NKK SWITCHES

WHITEPAPER

Selecting a Switch

MANAGING THE PROCESS OF CHOOSING THE PERFECT SWITCH

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Introduction

An electromechanical switch is a device that makes, breaks, or changes the connections in an electrical circuit by bringing together or separating the surface of two or more metallic contacts. While the switch could be one of the last components designed in a circuit, switch options continue to increase, and selecting the right switch is an essential part of designing any control panel or electronic device. It is imperative for designers to understand the key factors and options available when selecting a switch in order to specify the most suitable switch for each application.

The process for selecting a switch can be outlined in five steps:

- First, the needs of the end user must be considered - including factors such as illumination, feedback, and legend/labels.
- Next, engineering requirements must be examined: load, voltage and contact materials, momentary or maintained circuits, terminal type and mounting, etc.
- Third, care must be taken to comply with certain standards: RoHS and other government regulations must be taken into account.
- Fourth, once compliance with the applicable regulations is ensured, actuator type should be determined. Does the application call for a pushbutton, toggle, rotary, rocker, slide, paddle or keylock actuator?
- Finally, the switch selected must be reliable and robust enough for the application. This includes factors such as dust and moisture resistance, and the expected electrical life – is the switch good for 25,000 cycles, or 250,000?

By carefully evaluating and selecting switches based on these five factors, designers can be assured they are selecting the best switch for that particular application.

Meeting the Needs of the End User

One of the first things a designer needs to think about when selecting a switch is the needs of the end user. According to Steve Jobs (Apple), “Design is not just what it looks like and feels like. Design is how it works.” The design of every machine – how it works – includes one fundamental and very important aspect: How the user will interact with the machine. This design aspect – often called the man-machine interface – is a make-or-break element. If the designer does a poor job with the man-machine interface, the machine will be difficult to use and ultimately fail commercially.

The designer should ponder questions relating to interface and conditions surrounding the switch. For example: What types of feedback does the user require? Is illumination needed to show status? Are legends needed to indicate functions? Different switch options are available to meet these needs. Feedback alerts the switch operator to the occurrence of a transfer of circuit. Illuminated switches use an internal light, usually an incandescent bulb or LED, to indicate status. Additionally, legends, including polyester film inserts, engraving, hot stamping and pad printing can be used to identify specific functions. Some LED switches offer alternating legends and colors, that display one legend/color combination when the switch is “ON” and a different legend/color when “OFF.” Another form of feedback, tactile feel transmits a sensation to the operator to indicate a transfer of circuit.

For some applications, the programmable LCD offers a useful choice. These switches combine the easy-to-read, well-illuminated menus and multiple functions of a touchscreen with the tactile feedback of a dedicated function key. In large banks of switches, programmable LCDs can be invaluable; one control panel application utilized 116 of these switches to perform over 1600 functions.

Designers should also consider the ease of use of different switch sizes and designs. It is more important to select a switch that not only fits the size parameters but is also sufficiently user-friendly. This is an especially important factor in selecting switches for consumer products.

Engineering Specifications

Several engineering characteristics need to be evaluated when selecting a switch to be sure that it can perform the desired functions. Load is one of the first of these parameters to consider. When determining specifications, identifying the load characteristics focuses the designer on the necessary switch type.

Pure resistive loads are the simplest to switch. Due to very little arcing during the contact transfer, erosion is minimal. As a result, contact life is maximized.

Premature contact erosion can result from inductive loads. If the process does not follow manufacturers' switch specifications, inductive loads will lead to possible switch failure. For this reason, it is critical to take into account surge or inrush current, as well as voltage, when determining the maximum load, a switch can accommodate. Selecting switches with ratings exceeding anticipated surges will reduce the problem caused by arcing but will increase cost. Designers should always consult a switch manufacturer's product literature for guidelines to avoid under- and over-compensation.

In order to determine how much a "switch will switch," several rating factors must be examined. Ratings are expressed in different values, depending on the load characteristics, the account for voltage, contact material, and electrical operational life cycle. For instance, a switch rated at 6A @ 125VAC with a resistive load, silver contact materials and expected electrical life of 25,000 cycles can also be rated at 4A @ 125VAC with an inductive load (the electrical life would remain the same at 25,000 cycles).

Size and mounting constraints also factor into switch selection. How much space is available for the switch – is a standard, miniature, subminiature or micro-subminiature switch required? What mounting configuration is needed? In terminal type, designers can choose from surface mount, PC mount, solder lug, quick connect or wire-wrap terminals. Switches that need to be repaired or replaced in the field should have a simpler mounting type than those installed in more permanent environments.

Contact material is another item to think about when choosing switches. Most switches specify either silver or gold as their contact material. Due to excellent conductive qualities and low electrical resistance, silver contact material is most common. In situations where any power rating is required, silver is the best choice. Gold contacts are typically necessary when switching at logic level, generally defined as covering a microamp to 100ma range.

