

1621™

IEEE Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments

IEEE Computer Society

Sponsored by the
Microprocessors and Microcomputers Committee



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American National Standard (ANSI)*

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IEEE Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments

Sponsor

**Microprocessors and Microcomputers Committee
of the
IEEE Computer Society**

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Abstract: This standard covers the user interface for the power status control of electronic devices that ordinary people commonly interact with in their work and home lives, including, but not limited to, office equipment and consumer electronics. Key elements are terms, symbols, and indicators.

Keywords: electronic device, power control, power indicator, power state, sleep state, user interface

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Introduction

This introduction is not part of IEEE Std 1621-2004, IEEE Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments.

The electronics industry has been proactive in including product features that reduce power levels when possible to save energy and extend battery life. Much of this has been accomplished through industry work with the U.S. EPA ENERGY STAR[®] program^a, and globally, billions of dollars worth of electricity are saved each year through the use of power management (Kawamoto, et al. [B2]^b). Despite this success, many devices that are capable of power management are not saving energy because the power management features are disabled, incorrectly configured, or thwarted by hardware or software conflicts (PIER 500-03-012f [B3]), (Roberson, et al. [B5]), (Webber, et al. [B6]). For PCs, the great majority are not power-managing. For monitors, printers, and copiers, the rates are above 50%, but significant improvement is still possible. Thus, there is the potential for considerable additional savings through higher enabling rates in power management. In addition, there are a variety of reasons to expect that the opportunity for energy savings from power management will only increase in coming years, such as more devices and device types that can power manage, greater number of hours these devices are wanted to be available, and greater difference between on and sleep states.

The goal of this standard is to capture energy savings by increasing the rate at which power management features are enabled and operate successfully. This standard should lead to other benefits such as improved ease of use and reduced burden of customer support on manufacturers.

At present, power management controls in office equipment and other electronic devices show little consistency in the terms, symbols, and indicators used and in their overall structure. This is particularly true across device types (e.g., between a PC and a copier), but often holds even within the same type of device. For example, the standby mode on some copiers refers to the state when they are fully on and immediately ready to act, but the standby mode on some computers and monitors refers to a low-power mode in which they have reduced capability and take time to recover. "Standby power" also is used for a device's minimum power state, which is an off state for most devices. The combination of controls and indications of power status is the user interface.

The confusion and ambiguity of so many power controls preclude many people from being able to understand power controls and power status. The problematic interfaces further deter these people and others from attempting to change power management settings or successfully doing so.

This standard is intended to accomplish a broad similarity of experience of power controls of any electronic device that is used in a normal work or home environment. It is intended to do this through voluntary means. It is not intended to stifle innovation in user interfaces, nor preclude deviations from the standard where clearly warranted.

The first draft of this standard was based on research (Nordman, et al. [B4]) conducted at Lawrence Berkeley National Laboratory, and funded by the Public Interest Energy Research (PIER) Program of the California Energy Commission.

^aThis information is given for the convenience of users of this standard and does not constitute an endorsement by the IEEE of this program.

^bThe numbers in brackets correspond to those of the bibliography in Annex A.

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IEEE Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments

1. Overview

1.1 Scope

This standard covers the user interface for the power status control of electronic devices that ordinary people commonly interact with in their work and home lives, including, but not limited to, office equipment and consumer electronics. Key elements are terms, symbols, and indicators.

This standard does not specify maximum power levels, address safety issues, or cover internal mechanisms or interfaces for industrial devices.

1.2 Purpose

The purpose of this standard is to accomplish a similarity of experience of power controls across all electronic devices so that users will find them easier to use and be more likely to use power management features that save energy.

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 or corrigenda) applies.

ANSI/VITA 40, Service Indicators Standard.¹

CIE Technical Report 107, Review of the Official Recommendations of the CIE for the Colours of Signal Lights.²

¹ VITA publications are available from the VMEbus International Trade Association, P.O. Box 19658, Fountain Hills, AZ 85269, USA (<http://www.vita.com/index.html>).

