A New Angle on Tilt Switches

Switch manufacturers have been at the forefront of innovation for years, due in large part to the constant demand for ever-smaller devices for both consumer and industrial markets. However, changes to environmental manufacturing regulations like the Environmental Protection Agency's (EPA) mercury ban and new global restrictions like those included in the Restriction of Hazardous Substances (RoHS) directive have sparked a flurry of redesigns from component suppliers to OEMs. Component manufacturers now have to be as concerned about these environmental regulations as they are about details such as size, energy consumption or reliability when designing a new switch.

Pushbuttons, rotary switches, tactile devices and other components have completed the redesign process in order to restrict the use of lead, cadmium and other harmful chemicals. These types of switches have required mostly minor changes to meet environmental standards. However, one significant redesign, which has required the use of new technologies to support the environmental changes, has been that of the tilt switch.

Tilt Switch Overview

The tilt switch, which is known for its common use of mercury to measure angle changes, is one switch technology that has required a complete redesign in order to meet these new environmental standards and requirements of applications which require high reliability for a long period of time.

One of the most commonly used switches in a variety of applications, the tilt switch is a device implanted into appliances and equipment in order to measure angle movements above or below a horizontal axis. Until recently, most tilt switches had either been mercury-filled or pendulum based. In fact, tilt devices were the most common switch to implement the use of mercury for the purpose of measuring angle changes. However, mercury and pendulum tilt switches were not conducive to sensitive small angle changes. With environmental regulations that restrict, if not ban, the use of mercury, the utilization of numerous mercury-filled components is now prohibited in most applications.

Environmental Regulations:

For more than nine years now the EPA has conducted research on the environmental and health effects of mercury, which is a key component in tilt switches. As a result of this research, several mercury-limiting regulations have been implemented both in the United States and internationally. Tilt switches are directly affected by these new regulations, including RoHS, and engineers are currently looking for ways to incorporate environmentally compliant components while keeping their products user friendly and functional. With the advent of solid state tilt switches, industry designers have not only found a compliant device but a more sensitive switch that they can rely on.

The New Age of Tilt Switches

Within the past few years, new solid state tilt switch designs have revolutionized the tilt switch industry. These designs offer the smallest packaging for implementation of alternative mercury devices. Solid state switches contain two solid state devices an Infrared Light Emitting Diode (IRLED) and a phototransistor. The IRLED and the phototransistor are angled slightly toward each other, creating a focus point. The switch also contains a bright nickel- or gold-plated steel ball that functions as the mirror and rests at the focus point when the tilt switch is level. In the level condition, the infrared beam is reflected by the mirrored, curved surface of the ball to the phototransistor to conduct.

In the level condition, the mirror ball is held in place by a small hole just above the focus point. Surrounding this hole is a rose pedal shaped set of steps rising from the hole, like three steps arranged on the inside surface of a cone.

As the tilt switch is inclined away from the level condition, gravity causes the mirror ball to fall into the groove provided by the first steps. As the incline increases, the ball will operate when tilted in any direction from the level condition. At an incline between 0 degrees and 30 degrees, the output of the phototransistor is low; as the incline changes between 30 degrees and 60 degrees it will produce a high output until the ball comes back down in range.

Because the mirror ball is moved by gravity, the level condition of the ball is always in the same horizontal axis. As such, there are horizontal and vertical versions of these solid state solutions. The only significant difference between these versions is the through-hole terminal arrangement – the ball always operates against gravity in the horizontal arrangement. The only limit to the longevity of the design is the long life of the infrared beam.

The Future of Tilt Switches:

The solid state tilt switch has transformed a variety of applications such as vending machines, industrial equipment, heating and fan equipment, alarm devices, sporting equipment and medical applications. The introduction of the design has also enabled new application uses in a variety of markets and industries, which are already showing interest in implementing the design in metering, security and anti-tampering applications.

Some of the most identifiable appliances using tilt switches are chest freezers, clothes washers, clothes irons, space heaters and laptop computers. New applications for these improved tilt switches include motion-sensitive video game controllers, CD players, and shipping containers, where the tilt switch indicates whether or not the container has been kept level during transit.

As more regulations change the future of electronics, it will be necessary for design engineers and switch manufacturers to continue to produce and create new and innovative technology. Like the solid state tilt switch has impacted our everyday appliances, new standards will continue to push the evolution of the electronics industry. The results of such standards have already shown to be revolutionary.

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