Power Switch Labeling
for Medical and Other Devices

A project[1] is underway to standardize the user interface for controlling the power status of any electronic device, including medical devices. Current interface standards are not integrated (among symbols, indicators, and states), and not sufficient for modern devices. While this can cause user confusion and energy waste in office equipment and consumer electronics, in medical devices it may cause safety problems. This discussion reviews how to best label power controls.

Clearly and unambiguously labeling power switches and buttons for modern electronic devices is becoming increasingly challenging. The international symbols[2] for power control were established in 1973 with some dating back at least sixty years. At that time, most devices had just two power modes (*on*[3] and *off*), a single mechanical power switch, and zero power consumption in *off*. Today, electronic devices commonly have multiple power modes and multiple power switches[4]. In addition, many consume "standby" power — non-zero power consumption in the minimum power mode, usually an *off* mode — so that the only way to achieve zero power draw is to pull the plug.

An increasing portion of electronic devices have automatic controls — they can change their power state without user action, in some cases even to turn themselves *on* from an *off* state. Automatic controls and external power supplies are some of the reasons for the increasing use of "soft" switches and buttons that send a signal rather than change power status directly.

The existing vocabulary of symbols is not adequate to clearly and unambiguously capture all the common power control implementations we find on contemporary devices. The two major complicating factors are low-power "*sleep*" modes and non-zero-power *off* modes (commonly called "standby power"). However, solutions are needed that are as compatible as possible with current product usage, and minimize the disruption to the symbol standards. Consistency and clarity should be the paramount goals, to minimize confusion and errors.

User Interface Elements

Power Modes/States

Devices should be presented to users as having at most three basic power states: *on*, *sleep*, and *off*. There may be multiple forms of *on* (e.g. active vs. ready on a printer), multiple forms of *sleep* (as on some computers, monitors, and copiers), and multiple forms of *off* (e.g. hibernate,

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[1] For more information on the Power Management Controls project and the User Interface Standard see http://eetd.LBL.gov/Controls. The standard is the basis of some assumptions made here (e.g. at most 3 basic power states) and integrates switches, symbols, indicators, and terminology. This discussion derives from analysis of office equipment and consumer electronics, but likely applies well to medical equipment and other types of devices.

[2] IEC 60417: *Graphical Symbols For Use On Equipment.* International Electrotechnical Commission, 1998.

[3] For clarity, power modes are italicized.

[4] "Switch" here refers to anything performing the switch function, including buttons, lid switches, etc.

shutdown (*soft off*), and mechanical off (*hard off*)). *Sleep* modes are usually entered by means other than a power switch (such as a delay timer), and so are not generally identified by a switch position. When *sleep* does need to be labeled, a crescent moon symbol — ☾ — should be used (though not yet an IEC symbol). For power switches, the modes indicated by the switch position are generally are *on*, *soft-off* (non-zero power consumption) and *hard-off* (zero power consumption). Indicator lights generally differentiate among *on*, *sleep*, and *off*.

Switches

Switch types commonly found on consumer devices include:

- Rocker switch - 2 state. Switches between *on* and *soft-off* or *on* and *hard-off*. May be movable to *off* by automatic means.
- Rocker switch - 3 state, with *on* a momentary state. The intermediate state of the switch is *on* or automatic *off*.
- Push-button - 2 state, with a mechanically observable difference between the two states. Can be a notebook lid switch.
- Momentary contact switch — a button or slider. Only one stable state. Moving the switch may cause a transition to the opposite state, or always to *on*.

Symbols

The IEC power control symbols are: I for *on*, ○ for *off*, ⏼ for an *on/off* switch, and ⏻ for "standby". For both ○ and ⏼, safety standards specify that the *off* state is to be a zero-power *off* — *hard off*. This leaves just ⏻ for a multitude of other uses and meanings. There are many examples of devices which use non-IEC symbols for power controls. Needless to say, these create even more different labeling possibilities and opportunities for user confusion, and are not shown or discussed here.

Indicators

"Power indicators" are usually called just that. They usually show the "functional" power state — *on*, *sleep*, or *off*, and for mechanical switches, *sleep* occurs in the *on* position. They only rarely distinguish between *hard-off* and *soft-off*. Indicators are often simply adjacent to the power switch and not separately labeled; when they are, they are usually labeled with ⏻ or "power".