² CIE publications are available from the International Commission on Illumination, Kegelegasse 27, A-1030 Wien, Austria (<http://www.cie.co.at/>).

IEC 60073, Basic and Safety Principles for Man-Machine Interface, Marking and Identification—Coding Principles for Indicators and Actuators.³

IEC 60417, Graphical Symbols for Use on Equipment.

IEC 60447, Basic and Safety Principles for Man-Machine Interface (MMI)—Actuating Principles.

IEC 62301, Household Electrical Appliances—Measurement of Standby Power.

IEC 80416-1, Basic Principles for Graphical Symbols for Use on Equipment—Part 1: Creation of Symbol Originals.

IEC 80416-3, Basic Principles for Graphical Symbols for Use on Equipment—Part 3: Guidelines for the Application of Graphical Symbols.

ISO 7000, Graphical Symbols for Use on Equipment — Index and Synopsis.⁴

ISO 9186, Graphical Symbols — Test Methods for Judged Comprehensibility and for Comprehension.

ISO 9241-1, Ergonomic Requirements for Office Work With Visual Display Terminals (VDTs) — Part 1: General Introduction.

ISO 9241-10, Ergonomic Requirements for Office Work With Visual Display Terminals (VDTs) — Part 10: Dialogue Principles.

ISO/IEC 13251, Collection of Graphical Symbols for Office Equipment.

3. Definitions and special terms

3.1 Definitions

For the purposes of this standard, the following terms and definitions apply. *The Authoritative Dictionary of IEEE Standards Terms [B1]*⁵ should be referenced for terms not defined in this clause. In this standard, to increase clarity, power states are *italicized*.

General definitions

3.1.1 basic power state: *On, sleep, and off.* Some devices have multiple instances of one or more of the basic states (e.g., *light sleep, deep sleep*). Devices need not have any *sleep* states.

3.1.2 electronic device: An electronic machine, usually a commercial product, that people commonly use and interact with in their work or home life. In this standard, “device” is used as a shorthand for “electronic device.”

3.1.3 manual power control: An action taken by a user, or by an external device (including network activity), to change the power state of the device.

³ IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

⁴ ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/ Suisse (<http://www.iso.ch/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

⁵ The numbers in brackets correspond to those of the bibliography in Annex A.

3.1.4 power button: *See:* **power switch.**

3.1.5 power control: The combination of manual power control and automatic power management.

3.1.6 power control panel: A set of software controls for viewing and/or changing parameters relevant to the power control such as delay timers, switch behavior, summaries of usage patterns, and device behavior after unexpected power loss.

3.1.7 power indicator: A color, word, or other display that communicates the power state of a device to a user. Some power indicators also have audio indications and some have tactile indications.

3.1.8 power management (automatic): The active modulation of the energy consumption of a device for purposes other than the intended function of a product, such as mains electricity conservation, battery life extension, overheating avoidance, and noise reduction from less fan noise.

3.1.9 power mode: *See:* **power state.**

3.1.10 power state: A condition or mode of a device that broadly characterizes its capabilities, power consumption, power indicator coding, and responsiveness to input. All devices have at least one *on* state, and at least one *off* state (for some devices, *disconnected* is the only *off* state). *Syn:* **power mode.**

3.1.11 power switch: A user mechanism for causing a power state transition. *Syn:* **power button.**

3.1.12 tactile nib: A small raised surface on a key, button, or switch that does not interfere with normal usage but allows identification of the key through tactile means.

3.1.13 wake event: A manual or automatic action that causes a system to initiate a transition from a *sleep* power state to an *on* power state.

Power state definitions

3.1.14 disconnected: A form of the *off* power state in which all normal operating power supplies have been removed.

3.1.15 hard-off: An *off* power state in which the device uses no power from the mains or a normal operating battery.

3.1.16 off: A power state in which the device has less (or similar) power consumption, capability, and responsiveness than it does in the *sleep* or *on* state.

3.1.17 on: A power state in which the device has greater (or similar) power consumption, capability, and responsiveness than it does in the *sleep* or *off* state.