Whether a circuit is momentary or maintained will also influence the switch selection process. A maintained circuit remains open (or closed) after the switch is actuated, where a momentary circuit only remains open (or closed) while the switch is held in the appropriate position. For example, a doorbell is a momentary circuit – it only operates while being pressed down. A wall switch, on the other hand, is a maintained circuit. Many switches are offered in either momentary or maintained configurations.

Finally, designers must remember to consider a switch's life expectancy relative to the application. As alluded to previously, life expectancies vary widely and can vary within a particular switch category, depending on load, current and the type of contact mechanism involved. As a general rule, switches using momentary circuits have longer life expectancies than switches on maintained circuits. For example, a momentary circuit pushbutton could offer a rating of 1,000,000 operations minimum, while a similar pushbutton using a maintained circuit offers a rating of 200,000 operations minimum.

Rules and Regulations

Another important aspect of switch selection is compliance with government regulations and industry ratings. Most government regulations that affect switch selection have to do with the materials used in the switch. For more than nine years now the EPA has conducted research on the environmental and health effects of mercury and has produced several mercury limiting federal regulations in order to prevent these hazards. Such regulations include The Resource Conservation and Recovery Act (RCRA), The Clean Air Act (CAA) and The Clean Water Act. European countries have also produced regulations limiting the use of chemicals in manufactured goods and components, such as RoHS and Waste Electrical Electronic Equipment (WEEE). The RoHS directive, which took effect on July 1, 2006, attempts to limit, if not eliminate, the use of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE), in electronic devices as well as electrical components. Some switch designs were dramatically impacted by these regulations. Tilt switches, for example, used to be constructed almost exclusively using liquid mercury, but with the advent of EPA and other acts, the use of mercury has been completely phased out in favor of solid-state mechanisms.

In addition to government regulations, many switch applications require safety certification by UL, C-UL, and CSA. These industry organizations also set ratings for specific switch properties. For example, the UL94V rating measures the fire-retardant properties of a switch, and TV-5 and TV-8 ratings measure arc-proof properties. These ratings ensure that a switch will hold up to the demands of a particular application.

Actuator Style

In terms of actuator style, switch manufacturers offer a wide array of options to fit any design. Pushbutton switches may be the broadest sub-category of the switch universe. Available in illuminated or nonilluminated, momentary or maintained, and in many shapes and sizes, pushbuttons perform in a countless range of applications.

Toggles, rockers and paddles also come in a wide range of options from physical size to electrical rating, illuminated, momentary or maintained. They also offer a variety of circuit options, usually contained within two or three positions. An example would be a toggle, rocker, or paddle that is momentary when held to one side, off in the center position and maintained when flipped to the third position.

Rotary switches, which require a circular motion to select circuit combinations, come in all sizes and types ranging from micro-subminiature dip rotaries to very large and heavy-duty rotaries. Enclosed or open-deck versions are available in many poles with a variety of stop positions.

Keylock switches, a member of the rotary family, are a popular solution in many applications. Keylocks can be high, medium or low security and come in a wide variety of sizes, circuits and key options.

Another option is slide actuated switches, which are offered in a number of sizes, circuit functions and actuator style options. Many handheld devices often use slide switches to turn on a device.

Engineering Specifications

Designers need to keep in mind the operating environment of a given application. Will a switch be expected to function in spite of exposure to dust or moisture? Will there be extreme temperatures, humidity or dryness? Many switch applications offer an environment where temperature and humidity are tightly controlled. However, many applications such as medical devices, industrial controls, mining/ construction machinery and marine equipment require protection from dust, mist and often direct sprays of water. Environmentally sealed switches are specifically designed and manufactured to function in adverse environments.

Designers should choose switches with appropriate IP ratings for the level of protection they need. IP ratings are ratings specified by the IEC 60529 standard that classify the degrees of protection offered by switches and similar electronic components against the ingress of foreign objects and liquid. IP65-rated switches protect against dust and direct high-pressure sprays of water, and IP67-rated switches protect against temporary immersion in up to 1m of water. On the other end of the spectrum, IP60-rated switches only protect against the ingress of larger, solid objects such as dust.

Some manufacturers also offer splashproof boots that can be fitted to various switch designs. When installed, these boots provide additional protection from liquids on a front panel.

Conclusion

The switch selection process is especially important for designers to consider when determining which switch would be best suited for a given application. By following this process, they can identify the right switch for the job more quickly and avoid many problems down the line such as unhappy users, frequent failures/replacements, and even fire or safety hazards. Despite the numerous factors involved in selecting a switch, the process is not unmanageable. Most switch manufacturers offer selection literature that outlines their product specifications in an easy-to-read layout and have trained staff who can suggest switches based on specific needs and applications. The most important thing to remember is the goal mentioned by Steve Jobs: Design isn't just what it looks like, but how it works.