main operations should be located on the frontal surface or at the top of the product, and spatially arranged to be the first in order of functional operation.
- b) Controls should be discernible based on their shape, colour, tactile point, and markings to facilitate tactile recognition for a wider range of users.
- c) Only one function should be dedicated to each control. Assigning two functions into a single control increases the cognitive burden for a wide range of users.
- d) Controls for similar functions should be arranged into a group but need to be arranged in a logical order to facilitate easy understanding.
- e) Controls serving as a reference point of an arrangement should be distinguishable from other controls based on their shape, colour, tactile point, and marking to facilitate both visual and tactile recognition for a wide range of users.
- f) Controls for main operation should be distinguishable from the controls for function selection and value adjustment to facilitate user recognition for a wide range of users.
- g) Controls should be clearly marked using visual symbols or texts as well as with tactile symbols to provide information to users with limitations in vision.

NOTE ISO 24503:2011, 3.2, discusses how tactile dots and bars are to be used on the controls of consumer products for marking for identification of main functions.

EXAMPLE A control that starts a function can use a tactile dot to indicate initiation. A control that cancels a function may use a tactile bar to indicate cancellation.

4.2 Design considerations relevant for accessible design

4.2.1 Operability

4.2.1.1 General

A control should be operable, i.e. its intended use should be available, predictable, and consistent for all users regardless of user characteristics and physical limitations.

NOTE ISO 9241-400:2007, 4.2.2, discusses operability as one of design requirements for input devices (controls here).

4.2.1.2 Availability

The intended use of a control for any functionality of the consumer product should be easily found and obviously available for all users. This implies that the location, physical form, colour, texture, and size of the control should be considered during the design process.

NOTE Controls can vary in physical form, surface colour and texture, and size for coding to provide useful information for discrimination under adverse conditions as well as helping users with disabilities grasp and manipulate the control with ease.

4.2.1.3 Predictability

The use of a control should be predictable, i.e. it should be designed to operate and move according to the expectations of the intended user, regardless of user characteristics or physical limitations. Users can have expectations with regards to actions and responses accompanying the use of any control.

NOTE This implies that compatibility principles need to be considered when designing for users with diverse characteristics. Compatibility refers to the relationship of stimuli (manipulation of a control in this case) and responses (of products) to human expectations. Four types of compatibility need to be considered selectively or integrally to ensure predictability: conceptual, movement, spatial, and modality^[2].

4.2.1.4 Consistency

The use of a control should be consistent, i.e. it should operate and move in the same manner when used in similar situations regardless of user characteristics or physical limitations.

NOTE 1 Predictability can also be enhanced with provision of consistency in operation procedures and information on use context.

NOTE 2 Consistency in controls is related to products (i.e. internal consistency^[8]).

4.2.1.5 User compatibility

A control should be user-compatible, i.e. its design should accommodate characteristic differences of a wide range of users regardless of user characteristics or physical limitations.

NOTE ISO 9241-400:2007, 4.2.3, discusses the characteristics of the intended users being anthropometric and biomechanical capabilities that are well described in ISO/IEC Guide 71:2014, Clause 7^[4].

4.2.1.6 Psychological approachability

A control should provide a way to overcome psychological barriers to accomplish the task by providing appropriate layouts of control mechanisms and easy processes for interacting with products for a wide range of users regardless of user characteristics or physical limitations.

NOTE ISO 9241-400:2007, 4.2.5.5, presents the similar requirement in adequacy of device access and control access for physical approachability. However, designers also need to consider psychological aspect of approachability.

EXAMPLE If a consumer product has too many controls or has controls in very small sizes without proper layout, consumers can be overwhelmed and become hesitant to start using the product.

4.2.1.7 Equitability

A control should allow diverse users to accomplish tasks in an identical manner in the end. It should provide all users with a means to access and use the same functionalities. Controls should have alternative ways of interacting with a product that relates to the same functionalities.

EXAMPLE Consumers can operate a microwave oven using either a dial to set up a desired heating time or buttons to select a desired option for warming foods. Both would help accomplish the goal to warm the food, and therefore brings equitability in functionalities.

4.2.2 Controllability

4.2.2.1 General

The operation of a control should be controllable regardless of user characteristics or physical limitations. This means that all users should be able to initiate and complete the intended use of the product as required to accomplish the intended task. This also means that the control should be responsive.

The design of the control should prevent unintended loss of control during intended use, e.g. slipping in the case of hand operated controls, due to physical and sensory limitations of the user.

4.2.2.2 Responsiveness

A control should be responsive, i.e. the feedback following its actuation should be consistent, timely, accurate, and available in multiple modalities for all users regardless of user characteristics or sensory limitations. The feedback should be displayed in multiple modalities in order to be responsive regardless of user characteristics and sensory limitations.

