Designing Rugged Electromechanical Solutions for Harsh Environment Industrial Applications

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Whether designing electromechanical solutions for industrial instrumentation, automation or high-end testing equipment, OEMs are requesting switch designs that combine increased precision, versatility and functionality with ruggedness and reliability. Tactile feedback, including crisp actuation and audible clicks, as well as advanced materials and component sealing, are integral to effective industrial switch designs.

Operators of industrial machinery need clear cues that equipment is working correctly and that systems are fully functional, making more tactile features necessary. Audible clicks and tactile feedback are frequently achieved through positive snap-point action switch designs, in applications where operators wearing gloves need to interface with front-panel switches. Some solutions combine bi-directional switch models with a single switch function in both directions, or a double function in both directions; while others employ quadrant switch solutions, with either single function (four switches) or double functions (eight switches) in each of four different directions: up, down, left or right. These features ensure ease-of-use for the operator, simplifying operation of complex functions.

Precision

While standard pushbutton switches have long been deployed in these applications, Hall-effect pushbuttons are increasingly being incorporated into switch designs due to their extended life cycles (up to 10 million actuations) and precision capabilities. Hall-effect switches are solid-state electronic devices with no mechanical parts, and therefore are inherently more reliable than a mechanical switch. Hall-effect switches use a magnet and IC to detect motion and/or position by detecting the change in field strength of the magnet, providing a clean, fast, and linear output that is

switched without bounce – often a problem with mechanical contact switches.

Further, the Hall-effect circuit is sensitive and provides reliable, repetitive operation in close tolerance applications. Because the design uses a magnet, the electrical life is virtually limitless and the switch will not experience field failures. While Hall-effect switches are not as popular as traditional pushbutton solutions, they provide a long term, high reliability solution along with a controllable linear motion, which isn't typically available in a regular switch. This linear motion allows for precise output, which can be varied depending upon the exact position or travel of the switch.

Illumination

Industrial equipment features a large number of visual indicators for safety purposes, signifying the current state or function of a machine. To accomplish this, switch manufacturers are incorporating illumination into switch designs. LED indicators are typically mounted independently of the switch and interfaced with an IC that controls it for slow or fast blinking, or to produce various colors that indicate the machine status. By adding LED illumination to switch assemblies themselves, the BOM is simplified, the cost of materials is reduced, and the engineer's flexibility with circuit and panel designs is increased. Illumination of switches is particularly instrumental in applications where light pipe, manual work or assembly time needs to be reduced or eliminated.

Many switches are offered in illuminated and non-illuminated versions to meet these demands. For example, snap-on caps in a variety of colors are available for many switch models, allowing customers to purchase one standard switch (with or without LED illumination) and then incorporate many different colored caps based on their application-specific needs. This solution allows users to have fewer part numbers to inventory, thus simplifying their materials and assembly processes.

Sealing

Sealing is critical in industrial equipment as the harsh environment can cause failure with traditional switches. Shock, vibration, high temperatures and environmental contaminants such as dust and moisture are just a few of the concerns associated with industrial applications. Switch designs have had to evolve to conform to the special requirements of harsh environments. Switches have three-part seals that include an internal seal that protects the switching mechanism; an external panel seal that protects the enclosure; and a silicon rubber cap for additional protection from environmental contaminants. Naturally occurring dust, dirt and other foreign particles can find their way into even the smallest component crevices, producing an adverse effect on performance. While temperature ratings for these products are similar to the industry standard (-40°C to +85°C), sealing to IP67 & IP68 specifications also combat dust, dirt, chemicals, hydraulic fluid and other liquids.

Switches must carry a higher sealing rating to withstand submersion in water and other types of liquid, and many applications require that switches conform to IP67 and IP68 specifications. PC board-mounted switches must also be sealed to withstand several rounds of soldering and cleaning processes. Industrial automation applications are using PC board-mounted switches underneath overlays for

additional sealing and protection.

Materials
There are also increasing demands for materials capable of withstanding higher temperatures, particularly with surface mount processes. For example, some applications for through-hole switches have taken the surface mount solder temperature from 235°C to 260°C. In order to meet these high temperature requirements, process sealing becomes increasingly important. In addition to being able to withstand high temperature solder processes, many designs require that the operating temperature of switches be extended to a range of -40°C to +85°C. Although many switch applications never see this broad temperature range, it is becoming an industry standard to which each switch must conform.

Upgrading the plastic material to withstand high temperature processing not only allows for implementation into harsh environment applications, but the switches can now be put through RoHS compliant and compatible processing. High temperature plastics also provide the capability to develop a more reliable through-hole device for use in mixed-use profiles. Switch greases can also be modified to withstand higher temperatures.

Additionally, the materials used in harsh environment switches must be able to withstand chemicals, hydraulic fluids, hydrocarbons, oils and other potential contaminants.

Materials can vary greatly in cost, so it can be overkill to apply them in applications that don’t require higher-performance materials. Certain materials are able to withstand extreme environments, are durable enough to be almost maintenance-free and provide no interference with the equipment’s signal integrity.

Conclusion
Innovative electromechanical switches that meet industrial application requirements exhibit robust, versatile designs and provide precise outputs, tactile feedback and illumination options. Featuring greater circuit functionality and long life cycles, advanced solid-state switches offer clean, fast, and linear output that is switched without bounce.