3.1.18 sleep: A power state in which the device has greater (or similar) power consumption, capability, and responsiveness than it does in the *off* state, and has less (or similar) power consumption, capability, and responsiveness than it does in the *on* state.

3.1.19 soft-off: An *off* power state in which the device is allowed to use some power from the mains or a normal operating battery. When it is unknown whether the *off* power is zero, the *off* state is considered to be *soft-off*.

3.1.20 transition: A state of limited duration that occurs when a device takes a user-perceptible time to change from one basic power state to another.

3.2 Special terms

Several key words are used to differentiate between different levels of requirements and options, as described in this subclause.

may: Indicates a course of action permissible within the limits of the standard with no implied preference (“may” means “is permitted to”).

shall: Indicates mandatory requirements to be strictly followed in order to conform to the standard and from which no deviation is permitted (“shall” means “is required to”).

should: Indicates that among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain course of action is deprecated but not prohibited (“should” means “is recommended to”).

4. Power controls for electronic devices

4.1 General principles

The scope of devices covered by this standard includes those traditionally electronic, such as office equipment and consumer electronics, as well as appliances, telecommunications devices, space conditioning equipment, and any other device that has nontrivial power controls. In this context, devices are usually separately powered from the mains, separately controlled by the user for their power status, and have a separate power indicator.

This standard shall not be used to impede innovation in power controls, nor shall it be used to prohibit deviations from the standard in cases where the difference is clearly merited. This standard shall be interpreted in ways that maximize consistency across devices and simplicity and clarity for users.

The use of the English language to describe this standard in no way implies that English is to be preferred for use on products and in documentation. This standard makes no recommendations about language choices.

4.2 Power states

Power states for this standard are *as perceived by the user* and are not required to correspond directly to internal power states. Devices shall be limited to the three basic power states—*on*, *sleep*, and *off*. Any additional power states shall be variants of one of the basic states rather than a fourth state.

This standard does not address absolute power levels, nor does it make specifications about peak power consumption so that no restriction is placed on short-term fluctuations in power levels.

Power levels for purposes of this standard are only relevant as they affect long-term energy consumption. Thus, power should be measured over an extended time period; IEC 62301⁶ provides procedures for measuring average power over such periods.

The only power consumption (P) requirements of this standard for power states are as follows:

$$P_{\text{ON}} \geq P_{\text{SLEEP}} \quad \text{and} \quad P_{\text{SLEEP}} \geq P_{\text{OFF}}.$$

⁶ For information on references, see Clause 2.

Common forms of *sleep* are *light sleep* and *deep sleep*. As with basic power states,

$$P_{\text{LIGHT SLEEP}} \geq P_{\text{DEEP SLEEP}}.$$

Common forms of *off* are *soft-off* and *hard-off*. In *soft-off*, some power may be consumed by the device even though the power state is *off*. In *hard-off*, no power is consumed, either from mains power or a normal operating battery. Other than *hard-off* (including *disconnected*) and *soft-off*, this standard does not define substates.

For devices that can operate from battery power, attaining the *disconnected* state requires that the battery be removed or otherwise prevented from supplying power to the system. A device that is *disconnected* cannot be turned on until at least one source of the power supplies is connected. Incidental battery power such as that which supplies clock circuits but is not capable of powering the device in an *on* state does not qualify as normal operating power. A battery that provides only short-term operating power (e.g., <1 min for an orderly emergency shutdown) also does not qualify.

4.2.1 User experience of power states

Even in the *off* power state, a device may retain information about its functional state. For example, a television may remember the channel and volume settings when *off*, and a computer may remember its functional state in *off* through the use of a “hibernate” feature, saving the system state to nonvolatile memory (e.g., a hard disk).

Devices should have consistent **behavior**, **responsiveness to input**, and **capability to act** in all substates within a basic state. For example, wake events should be consistent across all sleep states. During transition states, behavior, responsiveness, and capability may be different from those of any basic power state. Some inconsistency is unavoidable, such as devices able to turn themselves on from *soft-off* but not from *hard-off*.

