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

Sponsored by the
Microprocessor Standards Committee
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# Introduction

(This introduction is not part of IEEE P1621, Draft 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, and globally, billions of dollars of electricity are saved each year through the use of power management[1]. 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 a hardware or software conflicts[2]. 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[3] 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 often when it is off. The combination of controls and indications of power status is the user interface.

The confusion and ambiguity of so many power controls precludes 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 is based on research conducted at Lawrence Berkeley National Laboratory, and funded by the Public Interest Energy Research (PIER) program of the California Energy Commission.

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[1] Kawamoto, Kaoru and Jonathan G. Koomey, Bruce Nordman, Richard E. Brown, Mary Ann Piette, Michael Ting, and Alan K. Meier. 2002. Electricity used by office equipment and network equipment in the US. *Energy—the International Journal.* vol. 27, no. 3, pp. 255-269. March, 2002.

[2] Nordman, Bruce, Alan Meier, and Mary Ann Piette. 2000. “PC and Monitor Night Status: Power Management Enabling and Manual Turn-off.” In Proceedings of the ACEEE 2000 Summer Study on Energy Efficiency in Buildings, 7:89-99. Washington, D.C.: American Council for an Energy-Efficient Economy. Also, Webber, Carrie A., Judy A. Roberson, Richard E. Brown, Christopher T. Payne, Bruce Nordman, and Jonathan G. Koomey. 2001. Field Surveys of Office Equipment Operating Patterns. LBNL-46930. Berkeley, Calif.: Lawrence Berkeley National Laboratory.

[3] This Draft Standard was initially published as Attachment 1 to California Energy Commission report #P500-03-012F, available at www.energy.ca.gov/pier/buildings/reports.html

 

The report of that research (The Power Control User Interface Standard[4]) is available at the project web site: http://eetd.LBL.gov/Controls and on the Energy Commission website (#P500-03-012F at www.energy.ca.gov/pier/buildings/reports.html).

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At the time this standard was completed, the working group had the following membership:

Bruce Nordman, *Chair*

The following members of the balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention. (To be provided by IEEE editor at time of publication.)

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[4] Nordman, Bruce, "The Power Control User Interface Standard — Final Report". Lawrence Berkeley National Laboratory. P500-98-032. Contract No. 500-98-032. LBNL-52526. December, 2002.

 

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# Draft 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

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 utilize power management features that save energy.

## 2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply. See Annex A for informative references. Uniform Resource Locators (URLs) provided in this standard are current as of the date submitted for publication.

CIE Technical Report CIE 107-1994, Review of the official recommendations of the CIE for the colours of signal lights, International Commission on Illumination.

IEC 447:1993, Man-machine interface (MMI) — Actuating principles.

IEC 60073:2002, Basic and safety principles for man-machine interface, marking and identification—Coding principles for indication devices and actuators.

IEC 60417-1:1998, Graphical symbols for use on equipment—Part 1: Overview and application.

IEC 60417-2:1998, Graphical symbols for use on equipment—Part 2: Symbol originals.

IEC 59/267/CD:62301:2002, Measurement of standby power. Draft.

IEC 80416-1:2001, Basic principals for graphical symbols for use on equipment—Part 1: Creation of symbol originals.

IEC 80416-3:2002. Basic principals for graphical symbols for use on equipment—Part 3: Guidelines for the application of graphical symbols.

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

ISO 9186:2001, Graphical symbols—Test methods for judged comprehensibility and for comprehension.

ISO 9241-10:2001, Ergonomic requirements for office work with visual display terminals (VDTs)—Part 10: Dialogue principles.

ISO 9241-1:1996, Ergonomic requirements for office work with visual display terminals (VDTs)—Part 1: General introduction.

ISO/IEC 13251:2000, Collective Standard—Graphical symbols for office equipment.

VITA 40-2002, Service Indicators.

## 3. Definitions, terminology, and acronyms

In this standard, to increase clarity, power states are *italicized*.

### 3.1 General Definitions

**3.1.1 device:** An electronic machine, usually a commercial product, that is commonly used and interacted with by ordinary people in their work or home life. This includes devices traditionally electronic, such as office equipment and consumer electronics, as well as appliances, telecommunications devices, space conditioning equipment, and any other device that has non-trivial 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.

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

**3.1.3 power control:** The combination of manual power control and automatic power management.

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

**3.1.5 power indicator:** A color, word, or other display that communicates the power state of a device to a user. 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. Power indicators may also have audio or tactile indications.

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

**3.1.7 power state:** A condition or mode of a device that broadly characterizes its capabilities, power consumption, power indicator coding, and responsiveness to input. Basic power states are *on*, *sleep*, and *off*. Devices may have multiple instances of one or more of the basic states (e.g. *light sleep*, *deep sleep*), and need not have any *sleep* states. All devices have at least one *on* state, and at least one *off* state (*unplugged*). The term “power mode” may be substituted and has identical meaning.

 

**3.1.8 power switch:** A user mechanism for causing a power state transition. May also be called a “power button”.

**3.1.9 tactile nib:** A small raised surface, usually on a key, that does not interfere with normal usage but allows identification of the key through tactile means only. May be also found on buttons or switches. Common examples are “F”, “J”, and “5” keys.