EXAMPLE For a consumer product that is not in operation right after turning on a power control but rather stays on standby instead, it is useful to provide a way for users to monitor the status of power at any time through various means of presentation.

4.2.2.3 Feedback

A control should provide effective feedback in multiple modalities, i.e. the user is given immediately perceptible and easily understandable indication that the product is responding to user actuation in multiple ways of presentation. Effective feedback should be provided within an adequate time range, without lagging. Feedback to indicate confirmation of operation should be distinguishable from the feedback to indicate error in operation.

NOTE ISO 9241-400:2007, 4.2.4, presents how effective feedback is provided for input devices.

EXAMPLE When auditory feedback is used, it is given within a perceptible frequency range. The frequency range audible by human ears is 20Hz - 20 kHz, but it decreases to 20 Hz ~ 6 kHz with age. Particularly, hearing loss due to ageing is more significantly experienced by males than by females.

4.2.2.4 Flexibility

The design of a control should give the user adequate and reliable access even with different control mechanisms that require different interaction modalities to use a product (e.g. by touch, gesture, voice) by providing multiple means of operation.

NOTE Flexibility in control can bring equitability in functionalities to accomplish the same goal with diverse mechanisms.

4.2.2.5 Reliability of control access

A control should be reliable so that its design prevents loss of control during intended use regardless of user characteristics or physical limitations. Users should be able to perceive the change in the state of controls where the intended function selection is cancelled or stopped in multimodal forms so as not to lose control of the function.

NOTE ISO 9241-400:2007, 4.2.5.4, presents the similar concept of reliability of device access for input devices.

EXAMPLE For a consumer product that provides a visual display to show the status of control, the same information needs to be presented in auditory modality with the same level of fine detail.

4.2.2.6 Adequacy of control access

The design of a control should enable the user to quickly and easily access the control during intended use without adversely affecting performance due to user's physical or cognitive limitations. Users need to perform with ease and timely regardless of user's physical or cognitive conditions. Access to controls is considered adequate when the controls can be located and actuated quickly and easily without interfering with the overall use of the control.

NOTE ISO 9241-400:2007, 4.2.5.5, presents the similar concept of adequacy of device access for input devices.

EXAMPLE Users need to be able to operate the controls of a product with one hand. All consumer products need to provide any form or mechanism that is operable by one hand without excessive force.

4.2.2.7 Provision of a reference point in a control

A starting point or a reference point (e.g. the first function or the last function of the array) should be clearly marked so that the user can perceive the cue through auditory and/or tactile perception for controls in which:

- functions are arranged in a linear fashion and are located inside an endless loop (or a carousel) even after one full turn with multiple rotation; and
- the user has to repetitively press the button or turn a dial in the same direction to locate the desired function.

EXAMPLE Providing indication of reference points in a carousel type of control, e.g. rotating dial or knob in an endless fashion, enables non-sighted users not to lose control during intended use by placing either a longer space or a longer dent between the last function and the first function so that the user can clearly perceive the difference and recognize it as a reference point.

4.2.2.8 Control-response ratio for self-adjustment

Users should be able to adjust the control-response ratio of controls so that users with diverse capabilities can adjust the system responsiveness up to their capabilities and avoid experiencing difficulties due to high sensitivity while manipulating controls.

If providing the adjustment capability in consumer products brings too much burden on the user, then the determination of an optimal control-response ratio should take into account the hand dexterity of people with physical limitations, particularly for people with various upper extremity disabilities.

NOTE The determination of optimum control-response ratio for any type of control or quantitative-setting control needs to take into account two components of human motions: a gross-adjustment movement and a fine-adjustment movement^[2]. Since persons with physical disabilities or older persons have difficulty with fine-adjustment movements, controls that help guide the fine movement for a quantitative value setting would make the product more accessible.

4.2.2.9 Reference point for value adjustment

Controls in which value or intensity is adjusted should be arranged and operated as follows.

- a) For controls where increment and decrement is adjusted using a single button, the starting value should be clearly displayed for users to recognize as the reference point of operation.
- b) For controls where increment and decrement buttons exist, users should be able to recognize them by shape (both in vision and touch). If the same shape is used for both buttons, then the increment button should be positioned relatively above or to the right of the decrement button.
- c) On dial-type controls, the direction of increment should be clockwise and the direction of decrement should be counter-clockwise. If the values within a dial control change in a linear fashion and with an endless loop after one full turn, a starting point or a reference value (i.e. the lowest or the highest value) should be displayed so that the user can perceive it through auditory and/or tactile perception to avoid losing control during value adjustment.

4.2.3 Error tolerance

All users should be able to recover from any predictable errors and complete the intended use of products with no, or minimal, corrective action or negative consequences.

All users should be able to explore a product without unintentionally activating controls or their functionality.