Devices shall operate such that they can be readily used by people who do not distinguish between or among device substates, but devices are not prohibited from communicating which substate the device is in.

User interfaces should not differ between *soft-off* and *hard-off* except when the *hard-off* symbols need to be used. Users should generally experience only *off*, and the terms *soft-off* and *hard-off* should only be used when necessary (see 4.5).

4.2.2 Relation between power states and operating system state

The state of a device operating system and the power state of the device shall be differentiated, but may have common controls. For example, a command to power on a device may also start the operating system, and a command to power down may also shut down the operating system. However, a device can be in a special mode and be *on* but without the primary operating system operative, and a device can be *off* but have the operating system state saved for immediate use after power on (this is commonly called “hibernate” although that term should not be used).

A command to “restart” a device operating system is generally not a power state transition, since the device usually begins and ends in the *on* state. However, it is appropriate to present a restart operation as a pair of power state transitions (power down immediately followed by power up).

4.3 Power symbols

Power symbols shall be those used in IEC 60417, as well as the sleep symbol. These symbols are listed in Table 1. IEC 60417 defines ⏻ ⁷ for use with a power switch that does not do a total mains disconnect, and hence the device consumes “standby” power. ⏻ is generally used and understood to mean “power,” as on power buttons, indicators, and elsewhere. ⏻ , therefore, means “power” with a nonzero power level in the *off* state. Electronic devices shall use ⏻ to be a synonym for “power” on power controls. No safety issue is introduced by the use of the ⏻ symbol on a switch that causes the device to go to a *hard-off* state.

Table 1—Power symbols

Symbol	Name	Usages in addition to use within power control panels
	On	On a switch, best used in conjunction with the off symbol, as on a rocker switch.
○	Off	On a switch, best used in conjunction with the on symbol, as on a rocker switch.
⓪	On/Off	For use on a power switch that always switches to <i>hard-off</i> in the <i>off</i> state. For use with a power indicator if the off indication is always <i>hard-off</i> and the distinction from <i>soft-off</i> is important.
⏻	Power	For use on a power switch or button if the <i>off</i> state is <i>soft-off</i> , is variable, is not known, or the distinction from <i>hard-off</i> is not important. Also for use with a power indicator, or as the icon for the power control panel.
☾	Sleep	For use on a sleep button, or with a sleep indicator.

In accordance with IEC 80416-3, symbols can be filled, be rotated, have their lines thickened, or be used on digital displays, as long as an ordinary user can recognize the symbol correctly.

4.4 Power metaphors, affordances, and terminology

Metaphors and affordances can be used in the construction of terminology, documentation, and product design. For power controls, they should be used as described below, but used precisely and sparingly.

Power states shall be understood to have physical relationships to each other. Specifically, *on* is taken to be above *sleep*, and *sleep* above *off*. Consequently, “power up” refers to a transition from *off* to *on*, *off* to *sleep*, or *sleep* to *on*. “Power down” refers to a transition from *on* to *off*, *on* to *sleep*, or *sleep* to *off*. “Power on” refers to a transition to an *on* state. “Power off” refers to a transition to an *off* state. Note that the physical relationship is only for the metaphor and affordance; this standard makes no requirements about the actual physical design or layout of power controls.

For low-power modes, the “sleep” metaphor shall be used for the name of the power state, for transitions (“going to sleep,” “waking up,” and a “wake event”), and for the sleep symbol—☾.

User terminology used for controls for power states shall be organized around the term “power.” Common examples include a “power switch,” “power button,” “power indicator,” “power control panel,” and “power management.” User terminology is often used on the outside of devices, in documentation, and on displays.

For power indicators, the colors and color names “yellow,” “amber,” and “orange” shall be considered to be equivalent, although orange is the least preferred. This standard uses the name “yellow” to be consistent with IEC 60073. The specific colors to use are specified in this subclause. Care should be taken when

⁷ This symbol, and the other symbols found in Table 1, are copyright © 2004, IEC, Geneva, Switzerland. www.iec.ch.

translating the color names to other languages so that the term used for yellow is clearly not that used for any form of “red.”