**3.1.10 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.

### 3.2 Power State Definitions

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

**3.2.2 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.

**3.2.3 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.

**3.2.4 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.

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

**3.2.6 unplugged:** A form of the *off* power state in which all normal operating power supplies have been disconnected. For devices that can operate from battery power, this requires that the battery be removed or otherwise disconnected from the ability to supply the system. A device that is unplugged 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 which provides only short-term operating power (e.g. for less than 1 minute) also does not qualify.

## 4. The Standard

### 4.0 General Principles

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. The standard shall be interpreted in ways that maximize consistency across devices and simplicity and clarity for users.

### 4.1 Power States

Power states for this standard are *user* power states, 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 62301 provides procedures for measuring average power over such periods.

The only power consumption requirements of this standard for power states are that:

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

Common forms of *sleep* are *light sleep* and *deep sleep*. As with basic power states, $\text{Power}_{\text{LIGHT SLEEP}} \geq \text{Power}_{\text{DEEP SLEEP}}$.

Common forms of *off* are *soft-off* and *hard-off*. *Soft-off* implies that some power may be consumed by the device even though the power state is *off*. *Hard-off* requires that no power is consumed, either from mains power or a normal operating battery.

### 4.1.1 User Experience of Power States

The *off* power state does not require information about the device functional state to be lost. 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 non-volatile memory (e.g. a hard disk).

When feasible, devices shall have consistent behavior, responsiveness to input, and capability to act in all substates within a basic state. For example, wake events shall be consistent across all sleep states when feasible.

Users shall not be required to understand the differences among substates to properly use a product, but devices are not prohibited from communicating which substate the device is in.

When feasible, user interfaces shall not differ between *soft-off* and *hard-off* except when the *hard-off* symbols need to be used. Users should generally experience only *off*.

### 4.1.2 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").

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).

## 4.2 Power Symbols

Power symbols shall be those used in IEC 60417 as well as the sleep symbol. The are listed in Table 1. IEC 60417 defines ⏻ as 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 non-zero power level in the *off* state. Electronic devices shall use ⏻ to be a synonym for "power" on power controls. Even if used on a power button that does go to a *hard-off* state, that should not introduce any safety issue.

 

**Table 1. Power Symbols**

| Symbol | Name | Usages in addition to use within power control panels |
|---|---|---|
| I | 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. |
| ⏼ | On/Off | For use on a power switch that always switches to *hard-off* in the *off* state. For use with a power indicator if the off indication is always *hard-off* and the distinction from *soft-off* is important. |
| ⏻ | Power | For use on a power switch or button if the *off* state is *soft-off*, is variable, is not known, or the distinction from *hard-off* 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, rotated, have their lines thickened, or used on digital displays, so long as the meaning remains clear.

## 4.3 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 transition to an *on* state. "Power off" refers to a transition to an *off* state.

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, though 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 Section 4.4. Care should be taken when translating the color names to other languages 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*.

## 4.4 Power Indicators

### 4.4.1 General Principles

Power indicators shall communicate stable device power states or transitions between power states. Power indicators may also communicate non-power-state information provided that ambiguity is not introduced.

### 4.4.2 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*.

Power indicator colors shall be used in accordance with CIE 1994, which specifies color limits for traffic signal lights. For fully saturated colors, green shall be between 498 *nm* and 508 *nm*; yellow between 585 *nm* and 593 *nm*; and red 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—|; *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—○. Table 2 presents a summary of power state indications.

**Table 2. Summary of power state indications**

| State/ Term | Indicators | | Symbol | Text / Displays |
|---|---|---|---|---|
| | **Power** | **Sleep** | | |
| On | green | off | \| | The lack of power-state information (and presence of other information). "On" may be substituted by a clear synonym, |
| Sleep | yellow | yellow | ☾ | The term "sleep". |
| Off | off | off | ○ | The display being *off*, or use of the term "off". |

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. one tenth of a second on followed by 1.9 seconds off).

Non-power 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 non-power-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.

### 4.4.3 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. more than one second), the power indicator shall communicate the fact of the transition state and its direction. Even for instant transitions, a “blink” of the 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 with audio capability shall have optional audio indications of power state transitions. The audio indications shall be of one of the types shown in Table 3.

**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). *Sleep* shall be accommodated in these indications by using a tone with a pitch intermediate between the two tones used for *on* and *off*. |
| 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.

## 4.5 Power Switch Labeling and Behavior

When feasible, pressing a power button shall 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 shall wake up the device.

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 <u>only</u> when *off* is a zero power state. It is also recommended that push-button switches be used for power controls when *off* is non-zero 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 then by unplugging from the mains or normal battery), both will have the power indicator off. Only inspection or manipulation of the power switches will clarify which mode it is in. When two power controls are present, the secondary control should be labeled with ⏻.

For devices which 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 60073arethat for a control that goes to *off*, red may be used and green shall not be used; for controls to go to *on*, green maybe 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.

## 4.6 Wake Events

Devices with *sleep* states shall have one more wake events. When feasible, wake events shall be consistent across all *sleep* states. When feasible, pressing a power button shall cause a wake event.

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.

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