The ⏻ *problem*

With clear and precise definitions for I, ○, and ⏼, a multitude of uses have been assigned to the ⏻ symbol on recent products, guaranteeing that some will be in conflict. This is exacerbated by the fact that "standby" has a wide range of definitions for office equipment alone, meaning anything from fully *on* to *sleep* to *off*. There is a large body of evidence that the symbol is best understood by people in the U.S. (and probably elsewhere) as meaning "power" (or (or "power-on", or the "on button"). The evidence includes anecdotes, product manuals,

several corporate logos, and user testing (several tests conducted over the last year in the U.S.). There is no existing symbol that means "power", so the usage of ⏻ as meaning "power" arose out of a clear need. The previous meaning of "standby" may have made sense at the time it was established (decades ago) but is now obsolete. The ⏻ symbol should be used as a substitute for "power" throughout the power control context as for a power button, power indicator, or power control panel.

Applications of Interface Elements

Good Applications

Some common applications are clear with the present symbols. Examples are devices with:

- A rocker switch in which *off* is zero power; it will be labeled with | and ○.
- A push-button 2 state switch in which *off* is zero power; it will be labeled with ⏼
- A push-button or momentary contact switch with non-zero power in off; it will be labeled with ⏻.

Applications with problems

Other applications raise ambiguities, inconsistencies, and confusion. These can lead to annoyance, energy waste, and in the medical context, perhaps safety concerns.

Soft-off. Some devices have a rocker switch that toggles between *on* and *soft-off*. When this occurs on office equipment, it usually has | for *on* and ⏻ for *off*. The problem with this is that it identifies ⏻ as meaning *off*, whereas when it is used on a power button, people interpret it as meaning *power* or *on*.

Multiple power switches. Other devices have two power switches: one which controls the functional power state (for which the *off* power level is not important) and the other which is used to switch the device to zero power. User manuals often call the latter a "main power" switch. The question arises as to whether the icon labeling of the two switches should make clear their relationship, or whether cues such as location are always sufficient (e.g. the main power switch being on the back of the device near where the power cord enters). Regardless, if the main power switch goes to zero power on *off*, it should have the | and ○ symbols.

Unknown *off* power. In some contexts, the power consumption while *off* may not be known or may change. This occurs in operating systems that may not know the power status of the hardware they run on and so may not know which symbol(s) to use. This also can occur with devices that can be operated on battery or mains power; their status while *off* may vary depending on whether the device is mains-connected, and also whether the battery is present[5].

[5] UPS (uninterruptible power supply) systems might also introduce similar ambiguity.

Automatic state changes. Automatic controls can change the power state, which is particularly a concern for transitions to and from *off*. This requires either avoiding switches (like most rockers) that mechanically show the power state, or utilize ones that can be physically moved by the device (some copiers use these).

Recommendations and Conclusions

Our goal should be a simple set of interface elements that are applied universally on products, including medical devices, in a clear and consistent way. In concert with the User Interface Standard, the following recommendations get us closer to that goal.

Create a new symbol for non-zero-power off.

The present set of international standard symbols for power control lacks a workable designation for equipment that are functionally off but continue to draw some power (the ○ symbol is reserved for zero power). This would solve the problem of a rocker switch with a non-zero off. Unfortunately, at present there are no obvious candidates.

Specify that ⏻ means "power", and use it for power buttons and indicators.

As noted earlier, while ⏻ officially means "standby", it is more generally used and understood to mean "power", as on power buttons, indicators, and elsewhere. This should be used to mean "power" on power controls — even if a power button goes to a *hard-off*, that should not introduce any safety issue. The symbol standard should be changed, but manufacturers need not wait for that to be finalized before using ⏻ for "power".

Only use rocker switches for power controls when off *is zero power,* and
Use push-button switches for power controls when off *is non-zero power.*

These recommendations get around the lack of a good symbol for soft-off.

Use caution with indicators when multiple power switches are used.

When a device has two power controls, or otherwise has a *hard-off* and *soft-off* mode, both will have the power indicator off. Only inspection or manipulation of the power switches will clarify which mode it is in. To avoid ambiguity, some devices have more than one power indicator to get around this, and some use a different color (e.g. red) to indicate *soft-off*, but both of these solutions are potentially confusing.

Use hard-off switches when possible.

Hard-off switches — labeled with ○ or ⏼ — have the advantage of eliminating "standby power".

Lend your support to the Power Management Controls project.

The user interface standard is being transformed into an IEEE standard. Contact the working group chair, Bruce Nordman, at BNordman@LBL.gov or 510-486-7089 with your comments, for project updates, and to join the working group.