Common terms used to refer to *on* states are *on*, *full-on*, *ready* and *active*, but no difference in meaning is implied by this standard to these different terms.

Standard translations of key terms shall be used in documentation, and on products (when present). Key terms include: power, *sleep*, *on*, and *off*.

4.5 Power indicators

4.5.1 General principles

Power indicators shall communicate stable device power states or transitions between power states. Power indicators may also communicate nonpower-state information provided that ambiguity is not introduced. Common examples are simple lights (e.g., a light emitting diode), text display (e.g., with a liquid crystal display), or an element of a larger visual display.

4.5.2 Static power states

For power indicators, color coding for power states shall be green for *on*, yellow for *sleep*, and off for *off*. Black or gray may be substituted for off (as on a graphic display or with a mechanical indicator). These color assignments are consistent with IEC 60073.

For *sleep* indicators, color coding for power states shall be off for *on*, yellow for *sleep*, and off for *off*. Sleep indicators are distinct from power indicators and are relatively rare.

Power indicator colors shall be used in accordance with ANSI/VITA 40, which specifies colors and allowable ranges—green shall be 525 nm (range 505 nm to 530 nm), yellow shall be 590 nm (amber; range 583 nm to 593 nm), and red shall be 630 nm (range 615 nm to 650 nm). ANSI/VITA 40 was designed for industrial electronic equipment status indicator applications and considers current cost and availability of light emitting diodes. For maximum accessibility for the color deficient, designers should consider the standard from CIE Technical Report 107, which specifies color limits for traffic signal lights—for fully saturated colors, green shall be between 498 nm and 508 nm, yellow shall be between 585 nm and 593 nm, and red shall be between 615 nm and 705 nm.





For text or graphic displays, *on* can be specified by the lack of power-state information (and presence of other information), the term “on” (or a clear synonym), or the on symbol— \perp ; *sleep* states can be communicated by the term “sleep” or the sleep symbol—; the *off* state can be communicated by the display being off, use of the term “off,” or the off symbol—. Note that the off symbol should only be used when it is known that the *off* state is a *hard-off* state. Table 2 presents a summary of power state indications.

Table 2—Summary of power state indications

State/ term	Indicators		Symbol	Text/displays
	Power	Sleep		
<i>On</i>	Green	Off	\perp	The lack of power-state information (and presence of other information). “On” may be substituted by a clear synonym or its corresponding standard translation.
<i>Sleep</i>	Yellow	Yellow		The term “sleep” or its corresponding standard translation.
<i>Off</i>	Off	Off		The display being <i>off</i> , or use of the term “off,” or its corresponding standard translation.

Power indicators may be on remote devices. For example, a computer may display the power state of other devices it can connect to. This allows indications of an *off* state other than an indicator light or entire display being off.

Some mechanical switches can reliably show the power state so long as the device is powered.

For devices for which a constantly illuminated power indicator would use excessive energy or be particularly intrusive, a brief flash of the power indicator in the appropriate color is allowed (e.g., 0.1 s on followed by 1.9 s off).

Nonpower information can be combined with power indications in the following ways. An error indication can be shown with a red color in the place of a power indication; when this is done, no power state information is communicated. When red is unavailable, alternating green and yellow at the normal flashing rate can be used to indicate an error, but shall not be used to indicate that a safety hazard is present. Alternating red and green or red and yellow shall be used to simultaneously indicate an error condition and power status. Other nonpower-state information, such as communication occurring, can be indicated by the slow flashing rate. Per IEC 60073, normal flashing rates are 1.4 Hz to 2.8 Hz, and slow flashing rates are between 0.4 Hz to 0.8 Hz.

4.5.3 Power state transitions

From the user perspective, some devices change from one power state to another instantly. For devices with user-perceptible transition times between states (e.g., >1 s), the power indicator shall communicate the fact of the transition state and its direction. This transition indication informs the user that behavior, responsiveness, and capability may differ from either static state. Even for instant transitions, a “blink” of the power indicator is recommended as it helps the user to see that the transition has occurred.

Color power indicators shall flash or otherwise modulate during transitions—green for a “power up” transition and yellow for a “power down” transition. Text or graphic indications shall flash or provide some other indication that there is a transition state. Flashing shall be consistent with IEC 60073 normal flashing rates (1.4 Hz to 2.8 Hz).

Devices that can indicate power state transitions with audio shall use one of the types shown in Table 3 when that feature is enabled to operate.


Table 3—Audio indications of power state transitions


Type	Details
Click	A power-up transition shall be indicated by a single click or beep. A power-down transition shall be indicated by a double click or beep.
Tone	Powering up shall be indicated by a rising tone or two tones with the second having a higher pitch than the first. Powering down shall be indicated by the reverse (a falling tone or two tones with the second having a lower pitch than the first). <i>Sleep</i> shall be accommodated in these indications by using a tone with a pitch intermediate between the two tones used for <i>on</i> and <i>off</i> , or a rising or falling tone that changes pitch less than the tone generated by an <i>on/off</i> transition.
Other	Other sound indications (e.g., musical notes or speech) shall clearly indicate the direction or endpoint of the transition.

Devices with extended transitions and the capability to display a progress indicator shall display one. A progress indicator shall show (via graphics or text) the estimated elapsed portion of the total transition time or the time remaining in the transition.


4.6 Power switch labeling and behavior

Pressing a power button should toggle the device between the two most commonly used power states. When a device is asleep, and can wake itself up, pressing a power button should wake up the device. An example situation in which these provisions cannot be met are products with a hard-off power switch and that commonly use a sleep mode, although in most cases (e.g., computer displays), the sleep and wake-up transitions are initiated by means other than the power switch.

Power switches shall be one of two types: *hard-off* and *soft-off*. When safety is involved, the user interface shall be unambiguous as to whether an *off* state is *soft-off* or *hard-off*. When safety is not involved, preference shall be given to the  symbol.

The present set of international standard symbols for power control lacks a workable designation for *soft-off*—equipment that are functionally *off* but continue to draw some power (the  symbol is reserved for zero power). Thus, designs should be avoided that would require such a symbol.

It is recommended that rocker switches be used for power controls **only** when *off* is a zero power state. It is also recommended that push-button switches be used for power controls when *off* is nonzero power. These usages avoid the need for a symbol that clearly means the *off* power state, but means *soft-off*.

When a device has two power controls, or otherwise has a *hard-off* and *soft-off* mode (with the *hard-off* obtainable other than by unplugging from the mains or normal battery), both will have the power indicator off. Only inspection or manipulation of the power switches will distinguish between the *off* states. When two power controls are present, the secondary control should be labeled with .

For devices that need an emergency override, it shall be accomplished by holding down a power button for at least four seconds. An emergency override will usually force the device into an *off* state and is necessary when ordinary means to do this are not possible.

In product design, consideration shall be given to the specifications of IEC 60073 for actuators for *on* and *off*. However, this standard makes no requirements for actuator colors. Among the specifications of IEC 60073 are that for a control that goes to *off*, **red** may be used and **green** shall not be used; for controls to go to *on*, **green** may be used and **red** shall not be used; and for controls that switch among power states, neutral color such as **white**, **grey**, and **black** are preferred, **yellow** and **green** are not to be used, and **red** is to be used only in special circumstances.

4.7 Wake events

Devices with *sleep* states shall have one or more wake events. Wake events should be consistent across all *sleep* states. Pressing a power button should cause a wake event (see 4.5).

For general purpose controls such as keyboards, and where the meaning of a key press depends on mode information not apparent in the *sleep* state, the wake event itself shall be discarded from the normal input stream.

4.8 Tactile interfaces

When a tactile marking is used on a power control, it shall be a single nib or set of three nibs in a horizontal line on the power button or on the “on” side of a power switch. Tactile nibs are commonly found on the “F” and “J” key on typewriter style keyboards, and on the “5” key on numeric keypads.

Tactile indications of states and transitions shall be broadly consistent with those of the other modalities of this standard.

Annex A

(informative)

Bibliography

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